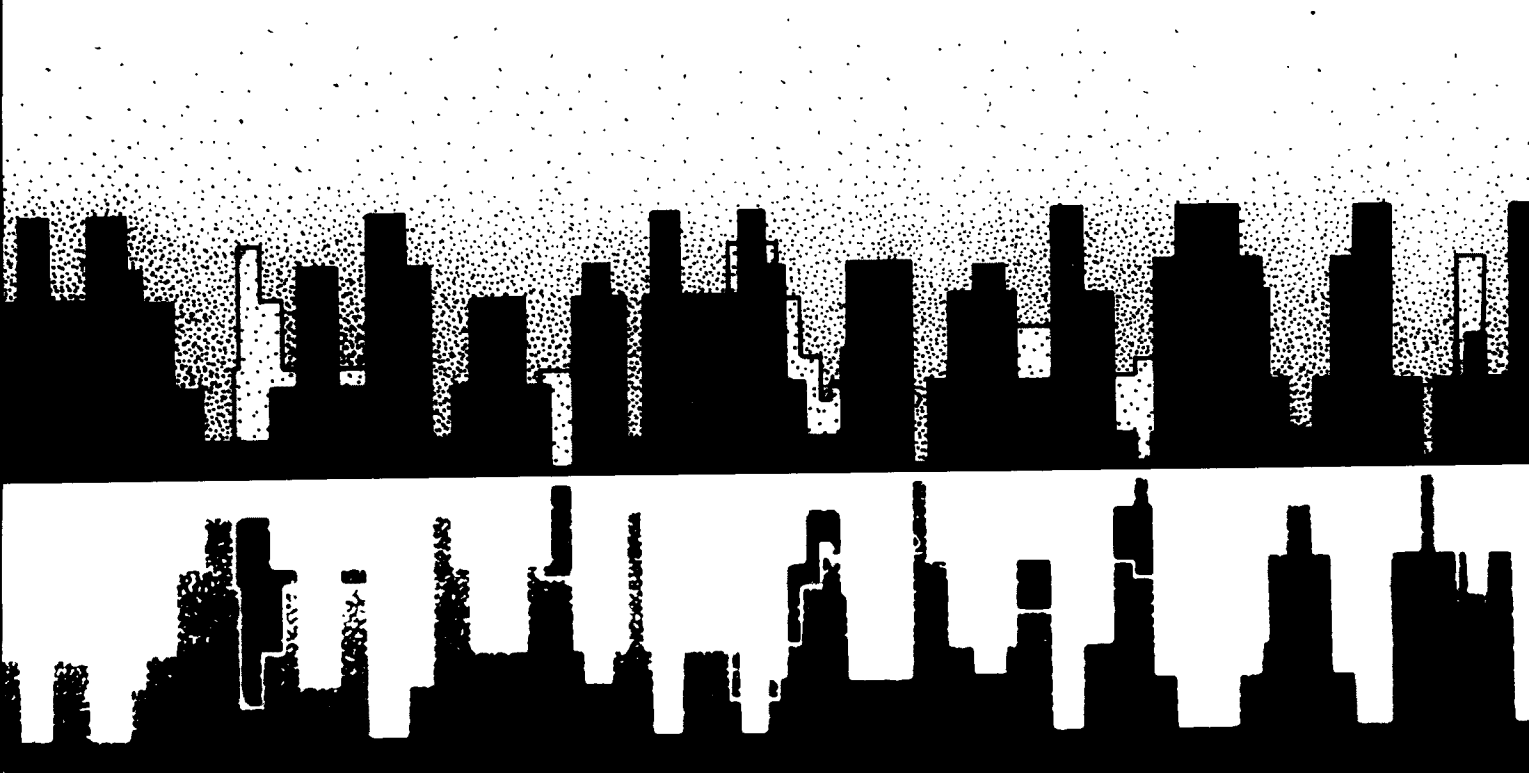
EPA-450/1-74-001
January 1974

# LEAD AND AIR POLLUTION:

## A BIBLIOGRAPHY WITH ABSTRACTS



U.S. ENVIRONMENTAL PROTECTION AGENCY

EPA-450/1-74-001

# LEAD AND AIR POLLUTION: A BIBLIOGRAPHY WITH ABSTRACTS

Air Pollution Technical
Information Center

ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Water Programs
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina

January 1974

This report is published by the Environmental Protection Agency to report information of general interest in the field of air pollution. Copies are available free of charge to Federal employees, current contractors and grantees, and nonprofit organizations - as supplies permit - from the Air Pollution Technical Information Center, Environmental Protection Agency, Research Triangle Park, North Carolina 27711, or from the Superintendent of Documents.

EPA-450/1-74-001

# CONTENTS


INTRODUCTION . . . . . v

ANNOTATED BIBLIOGRAPHY

A. Emission Sources . . . . . 1

B. Control Methods . . . . . 56

C. Measurement Methods . . . . . 105

D. Air Quality Measurements . . . . . 145

E. Atmoshperic Interaction . . . . . 196

F. Basic Science and Technology . . . . . 207

G. Effects - Human Health . . . . . 220

H. Effects - Plants and Livestock . . . . . 308

I. Effects - Materials . . . . . 336

J. Effects - Economic . . . . . 338

K. Standards and Criteria . . . . . 343

L. Legal and Administrative . . . . . 350

M. Social Aspects . . . . . 366

N. General . . . . . 367

AUTHOR INDEX . . . . . 371

SUBJECT INDEX . . . . . 383

# LEAD AND AIR POLLUTION: A BIBLIOGRAPHY WITH ABSTRACTS

## INTRODUCTION

The Air Pollution Technical Information Center (APTIC) of the Office of Air Quality Planning and Standards prepared, selected, and compiled the approximately 1835 abstracts on lead in this bibliography. The abstracts are arranged within the categories listed in the Contents. The abstracted documents are thought to be representative of available literature, and no claim is made to all-inclusiveness.

The subject and author indexes refer to the abstracts by category letter and accession number. The author index lists all authors individually; primary authorship is indicated by an asterisk. Generally, higher accession numbers have been assigned to more recent documents.

A previous publication* covered literature from 1950 through 1964. Duplication or omission in the present bibliography was prevented by checking its abstracts against those in the previous bibliography.

Current information on lead and many other air pollution-related subjects may be found in APTIC's monthly abstract bulletin.+

All of the documents abstracted by APTIC are currently on file at the Air Pollution Technical Information Center, Office of Air Quality Planning and Standards, Environmental Protection Agency, Research Triangle Park, North Carolina 27711. Readers outside the U.S. Environmental Protection Agency may seek the documents directly from publishers, from authors, or from libraries.

---

* Biological Aspects of Lead: An Annotated Bibliography, May 1972. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Order No. EP 4.9:104 @ $6.75 per two-part set.

+ Air Pollution Abstracts, Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Subscription price: $27.00 per year; $6.75 additional for foreign mailing. (more than 6300 abstracts and subject and author indexes in each issue, plus two separate cumulative indexes)

# A. EMISSION SOURCES

00962

R. I. Larsen

**AIR POLLUTION FROM MOTOR VEHICLES.** Ann. N. Y. Acad. Sci., 136(12):275-301, Aug. 26, 1966. (Presented at a meeting of the New York Academy of Sciences, April 6, 1966.)

Motor vehicles are a major source of urban air pollution. They emit carbon monoxide that reduces man's ability to transport oxygen to his tissues; lead that increases man's body burden of this toxic metal; cancerigenic hydrocarbons; and reactive hydrocarbons and nitrogen oxides that combine with sunlight to produce eye-irritating, plant-damaging, visibility-obscuring photochemical smog in New York as well as in California. Present and predicted air pollutant concentrations are compared with pollutant effects and air quality standards. Emission-reduction features presently used in new cars sold in California will improve air quality, but will not completely solve the problem. Indications are that 95 percent reduction in emissions of carbon monoxide, hydrocarbons, and nitrogen oxides from new cars sold in the United States may be needed by 1975. Such a 'clean-air car' by 1975 is suggested as a research goal for automobile manufacturers. At present, improved fuel cells or improved battery power seem to be the most likely means for achieving this goal. (Author abstract)

01565

E. S. Starkman

**ENGINE GENERATED AIR POLLUTION - A STUDY OF SOURCE AND SEVERITY.** Preprint. (Presented at the Federal International Societes Ingeneures Techniques De L'Automobile, Germany, June 15, 1966.)

A brief comprehensive view of the state of knowledge, legislation, research and application of devices to control the influence of reciprocating engine emissions on man and his environment is presented from the viewpoint and experiences of a California observer. The pollutants considered are: unburned hydrocarbons; carbon monoxide; oxides of nitrogen; carcinogens; particulate matter; lead; odor; and oxides of sulfur. Engine operating modes and severity of emissions; engine factors and emissions; and legislative control of emissions are considered.

01624

D.A. Jensen

**SOURCES AND KINDS OF CONTAMINANTS FROM MOTOR VEHICLES (INFORMATIVE REPT. NO. 4).** J. Air Pollution Control Assoc. 14, (8) 327-8, Aug. 1964. (TA-10 Vehicular Exhaust Committee).

The sources of the pollutants, the important compounds, and the magnitude of the several contaminant sources from both gasoline and diesel powered motor vehicles are indicated.

01868

J.W. Gardner

**AUTOMOTIVE AIR POLLUTION. (THIRD REPORT OF THE SECRETARY OF HEALTH, EDUCATION, AND WELFARE TO THE U.S. CONGRESS PURSUANT TO PUBLIC LAW 88-206 - THE CLEAN AIR ACT.) 89th Congress (2nd Session) (Document 83) Mar. 25, 1966. 17 pp.**

Reduced exhaust emissions of hydrocarbons and carbon monoxide have become a reality in California with the introduction of the 1966-model passenger cars and light commercial vehicles. Recognition of the need for still further control measures is evidenced by the adoption of nitrogen oxide standards by the California Board of Health. The Department of Health, Education, and Welfare is implementing the new responsibilities and authories conferred by the Motor Vehicle Air Pollution Control Act. Standards for the control of emissions from gasoline-fueled vehicles are being deveoped accordingly, to become effective with the 1968 models. Some additional technical information has become available. Further studies of the effect of ambient temperature on exhaust emissions indicate that low temperatures tend to increase exhaust hydrocarbons and carbon monoxide, particularly following cold engine starts. Preliminary results obtained from a study of the effect of leaded fuels indicate that combustion chamber deposits may not significantly affect the quantities of hydrocarbons and carbon monoxide emitted in exhaust gases. A survey conducted to measure carbon monoxide levels in urban communities suggests that human exposure to carbon monoxide may be greater than routine atmospheric monitoring data had indicated. A number of new projects are being initiated by the Government to study the performance characteristics of production-type exhaust emission controls in varied environments, to develop more definitive data on exhaust emissions from small cars and diesel-powered vehicles, to learn more about human tolerance of lead and carbon monoxide, and to effect control of oxides of nitrogen. An expansion of industry research in automotive air pollution and its control is indicated by the recent activities of technical associations. (Author summary)

02636

J. A. Walker

**INFLUENCE OF GASOLINE COMPOSITION ON THE CONSTITUTION OF ENGINE EXHAUST (PART II OF ATMOSPHERIC POLLUTION: A SURVEY OF SOME ASPECTS OF THE EMISSIONS FROM PETROL-ENGINED VEHICLES AND THEIR TREATMENT).** British Technical Council of the Motor and Petroleum Industries, England. Sept. 1965. 35-64 pp.

The major component, adverse to health, in gasoline engine exhausts is carbon monoxide. Fuel composition has no influence on the production of this toxic compound and it is recommended therefore that work is carried out to develop other practicable methods of minimixing CO in engines of European design. Traces of unburned hydrocarbons are also present in exhaust gases and in California they contribute to smog formation by participating in photochemical reactions promoted by sunlight. This reaction rarely occurs in Europe, and thus hydrocarbons are of importance only because they may make a small contribution to the presence of carcinogenic compounds in the air. The AMA has stated that in some 1966

model cars, an engine afterburner system will be fitted as original equipment which will convert CO and hydrocarbons to the harmless compounds CO2 and water. Any method adopted in Europe for removing CO from exhaust gases is likely to be of a similar type and inevitably the major part of the hydrocarbons present in the exhaust will also be converted into innocuous materials. It is recommended that work is carried out to assess the importance of the presence of oxides of nitrogen in the air, and if necessary to develop means of preventing their emission from gasoline engine exhausts. Particulate matter is emitted from engine exhausts consisting of sulphur compounds, carbon, compounds of lead and other materials. At the present it is not considered that these represent any appreciable health hazards, but it is recommended that close touch is maintained with workers in the U.S.A. and in the U.K. who are measuring the concentration and nature of particulate matter in the air, particularly under high traffic density conditions. Evaporation of gasoline vapours from the car fuel tanks and carburetors will probably be controlled in the U.S.A. The contribution to atmospheric pollution from these sources must be extremely small, but it is recommended that some work is carried out in European engines to investigate the factors involved. (Author summary)

03278

R. O. McCaldin.

**ESTIMATION OF SOURCES OF ATMOSPHERIC LEAD AND MEASURED ATMOSPHERIC LEAD LEVELS.** Public Health Service, Cincinnati, Ohio, Div of Air Pollution. (Presented at the Symposium on Environmental Lead Contamination, Public Health Service, Washington, D.C., Dec. 13-15, 1965.) Mar. 1966. pp. 7-15. GPO 0-210-345; ¼HEW-1440

Limited data is available regarding emission data from the following sources: industrial activities; burning of waste materials containing lead; re-entrainment into the air of lead- bearing soils. The following figures are stated for lead pollution in the Cincinnati Metropolitan area: 54 to 270 pounds per day for coal, depending on the amount of lead retained in the ash or air cleaning equipment, and 1,700 pounds per day from leaded gasoline. General urban air pollution levels for lead may run from about 1 to 3 microgram per cubic meter, but atmospheric measurements taken near automobile traffic may show about 40 microgram per cubic meter, depending on proximity to traffic density. It appears that the principal source of atmosphric lead in urban areas is that resulting from combustion of leaded gasoline. There are tables showing the lead consumption in the United States during 1963 and concentration of lead in the atmosphere with respect to sampling locations.

03279

K. H. Lewis.

**THE DIET AS A SOURCE OF LEAD POLLUTION.** Public Health Service, Cincinnati, Ohio, Div. of Environmental Engineering and Food Protection. (Presented at the Symposium on Environmental Lead Contamination, Public Health Service, Washington, D.C., Dec. 13-15, 1965.) Mar. 1966. pp. 17-20 GPO 0-210-345; ¼HEW 1440

Exclusive of individuals accidentally poisoned or occupationally exposed, it is generally agreed that the diet is the major source of lead exposure and contributes about 90 percent of the total intake. Techniques used to estimate dietary exposure include the direct determination of lead in whole diets and the calculation of lead intake from either the lead content of individual items that comprise a diet or the amount of lead excreted by the individual. Of particular interest is the amount of lead in milk. Milk is an important source of food, particularly for children, and it and its products are used throughout the country. In view of the importance of the diet as a souce of lead exposure to man and manifold factors which influence its level in food, any activity aimed at controlling the overall level of lead exposure should include continued surveillance of the diet and critical studies on the cause and effect relationships between lead in the environment and in food.

03280

M. B. Ettinger.

**LEAD IN DRINKING WATER.** Federal Water Pollution Control Administration, Cincinnati, Ohio, Basic and Applied Sciences Branch. (Presented at the Symposium on Environmental Lead Contamination, Public Health Service, Washington, D.C., Dec. 13-15, 1965.) Mar. 1966. pp. 21-7. GPO 0-210-345; HEW 1440

Lead or lead compounds come into direct contact with drinking water in a variety of ways. Lead chromate paints are favored by the water works industry for painting the inside of steel water- storage tanks. Copper tubing is one of the more popular means of conveying water in water distribution service systems. This is almost invariably soldered in a multiplicity of places with lead- solders. There is an abundance of evidence that lead derived from sources within the water distribution system has caused both morbidity and mortality. There are no clear and unequivocal rules for delineating the boundaries of conditions under which measurable amounts of lead cannot be picked up from water handling systems.

03982

B. Bryk, R. Malmstrom, E. Nyholm

**FLASH SMELTING OF LEAD CONCENTRATES.** J. Metals (Japan) 18, (12) 1298-9, Dec. 1966.

Encouraged by the good results of flash smelting processes, the Outokumpu Co. has worked on developing a flash smelting process for sulfidic lead concentrates. Beginning with laboratory experiments and followed by testing the different smelter units on a pilot-plant scale, the company was ready by 1964 to build a pilot-plant including all units necesary for the complete process. The process and its reactions are described. The pilot plant equipment for drying of the lead concentrate, its cyclone, and the air preheater are discussed.

04460

J. C. Gagliardi

**THE EFFECT OF FUEL ANTI-KNOCK COMPOUNDS AND DEPOSITS ON EXHAUST EMISSIONS.** 90th Congress ('Air Pollution--1967, Part I (Automotive Air Pollution)' Hearings before the Subcommittee on Air and Water Pollution of the Committee on Public Works, U.S. Senate, Feb. 13-14, 20-21, 1967, pp. 487-554.) (Presented at the Automotive Engineering Congress, Detroit, Mich., Jan. 9-13, 1967, Paper No. 670128.)

The effect of fuel anti-knock compounds and combustion chamber deposits on exhaust hydrocarbon emissions was investigated. Six Ford Galaxies equipped with production non-Thermactor 289-CID, 2V engines were operated on a light-duty driving schedule for periods of 12- 30,000 miles at Ford's Michigan Proving Grounds. Three fuel blends were used in mileage accumulation-Indolence Clear (a full boiling range nonleaded gasoline), Indolence 30 (Indolence Clear plus 3.0 ml/gallon of motor mix blend), and Indolence 30 plus 0.2 theory of an organic phosphorous compound. Two engine lubricants were evaluated for the first 12,000 miles - a petroleum base SAE - POW - 30 used for Ford factory fill and a

synthetic oil, di-2-ethyl hexal sebacate. After 12,000 miles, all test engines were operated on the petroleum based lubricant. Exhaust emissions were monitored at 3,000-mile intervals on the chassis dynamometer using the California Motor Vehicle Pollution Control Board seven-mode procedure. Additional seven-mode cycles were conducted on each engine after combustion chamber deposits were removed at the completion of the mileage accumulation phase. The increase in exhaust hydrocarbon (HC) emissions of the vehicles operating on Indolene 30 and Indolene 30 plus 0.2T phosphorus was substantially higher than the HC increase of vehicles operated on Indolene Clear (an average HC increase of 15 ppm for Indolene Clear versus an average HC increase of 171 ppm for Indolene 30). Operation of nonleaded fuel showed no deleterious effect on intake or exhaust valves or other engine components. (Author abstract)

05067

S. T. Cuffe, R. W. Gerstle, A. A. Orning, and C. H. Schwartz

**AIR POLLUTANT EMISSIONS FROM COAL-FIRED POWER PLANTS; REPORT NO. 1.** J. Air Pollution Control Assoc. 14, (9) 353-62, Sept. 1964 (Presented at the 56th Annual Meeting, Air Pollution Control Association, Detroit, Mich., June 9-13, 1963.)

Air pollutant emissions from two types of coal burning power plant furnaces were studied. Particulates entering the fly-ash collector from the low-intensity-mixing, vertically fired boiler of Unit A accounted for 60% of the ash contained in the coal charge. In the high-intensity-mixing, horizontally fired Unit B, 85% of the total ash entering the boiler in the coal was carried to the fly-ash collector. The fly-ash collectors effectively removed 85 to 95% of the particulate matter and showed essentially the same efficiency in removal of common trace metal compounds. Concentrations of sulfur trioxide ahead of the dust collector varied widely. For Unit A, the vertically fired boiler, they averaged about 4% of the SO2 concentration; for Unit B, the horizontally fired boiler, formation of SO3 was lower, averaging less than one percent of the SO2 concentration. The fly-ash collectors effected an appreciable reduction in sulfur trioxide emissions on Unit A but not on Unit B. For both units SO3 emissions were less than one percent of their SO2 emissions. Nitrogen oxide concentrations during normal full-load operation were increased 30 to 40% by passage through an electrical precipitator. Organic acid concentrations were appreciably higher than those of gaseous hydrocarbons, formaldehyde, and carbon monoxide. The very small concentrations of gaseous hydrocarbons, formaldehyde, and carbon monoxide indicated very complete and efficient combustion during both full-load and partial-load operation. Emissions of polynuclear hydrocarbons from large power plant boilers were found to be very small in comparison with those from smaller coal-fired units having less efficient combustion processes.

05171

f. g. rounds, P. A. Bennett, and G. J. Nebel

**SOME EFFECTS OF ENGINE-FUEL VARIABLES ON EXHAUST GAS HYDROCARBON CONTENT.** J. Air Pollution Control Assoc. 5 (2), 109-19 (Aug. 1955) and Trans. ASME (Am. Soc. Mech. Engrs.) 63, 591-601 (1955). (Presented at the Annaul Meeting, Society of Automotive Engineers, Detroit, Mich., Jan. 10-14, 1954.)

The aim was to obtain a better understanding of the factors influencing the concentration of hydrocarbons in engine exhaust. Initially, tests were made to determine the fraction of the total fuel supplied to the engine which appeared as hydrocarbons in the exhaust at different driving conditions. Later, more exhaustive tests were made to determine the effect of common engine-fuel variables at each driving condition. The data are based on mass spectrometer and/or Orsat analyses of exhaust gas samples obtained from 163 passenger cars and 8 public transit buses. Reductions in exhaust gas hydrocarbon content can be achieved through proper maintenance and design. Mass spectrometer analyses have indicated that the hydrocarbon content of engine exhaust gas varies appreciably with driving condition. The most important engine- fuel variable affecting the hydrocarbon content at idle was mixture ratio with the highest hydrocarbon contents being observed at rich mixtures. A substantial reduction in the average hydrocarbon content could be obtained by adjustment of the idle mixture ratio of all cars to the range resulting in best idle operation. The current trend toward the overhead valve V-8 engine should also help to reduce idle hydrocarbon losses since these engines will idle acceptably with leaner mixtures than either 6 cyclinder or line 8 engines. Fuel type was found to have essentially no effect on the exhaust gas hydrocarbon content. None of the engine-fuel variables investigated at part throttle were observed to affect significantly the hydrocarbon content. These included mixture ratio, compression ratio, fuel type, coolant temperature, engine type, engine speed, and engine load. The most important engine- fuel variable affecting the hydrocarbon content during simulated deceleration was manifold vacuum. The hydrocarbon content was found to increase sharply to high values at manifold vacuums above 21 inches of mercury. Since manifold vacuum during a closed throttle deceleration depends upon engine speed, the trend toward automatic transmissions and lower rear axle ratios made possible by higher output engines tends to reduce hydrocarbon losses by reducing engine speed at a given car speed. Limited studies using gasoline, LPD, and Diesel powered public transit buses have suggested that there is no significant difference in the total amount of hydrocarbon released to the atmosphere by the three different engines provided that the overall fuel consumption is comparable.

06220

K. Homma

**EXPERIMENTAL STUDY FOR PREPARING METAL FUMES.** Ind. Health (Kawasaki, Japan) 4, (3) 129-37, Oct. 1966.

The size and shape of the metal fumes generated in a high-frequency induction furnace were varied with the changing flow rate of the nitrogen carrier gas and the temperature of the furnace. The mechanism of the fume formation of toxic metals has not been explained clearly. Fumes with a narrow size range were produced if the evaporated metal vapor passed through a higher temperature zone than that of the molten metal and then was cooled gently in the carrier gas which was kept at a low velocity. The mean diameter of the fumes depended on the evaporating temperature. The size distribution was a function of the velocity of the carrier gas which agrees with previous studies with salt and metallic oxide. Based on the electron microscope, the lead fumes were spherical if the vapor was condensed with a steady rate of cooling and brought into the atmosphere at temperatures below the softening point. The fumes produced no spherical shapes with quick condensation and an increasing flow of the nitrogen carrier gas, in which case the fumes changed more to the oxide form.

06351

R. F. Abernathy and F. H. Gibson

**RARE ELEMENTS IN COAL.** (Bureau of Mines, Washington, D.C.) (Information Circular 8163). (1963). 73 pp.

Data are presented showing trends in the content of chlorine, phosphorus, titanium, and manganese although these elements are not included in the category of rare and uncommon elements in coal. It is suggested that elements may be called rare when the amount in the earth's crust is not much greater than 0.01 percent. By uncommon is meant unusual concentrations of elements greater than normally occur in the mineral matter of coal. The occurrence of 34 elements in coal is reviewed. These do not include the elements silicon, aluminum, iron, calcium, magnesium, sodium, potassium, and sulfur, which constitute the main part of the mineral matter in most coals. Some of the rare elements found in coal probably were derived from the original coal-forming plant material. Elements occuring in sufficient concentration to be detected as minerals usually are considered as extraneous substances deposited in coal beds from external sources. Three main stages of the enrichment of elements in coal are suggested: (1) Concentration during the life of the plants; (2) concentration during decay of the plants; and (3) concentration during mineralization of the coal. There are three hundred eighty (380) references.

08039

M. Alperstein, R. L. Bradow

**EXHAUST GAS EMISSIONS RELATED TO ENGINE COMBUSTION.** SAE (Soc Automot. Eng.) 4., 85(8):52-53, July 1968.

A study was made of combustion chamber formation inorganic and organic materials found in spark-ignition engine exhausts. The oxides of nitrogen are flame-formed with only a limited amount of NO decomposition occurring in the post flame period. Organic exhaust constituents contributed by slow-combustion reactions include olefins, aldehydes, ketones, and ring ethers when operating with isooctane fuel. The presence of tetraethyl lead inhibits slow-combustion reactivity, thus reducing concentrations of slow- combustion products in the exhaust.

08972

Brunner, M.

**THE INFLUENCE OF THE ENGINE FUEL COMPOSITION.** ((Der Einfluss der Treibstoffzusammensetzung.)) Text in German. Z. Praeventivmed. 11(2):206-219, March-April, 1966.

The relationships between the composition of gasoline for 2 and 4-cycle engines, diesel fuel, and the toxic exhaust gases are discussed. Tabulated data present the composition of regular and super gasolines, their influence on the exhaust gas composition, and the composition of diesel fuel as well as the sulfur content of diesel fuel and diesel exhaust gases. The composition of gasoline in 4-cycle engines has only a slight influence on the exhaust gas composition as far as CO and nitrogen oxides are concerned. The SO2 content in diesel exhausts, the lead content in 2 and 4 cycle engine exhausts and the oil smoke in 2-cycle engine exhausts have a relationship to the composition of the fuel. The air-fuel ratio is of much greater importance. For gasoline vapors which escape through the tank, carburetor and blow-by, the composition of the fuel, particularly its lead and aromatic hydrocarbon content, is important.

09210

Bucher, K.

**AUTOMOBILES AS PRODUCERS OF NOXIOUS SUBSTANCES.** ((Autos als Produzenten stofflicher Noxen.)) Text in German. Praxis (Bern), 55(7):178-181, 1966

Automobile traffic generates air pollutants by exhaust gas emission and also by attrition of tires. Although the deposition of rubber particles in the respiratory system does not cause acute changes it is not known whether the presence of rubber particles in the lymphatic system for long periods can be harmful. The noxious substances in the exhaust are lead, lead compounds, CO, and local irritants such as nitrogen oxides. In addition to these substances, photochemical smog is formed when unburned hydrocarbons react with nitrogen oxides. The time has come for definite measures against air pollution.

09355

Pahnke, Alden J. and Edward C. Squire

**LEAD IN GASOLINE: NO EFFECT ON EXHAUST EMISSIONS FOUND IN 18-MONTH CONSUMER-CAR TEST.** Oil Gas J., 64(50):106-110, Dec. 12, 1966.

Use of tetraethyl lead in gasoline does not significantly affect exhaust emission characteristics of vehicles driven by the motoring public. This is the conclusion reached after a test of leaded and unleaded gasoline in 122 privately owned and operated cars spanning a period of 18 months and covering a total of 2,500,000 miles. Carbon monoxide and hydrocarbon-emission levels of the cars operated on leaded gasoline were essentially equivalent to those of the cars driven on unleaded gasoline. Photochemical reactivity and nitrogen oxide levels for the two car groups were also equivalent, further demonstrating the absence of any effects of tetraethyl lead on vehicle emissions either positive or negative.

09393

Hettche, O.

**AIR POLLUTION IN LOCALITIES WITH HEAVY TRAFFIC IN METROPOLITAN CITIES.** ((Die Verunreinigung der Atmosphare an verkehrsreichen Punkten in Grossstadten.)) Text in German. Z. Praeventivmed. 11(2):122-133, March-April 1966. 27 refs.

Data on the variations in time of CO, SO2, NO, NO2, hydrocarbons, polycyclic hydrocarbons, lead compounds and dust in various European cities such as Stuttgarg, Frankfurt, Hamburg, Essen and London are discussed and compared with data from Los Angeles. In heavy traffic, concentrations of up to 20 mg. CO, 0.2 mg. NO, 0.1 mg. NO2, 0.05-0.4 mg SO2, 2-10 mg. hydrocarbons and 4 microgram of lead per cubic meter were found. Polycyclic hydrocarbons such as benzpyrene and coronene can be determined accurately only in tunnels by analysis of the intake air and the air in the tunnel. In Germany, more diesel engines are in operation than the 0.3 percent in Los Angeles. Diesels generate only about 1 percent CO but maintenance must be frequent and soot emission must be controlled. Two-cycle engines give a very low CO emission. Methods used in Germany for the determination of pollutants are outlined. Standardization of analytical methods is emphasized.

09686

R. L. Duprey

**COMPILATION OF AIR POLLUTANT EMISSION FACTORS.** Public Health Service, Durham, N. C., National Center for Air Pollution Control, Publication No. 999-AP-42, 67p., 1968. 126 refs.

Detailed emission factors are given for the following processes and industries: fuel combustion, refuse incineration, chemicals, food and agriculture, metallurgical refining, minerals, petroleum, pulp and paper solvent evaporation and gasoline marketing, and transportation (vehicle emissions).

10749

Gobson, F. W.

**NEW BUICK LEAD SMELTER INCORPORATES FORTY YEARS OF TECHNICAL ADVANCES.** Eng. and Mining J., 169(7):62-67, July 1968.

Four significant innovations in the design and operation of lead smelters will be combined for the first time when the new Buick complex goes on stream this year near Bixby, Mo. The plant, designed to produce 100,000 tpy of 99.99% lead, will feature: updraft sintering, air pollution control through production of sulfuric acid, continuous tapping of molten lead, and vacuum dezincing. While none of these processes is new, this will be the first plant to utilize all four.

11702

Ter Haar, G. L., R. B. Holtzman, and H. F. Lucas, Jr.

**LEAD AND LEAD-210 IN RAINWATER.** Argonne National Lab, Ill., Radiological Physics Div., Annu. Rept. ANL-7360, p. 144-146, July 1966 through June 1967. 16 refs. CFSTI: TID-4500

Samples of rainwater collected at semirural and rural sites were analyzed for lead and Pb210. The concentrations of the stable lead and Pb210 and the amount and type of rainfall in various samples are tabulated. The arithmetic mean lead concentration of 18.9 micrograms/l at the semirural site was essentially identical to the 17.4 micrograms/l at the rural site. Similarly, the mean concentrations of Pb210 were 1.26 and 1.78 pCi/l at the respective sites. There appeared to be a correlation between the type of rain and the concentrations; a shower had lower concentrations than a slow, even rainfall. Thundershowers ususally had lower concentrations. No correlation was found between lead concentration and length of time between rains. The rates of deposition of lead and Pb210 in the soil were small. The average specific activities of the lead (pCi Pn210/gPb) were 67,000 pCi/g at the semirural site and 104,000 pCi/g at the rural site; the correlation coefficients for concentrations of lead and Pb210 at the two sites were 0.98 (p less than 0.0001) and 0.63 (p less than 0.1), respectively. The data show a good mixing of lead and Pb210 in the atmosphere before they are returned to earth in rainfall. Thus Pb210 is a valid tracer for stable lead in the atmosphere.

12624

J. Cholak, L. J. Schafer, D. Yeager

**THE AIR TRANSPORT OF LEAD COMPOUNDS PRESENT IN AUTOMOBILE EXHAUST GASES.** Am. Ind. Hyg. Assoc. J. 29(6):562-568, Nov.-Dec. 1968. 13 Ref.

The movement of particulate lead compounds from the exhaust of gasoline-driven motor vehicles on a heavily travelled high-speed roadway (120,000 vehicles/24 hr) is under investigation in the Cincinnati area. The findings for the first year of the investigation indicate an average concentration of 7.8 microgm/cu m at the roadway, 1.7 microgm/cu m 1300 ft to the leeward, and 1.1 microgm/cu m at the station, 11000 ft leeward of the source of the Pb. The concentration of Pb in the air at the latter station is approximately the same as that of six years ago, as reported in the Public Health Service Publication No. 999-AP-12. The mass median equivalent diameter of the Pb particles was found to be approximately 0.30 micron, with 70% of the Pb being in the particles below 1 micron in diameter. Diurnal patterns reflected rush hour traffic as well as climatic conditions. Concentrations of Pb in soils and grasses varied according to the distance from the roadway, with most of the contamination occurring within 100 ft of the roadway. *Author's Abstract*

12751

McKee, Arthur G. and Co., San Francisco, Calif., Western Knapp Engineering Div.

**SYSTEMS STUDY FOR CONTROL OF EMISSIONS. PRIMARY NONFERROUS SMELTING INDUSTRY. (FINAL REPORT). VOLUME II: APPENDICES A AND B.** Contract PH 86-65-85, Rept. 993, 88p., June 1969. 72 refs. CFSTI: PB 184 885

A systems study of the primary copper, lead, and zinc smelting industries is presented to make clear the technological and economi factors that bear on the problem of control of sulfur oxide emissions. Sulfur oxide emissions for various types of smelting operations are tabulated, including gas flows and compositions and an analysis of sulfur oxides generation and recovery. Smelter flow diagrams are presented for the control methods of contact sulfuric acid, absorption, reduction to elemental sulfur, lime wet scrubbing, and limestone wet scrubbing. Sulfur oxide recovery processes that were investigated and rejected as not being suitable for economic analysis are listed. Cost estimates for various control processes are given.

12823

McKee, Arthur G. and Co., San Francisco, Calif., Western Knapp Engineering Div.

**SYSTEMS STUDY FOR CONTROL OF EMISSIONS. PRIMARY NONFERROUS SMELTING INDUSTRY. (FINAL REPORT). VOL I.** Contract PH 86-65-85 Rept. 993, 188p., June 1969. CFSTI: PB 184 884

A systems study of the primary copper, zinc, and lead smelting industries is presented to make clear the technological and economic factors that bear on the problem of control of sulfur oxide emissions. The nature of smelting practice is described, and potential air pollution problems in smelter areas are revealed. Five processes for the control of sulfur oxides are presented, including contact sulfuric acid, absorption, reduction to elemental sulfur, lime wet scrubbing, and limestone wet scrubbing. Current sulfur oxide emissions from U. S. smelters are given, and forseeabl emission trends are discussed. Markets for sulfur byproducts are mentioned, the costs of control by available methods are tabulated, and control method evaluation with plant models is considered. A research and development program for control methods and smelting process technology is recommended.

13524

Fuller, F. T.

**PROCESS FOR DIRECT SMELTING OF LEAD CONCENTRATES.** J. Metals, 20(12):26-30, Dec. 1968. 2 refs.

St. Joseph Lead Company has recently been investigating a single- step lead smelting operation involving a new approach and several new ideas. Costly handling of the intermediate product (sinter) would be eliminated, fuel for heating and reduction would be eliminated, as would recirculation of diluent. Off gases would be rich in SO2 making recovery as sulfuric acid economically attractive, and concentrates could be used as received. The process involves direct reaction of oxygen and PbS in a gas bubble in a lead bath. The reaction vessel resembled a slice cut from a Pierce Smith converter. A large square opening served as a gas and fume exit. Gas and fume leaving the converter were drawn into a short section of flue which then joined the plant dust-and gas-handling system. While the blow was in progress in the converter, the gas stream was analyzed for SO2, oxygen, and nitrogen by means of a continuously operating chromatograph on a 2-minute cy-

cle, and a strip chart recorder. Fume samples were collected. This condition was maintained by an automatic controller. The theoretical maximum for SO2 in flue gases is 16.6 percent, and 13 to 14% were obtained.

14033

Pahnke, Alden J. and James F. Conte

**EFFECT OF COMBUSTION CHAMBER DEPOSITS AND DRIVING CONDITIONS ON VEHICLE EXHAUST EMISSIONS.** Preprint, Society of Automotive Engineers, Inc., New York, N. Y., 24p., 1969. 15 refs. (Presented at the International Automotive Engineering Congress, Detroit, Mich., Jan. 13-17, 1969, Paper 690017.)

Hydrocarbon exhaust emission levels of new cars driven under consumer-type conditions increase during the initial 5000 to 10,000 miles of operation; the magnitude of the increase is less with vehicles equipped with exhaust control systems. The role of combustion chamber deposits in increasing hydrocarbon exhaust emission levels during the initial period of vehicle operation was considered. Analyses have shown these deposits to contain high concentrations of lead salts originating from the combustion of lead alkyls present in gasoline. Two consumer-type vehicle tests to determine the effect of leaded and unleaded gasoline on exhaust emissions were completed. One test involved 122 cars without exhaust control systems and the other, 36 cars with exhaust control systems. In both tests, hydrocarbon exhaust emissions of the leaded and unleaded cars increased during the initial period of mileage accumulation and then leveled out as equilibrium was reached. Average hydrocarbon emission levels of the leaded cars were higher than those of the unleaded cars with the difference or net lead effect amounting to 7% in both the 122-car and the 36-car tests. No significant differences in carbon monoxide or nitrogen oxide emission levels were observed. Photochemical reactivity levels were essentially the same for the leaded and unleaded car groups in the two tests. A limited study of the effect of mileage accumulation conditions on exhaust emission levels was carried out. Results obtained under rapid or accelerated mileage accumulation conditions did not correlate with consumer test results. (Author abstract modified)

14135

Warren, Harry V. and Robert E. Delavault

**LEAD IN VEGETABLES.** Lancet, vol. 1:1252, June 8, 1968. 12 refs.

The study points out the variations in the lead contents of oven-dried vegetable samples collected from various sites in England, Scotland, Wales, and British Columbia. The lead content was summarized in a table. Most of the abnormally high values could be correlated with soils containing large amounts of the metal. The lead in some of these soils was caused by intense industrial pollution. In other areas, there is ample evidence that the lead originates from the parent rocks of which those of Devonian, Carboniferous, and Permian ages are probably the most important. Many of the high-lead samples also came from private gardens, the owners of which are probably exposed to a higher lead intake than they would be if they bought their vegetables from the general markets.

14459

Weaver, E. E.

**EFFECTS OF TETRAETHYL LEAD ON CATALYST LIFE AND EFFICIENCY IN CUSTOMER TYPE VEHICLE OPERATION. Preprint, Society of Automotive Engineers, Inc., New York, 8p., 1969. 18 refs. (Presented at the International Automotive Engineering Congress, Detroit, Mich., Jan. 13-17, 1969, Paper 690180.)**

Effects of four levels of tetraethyl lead (TEL) on the efficiency and life of a commercially available hydrocarbon and carbon monoxide catalyst were investigated. The four fuels used in mileage accumulation were the base Indolene with no added lead and blends containing respectively 0.5, 1.5, and 3.0 ml TEL per gallon. The vehicles were eight Fords equipped with 289-CID non-emission controlled 2-V engines, unmodified except for a lean carburetor and the catalytic exhaust system. The eight vehicles were paired off and each pair operated on one of the four fuel blends. In each pair, a radial flow converter, which required no supplemental air, was located under the front seat in one vehicle and near the rear axle in the other vehicle. Exhaust emissions were monitored at approximately 3000-mile intervals during accumulation of 18,000 miles in customer-type service. Tetraethyl lead in the fuel adversely affected the rate of warm up, the ability of the catalyst to remove hydrocarbons from the exhaust, and accentuated the differences in performance between front and rear converters as mileage was accumulated. On non-lead fuel, the catalyst performed well in preferentially removing olefins and aromatic hydrocarbons to yeild an exhaust of very low reactivity, until problems were encountered with losses of catalyst. The catalyst removed CO, aliphatic aldehydes, and acetylenes equally well on leaded or non-leaded fuel. (Author abstract modified)

14461

Hall, C. A., A. E. Felt, and W. J. Brown

**EVALUATING EFFECTS OF FUEL FACTORS ON STABILIZED EXHAUST EMISSION LEVELS. Preprint, Society of Automotive Engineers, Inc., New York, 20p., 1969. 5 refs. (Presented at the International Automotive Engineering Congress, Detroit, Mich., Jan. 13-17, 1969, Paper 690014.)**

Single-cylinder engine studies showed that the severity of the test cycle used for deposit accumulation markedly affects the level of exhaust emissions obtained with stabilized combustion chamber deposits. These studies also show that the relative stabilized emission levels with non-leaded and leaded fuels vary significantly with the aromatic content of the base fuel. An extensive evaluation in three groups of passenger cars operated by their owners in normal service showed no significant difference between the stabilized emission levels obtained with commercial non-leaded and leaded fuels. A dynamometer engine test procedure was developed that simulates short-trip, city- type operation. The accelerated cooldown procedure allows for rapid accumulation of test mileage. Use of this dynamometer procedure showed that a prototype highly aromatic non-leaded fuel produced a higher deposit stabilized emission level than that obtained with an average presently used leaded fuel. (Author abstract modified)

14462

Gagliardi, J. C. and F. E. Ghannam

**EFFECTS OF TETRAETHYL LEAD CONCENTRATION ON EXHAUST EMISSIONS IN CUSTOMER TYPE VEHICLE OPERATION. Preprint, Society of Automotive Engineers, Inc., New York, 19p., 1969. 9 refs. (Presented at the International Automotive Engineering Congress, Detroit, Mich., Jan. 13-17, 1969, Paper 690015.)**

Effects of various concentrations of tetraethyl lead on exhaust emissions were investigated. Eight Ford Galaxies equipped with production non-exhaust emission-equipped 289-CID, 2-V engines were operated in customer service for 18,000 miles in

the Detroit area. Four fuel blends were used in mileage accumulation. All engines were operated on the same petroleum base engine lubricant. Exhaust emissions were monitored at approximately 3000-mile intervals using the California Motor Vehicle Pollution Control Board seven-mode procedure. Additional seven-mode tests were obtained on each engine after combustion chamber deposits were removed at the completion of the mileage accumulation phase. The increase in exhaust hydrocarbon emissions of vehicle operation on the leaded fuels was substantially higher than the hydrocarbon increase of vehicles operated on Indolene Clear (a full boiling range non-lead gasoline). At the 12,000 mile point, for example, the average hydrocarbon increase for the leaded fuels was approximately 100 ppm as hexane, while the hydrocarbon increase on Indolene Clear was negligible. No deleterious effect, due to the fuel used, was observed on any engine component. (Author abstract modified)

14945

Sano, I.

**PARTICULATE LEAD IN AUTOMOBILE EXHAUST GASES.** (Jidosha haikigasu chuno horoidojo namari kahobutsu). Text in Japanese. Kuki Seijo (Clean Air-J. Japan Air Cleaning Assoc., Tokyo), 7(2):6-8, June 1969. 11 refs.

Aerosols of lead-containing particles from automobile exhaust found in urban atmospheres were measured, with particular emphasis on their weight concentration and particle size. Automobiles were mounted on a dynamometer, and particles in the exhaust gas were collected by a Cottrell precipitator. Tests in the U. S. and Japan showed that the weight concentration of lead per cubic meter of air in cities was in the range of a few tenths of a microgram to several milligrams. The concentration was in the range where a deleterious effect upon human health might be found. An aerosol spectrometer and millipore filter were jointly used to analyze the urban air, where the particle size was found to be much smaller than 1 micron in diameter and the aerosols were considerably stable. For the purpose of establishing an ambient air quality criterion with respect to lead, Kehoe's study on humans and Huester's experiment on animals were considered. It is concluded that a method for detecting a lead-containing particle in an atmosphereic aerosol and measuring its size is technically difficult, but that the development of such a method is imperative.

15205

Murozumi, M., Tsaiwha J. Chow, and C. Patterson

**CHEMICAL CONCENTRATIONS OF POLLUTANT LEAD AEROSOLS, TERRESTRIAL DUSTS AND SEA SALTS IN GREENLAND AND ANTARCTIC SNOW STRATA.** Geochim. Cosmochim. Acta, 33(10):1247-1294, 1969. 71 refs.

Lead analyses in annual ice layers from the interior of northern Greenland and in annual layers of ice from the interior of the Antarctic continent are reported. It was shown that lead concentrations increased from less than 0.001 micrograms/kg ice in 800 BC to greater than 0.2 micrograms/kg ice today in north pole ice sheets. The sharpest rise occurred after 1940. The levels of lead in south polar ice sheets were generally below detection limits before 1940 and rose to about 0.020 micrograms/kg ice after 1940. The increase of lead with time in north polar snows was ascribed mainly to lead smelteries before 1940 and to burned lead alkyls after 1940. The difference between the concentrations of lead in northern and southern polar snows was ascribed to barriers to north-south tropospheric mixing which originate from meridional circulating cells and which hinder the migration of aerosol pollutants from the northern hemisphere to the Antarctic. Observations of the chemical concentrations of the common elements in ice from the interior of Greenland and Antarctica were explained in terms of simple relations among sea salts and terrestrial dusts. Ten times more dust and one-half as much sea salt were found in Greenland interior ice than in antarctic interior ice. The proportions of Na, Cl2, Mg, Ca, and K adhered closely to sea salt ratios in ices that were relatively free of silicate dusts. The amounts and chemical composition of silicate dusts in Greenland were no different in coastal and interior ices. There are seasonal variations in the amounts of pollutant lead, sea salts, and silicate dusts in the snows. Pollutant lead and sea salts were 2-3 times more concentrated in winter than in summer snows, while silicate dusts were three times more concentrated in spring than in winter snows. The interpretation of the data was consistent with most related chemical and meteorological observations at temperature latitudes. (Author abstract modified)

15295

Lee, Robert, E., Jr., Ronald K. Patterson, Walter L. Crider, and Jack Wagman

**CONCENTRATION AND PARTICLE SIZE DISTRIBUTION OF PARTICULATE EMISSIONS IN AUTOMOBILE EXHAUSTS.** Preprint, Public Health Service, Cincinnati, Ohio, National Air Pollution Control Administration, 25p., 1969(?). 24 refs.

Particulate samples of hot, concentrated automobile exhaust were fractionated and collected with cascade impactors in a specially designed sampling chamber. Samples of cool, diluted auto exhaust were also taken, and some were exposed to photoirradiation. Lead, nitrate, sulfate, and chloride components in exhaust emissions were predominantly of submicron size, a finding that is consistent with atmospheric measurements. In hot, concentrated automobile exhausts, more water soluble than water insoluble lead was found. The particle size distributions of sulfate and nitrate showed a monotonic temperature dependence, the average sizes decreasing with increasing exhaust temperature. With irradiation, the concentration of water soluble lead increased, and the concentration of water insoluble lead decreased. Two possible mechanisms, both based on photochemical transformation of lead compounds, are proposed as explanations for the relatively lower amount of lead that accumulates in the bones of mice exposed to irradiated exhaust. Irradiation produced an increase in the concentrations of particulate chloride, sulfate, and nitrate but a decrease in the average particle sizes. The particle size distribution of chloride in diluted exhaust was influenced by added SO2, while irradiation produced a narrow distribution of chloride in particles below 1 micron diameter with and without added SO2. (Author summary modified)

15599

Vendramini, R., G. G. Calapaj, and G. Rausa.

**A CHEMICAL AND STATISTICAL STUDY ON THE POLLUTION OF THE INTERNAL ATMOSPHERE OF THE AUTOVEHICLES FROM EXHAUSTED GASES.** (L'inquinamento da gas di searico nell'atmosfera interna degli autoveicoli.). Text in Italian. L'Igiene Moderna, 62(1-2):3-26, Sept. 1969. 31 refs.

In the metropolitan area of Padua, Italy, and on national and local high-ways branching out from this city, data was collected for two seasonal periods: Autumn-Winter (October 1967 to February 1968) and Spring-Summer (March to July, 1968). Urban traffic conditions were classified in three categories: free- flowing (on wider streets outside rush hours), medium

(same streets during rush hours), and sluggish (during rush hours on streets less than six meters in width and with a large number of traffic signals). Test automobiles were equipped with two pumps, one at a low level and one at a high level, which gave readings of atmospheric content between the two front seats. A N/10 solution of sodium hydroxide was used to trap formaldehyde and nitrogen oxide, while 1/1000 palladium chloride was used to detect carbon monoxide. The upper pump drew about 20 liters per minute of air through a SS 602/h paper filter, which captured lead from the air, this could then be extracted from the filter with nitric acid. Each sampling period lasted 10-15 minutes, during which time the vehicle was operated with closed windows, open vents, and no operating fans. All samples were collected on windless days. Results were expressed in ppm (carbon monoxide, nitrogen oxides, formaldehyde) and micrograms/mc (lead). Statistical analysis showed a relationship in the increase of other pollutants with respect to increased CO. Two indexes were calculated: the 'eta' of Cucconi and the 'rho' of Spearman. The other pollutants were found highly correlated with CO concentrations, regardless of seasonal variations. Presence of pollutants in the interior of motor vehicles was sufficiently high to cause hypoxia affecting vision and the higher centers of intellect.

15769

Pursall, B. R.

**POLLUTION IN ROAD TUNNELS.** Consulting Eng., 33(8):57-58, Aug. 1969. 9 refs

The sources and causes of the build-up of pollutants in road tunnels are discussed. The two main sources of poisonous exhaust gases are gasoline and diesel engines. Diesel exhaust emits a smaller percentage of carbon monoxide than the gasoline engine, but because the diesel engine is larger, it emits a larger volume. The diesel engine also produces more nitric oxide and nitrogen peroxide. Vehicles emit up to 50% more carbon monoxide on the up-gradient than on the level; on the down gradient, they emit 40% less. In calculations for two-way tunnels, an average figure for carbon monoxide emission can safely be taken. Tests showed that the amounts of carbon monoxide and other combustion products vary directly with speed. Differences in tunnel concentrations for the Sumner Tunnel in Boston and the Central Tunnel in London were attributed to different vehicle speeds and variations between British and American vehicles and fuels. The variations resulted in higher concentrations of lead and hydrocarbons in the Sumner Tunnel; carbon monoxide concentrations were similar for average daytime periods in both tunnels. The effects of carbon monoxide, nitrogen oxides, and lead compounds are briefly discussed. It was concluded that if the concentration of CO can be diluted to below 100 ppm, the concentration of nitrogen oxides and other gases should be relatively harmless. Visibility should also be satisfactory under these conditions. In a 2 way tunnel, the maximum ventilation rate was calculated to be 200 cu ft/min/ft. With one way traffic, ventilation is induced from the portals by the moving vehicles, but additional artificial ventilation would be necessary when the traffic is stopped or moving slowly. In most large tunnels, alarms operate if the CO concentration exceeds 250 ppm.

16156

Bernhart, Alfred

**AIR POLLUTION CONTROL EQUIPMENT FOR CARS.** Eng. J. (Toronto), 52(12):12-16, Dec. 1969. 15 refs.

In North American cities, cars, trucks, and aircraft contribute 57% of the air pollutants; in Los Angeles, the percentage is 68%. At 50 mph, the average car emits 80 cu m/hr of exhaust gases which contain 17 lbs/hr carbon dioxide, 3.5 lbs/hr carbon monoxide, 0.5 lbs/hr hydrocarbons, 0.5 lbs/hr nitrogen oxides, 4 gram/hr of lead particles, and 0.4 to 0.7 micrograms of benzo(a)pyrene. Engine exhausts contribute 97% of the total carbon monoxide emission, plus 65% of the total hydrocarbons, plus 100% of the nitrogen oxides; crankcase ventilation, 3% of the total carbon monoxide, plus 25% of hydrocarbons; carburetor, 5 to 10% of hydrocarbons; and the gasoline tank, 10 to 15% of the hydrocarbons. Combinations of crankcase emission return systems, evaporation proof carburetors and gasoline tanks, crankcase control devices, engine modification systems, or air injection systems should reduce daily emissions to 2.4 lbs of carbon monoxide, 0.05 lbs of hydrocarbons, and 0.08 lbs of nitrogen oxides. The devices will not reduce carbon dioxide emissions, which are expected to increase from 40 to 52 lbs per day. The cost of these devices will account for only 1.5% of the purchase price of a car.

16766

Charlson, R. J. and J. M. Pierrard

**VISIBILITY AND LEAD.** Atmos. Environ., 3(4):479-480, July 1969. 8 refs.

Evidence presented in the literature supports the belief that particulate matter emitted in the exhaust of automobiles causes visibility degradation. Since it has been shown that lead is a major component of this particulate matter (30-50 percent by weight as the metal), it appears that control of lead emissions could result in a significant improvement in visibility. Based on the literature, two approaches to the estimation of the percentage of extinction coefficient attributable to lead compounds are discussed. The magnitude of the estimated contribution makes it clear that this is an area of investigation which should be pursued.

17304

Focke, Rolf J.

**TOXICITY OF AUTOMOTIVE EXHAUST GASES.** (La toxicidad de gases de escape en automotores). Text in Spanish. Ingenieria (Mexico City), no. 1004:17-27, 1969 (?). 6 refs.

A total survey of the auto exhaust problem is made for a non-technical readership. Gasoline additives used to dissolve lead deposits in motors cause the formation of lead bromide and lead chloride, which evaporate at 800 C and could therefore cause air pollution. About 15% of all hydrocarbon vapors can be traced to the evaporation of fuel from tanks and carburetors. Crankcase ventilation is the source of about one third of all hydrocarbon pollutants. To prevent the formation of carbon monoxide, a stoichiometric mixture of air and fuel would have to be used: about 14.5 kg of air for each one kg of fuel; however, best effects are obtained with a rich mixture (lambda value equals 0.8-0.9), while the best fuel economy is obtained with a lean mixture (minus lambda equals about 1.1, with an allowance of 10-12% for power leakage). A further difficulty is the presence of unevaporated droplets of fuel, whose distribution is irregular from cylinder to cylinder. An investigation of the automotive pollution problem in the USA in 1962 cost 14 million dollars, of which the Federal and state governments contributed 9.8 million and the universities, 0.5 million, the rest coming from industry. By 1963, the cost of the investigations had reached 22 million. During 1962, the damage in the USA caused by this pollution amounted to 11 billion dollars.

17325

Odaira, Toshio

**AUTOMOTIVE EXHAUST EMISSIONS IN THE METROPOLITAN TRAFFIC IN VIEW OF AMBIENT AIR POLLUTION a-- IN TOKYO.** (Kankyo osen kara mita daitoshi ni okeru jidosha haiki gasu ni tuite). Text in Japanese. Kogai to Taisaku (J. Pollution Control), 2(2):109-117, Feb. 15, 1966.

An analytical investigation was undertaken of the effect of each component of auto exhaust gas on air pollution. Components of auto exhaust gas can be divided into those related to imperfect combustion and those indifferent to imperfect combustion. Gasoline oil is perfectly reduced in water, carbon monoxide gas, and a small amount of ashes with the proper supply of oxygen, relevant temperature, and time; but in actuality, it produces carbon monoxides and hydrocarbons by imperfect combustion. Compounds indifferently generated by imperfect combustion are nitrogen oxides, sulfur gases, and lead. One of the effects of nitrogen oxides on air pollution is currently recognized as an important constituent of photochemical smog which is caused by the existence of ultraviolet light, which nitrogen oxides can remain as nitrogen dioxide in a stable atmosphere. Crude oil, natural gas, and coal are the major hydrocarbon containing mmaterials whose sources are petrochemical plants and motor vehicles. Carbon monoxide emissions, which are largely responsible for air pollution in cities such as Tokyo, need to be controlled by technical devices or improved engine systems. Lead compounds have a relatively long lifetime, accumulating in the bodies of individuals constitutionally predisposed to chronic lead poisoning. The major source of lead had been lead plants and steel plants, but the recent increase of lead compounds in polluted atmospheres has been caused by the increasing number of motor vehicles using gasoline with lead additives.

17339

Dimitriades, Basil, B. H. Eccleston, and R. W. Hurn

**AN EVALUATION OF THE FUEL FACTOR THROUGH DIRECT MEASUREMENT OF PHOTOCHEMICAL REACTIVITY OF EMISSIONS.** J. Air Pollution Control Assoc., 20(3):150-160, March 1970. 11 refs.

Photochemical reactivities of vehicular emissions are reliably measured in laboratory experiments in which smog manifestations are observed directly. Results of the direct smog-chamber measurements revealed that the photochemical behavior of emissions may differ significantly from the behavior that is predicated from the exhaust composition using reactivity scales. The concept of direct measurement of reactivity was applied to determine differences in characteristics of emissions from 20 passenger vehicles, each tested using 10 different fuels. The primary objective of the fuel study was to assess the over-all effect on vehicle emissions of fuel modifications designed to reduce the photochemical pollution associated with automotive evaporative losses. A similar, brief, comparative study of leaded and nonleaded fuels was also made. Reducing volatility was found to reduce the over-all smog potential of vehicle emissions but involved some penalty by way of increased exhaust emissions. Replacing light olefin with the corresponding paraffin also reduced over-all smog potential and in this case exhaust reactivity was not affected. In general greater smog potential was found to be associated with prototype nonleaded fuels than with leaded fuels typical of products currently marketed. (Author abstract modified)

17365

Ellen, Richard P.

**OUR AUTOMOBILE: A CONTRIBUTION TO AIR POLLUTION.** Air Pollution Control Assoc, Pittsburgh, Proc. Air Pollution Control Assoc. Mid- Atlantic States Sect., Semi-Annu. Tech. Conf., Philadelphia, Pa., 1969, p. 44-54. 24 refs. (March 21.)

The harmful effects of pollutants on human health and current concepts of automotive emission control are considered. Systems to reduce engine exhausts, carburetor, and fuel tank emissions are reviewed. Attention is also called to the ability of fuel injection engines to cut hydrocarbon and carbon monoxide emissions in half and to the use of alternate fuels as a possible remedy for the exhaust emission problem. Federal and California emission standards for automobiles are compared. Human health responses are considered with respect to the following pollutants: carbon monoxide, nitrogen oxides, oxidants, and lead compounds.

17778

Stresemann, Ernst

**THE MEDICAL AND BIOLOGICAL IMPORTANCE OF EXHAUST GASES FROM MOTOR VEHICLES.** Staub (English translation from German of: Staub, Reinhaltung Luft), 29(6):11-16, June 1969. 58 refs.

Automobile exhaust gases affect more and more the hygienic conditions in Europe. The acute and chronic biological effects of these emissions are discussed on the basis of investigations carried out in laboratory or by medical and epidemiological methods. The effects of the individual components of automobile exhaust gases are presented (carbon monoxide, carcinogens, aldehydes, lead, nitrogen oxides, and oxygenated compounds), and the basically different nature of acute and chronic effects is discussed in detail. Conclusions with respect to preventive hygiene follow from the final consideration. (Author summary modified)

18211

Salooja, Kailash C.

**PEROXIDE REMOVAL USING LEAD DIOXIDE OR MANGANESE DIOXIDE.** (Shell Oil Co., New York) U. S. Pat. 3,306,846. 2p., Feb. 28, 1967. 6 refs. (Appl. Dec. 29, 1964, 4 claims.)

A treatment for gasoline-range hydrocarbons to increase their storage stability and resistance to deterioration caused by peroxide formation is proposed. It has been discovered that peroxides can be removed from peroxide-containing hydrocarbons by contacting them at ambient conditions with lead dioxide, manganese dioxide, or a mixture of both. The treatment may be effected by any means, but examples of a coated rod or plate method and a fixed bed method are given. The process is also not limited to bulk quantities, and can be applied to garage gasoline storage tanks, automobile tanks, or refineries. The treatment is generally carried out at ambient conditions with hydrocarbon in the liquid phase. Amounts of dioxides, temperature, and time are not critical, but approximate values are given. Tests and table illustrating the effectiveness of the process are reviewed.

18297

Tyler, C.

**HEAVY METALS WITHIN THE REGION OF NORRKOPING.** (Tungmetall- fororeningar inom Norrkopingsomradet.) Text in Swedish. Lund Univ. (Sweden), Institution for Ecological Botany, 12p., 1969.

Measurements have been made in the town of Norrkoping, Sweden with about 90,000 inhabitants of heavy metals such as lead, cadmium, cobalt, copper, chromium, nickel and zinc. In 59 sites, at least 50 meters from any road, three samples were taken at each site. The metals were analyzed in common mosses, Hypnum cupressiforme. The maximum values were lead: 286 ppm, cadmium: 4.9 ppm, cobalt: 41 ppm, copper: 265 ppm, chromium: 36 ppm, nickel: 38 ppm and zinc: 530 ppm. The high precipitation of cobalt, copper, cadmium, and zinc can probably be explained by emissions from an industry just outside the town.

18510

Hamilton, E. I.

**SOME PROBLEMS CONCERNING LEAD IN THE NATURAL ENVIRONMENT.** Proc. Intern. Symp. Radioecological Concentration Processes, Stockholm, Sweden, 1966, p. 355-358. 15 refs. (April 25-29.)

The significance of the distribution and concentration of lead in man can be approached by a consideration of its toxicity or by studies concerning damage to body tissue as a result of ionizing radiation emitted from the naturally occurring radioisotope of lead at mass-210. The concentration of lead and uranium in rocks is dependent upon their total chemical compositions. In general, the concentration of both these elements increases with the concentration of silica and potassium. The distribution and chemical form of lead and uranium in a soil depends on many factors including climate, organic content, and pH. Soils contain many organic species such as the amino acids that are capable of acting as modes of transport for various elements. The concentration and distribution of Pb(210) in rocks, soil, and vegetation is partially controlled by the distribution of radon. The concentration of lead in plants and foods is very variable and is simply an expression of the heterogenous distribution of lead in soils. Articles such as lead piping, paint, and solder are obvious sources of lead. Exhaust fumes of automobiles also contain lead. High concentrations of lead in the blood may result in permanent brain damage.

19598

Tada, Osamu

**AUTOMOTIVE EMISSIONS AND AIR POLLUTION.** (Jidosha haiki to taiki osen). Text in Japanese. Rodo Kagaku. J. Sci. Labour, Tokyo), 41(10):481-492, 1965.

An extensive review of the literature on chemical composition, photochemical production, environmental level, and biological effects of automobile exhaust gas is presented. Chemical composition of the automobile exhaust gas differs according to the action of the engine (idling, acceleration, cruise, and deceleration) and the air to fuel ratio. Exhaust gas of a diesel engine characteristically has low concentrations of carbon monoxide, hydrocarbons (olefins, paraffins, and aldehydes), nitric oxide, nitrogen dioxide, sulfur dioxide, and 3,4- benzpyrene. In a gasoline or propane gas engine, CO and aldehyde are increased during idling and deceleration of the engine, respectively. The 3,4-benzpyrene which is potentially carcinogenic is included more in the exhaust gas of a gasoline engine than that of a diesel engine. Lead is included in the anti-knock agent, and is changed to haloid lead or its ammoniac salt causing small particles of less than 5 microns in diameter (4 to 12% of the particles have diameters of 1 to 0.1 micron). The main components of the Los Angeles type smog are the secondary products (nitro-olefin, aldehyde, ozone, or other oxidants) of automobile exhaust gas emitted into the ambient air which have harmful effects on plants and human bodies. A systematic study of the automobile exhaust gas harmful to human bodies showed that the main pollutants from the ambient air are CO and Pb compounds, and neither benzpyrene nor anthracene is greatly related to air pollution. In Tokyo in 1962, CO, NO2, SO2, and HCHO showed high concentration in the center of Tokyo, while O3 had higher concentration in the suburban area. Principles of air pollution due to automobile exhaust gas should be established more precisely in Japan.

19684

Chow, Tsaihwa J. and John L. Earl

**LEAD AEROSOLS IN THE ATMOSPHERE: INCREASING CONCENTRATIONS.** Science, 169(3945):577-580, Aug. 7, 1970. 19 refs. (Presented at the American Chemical Society National Meeting Symposium on Geochemical Atmospheric Constituents, Houston, Texas, Feb. 25, 1970.)

In 1968 and 1969, concentrations of lead aerosols were determined for downtown San Diego and three other sites in the San Diego area: a mountaintop observatory 47 miles west of the city, an observation pier extending 1000 ft into the Pacific and located in a residential district, and a valley station located 10 miles inland in an area of heavy traffic flow. When considered together with previously reported concentrations for the mid-Pacific, the results show that the frequency of atmospheric lead distribution increases logarithmically from the mid-ocean to remote high mountains, to seashore, suburban, and urban environments. The annual lead concentration in San Diego, where the level set by the World Health Organization has already been exceeded, is increasing by 5% per year, that in the inland valley by 15%. In contrast, concentrations at the observation pier and mountain top are relatively low. The seasonal variations at the sampling sites are noted and explained by meteorological conditions. The isotopic composition of the lead aerosol in the San Diego area is similar to that of lead aerosol in the San Diego area is similar to that lead additives isolated from gasoline. This indicates that the excess lead in the aerosols can only be attributed to automobile exhausts.

19955

Murozumi, M., T. J. Chow, and C. Patterson

**LEAD, DUST, AND SALT IN FIRN AND ICE FROM CAMP CENTURY AND BYRD STATION.** Antarctic J. U. S., 4(5):218, Sept.-Oct. 1969.

As determined by analyses of salts, dusts, and lead in firn and ice at Camp Century, Greenland, and at Byrd Station, Antarctica, lead concentrations in north polar ice sheets have increased from less than 0.001 gamma Pb/kg ice in 800 B. C. to more than 0.200 gamma Pb/kg ice, the sharpest rise occurring after 1940. Lead levels in south polar ice sheets are generally below detection limits before 1940 and rise only to about 0.020 gamma Pb/kg ice after 1940. The increase of lead with time in north polar snow is ascribed mainly to contamination from lead smelters before 1940 and to burned lead alkys after 1940. Differences between the concentrations in north and south polar snow are ascribed to barriers to north-south tropospheric mixing. Seasonal variations exist in the amounts of pollutant lead, sea salts, and silicate dust in polar snows; concentrations of lead and sea salts are two to three times higher in winter than in summer snow, while silicate dust concentrations are three times higher in spring than in winter snow. Special care was taken to avoid the contamination of ice samples, which were found to have a purity nearly equal to that of the purest laboratory water.

20545

Megonnell, William H.

**THE AUTOMOBILE AND THE ATMOSPHERE.** Preprint, Missouri Univ., Columbia and Missouri Air Conservation Commission, Jefferson City, 11p., 1969. (Presented at the Conference on Air Pollution, Columbia, Mo., Nov. 18, 1969.)

The automobile has become one of the major sources of air pollution in the U. S. Today, approximately 90 million automobiles are producing smog in every major urban area in the country, and this is only of the automobile products that threaten the environment. The automobile is responsible for 75% of the carbon monoxide discharged to the air each year. It is responsible for more than 50% of the hydrocarbon emissions, 50% of the nitrogen oxides, and it is the chief source of lead. The Federal emission standards, which apply nationwide will significantly reduce the amount of pollutants discharged from the automobile. It is believed, however, that even with the more stringent standards contemplated for 1973, CO levels are not going to be reduced sufficiently in the cities to protect human health. These standards will prolong the downward curve in vehicle emissions until the early 1980's, when the level will again rise. It is recommended that the amount of tetraethyl lead in gasoline be reduced to the absolute minimum necessary to accomplish its function. There is also the problem of the basic components of the fuel itself, which affect such things as fuel volatility, reactivity, and other characteristics which have a bearing on pollution emission. Modifying the internal combustion engine may solve these problems. The final solution, the development of a relatively pollution-free vehicle, is left up to the automobile manufacturers and the petroleum industry.

20652

Hishida, K.

**CONTROL OF LEAD CUPOLA FURNACES FROM VIEWPOINT OF SMOKE PROPERTIES.** (Namari saiseiren sagyo ni tomonau haien no seijo to taisaku). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 4(1):81, 1969. (Proceedings of the 10th Annual Meeting of the Japan Society of Air Pollution, 1969.)

Smoke that accompanies lead refining contains complex dust particles. Lead scraps from dry-cell manufacturing are fused in the cupolas and the resulting crude ingots are refined into 97 - 98% purity by means of a kiln. Most of the dust particles originate from the bakelite (phenol formaldehyde) and glass fibers in the cupola fusion. An investigation was conducted on the characteristics of the dust particles, the elimination of which was attempted in a plant with two cupolas, one kiln, a cyclone scrubber, and a 23 meter high chimney. The quantity of dust particles was measured and their compositions were analyzed to obtain 85% lead and 15% sulfur trioxide; the chemical reation in the refining process was also examined. A filter, capable of collecting dusts up to the average size of 0.5 micron was installed. Problems such as cooling, plugging of pores, and noise were solved by cooling the exhaust to below the melting point of glass fibers; by adding no fresh air; and with exhaustive water treatment beforehand. The efficiency of the operation increased to 98%.

20927

Northern Research and Engineering Corp., Cambridge, Mass.

**NATURE AND CONTROL OF AIRCRAFT ENGINE EXHAUST EMISSIONS.** NAPCA Contract PH22-68-27, Rept. 1134-1, 388p., Nov. 1968. 136 refs. CFSTI: PB 187771

Aircraft are small contributors of pollutants in metropolitan areas; but in the vicinity of air terminals, the density of pollutant emissions and the resulting concentrations are comparable to emission densities and concentrations in adjacent communities of the same pollutants from other sources. Exhaust emissions of primary concern are carbon monoxide, organics and nitrogen oxides, emitted as gases or vapors, and particulate matter consisting mainly of lead compounds or carbon. Turbine emgine emissions are most serious during idle and taxi conditions, whereas piston engine emissions of CO and organics are high during all operating modes except cruise, perhaps due to afterburning. Nitrogen oxide emissions by turbine engines are greater than those from piston engines, which is less than from automobile engines of comparable size or fuel consumption. Emissions of all aircraft pollutants are expected to increase with more activity and changes in equipment; but reduction of emissions could be accomplished by combustion chamber modification, exhaust treatment systems, and curtailing ground operations of transport aircraft, although no practical methods have been developed for reducing nitrogen oxide emissions. (Author conclusions modified)

21069

Patterson, Clair C. and Joseph D. Salvia

**LEAD IN THE MODERN ENVIRONMENT. HOW MUCH IS NATURAL? Sci. Citizen, 10(3):66-79, April 1968. 38 refs.**

From isotope dilution studies of changing lead concentrations in polar snows of recent centuries and in seawater, lead concentrations apparently have increased about four hundred per cent between 1750 and 1950, and by about another three hundred per cent since 1940 near the North Pole. Samples of snow were collected in Thule, Greenland, from the vertical faces of ancient glaciers at the edges of the ice caps (800 B. C.), from deep tunnels at the polar research station Camp Century (200 years ago), and from surface snow layers in undisturbed virgin regions of the arctic. Data gathered in Antarctica were in sharp contrast with the Greenland results and suggest that the increase in lead content of Northern snows is due to atmospheric contamination; most industrial contamination of the air occurs in the northern hemisphere, and the prevailing air currents set up an effective barrier against the transmission of airborne contaminants to the southern hemisphere. Measurements taken in the Atlantic, Pacific, and the Mediterranean show that the recent distribution of lead in sea waters follows a pattern of relatively high surface concentrations which decrease sharply with depth. Much of the lead entering the stomach passes through the gastrointestinal tract unabsorbed; for a unit of lead entering the lungs and a unit of lead entering the stomach, nearly an order of magnitude greater fraction is absorbed into he body by the lungs. In the U. S., the significant range of blood lead is from about 0.05 parts per million to 0.4 parts per million, with a mean level of about 0.25 parts per million, while the mean body burden is about 200 milligrams of lead; a conservative estimate of average lead concentrations in existing urban atmospheres is about 1.3 micrograms of lead per cubic meter.

21109

Schroeder, Henry A.

**AIRBORNE METALS.** Sci. Citizen, 10(3):83-88, April 1968. 14 refs.

The frequency of cadmium, lead, and tin in the lungs of people from every country but Africa suggests industrial contamination as the source; lead and cadmium are among the elements known to shorten the life-span of mice and rats. Lead poisoning in human beings is a long-recognized problem, and

cadmium has been linked to at least one chronic disease of human beings, high blood pressure. It is likely that cadmium enters the air as a by-product of industrial processing of zinc, and the principle source of airborne lead is undoubtedly tetraethyl lead, an anti-knock agent added to gasoline since 1924. Although average lead concentrations in the air are not considered high, varying from 0.2 micrograms per cubic meter on the Great Plains and Rocky Mountain areas to 0.7 micrograms per cubic meter in New England and the Pacific Coastal states, concentrations of six micrograms per cu m, and in extreme cases seventeen to forty-five micrograms or more, have been measured in cities, especially on traffic- crowded streets or highways.

21722

Murozumi, M., Tsaihwa J. Chow, and C. Patterson

**CHEMICAL CONCENTRATIONS OF POLLUTANT LEAD AEROSOLS, TERRESTRIAL DUSTS AND SEA SALTS IN GREENLAND AND ANTARCTIC SNOW STRATA.** Geochim. Cosmochim. Acta, vol. 33:1247-1294, 1969. 71 refs. CFSTI, DDC: AD 697871

Lead analyses in annual ice layers from the interior of northern Greenland and from the interior of Antarctica are reported. Lead concentrations increase from less than 0.001 gamma Pb/kg ice at 800 BC to more than 0.200 gamma Pb/kg ice today in North Pole ice sheets, the sharpest rise occurring after 1940. The lead levels in South Pole ice sheets are generally below detection limits before 1940 and rise to only about 0.020 gamma Pb/kg ice after 1940. The increased lead levels at the North Pole are ascribed mainly to lead smelters before 1940 and to burned lead alkyls after 1940. The difference between the lead concentrations in the northern and southern polar snows is ascribed to barriers to north-south tropospheric mixing; these originate from meridional circulating cells which hinder the migration of aerosol pollutants from the northern hemisphere to the Antarctic. The Greenland interior ice contains about ten times more dust than Antarctic interior ice, but the latter contains twice as much sea salt as the former. The proportions of sodium, chlorine, magnesium, calcium, and potassium adhere closely to sea salt ratios in ices relatively free of silica dusts. In Greenland, the amounts and chemical composition of silica dusts are similar in both coastal and interior ices. Concentrations of lead and sea salts increase in the winter, while concentrations of silica dust increase in the spring. (Author abstract modified)

22367

Singer, M. J. and L. Hanson

**LEAD ACCUMULATION IN SOILS NEAR HIGHWAYS IN THE TWIN CITIES METROPOLITAN AREA.** Soil Sci. Soc. Am. Proc., 33(1):152-153, 1969 11 refs.

The use of tetraethyl lead in vehicle fuel has resulted in a general increase in the lead content of both the atmosphere and the soil. Most of the lead from gasoline exhausts is deposited as the highly soluble chlorobromide. The soil adjacent to 12 highways in the Minneapolis-St. Paul metropolitan area had lead accumulations in the range of 128 to 700 ppm. The lead concentrations found were related to traffic volume and distance from the highway. Further studies are needed to determine if biological or environmental hazards are possible from the lead contained in these soils. (Author abstract modified)

22370

Ruhling, Ake and Germund Tyler

**ECOLOGY OF HEAVY METALS- A REGIONAL AND HISTORICAL STUDY.** Botan. Notiser, vol. 122:248-259, 1969. 10 refs.

Samples of the moss Hypnum cupressiforme collected during 1968-69 in northeastern Gotaland, the low-land areas and the ridge areas of Skane (southern Sweden) were analysed for lead, zinc, copper, nickel and chromium. The concentration of these metals were significantly lower in the north-eastern area than in the areas of Skane, particularly in Pb, Ni, and Cr. Between the two areas in Skane differences were only established for Pb and Cu, with the largest concentrations in the humid ridge areas. The differences in the concentrations of these heavy metals between north-eastern Gotaland and Skane will be explained by the geographical position with respect to the large industrial regions of Europe. Samples of the same species, collected in Skane during 1870-1943 have also been analysed. Significant increases during the decades around 1900 were demonstrated for Cu and Zn. In the concentrations of Ni a rapid rise has occurred since about 1920, when this metal was introduced in the world production. The content of Ni in the samples from 1969 is more than twice as large as in the samples collected before 1920. The historical trends in the concentrations of Pb have earlier been demonstrated. There is little doubt that the rise in the concentrations of these metals is an effect of a larger air-borne supply, originating from human activity. (Author abstract modified)

22579

Wozniczek, Henryk

**AIR POLLUTION BY MOTOR CAR EXHAUST GASES.** (Zatrucie powietrza przez spaliny samochodowe). Ochrona Pracy, 21(5):14-17, May 1966. 16 refs. Translated from Polish. Franklin Inst. Research Labs., Philadelphia, Pa., Science Info. Services, 12p., Dec. 16, 1969.

Components from motor vehicle combustion gases are discussed in terms of concentrations emitted and the symptoms which they produce. Narcotic properties of saturated hydrocarbons increase with an increasing number of carbon atoms in the molecule, while all hydrocarbons mixed with air in suitable proportions form explosive mixtures. Hydrocarbon vapors above C5 do not require high concentrations, and a concentration of 1 mg/liter is sometimes sufficient to cause dangerous effects in the human organism in a period of a few minutes. Ethylene, propylene, butylene, hexylene, and heptylene induce almost the same disease symptoms as hydrocarbons of the paraffin series. A permissible concentration limit of 0.1 mg/liter is recommended for these unsaturated hydrocarbons of the ethylene series. Diolefins act on mucous membranes in the gaseous or vapor state. Unsaturated hydrocarbons of the acetylene series oxidize more readily than hydrocarbons of the paraffin and olefin series, and are able to very easily attract atoms, atom groups, and particles from other compounds to their molecules. Fatty acids and their anhydrides act destructively on tissues, while formaldehyde is already able to lead to chronic intoxication at a concentration of 0.02-0.07 mg/liter. Aldehydes induce diseases of the respiratory tract, liver and kidney diseases, and diseases of the eyes and skin. Pure ketones produce diseases of the respiratory tract, the eye protective system, and diabetes and anemia. The human organism can tolerate a maximum of 0.01% CO by volume on continuous action for 8 hours daily. Intoxication causes loss of consciousness, convulsions, breathlessness, and asphyxiation. Swelling of the lungs occurs in severe cases of intoxication from nitrogen oxides, while sulfur dioxide acts

similarly as a powerful irritant, especially on the mucous membranes. Gasoline vapors induce diseases of the respiratory system, nervous system, and the protective system of the eyes. Toxicity of gasoline vapors increases with increasing CO content in the mixture, and mental disturbances are among the chief symptoms of acute tetraethyl lead intoxication.

22825

Goodacre, Charles L.

**LEAD REMOVAL FROM GASOLINE NOT YET CERTAIN--OTHER POLLUTION FACTORS TO BE CONSIDERED.** Petrol. Times, 74(1898):62, 64, July 3, 1970.

The 'Queensberry Rules' pertaining to exhaust emissions are mentioned, as well as the difficulties encountered with the catalytic afterburner, Man-AirOx, and other attempts to control photochemical smog. Confounding this problem is the recent re-discovery that significant pollution carbon monoxide is apparently coming off the ocean. Certain sea life exudes carbon dioxide and forms a smog like haze on the surface of the sea to some 30-40 meters above the surface. Preceded by 1 year in California, Federal limits set for 1968 cars were unburned hydrocarbons 275 ppm and carbon monoxide 1.5%. Unfortunately, some cars were naturally high emitters, and the makers of such cars started to call for lead-free gasolines when Man-AirOx and UnDetox did not reduce the emissions sufficiently. A chemical company came out with a very expensive thermal reactor which reduced the unburned hydrocarbon emissions from 1000 ppm to 50 ppm and the CO from 5% to 0.50%. Yet, construction required high nickel alloys in an amount that approximates the world's yearly nickel output. The reactor also produced a foul-smelling exhaust with carcinogenic dross and was a potential fire hazard. Standards are becoming stricter, and oil companies have been asked to make lead-free gasoline available for 1972 cars. Hydrocarbon limits for 1970 are 180 ppm and carbon monoxide is limited to 1.1%.

22941

McJones, R. W. and R. J. Corbeil

**NATURAL GAS FUELED VEHICLES EXHAUST EMISSIONS AND OPERATIONAL CHARACTERISTICS.** Preprint, Society of Automotive Engineers, Inc. New York, 23p., 1970. 8 refs. (Presented at the Automotive Engineering Congress, Detroit, Mich., Jan. 12-16, 1970, Paper 700078.)

Natural gas fuel in a lean mixture with 25% excess air operates satisfactorily in an otherwise normal automotive engine. All exhaust emissions known to contribute to air pollution are reduced to levels meeting or bettering currently proposed standards. For example, carbon monoxide, lead, and soot are virtually eliminated, while oxides of nitrogen and hydrocarbons are reduced significantly. Emissions from carburetor and fuel tank evaporation are nearly zero. Dual-fuel operation with gasoline as a standby fuel permits immediate use of natural gas prior to the establishment of a widespread fueling network. (Author abstract modified)

22976

Fussell, D. R.

**ATMOSPHERIC POLLUTION FROM PETROL AND DIESEL ENGINED VEHICLES.** Petrol. Rev., 24(283):192-202, July 1970. 52 refs.

Major pollutants from the gasoline engine are unburned hydrocarbons, nitric oxide, carbon monoxide, lead, some sulfur oxides, and particulates. Up to 4% hemoglobin deactivation can occur after exposure to street concentrations of 15-25 ppm CO, while there is some evidence that 5-10% deactivation may disturb psychomotor abilities, visible and audible perception, and multiple limb co-ordination. Photochemical reactions in which unburned hydrocarbons are involved occur mostly in Los Angeles; the prime concern is their possible carcinogenic nature. The main interest in nitrogen oxide emissions is associated with its smog forming potential, while the concern with lead has to do with its being a cumulative poison. Vehicle emission legislation is mentioned for the United States and Europe. Emissions occur from the crankcase, the fuel tank, the carburetor, and the exhaust. The influence of mechanical and operating conditions, as well as fuel factors on emissions is discussed. Pollutant control techniques are also reviewed. As with gasoline engines, numerous mechanical and operating factors effect the emissions from diesel engines. When compared with the 'untreated' gasoline engine, diesels emit very much less CO, significantly less HC, but similar quantities of NO. White, black, and blue diesel smoke are discussed. The most effective of the antismoke additives have been colloidal dispersions of organic barium compounds.

23058

Hammond, P. B.

**LEAD POISONING. AN OLD PROBLEM WITH A NEW DIMENSION.** In: Essays in Toxicology. F. R. Blood (ed.), Vol. 1, New York, Academic Press, 1969, Chapt. 4, p. 115-155. 92 refs.

Sources and uses of lead, the metabolism of lead, its toxic effects, environment and the body burden, and the evaluation of blood levels are reviewed. Common forms of lead poisoning result from the mining, processing, and commercial dissemination of lead. The amount of lead produced annually in the United States is more than one million tons. Tetraethyl lead represented roughly 20% of U. S. lead consumption in 1966, while it is estimated that 70-80% of the TEL in motor fuel is eventually exhausted into the atmosphere to be either inhaled directly or deposited on vegetation, soil, and water. Much of the lead retained is probably actually swallowed, although it also can be absorbed through the gastro-intestinal tract. X-ray diffraction studies have suggested that lead assumes position within the bone crystal, either by ion exchange or by occupation of lattice interstices. At extremely low concentrations, lead is an effective nucleating agent for inducing the formation of calcium phosphate crystals; this property may serve to trap lead at the surfaces of bone crystals and it may be important in pathological processes of soft tissue calcification. More than 95% of the lead circulating in the blood is associated with erythrocytes, and the reamining is in the plasma. Long-term exposure to lead is potentially hazardous at some daily level of intake far below the acute toxic dose. Mortality and the incidence of lead poisoning in infants is much higher during the summer months than it is during the rest of the year. Exposure to light, particularly in the ultraviolet range, increases the excretion of coproporphyrin in the rabbit following administration of lead. The effects of lead are discussed on the hemopoietic system, on the central and peripheral nervous system, and on the kidneys. The minimum blood concentration of lead below which it is most unlikely that poisoning will ever occur is 0.08/100 gm blood. Lead poisoning in infants, domesticated animals and wildlife, is also discussed.

23239

Chow, T. J. and J. L. Earl

**LEAD AND URANIUM IN PENNSYLVANIA ANTHRACITE.** Chem. Geol., vol. 6: 43-49, 1970. 8 refs.

Lead concentration, its isotopic composition, and the uranium content of Pennsylvania anthracites was determined. Mass

spectrometic analyses were performed on samples which had been pulverized, weighed, and ashed at 425 C to constant weight. Square root of mass ratio corrections are incorporated in the data to compensate for velocity discrimination in the electron multiplier. Lead and uranium concentrations were determined by the isotope dilution method which is accurate to 0.01 micrograms. The ash content of the four washed Pennsylvania anthracites ranged from 9.5-12.8%, contrasted with the one Rhode Island unwashed meta-anthracite with 58% ash The uranium concentration of three Pennsylvania anthracite samples was 1.55, 2.10 and 2.65 ppm, respectively. For the Eastern Middle, Western Middle, and Southern Field anthracites, the average lead concentration was 11.4 ppm, with the Northern Field sample having a lead concentration of 33.8 ppm, three times higher than the others. This disparity is also reflected in the isotopic composition, with the Northern Field anthracite lead being less radiogenic than the other three leads. From the isotopic analysis, it is interpreted that common lead was incorporated into the ancient, bedded plant material in Carboniferous times prior to coalification, while the uranium was introduced into the anthracite after coalification.

23250

Myers, P. S.

**AUTOMOBILE EMISSIONS-A STUDY IN ENVIRONMENTAL BENEFITS VERSUS TECHNOLOGICAL COSTS.** Preprint, Inst. of Mechanical Engineers, London (England), Automobile Div., 19., 1969. 57 refs. (Presented at the Institution of Mechanical Engineers, Automobile Division Council, Coventry, England, Nov. 4, 1969, Paper 700182.)

Recent increase in man-caused additions to the atmosphere are markedly changing its quality. With rising population, these additions will increase in the future. The magnitude of the overall problem in relation to mass rate balances for particulate matter, carbon dioxide, and monoxide, nitrogen oxides, sulfur dioxide, lead, and hydrocarbons is discussed. Pollution from automobiles is discussed specifically, along with some possible solutions (both with the existing reciprocating engine and alternate power sources), the effect of controls, and the long- term reduction of emissions. Exhaust recycling, mixture variations, and catalytic exhaust systems are possible controls. Methods of cooperation between government, manufacturers, and the public are suggested. (Author abstract modified)

23280

Danielson, Lennart

**GASOLINE CONTAINING LEAD.** Swedish Natural Science Research Council, Stockholm, Ecological Research Committee, Bull. 6, 45p., Dec. 19, 1967. 145 refs.

In 1967, the world's use of leaded gasoline amounted to approximately 500 billion liters. At that time, the lead content of gasoline was 0.64 g/l, and has been increasing regularly since. Laboratory experiments on humans indicate that approximately 1/3 of the lead absorbed by the human body is permanently retained. Present trends indicate that the emission of lead from automobiles in Sweden will increase 100-200% by 1977. The safety margin between the present lead absorption for a person living in a city and that absorption which gives rise to chronic damage in man is apparently very small, possibly nonexistent. Gasolines of an octane rating equal to that of today's best leaded gases can be produced in quantity at a total increase in production cost of 2-3 0/gal. The recommendation is made that leaded gasolines be prohibited in Sweden, and that during the change-over period, the tax on leaded gasoline be increased and the tax on unleaded gas be decreased to provide motorists with an incentive to assist in the drive to reduce the lead content of the atmosphere.

23316

Kendler, J. and A. Donagi

**MOTOR CARS AS THE MAIN SOURCE OF AIR POLLUTION.** Text in Hebrew. Harefuah (J. Israel Med. Assoc.), 78(6):289-294, March 15, 1970. 20 refs.

Haagan-Smith of California discovered that the main source of air pollution is cars. Car engines are divided into two groups, gasoline fueled and diesel fueled. Gasoline engine exhaust contain carbon monoxide, lead, nitric oxide, nitrogen dioxide, and hydrocarbons The concentration and mix depend upon the condition of the engine and its motion status: idling, accelerating, cruising, or decelerating. By comparison, the diesel engine emits less CO, NO, NO2, and no lead at all. Two types of smoke are characteristic of diesel exhausts, hot smoke and cold smoke. The former is a result of burning too rich a fuel mixture in an attempt to get more power, which it does at the cost of eliminating the inherent economy of diesel operation. Certain faulty driving techniques provide a similar exhaust. Cold smoke, resulting from low-temperature combustion as when the engine is not up to its normal operating temperature, contains small particles of unburned fuel. Both diesel and gasoline engines are important contributors to air pollution and its concommittant danger to health, animal and vegetable life, and the weather. The principal differences between automotive and industrial pollution is that the former is emitted in more populated areas. In the United States and particularly in California, they are very advanced in the means of controlling or avoiding the problem of automotive pollution. Automobile manufacturers are compelled to install special devices on all new cars to reduce the emission of harmful gases. One of the main problems that has not been solved yet is the reduction of NO and NO2 emissions.

23561

Morgan, George B. and Guntis Ozolins

**THE IMPACT OF AIR POLLUTION ON THE ENVIRONMENT.** Preprint, National Air Pollution Control Administration, Cincinnati, Ohio, Div. of Air Quality and Emission Data, 12p., 1970.

The population of a large part of the world has been exposed to polluted air for many decades and, in some cases, centuries. Significant increases are forecast for the future. If control actions are not intensified, air pollution may increase by a factor of six to ten by the year 2000. Before any meaningful control efforts can be carried out, we must know what the ambient levels of pollution are and how they relate to levels established as causing health or economic effects. Many pollutants have always been a part of the natural atmosphere. They are now called pollutants because, with man's help, they are now excessive in quantity. Particulate pollution is the most recognized and pervasive. Its health effects are functions of both particle size and composition. Another significant effect is that, suspended in the atmosphere, particulates reflect away part of the sun's energy and could result in an over-all lowering of the earth's temperature. Gases, 90% of all pollutants, are the second class of pollutant. Examples are sulfur dioxide, nitric oxide, nitrogen dioxide, carbon monoxide, and hydrogen fluoride. A third major pollutant class is the family of hydrocarbons. These participate in photochemical reactions which result in the formation of secondary pollutants such as peroxyacyl nitrates, ozone, formaldehyde, other aldehydes, and ketones. It is from these secondary pollutants that the primary danger to both animal (including the human animal) and vegetable life arises. Numerous industrial processes and the ubiquitous automobile emit these assorted products that are a serious problem in the environment surrounding their source. Almost all human activity results in some form of air pollu-

tion, direct or indirect, particulate or gaseous. High-temperature combustion, automotive, industrial, and domestic, is the principal offender. Parameters that must be considered when evaluating effects of pollution include quantity, distribution, and environmental tolerance for pollutants, individually and in concert. Locally, micrometeorology and topography also require consideration. Of all identified pollutants, suspended particulates and sulfur dioxide have been the most extensively measured and studied. As analytical techniques become available, other pollutants will come under programmed surveillance. Among these are asbestos, mercury, lead, pesticides, fluorides, and biologically active metals. International assessment of these problems is necessary for the preservation of the biosphere.

23620

Schaefer, Vincent J.

**AUTO EXHAUST, POLLUTION AND WEATHER PATTERNS.** Bull. At. Sci., 26(8):31-33, Oct. 1970.

Most of the pollution comes from effluents which consist of invisible particulate matter and accompanying vaporous gases which cannot be seen when they are released into the atmosphere. If one looks at the air along a freeway or other heavily traveled road, very little if any exhaust smoke can be seen coming from the traffic, while going through a long vehicular tunnel, a bluish haze will be seen in the air and if the windows are open a foul smell can be noted. Such air contains tremendous numbers of small particles as well as gases of combustion, particularly carbon monoxide, carbon dioxide, the nitrogen oxides and hydrocarbons. While carbon particles are essentially inert, they can serve as frameworks on which gases adsorb and other liquids and solids agglomerate. When converting visible particles to invisible sizes, the residence time of such particles is greatly extended, and some of the natural nitrogen in the air is oxidized to produce nitrogen oxides. Hazards of the supersonic transport are cited, as well as inadvertent weather modification. A potent source of ice nuclei appears to be found in air polluted with automobile exhaust from leaded gasoline. Submicroscopic lead compounds probably react with small quantities of iodine vapor to form lead iodide. High concentrations of ice nuclei may stabilize clouds containing low amounts of liquid cloud water and thus reduce or prevent precipitation; on the other hand, if a rich source of moisture moved into a region and entrained extensive areas of polluted air containing many potential ice nuclei, it could produce excessive amounts of snow or rain.

23789

Eccleston, Barton H. and R. W. Hurn

**COMPARATIVE EMISSIONS FROM SOME LEADED AND PROTOTYPE LEAD-FREE AUTOMOBILE FUELS.** Bureau of Mines, Washington, D. C., Rept. of Investigations 7390, 24p., May 1970. 9 refs. CFSTI: PB 192004

An investigation is reported of the effect upon automobile emissions in changing from leaded to lead-free gasolines. Typical U. S. leaded gasolines and prototype lead-free gasolines of comparable octane quality were used in eight vehicles operated to simulate city driving. The experiments were run at 70 and 95 F. Exhaust and evaporative emissions were measured and the photochemical effect of the emissions was experimentally observed in an artificial smog chamber. Results of the study reveal the manner and degree in which the changes in fuel composition alter th amount and characteristics of both exhaust and evaporative emissions. The compositional differences between leaded and prototype lead-free fuels resulted in higher photo-chemical pollution potential of the emissions from the lead-free fuels. The effect is attributed to the photochemical characteristics of high-octane fuel components that are used in greater quantity in the lead-free fuels. Emissions of carbon monoxide, oxides of nitrogen, and aldehydes were not affected significantly by the changes from leaded to lead-free fuel formula. It is emphasized that these results are not related to the effect of lead, per se. Rather, they bear on the net effect on air pollution if fuel composition were to be changed to meet fuel octane and volatility requirements without the use of lead antiknock additives. (Author abstract modified)

24031

Widmark, Gunnar and Anders Laveskog

**RESEARCH CONCERNING VEHICLE EXHAUST AND LETTERS.** Stockholm Univ. (Sweden), Inst. for Analytical Chemistry, 1969. Translated from Swedish. Belov and Associates, Denver, Colo., 42p., June 19, 1970.

Notes pertaining to research on the amount of organic lead pollutants in the streets (city air) are enclosed. Possible research problems are suggested and include improving analytical methods to determine tetramethyl and tetraethyl lead in the same tests; improving the possibility to monitor reactions or converted products from TML/TEL: how much of the TML/TEL which is breathed is absorbed by the body and are the isotopic combinations of lead which are isolated from human blood distinguishable from the common mine lead in that district. Several comments concerning the test procedure are cited for the research analyst.

24080

Hoog, H.

**CONSERVING OUR ENVIRONMENT: WHAT CHEMICAL ENGINEERING CAN AND SHOULD DO.** Chem. Engr. (London), no. 240:CE204-CE210, July-Aug. 1970. 27 refs. (Presented at the 48th Annual General Meeting of The Institution of Chemical Engineers, Birmingham, England, April 21, 1970.)

Various types of pollution are considered with respect to their sources, effects, and the application of chemical engineering to their control. The types are air, rivers and lakes, oceans, soil, solids pollution, and noise and light. A general procedure is presented for minimizing pollution from new plants and specific examples are given of pollution control in the petroleum industry. Practices recommend for new plants include site-selection studies; pre-operational studies to establish a base level of noise and of air and water quality; optimization studies of alternative processes; and attention to pollution-conscious design, engineering, and construction. Specific measures for controlling air pollution from petroleum production include tall stacks, use of liquefied natural gas for power-generation plants, fuel-oil and flue-gas desulfurization, and removal of lead from gasolines. Water pollution by oil can be reduced by reusing process water, reducing effluent water by gravity separation or by air cooling followed by trim water cooling, and complete segregation of drainage systems for clean and oily water. Discharge of oil at sea is curtailed by the 'load on top' procedure. In this procedure, the mixture of oil and water produced by cleaning tanks at sea is separated in a special slip tank. After separation the clean water is pumped out and the next cargo loaded on top.

24156

Kobayakawa, Takashi

**SPECIAL EDITION ON MOTOR VEHICLE EXHAUST - FROM MANUFACTURER'S VIEWPOINT.** (Jidosha haiki tokushu a Meka toshiteno tachiba). Text in Japanese. Sangyo Kogai (Ind. Public Nuisance), 6(9): 553-562, Sept. 25, 1970. 3 refs.

Both a lead poisoning episode and a photochemical smog episode that occurred in Tokyo during the summer of 1970 are attributed solely to auto exhaust gas emissions. These accidents are discussed in the context of the problems facing automobile manufacturers in their attempts to control exhaust emissions. The technology exists for removing lead from vehicle emissions, but, reported in the United States the control devices have a number of disadvantages. A considerable quantity of CO and HC emission in return is evident, along with a slow-down of horsepower, troubles with engine unit, and an increase in fuel consumption. Apart from these mechanical aspects, the tolerance limit of lead in the human body has not yet been definitely determined. This factor also delays the development of prototype devices capable of meeting the ambient standard to be issued in the near future. The unforeseen photochemical smog can be attributed to sulfur mist: it was not photochemical smog in the strict sense because there were recognize differences between and Los Angeles smog. The existing Japanese carbon monoxide emission standard from motor vehicles is more strict than that of the United States, since the permissible limit varies according to maximum weight and types of vehicles.

24281

Livingston, H. K., J. L. Hyde, and M. H. Campbell

**EFFECT OF SULFUR ON COMBUSTION OF LEADED GASOLINE.** Ind. Eng. Chem., 41(12):2722-2726, Dec. 1949. 23 refs.

Sulfur compounds in gasoline combine directly or indirectly with tetraethyl lead in the engine cylinder to produce a lead reaction product of reduced antiknock activity. The extent of this reduction in antiknock activity is greatest for the more reactive sulfur compounds such as hydrogen sulfide, sulfur dioxide, mercaptans, or disulfides. Sulfur compounds that are very unreactive at low temperatures probably only affect the antiknock action of tetraethyl lead by contributing sulfur dioxide and trioxide to the burned gas formed on combustion. A small amount of this burned gas remains in the engine cylinder after the exhaust stroke and mixes with the fresh-air mixture. The sulfur oxides from the unreactive sulfur compounds then interact with the tetraethyl lead to reduce its antiknock efficiency. Variation of the Cooperative Fuels Research engine spark advance, to produce a large change in pressure-temperature-time relations existing in the fuel-air mixture, did not alter the antiknock efficiency of tetraethyl lead when sulfur-containing fuels were compared at a constant level of knock intensity. The sulfur-tetraethyl lead interaction is remarkably insensitive to engine conditions. Analyses of combustion chamber deposits from engines operating on leaded sulfur-containing gasolines show deposit composition to depend on sulfur concentration in the gasoline. Lead oxysulfates are more common than lead oxide or sulfate in typical deposits. (Author abstract)

24285

Swain, Robert E.

**SMOKE AND FUME INVESTIGATIONS. A HISTORICAL REVIEW.** Ind. Eng. Chem., 41(11):2384-2388, Nov. 1949. 18 refs.

Several outstanding cases of injury to animal and plant life by emanations from industrial plants at Ducktown, Tenn., Anaconda, Mont., Salt Lake City, Utah, and Trail, B. C. are cited in a historical survey of atmospheric pollution and the steps that have been taken to prevent and combat it. Sulfur dioxide from two copper smelters was the offender in Ducktown, reaching for 30 miles across the broad-leafed forests of northern Georgia. A crisis came when Georgia brought suit against Tennessee to compel it to cancel the franchise of the smelting companies, but out of this came the design, erection, and successful operation of an adaptation of the lead chamber process to convert SO2 from copper smelting operations to sulfuric acid. With the installation at the Anaconda smelter in 1910 of an enormous Cottrell system for electrical precipitation of solids, one of the most remarkable cases of injury to livestock by smelter smoke ever recorded passed into history. The emissions from the low stacks of an old plant operated at a neighboring location had killed all vegetation, and losses of livestock by arsenical poisoning had been heavy over the near-lying area. A new smelter was erected with stacks over 300 feet tall, but there were still emitted daily 2300 tons of SO2, 200 tons of sulfur trioxide, 30 tons of arsenic trioxide, 3 tons of zinc, and over 2 tons each of copper, lead, and antimony trioxide. Lead and SO3 fumes were soon put under complete control in Utah by liming and bag filtration, and by electrical precipitation. About $13,000,000 was invested at Trail in recovering airborne wastes and converting them to marketable by-products. These were tied together into a smoothly operating system and soon phosphate fertilizers of several types, ammonium sulfate, and sulfur were being produced on a large scale. Contributions of research and diurnal fumigation are also discussed.

24718

Withrow, Lloyd and Gerald M. Rassweiler

**EFFECT OF TETRAETHYLLEAD ON PREFLAME REACTIONS IN AN ENGINE.** Ind. Eng. Chem., 27(8):872-879, Aug. 1935. 11 refs.

Ultraviolet absorption spectra of the gaseous charge in an engine indicate that when tetraethyl lead is added to the fuel to prevent knock, there is an effect on the preflame reactions in that portion of the charge which, in the absence of tetraethyl lead, suddenly inflames at the time of knock. Atomic lead has been identified in the noninflamed charge in the knocking zone at the moment that antiknock action is being effected, but no accompanying absorption by lead monoxide has been observed. When lead is vaporized in a hot nichrome tube, the absorption spectra exhibit lead monoxide bands at lower temperatures than atomic lead lines. Comparison of experiments in and out of the engine indicate that lead monoxide is being reduced in the noninflamed charge. (Author abstract)

24829

**LEADED OR NON-LEADED GASOLINE...WHAT ARE THE FACTS? Ethyl, no. 2:4-10, 1970.**

The change from leaded to unleaded gasoline will not reduce hydrocarbon emissions, improve the particulate loading of the atmosphere, or make exhaust catalysts less prone to attrition and loss. By exposing millions of cars to excessive exhaust valve seat wear, unleaded gasoline will bring about a sevenfold increase in exhaust emissions. Increasing the aromatic content of unleaded gasoline to achieve antiknock quality equivalent to tha of leaded gasoline will specifically increase emissions of hazardou polynuclear aromatic hydrocarbons, phenols, and aldehydes, which participate in photochemical smog reactions. To produce unleaded gasoline meeting 91-octane requirements will increase refining costs by ten million dollars (5.17 cents a

gallon). One alternative to unleaded gasoline is the lean reactor approach developed by the Ethyl Corporation. Very low emissions are achieved in a lean reactor car through significant improvements in the induction, ignition, and exhaust systems. With this car it should be possible to meet gaseous emission levels that have been proposed for 1975.

24996

West, Wallace

**STEAMER TIME? Analog Sci. Fiction/Sci. Fact, 82(1):77-95, Sept. 1968. 5 refs.**

Steam-driven cars are gaining popularity because they produce virtually no hydrocarbons, no lead, and very little carbon monoxide nitrogen oxide, or other components of air pollution. Although other types of non-polluting engines exist, the steam engine has an advantage in that plans and specifications of once popular models still exist. In addition, conversion to steam engine manufacturing would require far less extensive changes than electri cars would. The history of steam cars is recounted, and personal experiences with steam cars are described. Turbine powered cars have been successfully tested by several Detroit manufacturers, but the emphasis is still being placed on control equipment which can be fitted to standard or slightly modified internal combustion engines. The emission requirements called for by recent Federal legislation are discussed in terms of the various types of controls, and the theory of internal combustion design is discussed. A type of steam car manufactured by the Williams Company is described, and the resistance it has met from the automobile establishment is documented.

25125

May, Hans, Eberhard Plassmann, and Franz Josef Dreyhaupt

**RESEARCH ON AUTOMOBILE EMISSION IN INDUSTRIAL CENTERS.** Preprint, International Union of Air Pollution Prevention Associations, 36p., 1970. 22 refs. (Presented at the *International Clean Air Congress, 2nd, Washington, D. C.*, Dec. 6-11, 1970, Paper SU-12C.)

North Rhine-Westphalia has developed a registration system for ever kind of emission contributing to air pollution. This registration system serves to produce an area-oriented emission register containing data on place, time, duration, quantity, type, condition, and temperature of emissions. The emission characteristics are computer processed to determine their relation to the operating condition of the responsible technical installations. For the registration of motor vehicle traffic, street sections are defined as line sources. The systems analysis used in the registration of traffic differentiates between two emission sources: the specific vehicle data and the specific traffic data. The former refers to the type of fuel mixture preparation, type of combustion, form of combustion chamber, compression ratio, and so forth; the latter to the number of vehicles and driving modes. These sources are determined by teststand investigations and investigations of traffic. With the help of test cycles, driving conditions for all possible traffic situations are simulated on a chassis dynamometer. These tests produce data about the average emission of exhaust components in relation to the driving condition. By use of traffic densities found with the help of aerial photos and traffic counts, exhaust emissions can be calculated as a function of time and place. It is hoped that the results will produce new ideas for city planning for the control of regional traffic planning. (Author abstract modified)

25295

Chow, Tsaihwa J.

**ISOTOPIC IDENTIFICATION OF INDUSTRIAL POLLUTANT LEAD.** Preprint, International Union of Air Pollution Prevention Associations, 15p., 1970. 10 refs. (Presented at the International Clean Air Congress 2nd, Washington, D. C., Dec. 6-11, 1970, Paper CP-2A.)

Each lead ore deposit has its characteristic isotopic composition which is fixed during mineral ore genesis, and this unique chemical property can be a useful tool in identifying the sources of lead pollutants. Research on the geochemistry of lead aerosols demonstrates that by correlating their isotopic compositions, the lead alkyl additives in gasoline are identified as the largest contributor to atmospheric lead pollution. In 1968 the United States consumed more than 260,000 tons of lead as antiknock additives, and their isotopic character suggests that a portion of the additives were made with lead imported from Canada, Peru, and Mexico. (Author abstract modified)

25417

Jaworowski, Z.

**STABLE AND RADIOACTIVE LEAD IN ENVIRONMENT AND HUMAN BODY.** Inst. of Nuclear Research, Warsaw (Poland), Dept. of Radiobiology and Health Protection, Rept. NEIC-RR-29, 181p., 1967. 220 refs.

A study was undertaken to determine the level of stable and radioactive lead in typical components of the biosphere and in the organism, as well as to examine their sources and temporal and geographical distribution. A historical review is included, and the abundance and isotopic composition of lead are considered. Methods of determination are described. Both natural and artificial origins are considered for the stable lead present in the ambient atmosphere, water, soil and food. The origin and levels of lead-210 are also discussed. Stable lead and lead-210 in the body, tissue distribution, skeleton concentrations, amounts in the hair, and their intake and elimination are included. Toxicity of lead is mentioned, as well as the half-lives and effective equilibrium of lead-210 and its daughters. Radiation dosimetry is discussed.

25581

Smith, D. S., R. F. Sawyer, C. A. Frondizi, and R. C. Carr

**THE EFFECTS OF LEAD ADDITIVES ON REACTIONS IN EXHAUST SYSTEMS.** In: Project Clean Air. California Univ., Berkeley, Thermal Systems Div., California Univ. Res. Proj. S-1, 23p., Sept. 1, 1970.

The continued reaction of carbon monoxide, nitric oxide, and hydrocarbons in the exhaust system of an internal combustion engine and the effect of lead alkyl on exhaust system reactions were investigated. The investigation included variations in the lead content of fuel, mixture richness, and compression ratio. The exhaust gas samples were drawn from locations six inches downstream to 40 inches downstream of the exhaust port. The exhaust gas was 600 C and at approximately atmospheric pressure in the test section. No measurable exhaust system reactions were observed for any of the sampled species. (Author abstract)

26100

Petroleum Inst., Tokyo (Japan), Gasoline Panel Group

**STATE OF AFFAIRS AND PROBLEMS INVOLVING AUTOMOTIVE FUEL GASOLINE.** (Jidosha gasorin no doko to mondaiten). Text in Japanese. Sekiyu Gakkai Shi (J. Japan Petroleum Inst., Tokyo), 13(11):23-38, 1970. 71 refs.

A very intensive and analytical report was prepared covering many aspects of automotive fuel, including combustion gas emission problems and other reference data. This chapter presents a comparison between Japanese gasoline and that used in the United States, which reveals a greater aromatic hydrocarbon content and higher specific gravity for the former. Volatility is related to the shape, temperature, and other characteristics of the manifold. Although a lower volatility results in lower evaporation losses, this adversely affects starting and warming-up engine operations. Gasoline properties and their relation to evaporative loss are depicted graphically. Lead anti-knock additives are mentioned, and deposits in the combustion chamber are discussed in relation to the amount of lead added. The combustion process in various parts of the engine is described.

26134

Katayama, H., T. Kobayakawa, Y. Shibusawa, M. Harada, and N. Yatsumaki

**SYMPOSIUM: RECENT PROBLEMS ON AUTOMOTIVE FUELS.** (Jidosha no nenryo mondai ni tsuite). Text in Japanese. Sekiyu Gakkai Shi (J. Japan Petroleum Inst., Tokyo), 13(11):844-854, Nov. 1970.

Problems concerning the control of pollution due to automobiles are discussed, particularly in terms of improvements of the engine and fuel. Exhaust emission control is mainly reviewed from a panel discussion of the Petroleum Society (Feb. 8, 1970, Osaka), with some corrections to bring the situation up to date and additions pertaining to conditions in Europe and the United States. Composition and the properties of gasoline are correlated to the composition of automobile exhaust, while engine operation is related to its fuel. Recent problems concerning light diesel oil, catalysts for cleaning exhaust emissions, and the production of leadless gasoline and its cost are reviewed. Emission control in Japan pertains to tail pipe exhaust, not to crankcase emissions or evaporation losses, in spite of their regulation in Europe and the United States. The amount of carbon monoxide which can be emitted is less in Japan than in the United States, as in the latter country it is determined from the average amount emitted rather than a maximum. Although methods for controlling carbon monoxide have been developed, simultaneously treating the oxides of nitrogen presents a problem. Recirculating exhaust gas for intake air is a possible way to control the nitrogen oxides. Standards to control the particulate matter emitted from automobiles yet need to be established in Japan.

26191

Hogan, Austin W.

**ICE NUCLEI FROM DIRECT REACTION OF IODINE VAPOR WITH VAPORS FROM LEADED GASOLINE.** Science, 158(3802):800, 1967. 3 refs.

Large amounts of ice nuclei, active at -15 C or colder, were generated by mixing vapors from leaded gasoline with iodine vapor. When unleaded gasoline was substituted for leaded gasoline, no particles could be observed. In a bottle with a capacity of 2 liters, the reaction between iodine vapors and leaded gasoline vapors produced more than 1,000,000 Aitken nuclei per cu cm. These results suggest that evaporative losses from carburetors and gas tanks can be a significant source of atmospheric lead and freezing nuclei.

26441

Oglesby, Sabert, Jr. and Grady B. Nichols

**A MANUAL OF ELECTROSTATIC PRECIPITATOR TECHNOLOGY. PART II -- APPLICATION AREAS.** Southern Research Inst., Birmingham, Ala., NAPCA Contract CPA 22-69-73, 875p., Aug. 25, 1970. 118 refs. NTIS: PB 196381

The application of electrostatic precipitators is reviewed for the electric utility industry, the pulp and paper industry, the iron and steel industry, the rock products industry, the chemical industry, in cleaning municipal incinerator dusts, for the petroleum industry, and in the nonferrous metals industry. Particular emphasis is placed on the dust and gaseous emissions of the processes discussed. This is followed by a tabulation of input and design parameters for precipitators operating on various types of dust control problems and an analysis of critical design parameters and test results. Cost data are also presented. The electrolytic reduction of aluminum, the production of copper, primary lead, and zinc reduction are discussed in the area of the nonferrous metals industry. In the petroleum industry, catalytic cracking and detarring are indicated as application areas. Refuse properties are discussed, as well as types of incinerators. Sulfuric acid production, the production of elemental phosphorus, phosphoric acid, and carbon black, warrant the use of precipitators in the chemical industry. In the rock products industry, the manufacture of Portland cement and the gypsum industry present problems. Coke ovens, sinter plants, blast furnaces, open hearth furnaces, basic oxygen converters, electric arc furnaces, scarfing machines, and iron cupolas are areas of application in the iron and steel industry. In the pulp and paper industry, precipitators are indicated for the recovery of boiler particulate emissions and sulfate process flue gases. Fly ash precipitators are needed in the electric utility industry.

26454

Lazrus, Allan L., Elizabeth Lorange, and James P. Lodge, Jr.

**LEAD AND OTHER METAL IONS IN UNITED STATES PRECIPITATION.** Environ. Sci. Technol., 4(1):55-58, Jan. 1970. 14 refs.

Atmospheric precipitation samples collected by a nationwide network of 32 stations throughout the United States were analyzed for lead, zinc, copper, iron, manganese, and nickel by atomic absorption. Values for each station averaged over approximately six months during 1966 and 1967 indicate human activity as the primary source of these materials in atmospheric precipitation. Maps of average concentrations of the elements are presented for the specified periods. The concentration of lead in precipitation correlated with the amount of gasoline consumed in the area in which the sample was collected. The overall mean concentrations of the metals in precipitation are compared with analogous values in surface water supplies. While the concentration of only lead is significantly high with respect to the allowable concentration in drinking water, the evidence indicates that lead forms insoluble materials in surface waters and is removable by sedimentation or by filtration. (Author abstract modified)

26552

Balke, S.

**CHEMISTRY AND ENVIRONMENT.** (Chemie und Umwelt). Text in German. Deut. Lebensm. Rundsch , 66(11):366-374, Nov. 1970. 20 refs

A major difficulty with the present approach to environmental preservation is that thinking on the subject is still dissipated among the many disciplines into which our scientific world is divided. Scientists are preoccupied with cleaning up individual sources of pollution, while in many cases each problem is meanwhile being strongly influenced by politics and other fac-

tors unrelated to ecology. The biosphere, in which human life exists, is an envelope of gases only 120-150 km in thickness. One German physicist has described man as 'a deep sea creature living on the floor of an ocean of air'. The chemical industry, which has often boasted that 'chemistry will conquer the world' poses one of the most serious threats to the human environment. In the area of air pollution, the automotive industry, rather than the chemical industry, is the chief offender, due to the harmful products create by the internal combustion engine. At the present time, about 15 million tons of motor fuel containing tetraethyl lead is being used annually in West Germany, and each liter of fuel contains an averag of 0.5 grams of lead. The United States used about 225 thousand tons of the anti-knock lead product in 1968. Other aspects of the problem discussed here are the contributions of biology, agricultur and the protection of plant life, radioactivity, chemical warfare, economic and legal factors, and food purity regulations. A strateg is outlined for combatting in an integrated way the problems of water and air pollution, noise pollution, food contamination, the relationship between technological goals and human freedom, the population explosion, and the impending dangers of a natural catastrophy or a serious disturbance in the biological balance of our world.

26645

Colucci, Joseph M. and Charles R Begeman

**CARCINOGENIC AIR POLLUTANTS IN RELATION TO AUTOMOTIVE TRAFFIC IN NEW YORK.** Environ. Sci. Technol., 5(2):145-150, Feb. 1971. 33 refs. (Presented at the Air Pollution Control Assoc., Annual Meeting, 61st, St. Paul, Minn., June 1968.)

Particulates and carbon monoxide were sampled at five metropolitan New York sites to relate polynuclear aromatic hydrocarbons to automotive traffic. The polynuclear aromatic hydrocarbons determined were benzo(a)pyrene, a strong carcinogen, and benz(a)anthracene, a weak carcinogen. A large 'absolute' filter, containing 26 sq m of all-glass filter paper, was mounted about 1.5 m above ground in a truck. Air was drawn through the filter at 140 cu m/min, while the volume filtered in a sampling period ranged from 92,000 cu m to 816,000 cu m. About 2% of the filter paper was used in analyses for lead, vanadium, and sulfate; the other 98% was extracted with benzene plus methanol (4 to 1), and the benzene soluble portion reduced to tar. Lead indicated automotive air pollution sources, and vanadium and sulfate nonautomotive combustion sources. Carbon monoxide was measured continuously during particulate sampling periods with a nondispersive infrared analyzer, also indicating automotive air pollution sources. Pollutant concentrations were highest at Herald Square, lowest in suburban Scarsdale. Benzo(a)pyrene concentrations ranged from 0.1 to 9.4 micrograms/1000 cu m, were higher during the day than at night, and highest in autumn and winter. For all data, the correlation coefficient for BaP and carbon monoxide was 0.65; for lead, 0.74; for vanadium, 0.54; and all were statistically significant. At individual sites, however, only some of these correlations were significant. BaP in air, even in heavy-traffic areas, appears related to both automotive and nonautomotive sources. At the central New York sites, BaP was lower than that measured in central Detroit, even though New York traffic was greater. BaP in New York was lower than that of most other U. S. cities, and much lower than BaP in European cities. (Author abstract modified)

26763

Caretto, L. S., M. W. McElroy, J. L. Nelson, and P. D. Venturini

**AUTOMOBILE ENGINE DEVELOPMENT. TASK FORCE ASSESSMENT.** In: Projec Clean Air. California Univ., Berkeley, Dept. of Mechanical Engineering, Task Force, 1, Vol. 1, 68p., Sept. 1, 1970.

A review is presented of the current knowledge and ongoing research and development efforts in the area of automotive emissions and control. Basic pollutant formation processes, emissions characteristics of current engines, current and proposed control techn iques, alternative power plants, special problems of chemical analysis, and effects of fuels and additives are discussed. Five broad subject areas of recommended research projects are classified. The most economical means to meet future emission standards may be the use of catalytic control devices. Dual catalyst systems, catalytic materials, and catalytic control evices. Dual catalyst systems, catalytic materials, and catalytic control devices are the areas of emphasis in this subject area. The goal of the projects in the basic combustion area is to elucidate the mechanisms by which pollutants are formed in various engine combustion systems. The pollutants considered include carbon monoxide, nitrogen dioxide, hydrocarbons, smoke, and odors. In the area of conventional engines, the replacement of air by oxygen to eliminate nitrogen oxides is under consideration. Non-conventional vehicle studies include hybrid systems and Rankine engine systems. Research projects devoted to finding batteries of sufficient energy and power density to be used for vehicular applications include solid state electrolyte batteries and nonaqueous electrolyte batteries. The sources of uncontrolled automotive emissions include the exhaust, crankcase blowby, and evaporation. Present and future emission standards are tabulated. Discussions of the turbine and diesel engine are included, and the role of tetraethyl lead in the exhaust is demonstrated.

26891

Patterson, C. C.

**LEAD.** Preprint, California Inst. of Tech., Pasadena, Div. of Geological Sciences, 17p., 1970 (?). 37 refs.

Beginning with the Industrial Revolution, world lead production climbed from 100,000 tons/yr in 1750 to 3,500,000 tons/yr in 1966. The rise in production is summarized in a table of the tons of lead smelted or burned as alkyls per yr since 1750. Industrial lead, which until recently was recognized as only an occupational health hazard, enters the oceans by rivers and by atmospheric aerosols. Contributions from both routes gradually increased during past centuries, but poliution from the atmosphere increased abruptly during the last two decades as a consequence of the increased use of leaded automotive fuels. It is likely that man has polluted the mixed zone of northern hemisphere oceans with industrial lead to such a degree that most of the lead originally there has been displaced. It is also probable that the average lead concentration in these oceans has been elevated by a factor of two or three, with a subsequent elevation of the lead body burden in higher organisms near the ends of the food chain. Tentative estimates of lead concentrations in the 100 meter surface layer of northern hemisphere oceans and at 200 meters are 0.25 and 0.12 gamma Pb/kg water, respectively.

26925

Loucks, Ronald H. and John W. Winchester

**POLLUTION CONTRIBUTIONS TO THE ATMOSPHERIC INVENTORY OF CHLORINE AND BROMINE IN AEROSOLS OVER CONTINENTAL U.S.A.** In: I. Occurrence of Halogens in Atmospheric Aerosols and Precipitation. II. Air Pollution Inputs of Trace Metals to Lake Michigan Water. Michigan Univ., Ann Arbor, Dept. of Meteorology and Oceanography, AEC Contract AT(11-1)-1705, ORA Proj. 08903, PR-3, p. 233-250, May 1970. 29 refs.

Particle size distributions of chlorine and bromine in continental aerosols, determined by sampling with cascade impactors and analyzing by neutron activation, show marked differences from fresh marine aerosols. Calculation of major sources shows most of the Cl in continental aerosols to be derived from the sea, but most of the bromine appears to be derived from the combustion of ethyl fluid. Approximately 95% of the total U. S. bromine production, about 100,000 metric tons of Br per year, is converted to ethylene dibromide and burned with tetraethyl lead. Most of the Br containe in the lead halide aerosol appears to be volatilized in the atmosphere and may react further, probably by bromination of organic materials. (Author abstract)

27113

Craig, Paul P.

**LEAD IN THE BIOSPHERE - A CASE STUDY IN UNNECESSARY INDUSTRIAL POLLUTION.** Brookhaven National Lab., Upton, N. Y., 6p., 1970. NTIS: BNL 14661

The average American today carries about 200 mg of lead in his body mainly in his bones, equivalent to about 3 ppm by weight, or close to toxic level. Most of this lead is a result of the activities of man from such sources as tetraethyl lead in gasoline and lead used as solder (e.g., in food cans), batteries, and pewter vessels. Atmospheric lead arising almost entirely from gasoline additives accounts for at least a third of the lead in urban-dwelling Americans. The contribution is largest in people working in atmospheres heavily laden with gasoline fumes such as garage mechanics and traffic police; lead levels are highest in congested urban areas and near highways. The response of the body to low doses of lead is complex and poorly understood, and lead poisoning is particularly insidious and hard to diagnose when less than massive doses are involved. There is some evidence that lead at existing levels may be producing damage, and that this damage is most likely to occur in children. Lead is a totally unnecessary pollutant in our urban atmosphere which should be removed from gasolines without delay.

27180

Mayer, Ludwik and Eugeniusz Trybula

**CAUSES, CONSEQUENCES AND PREVENTING OF ATMOSPHERE POLLUTION BY EXHAUST GASES EMANATED FROM INTERNAL COMBUSTION ENGINES: PART I. (Przyczyny, skutki i zwalczanie zanieczyszczenia atmosfery gazami wylotowymi z silnikow spalinowych). Text in Polish. Nafta (Katowice), 26(6):176-182, 1970.**

In comparison with the pollution problems of certain American citie and those of London, Paris and the Ruhr industrial complex of Europe, Warsaw and other Polish cities are still not seriously threatened by the problems arising from the use of automotive vehicles with combustion engines. In 1968, the following statistic were given on the use of automotive vehicles in Poland: 1,266,000 motorcycles, 275,000 passenger cars, 243,000 trucks, 24,500 buses. The number of motorcycles decreased from 1966 to 1968, while there were slight increases in the other categories (about 13% for passenger vehicles in the two years). Poland used 6.3 million tons of petroleum products in 1968, and 4.8 million tons in 1965 (compared with 70.3 million for West Germany in 1965). Of this total, 1.72 million tons of gasoline was used in Poland in 1968, and 1.39 million tons in 1965. The chemical processes occurring in the internal combustion motor are briefly examined, and the various products present in automotive exhaust are examined separately (carbon monoxide, carbon dioxide, unburned hydrocarbons, aldehydes, nitrogen oxides, sulfur oxides, lead oxides, polynuclear hydrocarbons, soot and smoke). The formation of smog is also explained.

27249

Hurn, R. W.

**AIR POLLUTANTS FROM INTERNAL COMBUSTION ENGINES.** Preprint, American Inst. of Aeronautics and Astronautics, New York, 14p., 1971. 3 refs. (Presented at the Aerospace Sciences Meeting, 9th, New York, Jan. 25-27, 1971, Paper 71-122.)

The basic engine and fuel factors which influence pollutants are discussed in the context of achieving low emissions; the penalty to performance, if any, is also discussed. Advantages and disadvantages in the use of lead-free gasoline, natural gas, and propane are reviewed. Finally, the more prominent characteristics of the several types of internal combustion engines are summarized with respect to the potential each holds for development to meet clean-air requirements. With less air than required for complete combustion, carbon monoxide is produced in addition to the dioxide and, typically, more hydrocarbon is left unburned than is the case with fuel-lean mixtures. In spark ignited engines, very lean mixtures tend to misfire with a resultant sharp increase in hydrocarbon emissions. Ignition timing and injection also have an influence on hydrocarbon emissions. The concentration of oxides of nitrogen in combustion gases is dependent primarily upon peak flame temperature reached in the combustion, but oxygen availabilit and time-temperature history also have an influence. While the relationship to combustion parameters is not well defined, it is believed that aldehydes are produced as intermediates in the combustion process. High temperature stress upon fuels in the presence of oxygen yields aldehydes, and they therefore are produced in misfire of very rich mixtures and in quenched or partial combustion. Smoke is produced when fuel is burned with insufficient oxygen. Although odor sources and originating mechanisms are very poorly understood, attention to efficient air utilization and some engineering measures are effective in reducing combustion related odor. The amount of carbonaceous particulate is related primarily to the availability of oxygen and to quenching in the combustion process; the amount of lead particulate is related to lead in gasoline.

27272

Stafford-Gaffney, W.

**AIR POLLUTION AND THE MOTOR VEHICLE IN AUSTRALIA.** S. African Mech. Engr. (Johannesburg), 20(11):360-363, Nov. 1970.

The main causes of automotive pollution--emission of carbon monoxide, oxides of nitrogen, and unburnt hydrocarbons which form a photochemical smog under the action of bright sunlight--are outlined. These include incomplete combustion, weak or rich fuel- air ratios, and the mode of engine operation. Excessive diesel smoke results from poor maintenance of fuel pumps and injectors, excessive fuel enrichment under tempo-

rary loads as when hill climbing, or excessive engine overloading. In doses increasing from 50 ppm over an 8 hour period, CO can produce effects ranging from dizziness, loss of vision, and lack of muscular control to acute nausea, collapse, coma, and finally death. Carbon monoxide is absorbed in the blood stream and severely restricts the blood's oxygen carrying capacity. Lead alkyls and asbestos fibers are also mentioned as they result from motor vehicles. Desirable courses of action to combat pollution are discussed along with possible control methods for both gasoline and diesel engine emissions. Recommendations which include emission standards are suggested to prevent serious pollution problems from developing in Australia in the future. (Author abstract modified)

27458

Felt, Arthur E. and Robert V. Kerley

**USE OF LEAD-FREE GASOLINE CAN PRESENT SERIOUS PROBLEMS.** Automotive Eng., 79(3):54-56, March 1971.

Consequences of leaving the lead out of gasoline may include an increase in engine octane number requirements and larger quantities of undesirable exhaust pollutants. The carbonaceous deposits formed in the absence of lead have a higher heat capacity than lead deposits, and so, after extended mileage, the result is a higher octane requirement for the engine operated on nonleaded gasoline. Aromatic blending stocks are used to bring back the octane number 'lost' when the lead is left out of gasoline, and the various emissions are increased in proportion to this increase in aromaticity. Results of octane measurements with 26 pairs of cars, one car of each pair having been operated on nonleaded gasoline and the other car on leaded gasoline, are mentioned. The major direct chemical effect of removing lead is an increase in the aldehyde content of the exhaust. The indirect effects occur when aromatic hydrocarbons are used to upgrade the octane number of gasoline in the absence of lead. There are three primary indirect effects: increased aromatic aldehydes, increased photochemical (smog forming) reactivity of the exhaust gases, and increased emission of polynuclear aromatics and phenols. The presence or absence of lead antiknocks in a fuel of constant hydrocarbon composition has no effect on polynuclear aromatic hydrocarbon emissions. The controlling factor is the aromatic content of the fuel burned. Some of these hydrocarbons are known to induce tumor formation in experimental animals.

27595

Carroll, Robert E.

**TRACE ELEMENT POLLUTION OF AIR.** Missouri Univ., Columbia, Environmental Health Center and Missouri Univ., Columbia, Extension Div., Proc. Missouri Univ. Third Annu. Conf. Trace Substances Environ. Health, Columbia, Mo., 1969, p. 227-231. 6 refs. (June 24-26.)

Trace elements constituting a present or potential community health hazard include lead, cadmium, beryllium, barium, nickel, and fluorides. As a contaminant from motor vehicle fuel, lead is known to be present in amounts sufficient to raise the body burden. Cadmium has been linked to hypertensive diseases, and high air levels seem to be correlated with increased mortality. Beryllium is recognized as a serious industrial hazard that can produce disease at very low concentrations. Because of its use in rocket and missile fuels, community beryllium levels must also be carefully monitored. Barium has become a community concern because of its increasing use as a motor vehicle and diesel fuel additive. No health effects have been demonstrated from current nickel levels, but further research is needed. Excess fluoride in air may pose regional problems involving contamination of animal forage or plant damage. A major problem in evaluating trace elements is that very little is known about the ecological cycles from air-to-food chains and water supplies. (Author abstract modified)

27858

Kohayagawa, Takeshi

**PROBLEM OF POLLUTION DUE TO AUTOMOBILE EXHAUST GAS.** (Jidosha haishutsu gasu kogai no mondai). Text in Japanese. Nippon Kikai Gakkai Shi (J. Japan Soc. Mech. Engrs. (Tokyo), 74(626):217-227, March 1971. 59 refs.

The extent to which lead in gasoline must be reduced is still an open question since leadless gasoline is likely to cause valve recession in existing automobiles and thus contribute to air pollution. Moreover, lead-free gasoline will have a low octane number unless aromatic hydrocarbons are added, and these cause photochemical smog. If the octane number is kept low, air pollution will be enhanced. The photochemical smog characteristic of Tokyo is unique in that the presence of peroxyacyl nitrates has not been detected nor ozone clearly identified. In Japan, 1973 and 1975 are target years for the reduction of air pollution. Problem area in controlling automotive emissions include methods for testing hydrocarbon activity, vapor loss, nitrogen oxides, airborne particulates, odors, and diesel smoke. To achieve emission reductions from 2-cycle and 4-cycle engines by the target years, studies are being conducted on improvements of engine factors, catalytic oxidation, secondary combustion, and improved fuels. In the case of 4-cycle engines, air-to-fuel ratios and improvements in ignition are also under investigation.

27943

Romanovsky, J. C.

**CRITERIA AND STANDARDS RELATING TO TRANSPORTATION AND ITS EFFECTS UPON AIR POLLUTION CONTROL.** Preprint, Air Pollution Control Assoc., Mid-Atlantic States Section, 13 p., 1970. (Presented at th Air Pollution Seminar, Harrisburg, Pa., Oct. 8-9, 1970.)

The Department of Health, Education, and Welfare has issued four ai quality criteria documents that impinge directly on the problem of transportation and air pollution. These documents deal with particulate matter, carbon monoxide, hydrocarbons, and photochemica oxidants. Particulates in the respiratory tract may produce injury separately or by acting in conjunction with gases. Lead and polycyclic organic matter are more specific components of the unclassified particulate matter common to urban atmospheres. Carbon monoxide is absorbed through the lungs and reacts primarily with the hemoglobin of red blood cells, thus decreasing the oxygen- carrying capacity of the blood. Levels common to polluted atmospheres have been related to the impairment of time-interval discrimination and visual acuity. Photochemical oxidants cause irritation of mucous membranes, damage to vegetation, and deterioration of materials. They affect the clearance mechanism of the lungs and alter resistance to respiratory bacterial infection. They have been implicated, too, as accelerators in the aging process. Hydrocarbons serve as precursors of other compounds that result in photochemical smog. Nitrogen oxides are also essential ingredients of the photochemical smog system. They have been associated with increased incidences of acute bronchitis and damage to vegetation and materials.

28210

Bolotov, M. P.

**CERTAIN SOURCES OF LEAD IN SOIL AND STREET DUST OF CITIES.** (O nekotorykh istochnikakh svintsa v pochve i v ulichnoy pyli gorodov). Text in Russian. Gigiena i Sanit., no. 1:49-50, 1940. 3 refs.

Lead content was determined for dust samples taken from various surfaces in the cities of Kranodar, Moscow, and Leningrad. Highest lead content was found in samples taken from rubber footwear (2368 mg/100 g), and in paint and scrapings from zinc- plated roofing (1860 mg/100 g). It is concluded that corrosion, abrasion, and atomization of lead-bearing materials constitutes an important pollution source.

28336

Kleinert, Reinhard

**GENERAL AND SPECIAL MARKETING QUESTIONS OF THE METAL LEAD.** (Allgemeine und spezielle Marktfragen des Metalls Blei). Text in German. Z. Erzbergbau Metallhuettenwesen, 24(1):18-25, 1971. (Presented at the Gesellschaft Deutscher Metalhuetten- und Bergleute Meeting, Berlin, May 28, 1970.)

Lead is used to manufacture storage batteries, cable sleeves, dyes and as an antiknock agent and for soldering metal. The use of tetraethyl lead is widely debated, some groups demanding a total prohibition. The outcome of this controversy cannot be predicted. The chairman of Ethyl Corp., USA, is resisting all efforts to introduce lead-free gasoline, which will cost the consumer much more. It is not positvely known whether lead contributes to air pollution; lead-free gasoline with a high octane content is dangerous to human health. It is assumed that some content is dangerous to human health. It is assumed that some limitation in the use of tetraethyl lead will be introduced in all industrialized countries sooner or later. In Great Britain, consumption of tetraethyl lead rose rapidly between 1967 and 1968, while a regressive tendency was observed between 1968 and 1969. On the average, the world's lead consumption will rise between 2.5 and 3.5% before 1980.

28394

Dabelstein, Werner

**THE PROBLEM OF LEADING GASOLINE.** (Zur Problematik der Benzinverbleiung). Text in German. Erdoel Kohle (Hamburg), 24(1):37-40, Jan. 1971. 16 refs. (Presented at the DGMK Bezirksgruppe Hamburg - Bremen, Hamburg, West Germany, Nov. 24, 1970.)

Lead alkyls, primarily tetraethyl lead and more recently tetramethy lead, have been used for more than 40 years as antiknock additives for gasolines for Otto engines to increase the octane number of the gasoline. Straight-run gasolines have octane numbers between 30 and 70 while Otto fuels containing lead have octane numbers of 100 (super) and 93 (normal). Removing lead from gasolines while maintaining the octane number would cost refineries four billion dollars. This would mean an increase in the price of gasoline 2-5 cents/gallon. Extensive experiments and observations have shown that there are no substitute additives for lead alkyls. Lead-free gasolines would not satisfy engines designed for super gasolines. Cars which run with normal gasoline would have to switch to lead-free super gasoline and no market would be left for lead-free normal gasoline. The major efforts, therefore, concentrate on reducing the lead content rather than eliminating it entirely. As studies have shown, the effects of leaded gasolines on humans are not as harmful, as once thought. Lead intake from food and drink is ten times as high as by inhalation. Ninety percent of the lead intake (including inhaled lead) is discharged directly, only 10% entering the blood stream.

28560

Rixmann, W. and K. E. Hailer

**CONTRIBUTION TO AUTOMOBILE TECHNOLOGY - A RETROSPECTIVE VIEW OF THE VDI/ATG MEETING IN MANNHEIM 1970.** (Beitraege zur Fahrzeugtechnik - Rueckblick auf die VDI/ATG-Tagung in Mannheim 1970). Text in German. (Automobiltechnische Zeitschrift) (Stuttgart), 73(2):62-71, Feb. 1971. 6 refs.

At the meeting of the expert panel on automobile technology (ATG) of the Association of German Engineers (VDI) in Mannheim, 1970, waste-gas emission from the rotating combustion engine, composition of exhaust gas from the FM-gasoline engine, and gas turbines for trucks were among the subjects discussed. Because waste-gas temperatures in Wankel engines are high (1000 to 1150 C), use of a hot flame reactor behind the engine is feasible. Ignition timing has been so optimized that exhaust- gas temperatures remain rather high over the entire operation range. The air quantity in the waste gas is 20%. According to the California test, the exhaust gases contain 150 ppm hydrocarbons and 1.02% by volume carbon monoxide. The FM engine reduces noxious emissions by influencing combustion. The formation of nitrogen oxides in the FM engine corresponds approximately to that of the diesel engine. Fuels with a lower lead content will pose no problems for the FM engine. The 350 HP gas turbine still operates at temperatures around 920 C and without a heat exchanger. The latter is in the development stage. The emission level of the gas turbine is much lower than of diesel engines, and the exhaust gases are also less noxious than those of diesel engines. A maximum of 320 to 400 ppm of nitrogen oxides, 0.1 to 0.01% by volume CO, and 150 to 0 ppm hydrocarbons is presently emitted.

28862

Dreessen, Waldemar C., Thomas I. Edwards, Warren H. Reinhart, Richard T. Page, Stewart H. Webster, David W. Armstrong, and R. R. Sayers

**THE CONTROL OF THE LEAD HAZARD IN THE STORAGE BATTERY INDUSTRY.** Public Health Bull. no. 262, 138p., 1941. 64 refs.

Following a preliminary survey of 26 lead storage battery factories the working environment was investigated in 13 plants. Manufacturing processes were studied to find out what materials were used in each operation and what products and by-products resulted. Air samples were taken at strategic locations to ascertain the atmospheric lead concentrations at the breathing level of workers. Samples were also taken under controlled and uncontrolled conditions to test the efficacy of control methods. In six of these factories, field offices and laboratories were set up and 766 male employees were examined. Blood specimens from each worker were divided for hematologic studies, chemical analysis of lead content, and a Kahn test; a urine sample was subjected to the usual chemical and microscopic tests. Nine men, all exposed to atmospheric lead concentrations in excess of 1.5 mg Pb per 10 cu m of air were diagnosed as cases of incipient plumbism. There were 168 men diagnosed as cases of lead absorption less affected than the cases of incipient plumbism. The prevalence of early plumbism increased with increasing atmospheric lead concentration. A study of the diagnostic value of several laboratory tests was made. Urinary lead concentrations correlated well with blood level concentration. Reticulotyte percentages (Osgood), stipple cell counts, and polychromatophilia were so

related in their occurrence that if one of these types of cell was found to be abundant the other types were likely to be numerous also. Albuminuria was found twice as frequently among lead-affected workers as among nonaffecte workers. No relation was found between atmospheric lead exposure and the occurrence of arteriosclerotic-hypertensive heart disease. Three-plus or four-plus Kahn reactions were obtained in 2.2% of the workers. Equipment and practices found to be effective in reducing lead exposure are discussed.

28873

Starkman, Ernest S.

**FORMATION OF EXHAUST EMISSION IN THE COMBUSTION CHAMBER.** Preprint, Federal International Societes Ingenieurs Technique de l'Automobile and Society of Automotive Engineers, New York, 21p., 1970. 14 refs. (Presented at the International Automobile Safety Conference Brussels, Belgium, 1970, Paper 15.3.D.)

A combination of optical methods and direct sampling of the combustion gases was applied to the cylinder of a spark ignition engine. The instantaneous concentrations of gases were studied. In addition to fixed species, such as carbon dioxide, carbon monoxide, and unburned hydrocarbons, the concentration of hydroxide was also measured. The formation of CO, NO, and unburned hydrocarbons and why they appear in the exhaust in relatively large quantities than simple theory predicts was determined. Engine variables as well as the effect of lead alkyl anti-knock agents were investigated. The effects of engine speed, spark timing, and fuel-air ratio are included. The influence of lead, both on the composition of gases in the cylinder as well as in the exhaust is reported. (Author summary modified)

29096

Vogel, Hans

**MAN, HIS ENVIRONMENT AND TECHNOLOGY.** (Der Mensch, seine Umwelt und die Technik). Text in German. Chem. Rundschau (Solothurn), 24(13):257, 259, March 31, 1971.

Above our cities hovers a haze which absorbs about 20% of the sunlight. In such polluted areas, 20 to 30% of the children suffer from rickets. About 350 chemical compounds, some of which are extremely toxic, are contained in gaseous particulate and emissions. Among them are carcinogenic substances and substances toxic to the respiratory, circulatory, and nervous systems. The emissions stem from stacks, automobiles, and home machines. The haze above Tokyo is so dense that is residents rarel see the sun. Pollutants have been measured at a height of 14 km above cities in the United States. Even the poles and the deserts suffer from air pollution. Lead from automobile exhausts has been determined in arctic ice. Carbon monoxide and nitrogen oxides pollute not only air but also water. The higher carbon dioxide content of the ambient air causes climatic changes. The equilibrium between assimilation and dissimilation is disturbed. The oxygen background concentration is one the decrease because of its consumption by combustion processes.

29127

Stacey, M. J.

**OIL REFINERS PREPARE FOR ANIT-POLLUTION CONTROLS.** Chem. Process Eng., 52(3):63, 65, 67, 69-70, March 1971.

Oil refineries are using many processes to reduce pollution in two areas--sulfur dioxide and particulate pollution from industrial and power generation installations, and the more complex pollution caused by motor vehicles. Fuel oils cause about 15% of all atmospheric SO2 pollution, as well as pollution caused by inccompletely-burned hydrocarbons, nitrogen oxides, and partial oxides of other oil contaminants. These pollutants are eliminated simultaneously by the processes of vacuum distillation, visbreaking (a modern thermal cracking process), and hydrogenation. Although medical research shows little evidence for the elimination of lead from gasoline, it has become a target for anti-pollution campaigners. The alkylation processes, which produces a high-grade gasoline blending stock from refinery gases, is likely to replace the use of lead alkyls to improve octane rating. Because European gasoline taxes are high, they encourage production of high-octane fuels. Thus, cracking processes such as polymerization and its modern counterpart, alkylation, will be increasingly used to produce gasolines of higher octane ratings which can also be blended with lower octane fuels. Although aromatic compounds also have high octane ratings, they produce unburned hydrocarbons. Afterburners can be used to limit hydrocarbon emissions.

29364

Kimura, Motoo

**AUTOMOTIVE FUELS AND AIR POLLUTION BY AUTOMOTIVE EMISSION.** (Jidosha yo nenryo to haishutsu gasu taiki osen). Text in Japanese. Jidosha Gijutsu (J. Soc. Automot. Engrs. Japan), 25(3):303-314, March 1971. 28 refs.

Air pollution caused by automotive emission was reviewed with emphasis on the automotive fuel, gasoline. It is suggested that de-leading and other increasingly severe requirements imposed upon the gasolines lack definite scientific grounds in Japan, and no definite conclusion is yet available either on the relationship between the constituents of fuels and those in automotive exhaust gases or on the effects on human health of lead compounds contained in the exhaust gas. Various studies on carbon monoxide, hydrocarbons, and nitrogen oxides in automotive emissions are reviewed. Since HC is an important constituent in photochemical reactions, the total reactivity against the quantity of aromatics in the fuel is discussed. It is indicated that the reactivity remains practically unaffected by the quantity of olefin in the fuel, and that the photochemical reactivity of the exhaust gas is not notably affected by fuel composition. The effect of tetra-alky lead and of de-leading gasolines is discussed. The emission of lea compounds from automotive engines is described. The negative factors resulting from the de-leading of gasolines such as valve recession and the subsequent increase in the cost of automotive fuel are emphasized.

29516

Urlaub, A.

**THE EXHAUST GAS COMPOSITION AT THE FM GASOLINE ENGINE.** (Ueber die Abgaszusammensetzung beim FM-Benzinmotor). Text in German. Automobiltech. Z. (Stuttgart), 73(4):115-121, April 1971. 3 refs. (Presented at the VDI-ATG Tagung, Mannheim, West Germany, Oct. 1970.)

The carbon monoxide emission of the FM engine is far below the maximum allowable concentration in California--130 g CO/kg fuel referred to lamda equals 1. Hydrocarbon emissions from FM engines were measured with both a flame ionization detector and an infrared analyzer. Again with reference to California standards, the hydrocarbon emissions were far below the allowable maximum value of 8.5 g CH/kg fuel in almost all operating ranges. By curtailing the air intake in FM engines, a further hydrocarbon reduction is achieved. Emis-

sions of nitrogen oxides from FM engines are comparable to those of diesel engines and lower than those of Otto engines. On the average, 15 to 20 nitric oxide kg fuel are emitted at lamda equals 1. The maximum allowable NO emission will be reduced in California to about 7.5 g NO/kg fuel beginning in 1974. This limit is not yet met by FM engines. By delaying combustion, the NO emission can be reduced from 20 g NO/kg fuel to 10 to 15 g NO/kg fuel. While this will increase CO emissions, they will remain below the California limit. Hydrocarbon emissions will also rise but not above the set limits. FM engines operate smoothly on lead-free or low-lead gasolines.

29539

Eda, Shizuo, Hiroshi Ito, Hiroshi Hikichi, Yoshiichi Funayama, Shijeo Nagayama, and Kaoru Nishiyama

**HEAVY METAL POLLUTION IN THE ONAHAMA INDUSTRIAL AREA. 1ST REPORT. DISTRIBUTION OF HEAVY METALS IN SOIL.** (Onahama kogyo chitai niokeru jukinzoku osen. Dai 1 po. Dojo no jukinzoku osen bunpu to sono kento). Text in Japanese. Fukushima Kogyo Koto Senmon Gakko Kiyo (Mem. Fukushima Tech. Coll.), 7(1):22-32, 1971. 15 refs.

The amount of heavy metal pollution in the Onahama industrial area soil was determined by an atomic absorption spectrometer. The concentration of cadmium, lead, copper, and zinc was 1.07 to 0.27 ppm, 51 to 12 ppm, 65.7 to 12.6 ppm, and 172.4 to 35.1 ppm respectively. The metal ratio Cd:Pb:Cu:Zn was 1:48:65:170. This pollution occurred more than two km from A refinery and was caused by the high stacks of the A and B refineries. The rate of cadmium compound sedimentation at Minamitomioka village in Onahama was 36 mg Cd metal/sq m, year. If the present rate of pollution continues the heavy metal concentration in the soil would be about three times the present concentration in 10 years. The quality grade of ore and the heavy metal ratio in the soil are used to determine whether copper or zinc is a greater pollutant.

29572

Paluch, Jan and Stanislaw Karweta

**AIR POLLUTION BY LEAD AND ZINC IN THE AREA OF COMBINED METALLURGICA WORKS AND ITS INFLUENCE ON VEGETATION AND SOIL.** (Die Luftverunreinigung durch Blei und Zink im Bereich eines metallurgischen Kombinates und ihr Einfluss auf Vegetation und Boden). Text in German. Wiss. Z. Humboldt Univ. Berlin Math. Naturw. Reihe, 19(5):495-497, 1970.

A study was made for over three years in the area of a large non-ferrous metals plant that started operations in 1966, and which was located in a formerly very clean wooded area. Its production includes zinc oxide and lead; by-products include sulfuric acid and ammonium sulfate. The zinc oxide melting furnaces emit about 30 tons of gas per month, containing about 50% zinc plus lead. Additional quantities of zinc and lead dust in the air originate from the charging of the furnaces with powdered raw material, from transportation and handling of scrap material, from the sintering plant for zinc-lead ores, and from the shaft furnace in which the metal oxides are reduced to metals. A distinct increase in dust fall and air pollution in the areas adjacent to the plant was observed, reaching a peak two years after start of operations, and then leveling off. Emission of zinc- and lead-bearing dust into th air was found to cause an accumulation of these metals in the soil and in plants, the accumulation in the soil was observed only in the surface layers. The emission of zinc and lead from the melting units takes place mainly in the form of oxides which are emitted together with considerable quantities of calcium oxide. The accumulation of these three metal groups leads to soil alkalinity. The process of assimilation of zinc and lead in plants is far more intensive than in the soil.

29661

Hasegawa, Toshio, Akiyoshi Sugimae, and Junko Fujii

**DETERMINATION OF LEAD CONTENTS IN AUTOMOBILE EXHAUST GAS.** (Jidosha haikigasu chu no namari ni tsuite). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 5(1):253, 1970. 3 refs. (Presented at the Japan Society of Air Pollution, Annual Meeting, 11th, Japan, 1970.)

Lead content and size were determined for the exhaust gas from running automobiles at the speed of 10 to 70 km/hr. Dust in the exhaust gas was collected by high volume air sampler and/or Cascade Sampler. The lead content of the dust collected on glass fiber filters was determined by emission spectrochemical analysis. The content was 6300 to 6500 microg/cu m at low speed and up to 3900 microg/cu m at high speed. More than 99% of this lead dust was less than 1 micron in size. The ratio of lead dust/total dust was 23% at low speed and 83% at high speed.

29782

Becker, K.

**WHY LEAD IN GASOLINE? THE EFFECT OF LEAD CONTAINING ANTI-KNOCK AGENTS FOR OTTO ENGINE FUELS.** (Warum Blei im Benzin? Wirkungsweise von bleihaltigen Antiklopfmitteln fuer Ottokraftstoffe). Text in German. VDI (Ver. Deut. Ingr.) Nachr. (Berlin), 25(9):7, 1971.

Since the discovery of the anti-knock effect of tetraethyl lead in 1920, this compound has been used as antiknock agent for gasolines. Usually 0.5 gPb/l are added to achieve octane numbers of 5 to 10. In spite of intense research, the exact operating mechanism of tetraethyl lead as antiknock agent remains known; however, the chain break theory is generally accepted. It is estimated that 70 to 80% of the lead residues are emitted; the remaining particles deposit in the combustion chamber and occasionally are loosened and then emitted. As the combustion chamber of the engine becomes smaller, because of the depositions, the octane number increases. However, these lead residues do reduce wear and tear. All attempts to replace tetraethyl lead with another antiknock agent have failed, since other compounds are either uneconomical or even more toxic than the lead compound.

29786

Becker, Karl H.

**PHYSICAL-CHEMICAL PROBLEMS OF AIR POLLUTION.** (Physikalisch- chemische probleme der Luftverunreinigung). Text in German. Chem. Unserer Zeit., 5(1):9-18, Feb. 1971. 46 refs.

Principal air pollutants are reviewed. Carbon monoxide is generated by the incomplete combustion of fossil fuels, for instance in an automobile engine which emits 0.5 to one ton of carbon monoxide per automobile per year. Since CO is converted to the harmless carbon dioxide at elevated temperatures only, it can stay in the atmosphere for two to three years. Sulfur dioxide is produced when heavy fuel oils and coal, containing sulfur in various concentrations are burned. When in the air, sulfur dioxide is oxidized to sulfur trioxide, which can combine with water vapor to form sulfuric acid and can cause the formation of smog which disappears from the atmosphere with rain. Hydrocarbons are emitted by petrochemical industrial plants and are also components of automobile exhausts. Automobile exhausts also emit nitric oxide and nitrogen dioxide.

Halides as pollutants usually occur in small concentrations, except in some areas of steel and aluminum producing plants where greater concentrations of hydrochloric and hydrofluoric acids may occur. The incineration of scrap synthetic materials, such as polyvinyl chloride and teflon also cause pollution from the chlorine and fluorine compounds. Other pollutants mentioned are carcinogens such as benzpyrene and other polycyclic hydrocarbons contained in the soot emitted by diesel engines and lead compounds present in automobile exhaust gases, if gasoline containing tetraethyl lead as antiknock agent is used.

29787

Eda, Shizuo, Hiroshi Ito, Hiroshi Hikichi, Sadakichi, Ejiri, Shigeo Nagayama, and Kaoru Nishiyama

**INVESTIGATION OF HEAVY METAL POLLUTION IN IWAKI CITY.** (Iwaki shi ni okeru jukinzoku osen chosa). Text in Japanese. Kogai to Taisaku (J. Pollution Control), 7(4):317-324, April 1971. 15 refs.

There are pollution problems of sulfur dioxide, heavy metals, dust, hydrogen sulfide, cyanide, mercury, and cadmium, in the Onahama industrial area. Analyses of the soil, paddy field rice, cadmium, copper, zinc, lead, and other heavy metals. Results showed that there is typical heavy metal pollution of the air which is carried by the wind. There is no need to worry about pollution of paddy fields, upland fields, and soils by factory effluents. Cadmium pollution of the soil exceeding 1 ppm is seen in only a few spots, and is considerably lower than Bandai Town, Fukushima Prefecture. A Pollution Prevention Agreement was imposed. The enterprises must comply with smoke emission standards and environmental standards and adjust their operation in accordance with meteorological conditions.

29872

Bryce-Smith, D.

**LEAD POLLUTION--A GROWING HAZARD TO PUBLIC HEALTH.** Chem. Brit., 7(2):54-56, Feb. 1971. 21 refs.

Levels of airborne lead are noted to have increased markedly since the Industrial Revolution, and very sharply since about 1940. The increase is particularly important because approximately 50% of airborne lead can be absorbed on inhalation, in contrast to the 5-10% absorbed from lead-contaminated food and water through the alimentary tract. Several studies have shown the principle source of airborne lead to be the lead-containing aerosol emitted with exhaust fumes from motor vehicles operating on gasolines with lead alkyl antiknock agents. As determined by a U. S. study, no other toxic chemical pollutant has accumulated in man to average levels so close to the threshold for overt clinical poisoning. Among the general population, blood-lead levels alone exceed those at which interference with metabolic processes can occur. Among children, even modest elevations of blood lead appear to be associated with biochemical abnormalities in the brain.

29936

Yamamoto, Takeo, Konosuke Nishida, Takashi Suzuka, and Tsuneo Honda

**ON COMPOSITION AND LEAD CONTENT OF COMMERCIAL GASOLINE.** (Shibai gasorin no sosei to enganryo ni tsuite). Text in Japanese. Preprint, Japan Society of Civil Engineers, Osaka, Kansai Branch, 2p., 1971. (Presented at the Japan Soc. Civil Engineers, Osaka, Kansai Branch, Annual Meeting, May 9, 1971, Paper 11-57.)

A study was conducted to determine if commercial gasoline contains more aromatics than before to compensate for decreased octane value resulting from reduction of the lead content in the fuel. If this is so, benzene, formed as a result of cracking or decomposition of heavy aromatics and similar unburnt substances, will increase to cause air pollution. The test samples were collected from 120 gasoline stands selected at random from among 400 located in Kyoto in July 1970 and Feb. 1971. The samples were collected at two different times to compare the lead content before the industry s voluntary control of lead content with that after voluntary control An atomic absorbency spectrometric analyzer was used for analysis of the lead content and a gas chromatograph for aromatic content. According to the gas chromatogram obtained, the two samples contained an extra-large amount of toluene indicating that some commercial gasolines have added thinner, organic solvent, or white oil. These two samples were sold at very low prices. Those found to contain benzene in excess of 5% weight, the regulatory criterion, accounted for 25% of the total number of samples. The TEL-converted value of the lead content indicated practically the same average value for all the manufacturers but one. The average value was somewhat lower than the JIS specification (0.79 ml/1). Some samples from the same manufacturer showed a lead content value of only 1/2-1/6 the average value for the same manufacturer. This causes some question as to product uniformity. All samples collected after commencement of the voluntary control showed less lead content than before. Results indicate an upward trend of aromatic content to secure a high octane value in line with the decreasing lead content of commercial gasoline.

30001

Clay, A. J.

**MARKET TENDENCIES FOR LEAD AND ZINC.** (Tendenzen auf dem Markt fuer Blei und Zink). Text in German. Metall. (Berlin), 25(5):523-524, 1971.

One reason for the decrease in the market for lead observed over the past six months of the last year is the controversy over lead in gasolines. Many countries introduced regulations to reduce the lead content in gasolines. There are signs of a new awareness, however, that lead is probably the least toxic substance in the exhaust gases of automobiles. Elimination of lead might, under certain circumstances, worsen the exhaust emissions. Because of pending regulations and the anti-lead drive, a surplus of 12,000 metric tons arose.

30027

Hawkes, A. S.

**GASOLINE, LEAD AND AIR POLLUTION.** World Petrol., 42(5):142, 144, 1946, June 1971. 13 refs.

Available evidence indicates that lead in automobile exhaust gas is not injurious to public health and that removal of lead from gasoline additives would reduce hydrocarbon emissions by only 1%. The presence of lead in gasoline is without effect on carbon monoxide emissions. Moreover, present catalytic exhaust control devices are ineffective with both leaded and unleaded gasolines. Octane requirements of unleaded-fuel cars average 6.3 research octane number (RON) higher for cars designed for regular-grade gasoline and 4.6 RON higher for premium-gasoline cars. It is also generally acknowledged that engines operating on unleaded gasoline face serious valve failure in a comparatively short period. In addition, removal of lead from gasolines will cause significant changes in the photochemical reactivity of exhaust gases by increasing emissions of partially oxidized aromatic hydrocarbons.

30067

Blanchard, Lawrence E., Jr.

**TAKING ANOTHER LOOK BEFORE WE TAKE THE LEAD OUT.** Automotive Eng., 78(12):24-29, Dec. 1970.

Although lead is incompatible with all catalysts that have been suggested for use in catalytic converter systems to reduce engine exhausts neither is any catalyst available for use with unleaded gasolines; removal of lead will only lead to inefficient cars at increased costs. Moreover, removal of lead antiknocks from all gasolines would reduce particulates in the atmosphere only about 1% on the average, and any improvement in visibility would be more than offset by the smog effects of the reactive hydrocarbons necessary to replace lead. As indicated by one recent study, the photochemical reactivity of auto emissions was increased by as much as 25% when a typical leaded gasoline was replaced with a prototype unleaded fuel. Future emission standards can be met by operating automobiles either with excess fuel or with excess air. These approaches have already been successfully tested on prototype cars and could easily be adopted to production models.

30414

Ubisch, Hans von and Karl Westerlund

**THE CONCENTRATION OF CARBON MONOXIDE IN A CITY BUILDING AND IN UNDERGROUND GARAGES.** Nord. Hyg. Tidskr. (Stockoholm), 52(1):48-52, 1971. 1 ref.

Although the pollution of urban outdoor air is well documented, that of indoor air has been neglected. A study was conducted to determine carbon monoxide concentrations inside a building and in underground garages. The results from measurements inside the building showed the variations of the traffic intensity in the area for Monday through Friday. Records from Saturdays and Sundays showed nothing more than another traffic rhythm. The contribution of smokers was negligible. However, if revolving doors are used, they may introduce carbon monoxide-rich air from the street level. The most important factor was the height of the air intake above street level. The CO in four underground garages was measured in the air intake and outlet. The ventilation systems were designed to keep CO-levels below the maximum allowable concentration levels. Carbon monoxide production per visiting car was calculated for the garages as 64, 51, 33, and 48 liters respectively. The differences reflect depths and distances in the garages and the type of traffic. Dusts were also sampled at the building and garages. Lead levels were approximately 0.5-one percent; iron levels were higher and zinc levels, lower.

30428

Ault, Wayne U., Ronald G. Senechal, and Woodland E. Erlebach

**ISOTOPIC COMPOSITION AS A NATURAL TRACER OF LEAD IN THE ENVIRONMENT.** Environ. Sci. Technol., 4(4):305-317, April 1970. 8 refs. (Presented at the American Chemical Society Meeting, Symposium on Air Conservation and Lead, 157th, Minneapolis, Minn., April 14-15, 1969; includes discussions by Paul W. Gast and Richard B. Holtzman.)

The isotopic ratio of lead-206 to lead-204 was investigated as a means of defining the lead in various environmental media; this isotopic ratio, together with appropriate abundance data, would allow distinguishing between lead from different sources. Significant differences were found in the lead isotopic ratios in rock and soils, grasses, tree leaves and tree rings, air particulates, and in some industrial products such as coal, fly ash, gasoline, and fuel oil. Leaf, grass, and soil samples taken across the New Jersey Turnpike showed a change in lead isotopic ratios from the Turnpike to a point one mile to windward. The mean value of the Pb-206/Pb-204 ratio in topsoil within 500 feet of the Turnpike was 18.2 plus or minus 0.2 and beyond 500 feet was 18.7 plus or minus 0.15. Lead sampled from soil profiles in two forested locations in northern New Jersey showed an increase in Pb-206/Pb-204 ratios, with depth from 18.7 to 19.9 in a 30-inch profile. The lead abundance decreased from 47.5 to 12.0 ppm. The mean ratios of Pb-206/Pb-204 from coal and gasoline analyzed were 18.8 plus or minus 0.2 and 18.3 plus or minus 0.3, respectively. The mean value for the same ratio in the published data on coal is somewhat higher. Fly ash and the coal from which it came both contained lead of the same isotopic ratio. (Author abstract modified)

30513

Kobaysshi, Yoshitaka

**ENVIRONMENTAL POLLUTION PREVENTION MEASURES IN FACTORY.** (Kojo ni okeru kogai boshi taisaku). Text in Japanese. Preprint, Safety Engineering Assoc., Tokyo (Japan), 22p., 1970. (Presented at the Association of Safety Engineering Seminar, 19th, Yokohama, Japan, Nov. 26-27, 1970.)

Various forms of environmental pollution for which industrial activities are primarily responsible are discussed, including the results of a survey of measures taken by 2512 plants to combat industrial pollution. With regard to air pollution, several major cities in the U. S. are compared with Tokyo in terms of sulfur dioxide, hydrocarbon, oxidant, carbon monoxide, and nitric oxide. Sources of industrial pollution are tabulated to indicate types of air pollutants discharged from particular branches of industry; for instance, SO2 from power generation, iron and steel manufacturing, oil refining and petrochemical operations. Of the 2512 plants surveyed in February 1970, only 1089 attempted to check industrial pollution. Antipollution measures being taken by representative firms are also listed by individual firms. The effects of sulfur oxides on human health is shown by a graphic representation of the case of Yokkaichi asthma; according to the graph, significant health effects are seen when man is exposed to air with an SO2 density of even less than 0.02 ppm for about a year, or to air with 1.0 and 2.0 ppm SO2 for a few minutes. The atmospheric density of CO (ppm) and rate of carboxyhemoglobin in blood (%) are discussed in relation to human health. A table of chemical substances with their critical density for offensive odors is given as well as a diagram indicating lead density by month in relation to rainfall and wind velocity. Another diagram indicates photochemical process in an experimental case and still another shows the relationship between lead density and cadmium density in the atmosphere.

30604

Matthes, Dieter

**REFLECTIONS ON THE PROBLEM OF AIR POLLUTION BY AUTOMOBILES.** (Ueberlegungen zum Problem der Luftverunreinigung durch Kraftfahrzeuge). Text in German. Tech. Ueberwach. Sicherheit Zuverlaessigkeit, 12(6):181-185, June 1971.

The conditions under which pollutants are emitted by the internal combustion engine, ways in which their emission can be limited, the testing of engines for the emission of pollutants, legislation governing their maximum emission levels in the U.S.A. and in Europe, and alternative automobile propulsion systems are reviewed. Both in the U.S.A. and in Europe, maximum emission levels are in force for carbon monoxide and hydrocarbons only until 1974. Since no simultaneous reduction of CO, HC, and nitrogen oxides through measures affecting

the thermodynamics and the kinetics of combustion in the engine can be expected within the next few years, a reduction of CO and HC can currently be accomplished only by means of afterburners and the catalytic oxidation of exhaust gases. A partial solution would be to feed the engine with a rich full mixture (lambda smaller than one) to reduce NOx emission to a simultaneously control CO and HC by afterburners, but this is unsatisfactory because it is uneconomical. No catalyst has been found which could withstand the presence of lead in gasoline; this, if catalytic oxidation of exhaust gases is to be introduced, lead will have to be eliminated from fuels. All measures designed to reduce pollution reduce the output of engines. Alternative propulsion systems are the internal combustion engine with rotary pistons whose high HC emission is compensated by higher combustion temperatures which potentiates the effectiveness of afterburners; engines fed by gaseous fuels which have very low CO and HC emission and tolerable NOx emission levels; gas turbine engines with low CO and HC emission which are used only for commercial vehicles because of cost of interest; the Stirling engine with low CO, HC, and NOx emissions whose construction problems have however not yet been solved satisfactorily; the steam engine with low CO, HC, and NOx emissions which is unwiedly, expensive, and uneconomical; and the electric engine which is emission-free but suffers from energy storage problems. All European legislation governing automobile emission limits should be promulgated by Common Market authorities.

30674

Ullman, William W.

**LEAD IN THE CONNECTICUT ENVIRONMENT.** Conn. Med., 35(6):360-362, June 1971. 12 refs.

Lead in the environment of the state of Connecticut is discussed. A task force has been active in reviewing all aspects of the hazards associated with lead-based paints and in developing recommendations to help formulate preventative programs. The main source of atmospheric lead is automobile gasoline. Approximately 70% of the lead in gasoline is exhausted from the tail pipe. Approximately half of the exhausted lead becomes airborne; about 250 million pounds of lead are discharged into the air each year from automobile exhausts. Industries burning coal and discharging airborne soil particles may also contribute to the lead present in ambient air. The absorption of lead in the respiratory tract depends on a number of factors, including the solubility of the compound and the particle size. It is estimated that lead inhaled from the atmosphere of Connecticut ranges from 0.001 to 0.05 mg/day. In a heavy smoker, a few micrograms per day of lead may be added to the body burden. The average smoker will absorb 10 mg of lead more/day than a non-smoker. The presence of lead in food and water is also discussed.

30759

Melton, Carl W., Ralph I. Mitchell, William M. Henry, Paul R. Webb, and W. Eugene Chase

**THE PHYSICAL-CHEMICAL CHARACTERISTICS OF PARTICLES ASSOCIATED WITH POLYNUCLEAR AROMATIC *HYDROCARBONS PRESENT* IN AUTOMOBILE EXHAUST (FINAL REPORT).** Battelle Memorial Inst., Columbus, Ohio, Columbus Labs., Contract CRC-CAPE-12-68-Neg. 59, Proj. CRC-CAPE- 12-68 Neg. 59, Rept. CRC-CAPE-12-68 Neg. 59, 42p., Jan. 29, 1970. 4 refs. NTIS: PB 196796

The physical-chemical characteristics of the particles associated with polynuclear aromatic hydrocarbons present in automobile exhaust were investigated. The major emphasis was placed on an attempt to determine whether there is a selective association between the presence of benzo(a)pyrene and specific particle types. Analyses were performed on single particle or aggregates and on particle-size fractions separated with the Battelle cascade impactor. Lead was found to be the metal constituent in the most prevalen smaller particles, and calcium and iron were found primarily contained in larger particles. Compositional variations among impactor size-fractions were not found to correlate with the distribution of benzo(a)pyrene which was detected in each impactor fraction analyzed. (Author abstract modified)

30976

Mueller, F.

**WASTE GAS DECONTAMINATION -- THE MAIN CONCERN OF RESEARCH DEVELOPMENT.** (*Abgasentgiftung*--ein komplexer Entwicklungsschwerpunkt). Text in German. Technik (Berlin), 26(7):450-451, July 1971. 10 refs.

No efficient alternatives to the combustion engine in automobiles will be available in the near future. Fuel cells are still much too expensive. The costs for one kW installed power are $2000. In 1967, 11 million passenger cars in East Germany emitted 10 million tons of carbon monoxide, one million tons of hydrocarbons, 750,000 tons of nitrogen compounds, and 5000 tons of lead compounds at the Leipzig fair, 95% of all CO concentrations measured in a 24-hr period exceeded the maximum allowable emission concentration. In Berlin, the figure was 45.5%. The drastic measures necessary to reduce auto emissions will require the cooperation of experts in many branches of the sciences.

31085

Tims, J. M.

**LEAD IN GASOLINE. 2. THE PROBLEMS.** Petrol. Rev., 25(294): 228-230, June 1971.

Lead alkyls currently provide the cheapest source of octane quality needed for modern engines. Any significant limitation on their use will force the oil industry to include more aromatics and alkylate in gasoline formulation. This can be done by such available processes as superfractionation, catalytic reforming, catalytic cracking, isomerization, alkylation, polymerization, and hydrocracking. However, the massive investment costs for appropriate plants will affect the price of gasoline. Moreover, the high octane materials produced by the processes are relatively high boiling, and this could upset both volatility and octane distribution. Aromatic amines have the further disadvantage of being toxic, bad-smelling, a source of nitrogen oxides production.

31088

Hawkes, A. S.

**LEAD IN GASOLINE. 1. THE ISSUE.** Petrol. Rev., 25(294): 227-228, June 1971.

Exhaust lead is not, as charged, a health hazard in urban areas or a source of increased hydrocarbon emissions. With regard to exhaust catalyst systems, the problem is not lead poisoning, but keeping the catalyst bed intact in a very severe environment for the required 50,000 miles of use. Unleaded fuels can cause severe valve recession, varnish deposits, and lube oil problems. Without lead, octane requirements also increase and front-end gasoline quality is more difficult to maintain. Estimates of the increased manufacturing cost of lead free fuels run from two to six cents/gallon.

31133

Kasamatsu, Gisaburo and Takahiro Matsue

**PUBLIC HARM BY EXHAUST GASES OF AUTOMOBILE.** (Jidosha no haiki no haiki gasu kogai (Zokuho). Text in Japanese. Hiroshima Kogyo Daigaku Kenkyu Kiyo (Mem. Hiroshima Inst. Technol.), 5(2):49-52, April 1971. 3 refs.

Fuels for automobile engines include gasoline, petroleum, and liquefied petroleum gas. Public automobiles use gasoline. Liquefied petroleum gas is used only by taxis and for reasons of economy rather than increased power. Engines operating on liquefied petroleum gas can be driven at a higher compression ratio without detonation than gasoline-operated engines. Tetraethyl lead must be added to gasoline to prevent detonation. The exhaust gas, therefore, contains lead compounds. Liquefied petroleum gas, by contrast produces clean exhaust gas containing no lead compounds and a maximum of one percent carbon monoxide. The internal combustion engine was studied at constant compression ratio and with power up. The efficiency of liquefied petroelum gas was lower than that of gasoline; but research at higher compression ratios showed that this problem can be solved. (Author abstract modified)

31136

Aalund, Leo R.

**NO REST FOR JAPAN S HARRIED REFINERS.** Oil Gas J., 69(19):34-36, May 10, 1971.

Japanese refiners must satisfy their country s voracious demand for oil energy while combatting the harmful impact of about seven billion lb/year of unwanted sulfur on the nation s environment. Differences between the product patterns of the Japanese and U. S. refining industries are cited. For one thing, since motor fuel is a small part of the product picture in Japan, the program to eliminate lead has not caused as much as a commotion there. Nevertheless, the Japanese refining industry expects that additional installation of catalytic reforming and cat cracking units will be necessary. The government is promoting importa of low-sulfur crude oil construction of fuel oil/flue gas desulfurization facilities, and development of low-sulfur crude sources overseas.

31313

Ullmann, William W.

**HEAVY METALS IN THE CONNECTICUT ENVIRONMENT.** Assoc. Food Drug Offic U. S. Quart. Bull., 35(3):147-152, July 1971. (Presented at the New England Association of Food and Drug Officials, Winter Meeting, Windsor, Conn., Feb. 4, 1971.)

Connecticut s involvement with the prevention of lead poisoning originated in the 1930 s with a program aimed at protecting occupationally exposed workers. Industrial air samples from areas where lead is used in manufacturing processes were periodically collected and analyzed, and urine and blood analyses were performed by industry on all workers who may have been exposed. Once a worker s blood lead level has reached 0.08 mg/100 cc, he is removed from the job to a function not involving lead until the level has returned to 0.07 mg/100 cc or less. Fatalities in Connecticut due to lead poisoning totaled 14 in the ten-year period from 1959 through 1968. Many more victims certainly were afflicted with non-fatal symptoms including mental retardation, damage to the central nervous system, convulsions, and anemia. As a result of the awareness of the critical problem of lead poisoning, a Governor s Task Force was commissioned in 1969 and has been active in reviewing all aspects of the hazards associated with lead-based paints and in developing recommendations to help formulate preventive programs. Lead poisoning in children and screening programs are discussed. Sources of lead and its absorption in the body are mentioned. The problem of mercury in food is also cited.

31315

Strunz, W.

**CHEMISTRY AND ENVIRONMENTAL HYGIENE.** (Chemie und Umwelthygiene). Text in German. Allgem. Prak. Chem. (Vienna), 22(2):25-31, Feb. 1971. (Presented at the Bundesinnungstagung des chemischen Gewerbes, Wien, West Germany, Oct. 23, 1970.)

There are 300 chemical substances which are termed air pollutants. Some of the most common air pollutants are sulfur dioxide, sulfur trioxide, hydrogen fluoride, fluorine, chlorine, nitrogen oxides, aldehydes, ketones, lead, hydrogen chloride, carbon dioxide, and carbon monoxide and tetraethyl lead. Among the heaviest polluters are power plants. In a thermal power plant with a capacity of 300,000 kW/hr, 70 tons of oil are burned and one million cu m flue gases are produced. The rain water in industrial centers has, at times, a pH of five. Automobiles are also heavy polluters. In Vienna, 90,000 tons of CO are emitted into the air/day. The emissions of hydrocarbons, lead, and SO2 are 9000, 0.55, and 180 tons respectively. The maximum allowable concentration for nitrogen oxides is one mg/cu m air, for Cl2 0.3 mg/cu m air, for hydrogen sulfide 0.15 mg/cu m, for SO2 0.40 mg/cu m, for lead 0.004 mg/cu m, for 0.1 mg lead/day. The atmospheric pollution affects humans, animals, and plants.

31323

Sherwood, P. T. and P. H. Bowers

**AIR POLLUTION FROM ROAD TRAFFIC--A REVIEW OF THE PRESENT POSITION.** Ministry of Transport, Crowthorne (England), Road Research Lab.; Ministry of Transport, Crowthorne (England), Earthworks and Foundations Section; Ministry of Transport, Crowthorne (England), Climate Section, RRL Rept. LR 352, 28p., 1970. 28 refs. NTIS: PB 196744

To provide a basis for assessing the needs for further research into the problem, the present position in Great Britain concerning air pollution from traffic is presented. Carbon monoxide, oxides of nitrogen, lead compounds, smoke, unburned fuel and secondary products produced from the fuel, and various particulate matter are cited. None of the major components of air pollution from traffic has been identified in concentrations large enough to be considered to have a more or less immediate and permanent effect on health, though some temporary effects may be present. There may, however, be temporary effects that affect behavior and there is no doubt that smoke and smell from traffic are unpleasant. Consideration should be given to these two aspects to find the extent of the problem so that the value of emission controls can be assessed. Methods of reducing emissions from road vehicles are discussed, as well as the legislation in force for controlling emissions in other countries. If controls of invisible emissions are introduced in Great Britain, it will be necessry to establish whether the legislation is having any effect. There will, therefore, be a need for a rapid method of assessing whether a vehicle complies with the law and for monitoring the levels of pollutants in the air. (Author abstract modified)

31324

Freed, Virgil H.

**TETRAETHYL LEAD IN GASOLINE.** In: Environmental Quality in Oregon 1971. Oregon State Univ., Corvallis, Environmental Health Sciences Center, NSF Grant GT-14, p. 30-33, 1971.

The removal of lead from gasoline is proclaimed to be the only possible solution to cleaning the atmosphere by some authorities and is condemned as a measure which will increase pollution by others. In order to significantly reduce emissions, it may be necessary to attach auxiliary equipment such as a direct flame afterburner or the catalytic reactor to the auto exhaust pipe. Research showed that tetraethyl lead oxidation products in auto exhaust will poison the catalyst and reduce its efficiency. Another important reason for removing lead may be biological. The tetraethyl lead oxidation products are emitted as condensed particulate matter which have quite small diameters. Biologically significant distribution of lead does occur along freeways and city streets. The levels of lead in the blood of persons living and working in large cities can be twice that of persons living in suburban or rural areas. Possible chronic physiological effects are a concern. The use of unleaded gasolines will eliminate one source of lead contamination in the environment, but the octane rating must be consistent with the engine requirements.

31395

Wegner, Helmut

**ENVIRONMENTAL PROTECTION, A TASK OF EUROPEAN INTERNAL POLICY.** (Umweltschutz, eine Aufgabe europaeischer Innenpolitik). Text in German. Staedtehygiene (Uelzen/Hamburg), 22(7):149-151, July 1971.

The fight against air pollution is a struggle for life. Little is yet known about the regeneration of air. The 13.9 million passenger cars now operating in Germany annually emit eight million tons of carbon monoxide, 1.2 million tons hydrocarbons, 900,000 tons nitrogen oxides, 12000 tons particulates and 7000 tons of lead. Industry spends about $120 million/yr on air pollution control measures. The cement industry succeeded in reducing dust emissions from 25% of its production to one percent. In the industrial center between Duisburg and Dortmund, where the world s heaviest dust emissions weree measured in the early 1960 s dust emissions are one fifth of former values. According to predictions of cancer researchers, nearly 18 million Germans will develop cancer, half of whom will die from it. The cause is to a large extent the increasing quantities of carcinogens in the atmosphere.

31520

Gammelgard, P. N.

**STATEMENT.** Public Health Service, Washington, D. C., Symp. Environ. Lead Contamination, 1965, p. 131-133. (Dec. 13-15.) NTIS: PB 198104

It is suggested that a regulation requiring the petroleum industry to make lead-free gasoline will drive dozens of the nation s 270-odd refineries out of business overnight. Before action is taken in either reducing or eliminating lead from gasoline, it is hoped that more work will be done to reach an objective definition of the role of lead in the environment as it affects health and welfare.

31525

Stokinger, Herbert E.

**RECENT HISTORY OF LEAD EXPOSURE IN U. S. INDUSTRY, 1935-1965.** Public Health Service, Washington, D. C., Symp. Environ. Lead Contamination, 1965, p. 29-36. (Dec. 13-15.) (PHS Pub. 1440) NTIS: PB 198104

A review has been made of mostly hitherto unassembled and unpublished data on lead exposure as measured by concentrations in air and in urine, in seven of eight work categories representing the major uses of lead: auto body, collision and manufacture; foundries, printing (electro-type); storage battery manufacture and rebuilding; secondary smelters. The large category of munitions is excepted. Insofar as the concentration of lead in air and in urine can be used as measures of exposure to inorganic forms of lead, the clear, consistent, and unmistakable conclusion is that exposure to airborne lead, dust, and fumes, is less by a factor of several magnitudes in all industrial categories since 1934. This decrease has continued, but at a slower rate since 1945. Of a ninth work-exposure category, involving exposure to gasoline additives and their breakdown products, only one, garage mechanics, showed evidence of exposure slightly in excess of normal, but still well below acceptable limits. (Author conclusions modified)

31596

Corner, E. S. and A. R. Cunningham

**VALUE OF HIGH OCTANE NUMBER UNLEADED GASOLINES IN THE U. S.** Preprint, American Chemical Society, Washington, D. C., 26p., 1971. 27 refs. (Presented at the American Chemical Society, Division of Water, Air, and Waste Chemistry, Los Angeles, Calif., March 28-April 2, 1971.)

A study was undertaken to define the optimum octane level of future unleaded gasoline. Calculations of the value of octane number to the consumer have been based upon fuel economy considerations at constant performance. Even though the consumer will pay more for higher octane number gasolines, the better fuel economy obtainable can reduce his actual transportation costs per mile of travel. Although additional crude (or energy equivalent) is required to manufacture a given volume of higher octane number gasolines, the better fuel economy obtainable in higher compression ratio engines can more than compensate for this additional crude per unit volume of gasoline produced. The effect of compression ratio on fuel economy has been computed, as well as the relationship between compression ratio and octane number. It is necessary to convert octane number requirements in terms of primary reference fuels to requirements in terms of Research and Motor octane number qualities, which are the variables defining the road antiknock performance of both clear and leaded gasolines. A multi-grade system permits a much higher compression ratio than does a single grade at a constant Research octane number gasoline pool. The relationship between relative fuel economy and pool Research octane number was examined, as well as the value of octane numbers to the customer, costs of unleaded gasolines, and conservation of natural resources. As pool Research octane numbers increase, value to the customer of the higher octane number gasolines increases. At the same time, the cost to the customer of the higher octane number gasolines also increases. However, the customer will benefit as long as the rate of increase in value is greater than the rate of increase in cost. The customer benefits in potentially lower transportation costs up to the 97% pool Research octane number unleaded gasoline.

31632

Cross, F. L., Jr., R. J. Drago, and H. E. Francis

**METAL AND PARTICULATE EMISSIONS FROM INCINERATORS BURNING SEWAGE SLUDGE AND MIXED REFUSE.** American Society of Mechanical Engineer New York, Incinerator Div., Proc. Natl. Incinerator Conf., Cincinnati, Ohio, 1970, p. 62-64, 189-195. 3 refs. (May 17-20.)

A municipal incinerator is described that has two separate 150-ton/day, circular batch-fed furnaces with individual secondary-combustion chambers. Effluent from these two chambers feeds into a single expansion and waterspray chamber before enterin the 196 plus or minus ft stack. Waste heat from one furnace is used to dry sewage sludge by the Raymond process; dried sludge is then returned to the same furnace and burned in suspension. The spray chamber has refractory baffles that are continuously wetted and a drain system that leads to a clarifier for fly-ash settling and disposal. Water from the clarifier is returned to the sewage-treatment--plant effluent line. As determined by stack-sampling tests, metals are important constitutents in air-pollutant emissions from municipal incinerators. Emissions of metals while burning refuse ranged from 0.007 lb/hr (cadmium) to 1.5 lb/hr (lead); when both refuse and sludge were burned, at a 3.5 to one ratio, the range was 0.007 lb/hr (cadmium) to 2.13 lb/hr (zinc). Design engineers must develop methods of removing and recovering metals from incinerator stack gases.

31649

McCaldin, Roy O.

**ESTIMATION OF SOURCES OF ATMOSPHERIC LEAD AND MEASURED ATMOSPHERIC LEAD LEVELS.** Public Health Service, Washington, D. C., Symp. Environ. Lead Contamination, 1965, p. 7-15. 15 refs. (Dec. 13- 15.) (PHS Pub. 1440.) NTIS: PB 198104

Literature on sources of lead emissions and atmospheric lead levels is reviewed. Emissions resulting from insecticide, storage battery, and paint manufacture are discussed. Other possible lead emission sources are municipal incineration, burning dumps, burning waste materials associated with building demolition, and combustion of lead-burning fuels. Re-entrainment into the air of lead-bearing soils is a source of pollution but only a minor contribution for urban soils. The use of emission inventories as a point of departure to estimate the relative quantity of lead emitted when coal and gasoline are burned is discussed. Data on atmospheric lead levels for specific urban areas are presented. The conclusions indicate that data on lead emissions and its sources are minimal. Based on available data, the principal source of atmospheric lead in urban areas is combustion of leaded gasoline.

31934

Ohira, Toshio, T. Komeiji, Y. Igoshi, K. Asakoya, T. Kubodera, T. Yamamoto, and Z. Shinozaki

**MEASUREMENT OF LEAD AND AROMATIC HYDROCARBON IN GASOLINE.** (Gasolin chu no namari oyobi hokozoku tanka suiso no sokotei). Text in Japanese. Taiki Osen Nyusu (Air Pollution News), no. 65:4-6, July 1971.

Benzene, toluene, and the other aromatic hydrocarbons contained in gasoline have been implicated as one of the causes of photochemical smog. Major gasoline blends on the market were tested to determine to what extent they contained tetraethyl lead, aromatic compounds, and thinner. It has been suggested that aromatic compounds are added to gasolines to maintain octane as lead compounds were removed. The lead standard (less than 0.3 ml/liter) was met for all brands, and, except for one or two brands, there was no marked difference in aromatic hydrocarbon content between the gasolines. Since the blend with a high concentration of aromatic hydrocarbons also had a high lead concentration, it was concluded that aromatic compounds were not added intentionally. No thinner was added to the various blends.

32035

Horton, Robert J. M.

**MAJOR SOURCES OF LEAD POLLUTION.** Public Health Service, Washington, D. C., Symp. Environ. Lead Contamination, 1965, p. 137-142. (Dec. 13-15.) NTIS: PB 198104

Air pollution levels for lead at ordinary urban measuring stations show values ranging from one to three micrograms/cu m of air. Rural values are normally below these levels, while measurements taken near automobile traffic may be as high as 40 micrograms/cu m, depending on the proximity to the roadway and traffic density. The average daily diet contains about .3 mg/day of lead, with a range from .1 to two mg. Contamination of drinking water by various sources was reviewed in terms of the Public Health Service drinking water standards of .05 mg/l. Also, a review was made of mostly hitherto unassembled and unpublished data on lead exposure measured by concentrations of lead in air and urine in seven or eight work categories representing the major uses of lead: auto body manufacture and repair, foundries, electrotype printing, storage battery manufacture, rebuilding of storage batteries, and secondary smelters. Lead in tobacco and paints was also considered.

32447

**THE REDUCTION OF AIR POLLUTANTS THROUGH OTTO FUELS FOR AUTOMOBILES.** (Zur Verminderung von Luftverunreinigungen durch Ottokraftstoffe fuer Kraftfahrzeugmotoren). Text in German. Staedtehygiene (Uelzen/Hamburg), 22(8):193-194, Aug. 1971.

Annual lead emission in West Germany was low (7000 tons) compared to emissions of carbon monoxide (8 million tons), hydrocarbons (1.2 million tons), nitrogen oxides (900,000 tons), and particulates (12,000 tons), but it was the most toxic of all emissions. Allowable working place concentrations for lead were between 20 and 200 micrograms, compared to 50 mg for CO. The lead content in the blood of street cleaners in Frankfurt/Main was much higher than in a control group consisting of a cross section of the population. In 15% of the workers, the concentration had reached the critical level. An extremely high lead concentration was measured in the atmosphere over Frankfurt. These findings triggered federal government action into ruling that by Jan. 1, 1972, gasoline lead concentration may not exceed 0.40 g/l; by Jan. 1, 1976, the concentration shall further decrease to 0.15 g/l.

32492

Kumashiro, Kazuo and Masana Ogata

**THE EARTH SURFACE POLLUTION BY LEAD AT CROSSROADS.** (Kosaten ni okeru doro dojo no namari osen). Text in Japanese. Igaku to Seibutsugaku, 82(3):89-91, March 10, 1971. 4 refs.

Lead and potassium were determined in soil alongside heavily traveled roads, moderately traveled roads, and roads with little traffic in Okayama City. The traffic volume was 3000-4000 cars/hr in the first group, 500-1000 cars/hr in the second group, and 0-10 cars/hr in the third group. Significant differences were not found concerning the potassium content of the soils from the three different groups. The mean lead con-

tent was 480 ppm for the first soil group, 110 ppm for the second group of samples, and 30 ppm for the third group.

32523

Suzuki, Takashi, Yukio Isogai, Tokushige Fukami, and Hatsune Ito

**A SIMPLE METHOD FOR DETERMINATION OF LEAD IN GASOLINE.** (Gasorin chu namari no kan-i teiryoho). Text in Japanese. Nagoya-shi Kogyo Kenkyusho Kenkyu Hokoku (Res. Rep. Nagoya Munic. Ind. Res. Inst.), no. 45:24-26, 1971. 3 refs.

Lead in gasoline was analyzed by the ethylenediaminetetraacetic acid (EDTA) absorption photometric method and dithizone colorimetry following extraction with concentrated nitric acid, to determine if the methods were sufficiently practical and simple. A desired amount of gasoline was taken into a separator funnel, mixed with concentrated nitric acid in an amount 1.5 times greater than the sample, and shaken for 20 minutes or more. The acid layer containing oxidated organics formed in the process was extracted, mixed with perchloric acid, and heated (for complete oxidation/decomposition of the organics) until white smoke was emitted. After being made alkaline by addition of ammonium hydroxide, the lead was then determined by EDTA or dithizone absorption photometry. Results obtained with both methods for several brands of commerical gasoline were in satisfactory agreement with those obtained by the Japanese Industrial Standard method.

32621

World Health Organization Geneva (Switzerland), Expert Committee on Urban Air Pollution and Motor Vehicles

**URBAN AIR POLLUTION WITH PARTICULAR REFERENCE TO MOTOR VEHICLES. REPORT OF A WHO EXPERT COMMITTEE.** World Health Organ. Tech. Rept Ser., no. 410:1-53, 1969. 20 refs.

Worldwide trends in urban air pollution and control legislation are briefly reviewed. Air pollution from motor vehicles is considered at length in terms of the sources, nature, and composition of pollutants; methods of sampling and analysis; and the effects of vehicle exhaust on visibility, health, vegetation, and materials. Technological methods of controlling motor vehicle pollution are evaluated as is control through fuel modification or alternate power systems, such as steam, electric, or gas turbine engines. The necessity of supplementary control though environmental and health surveillance programs is stressed. Problems in applying air quality critera and standards are noted, and a recommendation is made for a worldwide collaborative study of air pollution in urban areas. Such a study would provide a means of asessing the relative contributions of different sources of pollution in different countries and permit the prediction of probable future trends in pollution. In addition, seven specific areas where more information is required are outlined. Spark ignition engines and diesels produce emissions of particulates, nitrogen oxides, carbon monoxide, hydrocarbons, lead, peroxyacyl nitrates, ozone, smoke and oxidants from exhaust, crankcase emissions, and fuel evaportaion.

32748

Dedolph, Richard, Gary Ter Haar, Richard Holtzman, and Henry Lucas, Jr.

**SOURCES OF LEAD IN PERENNIAL RYEGRASS AND RADISHES.** Environ. Sci. Technol., 4(3):217-223, March 1970. 9 refs. (Presented at the American Chemical Society, Division of Water, Air, and Waste Chemistry, National Meeting, 157th, Minneapolis, Minn., April 1969.)

Experiments designed to assess the relative importance of air, water, and soil as sources of lead in perennial ryegrass and radishes showed that only air and soil were significant sources. Subsequent experiments reaffirmed that both grass and radish leaves derived two to three micrograms of lead/gr of dry weight from soil sources. Leaf lead levels in excess of this were derived from, and quantitatively related to, atmospheric lead concentrations. Lead levels in radish roots were less than or equal to soil derived leaf lead levels. The lead concentration in this edible portion of the radish plant was apparently unaffected by variations in lead concentrations in either soil or air. Collectively these data woul ' not support a contention that the food of prehistoric man contained only a small fraction of the lead in the food of contemporary man, urless one assumes that prehistoric man assiduously eschewed plants as a food source. (Author abstract)

32875

Hishida, Kazuo

**PRESENT SITUATION OF AUTOMOBILE EXHAUST GAS POLLUTION AND FUTURE POLICY.** (Jidosha haishutsu gasu kogai no genjo to kongo no taisaku). Text in Japanese. Toshi Kaihatsu (Urban Development), 9(100):68-74, Aug. 1971. 11 refs.

Carbon monoxide concentration varied from 3.4 ppm to 27.5 ppm, depending upon the time of day, at intersections in Tokyo; in non-urban areas, CO concentrations ranged between 1.1 and 6.0 ppm. Nitrogen oxides and hydrocarbons emitted from automobiles are considered to be the cause of photochemical smog. Automobile exhaust gas and sulfuric acid mist from chimneys were thought to cause a pollution episode on July 18, 1970, when students at the Rissho High School became ill. Oxidant concentrations were unusually high. Lead concentrations were highly correlated with CO concentrations at one intersection. In order to minimize CO concentrations, idling must be controlled, exhaus control devices installed, garages designated where repairs can be made, and traffic volume reduced. Blowby reduction and evaporation control equipment should be installed to control HC emissions. Cooperation between the gasoline manufacturer and the public is needed to produce low lead gasolines. April 1974 is the present deadline for lead gsolines.

33087

Sticksel, Philip R. and Richard B. Engdahl

**DERIVATION OF THE EMISSION DATA AND PROJECTIONS USED IN PLANNING.** In: The Federal R and D Plan for Air Pollution Control by Process Modification. Battelle Memorial Inst., Columbus, Ohio, Columbus Labs., APCO Contract CPA 22-69-147, Rept. APTD-0643, p. B-1 to B-19, Jan. 11, 1971. 11 refs. NTIS: PB 198066

The derivation of the emissions data and projections used in the five-year research and development plan for the reduction of emissions from energy-conversion combustion sources by combustion process modification are presented. The emissions include particulates, carbon monoxide, hydrocarbons, nitrogen oxides, lead, sulfur oxides, ash, and polynuclear aromatics. Sources include power plants, industry, steam generation, gas turbines, internal combustion engines, residential heating, aircraft, trucks, diesel engine, natural gas engines, and automobiles.

33169

Autelitano, di Giuseppe

**TOXIC GASES EMITTED BY MOTOR VEHICLES.** (I gasi nocivi emessi dagli autoveicoli). Text in Italian. Inquinamento., 13(5):14-20, 1971. 16 refs.

A review of the literature discloses that the highest concentration of carbon monoxide in the air is encountered in the centers of cities, where traffic is heavier, rather than in the suburbs. Under equal traffic conditions, the greatest CO levels are found at stop signs and stop lights where the engines of the automobiles are often subjected to acceleration and deceleration. Local conditions greatly affect the CO levels, as demonstrated by observations made in underpasses and tunnels where the circulation of the air is confined. The level of CO in the air of large cities such as Rome and Milan was about 50 ppm, which is a lower figure than the limit values (100 ppm) set by the American Conference of Government Industrial Hygienists. Lead, another component of automobile exhaust, was from 0.7 micrograms/cu m of air in Detroit to 5.22 mg in dust in Milan. The toxic effects of CO and lead are reviewed. Other significant components of automobile exhaust are hydrocarbons, nitrogen dioxide, particulates, and sulfur dioxide.

33293

Ettinger, Morris B.

**LEAD IN DRINKING WATER.** Public Health Service, Washington, D. C., Symp. Environ. Lead Contamination, 1965, p. 21-27. 12 refs. (Dec. 13-15.) (PHS Pub. 1440) NTIS: PB 198104

Data on the lead content of both raw and finished water in the United States have been gathered from various public health sources, including data generated by routine monitoring activities such as the Water Pollution Surveillance System and the monitoring of water supplied to interstate carriers. Lead from motor boats, lead removal by sewage treatment processes, lead in unfiltered surface waters, lead dissolved in surface waters, and lead in rain water are mentioned. In addition, the avenue of entrance of lead into the water supply reaching the tap of the general consumer has been reviewed. In the analysis of the data, the recently reviewed Grounds for Rejection limit of 0.05 mg/liter for lead in drinking water has been used as a suitable guide point in considering the lead present in various waters.

33350

Rossini, Frederick D., Philip Myers, Bruce Bailey, S. L. Meisel, G. J. Stopps, A. L. Aronson, Gary Ter Haar, Bruce H. Simpson, and A. F. Forziati

**PANEL DISCUSSION. SCIENCE AND THE ENVIRONMENT (I) - LEAD IN GASOLINE.** J. Wash. Acad. Sci., 61(2):138-147, 1971. (Presented the Symposium Science and the Environment, Washington, D. C., Jan. 21, 1970.)

A panel discussion considered the effect of lead in gasoline. The indiscriminate setting up of standards, which are technologically unattainable within the given time schedule, will seriously cripple the economy of our society and tend to immobilize a very mobile society. Problems in acquiring a definition of particulates in emission testing procedures are indicated. The generation of ammonia and other emissions from the tailpipe is cited. Cost-benefit considerations and the control of lead emissions are mentioned.

33365

Myers, P. S.

**SPARK IGNITION ENGINE COMBUSTION AND LEAD.** J. Wash. Acad. Sci., 61(2):58-74, 1971. 36 refs.

Lead is used in gasoline to prevent knock, i.e., to permit the last part of the air-fuel mixture to burn, to withstand higher pressures and temperatures before auto-igniting. The ability to withstand higher thermal stresses permits higher compression ratios, which in turn give better fuel economy and higher power output. The addition of lead does not affect the cool flame limits during motored operation but definitely affects auto-ignition limits. Lead does not seem to significantly affect energy release rates. However, its effect on auto-ignition limits can differ between different fuels. It appears that the lead must first decompose to lead oxide and that different kinds of lead oxides have different antiknock capabilities. Different fuels have different antiknock characteristics. Thus removal of lead, which will cause a decrease in gasoline antiknock quality, must be accompanied either by a reduction in engine compression ratio or a change in refining techniques to produce fuels having higher antiknock properties. It appears that removal of three cc of lead plus reduction in compression ratio would give an increase in fuel consumption of as much as 10%. Lead also affects combustion chamber deposits which in turn affect knock and, to a lesser extent, exhaust emissions. There is some evidence to indicate that deposits from unleaded gasoline cause a higher increase in antiknock requirement than do deposits from leaded gasoline. There is also some evidence to indicate that leaded deposits cause slightly higher exhaust emissions. Lead normally acts as a poison for catalysts to reduce exhaust pollutants but does not seem to affect exhaust pollutant reactions per se. (Author abstract)

33378

Cheklich, George E.

**U. S. ARMY S HYBRID COMBUSTION ENGINE AND THE 1975 FEDERAL EXHAUST EMISSION STANDARDS.** J. Wash. Acad. Sci., 61(2):85-90, 1971.

Two processes utilizing the stratified charge principle (a form of hybrid combustion) are under investigation: The Texaco Combustion Process (TCP) and the Ford Combustion Process (FCP). Only a small amount of fuel reaches the combustion chamber walls in a stratified charge engine, leading to reduced quenching and thereby minimizing unburned hydrocarbons. Very lean air-fuel ratios minimize formation of carbon monoxide and nitrogen oxides. With a FCP hybrid combustion engine and a catalytic reactor, the highest production army vehicle (the M-151 jeep) surpasses the 1975 Federal emission standards. Even without the catalyst, the FPC engine easily meets the 1972 standards. Currently, the TPC system approaches the 1972 standards without a catalyst and the 1975 standards with a catalyst. However, expected significant improvements in emissions should make TCP performance comparable to the FCP. Major advantages of the TCP are its capability to be turbocharged and the fact that it is not octane or cetane limited. The use of low-octane lead-free fuels is possible. Exhaust emission data for both systems are tabulated.

33626

Bailey, Bruce S.

**GASOLINE-MOTOR ENGINEERING.** J. Wash. Acad. Sci., 61(2):74-84, 1971. 4 refs.

A maximum efficiency obtainable by a gasoline engine is limited, among other things, by the octane number of the available fuel. Lead has been instrumental in making possible

today s high octane gasolines, and the removal of lead from gasoline will produce direct and indirect octane losses that will force substantial reductions in engine efficiency. A review of pure hydrocarbon octane data indicates that: the octane potential of unleaded gasolines is not as high as present leaded gasolines; good motor octane performance will be particularly difficult to achieve in unleaded gasolines; and high octane unleaded gasolines will require high concentrations of aromatics. The two real problems resulting from the use of lead are increased exhaust-system corrosion and decreased spark-plug life. Both problems can be minimized through use of high-quality gasolines and engine oils and proper maintenance procedures. No ready solution exists for the problems, particularly valve recession, that occur when engines are operated under heavy duty conditions on unleaded gasolines. Future use of lead antiknocks should not be foreclosed until it is clear that a clean engine cannot be developed which uses leaded fuels. (Author abstract modified)

33667

Sies, W.

**THE GENERAL SITUATION ON THE LEAD SECTOR.** (Allgemeine Situation auf dem Bleisektor). Text in German. Metall. (Berlin), 25(10):1195-1196, Oct. 1971. (Presented at the Internationalen Blei-Tagung, 4th, Hamburg, West Germany, Sept. 22, 1971.)

The status of lead emissions from automobiles is reviewed. Due to the higher demand for better automobile performance, lead consumption for the production of tetraethyl lead doubled since 1960, but is projected to decrease after 1975 due to regulations limiting the addition of lead to gasolines.

33710

Kifune, Ikuei, Ryuichi Sugai, Yoshio Urushiyama, and Eiko Abe

**INVESTIGATION ON AUTOMOBILE EXHAUST GASES IN NIIGATA CITY.** (Niigata shinai ni okeru jidosha haiki gasu chosa hokoku). Text in Japanese. Niigata-ken Eisei Kenkyusho Shudankai Shoroku (Niigata Prefect. Public Health Lab. Meet. Abstr.), 1970:21-22, 1970.

Automobile exhaust gases were monitored and measured at four main intersections of Niigata City. Carbon monoxide was measured by high volume air sampler, and lead concentration was determined by atomic absorption spectrometry. Traffic volume from 8:00 am-6.00 pm was calculated each for ten minutes on the hour. The traffic volume mean values were 1050 cars/ten minutes at the line Toko crossroads and 400 cars/ten minutes at the Yamanoshita Boseki, Sekiya Dankuro, and Furumachi crossroads. The mean CO value was 6.4 - 8 ppm, with the maximum at 9.8 - 12 ppm. A reciprocal relationship between CO and numbers of running cars for all time-zones was established for two intersections. The maximum and minimum lead values were 3.81, 2.02 micrograms/cu m at two separate crossroads. For correlations between lead and dust concentrations the rate of lead in dust was 0.6% for rainy and 0.2% for fine days at the Toko line crossroads.

33822

Pierson, William R., Wanda Brachaczek, and Joseph T. Kummer

**SEARCH FOR AIRBORNE PARTICULATE DEBRIS FROM RUBBER TIRES.** Am. Chem. Soc., Div. Water Air Waste Chem., Gen. Pap., 11(2):236-244, 1971. 13 refs. (Presented at American Chemical Society, Division of Water, Air and Waste Chemistry, National Meeting, 162nd, Washington, D. C., Sept. 12-17, 1971.)

To determine how much of the material lost from rubber tires becomes airborne particulate matter, air collected from exhaust ducts and from the vicinity of tunnel exit ports was analyzed for styrene-butadiene rubbert (SBR), zinc, bromine, and lead by infrared adsorption spectroscopy. The results are presented as Zn/Pb, Zn/Br, and SBR/Pb ratios, under various meteorological conditions, between amount of tire particulate and amount of gasoline-engine exhaust particulate. The tire data pertain to tires of all vehicles. The lowest results are presumably the more definitive ones since all are upper limits. The ratios indicate that there is, at most, less than 40% as much particulate matter from tire wear as from exhaust. The upper limit on tire particulates suspended in the atmosphere should be lower, as tire-wear particles tend to be bigger than exhaust particles. On the other hand, tire-wear conditions at the two tunnel sites are relatively mild, and more work will be necessary to justify dismissing tire particulates as a relatively insignificant concern.

33963

Chiba Prefecture (Japan) Dept. of Hygiene

**WHITE PAPER ON ENVIRONMENTAL HAZARDS IN CHIBA PREFECTURE. 1970.** (Chiba-ken kogai hakusho. Showa 45 nendo ban). Text in Japanese. 384p., Feb. 1971.

The paper consists of general considerations the actual condition and countermeasures of environmental hazards in Chiba, problems for the future and a data section. The progress of the pollution problem after the first occurrence and changes of the administrative organization in Chiba Prefecture are discussed. The following pollutants are discussed: odors, carbon monoxide, nitric oxide, nitrogen dioxide, hydrocarbons, suspended particulates, lead, sulfur oxides, and smog. Various standards and regulations, the general aspects of the pollution sources, the relation to meteorological factors, and the effects on human bodies and plants are discussed. Future problems on administrative treatment, especially the pollution control program in the Chiba-Ichihara district are discussed in detail. Results of determination of air pollution, water pollution and ground shrinkage in 1969 and 1970 are included in the data section. Measurement and control methods are discussed.

33965

Fukuoka Prefectural Government (Japan), Public Nuisance Section

**FUKUOKA PREFECTURE WHITE PAPER ON ENVIRONMENTAL HAZARDS. 1970.** (Showa 45 nendo kogai hakusho). Text in Japanese. 167p., Jan. 1971.

The actual condition, administration, and public problems related to environmental hazards caused by air, water, and noise pollution in Fukuoka Prefecture were summarized. Industrial emissions, automobile exhaust gases, and emissions from heaters are the major sources of pollution. The condition of pollution and its control was discussed for different areas within the Prefecture. The influence of cadmium on crops and humans in the Omuta district is discussed. Farmers in Omuta received a chronic intoxication of cadmium. Metals, suspended dust, lead, sulfur oxides, oxidants, nitrogen oxides, hydrocarbons, and carbon monoxide are other important pollutants. Control methods, measurement methods, and effects on human health are mentioned. The environmental control program, legislation, advisory services, and standards are also discussed.

34018

Bernhart, A. P.

**NOTES ON AIR POLLUTION: THE INGREDIENTS DEFINED. PART I.** Water Pollution Control (Toronto), 109(10):41-42, Oct. 1971. 19 refs.

The problem of air pollution in Canada is reviewed with respect to effects on human health (respiratory diseases), animals, plants, buildings (soiling and deterioration), traffic (visibility), and economy; breakdown by individual pollutant; and major sources. The major pollutants and their sources included suspended particulates and dust fall from furnaces, incineration, and cement plants; pollen from grasses and trees; sulfur oxides from coal furnaces; carbon monoxide from cars; hydrocarbons from engine exhausts and gasoline evaporation; aldehydes from diesel exhausts and dry cleaners; nitrogen oxides from power plants; oxidants; odors from slaughterhouses, garment factories, glue factories, and diesel buses; fluorides from aluminum and fertilizer plants; lead from car exhausts; benzopyrene; carbon dioxide; and other minor pollutants, i.e., organic acids, hydrogen sulfide, ammonia, chlorine, and bromine.

34031

Keller, J. G.

**UNLEADED MOTOR FUEL AND THE VALUE OF OCTANE.** American Petroleum Inst., New York, Div. of Refining, Proc. Am. Petrol. Inst., Div. Refining, vol. 51:898-921, 1971. (Presented at the Midyear Meeting, 36th, San Francisco, Calif., May 12-14, 1971.)

Strong social, legislative, regulatory, and technical pressures are expected to cause the use of lead alkyls as octane improving agents to be phased out of motor fuel in the United States. A study of the relationship of octane number to engine compression ratio and thus to efficiency indicates that higher compression ratios and higher octane numbers are desirable. The customer would obtain lower transportation costs up to 97 unleaded pool Research octane number. He would benefit substantially in two- or three-grade marketing systems over a single system at all levels of pool octane number. Also, natural resources (crude petroleum equivalent) are conserved as pool Research octane number increases up to 97 Research octane number. (Author abstract modified).

34040

Medeiros, Robert W.

**LEAD FROM AUTOMOBILE EXHAUST.** Chemistry, 44(10):7-9, Nov. 1971. 5 refs.

Air pollution due to leaded gasoline consumed in motor vehicles was examined with respect to background material on lead in gasoline, octane rating as a measure of engine performance, and conversion of tetraethyl lead in the gasoline to lead bromide and lead chloride. The direct correlation between increased lead content in city air and traffic conditions demands new research into gasoline additives. Control methods for lead emissions from motor vehicles include low-lead or lead-free gasolines and substitutes for lead in gasolines.

34068

Djuric, Dusan, Zarka Kerin, Ljubica Graovac-Leposavic, Ljiljana Novak, and Marija Kop

**ENVIRONMENTAL CONTAMINATION BY LEAD FROM A MINE AND SMELTER.** Arch. Environ. Health, vol. 23:275-279, Oct. 1971. 1 ref. (Presented at the Conference on Inorganic Lead, Amsterdam, Netherlands, Nov. 28, 1968.)

The contamination of a large area in Yugoslavia by lead from a mine and smelter is illustrated in a preliminary report by fragmentary data obtained by the determination of lead in the surrounding air, in the water of a river draining the area, in the soil, and in local vegetation. A screening test (determination of the urinary excretion of delta-aminolevulinic acid) applied to groups in the population suggests that the absorption of lead by members of the groups may be hazardous. (Author abstract)

34177

Struth, Bert W.

**THE IMPACT OF NEW GASOLINE SPECIFICATIONS ON REFINERIES OF THE FUTURE.** Preprint, American Inst. of Chemical Engineers, New York, 26p., 1971. (Presented at the American Institute of Chemical Engineers, National Meeting, 68th, Houston, Tex., Feb. 28-March 4, 1971.)

Normal growth, a changing natural resources picture, obsolescence, and pollution control will result in refinery expansion of over 10 billion dollars over the next decade. The refinery processing resulting from anticipated changes in gasoline specifications due to pollution control regulations is discussed. The major question facing the industry is how to replace the leaded octane numbers. Advantages and disadvantages connected with catalytic cracking, alkylation, hydrocrackling, residuum upgrading processes, and catalytic reforming are considered, as well as the supply/demand balance. Future trends are cited. Isopentane separation from the light straight run, followed by isomerization of the normals, appears to be the first step in upgrading the low-octane naphthas. The carbon-6 to carbon-9 aromatics are by far the most economically available hydrocarbons. The feed for catalytic reformers will change drastically. Next to aromatics, alkylate made of isobutane and C2 to C5 olefins offers the refiner the next highest research octane value component. The effect of lead removal is discussed.

34341

Rossenbeck, Martin

**FUEL MODIFICATIONS FOR THE PROTECTION OF THE ENVIRONMENT.** (Kraftstoffwandel im Zeichen des Umweltschutzes). Text in German. Automobiltech. (Stuttgart), 73(11):415-421, Nov. 1971. 62 refs.

Tetraethyl lead has been used for more than 45 years all over the world as an anti-knock agent in gasoline for automobiles. The first country which limited the leat content was Sweden. The maximum allowable concentration has been reduced to 0.7 g/l (beginning with January 1, 1970) from 0.84 g/l. The Federal Republic of Germany has passed a law reducing the lead content to a maximum of 0.40 g/l beginnig with January 1, 1972 and to 0.15 g/l by January 1, 1976. The U. S. has no law yet for limiting the lead content. Lead is emitted in the combustion of hard coal in the form of lead oxide; in the vicinity of lead-working plants, lead has been found in larger concentrations (particle size: 0.5 to 5 micron). The main charactertistic of the lead compounds emitted by automobiles is the small particle size which is on the average less than 0.125 micron. Part of the inhaled or ingested lead is deposited in the bones and part in the blood. Lead is a toxin which interferes with the blood formation. A correlation exists between the lead content in the blood, in the urine, and in the air. The effect of lead on humans and their organs was studied for the first time by exposure to an atmosphere with constant lead concentrations for half a year. Initially, the lead content in the blood rose until it had reached a certain plateau. The limitation of the lead in gasoline will reduce the octane number from 100

to 98 for super gasoline and to 91 for normal gasoline. A reduction of 0.40 g lead/l should cause no trouble with most of the presently existing engines. For reduction to 0.15 g/l other anti-knock agents must be found.

34350

Wolff, Josef

**INTEGRATION PROBLEMS OF TRAFFIC AND TOURISM. PRESENT SITUATION AND DEVELOPMENT.** (Integrationsprobleme in Verkehr und Touristik. Derzeitige Situation und Entwicklung). Text in German. Tech. Ueberwach. (Duesseldorf), 12(11):318-325, Nov. 1971.

Traffic is one of the major polluters of the environment. The emissions by automobiles must be divided into gaseous combustion products, fuel losses, tire abrasions, and old oil. By 1980, 21.5 million automobiles will consume 30 million tons of fuel per year. The efforts by the automobile industry and the federal government of the Federal Republic of Germany are directed toward improvement of the old vehicles and novel construction for the new cars. Through such measures emissions can be cut by 50%. Further research concerning the biomedical influence of gas components such as hydrocarbons, carbon monoxide, nitric oxide and lead will be necessary. An exhaust gas monitoring station has been established in Essen and other parts of the country.

34442

Malschaert, F. P.

**AUTOMOBILE AIR POLLUTION AND WAYS TO FIGHT IT.** (Luchtverontreiniging door benzinemotoren en middelen tot bestrijding). Text in Dutch. Ingenieursblad, 40(15-16):417-428, 1971. 6 refs.

The harmful components of the automobile exhaust gases are carbon monoxide, unburned hydrocarbons, nitrogen oxides, sulfur dioxide, and lead. The concentration of these pollutants depends on the thermodynamics of the engine. A gasoline engine exhaust contains high CO, high HC, and low NOx concentrations. The diesel engine exhaust contains low CO, low HC, but high NOx concentration. Comparisons of a typical European and American automobiles are given. The emissions of NOx, CO, and hydrocarbons during stationary running, acceleration, deceleration, and constant speed running of a passenger car is sketched. European Economic Community tests are discussed. Passenger cars are tested inspection stations in Sweden. Automobile standards issued by the State of California and the Federal government are mentioned. Different methods of reducing air pollution are given, such as improved carburetion, a transmission controlled spark advance system, and an exhaust gas collector reactor. Methods of NOx and Pb reduction are summarized. A list of topics of interest for research in automobile air pollution is included.

34647

Hamilton, Wayne L. and James E. Miller

**HIGH LEAD CONCENTRATIONS IN COLUMBUS SNOW.** Ohio J. Sci., 71(5):313-316, Sept. 1971. 4 refs.

Lead concentrations in snow collected on the ground within 100 feet of streets and roads in January, 1970, were determined by atomic absorption spectrophotometric analysis of dissolved and particulate fractions of impurities. Twenty-seven samples of snow were collected over a 20 sq mile, suburban, mainly residential part of Columbus, Ohio. Measured concentrations were between 0.05 and 1.09 ppm Pb, with an average of 0.41 ppm. In all but one sample, the lead concentration exceeded the U.S. Public Health Service safe limit for drinking water of 0.05 ppm. The temporal and areal distributions of concentrations, together with a comparison with iron concentrations measured in the same samples, indicated that automobile exhaust was the probable source of the lead. (Author abstract)

34774

Baba, Arimasa

**AIR POLLUTION AND FUEL.** (Taiki osen to nenryo). Text in Japanese. Naika, 21(5):810-812, May 1968.

Air pollution due to imperfect combustion of fuels is examined. Soot, containing 80.0-92.4% carbon and 20-1.6% hydrogen, forms when the air supply is not sufficient for burning the fuel at a high temperature. Highly volatile fuel creates less soot because it mixes well with the air and combustion is quick. A new type of coal fuel is being developed by treating coal at less than 450 C and forming it into a shape and size that would facilitate ventilation and prevent fly ash. Common fuels in the order of least soot production include city gas; natural gas (methane); propane (liquid petroleum gas) kerosene; anthracite; coke; heavy oil; volatile bituminous coal; tar; city dusts and solid waste. Japanese coal contain less than 1% combustible sulfur; the raw oil, used in Japan before the war, also had very little sulfur content. Oil imported from the Near and Middle East contains around 2% sulfur. Sulfur dioxide, influenced by many factors, and turns into sulfur trioxide photochemically or by the catalytic action of suspended particulates. Sulfur dioxide and SO3 in smoke can be cleansed by liquid absorbent, or treated by manganese oxide, lime, activated coal, or ammonia; the most effective SO2 control method would be to import heavy oil with minimal sulfur content. Automobile exhaust gas contains carbon gas, water, carbon monoxide, aldehyde, tar-like hydrocarbons and nitrogen oxides. Ideal gasoline would contain mostly isoparaffin, without tetraethyl lead CO and would have a high octane value. Diesel engines emit less than 0.1% but create much soot.

34788

Proctor, Paul Dean and Thomas R. Beveridge

**POPULATION, ENERGY, SELECTED MINERAL RAW MATERIALS, AND PERSONNEL DEMANDS, 2000 A. D.** Preprint, Society of Mining Engineers, AIME, N. Y., New York, N. Y., 19p., 1971. (Presented at the American Institute of Mining, Metallurgical, and Petroleum Engineers, Annual Meeting, New York, Feb. 26-March 4, 1971, Paper 71-H-107.)

The people of the United States currently consume 32% of the world s energy and similarly large percentages of the world s mineral raw materials. A minimal two percent increase per year in the standard of living in the United States and a four percent increase elsewhere in the world, beyond the demands of the estimated population increases, suggest the magnitude of the increased need for energy-mineral raw materials and the possible crises the world will face in these areas by 2000 A.D. Iron ore, copper, lead, and zinc, sulfur, and fertilizer consumption and projections are considered. Better trained and increased manpower needs are also indicated.

34916

Bureau of Census, Washington, D. C.

**PRODUCT CLASSES - VALUE SHIPPED BY ALL MANUFACTURING ESTABLISHMENTS: 1947, 1954, 1958, 1963 TO 1967.** In: Smelting and Refining of Nonferrous Metals and Alloys. p. 33C-29, 1970.

Quantities shipped by all manufacturing establishments of copper, lead, zinc, aluminum, primary nonferrous metals, and secondary nonferrous metals are tabulated for 1947, 1954, 1958, and 1963 to 1967. Both smelter and refined materials are included.

34921

Bureau of Census, Washington, D. C.

**MATERIALS CONSUMED, BY KIND: 1967 AND 1963.** In: Smelting and Refining of Nonferrous Metals and Alloys. p. 33C-31, 1970.

The quantity consumed in the smelting and refining of nonferrous metals and alloys of aluminum ingot, aluminum and aluminum-base alloy scrap, copper, lead, zinc, and tin is listed for 1963 and 1967. Delivered costs are also indicated.

35050

Wagner, T. O.

**MOTOR GASOLINE AND AUTOMOTIVE AIR POLLUTION.** SAE (Soc. Automot. Engrs.) Spec. Pub., no. 365:55-62, June 1971. 6 refs.

Until 1970, the emission standards and the car modifications needed to comply with them had relatively little effect on gasoline quality, either in California or the remainder of the country. The only regulation on gasoline relevant to vehicle pollution was a limit of about 15% placed on total olefin content by California, and this limit required relatively small changes in refinery operations for compliance. Then, in 1970, Ford and General Motors announced that nearly all of their 1970 and later model cars would be designed to operate on unleaded gasoline of 91 Research octane number. The production capabilities of the petroleum industry, the effect of leaded gasoline on emissions, consumer advantages and disadvantages of unleaded gasoline, gasoline volatility, and future gasoline quality are discussed.

35052

Kiyoura, Raisaku

**ENERGY AND POLLUTION -- DEVELOPMENT OF POLLUTION-FREE FUEL.** Chem. Economy Eng. Rev., 3(11):25-32, Nov. 1971. 1 ref.

The world s energy consumption has been increasing at an average annual rate of four to five percent, while Japan s consumption has been expanding at a rate of more than 10%. Coal, petroleum, natural gas, and electric power consumption figures for major countries are presented tabularly. In Japan, the rapid rise in energy demand has sharply increased the nation s dependence on imported raw materials such as oil, coking coal, and iron ore in the energy consuming sectors. The rise in energy consumption and the increase in industrial wastes are contributing to air pollution. Efforts are being made with added momentum, however, to secure low-sulfur crude, to develop desulfurization techniques, to generate atomic energy on a commercial basis, and to import a large volume of liquefied natural gas. Nationwide emissions and emission sources are indicated for the United States. Sulfuric acid fallout is discussed; the air stream which moves from south to north carries acidic air from central Europe and blows it north. Lead compounds in automobile exhaust are also mentioned. Sulfur oxide control processes include activated carbon, Reinluft method, manganese oxide, alkalized alumina, limestone, scrubbing, ammonia, oxidation, absorption, and adsorption. Japanese efforts against pollution and Japanese standards are given.

35065

John, Matt K.

**LEAD CONTAMINATION OF SOME AGRICULTURAL SOILS IN WESTERN CANADA.** Environ. Sci. Technol., 5(12):1199-1203, Dec. 1971. 19 refs.

The content of nitric acid soluble lead among 700 soil samples, mostly from agricultural soils in British Columbia, was related to proximity to industrial and population centers. Soluble lead was immobilized in surface horizons and ranged from 0.5 to 180.4 ppm in the agricultural soils. The soluble lead content in surface samples collected near a battery smelter was as high as 59,580 ppm. Fractionation of lead into total, native, and soluble forms was useful in assessing the degree of soil pollution. Since plant availability of lead may depend on many factors other than soil lead content, it is difficult to conclude whether some of the high levels of lead present in these soils could result in excessive accumulation in plants. (Author summary modified)

35078

Loebsack, Theo

**THE POLLUTED AIR (2).** (Die verpestete Luft (2)). Text in German. Kosmos (Stuttgart), 67(9):379-382, Sept. 1971.

By photochemical processes, sulfur dioxide is changed into sulfur trioxide. Ozone can form in smog under the influence of sunlight, and then combine with other pollutants, becoming an irritant to the eyes and the respiratory organs. Ozone inhaled for an extended period of time can cause fatal lung edema. Between 1900 and 1960 the concentration of carbon dioxide and dust in the air rose from an average of 290 ppm to 330 ppm. A meteorologist in Munich has calculated that an increase of 10% CO2 causes the average temperature of the atmosphere to go up by 0.3%. This in turn creates an increase of the water vapor content, the cloud cover becomes denser, with a consequent detrimental effect on plant photosynthesis due to the weakened light energy, resulting in reduced formation of oxygen by the plants. The exhausts from gasoline engines produce, apart from carbon monoxide, unsaturated hydrocarbons, nitric oxides, lead compounds, and the carcinogen 3,4-benzopyrene. An interesting aspect with combustion engines is the fact that they consume vast amounts of oxygen. One study reveals that nobody in the United States would be alive now, if the human demand for oxygen were covered solely by the oxygen produced by the plants in the U. S. In actual fact, one third of the demand is derived from sources outside the boundaries of the continental U. S., for instance from the oxygen produced by the plant plankton of the Pacific Ocean. Pollution of the air by fluorides is caused by emissions from metallurgical plants of the aluminum, iron, and non-ferrous metal industries, ceramics industries, and plants manufacturing phosphorus and phosphate fertilizers.

35123

Pierrard, J. M. and R. A. Crane

**AUTO EXHAUST -- LEAD VS AROMATICS.** Hydrocarbon Process., 50(9):142-146, Sept. 1971. 17 refs. (Presented at the Air Pollution Control Association, Atlantic City, N. J., June 29, 1971.)

Laboratory and field tests were conducted to determine the effect of particulate emissions in vehicle exhaust on atmospheric soiling and visibility degradation. Leaded and unleaded gasolines were compared using 1969, 1970, and 1971 model automobiles. In the first phase of the investigation, cars were operated on a programmed chassis dynamometer on leaded and unleaded fuels of both high and low aromatic content, and

the soiling and visibility degradation effects of the particulate matter in the diluted exhaust were determined. In the second phase, two fleets of cars were driven in the controlled atmosphere test space afforded by an idle traffic tunnel. Soiling and visibility degradation were more severe with the unleaded fuel at both high and low aromatic content. Unleaded gasoline caused 84% more degradation of light transmission than leaded, and soiling was 57% worse for unleaded gasoline.

35168

McCabe, Louis C.

**AIR POLLUTION REGULATIONS IN LOS ANGELES COUNTY.** Lead Industries Assoc., New York, Proc. Lead Hyg. Conf., Chicago, Illinois, 1948, p. 102-11. 2 refs. (Nov. 15-16.)

Los Angeles air pollution regulations affecting metallurgical industries and from an investigation of air pollution problems in ferrous and nonferrous industries in the area are summarized. Smoke cannot exceed Ringelmann No. 2 for more than 3 min/hour, and no contaminant can be emitted that is as opaque as smoke at Ringelmann No. 2. Particulate matter cannot exceed 0.04 grains/cu ft at the point of discharge. Lead and zinc oxides are restricted to 0.035 grains/cu ft and sulfur compounds to 0.2% by volume (calculated as sulfur dioxide). The average loss due to volatilization and recondensation for brass foundries and smelting operation is about 1% of the melt charged. A loss of this magnitude is in violation of the present rules. Foundries handling copper-lead, magnesium, aluminum, and high nickel-brass alloys will be within legal limits, provided good foundry practices are followed. For the ferrous industry the percent loss is 0.5 to 0.9. Most of the time, the ferrous industry violates the present law on stack loading and opacity. Three types of equipment can be applied at nonferrous installations at reasonable expense: fabric filters, mechanical scrubbers, and packed towers. Installation costs will run from $.25 to $1.50/cu ft of gas handled.

35199

Felt, A. E. and R. V. Kerley

**ENGINES AND EFFECTS OF LEAD-FREE GASOLINE.** Society of Automotive Engineers, Inc., New York, 8p., 1970. 19 refs. (Presented at the Society of Automotive Engineers, Mississippi Valley Section Meeting, Oct. 22, 1970, Paper 710367.)

Problems posed by the use of lead-free gasoline in conventional passenger cars are discussed. Under heavy-duty operation, severe exhaust valve seat wear can occur. This will eventually result in one or more valves remaining open with extremely high exhaust emissions. Combustion-chamber deposits formed in the absence of lead are typically more carbonaceous. These deposits have a higher heat capacity than lead deposits and the result, after extended mileage, is higher octane number requirements for engines operated on leaded gasolines. The use of aromatic blending stocks to increase the octane number of nonleaded fuels increases undesirable exhaust emissions. Amounts of phenols, benzaldehydes, total aromatic aldehydes, and polynuclear aromatic hydrocarbons in the exhaust are directly proportional to the aromaticity of the fuel. In addition, the photochemical reactivity of automobile emissions can be increased by as much as 38%. (Author abstract modified)

35224

Halley, James H. and Bruce E. McNay

**CURRENT SMELTING SYSTEMS AND THEIR RELATION TO AIR POLLUTION.** Preprint, American Inst. of Chemical Engineers New York and Inst. Mexicano de Ingenieros Quimicos, 20p., 1970. 5 refs. (Presented at the American Institute of Chemical Engineers and Institute Mexicano de Ingenieros Quimicos, Joint Meeting, 3rd, Denver, Colo., Aug. 30-Sept. 2, 1970.)

The non-ferrous smelting operations, using metallic sulfides as feed material, are briefly described. These include copper, lead, and zinc smelting. Conditions and the nature of waste gas streams are discussed in relation to extraction and recovery of sulfur. Major problems of high temperatures, unclean gases, and low sulfur oxide concentration are noted. Possible changes in equipment and processes are discussed, as well as the manufacture of sulfuric acid from relatively strong sulfur dioxide waste gas. (Author abstract modified)

35353

Gagliardi, J. C., E. E. Weaver, and C. S. Wodkowski

**EFFECTS OF NON-LEADED FUELS ON EXHAUST HYDROCARBON COMPOSITION AND CATALYST LIFE.** Am. Chem. Soc., Div. Petrol. Chem., Preprints, 16(2):E65-E69, March/April 1971. 23 refs.

The effects on non-leaded or low-leaded gasolines and fuel additives on the level of total hydrocarbon emissions, hydrocarbon composition of exhaust, photochemical reactivity of hydorcarbons in exhaust, and particulate emissions have been investigated, along with the use and effects of catalytic control systems. Currently marketed non-leaded fuels were similar in composition to regular leaded fuels and therefore emitted exhaust of similar composition and photochemical reactivity. Hydrocarbon emissions with non-leaded fuels would increase no more than 10% due to combustion chamber deposits, while with leaded fuels they would increase as much as 35%. Olefin content of the exhaust increased with olefin content of fuels. An increase in aromatic content indicated a slight decrease in total hydrocarbon emissions. Aromatic aldehydes were in the exhaust only if aromatic hydrocarbon were determined in the fuels. Catalytic devices had a relatively short life with leaded fuels; they permitted the control of hydrocarbons and hydrocarbon reactivity, aldehydes, polynuclear aromatic hydrocarbons, and carbon monoxide to low levels. Lead derived particles were a major portion of the particulate matter in the exhaust. (Author summary modified)

35398

Carpenter, Kathleen E.

**A STUDY OF THE FAUNA OF RIVERS POLLUTED BY LEAD MINING IN THE ABERYSTWYTH DISTRICT OF CARDIGANSHIRE.** Ann. Appl. Biol. (London) 11(1):1-23, April 1924. 16 refs.

The fauna of certain streams in the Aberystwyth district of Wales was examined with respect to substratum, water acidity, and correlation with pollution by lead mining and lead washing operations. Such operations affected the rivers by the discharge into the waters of galena particles in all stages of divisions and by the formation of lead salts in diffusible form through chemical interaction with natural water. The correlation of fauna lists with water analyses determined that poverty of fauna, especially fish, was always accompanied by the presence of lead salts. (Author summary modified)

35477

Hinkamp, J. B., M. E. Griffing, and D. W. Zutaut

**AROMATIC ALDEHYDES AND PHENOLS IN THE EXHAUST FROM LEADED AND UNLEADED FUELS.** Am. Chem. Soc., Div. Petrol. Chem., Preprints, 16(2):E5-E11, March/April 1971. 32 refs.

The effect of aromatic hydrocarbons on the concentration of aromatic aldehydes and phenols in the exhaust of cars operating on various fuels and determined test cycles was investigated. Two fuels of equal octane level, leaded and unleaded, were tested for the effects of the removal of lead antiknocks. Although total aldehyde concentration was not significantly altered by fuel composition, the concentrations of total aromatic aldehydes and benzaldehyde increased with the aromatic content of the fuel. Phenol concentration increased with fuel aromaticity in both the cold and hot cycle tests.

35481

Esso Research and Engineering Co., Linden, N. J., Products Research Div.

**FIRST ANNUAL REPORT ON GASOLINE COMPOSITION AND VEHICLE EXHAUST GAS POLYNUCLEAR AROMATIC CONTENT.** National Air Pollution Control Administration Contract CPA-22-69-56, Coordinating Research Council Proj. CAPE-6-68, 117p., Feb. 17, 1970. 18 refs. NTIS: PB 200266

Exhaust emissions of phenols and polynuclear aromatic hydrocarbons (benzo(a)pyrene and benz(a)anthracene) were investigated on cars with and without emission controls to determine the effects of fuel and vehicle variables, emission rates, phenol emission, increasing fuel aromaticity and polynuclear aromatic hydrocarbon content, changes in 0combustion chamber deposits, and adding lead to both deposits and fuels. Pollution control methods for reducing carbon monoxide, nitrogen oxides and unburned hydrocarbon emissions were examined. The effect of air-fuel ratio, spark timing, operating cycles, and oil consumption on exhaust emissions was also studied. Experimental procedures and test data are included.

35484

Peters, Bruce, Harrison Sigworth, Jr., P. S. Myers, and O. A. Uyehara

**THE 1970 CLEAN AIR CAR RACE AND THE UNIVERSITY OF WISCONSIN ENTRIES.** Am. Chem. Soc., Div. Petrol. Chem., Preprints, 16(2):E73-E86, 1970. 9 refs.

Two spark ignition engine powered cars, fueled by unleaded gasoline and liquid petroleum gas, and equipped with extensive intake and exhaust system modifications for low emissions are examined against the results of a Clean Air Car Race. The modifications included retarded spark-timing, blowby emission control, special carburetion, catalytic muffler, exhaust port air injection, exhaust gas recirculation, thermal reactor, and changed air-fuel ratio. Test description, procedures, and results and control equipment used are discussed. Concentrations of unburned hydrocarbons, carbon monoxide, nitrogen oxides, and particulates emitted were determined.

35676

Federal Aviation Administration, Washington, D. C., System Planning Div.

**CHESTERFIELD COUNTY AIRPORT, CHESTERFIELD, VIRGINIA. DRAFT ENVIRONMENTAL IMPACT STATEMENT PURSUANT TO SECTION 102 (2) (C) ENVIRONMENTAL POLICY ACT OF 1969 (P.L. 91-190).** 24p., April 27, 1971. 2 refs. NTIS: PB 198759

The potential impact on the environment of a proposed airport to accomodate single-engine and light twin-engine aircraft at Chesterfield, Virginia, is investigated. Site description, construction techniques, noise levels, water pollution, and effects on air quality are considered. Projected emission concentrations of carbon monoxide, organics, nitrogen oxides, particulates (lead compounds and soot), and sulfur dioxide were computed for engine cycles, and air quality criteria were established.

35788

Koide, Minoru and Edward D. Goldberg

**ATMOSPHERIC SULFUR AND FOSSIL FUEL COMBUSTION.** J. Geophys. Res., 76(27):6589-6596, Sept. 20, 1971. 19 refs.

Chloride and sulfate concentrations in ice samples from the Greenland ice sheet were spectrophotometrically determined and compared with previously reported values. The analyzed samples were collected in 1964-1965 and were primarily from the Camp Century area and from a virgin site 80 km east-southeast Camp Century. The determined values are uniformly higher than published values; but regardless of the the values used, substantial changes in the sulfate-chloride ratios do not appear until 1964-1965. The sulfur dioxide released in the combustion of fossil fuels appears to be competing during the last decade with natural processes such as volcanoes and the oxidation of hydrogen sulfide derived from organic matter. In recent glacial strata, the amount of sulfate co-varies with the amount of lead, suggesting similar source areas and atmospheric paths for the two pollutants.

35818

Padrta, F. G., P. C. Samson, J. J. Donohue, and H. Skala

**POLYNUCLEAR AROMATICS IN AUTOMOBILE EXHAUST.** Am. Chem. Soc., Div. Petrol. Chem., Preprints, 16(2):E13-E23. March 1971. 8 refs. (Presented at the Los Angeles Meeting, March 28-April 2, 1971.)

Polynuclear aromatic hydrocarbons (PNAH) in auto exhaust were spectrometrically analyzed following sampling with thermal gradient traps, benzene extraction, and benzene concentration. To learn more about the origin of PNAH in exhaust, fuel, and motor oil compositions were varied. Also, both new and old engines were used. Addition of C8 aromatics to indolene did not significantly alter the level of PNAH in the exhaust, but addition of C8 aromatics to isooctane noticeably increased the level of PNAH in exhaust over isoocatane without added aromatics. Lead-free and leaded Indolene produced essentially similar PNAH exhaust levels. Larger differences in PNAH levels were observed for different engine wear conditions than for different fuels. A catalytic converter operating at higher than normal space velocities reduced PNAH in exhaust by 90+% and C8-C10 alkylbenzenes by 95+%.

35919

Griffing, M. E., A. R. Maler, J. E. Borland, and R. R. Decker

**APPLYING A NEW METHOD FOR MEASURING BENZO(A)PYRENE IN VEHICLE EXHAUST TO THE STUDY OF FUEL FACTORS.** Am. chem. Soc., Div. Petro Chem., Preprints, 16(2):E24-E31, March 1971. 19 refs. (Presented at the Los Angeles Meeting, March 28-April 2, 1971.)

The effect of fuel aromaticity and tetraethyl lead content on benzo(a)pyrene emissions from cars using prototype fuels and cars without emission control devices was investigated. Complete experimental procedures and test data are discussed. In general, the BaP emitted was increased with an increase in fuel aromaticity; tetraethyl lead content had no effect on BaP emissions. Using a car not equipped with emission control devices, a positive straight line relationship was determined between fuel aromaticity and BaP emissions. The nonaromatic portion of the fuel formed some BaP emissions during combustion. The BaP emissions varied more during cold cycle operation than during hot cycles. Of the two alternates for ob-

taining octane number, low aromatic leaded fuels produced less BaP than higher aromatic unleaded fuels. A new tracer injector and sampling system was used for the tests. (Author conclusions modified)

35953

**LEAD ELIMINATION FROM LEADED GASOLINE.** (Blei-Eliminierung aus dem Bleibenzin). Text in German. Protectio Vitae, 16(5):231-234, Oct. 1971.

Man s use of lead has led to pollution of the environment to 0the extent that the natural background concentration can no longer be determined. The lead contamination by industries is enhanced by the combustion of lead-containing gasolines. The lead concentrations in the gasolines differ and range from 0.2 g/l to 1.1 g/l (average 0.44 g/l). The total quantity of lead emissions from automobiles is estimated to amount to several hundred thousand tons per year for the northern hemisphere. This amount increases each year by 3.5%. The ground level air along highways and streets and in cities contains about 10 micrograms Pb/cu m. Sometimes this amount rises to 40 micrograms/cu m and more. According to the World Health Organization, the air man breathes should not contain more than two micrograms Pb/cu m. Inhaled and ingested lead has a long residence time in organs, which increases the danger of an accumulation of the element. The smallest concentrations of lead inhibit the activity of the delta-aminolevulinic acid dehydratase. Tetraethyl lead can permeate healthy skin and can concentrate in the central nervous system.

35957

Tada, Osamu

**METAL FINISHING INDUSTRY AND ENVIRONMENTAL HEALTH.** (Hyomen shori kogyo to kankyo eisei). Text in Japanese. Hyomen Shori Janaru (Metal Finish. J.), 4(4):62-66, April 1971.

The effects of various metal finishing processes such as welding, coating, and plating on the working environment and the maximum permissible concentration of pollutants are reviewed. In metal plating pretreatment, inhaling of vapors of trichloroethylene or perchloroethylene can damage nervous system and liver. Various acid baths give off mists, nitric oxide, and nitrogen dioxide, which can cause respiratory disorders, bronchitis, and pneumonia. Electrolysis mist can cause inflammation of membranes in the nose and throat. Inhalation of zinc fume can cause headache, exhaustion, debility, high fever, but the effects are not long-lasting. Ammonium chloride inhalation causes discomfort, but poisoning cases have not been reported. Ammonia can irritate eyes and respiratory systems. Lead can cause chronic disorders to blood cells, digestive systems, or nervous systems. Common effects of organic solvent used for paints, coating, and sealing materials are paralysis of the body, irritation of skin and membranes, and disorders of liver, kidney, nerve, and blood. During paint spraying, skin damage can occur, particularly with epoxy-based plastic. During the drying of paints, thermal decomposition of melamine creates formaldehydes, which irritate eyes, irritate the respiratory system, and cause general discomfort. Maximum permissible concentration is five ppm, but even one to two ppm creates a considerable irritation of eyes and noses. A harmful amount of ozone can be created in welding by inert gas arc, especially when welding nonferric metals. A concentration of one to two ppm causes headache, dizziness, nausea, and higher concentrations cause bronchial and lung inflammations.

36006

Tanaka, Katsuhiko, Katsuhisa Fukaya, Kiyoshi Yoshitani, Syozo Fukui, and Saburo Kanno

**HYGIENIC CHEMICAL STUDIES ON PUBLIC HAZARDS BY HARMFUL SUBSTANCES. IV. ATOMIC ABSORPTION PHOTOMETRIC DETERMINATION OF LEAD IN GASOLINE.** (Yugaibutsu ni yoru kogai no eisei kagakuteki kenkyu (daiyonpo). Genshi kyuko kodoho ni yoru gasorin-chu no namari no teiryoho). Text in Japanese. Eisei Kagaku (J. Hyg. Chem.), 17(6):393-397, Dec. 1971. 2 refs.

Atomic absorption spectrophotometry of different kinds of organic lead gave different values of lead even in the equivalent concentration of lead when using a premix burner. However, a total consumption burner gave equal absorptions for equivalent concentration solutions of lead diethyldithiocarbamate, tetraethyl lead, and tetramethyl lead. A simplified method for the determination of the lead content of gasoline was established based on this fact. The sample of gasoline is diluted with methyl isobutyl ketone and absorbance is measured at 2170 A, using the total consumption burner. The standard solution is prepared from the standard aqueous lead nitrate solution by the addition of sodium diethyldithiocarbamate solution and by extracting it with methyl isobutyl ketone. This method is convenient and safe, because dangerous tetraalkyl lead is not used as the standard substance. The lead content of 24 kinds of commercial gasoline was analyzed by this method.

36032

Wiklander, Lambert

**LEAD IN SOIL AND PLANTS. I. INFLUENCE OF MOTOR VEHICLES.** (Bly i mark och vaxter. I. Inverkan av motortrafik). Text is Swedish. Grundfoerbattring, 23(3-4):163-169, 1970. 3 refs.

Snow accumulated during the winter in Uppsala, Sweden, was analyzed for lead at various distances from a main road. Samples of soil were collected in the spring at depths of 0-1 and 10-15 cm, and samples of wheat were collected in August. Shoots of a Norwegian spruced hedge were also cut and analyzed. The atmospheric deposition of lead was high close to the road and rapidly decreased to a normal value at 45 m. The accumulation of lead in the soil surface showed a similar pattern, while at a depth of 10-15 cm the lead concentration was invariable with the distance. Lead content of the wheat and Norwegian spruce was high in the proximity of the road. Soil profiles from a park area in Gothenburg with heavy traffic ranged from 12-117 ppm of soluble lead and 69-425 ppm total lead.

36080

Crouse, W. W., R. H. Johnson, and W. H. Reiland

**EFFECT OF UNLEADED FUEL ON LUBRICANT PERFORMANCE.** Preprint, Society of Automotive Engineers, Inc., New York, 6p., 1971. 1 ref. (Presented at the Society of Automotive Engineers, Mid-Year Meeting, Montreal, Quebec, June 7-11, 1971, Paper 710584.)

The performance of motor oils in engines run on unleaded fuels was evaluated using several makes of United States cars. These oils were run in high mileage or turnpike service, as well as suburban service. The performance with unleaded fuels was not significantly different from that for leaded fuels in the areas of wear, sludge, varnish, or rust. Valve seat recession was detected in several of the cars, but had an effect on performance in only one case. Further testing using laboratory engines and a patrol fleet in pursuit service demonstrated the ef-

fect of lubricant composition on valve seat recession. In addition, engines preconditioned on leaded fuels afforded better protection against valve seat recession than new engines. (Author abstract modified)

36082

Bell, A. G., J. A. Keene, and K. Reders

**ROAD ANTIKNOCK PERFORMANCE OF LOW LEAD AND NONLEADED GASOLINES IN EUROPEAN CARS.** Preprint, Society of Automotive Engineers, Inc., New York, 27p., 1971. 6 refs. (Presented at the Society of Automotive Engineers, Mid-Year Meeting, Montreal, Quebec, June 7-11, 1971, Paper 710625.)

An experiment designed to evaluate the road antiknock performance of low-lead and nonleaded gasolines is described. Over 100 test fuels covering a wide range of research octane number, lead content, sensitivity, and front-end quality were prepared. They were then tested in nine European and one American car under both accelerating and wide-open throttle constant-speed conditions. The design of the experiment and the analysis and interpretation of the results are described. In general, in European cars knocking at low speed, road antiknock performance can be adequately described in terms of research octane number, sensitivity, and front-end quality, and that there is no additional benefit to be gained from the use of a high concentration of lead. By contrast, in European cars knocking at high speed and in the one American car tested, gasolines with a high lead content gave a better performance than the equivalent nonleaded gasolines. This was particularly so in the case of fuels leaded with tetramethyl lead as opposed to tetraethyl lead. (Author abstract)

36083

Pless, Loren G.

**SOME EFFECTS OF EXPERIMENTAL VEHICLE EMISSION CONTROL SYSTEMS ON ENGINE DEPOSITS AND WEAR.** Preprint, Society of Automotive Engineers, Inc., New York, 13p., 1971. 20 refs. (Presented at the Society of Automotive Engineers, Mid-Year Meeting, Montreal, Quebec, June 7-11, 1971, Paper 710583.)

Passenger car tests were conducted to evaluate the effects on deposits and wear of three types of vehicle emissions control systems intended to reduce either evaporative emissions, oxides of nitrogen in the exhaust, or crankcase emissions. These tests used 1965-70 model cars, operating with leaded commercial gasolines and 13 different engine oils, in several kinds of service. A crankcase storage evaporative emissions control system increased engine rusting in short-trip service, and increased sludging and valve train wear in low-speed, stop-and-go service. When the crankcase purging rate was reduced in vehicles with crankcase storage to overcome hot-starting and driveability problems, such deposit and wear increases were even larger than with the production positive crankcase ventilation (PCV) valve purging rate. An exhaust gas recirculation (EGR) system for reducing oxides of nitrogen increased engine rusting in short-trip service. Heavy lead-salt deposits accumulated in the EGR system in other tests. Doubling the PCV valve idle air-flow rate from two to four cfm greatly reduced engine rusting in short-trip service. This reduction in rusting was about the same as that obtained, using production two cmf PCV valves, by doubling the concentration of rust inhibitor in the engine oil. Progressively increasing the PCV rate also progressively decreased engine deposits and oil degradation in mixed city-suburban-expressway service. A deep-breathing PCV system providing more thorough ventilation of the engine crankcase reduced deposits and oil degradation. (Author summary modified)

36084

Morris, W. E., J. D. Rogers, Jr., and R. W. Poskitt

**CARS AND THE NEW GASOLINES 1971.** Preprint, Society of Automotive Engineers, Inc., New York, 56p., 1971. 14 refs. (Presented at the Society of Automotive Engineers, Mid-Year Meeting, Montreal, Quebec, June 7-11, 1971, Paper 710624.)

The recent introduction of lower compression ratio engines and the concurrent marketing of unleaded and low-lead content gasolines of generally lower octane number made it appropriate to investigate the interrelationships of engine performance and gasoline octane quality using the new engines and fuels. Fuel economy of eight 1971 cars was 6.6% lower than that of eight corresponding 1970 cars. Acceleration performance of these 1971 cars was significantly poorer than that of the 1970 cars. Commercial leaded or unleaded gasolines of 91 research octane level are expected to knock in more than half the 1971 cars. Research octane number is a poor index of road octane performance for either premium or regular gasolines in 1970 and 1971 cars. As has been the case for many years, the road octane quality of premium gasolines in 1970 premium cars is related to R plus M/2 (0.5 research plus 0.5 motor octane number). The road octane quality of regular gasolines in 1971 cars and in 1970 regular requirement cars is related primarily to motor octane number. At a given motor octane level, lead content has little effect on road octane number in 1971 cars or in 1970 regular requirement cars. Currently available unleaded commercial gasolines generally are high in sensitivity (research minus motor octane number) and aromatic content relative to leaded commercial gasolines. Because of their higher sensitivity, typical unleaded gasolines must be higher in research octane quality than leaded gasolines to give the same road octane number. For equal road octane number, unleaded premium gasoline must be about four research octane numbers higher than the leaded premium and unleaded regular must be about one research octane number higher than leaded regular. (Author summary modified)

36527

Rossenbeck, Martin

**FUEL AND THE PROTECTION OF THE ENVIRONMENT, PART I.** (Kraftstoffwandel im Zeichen des Umweltschutzes). Text in German. Automobiltech. Z. (Stuttgart), 73(11):415-421, Nov. 1971. 62 refs.

The current lead content limit in gasoline in the U. S. is 1.12 g Pb/l, against 0.84 g Pb/l in Japan, and 0.7 g Pb/l in Sweden. In West Germany the maximal permissible lead content will be gradually reduced to 0.40 g/l on Jan. 1, 1972, and to 0.15 g/l on Jan. 1, 1976. Lead compounds emitted by automobile exhaust gases have a particle size below 0.125 micron and thus remain suspended in the atmosphere; industrial lead emission consists of coarse particles, 0.5 to 5 micron in diameter. The maximal permissible atmospheric lead concentration in West Germany is 0.2 mg Pb/cu m. Lead which is inhaled and reaches the lungs is more dangerous than lead ingested with food. Part of the lead is deposited in bones, part is eliminated by the blood. It is unresolved whether only the blood level of lead or the total body lead content should serve as a criterion of lead poisoning. As of July 1, 1971, there are 12 low lead gasolines and 9 lead-free gasolines with an octane rating of 91 on the market in the U. S. The automobile industry reacted to reduced octane ratings by lowering the compression ratio and hp of cars. To compensate for the elimination of tetraethyl, lead refineries are raising the octane rating of gasolines by introducing new technologies including reforming, hydrocracking, isomerization, alkylation, polymerization, the molecular sieve treatment, and cracking.

36535

Lafferty, W. L., Jr. and R. W. Stokeld

**ALKYLATIN AND ISOMERIZATION.** Advan. Chem. Ser., no. 103:130-149, 1971. 45 refs.

Alkylation processes for the production of highly branched paraffins for use in high octane gasoline have attained exceptional importance in the petroleum industry over the past 30 years. The rapid growth of alkylation created large demands for isobutane, and to help supply these demands, butane isomerization processes were developed. Subsequently, isomerization technology was applied to higher molecular weight paraffins, and various isomerization processes were developed to complement alkylation as a tool for gasoline manufacture. If the demand for gasoline continues to increase at the present rate, 40,000-60,000 BPD of new alkylation capacity will be added annually in the years ahead. Gradual reduction or total elimination of lead antiknock compounds will result in even higher annual growth rates of alkylation, and in additional isomerization capacity. Legislation on the volatility, olefin content, or aromatic content of gasoline could also accelerate the growth of alkylation and isomerization.

36541

Stoefen, Detlev

**AGAIN: THE FUTURE FUEL FOR AUTOMOBILES.** (Nochmals: Der kuenftige Autotreibstoff). Text in German. Staedtehygiene (Uelzen/Hamburg), 22(11):265, Nov. 1971. 2 refs.

The fear has been voiced that a reduction of the lead content in the gasoline would lead to irresponsibly high concentrations of aromatic hydrocarbons (benzene, toluene, and xylol). This fear has come true. Heavy fractions of mineral oil are used for conversion to gasoline. For this conversion the reforming process is primarily used in Europe. During this process cyclic hydrocarbons are converted into aromatics. At a maximum allowable lead content of 0.15 g/l, as is presently required by the law, the aromatics concentration is about 50% if the present anti-knocking properties are to be maintained. The benzene content should be kept below 5%.

36623

Pearce, A. W. and C. S. Windebank

**CLEAR AIR-THE BALANCE SHEET: THE VIEWPOINT OF THE FUEL INDUSTRIES-OIL.** Nat. Soc. Clean Air Proc. Ann. Conf., p. 104-117 1970. (Presented at the National Society for Clean Air, Annual Conference, Southport, England, Oct. 20-23, 1970.)

Although petroleum products have advantages over solid fuels from almost every aspect of air pollution, they are nevertheless a significant emissions source because of the immense quantity consumed and the projected rate of growth of this demand. Basically, pollution from fossil fuels can be limited by using fuels with low carbon-hydrogen ratios (petroleum products, and gas in particular) and by burning them with maximum efficiency. Current abatement efforts and control methods are reviewed for the principal pollutants, including particulates, carbon monoxide, hydrocarbons, nitrogen oxides, and lead compounds from automotive exhausts, and sulfur oxides. Continuing research on improved control technology is being conducted by individual petroleum firms, by petroleum industry trade associations, and study groups (domestic and international), and in cooperation with other concerned industries, e.g., autombile manufacturers. Summary data are included on world and United Kingdom energy consumption, U. K. fuel usage and smoke emissions, and sulfur dioxide sources, emissions, and concentrations.

36664

Dept of Commerce, Washington, D. C., Technical Advisory Board Panel on Automotive Fuels and Air Pollution

**AUTOMOTIVE FUELS AND AIR POLLUTION.** 32p., March 1971.

Results are presented of a study on the influence of fuel composition, including additives, on the amount and nature of atmospheric pollutants from automotive vehicles. Specifically, the panel concerned itself with the influence of fuel composition on the ability of auto manufacturers to meet increasingly stringent emission standards for future vehicles; the influence of fuel composition on emissions from present vehicles; increased costs associated with some potential changes in fuel composition; and other sources of pollutants which will become important when exhaust emissions are substantially controlled. Regulatory strategies are defined which will result in the availability of low leaded and unleaded fuels when needed and which impose only modest demands for construction and small increased fuel costs to the public. Removal of lead in high octane fuels would probably result in an increase in the aromatic hydrocarbon content of fuels, but these could be removed by an additional step in the refining process. The Environmental Protection Agency should be granted authority to regulate the following aspects of fuel: amount of lead-containing additives; amount and nature of aromatic hydrocarbons, olefin content and volatility; detergents and other additives.

36846

Yoshinaga, Shunichi and Sadao Iki

**SOIL CONTAMINATION BY HEAVY METALS IN ATMOSPHERIC DEPOSIT IN KITAKYUSHU CITY.** (Kitakyushushi ni okeru dojochu no kinzoku seibun). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 6(1):212, 1971. (Presented at the National Council Meeting of Air Pollution Studies, 12th, Nagoya, Japan, Oct. 27-29, 1971.)

The manganese, titanium, zinc, nickel, cobalt, copper, chromium, cadmium, lead, and vanadium contents in soil collected at ten polluted locations in Kitakushu City were measured and compared with those in the unpolluted area, Fukuoka and Kyoto City. The metallic composition of soil was very similar to that of suspended particulates and deposited particulates. The metallic content in soil of Kitakushu City were generally higher than the Clark s number, particularly Zn, Cu, Cd, Pb, and V content.

37015

Bach, W.

**AUTOMOBILE EXHAUST HAZARDS.** (Ein Beitrag zur Schaedlichkeit der Autoabgase). Text in German. Vitalst. Zivilisationskr., vol. 13:120-123, June 1968. 27 refs.

The extent of the air pollution problem caused by automotive exhausts, and potential hazards to human health are examined. As of January 1966, world vehicle registration was 177 million, of which about 90 million were registered in the United States and about 10 million in West Germany. Estimates indicate that a car consuming 45 liters of gasoline emits about 19 liters of carbon monoxide, four liters of hydrocarbons, and one liter of nitrogen oxides. Other major constituents of automotive exhausts include ozone, aldehydes, sulfur dioxide, and lead. Symptoms resulting from exposure to exhaust components are discussed, and measured concentrations are compared with official threshold values.

37166

Kiyoura, Raisaku

**ENERGY AND POLLUTION -- DEVELOPMENT OF POLLUTION-FREE FUEL.** Chem. Economy Eng. Rev., 3(11):25-32, Nov. 1971.

Data are presented on energy consumption in major countries, emission of air pollutants in major countries, nationwide emissions in the U. S., sulfur dioxide concentrations in major industrial nations, and sources of carbon monoxide, sulfur oxide, and particulate emissions. The decrease in the pH value of precipitation in Europe and the parallel increase in the sulfuric acid content is discussed, as is the worldwide increase in lead pollution. Major requirments of the U. S. Clean Air Act are summarized and major flue-gas desulfurization processes are outlined. Japan, with its severe environmental standards for sulfur oxides, is making extensive efforts to produce sulfur-free fuel. Numerous heavy-oil desulfurization plants are in existence, and the average sulfur content of imported crude has been reduced to 1.8%. In oil refining, the investments in desulfurization facilities represent 14.7% of the investments in total equipment.

37176

Ter Haar, G. L., D. L. Lenane, J. N. Hu, and M. Brandt

**COMPOSITION, SIZE AND CONTROL OF AUTOMOTIVE EXHAUST PARTICLATES.** J. Air Pollution Control Assoc., 22(1):39-46, Jan. 1972. 14 refs. (Presented at the Air Pollution Control Accosiation, Annual Meeting, 64th, Atlantic City, N. J., 1971, Paper 71-111.)

Several vehicles manufactured during 1966-1970, operated on a chassis dynamometer under Federal 7-mode cycle conditions, were tested to determine total particulate composition, size of exhausted lead particulates, and the effects of traps on total lead emitted. Cars varied widely in the amounts and composition of their particulate emissions. Cold-cycle operation gave 2-8 times more particulate than hot engine operation. Lead compounds represented less than 1/3 of the total particulates, the remainder being carbon compounds along with ammonium and nitrate ions and unknown materials. Exhausted lead varied with the condition of the exhaust system and ranged between 7 and 30% of the lead consumed by the engine. Fuel additives affected the amount of emitted particulates. Probe sampling techniques underestimated by a large factor the amount of particulates emitted by vehicles. Trapping systems offered potential for greatly reducing the emission of suspended total particulates. The size of lead particulates was determined using 26 1966-model cars with stabilized exhaust deposits. Under Federal Cycle conditions, 18% of the lead burned was emitted as fine and 11% as course particles. (Author abstract modified)

37190

**ENVIRONMENTAL PROTECTION AND CULTIVATION OF THE ENVIRONMENT IN LOWER SAXONY.** (Umweltschutz und Umweltpflege in Niedersachsen). Text in German. Staedtehygiene (Uelzen/Hamburg), 22(11):266-267, Nov. 1971.

The emission limit values for sulfur dioxide and dust are exceeded in Lower Saxony during normal weather conditions only in individual critical areas. In the Nordenham area the soil and the vegetation are heavily enriched with lead and zinc dust, sulfur dioxide, and fluorine. The lead content of the soil has reached 120 times and zinc has reached 150 times the normal values. The milk of animals grazing in this area has to be heavily mixed with other milk in order to make it drinkable. In Delmhorst, the natural composition of the air is changed by the emissions of a linoleum plant and a lacquer-resin plant. During the oxidation of linseed oil and the melting of resins, acrolein, formic acid, acetic acid, and phenols are liberated. In Osterwald, the fluorine emissions of a ceramic plant has destroyed a large forest. Injuries in forests were also observed in Bad Salzdetfurth from the emissions of a potassium plant and near Munich by a cellulose plant. Animal mass breeding stations cause unbearable odor emissions in Suedoldenburg, Bersenbrueck, Diepholz, Bassum, and Nienburg.

37312

Robbins, John A. And Franklin L. Snitz

**BROMINE AND CHLORINE LOSS FROM LEAD HALIDE AUTOMOBILE EXHAUST PARTICULATES.** Environ. Sci. Technol., 6(2):164-169, Feb. 1972. 18 refs.

Preliminary experiments indicate that bromine and chlorine are lost relative to lead in particulate matter present in fresh automobile exhaust from combustion of leaded gasoline. The loss rate for bromine is much greater than for chlorine during the first hour, and the rate is apparently not affected by the presence or absence of sunlight during this time. The measured loss rates may be accounted for quantitatively by assuming outward diffusion of halide ions to particle surfaces where they are volatilized. With additional information, especially simultaneous particle size distribution measurements, alternative models could be examined using techniques developed in this work. (Author conclusions)

37372

Yamaki, Naoomi

**EXHAUST GAS POLLUTION AND FUEL.** (Haiki gasu kogai to nenryo). Text in Japanese. Preprint, Japan Society of Mechanical Engineering, Tokyo, 17p., 1971. 40 refs. (Presented at the Seminar on Environmental Pollution by Internal Combustion Engine and its Countermeasure, Tokyo, Japan, Nov. 29-30, 1971.)

The relationship between fuels and automotive exhaust gas, and various components of exhaust gas which are regarded harmful pollutants are reviewed. Tests on exhaust gas using lead gasoline and non-lead gasoline showed that the exhaust contained 23 to 50% aromatic hydrocarbons. Omission of lead from gasoline results in an increase of aromatic hydrocarbons in exhaust, and consequently increases toxic aromatic aldehydes. When the hydrocarbon composition in fuels is the same, non-lead gasoline emissions contain 10 to 14% more aldehydes than lead gasoline. Theoretically, 20 to 30% of the total lead supply is contained in the exhaust deposit of a car with a 20,000 to 30,000 mileage. Therefore, 70 to 80% of the entire lead content in the deposit and lubricant is emitted in the air. A car driving in a city emits 20 to 60% of lead supply; the rest is accumulated in the exhaust system. Of the emission, 27 to 39% are particles of more than five micron which settle quickly; the rest is suspended in the air. Alkyl lead which is added to gasoline as an antiknock agent increases the amount of lead emission, but it also lowers the catalytic action of purifying exhaust gas. The effect of the catalyst decreases in proportion to the amount of lead additive. By using non-lead fuel, the exhaust emission standard could be met successfully by use of a catalyst, even after 50,000 miles.

37648

Balke, Siegfried

**CHEMISTRY AND ENVIRONMENT.** Chemie und Umwelt. Text in German. Tech. Ueberwach. Zicherheit Zuverlaessigkeit, 12(2):33-36, Feb. 1971.

Air pollution is caused by industry, households, traffic, soil erosion, and metabolic processes. The internal combustion engines driven by fuels containing lead pollute the air because of the exhaust gas. In the Federal Republic of Germany, the annual consumption of fuel containing tetraethyl lead amounts to 15 million tons containing about 0.5 g pure lead per liter fuel. In 1968 in the USA, about 225,000 tons of antiknock compounds were consumed. The general situation concerning radioactive material did not become worse because of the severe legislation in the Federal Republic of Germany and the prescriptions of EURATOM. Special attention is paid to still active gaseous by products deriving from nuclear fission.

37721

Ministry of Health and Welfare (Japan) Dept. of Environmental Pollution Control

**ABOUT THE NATURE AND EFFECT OF HARMFUL SUBSTANCES (POISONOUS AND DELETERIOUS SUBSTANCES CONTROL LAW.** Article 2, Item 1, No. 3. (Yugai busshitsu (Ho dai 2 no, Dai 1 ko, Dai 3 go) no seijo oyobi eikyo ni tsuite). Text in Japanese. 44p., May 1971.

The nature, permissible concentration, and measurement methods of cadmium, chlorine, fluorine, lead, nitrogen, and their compounds. Cadmium and its compounds include metallic cadmium, cadmium oxides, and cadmium salts. Oral and inhaled toxicities are mentioned. The dithizone method is used to measure cadmium. The rhodanic mercury method is used to measure hydrogen chloride and the detecting tube method and the orthotolizine method is used to measure chlorine. Acute and chronic effects of chlorine compounds are discussed. Fluorine, hydrogen fluoride, difluoric oxides, and fluorides are measured by the alizarin complexon method. Lead, inorganic lead compounds, metallic lead, lead oxide, lead chloride, and organic lead each have unique toxic properties. The dithizone method is used to measure lead. Nitric oxide, nitric anhydride, nitrous oxide and nitrogen dioxide are discussed. The detecting tube and naphthylethylene-diamine methods are explained.

38022

Giaume, L., E. Godani, and B. Nardi

**ATOMIC ABSORPTION DETECTION OF TRACE AMOUNTS OF LEAD IN LIGHT DISTILLATES.** Text in Italian. Riv. Combust. (Milan), 25(11):509-512, Nov. 1971. *(Presented at the* Symposium on Developmental, Analytical, and Instrumental Chemistry in the Petroleum Industry, Rome, Italy, May 27-28, 1971.)

Lead present as lead alkyls in low concentrations (50-500 micrograms/kg) in light petroleum distillates (e.g., solvents, naphthas, and gasolines) is determined by direct combustion of the sample in the burner of an atomic absorption spectrophotometer, followed by measurement of absorbance at 2833 A. The measured absorbance is then compared with a blank having a lead content below 10 micrograms/kg. The method is rapid and has satisfactory accuracy and repeatability. However, the spectrophotometer response is affected by tetraethyl lead and tetramethyl lead radicals and other organolead compounds.

38330

Rossenbeck, Martin

**FUEL CHANGES WITH A VIEW TO ENVIRONMENTAL PROTECTION. PART II.** (Kraftstoffwandel im Zeichen des Umweltschutzes). Text in German. Automobiltech. Z. (Stuttgart), 73(12):466-469, Dec. 1971. PART I. Ibid., 73(11):415-420, Nov. 1971.

38331

Schwanecke, R.

**WAYS TO A LEAD-FREE GASOLINE. (Wege zum Bleifreien Benzin). Text in German. Wasser Luft Betrieb, 15(12):442-445, Dec. 1971. 3 refs.**

At present three possibilities exist for production of a lead-free gasoline with about 92 to 102 RON (research-octane-number), namely reforming, isomerization, and alkylation. In catalytic reforming the initial material for powerforming is naphtha from the mineral oil distillation. Naphtha is first desulfurized, heated, compressed, and passed over the catalytic beds of the three reactors. There the naphthenes are converted to aromatics at temperatures between 450 and 500 C and at pressures of 10 to 30 atm. The investment costs for a reforming plant with an output of 1 million tons/yr amount to about 6 million dollars, including the catalyst but without desulfurization and stabilization. For the isomerization process, a mixture of pentane/hexane from the crude oil distillation is heated with hydrogen to between 350 and 450 C and compressed to 20 to 40 atm and desulfurized. After stabilization, hydrogen is added again and the aromatics present in the mixture are converted to paraffins at 330 C and 60 atm. For better activation of the catalyst, a small quantity of hydrogen chloride is added; finally the mixture is converted at 160 C and 18 to 25 atm to an isomeric mixture consisting primarily of methylpentanes and methylbutanes. For alkylation of paraffins or naphthenes, the isobutane is brought to reaction with suitable olefins at 20 to 25 C in presence of hydrogen fluoride as a catalyst. In a fractionating column the light hydrocarbons (propane, Hydrogen fluoride) are driven off and the paraffin/alkylate mixture is stabilized. The German Federal Republic would have to invest $190 million for construction of reforming, isomerization, and alkylation plants, should the gasoline become lead-free. The price of the gasoline would go up 1-2 cents/l fuel.

38522

Fersen, Olaf von

**THE ROTATING COMBUSTION ENGINE TODAY. RO 80 HAS OVERCOME BEGINNER S MISTAKES, CONTINUOUS EXISTENCE OF THE MODEL IN QUESTION.** (Der Kreiskolbenmotor heute. Ro 80: Kinderkrankheite ueberwunden, Weiterbestand des Modells in Frage gestellt). Text in German. VDI (Ver. Deut. Ingr.) Nachr. (Berlin), 26(1):6, 7, Jan. 1972.

There are indications that the RO 80 as car model will go out of existence but the rotary piston engine will continue to gain increasing interest at home and abroad, primarily because of the problem of exhaust gas decontamination. The rotary piston engine operates with low-lead or unleaded gasolines without great reduction of the engine power. The shape of the combustion chamber, which is theoretically an unfavorable one, helps to keep the development of oxides of nitrogen low. The carbon monoxide and hydrocarbon contents are rather high, but they can be easily removed by afterburning. The relatively high temperature of the exhaust gases greatly aids afterburning. The pollutant concentrations in the exhaust gases of the rotary piston engine plus thermal reactor are much lower than the limit values set by the Europe test: 6.5 g/test instead of 13 g/test for CH and 90 g/test instead of 182 g/test for CO.

38543

Lajthay, Jeno

**ELIMINATION OF ENVIRONMENTAL POLLUTION CAUSED BY TRAFFIC.** (A kozlekedes kornyezeti artalmainak kikuszobolese). Text in Hungarian. Jarmuvek, Mezogazd, Gepek, 18(12):441-447, Dec. 1971. 10 refs.

General characteristics of air pollution caused by internal combustion engines are outlined, and measures for the total elimination of pollution by traffic are described. In the exhaust gas, carbon monoxide accounts for 91%, unburnt hydrocarbons for 63%, nitrogen oxides for 48%, and sulfur oxides for 4% of the total volume of gaseous pollutants. Dust from exhaust amounts to 8% of the total volume. Modifications on engines give only partial decreases of pollution. A total ban on lead should be introduced. The use of natural gas instead of gasoline requires comprehensive research. Total elimination of air pollution caused by traffic could only be reached by vehicles powered by electric energy. Vehicles powered by accumulators, fuel cells, possibly by primary elements could be employed in different fields. The main emphasis should be on city traffic. Also, railroad transportation could profit from the electric drive. Compared to the operating costs of internal combustion engines per km, savings of 55%, 45%, and 20% could be reached with electrically powered small city cars, trucks, and fork-lifts, respectively.

38625

Sawyer, Robert F.

**ATMOSPHERIC POLLUTION BY AIRCRAFT ENGINES AND FUELS -- A SURVEY.** California Univ., Berkeley, Dept. of Mechanical Engineering, Advisory Group for Aerospace Research and Development Rept. AGARD-AR-40, 38p., March 1972. 109 refs.

The problem areas of aircraft air pollution, grouped under the main categories of engines, fuels and lubricants, aircraft operations, airports, atmospheric interactions, and control and enforcement, were surveyed, and research within the areas was reviewed. Air pollutants from aircraft include carbon monoxide, nitrogen oxides, hydrocarbons, sulfur oxides, aldehydes, carbon dioxide, smoke, particulates, lead, metals, odorous sulfur compounds, halogen compounds, and odorants. Specific areas of studies within the main categories are engine emission characteristics, test procedures, visible smoke reduction, nitric oxide formation, CO and hydrocarbons at low power, particulate emissions, exhaust odor and aldehydes, effect of reheat, combustor modeling, piston engines, auxiliary power units, effect of fuel composition and properties, lubricant contribution, fuel damping, ground operations, flight operations, aircraft control, air quality within aircraft, at and near airports, and in terminal buildings, V/STOL facilities, airport siting, effects of low and high altitude emissions and air basin impact, establishment of emission standards, enforcement procedures, cost-effectiveness and trade-off, and international controls.

38759

**METALS IN FOREIGN COUNTRIES. INCREASING ACTIVITY ON METAL MARKETS.** (Metalle im Ausland. Zunehmende Belebung an den Metallmaerkten). Text in German. Metall (Berlin), 26(4):412-413. April 1972.

The lead market was mildly active to active in the second half of February and the first half of March in Europe and particularly London. In the U. S. there was a lively demand for the metal. Lead producers were hardly impressed by an announcement that gasoline producers have to produce at least one type of lead-free gasoline beginning with July 1, 1974. At present, 1/10 of the world lead production is used for the manufacture of the anti- knocking agent tetraethyl lead.

38819

Terada, Kiyoshi

**FUELS, COMBUSTION, AND KILNS.** (Nenryo, nensho oyobi chitsuro). Text in Japanese. Seramikkusu (Ceramics), 6(5):307-311, 1971.

The relationships between the combustion of fuels in ceramic kilns and soot are discussed. The composition of the combustion gas in a kiln is not necessarily the same as that in the flue. The combustion gas from a ceramic kiln contains, in addition to soot created in the combustion of fuels, dusts and gases created by the materials treated in the kiln, carbon monoxide, soot dust, sulfur dioxide, dust particulates, volatile materials in the treated materials such as lead or alkali, and special soot such as ammonium chloride. When the flames are suddenly cooled on the surface of a low-temperature material, soot is created on the surface of the material and carbon monoxide and hydrogen are emitted. When gas fuel or liquid fuel sucks in a large amount of cool air, the flames are drastically cooled. The thin film of soot formed on the surface of the material has a low heat conductivity and it lowers the heat capacity of the kiln. This sucked air is called false air. The quantity of false air may be calculated simply and accurately by analyzing combustion gas, and by analyzing the gases at various places in the furnace where false air is most likely to enter; the exact locations and amounts may be measured and calculated, and actual control and prevention method may be devised.

38891

Grandjean, E.

**POWER PRODUCTION AND ENVIRONMENTAL PROTECTION.** (Energieproduktion und Umweltschutz). Text in German. Technica, 19(6):418-419, March 1972.

The increasing air pollution is caused by the population increase, the technological and economical progress, and the increase of power consumption. In Switzerland the combustion of fuel oil and gasoline provides the major source of air pollution. The combustion of fuel oil mainly causes the emission of sulfur dioxide as well as nitric oxide and nitrogen dioxide; automobiles are primarily responsible for the emission of carbon monoxide. In the year 1963 the SO2 emission for the entire city of Zurich was calculated to have amounted to about 1.8 tons. A reduction of the sulfur concentration in fuel from 0.52% to 0.39% in Lausanne lead to a reduction of the SO2 concentration in the city atmosphere from 0.035 ppm to 0.017 ppm. An automobile emits about 300 to 1000 l/min exhaust gas. Apart from CO they also emit small amounts of aromatic hydrocarbons and lead.

39035

Garcia Escolar, L. and M. Paz Castro

**DETERMINATION OF LEAD IN GASOLINES. VI.** (Determinacion de plomo in gasolinas. VI.). Text in Spanish. Ion (Madrid), 32(367):100-101, Feb. 1971. 1 ref.

Increased amounts of mineral digesting agents are required for lead determination in gasolines with large amounts of nonsaturated hydrocarbons. The excess of chlorine is then removed with hydrogen peroxide, sodium thiosulfate, or sodium bisulfite. The technical procedure includes extraction of 10-25 ml gasoline samples with carbon tetrachloride chlorine solutions and reextraction with distilled water. The water extracts are then brought to boiling temperatures, treated with a few drops of 3% H2O2, and added to a known amount (10 ml) of EDTA. The mixture is removed from the heating plate 1 min later, 1 ml of hydroxylamine and 1 ml of potassium cyanide

are added (to prevent interference with manganese or iron, respectively), and the mixture is titrated with a 0.01 M magnesium ion solution in the presence of an appropriate indicator Utilization of 2,3-dimercapto-1-propanole which displaces lead (but not manganese) from its EDTA complex is required to account for large amounts of manganese, if present in the sample. Reference is made to a previous paper where the technological procedure for the analytical method was thoroughly described. Utilization of H2O2 for the removal of excessive chlorine from digested gasoline samples was tested on two automobile and two aircraft fuel varieties (10-12 fold repetitions) and satisfactory reproducibility of analytical figures was observed.

39067

Aalund, Leo R.

**REFINING TRENDS ARE SUBMERGED BY FLOOD OF UNCERTAINTIES.** Oil Gas J., 70(13):108, 111, 115, 117, 120, 125-126, March 27, 1972.

Leading the list of uncertainties confronting refinery industry planning are capital availability, crude oil supply, lead removal, fuel costs, refinery sites, processing schemes and product patterns, and environmental protection regulations. In 1965 capital expenditures for refining were $600 million, in 1970, $1.075 billion. This was a growth rate of over 12%/yr. After capital, the biggest uncertainty facing refiners is U. S. oil-import policy, and the increasing reliance on both foreign crude and capacity. The Environmental Protection Agency timetable for lead removal from gasoline and the motor vehicle modified with a lower compression motor and a catalytic converter present the refiner with difficult to meet process modification requirements. The choice between hydrocracking and catalytic cracking is considered.

39152

Kaltstein, Andrej

**AIR POLLUTION - ITS PHYSICAL EFFECTS - CAUSES AND REDUCING MEASURES.** (Luftverschmutzung - Ihre gesundheitlichen Auswirkungen - Ursachen Abhilfemassnahmen). Text in German. Bl. Nat. Umweltschutz, 52(2):36-39, April 1972.

Air pollution caused by automobiles has quadrupled in the past two years, as determined by measurements for the area of Munich. The automotive emissions which are considered harmful to man are hydrocarbons, nitrogen oxides, carbon monoxide, lead, and fine dust. The maximum allowable concentration for NOx (0.5 ppm) is exceeded at many points in Munich. Maximum CO concentration measured in Munich was 100 ppm; such high concentrations impair the vision and alertness. Persons which are frequently in traffic situations in Munich may accumulate carboxyhemoglobin concentrations of 2-6%. The lead concentration in the larger cities of West Germany measure 5-10 micrograms/cu m. In Moscow, where leaded gasoline is prohibited, the lead content of the air is only 0.7 micrograms/cu m. Although the air pollution situation calls for immediate drastic action, the federal government has drafted an emission protection law which deserves to be called an industry protection law. The polluter is not held responsible for control or clean-up, and, even in severe cases, risks no interference from authorities.

39367

Biersteker, Klaas

**AIR POLLUTION CONTROL IN THE NETHERLANDS.** Tijdschr. Soc. Geneesk., 50(1):17-21, Jan. 1972. 22 refs. (Presented at the Regional Office of WHO, Copenhagen, Denmark, Jan. 19-22, 1971.)

Trends and developments in air pollution control in the Netherlands are reviewed. Although the problem is not a new one, factors such as the absence of very large cities, the limited use of soft coal the presence of strong winds, topographic factors, and late industrial developments contributed to a relatively favorable pre-war situation. The main areas of concern at the moment include the malodors produced by refineries, petrochemical industries, and food and feed operations; the transmission and amplification of trace elements, e.g., lead, mercury, and cadmium, and of pesticides; the potential hazard of production, storage, or transport of dangerous chemicals; photochemical smog due to traffic exhaust and hydrocarbon emissions from industries; and the inhalation of asbestos fibers. The use of natural gas for domestic heating, higher chimneys, and improved urban ventilation have greatly minimized pollution due to sulfur dioxide and smoke. Control measures for the pollutants and their sources are implemented by legislation, inspections, air pollution effect studies, air quality controls, permits, and emission standards. New legislation now opens possibilties to approach the pollution on a regional scale, which is essential for effective control.

39462

Midwest Research Inst., Kansas City, Mo.

**PARTICULATE POLLUTANT SYSTEM STUDY. VOLUME III - HANDBOOK OF EMISSION PROPERTIES.** Air Pollution Control Office Contract CPA 22-69-104, MRI Proj. 3326-C, 626p., May 1, 1971. 302 refs.

Details of the methodology employed to obtain data concerning the kind and number of stationary particulate sources, the chemical and physical characteristics of both the particulates and carrier gas emitted by specific sources, and the status of current control practices, are presented. Emission factors and rates, chemical and physical properties of effluents, and control practices and equipment are given for stationary combustion processes (power generation and furnaces); mineral processing; agricultural operations (field burning, grain elevators, cotton gins); iron and steel manufacturing; cement manufacturing; forest products industry (sawmills, pulp industry); primary nonferrous metallurgy (copper, lead, zinc, and aluminum smelting and refining); clay products; fertilizer manufacturing; asphalt; ferroalloy manufacturing; iron foundries; secondary nonferrous metals industry; coal preparation; carbon black manufacturing; petroleum refining; acid manufacture (sulfuric acid and phosphoric acid); and incineration. The control equipment includes cyclones, wet scrubbers, electrostatic precipitators, fabric filters, mist eliminators, and afterburners. Effluents include dusts, particulates, fly ash, sulfur oxides, hydrocarbons, and other noxious gases. Costs for control equipment purchase and operation are given. This handbook constitutes a reference source for available information on the distinguishing features of the various particulate pollution sources and should be of value to air pollution regulatory agencies, control equipment manufacturers, and industrial concerns.

39603

Lear, William P. and Kenneth L. Nall

**VEHICLE AIR POLLUTION - THE PROBLEM AND ITS SOLUTION.** Preprint, Society of Automotive Engineers, Inc., New York, 28p., 1970. 82 refs. (Presented at the Society of Automotive Engineers, Chicago Section, May 12, 1970, Paper 710272.)

The internal combustion engine probably cannot be economically modified to eliminate detrimental air pollution products of combustion. Both gas turbines and steam engines are inherently low-emission vehicles which must be considered as the best alternative currently available. Total future automotive emissions by type of pollutant and high- and low-emission vehicles are calculated as a function of time, and costs of enforced control of pollution from internal combustion engines are estimated for California and the entire U. S. A vapordyne power system, including steam involute expander, having very low emissions is described in detail, and a hybrid turbine-electric system is noted. Both are designed to run on kerosene but burn any combustible liquid. A public transporation system, based on a low-emission bus of completely new design, is also detailed. Several aspects of urban air pollution are discussed, including the role of nitric oxide and nitrogen dioxide in smog formation and the chemistry of combustion with application to hydrocarbon fuels. The concentration of major pollutants (carbon monoxide, hydrocarbons, nitrogen dioxide, lead, ozone, and sulfur oxides) in the U. S., and health hazards from air pollution are briefly considered. An appendix gives the mathematical basis for computation of future air pollution from motor vehicles.

39609

Habibi, K.

**AUTOMOTIVE PARTICULATE EMISSIONS AND THEIR CONTROL.** Preprint, Society of Automotive Engineers, Inc., New York and American Chemical Society, Washington, D. C., 7p., 1970. (Presented at the Society of Automotive Engineers-American Chemical Society, Joint Meeting, Midland, Mich., Oct. 24, 1970, Paper 710638.)

Two methods of sampling automotive exhaust particulates, a proportional and a total collection system, are briefly described and studies of exhaust lead size distribution, effect of mileage on size of exhaust lead, total particulate emissions from leaded and unleaded cars, and emission of exhaust tars are summarized. Age and mileage of the vehicle have the most pronounced effect on the size of exhaust lead particles; average diameter increased from about 1-2 micron at low mileage to over 15 micron at 28,000 mi. Under typical motorist driving conditions, about five times the volume of particulate matter was emitted with the unleaded car compared with the vehicle run on leaded fuel. Both cars failed to meet the proposed 1975 particulate emission standard of 0.1 g/mi.; an advanced trap system based on particle growth and tail pipe cyclones is described that is capable of reducing emissions to less than the proposed standard and that effectively removes particles in a wide size range, including a 2:1 reduction in those particles smaller than 0.2 micron diameter. The numerous and complex problems in automotive particulate sampling and measurement are discussed.

39610

Taliaferro, Harold R., Lawrence T. Wright, and Russell C. Mallatt

**GASOLINE FOR REDUCING AUTOMOBILE POLLUTION.** Preprint, American Assoc. for the Advancement of Science, Washington, D. C., 29p., 1970. 9 refs. (Presented at the American Association for the Advancement of Science, Annual Meeting, 137th, Chicago, Ill., Dec. 26, 1970.)

Regular use of lead-free gasoline, either in new cars or cars which have used leaded gasolines, reduces unburned hydrocarbons in the exhaust and eliminates the exhaust of lead-containing particulate. A test of cars in commuter driving service and a survey of drivers by a marketing research firm have yielded maintenance cost savings for unleaded gasoline users in the range of 2 to 5 cents/gal of gasoline purchased. Exhaust valve recession can be demonstrated when some current engines are operated long distances at very high speed and load on unleaded gasolines. Valve recession is minimized by the addition of a phosphorus-containing additive and several refiners are using this additive. Critics of the new unleaded gasolines have claimed they contain more aromatics than the current leaded premium and regular gasolines and that these aromatics yield exhaust with greater smog-forming potential. However, analyses reveal that they are similar in aromatic content to the current leaded gasolines. The extent to which changes in gasolines will be required in the future to reduce emissions from new and used cars is not clear. However, both gasoline volatility and hydrocarbon-type composition, which are now of concern, will be of less importance in the future as more efficient evaporation loss control and exhaust treatment devices are installed on new cars. (Author abstract modified)

39754

Coordinating Research Council, Inc., New York, Air Pollution Research Advisory Committee

**THE EFFECTS OF LEADED AND UNLEADED GASOLINES ON EXHAUST EMISSIONS CAUSED BY COMBUSTION CHAMBER DEPOSITS. (FINAL REPORT).** Rept. CRC 441, Project CRC-APRAC-CAPE-3-68, 101p., July 1971. 4 refs. NTIS: PB 201946

The influence of lead alkyls in gasoline on combustion chamber deposits and their effect on exhaust emission levels were investigated. Hydrocarbon emissions from consumer-type cars using unleaded fuels to accumulate mileage were about 7% lower on the average than the cars using leaded fuels. The net lead effect was essentially the same for cars with and without exhaust control systems. Lead did not have any effect on carbon monoxide and nitrogen oxides emissions. In rapid mileage accumulation vehicle tests, the overall hydrocarbon net lead effect was 20%, or about three times as great as in the consumer-type vehicle tests. In laboratory engine and special tests, combustion chamber deposits were responsible for almost all of the increase in hydrocarbon emission. There was a 1-10% increase in hydrocarbon emissions due to lead alkyls. Test summaries are tabulated in detail.

40314

Kehoe, Robert A., Frederick Thamann, and Jacob Cholak

**ON THE NORMAL ABSORPTION AND EXCRETION OF LEAD. III. THE SOURCES OF NORMAL LEAD ABSORPTION.** J. Ind. Hyg., 15(5):290- 300, Sept. 1933. 70 refs.

Certain classes of foodstuffs frequently contain more than average amounts of lead; among these in the order of increasing importance are, bread-stuffs, meats, processed meats, ice-cream, candy, leafy green vegetables, and certain fruits. Opportunities for the ingestion of lead with food are greater under the more highly industrialized conditions of American life than in the more primitive Mexican environment. This is attributed to the use of lead insecticides. The presence of lead in food is to be expected partly as a normal occurrence and partly as a consequence of contamination from a variety of sources. The chief problem from lead compounds is not in the lead absorption of the general public but in the high incidence of occupational lead poisoning. Lead mines, lead smelters, automotive exhaust, pottery, and water pollution are other sources of lead.

40455

Ellis, J. C.

**FUTURE AUTOMOTIVE FUELS.** Automotive Eng., 80(6):36-41, June 1972. (Presented at the International Conference on Transportation and the Environment, Washington, D. C., May 31-June 2, 1972.)

The influence of emission control requirements on gasolines is analyzed. It is believed that gasoline properties will become more important in future years, even if the present severe federal emission standards are modified. The gasoline of the future will be unleaded and of octane quality appropriate to satisfy antiknock requirements of cars. Future gasolines will also be free of all other materials inimical to engine and control system performance and durability. Additives containing only carbon, hydrogen, oxygen, and nitrogen are acceptable materials, provided they impart no deleterious characteristics to the bulk fuel and are not toxic or odoriferous. Materials such as lead, phosphorus, and sulfur, which poison catalysts or otherwise impair control system performance, will be restricted. It is predicted that the use of light olefins will not be restricted beyond the regionally imposed limits on bromine number control. Aromatic content of gasoline is expected to increase as lead is phased out and as octane quality of the unleaded grades begins to increase. This increase will have a minor effect on hydrocarbon quantity and reactivity. Evidence available at this time indicates that some reduction in the higher boiling constituents of gasoline is beneficial, and the ability of existing prototype engines and control systems to approach the 1975 emissions standards appears to be improved by such fuels. Modest changes, therefore, to accommodate emissions control requirements as well as passenger-car driveability and customer acceptability will be made.

40583

Wells, A. E.

**CONDITIONS IN AND AROUND THE SELBY SMELTER AND THE SELBY SMOKE ZONE.** Bull. Bureau Mines, no. 98:63-81, 503-520, 1915. 86 refs.

Dusts, fumes, and gases from metallurgical furnaces at the Selby Smelter, Contra Costa, California, were measured and analyzed. The furnaces were those in the roasting department, smelting department, lead refinery, and gold and silver refinery. Also studied were the effects of general wind conditions and topography on contaminant dispersion in and around the smelter and the Selby smoke zone. The only uncontrolled contaminants during the investigation were the dust and fumes from roasters during part of the period and the sulfur dioxide from the roasters during the whole period. Lead- and arsenic-containing dust and fumes from roasting furnaces eluded baghouse control due to improper cleaning of bags and accidental placement of a damper in the flue. Amounts of sulfur dioxide produced by roasting furnaces were variable and depended largely on the charge and operating conditions. To a degree not usual around most smelters, all natural conditions in the Selby smelter area tend to retard the dispersion and diffusion of smelter emissions, making them more concentrated over the smoke zone than would be expected. Thus, even small amounts of SO2, dust, and fume pose a serious problem.

40677

Yamaki, Naoomi

**AIR POLLUTION BY AUTOMOBILES AND ITS CONTROL.** (Jidosha taiki osen no genjo to sono taisaku). Text in Japanese. Mitsubishi Sekiyu K. K. Gijutsu Shiryo (Tech. Rev., Mitsubishi Oil Co., Ltd.), 20(1): 66-82, Nov. 1971. 16 refs.

Carbon monoxide, photochemical smog, and lead pollution are discussed as important air pollutants in Japan, referring to environmental standards. Emission quantities by sources and load ratio are presented by a table. According to the 1967 records, 874,000 tons of CO were emitted from automobiles, 1000 tons from factories and power plants, and 2000 tons from airplanes. The ratios were 99.7%, 0.1%, and 0.2% respectively. 35.9% of the nitrogen oxides came from automobiles 63.5% from factories and electric power plants, and 0.6% from airplanes. The total nitrogen emission was 178,000 tons. The total hydrocarbon emission was 185,000 tons, of which 97.1% came from automobiles, 1.6% from factories and power plants, and 0.5% from airplanes. Of the 460,000 tons of sulfur oxides emissions, 1.0% came from automobiles and 99% came from factories and power plants. Characteristics, damages, and the formation mechanism of photochemical smogs were studied. The relationships of oxidant and the concentration of hydrocarbons and nitrogen oxides were analyzed on the basis of data from main cities of the United States. Exhaust manifold reactors, catalytic converters, and recirculation of exhaust gas are discussed as positive technical improvements for the future. Fuel improvements and non-lead gasoline are also discussed.

40759

Lehnert, G.

**LEADED GASOLINE - AN ECOLOGICAL POISON? (Bleibenzin - ein ekologisches Gift)? Arch. Hyg. Bakteriol. (Munich), 152(5): 559-563, 1969 (?). 36 refs. Translated from German. Leo Kanner Assoc., Redwood City, Calif., llp., Dec. 1971.**

The demands of todays automobile engines on antiknock performance have led to the practice of adding tetraethyl lead and/or tetramethyl lead to the fuel, with maximum concentrations of 1.12 g/l. During the combustion process, the lead alkyls break up into water, carbon dioxide, and lead oxide. Since the melting point of Pb2O3 is at 900 C, in order to avoid a clogging of the cylinder chambers, ethylene dichloride and dibromide are added to the knock suppressor. By means of these halogen compounds, more volatile lead chloride and lead bromide are created which, together with other highly toxic exhaust gas components, escape from the engine into the atmosphere. By means of these automobile exhausts, the general public is contaminated by lead through inhalation. Based on an average atmospheric Pb(II) concentration of 2 cu/m, the human organism is burdened with approximately 30 micrograms Pb(II)/l at an average volume of breath inhaled of 10 l/min. The primary cause for clinically objectifiable Pb(II) damage is the ability inherent to a greater or lesser degree in all inorganic matter to act as enzyme effectors. Since Pb(II) forms quite stable mercaptides with thiol groups, it is the prototype of an inhibitor of SH containing enzymes. Hence, in addition to a disturbance of the electrolyte equilibrium, it also influences numerous metabolic processes, possibly the biosynthesis of hemoglobin, the nucleic acids, proteins, and various hormones.

40776

Patterson, Donald J.

**THE AUTOMOBILE AIR POLLUTION RESEARCH AND EDUCATION.** Michigan Univ., Ann Arbor; Eastern Michigan Univ. Ypsilanti; and Wayne State Univ., Detroit, Mich., Proc.: Mich. Water Air Pollut. Stand., 1970, p. 36-51.

Gasoline powered automobiles emit unburned hydrocarbons, carbon monoxide, oxides of nitrogen, oxides of sulfur, and particulate matter. On a nationwide basis, automobiles contribute 92% of the CO, 4% of the SO2, 46% of the oxides of nitrogen, 63% of the hydrocarbons, and 8% of the particulates

in the atmosphere. Exhaust emissions have been reduced by 70% and good potential remains for an additional 25% reduction. Annual inspections of emission control devices are advised. The petroleum industry has proven that emissions are unrelated to fuel blend. They have found that the tendency to form combustion chamber deposits is caused by tetraethyl lead and future additives that modify or reduce deposit buildup can improve the emission picture. A reduction in fuel volatility can cut evaporative losses of hydrocarbons in half. There are, however, many who feel that the gasoline engine will be unable to meet emission levels set for 1980. As a result, a great deal of interest has been generated in alternative power plants such as electric car and steam engines. Research and study programs at the University of Michigan are discussed.

40947

Mutsaars, P. M. and J. E. Van Steen

**DETERMINATION OF LEAD ALKYLS IN GASOLINE: A COMBINED GAS CHROMATOGRAPHIC-FLAME PHOTOMETRIC METHOD.** J. Inst. Petrol. (London), 58(560):102-107, March 1972. 9 refs.

A method was developed for separation and detection of lead alkyls by combining gas chromatography with flame photometry. Any chromatograph is suited, but in this case a coiled aluminum column filled with Chromosorb was used. The flame photometer was a model 139 UV-VIS Hitachi Perkin Elmer spectrophotometer equipped with a modified flame attachment and photomultiplier unit, connected to a Honeywell-Brown type 15-1 mV potentiometric recorder with disc integrator. The method proved to be fast, reliable, and accurate. The whole concentration range from 1000 ppm down to 1 ppb can be covered by injecting a suitable amount of sample. No previous treatment of the sample is necessary. Interference by other components is almost completely eliminated. (Author summary modified)

40981

Coenen, R., W. Fritsch, S. Goetzmann, H. Kesberger, J. Langhein, H. D. Piotrowski, and R. Schladitz

**CHEMICAL-TOXICOLOGICAL PROBLEMS OF ENVIRONMENTAL PROTECTION.** (Chemisch-toxikologische Probleme des Umweltschutzes). Text in German. Naturwissenschaften (Berlin), 59(3):106-111, March 1972. 2 refs.

In May 1970, the Federal German Government commissioned the Study Group for Systems Research, Heidelberg, to carry out a study of environmental pollution. Questionnaires were sent in two stages to representatives of university departments, independent research organizations, industry, and local authorities (182 questionnaires sent, 95 replies received). Estimates are made of the contributions to air pollution from industrial, domestic, and traffic sources; the main pollutants are sulfur and nitrogen oxides, carbon monoxide, dusts, and aerosols containing noxious substances, particularly lead. Methods of garbage disposal were reviewed as well as pollution due to industrial and sewage effluents, and the effects of pesticide usage in agriculture. The section on the toxic effects of pollutants on humans and ecosystems revealed how little is known in this field. Of the 3.6 million tons of SO2 emitted in 1969, 44% came from power plants, 15%, by domestic heaters; and the remainder, from industrial or other firing systems. Four million tons of dust was emitted in 1969. Of the 8 million tons of CO, 90% came from traffic which also solely accounted for the 7000 tons of lead emitted in 1969, and for 50% of the 2 million tons of hydrocarbons as well as for 45% of the 2 million tons of NOx. In addition to these pollutants, such substances as fluorine, hydrogen sulfide, carbon disulfide, and organic compounds such as mercaptans and aldehydes must be considered annoying and possibly dangerous.

41035

Tokyo Metropolitan Government (Japan) Itabashi Ward Office

**ANNUAL REPORT ON ANTI-POLLUTION BUSINESS - 1970.** (Kogai taisaku jigyo nenpo). Text in Japanese. 95p., Dec. 1971.

At an air/fuel ratio higher than 14.7, almost no carbon monoxide was evolved from engines. However, the air/fuel ratios of automobile engines were usually under 14.7, therefore, the formation of carbon monoxide could not be prevented. Sixty percent of the hydrocarbons in air are from automotive exhaust gas, whereas the 40% result from other reasons such as blow-by gas. Lead and CO concentrations were measured at 27 intersections in Tokyo, and the average CO concentration was 9.3 ppm, while seven intersections had hourly average lead concentrations for 10 consecutive hours higher than 5 micrograms/cu m. There are 5047 factories in this ward, of them 45 factories were tested for harmful pollutants in 1969. All were found having more than one harmful pollutant. Air pollution control regulations on car exhaust gas were revised from Jan. 23, 1971. Controls on factory pollution has also been reinforced.

41145

Mueller, Peter K. and Miles Imada

**ORIGINS OF SUBMICRON PARTICUALTE MATTER IN THE ATMOSPHERE.** Preprint, Air Pollution Control Assoc., Pittsburgh, Pa. 28p., 1970. 33 refs. (Presented at the Air Pollution Control Association, West Coast Section, Technical Meeting, 5th, San Francisco, Oct. 1970.)

A perspective of the current information about submicron particulate matter in the atmosphere was presented. The primary sources of these particles are attributed to anthropogenic origins and evolved directly from stationary as well as vehicular sources. Suspended particulate matter exists in a size range anywhere from condensation nuclei (0.002 micron) to giant particles (10-20 micron). Most of the aerosol mass is concentrated in the size range from 0.1 to 20 micron. Concentration and size distribution by number and chemical composition as a function of particle size were discussed. Lead, sulfate, and other metal content in particulates were also discussed. Particles vary in the atmosphere due to various meteorological conditions such as rain, fog, smog, and time of day. Data from the National Air Sampling Network for several cities is mentioned.

41518

Kellogg, Herbert H.

**ENGINEERS AND THE ENVIRONMENT.** J. Metals, 24(6):13-17, June 1972. 13 refs.

The drop in engineering enrollment in colleges is just one symptom of ecological consciousness and public disenchantment with technology and its products. The need for new priorities and the concept of social thrift is exemplified in our handling and use of lead and aluminum and the projections of their future use and supply. At the present rate of consumption, known world reserves of lead will be exhausted in 26 years. Even with a five-fold increase in reserves, the 2% annual growth rate in lead consumption will result in exhaustion within 64 years. Lead must be eliminated as a gasoline additive, and all storage batteries must be recycled. Bauxite reserves for aluminum production are expected to last only 31

years at the present expansion rate of 6.4%/yr. The cost of producing aluminum from clays and shales will be considerably greater than at present. A pound of aluminum uses 11 times more coal than a pound of steel, producing in the process high air pollution potential. As of 1968, 2% of the domestic aluminum supply was generated from the recycling of scrap. The U. S. Bureau of Mines projects that the use of aluminum for can and packaging will increase from 460,000 t in 1968 to 2,300,000 t by 2000.

41604

Cipriano, Joaquim Mendes

**A FAST AND PRECISE METHOD FOR THE DETERMINATION OF LEAD IN GASOLINES.** (Metodo rapido e preciso para determinacao do chumbo nas gasolinas). Text in Portuguese. Rev. Port. Quim., 5(3):129- 132, 1963. 2 refs.

A method for the determination of tetraethyl lead in gasolines by means of direct titration with a disodium salt of EDTA reagent is presented. Lead compound extracts obtained according to the American Society of Testing and Materials procedure are collected into a 200 ml volumetric flask and brought to volume with distilled water at 20 C. Fifty ml from this solution are then treated with 2.0 g of tartaric acid, and an excess of concentrated ammonia after neutralization in the presence of litmus paper. Titration is performed with a standard solution of the EDTA reagent in the presence of eryochrome Black T as an indicator and following addition of 1.0 ml of magnesium chloride reagent. A small amount of potassium cyanide should be added to gasoline extracts containing manganese metal additives such as nickel, cobalt, cadmium, to prevent interference. Potassium cyanide cannot prevent interference from calcium or magnesium. Comparison with the ASTM method which is a gravimetric procedure lasting 24 hrs, opposed to the above technique which is performed within 1.0 hr and with the French Petroleum Institute method indicated the new met5hod to be of satisfactory accuracy.

41654

Aktiebolaget Atomenergi, Stockholm (Sweden), Guidance Group

**AIR POLLUTION FROM MOTOR VEHICLES.** 123 refs. Translated from Swedish. 202p., 1971.

Vehicles are responsible for roughly half of the total amount of air pollution which is emitted in Sweden. Such pollutants are primarily carbon monoxide, hydrocarbons, nitrogen oxides, soot, and lead compounds. Extensive measurements of exhaust pollutants were carried out in Stockholm and in other cities. The fast growth of the number of vehicles in Sweden has led to Sweden having the highest number of motor vehicles per inhabitant in Europe. An estimation was made of the average emission per motor vehicle of the various exhaust pollutants at an exhaust gas laboratory. Results are summarized for both gasoline-fueled and diesel-fueled vehicles. Possible control measures for reducing air pollution by motor vehicles were studied, including town and traffic planning, technical measures on gasoline-fueled vehicles, altered composition of fuels, technical measures on diesel-fueled vehicles, enactment of regulations, and alternatives to the internal combustion engine. The effects of proposed emission standards and estimated costs were calculated.

41738

Zeilinger, K.

**FUELS WHICH DO NOT HAVE HARMFUL EFFECTS ON THE ENVIRONMENT.** (Umweltfreundliche Kraftstoffe). Text in German. Umschau (Berlin), 72(10):322-323, May 1972. 3 refs.

The problems of fuels with minimum harmful effects on the environment and the basic trends in this area are outlined. The carbon monoxide and hydrocarbon contents in exhausts are largely dependent on the excess-air ratio, while nitric oxide is formed at high temperatures. Fuels with minimum harmful effects on the environment should satisfy several requirements: high volatility and low viscosity for minimum hydrocarbon and CO emission; wide range of ignition temperatures for minimum hydrocarbon, CO, and NO emissions; low rate of combustion for minimum NO; high octane number with low lead content; purification of carburetor, suction pipes, and combustion chamber; and minimum smoke from diesel fuels. Some of these requirements cannot be realized by the available technical means. Due to the reduction of lead content, changes in the structure of hydrocarbons are necessary, while hydrocarbons with chain structure will be preferred to aromatic hydrocarbons. The compression rate will be reduced due to the decrease in the octane number in a near transitory period. While the changes in the fuel structure are not likely to entail important changes in the exhaust composition, there are no additives available for widening the ignition temperature range. Cyclohexane, added to diesel fuel at a rate of about 3% by volume as a smoke inhibitor, reduced soot, CO, and NO emissions. ½0

41889

Soukup, Albert V.

**SURVEY OF WATER QUALITY.** In: Helena Valley, Montana, Area Environmental Pollution Study. Environmental Protection Agency, Research Triangle Park, N. C., Office of Air Programs, Pub-AP-91, p. 61-63, Jan. 1972. NTIS: PB 207126

Water samples were taken at seven locations in Helena Valley, Montana, between July, 1969 and April, 1970. All samples were analyzed for the following: arsenic, cadmium, lead, zinc, iron, manganese, sulfate, fluoride, chromium, silver, copper, cobalt, nickel, chloride, nitrate, boron, cyanide, selenium, pH, specific conductance, turbidity, color, and total dissolved soilds. Analyses of the first seven components gave pertinent information to the study. The chemical constituents determined did not exceed the mandatory limits of the Public Health Service Drinking Water Standards. The sulfate results show that there is no contamination by sulfur dioxide. The water in Prickly Pear Creek contains elevated levels of arsenic, cadmium, lead, zinc, iron, and manganese. The water at the Helena city water intake has elevated levels of arsenic, lead, and manganese. These elevated levels are due to the smelting complex in East Helena.

41890

Miesch, A. T. and Claude Huffman, Jr.

**ABUNDANCE AND DISTRIBUTION OF LEAD, ZINC, CADMIUM, AND ARSENIC IN SOILS.** In: Helena Valley, Montana, Area Environmental Pollution Study. Environmental Protection Agency, Research Triangle Park, N. C., Office of Air Programs, Pub-AP-91, p. 65-80, Jan. 1972. 12 refs. NTIS: PB 207126

The arithmetic mean concentration of lead, zinc, cadmium, and arsenic in the upper 4 in. soil layer within a 0.67-10-mile radius of the smelter stack at East Helena, estimated by integration of the appropriate regressions equations, are as follows: lead, 69 ppm; zinc, 79 ppm; cadmium, 2.5 ppm; and arsenic, 11 ppm. Similar estimates for the 6 to 10 in. depth zone are lead, 22 ppm; zinc, 58 ppm; cadmium, 1 ppm; and arsenic,

7 ppm. Assuming that the original metal contents of the soils were similar to the mean concentrations of the metals in the soil samples collected outside the Helena Valley in this investigation, the amounts of each that have been added by smelter contamination to the upper 10 inches of soil in the area beyond 0.67 mile from the smelter are as follows: lead, 10,000 tons; zinc, 5600 tons; cadmium, 290 tons; arsenic, 860 tons. Contamination beyond that attributable to the smelter was noted along railroad tracks but not highways.

41945

Fish, R. A.

**POLLUTION.** J. Oil Colour Chemists Assoc. (London), vol. 55:493- 506, 1972.

Under the aegis of the Clean Air Acts of 1956 and 1968, the emission of smoke in London has been reduced from an average of 309 micrograms/cu m in the winter of 1958-9 to 66 micrograms/cu m in 1969-70. The sulfur dioxide content of the air was ignored by the Clean Air Acts and has probably increased. The steady decrease to 192 micrograms/cu m for 1969-70, two-thirds of that for 1958-65, is thought to result from the high stack policy of the Central Electricity Generating Board. It is thought that further substantial reductions would result if the use of low-sulfur fuels became mandatory. Street level measurements of carbon monoxide rarely exceed 50 ppm, and the total contribution of the automobile to air pollution is small. Studies are in progress to determine the relationship between the automobile and carbon oxides, hydrocarbons, nitrogen, and lead. It is suggested that a pilot monitoring system be established for all pollutants, especially the nitrogen oxides. The history of river pollution, refuse disposal, radioactive waste disposal, and noise pollution are all discussed.

41959

Duffy, Leo J., Neil R. Everett, James J. Sevcik, and Frank J. Piehl

**KEEPING THE LEAD OUT OF UNLEADED GASOLINES.** Preprint, American Petroleum Inst., New York, Div. of Refining, 19p., 1972. 2 refs. (Presented at the American Petroleum Institute, Division of Refining, Midyear Meeting, 37th, New York, May 9, 1972, Paper 01-72.)

The decision of American Oil Company to market an unleaded (less than 0.05 g/gal) gasoline on a broad basis in 1970 resulted in many problems of blending and transporting a lead-free product from the refinery to the motorist and keeping it lead-free in a system full of lead. Their solution or minimization is discussed, including analytical methods used to determine lead at this level; monitoring lead at the refinery; preventing contamination in transportation of the gasoline by pipeline, barge, tanker, truck, or rail; monitoring at the station pump; and mobile laboratories to monitor lead throughout the entire marketing operation. A gasoline can be produced and distributed which meets, on the average, the proposed 0.05 g/gal level set by the EPA. However, these levels cannot be achieved with complete consistency with the present distribution system as long as the industry is distributing both leaded and unleaded gasolines.

42080

Hayashi, Hiroshi

**AIR POLLUTION DUE TO AUTOMOBILE EMISSION.** (Jidosha kogai). Text in Japanese. Kagaku Kogyo (Tokyo), 23(7):951-956, July 1972.

The public nuisance due to automobile emissions is mainly air pollution, noise, and interference of electric waves. The waste gas from automobiles contains carbon monoxide, hydrocarbons, nitrogen oxides, dust, oil mist, lead, black smoke, and hydrocarbons such as aldehydes and ketones. According to the Department of Public Welfare of the Japanese Government, the breakdown of pollution is as follows: 99.2% sulfur dioxide by industry, 92.8% dust by industry, 99.3% CO by gasoline, 90.5% HC by gasoline, 73.1% nitrogen oxides by industry, and 18.1% nitrogen oxides by gasoline. Hydrocarbons and CO are mainly emitted by automobiles. Both HC and NOx cause photochemical reactions and develop toxic ozone, oxidant, and smog. Diesel engines emit less nitric oxide than gasoline engines. However the mixed gas for gasoline engines is homogeneous and the mixed gas for Diesel engines is heterogeneous. Control methods are mentioned.

42212

Radzimirski, S.

**REASONS FOR THE OCCURRENCE OF NOXIOUS COMPONENTS IN AUTOMOTIVE EXHAUST EMISSIONS.** (Przyczyny powstawania skladnikow szkodliwych w spalinach samochodowych). Ochrona Powietrza (Warsaw) (English translation), 4(15):6-18, 1970. 12 refs.

The three main sources of emission of noxious gases from automobiles are the exhaust system, the crankcase, and the fuel feed system. The exhaust system is the principal source of air pollution associated with automotive engine operation. It accounts for about 65% of the hydrocarbons, 98% of the carbon monoxide, and 100% of the nitrogen oxides and carbon black present in automotive exhaust emissions. Hydrocarbons occur in exhaust gases due to the incomplete combustion of fuel. The principal reason for their emission, in distinction to CO is not the composition of the air-fuel mixture, but the quenching effect of the combustion chamber walls, consisting of the temperature in the vicinity of the walls being too low to allow oxidation of the fuel. Among the hydrocarbons emitted from the exhaust system are heavy aromatic hydrocarbons which are suspected of carcinogenic activity; benzopyrene and dibenzoanthracene show the highest biological activity. Nitrogen oxides are formed in the combustion chamber in a reaction with oxygen. The maximum concentrations of nitrogen oxides in exhaust gases depend primarily on the temperature in the combustion chamber. Exhaust gases also contain sulfur compounds, lead compounds, and aldehydes. The engine crankcase is a second source of noxious emission. Approximately 20% of the hydrocarbons emitted from the automobile result from crankcase emissions. The gases emitted from the crankcase also include CO whose concentration is 0.2-0.5% by volume. The fuel-feed system accounts for some 15% of all hydrocarbons exhausted by vehicles with internal combustion engines. The cause of emission of these compounds is the vaporization of the fuel. In certain cases, at high environmental temperatures, the fuel losses due to evaporation may exceed five percent of the fuel supplied.

42377

Corbeil, R. J. and S. Smith Griswold

**ADVANTAGES OF NATURAL GAS (METHANE) AS A FUEL FOR MOTOR VEHICLES.** International Union of Air Pollution Prevention Associations, Proc. Int. Clean Air Congr., 2nd, Washington, D. C., 1970, p. 624-631. (Dec. 6-11, Paper EN 10A.)

The advantages of natural gas over conventional gasolines were presented; test results were obtained from vehicles equipped with the dual fuel system, which permits operation with gasoline as a standby fuel and routine operation on compressed natural gas. The use of compressed natural gas is

restricted because fueling stations are widely spaced and tank size and weight are limited. Liquefied natural gas permits extended range and is best suited for vehicles traveling more than 80-100 miles between fuelings. The gas/air mixer provides uniform mixture distribution and maintains excess air in the mixture at all times; virtual elimination of carbon monoxide is an expected result. In addition, hydrocarbon emissions from the carburetor and fuel tank evaporation are almost zero. The chemical characteristics of natural gas along with the accurate control of the variable venturi mixer permit satisfactory vehicle operation with low oxides of nitrogen. Thus the use of natural gas can reduce emissions to levels of any exhaust emission standards yet proposed. Other advantages are: the total elimination of lead; the virtual elimination of soot; the improvement of odor; reliable idling; stumble-free acceleration; and greater safety. Natural gas also has economic advantages: approximately 50% benefit when idling and substantial savings on operating and maintenance costs; and easy starting.

42676

Ministerium fuer Arbeits, Gesundheit und Soziales des Landes Nordrheim-Westfalen, Duesseldorf (West Germany)

**NONFERROUS METALLURGY.** (NE-Metallerzeugung). Text in German. In: Reine Luft fuer morgen. Utopie oder Wirklichkeit. Moehnesee- Wamel, West Germany, K. ron Saint George, 1972, p. 60-65.

The present situation and future trends in the output and emissions in the nonferrous metallurgy of North Rhine-Westphalia are described. The aluminum industriy, which accounts for more than 50% of the total output of West Germany, will experience rapid growth. The basic pollutants are gaseous fluorine compounds (0.8-1.5 kg/t), aluminum- and fluorine-bearing dust (9-20 kg/t), sulfur dioxide (3-15 kg/t), and carbon monoxide. Aluminum remelting is expected to increase 100% by 1980. Chloride aerosols, metal oxides, and gaseous fluorine compounds are the chief pollutants. Dust separation at a rate of 15% was applied to rotary furnaces in 1970. Dust emissions will decrease from 1320 tons in 1970 to 680 tons in 1980 by lowering the dust concentration to 150 mg/N cu m and 100 mg/N cu m for rotary furnaces and thermal chips treatment facilities, respectively. Gaseous fluorine emissions, 90 tons in 1970, will be reduced to 50 tons in 1980 by applying wet-type gas cleaning. Sulfur dioxide emissions from lead manufacturing will be reduced 90% due to waste-gas desulfurization. The efficiency of SO2 separation at sulfuric acid production facilities is 98%. Lead and zinc emissions, amounting to 350 and 180 tons in 1970, will decrease to 50 tons each in 1975. Sulfur dioxide emissions from copper manufacturing, for which a 2% yearly rate of growth is predicted, will rise from 900 tons in 1970 to 1100 tons in 1980, the waste-gas SO2 concentration being 0.2 g/N cu m. Hydrochloric acid emissions, now 500 tons, will decrease by 50%. While total dust emission will be reduced from 600 to 300 tons, no further reduction in lead, zinc, and copper emissions is possible. The dust emissions from copper alloy manufacturing will be 10% of the 1970 level by 1980, as an upper limit of 50 mg/N cu m will be set in 1973. Sulfur dioxide emissions from zinc manufacturing, for which electrolytic processes are increasingly used, will decrease from 1800 tons in 1970 to about 1500 tons in 1980. The imposition of a maximum allowable dust emission of 50 mg/N cu m in 1973 will result in zinc and lead emissions, now 160 and 40 tons, decreasing to 80 and 20 tons, respectively, despite a growth rate of 40%.

42679

Ministerium fuer Arbeits, Gesundheit und Soziales des Landes Nordrheim-Westfalen, Duesseldorf (West Germany)

**TRAFFIC AS AN EMISSION SOURCE.** (Die Emittentengruppe Verkehr). Text in German. In: Reine Luft fuer morgen. Utopie oder Wirklichkeit. Moehnesee-Wamel, West Germany, K. von Saint- George, 1972, p. 78-81.

Trends in transportation generated air pollution in North Rhine- Westphalia are outlined. Railroad traffic, consuming about 1.5 million tons of coal and some 0.6 million tons of fuel and Diesel oil in 1969, is minor pollution source, and a steady decrease in railroad emissions is expected. While pollution due to ships continues to be negligible, that due to air traffic is increasing rapidly. The traffic-generated air pollution is primarily due to road traffic. Automotive emissions will not increase at a rate corresponding to the expected increase in the number of vehicles because the intensity of use will decrease. While the standards imposed in 1971 resulted in a relative decrease in carbon monoxide and hydrocarbon emissions, a slow increase in CO and a higher increase in hydrocarbon emissions, as well as disproportionately high rise in nitrogen oxides emissions are expected. By the end of the decade CO and hydrocarbon emissions will be at their 1970 levels. The lead content of gasoline, set at 0.4 g/l as of 1972, will be further reduced to 0.15 g/l in 1976. As the present emission standards, except for those on lead, are not satisfactory, further standards requiring 80% reduction as against the 1971 level, should be introduced as of 1976 (3 g of CO, 0.3 g of hydrocarbons, and 0.25 g of nitrogen oxides per km). These should be followed by an additional reduction of 35% as of 1980.

42726

Worcester, A. and D. H. Beilstein

**LEAD - PROGRESS AND PROGNOSIS. THE STATE OF THE ART - LEAD RECOVERY.** Preprint, American Inst. of Mining, Metallurgical and Petroleum Engineers, New York, Metallurgical Society, 22p., 1971. (Presented at the American Institute of Mining, Metallurgical and Petroleum Engineers, Annual Meeting, 100th, New York, Feb. 26-March 4, 1971, Paper A71-87.)

Present methods in general use to recover lead metal from its ores, including methods for sintering, heavy smelting, drossing, refining, and emissions control, are described. Baghouses and electrostatic precipitators are the most common dust and fume collectors. In some emission control operations sulfuric acid, cadmium, and thallium are recovered. Probable short and long term advances in the lead recovery process are suggested. The history of lead smelting is briefly reviewed. Lead consumption in the United States in 1970 was 1.267 million tons, distributed as chemicals: 278,000 tons; batteries: 570,000 tons; pigments: 98,000 tons; and metal: 371,000 tons.

42791

Yamakawa, Tsumoru and Shigeaki Suzuki

**LEADLESS GASOLINE MANUFACTURING SYSTEM.** (Muenka gasorin seizo sochi). Text in Japanese. Sangyo Kikai (Ind. Machinery), no. 258: 9-14, March 1972. 2 refs.

Various methods of contact formation of non-leaded gasoline are discussed. For a change of gasoline quality, dehydration, paraffin hydrocarbon isomerization, isomerization and cyclic dehydration, and hydrogenation decomposition are practiced. The most important is the dehydration process. The format of dehydration is classified by the method of catalyst packing; there are the fixed bed process, the moving bed process, and

the fluidized bed process. Discussion of the types of reactors presently used in Japan include (1) the IRE cyclic power forming method, (2) the magna forming method, (3) the platforming method, (4) and the reinforming method. The IRE method can control the process severity automatically and transfer the reactor without dropping the operation efficiency. The magna forming method can operate at two levels, the first at a low temperature and low cycle, and the second at a high recycle. The platforming method contains the total reaction processes in one system. The reinforming method can be operated at a lower pressure than the other methods.

42980

Norbye, J. P.

**THE WANKEL ENGINE--AN EVALUATION OF ITS POTENTIAL.** Preprint, American Society of Mechanical Engineers, New York, 12p., 1972. (Presented at the American Society of Mechanical Engineers, Design Engineering Conference and Show, Chicago, Ill., May 8-11, 1972, ASME Paper 72-DE-33.)

Lower cost, lower weight, less bulk, and cleaner emissions are some of the reasons why the Wankel engine, which is a rotary type of internal combustion engine, will replace the V-8 in many applications. Its compactness facilitates installation and makes for improved space utilization in the vehicle -- offering greater opportunities for new vehicle concepts. It has far fewer parts than the piston engine, and since it has no reciprocating parts, it is practically free of vibration. It has about twice the power-to-weight ratio of a V-8 engine. The Wankel engine supplies power for about 2/3 of its combustion phase, against only 1/4 in the piston engine. It can digest low octane lead-free fuel without loss of power or economy, and is uncritical of lube oil quality. The design lends itself well to automated manufacture and assembly. The advantages of the Wankel engine as a power source for automobiles are considered. (Author abstract modified)

43271

Environmental Protection Agency, Research Triangle Park, N. C., Office of Air Programs

**METALLURGICAL INDUSTRY.** In: Compilation of Air Pollutant Emission Factors. OAP Pub-AP-42, p. 7-1 to 7-22, Feb. 1972. 61 refs. NTIS: PB 209559

Primary and secondary metal industries are discussed. The primary industries, producing metals from ore, reviewed are: non-ferrous operations of aluminum ore reduction, copper smelters, lead smelters, zinc smelters, iron and steel mills, ferroalloy production, and metallurgical coke manufacture. Large quantities of sulfur oxides and particulates are emitted by these industries. The secondary metallurgical industries, which recover metal from scrap and salvage and produce alloys from ingot, include aluminum operations, brass and bronze ingots, gray iron foundries, lead smelting, magnesium smelting, steel foundries, and zinc processing. The major air contaminants from these operations are particulates in the forms of metallic fumes, smoke, and dust. Control methods used are: cyclones, electrostatic precipitators, filters, and baghouses.

43346

Parker, Albert

**ESTIMATES OF AIR POLLUTION IN THE UNITED KINGDOM IN THE YEAR 1970- 71.** Clean Air, 1(6):18-19, 1972. 1 ref.

Energy generation and smoke and sulfur oxide emission from fuel combustion and emissions of carbon monoxide, hydrocarbons, aldehydes, nitrogen oxides, and SOx from petrol and diesel engines are estimated and tabulated for the United Kingdom in 1970-1971. Smoke and SOx concentrations generated by combustion of coal for fuel in domestic heating, railways, coal mining, electric power stations, coke ovens, the gas supply industry, carbonization plants, and fuel plants equaled 0.72 and 3.40 million metric tons, respectively. Coke combustion for domestic and industrial sources contributed 0.17 million metric ton of SOx. The use of oil for power sources in domestic, industrial, and commercial sources, the gas supply industry, road transport, railways, and marine craft resulted in emissions of 6.07 million metric tons of SOx. Equivalents for hydro-electricity, nuclear power generation, and natural gas are included. Petrol and diesel engines, respectively, emitted 6.7 and 0.11 million tons of CO; 0.34 and 0.021 million tons of hydrocarbons; 0.01 and 0.003 million tons of aldehydes; 0.23 and 0.07 million tons of NOx; and 0.025 and 0.04 million tons of SOx. The amount of lead in the compounds discharged in exhaust gases from petrol engines was estimated at about 6000 tons.

43776

Ohba, Hideki

**MORE RESTRICTIONS ARE REQUESTED ON AUTO-EXHAUST.** (Jidosha no motarusu osen mondai - isogareru jidosha haishutsu gasu no kisei). Text in Japanese. Kogai to Taisaku (J. Pollution Control), 8(7):641-653, July 1972. 17 refs.

There were more than 1,700,000 automobiles in Japan in the year 1970, almost three times that in 1965. Statistics show that 99.7% of the carbon monoxide, 97.9% hydrocarbons, 35.9% nitrogen oxides, and about 1% sulfur oxides in air resulted form automotive exhaust. The carboxylhemoglobin concentration in the blood of nonsmokers increases 2.0 to 2.5% after being exposed to 10 to 15 ppm of CO for more than 8 hours and a high concentration of nitrogen dioxide causes edema of the lung. The lead content in blood of human beings increases as that in air increases. From July 1972, the maximum of volatile HC has been restricted at 2 g/test and from Oct. 1972, that of CO concentration in exhaust at idling decreased to 4.5%. From April, 1974, non-leaded gasoline will be supplied. The improvements of the gasoline will be supplied. The improvements of the gasoline engine and the development of alternative engines are also discussed.

43966

Inokoshi, Yukio, Kunihiko Asakino, Tadayoshi Kubodera, and Tatsuo Yamamoto

**MEASUREMENTS OF AROMATIC HYDROCARBONS IN GASOLINE.** (Gasorinchu no hokozoku tanka suiso no sokutei). Text in Japanese. Tokyo-toritsu Aisotopu Sogo Kenkyusho Nenpo (Tokyo Met. Isotope Gen. Res. Inst. Annu. Rept.), 1971:46-49, Oct. 1971.

Aromatic hydrocarbons in gasoline are regarded as one of the causes of photochemical smog. In July, 1970, 12 regular and high octane gasoline brands on the market in Japan were investigated. Two gas chromatograph units were used to analyze and measure the aromatic hydrocarbons. Infrared absorption spectra and mass spectra were also used. Standard solutions of ether, benzene, and ethyl acetate were used to measure the thinner. The results of measurement for lead, tetraethyl lead, benzene, toluene, and xylene are presented in tables. The gas chromatograph of aromatic hydrocarbons in gasoline is presented. The results indicate that high counts of aromatic hydrocarbons in gasoline does not necessarily accompany low amounts of lead.

44227

Harmsen, Hans

**WHAT IS EACH INDIVIDUAL S CONTRIBUTION TO ENVIRONMENTAL POLLUTION? (Was traegt der Einzelne zur Belastung der Umwelt bei)? Text in German. Staedtehygiene (Uelzen/Hamburg), 23(7):161-164, July 1972.**

Cars have become the number one air polluter. The carbon monoxide concentration which accumulates during traffic rush hour is already so high that it impairs the capacity of the driver. While all hydrocarbons, carbon monoxide, and the oxides of nitrogen are dissociated through solar radiation, the lead additive to the fuel which is emitted cannot be destroyed and thus tends to be stocked in the environment. The reduction of the lead concentration in the fuel is no real help, although such a step is to be welcomed. A real solution would be provided solely by the development of an electric drive.

44252

Kimura, Motoo

**POLLUTION BY AUTOMOTIVE EXHAUST GAS AND FUEL.** (Jidosha haishutsu gasu kogai to nenryo). Text in Japanese. Gijutsu Shiryo (Tech. Data), 20(1):105-121, 1971 (?). 41 refs.

Air pollution caused by the exhaust gas from a gasoline engine and its relationship to fuel are discussed. The carbon monoxide concentration in exhaust gas depends almost exclusively on the air/ fuel ratio (A/F). An A/F ratio of about 11 gives the minimum CO concentration. Equations have been derived for the calculations of olefins, paraffins, and aromatic hydrocarbons in exhaust gas by using fuels of known compositions for combustion in automobile engines at different conditions. Approximately 30% of the hydrocarbons in exhaust result from unburned fuel; the higher the aromatic hydrocarbon concentration in fuel is, the higher the hydrocarbon content in exhaust gas. No relationship has been found between the fuel composition and the nitrogen oxide concentration in exhaust gas. Studies of lead in exhaust gas show that 70 to 80% of the total lead compounds are discharged from the exhaust pipe, while 20 to 30% remain in muffler and in lubricants, and most of the lead compounds are micro-particles of less than 5 micron.

44464

Mortstedt, S. -E., K. -E. Egeback, and A. Laveskog

**DUST EMISSIONS ASSOCIATED WITH AUTOMOTIVE EXHAUST.** (Stoftutslapp med bilavgaser). Text in Swedish. Aktiebolaget Atomenergi (Sweden), Rept. BIL-70, 21p., Nov. 17, 1971. 4 refs.

Results of exhaust dust emission measurements, carried out on five different type four-stroke engines (Diesel engine with direct fuel injection, preignition Diesel, conventional Otto engine with electronically controlled fuel injection, and liquified gas- and propane-propene gas-fueled Otto engine) are summarized. The total exhaust volume was filtered, and gravimetric dust determination was applied. While the highest amounts of dust were emitted by Diesel engines, the emissions from gas-powered engines and Otto engines with electronically controlled fuel injection were lowest. Though gasoline engines emitted less dust than Diesel engines, their dust contained 40 to 90% of the lead compounds in the form of particles largely below 1 micron. One One part of the lead alkyl may be adsorbed by dust particles. Both the total dust and the lead emission was lower from prechamber type than from conventional engines. The bulk of the lead is retained within the exhaust system under low load conditions, and is blown out under high loads. The emissions were lower from a warm than from a cold motor. The emission from a Diesel with direct fuel injection as measured during idling was less than one tenth of that measured under full load.

44682

Doelling, R. P., A. F. Gerber, and M. P. Walsh

**EFFECT OF GASOLINE CHARACTERISTICS ON AUTOMOTIVE EXHAUST EMISSIONS.** Am. Soc. Testing Mater. Spec. Tech. Publ., no. 487:20-35, 1971. 20 refs. (Presented at the American Society for Testing and Materials, Annual Meeting, 73rd, Toronto, Ontario, June 21-26, 1970; includes a discussion.)

Fuel modifications encompassing composition, volatility, and lead content were investigated as a means of reducing automotive exhaust emissions. Several test programs are summarized, and numerous conclusions are listed. Fuel hydrocarbon composition has no effect on exhaust hydrocarbon emission levels. However, the percentages of aromatics, olefins, and saturates, in the exhaust increase with increased percentages of the corresponding hydrocarbon type in the fuel. Fuel hydrocarbon composition has no significant effect on exhaust hydrocarbon reactivity. Olefins are generated during the combustion process. Higher-boiling components of gasoline have no significant effect on exhaust hydrocarbon or carbon monoxide emission levels. Exhaust hydrocarbon levels of vehicles operated on fuel leaded to 3.13 g/gal are significantly greater than the exhaust hydrocarbon levels of vehicles operated on unleaded fuel. Similar increases in exhaust hydrocarbon levels result from operation on fuel leaded to 1/2, 1, 2, and 3 g/gal but not with unleaded fuels. Engine operation on fuel leaded to only 1/4 g/gal also increases exhaust hydrocarbon emission levels. As fuel lead content is increased, equilibrium hydrocarbon emission levels are obtained after fewer hours of engine operation. (Author abstract modified)

44821

Bell, A. G., J. A. Keene, and K. Reders

**ROAD ANTIKNOCK PERFORMANCE OF LOW-LEAD AND NONLEAD GASOLINES IN EUROPEAN CARS.** Preprint, Society of Automotive Engineers, Inc., New York, 27p., 1971. 6 refs. (Presented at the Society of Automotive Engineers, Mid-Year Meeting, Montreal, Quebec, June 7-11, 1971, Paper 710625.)

An experiment designed to evaluate the road antiknock performance of low-lead and nonlead gasolines is described. Over 100 test fuels covering a wide range of research octane number, lead content, sensitivity, and front-end quality were prepared. They were then tested in nine European and one American car under both accelerating and wide open throttle, constant speed conditions. In European cars knocking at low speed, road antiknock performance can be adequately described in terms of research octane number, sensitivity, and front-end quality, and there is no additional benefit to be gained from the use of a high concentration of lead. In European cars knocking at high speed and in the one American car tested, gasolines with a high lead content gave a better performance than the equivalent nonleaded gasolines. This was particularly so in the case of fuels leaded with tetramethyl lead as opposed to tetraethyl lead. (Author abstract modified)

45072

Lagerwerff, J. V.

**HEAVY-METAL CONTAMINATION OF SOILS.** American Assoc. for the Advancement of Science, Washington, D. C., Agr. Qual. Environ., 1966, p. 343-364. 101 refs. (Dec.)

A soil is contaminated when foreign substances are introduced into the plow layer damaging the quality or quantity of crops produced. The five major sources of heavy metals are aerosols, pesticides, limestone or phosphate fertilizers, manures and sewage sludge, and mine waste. Heavy metals considered are copper, zinc, manganese, nickel, aluminum, mercury, cadmium, and lead. The interrelated factors of pH and microbial activity determine the equilibrium between the mobile low-valency forms and the less mobile high- valency forms. To some extent the metals occur as chelates by accumulating biologically in living systems or by reacting with soil organic matter. The usual order of decreasing competition with Fe is Cu, Co, Ni, Cr, Zn, Mn, Pb. The toxicity to plants does not necessarily follow this order. Phosphates of the metals are insoluble in high pH. Unfavorable effects on plants can usually be alleviated by liming, stubble mulching, or application of phosphates until the pH is at or above 6.5. Foliar or direct application of Fe alleviates unfavorable effects in some cases. Absolute values for treatments depend on plant species and ecological conditions.

45092

Platt, M., R. C. Baker, E. K. Bastress, K. M. Chng, and R. D. Siegel

**THE POTENTIAL IMPACT OF AIRCRAFT EMISSIONS UPON AIR QUALITY.** Northern Research and Engineering Corp., Cambridge, Mass., Environmental Protection Agency Contract 68-02-0085, Rept. 1167-1, APTD-1085, 333p., Dec. 29, 1971. 57 refs. NTIS: PB 208950

Predicted concentrations of total hydrocarbons and carbon monoxide due to aircraft emissions exceed their respective national ambient air quality standards in the vicinity of major aircarrier airports. Predicted concentrations of nitrogen dioxide due to airport emissions alone do not exceed the standard, but can contribute significantly to excessive concentrations. Aircraft contributions are small for particulates and sulfur dioxide. Lead levels are significant but do not presently exceed the level associated with increases in blood-lead levels. Future projections indicate that nitrogen oxides will rise sharply through 1980. Total hydrocarbons should drop. However, total concentrations of hydrocarbons and CO are still projected to exceed national air quality standards. Based on preliminary estimates, emissions of CO, total hydrocarbons, NOx, and particulates from turbine-engine aircraft can be largely reduced. Some control methods have not been developed or tested. Control methods include catalytic reactors, increasing idle speed, redesigning the combustion chamber, water injection, and changing air-fuel ratio. Meteorological conditions affecting air quality are also discussed.

45136

Morris, W. E., J. D. Rogers, Jr., and R. W. Poskitt

**CARS AND THE NEW GASOLINES 1971.** Preprint, Society of Automotive Engineers, Inc., New York, 56p., 1971. 14 refs. (Presented at the Society of Automotive Engineers, Mid-Year Meeting, Montreal, Quebec, June 7-11, 1971, Paper 710624).

Fuel economy of eight 1971 cars was 6.6% lower than that of eight corresponding 1970 cars. Acceleration performance of these 1971 cars was significantly poorer than that of the 1970 cars. Commercial leaded or unleaded gasolines of 91 research octane number are expected to knock in more than half of the 1971 cars. Research octane number is a poor index of road octane performance for either premium or regular gasolines in 1970 and 1971 cars. Road octane quality of premium gasolines in 1970 premium cars is related to the research octane number plus the motor octane number divided by two, as has been the case for many years. Road octane quality of regular gasolines in 1971 cars and in 1970 regular requirement cars is related primarily to motor octane number. At a given motor octane level, lead content has little effect on road octane number 1971 cars or in 1970 regular requirement cars. Currently available unleaded commercial gasolines generally are high in sensitivity (research minus motor octane number) and aromatic content relative to leaded commercial gasolines. Because of their higher sensitivity, typical unleaded gasolines must be higher in research octane quality than leaded gasolines to give the same road octane number. For equal road octane number, unleaded premium gasoline must be about four research octane numbers higher than leaded premium and unleaded regular must be about one research number higher than leaded regular. (Author summary)

45145

American Assoc. for the Advancement of Science, Washington, D. C., Air Conservation Commission

**POLLUTANTS AND THEIR EFFECTS.** In: Air Conservation. AAAS Pub. 80, p. 60-194, 1965. 267 refs.

The sources, reactions, atmospheric concentrations, plant, animal, and property damage effects, measurement, control, and global implications are reviewed for sulfur and its compounds (sulfur oxides, mercaptans, and hydrogen sulfide), carbon monoxide, carbon dioxide, nitrogen oxides (nitric oxide and nitrogen dioxide), photochemicals (hydrocarbons, aromatics, and aldehydes), particulate matter, lead and other metals, fluorides, radioactive pollutants, and economic poisons such as pesticides and fungicides. The epidemiological relationship between lung cancer and exposure to air pollutants is discussed. Incomplete combustion of organic materials is a primary source of airborne carcinogenic aromatic hydrocarbons. Agricultural uses, including ground and aerial application and nonagricultural uses of economic poisons are described. Radioactive contamination of the atmosphere results from the reactor fuel cycle; the use of nuclear energy as a source of propulsive power,; the use of radioisotopes in industry, agriculture, medicine, and scientific research; and from nuclear weapons testing. The radionuclides that are present in the radioactive debris from fallout and that have the greatest significance in terms of their effects on man are strontium-90 and strontium-89, which are beta emitters and principally irradiate the skeleton; cesium-137, which is a beta-gamma emitter and concentrates in soft tissues, resulting in internal whole-body irradiation; carbon-14, a beta-gamma emitter, which accumulates in the body and delivers whole-body irradiation; iodine-131, a beta-gamma emitter, which concentrates in the thyroid gland; and a number of short-lived fission products that produce extermal whole-body irradiation when deposited on the ground. The behavior of these materials in the food chain is examined. Monitoring systems and countermeasures for radiation pollution are described.

45274

Lockhart, Luther B., Jr., A. W. Ali, and P. W. Mange

**A SURVEY OF AUTOMOTIVE EMISSIONS.** Naval Research Lab., Washington, D. C., Chemistry Div.; Naval Research Lab., Washington, D. C., Space Sciences Div.; and Naval Research Lab., Washington, D. C., Plasma Physics Div.; NRL Problem KO3-50, Proj. 74073-1507, NRL-MR-2346, 43p., Oct. 1971. 30 refs. NTIS, DDC: AD 738799

A survey was made of the generation, dispersal, and removal processes for the various automotive emissions and their natural counterparts in the atmosphere, and of their effects on man and his environment. In only a few categories, such as carbon

monoxide and lead, are automotive emissions of significance relative to other anthropogenic or natural sources of pollutants in the atmosphere as a whole; however, localized effects can be overriding as a result of peculiar geographical or meteorological factors. Under certain conditions of population density, automobile usage, and weather, photochemically modified automotive effluents have approached the threshold toxicity limits for susceptible individuals and plants. Upon the breakup of smog-producing inversion conditions, normal atmospheric processes of photooxidation and deposition rapidly return the atmosphere to its near-primitive purity. There are apparently no significant long-term atmospheric changes that man might produce which cannot be rapidly reversed at any time by man s curtailment of his own activities. (Author abstract)

# B. CONTROL METHODS

00015

L. J. E. Hofer, J. F. Shultz, and J. J. Feenan

**EFFECT OF LEAD DEPOSITS ON ACTIVITY OF AUTOMOTIVE EXHAUST CATALYSTS.** Bureau of Mines, Washington, D.C. (Report of Investigations 6243.) 1963, 26p.

This study, part of a broad program of research in air pollution related to minerals, was conducted to determine the nature and extent of the poisoning of catalysts when used to remove certain air pollutants from exhaust gases. The poisoning examined in this investigation occurs when leaded gasoline is used as a fuel for automotive engines. The smog in the Los Angeles area is attributed to the effect of radiant energy on the mixture of hydrocarbons and nitrogen oxides found in the atmosphere there. To prevent the escape of these hydrocarbons into the atmosphere catalvtic mufflers have been proposed. In principle, these are simple and nonmechanical, consisting of a vessel charged with a catalyst capable of destroying the exhaust hydrocarbons by catalyzing their oxidation. However, these catalysts are severely affected by the particulate matter, mainly in the form of lead sulfate, lead oxysulfate, and lead chlorobromide, contained in the exhaust gas. Deposition of lead on the catalyst restricts catalytic activity. After 20,000 miles of operation, the temperature necessary to achieve 50% conversion of isopentane in a mixture of 0.2% isopentane, 2% CO and 4% oxygen, and the balance N at 10,000 hourly space velocity has risen from 400 to 500 C. even with a catalyst taken from the exit portion of the catalyst bed. The rest of the catalyst was more severely affected. It would appear that operation for 20,000 miles is near the limit for a catalyst.

00063

**DEVELOPMENT OF DEPLETED-URANIUM CATALYSTS FOR DESTRUCTION OF AIT POLLUTANTS IN AUTOMOBILE EXHAUST.** (Fiscal Year 1961 Rept. of Research Progress). Bureau of Mines, Washington, D. C. 1961. 61 pp. CFSTI: PB 171980

Uranium-based catalysts supported on activated alumina have been studied by bench-scale laboratory methods to determine their effi- cacy for effecting catalytic oxidation of selected combustible air pollutants in automobile exhaust and in the exhaust stream of a single-cylinder test engine operated continuously for 2 weeks. An alumina-supported uranium/oxide catalyst was tested in afterburner units in a mobile laboratory under modified road-use conditions, in conjunction with a dynamometer-connected engine mounted on a test stand, and in a passenger car under typical road-use condi- tions. A CU-CR promoted, supported uranium-oxide catalyst was tested in afterburner units in engine-dynamometer runs and in 10,000 mi. of passenger car operation under typical road-use conditions. Below 600 C, unpromoted uranium catalyst was only moder- ately effective for oxidation of the hydrocarbon and ineffective for CO. The alumina support was only about 5% as effective as the supported catalyst. Tests of a uranium-based catalyst promo- ted with both CU and CR indicated that both hydrocarbons and CO would be removed in substantial amounts at a bed temperature of 500 C. A CU-CR-promoted, uranium-oxide catalyst gave some promise of achieving signigicant destruction of hydrocarbons and CO in afterburner units used in passenger-car road tests and en- gine-dynamometer tests. Passenger-car evaluation of the promoted catalyst indicated about 60% removal of hydrocarbons during idling operation after warmup, acceleration, and deceleration; under cruise conditions, from 20 to 50% was removed. From 25 to 55% of the CO was destroyed under the foregoing conditions. Engine- dynamometer tests gave results somewhat more favorable than those from road tests. Radiation monitoring of both passenger-car and engine-dynamometer operations indicated that there were no apparent radiological hazards.

00107

S. S. Griswold

**CONTROL OF STATIONARY SOURCES (TECHNICAL PROGRESS REPT. VOLUME 1).** Los Angeles County Air Pollution Control District, Calif. Apr. 1960. 191 pp.

As a result of the intensive source control measures administered in Los Angeles County, Virtually all industrial operations have been brought within the scope of the air pollution control program. From the melting of metal to the painting of manufactured goods, specific industrial processes and equipment have been subject to air pollution control measures. This volume provides individual discussion of control techniques applied to the most significant stationary sources of air contamination. Certain source emission problems, such as those traceable to the operation of railroad locomotives and ships, are not discussed in this volume in view of the current unimportance of the source. The material reported in this volume generally contains only those developments occurring subsequent to the publication of the Second Technical and Administrative Report on Air Pollution Control in Los Angeles County, 1950-51. (Author)

00899

R. Gelius R. Muller

**(THE ELIMINATION OF LEAD FROM FUELS CONTAINING TETRA ETHYL LEAD BY MEANS OF SULFUR TRIOXIDE.) Die Entbleiung Tetraathylbleihaltiger Kraftstoffe mit Schwefeltrioxid. Chem. Tech. (Berlin) 18(6):371, June 1966.**

Freshly prepared 0.2-0.4 M sulfur trioxide solution in dichloromethane was used to separate tetraethyl lead from 3 types of gasoline used as test samples. The tetraethyl lead content was determined before and after sulfur treatment by complexometric titration with xylenol orange as an indicator. The sulfur trioxide solution was added at room temperature in 1:4, 1:2 and 1:1 ratios to 250 ml. of the test gasoline. After several minutes the brown and black sulfonation products of the tetraethyl lead appeared; the filtrate was fenerally clear. Except in the case of the third test gasoline which was an imported gasoline of unknown origin, treatment with sulfur trioxide in a 1:4 ratio resulted in the removal of more than 90% of the tetraethyl lead. When the ratio of sulfur trioxide to gasoline was increased to 1:2, the separation reaction was almost quantitative.

01484

A. J. Celebrezze

**AUTOMOTIVE AIR POLLUTION (A REPORT TO THE U.S. CONGRESS IN COMPLIANCE WITH PUBLIC LAW 88-206, THE CLEAN AIR ACT).** Preprint. Dec. 1964.

Photochemical air pollution or smog is a problem of growing national importance and is attributable largely to the operation of the motor vehicle. Manifestations of this type of air pollution are appearing with increasing frequency and severity in metropolitan areas throughout the United States. Biological studies of animals show that the photochemical reaction products of automotive emissions produce adverse health effects. There is substantial evidence that these effects may appear in humans after extended exposure to air which is known to be polluted with these same products in many of the larger urban areas. Laboratory experiments have demonstrated that reductions of atmospheric hydrocarbons, an important emission from motor vehicles, can reduce photochemical air pollution and such manifestations as eye irritation and plant damage. Other automotive emissions such as nitrogen oxides and carbon monoxide have also been determined as significant. Nitrogen oxides, which appear in engine exhaust gases as well as the effluent of other combustion processes, also play an important role in photochemical air pollution. Technical procedures for reducing these emissions are not so clearly established as for hydrocarbons. Carbon monoxide, although not a contributor to atmospheric photochemical reactions, is a directly toxic substance. Technical procedures have been developed which substantially reduce emissions of this pollutant. The current problem and progress in its resolution are reported. (Author summary modified)

01851

C.R. Begeman

**CARCINOGENIC AROMATIC HYDROCARBONS IN AUTOMOBILE EFFLUENTS.** Society of Automotive Engineers, Inc., New York also published in Vehicle Emissions (Selected SAE Papers) 6, 163-74, 1964. (Presented at Congress of the Society of Automotive Engineers, Detroit, Mich., Jan 8-12, 1962, Paper 440C.)

This paper is part of the joint effort by the General Motor Research Laboratories and the Sloan-Kettering Institute to evaluate the contribution by automobiles to the trace amounts of carcinogenic hydrocarbons in the atmosphere. Benzene-soluble 'tar', containing carcinogenic polynuclear aromatic hydrocarbons, is recovered from the total volume of exhaust and blowby gases of an engine operated on a simulated city driving schedule. Fuel composition was found to influence both the pyrene, a carcinogen. Iso-octane and diisobutylene fuels gave only 20% as much 'tar' as did a typical commercial gasoline, and a fuel comprised of equal volumes of ortho-xylene and benzene gave 70% as much 'tar' as did gasoline. The emission rate of benzo(a)pyrene with diisobutylene fuel was only 7% of the rate with gasoline. Benzo(a)pyrene emission in blowby gas was less than 4% of the total benzo(a)pyrene emitted from the engine. On the assumption that benzo(a)pyrene from automobiles settles out of the air in the same manner as the lead from exhaust gas, automobiles may contribute, on the average, about 2% of the total benzo(a)pyrene in the air over cities. On the other hand, if benzo(a)pyrene is dispersed with little or no settling, as is the case for carbon monoxide from exhaust gas, the contribution of benzo(a)pyrene by automobiles may average about 10%. (Author abstract)

03125

Mahler, E. A. J.

**METHODS OF REDUCING POLLUTION CAUSED BY SPECIFIC INDUSTRIES. (CHAPTER II. NON-FERROUS METALS).** European Conf. on Air Pollution, Strasbourg, 1964. p. 279-282.

This report does no more than attempt to indicate in a general way the nature of the emissions from processes used in non-ferrous metallurgy, the means taken to deal with them from information based on the national reports and the writer's own experience with the results achieved. For achievements and the special problems of different countries reference should be made to national reports . Zinc, lead, and aluminum are considered.

03232

G. W. Thom and A. F. Schuldt

**THE COLLECTION OF OPEN HEARTH DUST AND ITS RECLAMATION USING THE SL/RN PROCESS.** Can. Mining and Met Bull. (Montreal) 59, (654) 1229-33, Oct. 1966

The authors describe the dust collection system for iron oxide dust from the basic oxygen hearths using electrostatic precipitators, then removing the zinc and lead oxides and sulfur compounds by direct reduction in a rotary kiln using the SL/RN Process. (SL/RN designates the two groups of companies who developed the process.) In this process bentonite is added to the dust to form green balls. Then dolomite and anthracite were added to the balls which were fed into the kiln. The coal acted as a reductant and also provided energy. The dolomite removed released sulfur. The results of kiln tests are presented.

03337

Beinstock, D., Brunn, L. W., Murphy, E. M. and Benson, H. E.

**SULFUR DIOXIDE - ITS CHEMISTRY AND REMOVAL FROM INDUSTRIAL WASTE GASES.** Bureau of Mines, Washington, D. C. (Information Circular 7836.) 1958. 101 pp.

More progress had been made in removing SO2 from flue gases by gas-washing processes than by other techniques. The developed processes include the Battersea, the Howden-I.C.I. cyclic lime, the basic Al2(SO4)3 I.C.I., the Lurgi 'sulfidine', the Fleming and Fitt dimethylaniline, the ammoniacal liquor, the Johnstone and Singh Na2SO3, and the Mg(OH)2 system. A major disadvantage common to all these wet absorption processes is that cooling of the gases occurs; the scrubbed gas, which still contains some SO2, loses its buoyancy and may settle in the immediate vicinity of the plant. No commercial methods based on adsorption have been developed for removing SO2 from flue gases. However, the use of an adsorption process is conceivable, and fundamental data for adsorption of SO2 on C, SiO gel, Pt, and on the oxides of A, Fe, and V are presented. Reduction of SO2 with gaseous reactants, H2, H2S, CO, and CH4 occurs at commercially feasible rates and temperatures. Reduction products include S, H2S, and CS2. Several commercial processes are based on these methods. Reduction of SO2 with C in the form of coke and anthracite has also been practiced on a laboratory and plant scale. SO2 may be oxidized to SO3 with air or oxygen in the presence of a catalyst as in the contact-acid process, or with O3, light, or electrical discharge. Basic metallic oxides in the solid phase might serve as effective absorbents of SO2 at flue-gas temperatures. Sulfates formed in the absorption could be electrolyzed for recovering S as H2SO4 and for regenerating metallic oxide. Electrolytic recovery would be desirable at a

powerplant installation, where electrical energy is available at a low cost. Thermal decomposition of sulfates could also be employed and SO2 or SO3 recovered. Sulfites formed in the absorption also could be thermally decomposed or oxidized with air to the sulfate. The Bureau has considered removing SO2 from flue gases by develloping absorption processes, which could be conducted at flue-gas temperatures in order to prevent loss of buoyancy of the flue gases. Several possible methods, including both solid-phase and gas-phase reactions, are suggested as hot-absorption processes.

03754

G. L. Allen, F. H. Viets, and L. C. McCabe

**CONTROL OF METALLURGICAL AND MINERAL DUSTS AND FUMES IN LOS ANGELES COUNTY, CALIF.** Bureau of Mines, Washington, D.C. (Information Circular 7627.) Apr. 1952. 85 pp.

The nonferrous pyrometallurgical industry of Los Angeles has three unusual characteristics that contribute to its difficulties in developing suitable fume control: (1) It consists of a multiplicity of relatively small establishments subject to wide variations in products and operating schedules; (2) operations are largely of the secondary or reclaiming nature; and (3) much of the industry is concentrated near the center of a city. A difficulty inherent in most nonferrous foundries is the high volatility of zinc and the extremely small mean particle size of the resulting zinc oxide fume. The nonferrous industry has found only one type of equipment that could be depended upon to adequately remove particulate matter emitted by the larger furnaces in which the gases are characterized by heavy dust loadings at high temperatures. This is a specially equipped baghouse, and its first cost is rather high. For smaller furnaces, particularly of the crucible type, the conventional sock-type baghouse has proved satisfactory. The inert slag cover, which reduces emission at the source, has proved fairly effective and economical, particularly with the crucible-type furnace and pouring ladle, but is successful use depends on the skill of the operators. The gray-iron-foundry branch of the ferrous industries has not fared as well as the nonferrous branch, despite extensive investigation and development of equipment for control of cupola emissions. Appreciable progress has been made in adapting equipment suitable technically and cost-wise for cupola-exit gases, and development continues. Equipment capable of producing the required clearances is available but is not within the financial ability of many small foundries. The baghouse equipped with specially woven glass-fabric bags, as used commercially in the nonferrous industry, has technically been the most successful single device to date for controlling cupola emissions and has been proven in pilot operations. After extensive investigation, electrical precipitation has been adopted for cold-metal open-hearth work, and hydrodynamic scrubbers and baghouses have been adopted for electric-steel-furnace fumes. In addition to the fact that such equipment removes the necessary dust, capital and operating costs were important factors in their selection.

05214

Bureau of Mines, Washington, D. C. (Jan. 1963 48 pp.) (Rept. No. TID-8213.)

**DEVELOPMENT OF DEPLETED-URANIUM CATALYSTS FOR DESTRUCTION OF AIR POLLUTANTS IN AUTOMOBILE EXHAUST (REPORT OF RESEARCH PROGRESS-FISCAL YEAR 1962).**

Catalysts were tested for oxidation activity in the continuous flow system. Four catalysts, all impregnated on alumina spheres, were active enough to oxidize isopentane from 0.2 percent concentration to below 0.033 percent at 600 C. in the presence of 2 percent carbon monoxide and 4 percent oxygen at an hourly space velocity of 10,000, (which corresponds to a reasonably sized muffler of 1/2 cubic foot volume for an average automobile.) Two catalysts were also active enough to oxidize the carbon monoxide content from 2 percent to 1.5 percent at temperatures below 400 C. A promoted urania catalyst was shown to be effective in oxidizing automotive exhaust when used in a muffler of a 1/2-ton truck. With a non-leaded gasoline practically complete conversion of hydrocarbons and carbon monoxide was obtained during the idle portion of the cycle and fairly high conversions of the hydrocarbons were obtained while cruising at 30 mph. Carbon monoxide produced by the engine during the 30 mph cruise was less than 0.3 percent. At this low concentration, carbon monoxide was not oxidized by the catalyst. However, this quantity emitted to the atmosphere is not of significant pollutant value. In operating the engine under idle conditions from a cold start the temperature of the exhaust is insufficient to start and sustain catalytic activity. However, during the driving cycle the temperature of the exhaust leaving the engine is sufficient to maintain high catalytic activity. After reaching operating temperatures (400 C.) the catalytic reactor generates enough heat to operate effectively even at idle conditions for extended periods. With a leaded gasoline there was a gradual loss in catalytic activity. The efficiency of the catalyst in oxidizing hydrocarbons and carbon monoxide decreased by 23 percent over a period of 122 hours and 1,366 miles with the leaded gasoline (2 ml TEL/gallon). This rate of decline is excessive for commercial application. To retard the decline in activity, a replaceable zone of unimpregnated alumina spheres, located before the catalytic reactor, may be sufficient to remove most of the lead.

05300

Lodwick, J. R.

**CHEMICAL ADDITIVES IN PETROLEUM FUELS: SOME USES AND ACTION MECHANISMS.** J. Inst. Petrol. (London) 50, (491) 297-308, Nov. 196 (Presented at the Northern Branch Symposium, Manchester, England, Apr. 23, 1964.)

The paper enumerates the types of anti-oxidants, copper deactivators, corrosion inhibitors, combustion chamber modifiers, anti-icing compounds, anti-knock agents, and anti-static additives in current use or proposed for use in the near future. Where possible the action mechanisms whereby these additives operate have been given and discussed. (Author summary)

06493

V. A. Mikheev, and G. S. Gubauidullin

**AGGLOMERATING ROASTING OF LEAD CHARGES ON AN UP-DRAFT SINTERING MACHINE, WITH RECIRCULATION OF GASES AND THE USE OF OXYGEN.** Soviet J. Non-Ferrous Metals (English Transl.) 4(4), 26 (Apr. 1963). Russ. (Tr.)

The advantages of using agglomerated roasting of sulfidic lead concentrates on an up-draft sintering machine were outlined. Gas recirculation was used to explain the possibility of obtaining gases with increased sulfurous anhydride concentrations in the sintering machine and further use of these gases in the sulfuric acid industry. That possibility makes it possible to effect a substantial increase in agglomerating roasting efficiency, to eliminate atmospheric contamination with harmful gases and to effect a more complex extraction of valuable charge components.

07606

Lagarias, J. S.

**DISCHARGE ELECTRODES AND ELECTROSTATIC PRECIPITATORS.** J. Air Pollution Control Assoc., 10(4):271-274, Aug. 1960. 4 refs. (Presented at the 52nd Annual Meeting, Air Pollution Control Assoc., Los Angeles, Calif., June 21-26, 1959.)

Discharge electrodes are made in many shapes and of different materials depending upon the application involved. Factors which must be considered include the type of dust, operating temperature, corrosion, and ozone generation. The efficiency of a precipitator is shown to depend on the total power input and is especially sensitive to the discharge current. Laboratory and field data verify the use of barbed discharge electrodes to improve precipitator efficiency.

08562

Culhane, F. R.

**PRODUCTION BAGHOUSES.** Chem. Eng. Progr., 64(1):65-738 Jan. 1968. 1 ref.

Tests and field results are discussed for several baghouse installations associated with roasters, sintering machines, and reverberatory furnaces in the lead, zinc, and copper industries. Design considerations, such as air-to-cloth ratio and type of construction, are discussed. (Authors abstract)

09231

Lemmenmeyer, W. K.

**TRENDS IN AUTOMOTIVE ENGINEERING.** ((Tendenzen in der Automo- biltechnik.)) Text in German. Z. Praeventivmed., 11(2):226- 236, March-April 1966. 20 refs.

The effects of automobile design on exhaust gas emission are dis- cussed. To produce correct gasoline-air mixtures under varying operating conditions modern carburetors should be equipped with systems for idling, starting, accelerating, operating speed, and rich mixture production. Vehicles operated at elevated altitudes exhaust more CO, but a barometric sensor can be used to eliminate this problem. Forced crankcase ventilation, by which the gases are returned through the air filter into the engine, can reduce the amount of unburned hydrocarbons in the exhaust by 20-40 percent. The removal of CO by afterburners was not successful but chem- ical catalysts are being tested for this purpose. The system of air injection into the exhaust is considered promising. Gas tur- bine exhausts contain neither CO nor lead. Wankel engine ex- hausts contain high amounts of unburned hydrocarbons and CO.

09798

Hammond, William F., James T. Nance, and Emmet F. Spencer

**SECONDARY BRASS-AND BRONZE-MELTING PROCESS.** In: Air Pollu- tion Engineering Manual. (Air Pollution Control District, County of Los Angeles.) John A. Danielson (comp. and ed.), Public Health Service, Cincinnati, Ohio, National Center for Air Pollution Control, PHS-Pub-999-AP-40, p. 270-284, 1967. GPO: 806-614-30

The control of air pollution in brass- and bronze-melting processes is discussed in terms of the type furnace utilized. The reverberatory, electric, crucible, and cupola type furnaces are used. A comparison of emissions from various type furnaces is outlined. The air contaminants emitted from brass furnaces consist of products of combustion from the fuel, and particulate matter in the form of dust and metallic fumes. In copper-base alloy foundries, as much as 98 percent of the particulate matter contained in furnace stack gases may be zinc oxide and lead oxide, depending upon the composition of the alloy. The particle sizes of zinc oxide fumes vary from 0.03 to 0.3 microns. Lead oxide fumes are within this same range of particle size. Regardless of the efficiency of the control device, air pollution control is not complete unless all the fumes generated by the furnace are captured. Hooding and ventilation requirements of the various types of furnaces are discussed separately since different problems are encountered with each. An example problem illustrates calculations involved in designing a side-draft hood for a rotary- tilting-type furnace. Baghouses with tubular filters are used successfully to control the emissions from brass furnaces. The results of tests performed on baghouses venting brass furnaces are outlined. Electric precipitators have not proved entirely satisfactory on lead and zinc fumes. A number of dynamic and static scrubbers have been tested on brass furnaces and all have been found unsatisfactory. The results of several scrubber tests are summarized.

10558

Lange, Alfred and Werner Trinks

**THE ELECTRICAL RESISTANCE OF LEAD AND ZINC COMPOUNDS, WITH SPECIAL REFERENCE TO THE GAS PHASE. APPLICATIONS TO ELECTROSTATIC GAS CLEANING.** ((Der elektrische Widerstand von Blei- und Zinkverbindungen unter besonderer Berucksichtigung der Gasphase. Ein Beitrag zum Problem der elektrischen Gasreinigung.)) Text in German. Neue Heutte, 12(2):81-88, Feb. 1968. 8 refs.

The use of electrofilters in dust elimination from flue gases in nonferrous metallurgy in many cases is attended by failure due to the poor conductivity of the dust deposited on the filter electrodes. Hence, the determination of the electrical resistance of particular dust types is of interest. The literature on this subject is reviewed and original resistance measurements are reported which utilized a specially constructed apparatus permitting gas phase measurements up to temperatures of 400 degrees C. Electrical resistance measurements of lead oxide, carbonate and sulfide are described and illustrated by graphs. The results of these measurements and of deposition experiments with lead oxide and lead sulfate fly ash are detailed. At high temperatures the resistance of lead and zinc compounds lies below the critical limit, thus deposition in a hot-gas atmosphere (EGR) is possible in principle; however, larger quantities of gas and larger filters are consequently required. The reported results suggest that lead oxide fly ash should be deposited in the temperature range of 320 and 380 degrees C., and lead sulfate fly ash at temperatures above 350 degrees C. During the deposition of lead oxide fly ash, the partial oxygen pressure of the gas phase should be as high as possible, in contrast to the conditions required for zinc oxide fly ash. In the deposition of lead sulfate fly ash, especially, the constant presence of SO2 in the gas phase is essential.

13982

Yemel'yanov, B. V., Z. N. Shemyakina, and V. N. Shvarov

**REMOVAL OF TETRAETHYL LEAD FROM AIR BY OZONIZATION ON A SOLID CATALYST.** (Ochistka vozdukha ot tetraetilsvintsa okisleniyem ozonom na tverdom katalizatore). Text in Russian. Khim. Prom. (Moscow), 44(7):498-500, 1968. 14 refs.

Laboratory and pilot studies of the removal of tetraethyl lead from air by ozonization on solid catalysts are discussed. Activated charcoal was found to be a more effective catalyst than aluminum oxide or silica gel. Pilot operation with this process began in 1964, processing air at a rate of 500,000 cu

m/hr at a cost of 5.53 kopecs per 1000 cu m. The catalyst was replaced every 4-6 months and the degree of purification in the second year of operation was 92% with no traces of mineral zinc or ozone in the purified air. Replacement of the catalyst and adjustment of the operating regime raised the degree of purity to 99% and reduced operating cost. This method is recommended for industrial application and for portable equipment to be used with various forms of gasoline transport.

14604

Hamblin, R. J. J. and W. J. Faust

**CATALYTIC SYSTEMS FOR LEADED AND UNLEADED GASOLINE EXHAUSTS.** Franklin Inst. Research Labs., Philadelphia, Pa., Materials Science and Engineering Dept. and Public Health Service, Durham, N. C., National Air Pollution Control Administration, Proc. First Natl. Symp. on Heterogeneous Catalysis for Control of Air Pollution, Philadelphia, Pa., Nov. 1968, p.131-159.

The problems of achieving complete catalytic combustion of oxidizable components other than unburned hydrocarbons, carbon monoxide, and nitrogen oxides are discussed. A catalyst placed in the exhaust system must be capable of dealing with lead, halogens, sulfur, and phosphorus in all combinations with oxygen and with each other. The catalyst must have a size and shape consistent with requirements for good flow distribution and low pressure drop. The catalyst bed itself and the individual particles must also not be subject to plugging by particulate matter. A catalytic converter lowers the concentrations of all pollutants in the exhaust gas stream and does not manufacture any new ones. The automobile manufacturers achieved significant reductions in carbon monoxide and hydrocarbon emission levels by controlling carburetion and ignition and by adding secondary air to the exhaust system. However, the still lower levels of emission desired after 1970 will be difficult to attain without further losses in vehicle performance. They may even be unattainable without catalytic converters. The use of present-generation catalysts may permit the recovery of the performance that already is sacrificed by engine modifications. The development of catalysts which can operate successfully for extended mileage on leaded fuels was accomplished. The performance of catalysts on unleaded fuels is outstanding. With leaded or unleaded fuel, a catalytic converter coupled closely to the exhaust manifold, under any engine operating conditions, assures lower emission levels than any other system.

15208

Agarkova, N. A., M. A. Ryss, V. N. Gusarov, V. P. Zaiko, and I. S. Bedov

**PURIFICATION OF THE OUTGOING GASES WHEN FERROTUNGSTEN IS MELTED IN ELECTRIC FURNACES, AND REUSING THE DUST EXTRACTED.** Steel (USSR) (English translation from Russian of: Stal'), no. 6:565- 567, June 1969. 2 refs.

The gases evolved during the melting of ferrotungsten include particles of rare and toxic substances. A system was proposed for purifying the outgoing gases in which a battery cyclone is followed by an electric filter. This system is an effective means of preventing contamination of the atmosphere. A pyrometallurgical method of reusing the dust enables scarce, costly elements (bismuth and lead) to be extracted. The elements in the dust are selectively reduced. When the dust is remelted in an electric furnace with a shortage of the reducing agent, nearly all the lead and bismuth are extracted to form an alloy. The tungsten is not extracted and remains in the slag This two- stage method provides a considerable saving due to the additional extraction of tungsten and the sale of a product containing the valuable bismuth.

16053

**HI-PURITY LIQUID SO2 FROM ROASTER GASES.** Chem. Eng., 60(4):274-277, April 1953.

Liquid sulfur dioxide of 99.9975% purity can be manufactured on a commercial scale by the absorption-desorption process using by-product roaster gases as the sulfur dioxide source and dimethylaniline (DMA) as the absorption medium. The process utilizes chemical and antimonial lead as the chief materials of chemical construction. Lead is used because of its excellent resistance to the corrosive characteristics of sulfur dioxide in combination with DMA. Sulfur dioxide from the roasting gases is conveyed to the sulfur dioxide plant and cleaned. The gas then enters an absorbing tower consisting of a series of bubble caps which force the gas into intimate contact with DMA. The quantity of gas that is dissolved in DMA depends upon the temperature, the cooler the liquid, the greater the quantity of gas dissolved. During absorption, the temperature of DMA liquid increases and it must be cooled at intervals by recirculation through a water-cooled lead pipe coil situated outside the tower. The DMA saturated with sulfur dioxide is passed through heat exchanger coils where it is preheated on its way to the stripping tower. In the stripping tower, it is heated with indirect steam heat and denuded of its sulfur dioxide content. The heated, stripped DMA liquid leaving the stripping tower passes back through the heat exchanger, where it is cooled before reentering the absorbing tower. The sulfur dioxide from the stripping tower passes through a third bubble cap tower where concentrated sulfuric acid reduces its water content to less than 25 ppm. The pure gas passes to a compressor where it is liquified under pressure and stored in a large steel tank.

17525

Hashimoto, Kiyotaka

**THE POINT OF PLANNING AND ITS EFFECT ON OPERATION RESULT OF AN ELECTRIC PRECIPITATOR IN VARIOUS INDUSTRY SMOKE ABATEMENT (VI) -- FLUE GAS TREATMENT AT REFINERIES (I).** (Gyoshubetsu ni miru denkishujinsochi no setsubikeikaku to untenkoka. (VI) Seirenjo ni okeru haigasu no shori (I)). Text in Japanese. Kogai to Taisaku (J. Pollution Control), 3(5):303-309, May 15, 1967.

Vaporized substances from a melting furnace become oxidized when they come into contact with air and are cooled. The oxidized substances form a metallic dust which has surface area out of proportion to its weight. This dust damages clothing and curtains. Furthermore, the dust is high in electric resistivity and poor in water-absorbency. Its removal in an electrostatic precipitator requires that the relative humidity of the waste gas be high. Smoke abatement in several typical nonferrous-metal refining processes is described. Among the points considered are Weltz-kiln dust control in zinc refining, dust control in zinc re-refinement from the slag of copper refining, alloying furnace dust recovery, and cadmium recovery from zinc refinery waste gases. Zinc waste gas is effectively purified in electrostatic precipitators. In precipitating lead dust, the relative humidity of the gas should be over 40%. An automatic regulator is suggested for lead dust. Dust generated by titanium oxide refining is worth recovering as a final product; this dust is easily treated in an electric precipitator when precipitated at high temperatures. For sulfur trioxide control, it is necessary to cool the gas and precipitate the dust as a mist. For optimum precipitation of copper refinery dust, care must be taken to avoid air leaks.

17906

Agnew, W. G.

**AUTOMOTIVE AIR POLLUTION RESEARCH.** Proc. Roy. Soc. (London), Ser. A., 307(1489):153-181, Oct. 1968. 68 refs.

Some of the progress which has been made in the United States toward the objectives of automotive air pollution research with respect to photochemical smog, carbon monoxide, polynuclear aromatic hydrocarbons, lead, and diesel smoke and odor are reviewed and discussed. Automotive air pollution research has as its objectives: (1) to understand the nature of the atmospheric effects; (2) to understand the nature of vehicle emissions; and (3) to develop concepts for the control of significant pollutants. Attempts to determine the magnitude of hydrocarbon and nitrogen oxide emissions from vehicles immediately face two severe difficulties: (1) automobiles are operated in an almost infinite variety of steady-state and transient driving conditions, ambient conditions, and states of repair; and (2) the exhaust is made up of hundreds of individual compounds with different degrees of significance and the proportions of these compounds vary with operating conditions and fuel types. The estimated contributions of the engine crankcase, exhaust, and carburetor and fuel tank to the hydrocarbon and nitrogen oxide emissions from an average uncontrolled vehicle are presented. Numerous charts and illustrations are given. Polynuclear aromatic hydrocarbons and lead in the atmosphere appear to be below the levels of any health hazards, but information in this area, as well as understanding of the vehicle emissions of these materials, is inadequate. Diesel smoke is currently a commercial economic problem requiring legal enforcement, but its odor remains a chemical mystery.

18053

**NO LEAD, LESS RVP COMING IN GASOLINE.** Can. Chem. Process., 53(3): 47-50, March 1969.

The problems of air pollution control must be faced by automotive engineers and gasoline refiners. If the motor vehicle industry staves off pressure to do away with pollution-causing power units, it will only do so as a result of measures that remove at least 80% or more of the noxious fumes. This may force sacrifices in fuel economy since most anti-pollution devices appear to reduce the mileage per gallon. It could also put the manufacturers of lead additives out of business and complicate the task of refiners seeking to achieve maximum octane ratings at the lowest cost. With the many unknowns in the equation, it is difficult to assess how the refiners will respond to the public demand for pollution control. Although many technological tools are available, use of them will require a readjustment in the use of the hydrocarbon fractions. Two approaches under study that may minimize the loss in fuel economy are discussed.

19331

Gardner, Conrad O.

**AIR POLLUTION PREVENTION SYSTEM AND APPARATUS.** (Assignee not given.) U. S. Pat. 3,503,188. 4p., March 31, 1970. 18 refs. (Appl. April 25, 1966, 3 claims).

A system is proposed for collecting and processing exhaust emissions from motor vehicles travelling along a highway. Automobiles are provided with both magnetic sensors for locating metal inlet gratings embedded in the highway and a moveable extension of the exhaust pipe; the extension controlled is nearly flush with the gratings. The gratings are positioned on top of a main duct running parallel to and under the highway. Suction fans are located in side ducts in such a manner as to draw exhaust emissions through the inlet gratings and main duct to processing units where gases will be purified and the purified air returned to the atmosphere. The processing units can be designed to remove a particular contaminant. One unit, for instance, could be equipped with a catalytic muffler for the oxidation of hydrocarbons and another supplied with ammoniacal solutions for the absorption of carbon monoxide. Either unit could additionally be provided with an electrostatic precipitator for the recovery of particulate lead. The bulk equipment that can be used by the processing units has the advantage of higher efficiencies than the compact pollution-control devices installed in cars.

19637

Grennard, Alf H.

**LEAD ADDITIVES IN GASOLINE AND UNNECESSARY AUTOMOTIVE EXHAUST EMISSIONS.** Preprint, 23p., 1969 (?).

Gasolines and the limited prospects of reducing the lead content with regard to the existing refinery pattern in Europe are discussed. It is not regarded as a promising prospect, since limitations of the lead content tend to increase the price of gasoline. Gasolines contain a number of poisonous materials including aromatics and organic lead compounds. Due to their vapor pressures, they evaporate when stored in open vessels such as gasoline tanks and carburetors. Closed fuel systems and devices for recovering gasoline vapors have been developed to solve these problems. Another method of controlling automotive emissions is by mechanically or electronically controlling the fuel injection. Improving the combustion chamber, reducing the carbon/hydrogen ratio of the fuel, and changing to gaseous fuels can also reduce poisonous emissions.

19710

O'Neill, Donald

**SWITCH TO UNLEADED FUEL OFFERS BENEFITS, POSES PROBLEMS.** S.A.E. (Soc. Automot. Engrs.) J., 78(8):17-26, Aug. 1970.

Without lead in the gasoline, cars have reduced hydrocarbon emissions; long-life exhaust catalytic converters become technically feasible. Since valve recession occurs under some high-speed, high-load conditions, engine valve trains must be modified to run with all types of fuels, and engine compression ratios must be reduced and spark timing modified to accommodate the lower octane numbers. Commencing July 1, 1971, every gasoline marketer in California will be required to provide at least one grade of fuel with a minimum 90 octane number that contains a maximum of 0.5 g Pb/gal. Implications of the California proposals on the refining industry are assessed. The deleterious effects of leaded gasoline on catalytic converters and two other exhaust control devices are described. The most immediate benefit accruing from the removal of lead from gasoline is a 20-ppm reduction in hydrocarbon emissions from new cars. Without lead deposits, spark-plug life would be extended and the anti-foul phosphorus additive used in some gasolines could be eliminated. Though experimental particle traps are up to 65% effective, removal of lead from gasoline would eliminate a prime source of particulate matter.

19725

Vdovichenko, V. T., N. P. Galenko, and A. V. Larionov

**CONVERSION OF METHANE TO CARBON DISULFIDE BY SULFUR DIOXIDE.** (Konversiya metana sernistym angidridom do serougleroda). Text in Russian. Zh. Prikl. Khim., vol. 32:347-350, 1959. 10 refs.

Production of carbon disulfide by reaction of natural gas (98% methane) with sulfur dioxide was investigated at temperatures ranging from 700-1000 C using a number of catalysts: alumina gel; bentonite; bentonite impregnated with Pb++ or Fe++; pumice impregnated with Pb++; and silica gel impregnated with Pb++. Pumice impregnated with 5% Pb++ by treatment with lead acetate proved to be the best catalyst, giving a maximum CS2 yield of 0.92 g/liter SO2 at 900 C with a CH4/SO2 ratio of 3.10.

19808

Kobayakawa, Takashi

**EXHAUST EMISSION CONTROLS OF U.S.A. AND EUROPE.** (Obei ni okeru haikigasu taisaku). Text in Japanese. Kuki Seijo (Clean Air - J. Japan Air Cleaning Assoc., Tokyo), 8(2):18-26, June 1970. 4 refs.

Smogs essentially fall into two different categories. London type smog has little to do with automobile exhausts and is the combination of household and industrial smoke plus fog. On the other hand, the smog characteristic of Los Angeles is mainly due to automobile emissions and is known as photochemical smog. The two types of smog are compared according to meteorological, seasonal, diurnal conditions, and their main sources. Various emission standards of the state of California are listed for carbon monoxide, hydrocarbons, nitrogen oxides, and smoke emissions, in addition to future control programs. Although smog in Japan and Europe falls into the London type, the significance of carbon monoxide is being recognized in large cities such as Paris and London. Nitrogen oxides are also demanding attention, but further research is yet to be conducted in Japan. Different emission standards for automobiles are listed and compared for the United States, Japan, and Economic Commonwealth of Europe. Another important component of air pollution from automobiles is particulates arising from the lead additives in gasoline. It has come to be recognized by the automobile manufacturers in the United States that the removal of lead additives would contribute to abatement with respect to the following points: the effectiveness of catalysts for removing carbon monoxide and hydrocarbons will be prolonged; manifold reactor life will be extended; the effectiveness of exhaust recycling system will be boosted; and other benefits such as avoiding the formation of lead salts will be gained. In connection with the above, several different types of exhaust treatment systems are introduced by means of block diagrams. Other methods of powering automobiles are considered, such as electric and steam engines, but they are still much underdeveloped. The present attempts by European countries to abate automobile exhaust pollution, especially the visible black smokes and obnoxious odors, are discussed.

20735

Moser, Charles E.

**AUTOMOTIVE EMISSION RESEARCH.** Chem. Eng., 77(9):221-226, April 27, 1970.

Advances in the reduction of automotive air pollution since 1962 are reviewed and current and proposed programs concerning automotive emission suppression are discussed. Fuels are considered in terms of their vapor pressure, olefin content, and the effects of their lead content as an atmospheric pollutant. Engine modification programs discussed included catalytic reactors to render exhaust fumes innocuous, thermal reactors for additional combustion, and fuel evaporation recovery systems to prevent the escape of smog-forming hydrocarbons into the atmosphere. Principle emphasis is on the current and proposed studies to accurately define the problem in terms of realistic driving cycles, types and amounts of pollutants released into the atmosphere, chemical and physical factors involved in the build- up and dispersion of pollutants once they reach the atmosphere, and the relationship between the physical and chemical properties of pollutants. Also discussed are engineering studies for the development of improved instrumentation and corresponding measurement techniques to precisely identify individual pollutants and reactions among them.

20740

Spengler, Guenter and Gerhard Haupt

**THE EFFECT OF FUEL ADDITIVES PREVENTING SOOT FORMATION IN THE COMBUSTION OF DIESEL ENGINES.** (Ueber die Wirkung russhemmender Kraftstoff-Zusaetze bei der Verbrennung im Dieselmotor). Text in German. Motortech. Z. (Stuttgart), 31(3):102-108, 1970. 11 refs.

The soot preventing properties of 29 chemical compounds were studied in a diesel engine; 18 were metal-containing compounds and 11, organic compounds. All tests were performed with a one-cylinder four stroke diesel engine. Commercially available diesel fuel was used. The influence of the fuel/air ratio and of the number of revolutions on soot formation was studied. At 1650 rpm, a minimum of soot formation occurred. A clear relation between soot formation and the amount of oxygen present could be confirmed. At diminshed oxygen partial pressure, the soot formation clearly increased. The fuel/air ratio also influenced the formation of components adsorbed by soot. These components are primarily products of incomplete combustion of the fuel or of partial oxidation of the fuel molecules, or products of polymerization or condensation. The quantity of polycyclic aromatics increased slowly until the fuel to air ratio dropped to 1.15; below that, the increase was rapid. Formation of aromatics and adlehydes depends largely on the fuel quantity and the oxygen partial pressure in the cylinder, as well as on the residence time. Of the metal-containing additives, methylcyclopentadienyl manganese tricarbonyl, ironpentacarbonyl, and tetraethyl lead were most effective. The effect of methylcyclopentadienyl manganese tricarbonyl began with the addition of 0.22g/l. Larger quantities (about 7.2 g/liter) were required with the use of organic additives. Also, their efficiency was not as high as that of metal containing additives. They were not able to remove more than 22% of the total soot content.

20844

**THE WAR ON POLLUTION. AIR QUALITY CONTROL. QUESTIONS AND ANSWERS.** Oil Gas J., 68(24):97-117, June 15, 1970.

The direct and indirect contributions of the petroleum industry to air pollution center largely around the refining operations. Direct contributions, in the form of tank vapors, gas flares, and slush pits, are uneconomical to the refinery and therefore kept to a minimum. Controls in the form of vapor-recovery equipment, salvaging of waste products, and emission controls are extensively used. Indirectly, through fuel production, refineries are responsible for automobile emissions. These emissions are being reduced by employing control devices on the automobile and by changing the composition of the fuel itself. Catalytic and thermal afterburners, thermal-reactor systems and lean-reactor methods of control are discussed, as well as a radical manifold converter which is used to refine lead-free gas. The effect of lead-free gas on performance is described, and possible engine redesigns are considered. The role of tetraethyl lead in increasing octane rating and therfore increasing exhaust emissions is quite significant, and is

discussed in depth. Representatives of leading oil companies discuss methods of analysis and air quality standards as they apply to the respective geographical areas.

21040

Yarrington, Robert M. and William E. Bambrick

**DEACTIVATION OF AUTOMOBILE EXHAUST CONTROL CATALYST.** J. Air Pollution Control Assoc., 20(6):398-401, June 1970. 10 refs.

A catalytic converter for controlling automobile exhaust emissions was evaluated in California in 1964. Results of this fleet test and subsequent analysis of the spent catalyst are presented. Statistical analysis of dynamometer test indicates a strong effect of tetraethyl lead content of the gasoline on activity decline. Analysis of spent catalyst revealed that both surface area and accumulated lead are major factors in activity decline. At above 100 sq m/g, a further increase in surface area at constant lead level resulted in a decline of activity. (Author abstract)

21303

Wilson-Jones, R. A.

**ENGINES.** Automobile Engr., 60(6):200-210, May 8, 1970.

The technology available to restrict automobile-caused pollution is reviewed. To meet current legislation, attention has been turned from minor modifications to further refinements in induction and ignition systems. The concensus in design is toward the V-type engine; several significant new V-types have recently been announced. The Wankel engine is being increasingly used. Its advantages are small size and weight for a given output. Fuel injection systems are increasing due to high costs for modified carburetors. Fuel will probably be lead-free in the near future. The development of complex anti-emission equipment such as exhaust recirculation devices and thermal and catalytic reactors is of prime importance in pollution control.

21324

Kato, Yujiro

**PLANS AND OPERATIONAL EXAMPLES ON FILTER TYPE DUST COLLECTOR SYSTEM AT VARIOUS INDUSTRIES (VI). THE ROLE OF BAG FILTERS IN THE METALWORKING INDUSTRY.** (Gyoshubetsu ni miru rokashiki shujin sochi no keikaku to unten jisshi rei (VI). Kinzoku kogyo ni okeru baggu firuta). Text in Japanese. Kogai to Taisaku (J. Pollution Control), 4(10):663-668, Oct. 15, 1968.

The operational conditions of bag filters used for emission control in the metalworking industry are illustrated by examples. In the zinc refining industry, bag filters are used at various points. The baghouse for the independent electric power plant which is provided to allow the exhausted material to cool down is one example. Another is the baghouse for controlling emissions from a smelting furnace exhaust. The applications of bag filters to the aluminum industry is illustrated by the baghouse used to control emissions from an alumina coveying process. In a powdered lead manufacturing plant, a complete dust collector has to be provided since the lead dust is extremely toxic and cannot be allowed to escape into the atmosphere. Complete hooding is also necessary. In the nonferrous metal working industry, emissions are commonly worth recovering. High efficient dust collectors are adequate for this purpose. In the iron and steel industry, the collected material from the exhaust is generally of little value, but dust collectors are necessary for air pollution control. Their use is typified by baghouses equipped for controlling emissions from electric-arc steelmaking furnaces and from electric furnaces for ferro-alloy manufacture. In the metal processing industry, bag filters are also used for controlling emissions from various processes. An example is the baghouse equipped for controlling emissions from the finishing process of iron casting.

21719

**ADDITIVES FOR FUELS.** In: Petroleum Products, Properties, Quality, Application. (Nefteprodukty, Svoystva, Kachestvo, Primeneniya.) B. V. Losikov (ed.), 1966, Chapt. 5. 98 refs. Translated from Russian. Foreign Technology Div., Wright-Patterson AFB, Ohio, Translation Div., p. 304-394, Aug. 22, 1969. CFSTI, DDC: AD 698546

Five principle categories and 16 sub-categories of motor fuel additives are identified. Physical and chemical properties of specific additives in each sub-category are discussed, both singularly and in combination. Two categories in most widespread use are additives that improve fuel motor properties and additives that improve stability of fuels during storage, shipment, and use in engines. Other categories identified include additives that reduce detrimental effects of fuels on apparatus and mechanisms, additives that facilitate the use of fuels at low temperatures, and a category identified as other additives which includes such sub-categories as dyes, additives that prevent the accumulation of static electricity, and additives that prevent microorganism spoilage of fuels. It is of particular interest to note the superiority of manganese based anti-knock compounds over lead based anti-knock compounds.

21762

Steinhagen, William K.

**AIR POLLUTION CONTROL METHODS FOR THE GASOLINE POWERED INTERNAL COMBUSTION ENGINE.** General Motors Corp., Detroit, Mich., 29p., 1967. 36 refs. (Presented to the Panel on Electrically Powered Vehicles, Office of the Secretary, Dept. of Commerce, Feb. 18, 1967.)

Three sources of emission are identified for the internal combustion engine: crankcase emissions, evaporation losses, and exhaust emissions. It is claimed that crankcase emissions are of academic interest since this source of emission has been completely controlled by positive crankcase ventilation techniques. Evaporation losses are identified as originating in the automobile's fuel tank and carburetor. Control appears to be technically feasible, but the present progress in this field is limited to checking procedures for measuring these losses. The approach to control showing the most promise is the adsorption-regeneration technique, but no production hardware is yet designed. Several exhaust control systems are in the development and/or field test stage. Air injection reaction (AIR), controlled combustion system, and catalytic reactors are but a few. The first of these operates by injecting air into the exhaust manifold to more completely burn hydrocarbons and to oxidize CO to CO2. The second utilizes heated carburetor air to permit operation on a leaner fuel mixture, thereby reducing the concentration of all pollutants in the exhaust gas. The principle drawback to using catalytic exhaust manifolds is that the catalyst is rapidly fouled by the lead in the gasoline. Brief mention is made of the control of the lead content of gasoline as being beneficial in the control of automotive emissions.

22414

Dishart, K. T.

**EXHAUST HYDROCARBON COMPOSITION. ITS RELATION TO GASOLINE COMPOSITION.** American Petroleum Inst., New York, Div. of Refinin Proc. Am. Petrol. Inst., Sect.

III, vol. 50:514-543, 1970. 12 refs. (Presented at the American Petroleum Institute, Division of Refining, Midyear Meeting, 35th, Houston, Tex., May 13-15, 1970.)

The influence of changes in hydrocarbon composition of leaded gasolines on the individual hydrocarbons found in the exhaust of vehicles equipped with various types of emission control systems is determined. Changes in gasoline olefin content have little effect on the amounts of the predominant olefins in the exhaust-- ethylene, propylene and isomeric butylenes. Increases in gasoline aromatic content increases the amounts of the predominant aromatic compounds found in the exhaust -- toluene, meta and para xylene -- but decreases the amounts of predominant exhaust olefins. The source of the ethylene, propylene, and butylenes is attributed to the high octane alkylate components which, in leaded gasolines, decrease as the fuel aromatic content increases. While the type of emission control device affects the level of hydrocarbons in the exhaust, the relative amounts of individual hydrocarbons remain fairly constant, except with an exhaust manifold thermal reactor control system which markedly reduces the proportion of the 'reactive' hydrocarbons as well as markedly reducing the total hydrocarbons in the exhaust. Leaded premium grade gasolines with similar octane quality and volatility characteristics are used. The aromatic and olefin contents of these gasolines covers the usual range found in today's commercial premium gasolines. The vehicles in which these fuels are tested are equipped with different types of emission control systems. These include the conventional air injection and engine modification systems, and a Du Pont exhaust manifold reactor system capable of very low exhaust emission levels. Also included is a car without a control system. (Author abstract modified)

22436

Barbier, J. C., J. Cosyns, M. Derrien, and J. F. Le Page

**OLEFIN REDUCTION IN GASOLINES BY HYDROGENATION.** American Petroleum Institute, New York, Proc. Am. Petrol. Inst., Sect. III, vol. 50:12-48, 1970. 13 refs. (Presented at the American Petroleum Institute, Division of Refining, Midyear Meeting, 35th, Houston, Tex., May 13, 1970.)

A review of the effects that are caused by the presence of olefinic compounds in fuels, and of methods to reduce the olefin content of gasoline is presented. When olefins are emitted into the atmospher by losses through evaporation during storage, transfer, or use, the are more susceptible than other families of molecules to photochemical transformations in the atmosphere, which lead to smog eye irritation, and other phenomona. To reach a required octane rating, adding olefins serves to reduce the lead content and in thi way to decrease the risks of lead pollution. Various methods to reduce the olefin content of gasoline are discussed, particularly hydrogenation. The chemical reactions, catalysts, and operating conditions of each method are presented.

22492

Rozenshteyn, I. S. and K. N. Gorbunova

**MEASURES TO ELIMINATE ATMOSPHERIC POLLUTION FROM 'VTORTSVETMET' MILLS.** In: American Institute of Crop Ecology Survey of USSR Air Pollution Literature. Effects and Symptoms of Air Pollutes on Vegetation; Resistance and Susceptibility of Different Plant Species in Various Habitats, In Relation to Plant Utilization for Shelter Belts and as Biological Indicators. M. Y. Nuttonson (ed.), vol. 2, Silver Spring, Md., American Institute of Crop Ecology, 1969, p. 24. 1 ref. (Also: Akad. Nauk SSSR. Ural. Filial. Komis. po Okhrane Prirody. Rastitel' nost' i promyshlennye zagrayzneniya. Okhrana prirody na Urale. V (Sverdlovsk), 1966, p. 59.) Areas where lead-babbit shops are located suffer from heavy pollution by lead oxides discharged from the furnaces and the ventilation system. The average daily concentration of lead, in some cases at 200 m, was 0.085 mg/cu m, and at 1000 m, 0.026 mg/cu m. These values are 122 and 38 times higher than the permissible limit for air in settled areas. To reduce the lead discharge and purify the exhaust gases from the furnaces, a scrubber-cooler, compound cyclone, and bag filter complex was installed. Following purification, the gases are discharged through an 80 m stack. After installation, the average daily concentration of lead, in the atmosphere beyond the 500 m sanitation protective zone of green plants, was lowered to 0.00035 mg/cu m. Discharge from the ventilation system of lead-babbit shops should also be purified in bag filters. To protect the population from the injurious effects of industrial discharges, a protective zone belt of green plants should be included in the sanitation plans.

22520

Hama, Akira

**DUST CONTROL OF REVERBERATORY AND BLAST FURNACES FOR BATTERY SCRAP.** (Namariyokai seiren saiseiro no haigasu shujin no jisshi rei). Text in Japanese. Kogai to Taisaku (J. Pollution Control), 6(8):645-648, Aug. 1970.

The flue gas from a lead refinery contains 50-70% lead in the dust, and its high density makes the rising and dispersion of the gas difficult. The operation of the furnace without the use of a dust collector is almost impossible. Low-cost, wet type dust collectors used to be employed for lead reverberatory furnaces, but because of the difficulty due to high SO2 and SO3 contents in their maintenance, efficiency, waste-water control, and dust collection a dry-type apparatus was developed employing a bag filter. The design and operation of the dust collector are described. An inverted U-shaped, venturi type spray system is employed to cool the gas to 80-90 C. The main feature of the present device is the vibro-clean bag filter. The dust accumulated on the cloth felt filter is shaken off by a one-half second blast of air, at a pressure of 400-500 mm Hg, vibrating at a frequency of 1000 Hz. The felt filter is operated at the flow speed of 1.0-1.5 cu m/min, and the pressure loss of 150-200 mm Hg. The filter is renewed after a period of 10-15 months. A safety device for the abnormal temperature rise of the filter and its maintenance is described. The development of an inexpensive anti-corrosive liner material and an SO2-removal device are some tasks left for the future.

22834

Frederick, Franklin P.

**TAKING THE LEAD OUT OF PETROCHEMICALS.** Oil Gas J., 68(36):115-119, Sept. 7, 1970. 2 refs.

A model was designed to study the transition to an unleaded octane and its effect on the business environment. At one extreme, significant impact would be felt by the automobile manufacturers, at the other it would be felt most strongly in the refining and petrochemical industry. One of these is a condition which represents a decrease in the octane requirements of the automobile population, while the other extreme would require continuing production of actane quality to satisfy the present car population. At very high octanes, most of the current octane contributors cease to be effective when blended without lead. The most notable is butylene alkylate. Ethylene alkylate has a high octane but generally is sufficiently more expensive than aromatics so as to be uneconomical. The net effect of lead removal with high octane demand is the reduction of aromatics to petrochemical while increasing the availa-

bility of olefin plant feeds. Five cases are analyzed and summarized when the model of an integrated fuels-petrochemical refinery was used to examine the influence of lead elimination on the long term economic outlook.

22890

Bastress, E. Karl and Ronald S. Fletcher

**AIRCRAFT ENGINE EXHAUST EMISSIONS.** Preprint, American Society of Mechanical Engineers, New York, 12p., 1969. 7 refs. (Presented at the American Society of Mechanical Engineers, Winter Annual Meeting, Los Angeles, Calif., Nov. 16-20, 1969, Paper 69-WA/APC-4.)

A study of aircraft engine exhaust emissions is presented. Both jet and propeller type engines are considered. Aircraft are classified by operation, with appropriate emission factors assigned for different operations. Aircraft fuel characteristics are discussed, and consumption figures are presented. Emissions of concern are carbon monoxide, hydrocarbons, nitrogen oxides, and particulate matter consisting of lead compounds and carbon. Average daily emissions for air terminals are tabulated. Reduction of emissions can be accomplished through fuel modification, engine design modification, and by altering ground operations. The principal impact of aircraft emissions is local in nature and is expected to become more severe in future years.

23540

Fisher, C. E.

**CATALYTIC CONVERTER--PANACEA OR PANDORA.** Air Pollution Control Assoc., Los Angeles, West Coast Section, Proc. Air Pollution Contro Assoc., West Coast Sect., 1st Tech. Meet., Los Angeles, Calif., 1957, p. 52-59. (March 25-26.)

Three approaches to controlling the emission of unburned hydrocarbons from motor vehicle exhausts are represented by improved design of the internal combustion engine, carburetor fuel shut-off devices which restrict the flow of fuel during deceleration, and devices such as afterburners and catalytic converters that oxidize the combustibles contained in the exhaust. Gains from the first approach are offset by the development of larger displacement engines, while shut-off devices will produce only a 10-20% removal of hydrocarbons. Catalytic converters appear capable of oxidizing hydrocarbons to a level of approximately 100 ppm and thus offer the best possibility of success. However, their design and operation involve a host of problems including cost, space required for installation, length of time required to heat the catalyst, and deterioration of the catalyst at high temperatures. Costs of a unit will be reduced and its installation simplified by reducing the mass of catalyst required. A smaller catalytic bed will be heated to operating temperatures more quickly with resultant higher efficiency; it can be protected against excess temperatures by a thermostatically controlled air valve. These smaller beds will be a possibility, once lead which requires a large quantity of catalyst is removed from motor fuel.

23697

Ebel, Robert H.

**CATALYTIC REMOVAL OF POTENTIAL AIR POLLUTANTS FROM AUTO EXHAUSTS.** In: Advances in Environmental Sciences. J. N. Pitts, Jr. and R. L. Metcalf (eds.), vol. 1, New York, Wiley-Interscience, 1969, p. 237-287. 131 refs.

A review of catalyst technology in relation to the control of hydrocarbons, carbon monoxide, and oxides of nitrogen is presented. The argument contained is principally for the systems approach to the problem of catalytic muffler design, the system to include all phases and modes of automobile design, operation, and maintenance. Rather than create one all-purpose device for all cars under all conditions, it is better to make the necessary trade-offs in carburetion, combustion chamber design, exhaust manifold design, fuel economy, maintenance schedules and techniques, and performance to obtain maximum emission control for each class of power train. The problem of lead pollution of the catalyst and back-pressure build-up would be handled by replacement in much the same way an ai filter is replaced. Temperature is controlled by distance from the exhaust manifold; temperatures catalysts can handle rather than the real malfunction temperatures and frequent thermal cycling is discussed. Reliability data at temperature is based on steady state operating conditions cited in petroleum processing. An excellent, detailed discussion of carburetion and combustion is included in the description of the chemistry of pollutant generation. Choices available to the petroleum industry and the auto industry are listed and probable decisions specified. For the auto industry, the alternatives listed include an alternate power source, (steam or electric), modification of existing engines to meet increasingly restrictive emission limitations, or catalytic mufflers. A combination of the second and third choices is expected. Auto manufacturers have demonstrated that the average car in good condition can pass the California 7-mode test. Unfortunately, cars are mass-produced and vary, even when new, in accordance with the bell curve of distribution. Since every car will have to pass inspection, redesign will continue on engines, carburetors, and accessory systems for exhaust recirculation, fuel injection, air injection, and water injection. Production tolerances will be tightened as far as economically practical. But in the end and at the end will be added one or possibly two catalytic mufflers in series. In the latter case, oxides of nitrogen and the remaining pollutants would be separately oxidized.

23923

**EUROPE STUDYING LEAD-FREE GASOLINE.** Automotive Ind., 143(3):33-35, Aug. 1, 1970.

Elimination of lead from gasoline results in the reduction of octane values, which in turn means that lower engine compression ratios are mandatory. While this will not have too much effect on large American engines, in Europe the small high-efficiency engine relies on high compression for that efficiency. Sweden is introducing regulations to reduce the lead content of gas progressively until fuel is lead-free by 1980. Volvo was the first European manufacturer to fit emission-control as standard on all its cars in 1968. A large proportion of these Volvo cars are fitted with the Strombery Constant Depression Starter Emission (CDSE) carburetors as supplied by Zenith in England. Zenith has been in the forefront in Europe in exhaust control, and its laboratories at Dunstable were among the first to be certified by the California authorities. The diesel, gas turbine, and Wankel engines are mentioned.

24182

**LEAN REACTOR CAR CUTS EXHAUST EMISSIONS.** Ethyl, no. 1:31-33, 1970.

An engine was modified by the Ethyl Corporation to produce very low exhaust emissions while operating on conventional leaded gasoline. Emissions have been reduced to less than 50 ppm unburned hydrocarbons, 0.4% carbon monoxide, and 600 ppm nitrogen oxides. Ethyl's major modifications comprise an experimental high-velocity carburetor, including deceleration control and improved choke, a two-step control of vacuum ignitions advance, and an exhaust system that includes stainless

steel port liners, insulated stainless steel exhaust reactors, and a large insulated exhaust pipe. The high-velocity carburetor feeds thoroughly mixed fuel and air to the engine's cylinders, permitting satisfactory car operation on extremely lean air-fuel mixtures. These lean mixtures also provide substantial oxygen in engine exhaust.

24184

Martin, Richard

**TEL...POLLUTION...'JUMBO' TANKERS...RESID SHORTAGE...LABOR...** Petro/Chem Engr., 42(10):11-12, 18, 20, 24, 26, 28, 30-31, 33-34, 36-38, Oct. 1970.

Of the 90 million tons of pollutants discharged to the atmosphere by the nation's 105 million vehicles, about .0025% is lead particulates from antiknock compounds. This means that lead pollution from vehicle exhaust constitutes .0001% of all pollutants from all sources. Nevertheless an estimated 90% of 1971 model cars will have engines designed for 91-octane fuel rather than the traditional 94-100 octane fuels. Among the refineries that will make no lead gasolines are American Oil, Atlantic Richfield, Shell Oil, Standard Oil of California, and Texaco. Low-lead fuels will be available from Gulf Oil, Humble Oil, Marathon Oil, Sun Oil, Phillips Petroleum, and Standard of California. No decision regarding lead has been reached by Mobil Oil or Continental Oil. Capital investment costs for unleaded gasolines will be massive for both refineries and retail outlets, adding about three cents a gallon to the price of gasoline. Strongly opposed to the removal of lead is the Ethyl Corporation, which maintains that removing lead will increase both carcinogens and smog. The company believes that all emissions can be burned to a point where they are harmless in a thermal reactor, i.e., a 'built-in stove.' Restrictions on lead antiknocks are also opposed by the Du Pont company, which is designing a thermal reactor system to meet the projected 1980 emission goals. Also Noted are the environmental threat posed by supertankers, the incapacity of the refining industry to supply the demand for residual fuel oil, and the health and safety provisions now being demanded for union contracts.

24186

Ewing, Robert C.

**LEADED AND UNLEADED GASOLINE ARE BLENDED IN THE SAME UNIT.** Oil Gas J., 68(38):139-141, Sept. 21, 1970.

American Oil Company's two-year-old leaded gasoline blender at its Texas City refinery is being converted to blend both leaded and lead-free gasoline on an alternate basis. The blender, largely automatic, is a combination batch and on-line blender. Two large shipping tanks are being cleaned and reconditioned to to facilitate the new unleaded product. Storage tanks provide the advantage of correcting a blend should a malfunction of equipment produce an off-specification blend. Two additional smaller tanks are being revamped to be used as flush or mixed component tanks. They will be equipped with foam valves for fire prevention and mixers to agitate the mixed stocks. Since the new lead-free gasoline is to be dyed blue, new dye tanks, lines, loading meters, isolating valves, and pumps must be installed. Mode switches, part of an interlocked system set in the control-room panel, control leaded, flush, and unleaded operations; a blocked system allows lead and bronze dye to be injected simultaneously only if the blue dye valve is closed. Knock engines produce both research and motor octane numbers. Starting the blend is discussed, as well as switching from a leaded to unleaded gasoline.

24553

Welch, Harry V.

**COLLECTION OF LEAD AND ZINC DUSTS AND FUMES BY THE COTTRELL PROCESS.** Trans. AIME (Am. Inst. Mining, Metallurgical, and Petroleum Engr.), vol. 121:304-338, 1936. 42 refs.

A review of the historical background of Cottrell precipitators and a discussion of the theory of conditioning blast furnace and Dwight-Lloyd gases is followed by a summary of the design, operation, and application of various Cottrells. Included are the exposed pipe, submerged pipe, plate, rod-curtain, screen, and cylindrical-rod designs. Collection of lead and zinc dusts and fumes by the Cottrell process at a selected number of representativ smelters is described.

24696

Logan, John O. and C. G. Gerhold

**SUMMARY OF STATEMENT OF JOHN O. LOGAN AND C. G. GERHOLD OF UNIVERSAL OIL PRODUCTS CO., DES PLAINES, ILL., WASHINGTON, D. C., MARCH 20, 1970.** In: Air Pollution-1970, Part 3. 91st Congress (Senate), Second Session on S.3229, S.3466, S.3546, p. 1141-1150, 1970. (Hearings before The Subcommittee on Air and Water Pollution of the Committee on Public Works and the Committee on Commerce, March 24, 25, 1970.

The results of research on control of automobile emissions are presented. In order to achieve best possible control, a combination of engine redesign, fuel control, and catalytic converter system must be employed. Data resulting from the installation of a catalytic converter on a standard vehicle with modified carburetion using lead-free gasoline are presented. Catalytic control of nitrogen oxide and hydrocarbons is obtained. Strict control of air-fuel ratios are necessary to achieve the desired control. Similar results could not be achieved with conventional leaded gasoline. A discussion of the role of lead in achieving octane ratings is included. Tampering with olefins and aromatics in fuel should be considered with extreme caution. Refining costs and technology to produce optimum fuels are discussed.

24722

Mikita, J. J. and E. N. Cantwell

**EXHAUST MANIFOLD THERMAL REACTORS - A SOLUTION TO THE AUTOMOTIVE EMISSIONS PROBLEM.** In: Air Pollution - 1970. Part 2. 91st Congress (Senate), Second Session on S.3229, S.3446, S.3546, p. 521-538, 1970. (Hearings Before the Subcommittee on Air and Water Pollution of the Committee on Public Works, March 19, 20, and 23, 1970.)(Presented at the National Petroleum Refiners' Assoc. Annual Meeting, 69th, San Antonio, Tex., April 5-8, 1970.)

An exhaust emission control system is described which comprises an exhaust manifold thermal reactor to control the hydrocarbons and carbon monoxide and an exhaust gas recirculation system to control nitrogen oxide levels. This system will meet the proposed standards for 1975 which require that hydrocarbons be reduced to less than 0.5 gram per mile, carbon monoxide to 11 grams per mile, nitrogen oxides to 0.9 gram per mile, and particulate matter to 0.1 gram per mile. The reactors provide a high-temperature zone in which the hydrocarbons and carbon monoxide are oxidized thermally to carbon dioxide and water. They will also operate satisfactorily with leaded fuels, while long-term tests have shown that they are capable of controlling HC and CO emissions for the normal life of the vehicle or 100,000 miles without any maintenance. Considerations do exist which pertain to its size and

the excessively high temperatures in the interior of the reactor. Introduction of the exhaust gas into the carburetor dilutes the incoming fuel/air mixture to the engine with the inert material (exhaust gas) and lowers the peak combustion temperatures within the cylinder, thus reducing the formation of nitrogen oxides. With regard to the removal of lead particulate from the exhaust gas stream, one of the more effective ways to accomplish separation and retention of such particulates is to employ an inertial device, such as a cyclone.

24813

Yanagihara, Shigeru

**EMISSION AND PERFORMANCE OF GASOLINE ENGINE.** (Gasorin kikan no seino to haiki joka gijutsu). Text in Japanese. Nenryo Kyokaishi (J. Fuel Soc. Japan, Tokyo), 49(521):646-655, Sept. 20, 1970. 14 refs.

Most automobile emissions are products of a high temperature and high pressure combustion chamber. The formation of carbon monoxide and nitric oxide are explained by equilibrium in the combustion reaction; the quench zone in the combustion chamber yiel unburned hydrocarbons. Carbon monoxide and hydrocarbons can be oxidized in the expansion stroke or exhaust systems. Reduction of nitric oxide and particulate emission is a serious problem for exhaust control techniques. Although an exhaust thermal reactor and catalytic converter have been developed, non-leaded fuel is necessary for their effective operation. A low emission vehicle should appear by 1975, but the power plant of the family car still may be the gasoline engine. In the near future, fuel will be subject to more severe restrictions to reduce the pollutants in exhaust gas; as an immediate target, at the risk of reducing some of gasoline's performance, it would be made in such a way that emission of pollutants would be about 10% of the former level. In 5 or 10 years, automobiles should hardly be a problem as sources of environmental pollution.

25033

Rueb, Friedmund

**AIR POLLUTION CONTROL IN INDUSTRIAL PAINT-SPRAYING PLANTS.** (Luftreinhaltung in industriellen Lackierbetrieben). Text in German. Wasser Luft Betrieb, 14(9):347-353, Sept. 1970.

The construction and operation of paint spray booths and cabins with dry separators, of water-rinsed booths, of enclosed spraying and drying booths, the drawing off and reclamation of organic solvents, thermal combustion of polluted air, and its catalytic combustion are described. In dry separation, paint mists are drawn off by ventilators through labyrinth filters; wet separation where the walls of the spray booths are constantly being rinsed with water or where the mist has to pass through a screen of water produces exhaust air of higher purity and minimizes the danger of fires. Enclosed spray booths use principally for spray painting automobiles are so constructed that the operator is supplied fresh air. Paint and solvent separation is the same as in open booths. The recovery of solvents is accomplished by absorption with activated carbon whence the solvent is expelled by steam. When the emission of solvents into the atmosphere exceeds 10 kg/hr, then the German law stipulates the mandatory use of a thermal or catalytic combustion installation. The presence in the atmosphere of catalytic poisons like lead or phosphoric acid esters makes catalytic combustion inapplicable. Combustion takes place at 650-800 C. The advantage of catalytic combustion is that it operates with higher concentrations and lower temperatures.

25096

**AN EFFICIENT PROGRAM FOR CONTROL OF THE LEAD CONTENT OF GASOLINES.** (Un programma razionale per il controllo del piombo nelle benzine). Text in Italian. Riv. Combust. (Milan), 24(7-8):360- 364, July-Aug., 1970.

The work of a convention held in Sacramento, California, March 4-5, 1970, under the auspices of the California Air Resource Board, for the purpose of examining the effect of lead-alkyl additives on the emissions from automotive vehicles is reported. Limitations in the use of lead additives were examined in the light of three possible methods of reducing emissions that would be benefited by such a limitation: catalytic convertors, thermal reactors, and recycling of exhaust. As much as 45% greater emissions of hydrocarbons has been attributed to deposits inside the engine and exhaust system that promote their formation. It has been shown that the emission of solid particles from the exhaust is directly proportional to the content of lead additives. The relationship of lead additives to octane rating is discussed in detail, the conclusion being reached that in many case the use of 'extra' gasolines rather than 'regular' is a wasteful practice. About 90-95% of present day vehicles could operate on 'regular' gasolines, and 50% could use a proposed gasoline with an octane rating of 90.

25155

Uchida, K.

**TRENDS IN AUTOMOBILE EXHAUST GAS CONTROL TECHNOLOGY.** (Jidosha haiki gasu gijutsu taisaku no doko). Text in Japanese. Kagaku Kogyo (Tokyo), 21(12):1632-1636, Dec. 1, 1970.

In automobile exhaust gas, carbon monoxide is more prevalent during idling; hydrocarbons, during deceleration; and nitrogen oxide during acceleration. The thermal reactor, a control device, oxidizes unburnt hydrocarbons and carbon monoxide, and no catalyst is used. Oxidants are supposed to be related to NO2, and lowering the maximum temperature of gas in the engine cylinder is one of the effective means to reduce NOx in automobile exhaust. Since exhaust gas itself contains characteristics of inactive gas, it might be utilized for dilution of fuel-air mixtures by circulating it into the engine's induction system. The results of testing were favorable with an average emission of 1.3 g/mile after a 20,000 miles running test. A combination of thermal reactors and exhaust gas circulation equipment was attached to a V-8 engine and the results are tabulated. No routine method has been developed to grasp amounts of lead compounds and other fine particles, although there is available a cyclone type separator. With mechanical improvement, the separator will be able to trap 90% as compared to the present 70% for solid inorganic matters as was proved by a 67,000 mile test on a chassis dynamometer. If 4-alkyl lead is completely eliminated from gasoline, the ratio of the HC mixture within the gasoline would change, and unburnt HC, one of the causes for photochemical smog, might increase. Also, 4-alkyl lead is effective in forming oxidized film over the valve sheet of the engine, preventing it being burned up. The use of catalyst leaves much to be improved.

25301

Ninomiya, J. S., W. Bergman, and B. H. Simpson

**AUTOMOTIVE PARTICULATE EMISSIONS.** Preprint, International Union of Air Pollution Prevention Associations, 19p., 1970. 17 refs. (Presented at the International Clean Air Congress, 2nd, Washington, D. C., Dec. 6-11, 1970, Paper EN-10G.)

A special constant volume sampler was constructed to make short-interval mass rate studies of vehicle exhaust particles,

and a high-resolution, 10-stage Anderson impactor was built to operate for long periods of time and to collect samples for chemical analysis and for microscopic determination of size distribution. Significant reductions in exhaust particle mass emissions were observed when tetraethyl lead and lead scavengers were removed from gasoline. A reduction of 77% with nonleaded fuel was observed under stabilized operation conditions; however, 40-93% reduction was observed under various test conditions. Greater differences in particulate emissions between fuels were observed with the total volume sampler after continued vehicle operation. Particle size distribution was noticeably different with leaded vs. nonleaded fuel; particles smaller than 0.1 micron represented about 40% of the total particulate mass with leaded fuel compared to about 10% with nonleaded fuel. Particulate mass emissions decreased rapidly with successive driving cycles after starting cold. With leaded fuel, the particulate emission rate dropped about 50%, comparing the first four 'cold' cycles to the stabilized rate. With nonleaded fuel, a drop of 80% was noted.

25334

Bainbridge, C. A.

**FUME CONTROL AND RECOVERY IN LEAD SMELTING FURNACES.** Chem. Process Eng., vol. 41:344-345, 347, 351, Aug. 1960.

Probably the most popular type of gas-cleaning process in the lead industry is the fabric filter because of its high efficiency, economy of operation, and ease of maintenance; it is applied in many forms from the old-fashioned, hand-operated, so-called bag house, requiring a relatively large staff, to the modern, fully automatic, multi-compartment plant run by one man part-time. Despite careful control of the process to produce lead from scrap materials, the high temperature in the furnace inevitably causes some of the lead to evaporate, and the vaporized lead when it leaves the furnace combines with oxygen to form lead oxide. Hood and duct design, the gas-cooling plant, filter plant, and operational experience are discussed for the new production unit of a lead company. Horizontal ducting was used between the furnaces, and provided with an adequate number of cleaning doors and fume hoppers with fitted lids to facilitate regular cleaning. Final design of the cooling section which had to dissipate over 1 million BTU/hr consisted of a series-parallel arrangement of four inverted 'U' tubes mounted on trough section hoppers, connected by a screw conveyor and an isolating valve arrangement for occasions when only one furnace would be in operation. Because of the sticky nature of lead fume, cleaning doors were put at the top of each 'U' tube and on each hopper. Filter plant requirements location of fans, and plant instrumentation are also cited.

25377

Hoekstra, James

**TREATMENT OF COMBUSTIBLE WASTE PRODUCTS.** (Universal Oil Products Co., Des Plaines, Ill.) U. S. Pat. 3,409,390. 8p., Nov. 5, 1968. 5 refs. (Appl. April 1, 1963, 7 claims).

A method is described for effecting the oxidation of noxious exhaust gases, which comprises contacting these gases at oxidation conditions with a catalytic composite consisting essentially of alumina, a platinum group metal component in an amount of from about 0.1 to 1% by weight thereof, and in excess of 1% by weight of an alkaline earth component selected from the group consisting of calcium, strontium, and barium. The alkaline earth component, when incorporated into the catalyst composite, is critically important in improving the stability or the life of the catalyst, as well as decreasing lead pick-up when effecting the conversion of automobile exhaust gases. While the use of a catalytic composite encompassed by the present invention is adaptable to the elimination of products of incomplete combustion from internal combustion engine exhaust gases, other products may also be treated such as unsaturated hydrocarbons, alcohols, ketones, carbon monoxide, nitrogen oxides, and sulfur oxides.

25470

Brass and Bronze Ingot Inst., Chicago, Ill. and National Air Pollution Control Administration, Raleigh, N. C.

**AIR POLLUTION ASPECTS OF BRASS AND BRONZE SMELTING AND REFINING INDUSTRY.** Pub. AP-58, 63p., Nov. 1969. 18 refs. NTIS: PB 190259

The principal source of atmospheric emissions in the brass and bronze ingot industry is the refining furnace. The exit gas from the furnace may contain the normal combustion products such as fly ash, soot, and smoke. The use of low-sulfur fuel results in trace amounts of sulfur oxide emissions. Because zinc is a major low-boiling-point alloying constituent, appreciable amounts of zinc oxide are normally present in the exit gases also. Analysis of dust collector catch indicates that from 56 to 96% of the collected dust is zinc oxide. About 6 to 8% is lead oxide along with lesser amounts of other metallic oxides. These small particles are in the submicron range, wherein they have the greatest opacity to light; therefore, the uncontrolled emissions form dense plumes. The only air pollution control equipment to receive general acceptance in the brass and bronze ingot industry is the baghouse filter collector. The emissions from a baghouse in satisfactory condition are usually invisible. Cost for installation of a baghouse depends to a large extent upon the auxiliary equipment required for proper ductwork, hooding, gas cooling equipment, and so forth. Reports indicate installed costs for dust collection systems of up to $5.00 or more per cubic foot per minute capacity. Information from a few installations that use wet scrubbers and electrostatic precipitators indicates that significant maintenance problems and low efficiency have been encountered. Most of the material preparation processes involving mechanical or wet treatment do not produce air pollutants. Some heat treatment operations produce emissions that are combustible. These fumes may be satisfactorily controlled by an afterburner or by secondary combustion techniques. The major air pollution control problem is the capture and ducting of fume emissions from the furnaces to the baghouses. Capturing the dust-laden gases generated during charging and pouring operations is particularly difficult. Ultimate control of air pollution and occasional in- plant contamination may require changes in furnace design, new metallurgical processes, or new technology for the capture of fumes at the point of generation. (Author summary modified)

25781

Hallows, R. L. and B. M. O'Harra

**MODERN AUTOMATIC BAGHOUSES FOR COLLECTION OF LEAD-FURNACE FUMES.** Trans. AIME (Am. Inst. Mining Metallurgical and Petroleum Engrs.), vol. 121:299-303, 1936.

A comparison is drawn between automatic and old style baghouses for filtering fumes, based on operating experience with both types in a lead smelter. The modern type is characterized by its small filtering bags and frequency of shaking (usually every few minutes) as opposed to the old type which uses much larger bags shaken at much longer intervals (2-12 hrs apart). Good practice for the modern baghouse calls for

only 1 sq ft of filter cloth to handle from 3-8 cu ft of gas per minute; thus, the filtering area may be as little as one-tenth that in the old type for handling the same volume and dust concentration. This is the most striking differenc and probably the greatest single advantage of the new type; others include greater cleanliness and uniform draft conditions due to the frequency of cleaning, more convenient repair of leaks, and lessene danger of fire. Although initial bag equipment costs for the new type are lower, the longer life of a bag in the old baghouse is much longer, so the cost of bag replacement is considerably in favor of the old type. Little trouble or expense is experienced in maintaining the new filters. Operating details are given.

25894

Kobayakawa, Takashi

**CONTROL TECHNIQUE OF MOBILE EXHAUST EMISSION.** (Enjin ni okeru haiki gasu boshigijutsu no tenbo). Text in Japanese. Kogai to Taisaku (J. Pollution Control), 6(11):851-858, Nov. 1970.

Reviews and comments on automobile exhaust emission control technology are presented. The criteria established toward reductio of various pollutants that have to be met by 1973 and 1975 are also discussed. The need to establish control criteria based on more scientific research and their data is pointed out. No environmenta control criteria except for carbon monoxide has yet been establishe for automobile exhaust. Much more time is necessary to define criteria for nitrogen oxides, hydrocarbons (HC), lead, or particulates in the exhaust gas. The formation mechanism of photochemical smog remains yet to be clarified, particularly in Japan where the study of emission factors such as NOx and HC is lagging. To meet the criteria by 1975, the measures being taken or conceived include the development of exhaust gas purifiers and lead reduction of gasoline. Exhaust reactors, catalyst converters, and afterburners are the purifiers. Each has problems to be solved such as how to keep the exhaust gas at high temperature for reaction with the exhaust reactor, the development of catalysts made of low-cost material such as copper, manganese, and iron, and availability of material withstanding the burning temperature of over 1000 C for the afterburner. Lead reduction is not as simple as is generally assumed. A perfectly lead-free gasoline is said to cause damage in the valves, contributing to further pollution, but automobile manufacturers in Japan are said to come up with cars that can use lead-free gasoline.

26153

Stanford Research Inst., Irvine, Calif.

**STUDY OF CATALYTIC CONTROL OF EXHAUST EMISSIONS FOR OTTO CYCLE ENGINES. (FINAL REPORT).** NAPCA Contract CPA 22-69-115, 60p., 1970. 40 refs. NTIS: PB 193533

Results are presented of a state-of-the-art study of the chemistry of various catalytic systems for control of nitrogen oxides, hydrocarbons, and carbon monoxide and their application to motor vehicles, based mainly on the scientific and patent literature published between 1960 and 1969. Subjects discussed include assessment of catalyst performance, effects of tetraethyl lead, properties of catalyst carriers, solid-state interactions, catalyst preparation and regeneration, and costs. A promising approach for NOx control appears to be its reaction with CO in a two-stage catalytic system, but data are incomplete and meager, and no reduction system for these emissions has yet been demonstrated that would be operative with leaded fuels for an extended period under practical operating conditions. Although many of the problems associated with the physical and mechanical properties of the solid catalysts have been partially solved (such as attrition, sintering, flow resistance), the chemical interactions due to additives (lead compounds) and gasoline contaminants (sulfur compounds, metal compounds) require further attention. Catalyst systems will require excellent engine maintenance for emission control effectiveness. Estimated equipment and operating costs on new and used vehicles are given based on a metal-oxide catalyst system operating with lead-free fuel. Costs of the dual-catalyst systems for control of NOx CO, and HC to within 1975 standards, or better, range from $113 to $320, or prorated over a 50,000-mile driving period, 0.60 to 1.240 per mile.

26243

Adler, Stephen Fred and Robert Murphy Yarrington

**IMPROVED PROCEDURE FOR PURIFYING THE EXHAUST OF INTERNAL COMBUSTION MOTORS.** (Procede perfectionne de purification des gaz d'echappement des moteurs a combustion interne). Text in French. (American Cyanamid Company, New York) French Pat. 1,539,444. 5p., Sept. 13, 1968. (Appl. Oct. 4, 1967, 5 claims).

The elimination of lead products from the exhaust of gasoline motors is improved by means of prolonging the life of the lead-sensitive catalyst. This is accomplished by providing another catalyst, which promotes the formation of sulfur dioxide from the other oxides of sulfur present in the exhaust. The sulfur dioxide then reacts with the volatile lead compounds to form less volatile compounds, after which the exhaust gases are brought in contact with a purifying catalyst which converts the products of incomplete combustion into carbon dioxide and water. A preferred formula for the first catalyst is a mixture of 7-9% vanadium oxides, 10-15% potassium oxides, 20-30% of a substance yielding sulfate ions, and a silicon base. The vanadium can be replaced by other noble metals, and any pyrosulfate of an alkali metal can be used, provided it melts at a reasonably low temperature.

26269

Pitts, J. N., Jr.

**ALDEHYDES, POLYNUCLEAR AROMATIC HYDROCARBONS, AND ATMOSPHERIC LEAD.** In: Project Clean Air. California Univ., Berkeley, Task Force No. 7, Section 5, 4p., Sept. 1, 1970. 7 refs.

Aldehydes, aromatic compounds, and lead compounds in automobile exhaust are discussed with reference to their photochemical reactivities. Aldehydes are far more reactive than aromatic hydrocarbons and constitute a noteworthy portion of exhaust. Lowering hydrocarbon emissions by increasing air-fuel ratio alone could result in substantial increases in aldehydes, but compromises in mixture ratio and spark timing would probably produce parallel reductions of both aldehydes and hydrocarbons. Removal of lead additives from gasoline with concommitant increases in monocyclic aromatic compounds might lead to an increase in polynuclear compounds and also increased photochemical reactivity of exhaust. While neither polynuclear compounds nor aldehydes are presently associated with health problems, the former have carcinogenic properties and the latter may play a synergistic or antagonistic role in tumor induction. When irradiated, certain inorganic compounds produced by leaded fuels may produce lead oxides that in turn catalyze or photosensitize the oxidation of gaseous pollutants. Aspects of smog chemistry requiring additional research are noted.

26532

Honma, Katsunori

**COLLECTION EFFICIENCY OF RESIN-TREATED FILTER MATERIALS FOR METALLIC FUMES.** (Jushishori rozai no kinzokufyumu ni taisuru hoshuritsu). Text in Japanese. Sefuti Daijesuto (Safety Dig.), 16(3):12-19, March 1970.

The Micron-Filter and Electro-Filter are electrostatic filters that are made of wool treated with resin. Laboratory experiments were conducted in order to measure their collection rates according to particle size for lead, zinc, and antimony fumes. The filters are not only effective against mineral dust particles, but also many types of metallic fumes. Thus any differences in collection rates for mineral dusts and metallic fumes should be attributed not to the quality of particles, but to the effects of particle size. For multi-dispersive lead fumes, the collection rate for Micron-Filter was on the average 98.5%, and 99.7% for Electro-Filter at 5 cm/sec. With a dust mask made out of these materials, the lead fume concentration will be below the allowable concentration of 0.15 mg/cu m.

26600

**HOMESTAKE POLLUTION CONTROL.** Mining Mag. (London), 124(1):26-27, Jan. 1971.

Among the innovations claimed for a new smelter producing approximately 100,000 tons of lead concentrate annually is updraft sintering. By blowing a draught of air upward, rather than downwar through the sintering machine, higher lead-content sinter is produced, more sulfur is removed, lead is eliminated in windboxes, and the gas produced is suitable for direct conversion to sulfuric acid. The sulfur dioxide gas from the sinter machine is filtered through a six-compartment baghouse to eliminate dust and metallic fume impurities, cooled in a tower packed with ceramic rings to eliminate excessive water vapor, then passed through an electrostatic precipitator where any remaining fume and dust are removed along with any acid mist. Conversion of the purified SO2 to SO3 takes place on a vanadium pentoxide catalyst; the SO3 produced is absorbed in sulfuric acid. In addition to dust from the sinter machine and primary crushers, the baghouse also handles smoke from two lead blast furnaces and a dross reverberatory furnace. Overall dust and fume recovery is estimated to be in excess of 99%, and there is no visible plume from the stack.

27371

Moran, John B. and Otto J. Manary

**EFFECTS OF FUEL ADDITIVES ON THE CHEMICAL AND PHYSICAL CHARACTERISTICS OF PARTICULATE EMISSIONS IN AUTOMOTIVE EXHAUST. INTERIM REPORT.** Dow Chemical Co., Midland, Mich., Organic Chemic Dept., Contract CPA-22-69-145, 169p., July 1970. 2 refs. NTIS: PB 196783

A research program is reported that is intended to develop methods of generating, collecting, and analyzing particulates in automotive engine exhaust by a means sufficiently accurate and reproducible to allow determination of the effects of fuel additives on exhaust particulate size, concentration, and composition. It was determine that it is essential to condition the clean (new) engine with the test fuel for a period of at least 75 hours under cycled conditions before stable gaseous and particulate emissions are achieved. An air dilution chamber was designed which allows for cooling, dilution, and mixing so that representative particulate samples can be obtained at a sampling station which is essentially equivalent to 8-10 feet downstream of the end of the exhaust pipe on a vehicle at highway speeds. Temperature of the diluted exhaust at the sampling station is around 110 F. The work reported was conducted using a 1970 Chevrolet 350 CID engine of 9.0:1 compression ratio with a standard exhaust system attached, loaded by means of an engine dynamometer. Sampling was conducted with the engine operating at 2250 RPM and 17.0' Hg manifold vacuum from 4 of the 8 cylinders. A few sampling runs were conducted under mild cycled conditions consisting of several cruise modes. Special analysis techniques were developed for the analysis and characterization of exhaust particulates. The details of these techniques are included From studies with an anti-knock compound (tetraethyl lead), lead scavengers, and a detergent additive (DMA-4A) showed that increased concentration of TEL from trace levels to intermediate levels (1.5 ml/gal) produces an unusual increase in hydrocarbon emissions buildup and in combustion chamber deposits but a small increase in particulate emissions. Additives which effectively remove reaction products from the combustion chamber also reduce hydrocarbon emissions of the stable, conditioned engine but, as a result, increase particulate emission levels. It appears that, in effect, the presence or absence of TEL and scavengers does not substantially change the total amount of organic material present in all collected particles, but the percentage organic is much higher for low TEL fuel runs because the mass of particles emitted is much lower, probably because the essentially same base fuel is used for all runs.

27503

Morse, Tony

**CLEAN AIR: IT'S UP TO OIL MEN, SAY CAR MAKERS.** Engineer (London), 230(5951):14, Feb. 12, 1970.

American car manufacturers claim that they have cut pollution drastically through engine design changes and hardware devices. In appealing to the oilmen to produce a lead-free gasoline, the chief of Atlantic Richfield announces that his company plans to sell lead-free gasoline in California by the end of 1971, providing the motor companies can produce an engine which will run on it. Accepting that lead alkyls are essential at present as an antiknock agent, there are four good reasons for eliminating, or at least reducing the tetraethyl lead and tetramethyl lead additives. Health hazards are one argument against them, while they also tend to deactivate the catalysts used in pollution control systems. Tetraethyl lead tends to inhibit hydrocarbon oxidation in the combustion chamber, thus increasing hydrocarbon emissions. Lead and/or lead scavengers used with tetraethyl lead detract from lubricant performance and exhaust system durability. The problem in Britain is small compared to the U. S., with tetraethyl lead additions at about 2 ml/gal as compared with up to 4 ml/gal. However, recent studies on carbon monoxide in city centers show that there is a marked fall-off in driver reaction in summer congested traffic. Volatility directly affects vehicle efficiency and also the evaporative emission control devices. Olefin content is also important, but engine combustion produces reactive olefinic compounds even when they are absent from the fuels.

27824

Jesser, Benn W.

**AIR RESOURCE MANAGEMENT IN THE PETROLEUM INDUSTRY.** American Inst. Chemical Engineers, New York and American Society of Mechanical Engineers, New York, Proc. MECAR Symp. Design and Operation for Air Pollution Control, New York, 1968, p. 26-31. Oct. 24.

By the end of 1968, the petroleum industry will have expended over a billion dollars in three years for air and water conserva-

tion. Of the $380,000,000 earmarked for 1968, 45% is for air pollution control, 55% for water pollution control, and 8%, or 28.4 million dollars, for research and development. Technology is available to solve the problem of the projected rise in sulfur dioxide emissions but it is not economic at this time and continued research of considerable magnitude will be necessary to the solve the problem. It can be hoped that controls restricting the sulfur content of oil to 1% or 0.3% will not be applied on a nationwide basis before the industry can develop commercially feasible flue gas and fuel desulfurization processes. With regard to desulfurization of fuel, the industry is at the threshold of commercial success, though the costs of desulfurization may increase the cost of fuel as much as 25-30%. Also under development are means and mechanisms for controlling lead and nitrogen oxide emissions from refineries. The means are already available for controlling particulates, carbon monoxide, and hydrocarbons.

27850

**WILL THE NEW GASOLINES LICK AUTO POLLUTION? Consumer Repts., 36(3):156-159, March 1971.**

This year, the auto industry reduced compression ratios and made other modifications in most of the 1971 engines to allow the use of lower-octane gasoline. This in turn has permitted oil companies to reduce or eliminate lead in some of their gasolines. Criticisms leveled at the new engines and gasolines include the charges that they may increase other atmospheric pollutants through decreased efficiency and fuel economy, produce hydrocarbon emissions that react more readily with sunlight to form smog, or cause valve recession. Some ecologists are also concerned about the environmental effects of phosphorus-containing additives being used as substitutes for lead. The validity of these charges is examined. It is concluded that low- or no-lead gasolines are only a very small step in the direction of a 'clean' engine, which, in any case, should be only an intermediate goal. What the country clearly needs are alternatives to the automobile, not just its engine.

27876

Wishart, Donald J.

**CONTROL OF HARMFUL EMISSIONS FROM ENGINE EXHAUSTS.** SAE Australasia, 39(6):205-207, Nov.-Dec. 1970.

The recent Australian Senate Select Committee report on air pollution indicates that every one pound of gasoline burned in cars, roughly one half pound of harmful products is discharged. Per pound of gasoline these products include 0.417 lb carbon monoxide, 0.042 lb hydrocarbons, 0.014 nitrogen oxides, and 0l002 lb others such as sulfur and lead compounds. Formation of carbon monoxide depends almost entirely on the ratio of air to fuel. If the mixture is rich there is not enough oxygen for complete oxidation of the carbon of the fuel. Causes of unburned hydrocarbons include flame quenching, the use of richer than stoichiometric mixtures, use of a fuel with too high a final boiling point, precombustion reactions, and misfiring. Nitric oxide concentrations in exhaust gases are related to peak combustion temperature, the lower the temperature the lower the NO concentration. A typical series of curves of air/fuel ratio versus CO, HC, and NO concentrations in exhaust gas are presented. Operation at eigher a rich or lean mixture is mentioned, as well as use of the Wishart split cycle. Because the Wishart cycle is particularly emenable to stratified combustion, lean mixtures can be used with resultant complete oxidation of the fuel to carbon dioxide and water. The split cycle engine operates on lead free fuels so that this source of air pollution is eliminated. Results of emission tests are mentioned.

28059

**BILL PROPOSED FOR THE LIMITATION OF THE LEAD CONTENT IN FUELS FOR OTTO ENGINES.** (Der Gesetzentwurf zur Begrenzung des Bleigehalts von Ottokraftstoffen). Text in German. Erdoel Kohle (Hamburg), 24(1):55-56, Jan. 1971. 14 refs.

A bill has been proposed which limits the lead content in fuels for Otto engines to 0.4 g/liter. It is to become effective in Jan. 1972, while a further reduction of the lead content to 0.15 g/liter is proposed for the beginning of 1976. However, the oil industry does not see itself able to meet this deadline, as new processes and new plants would be needed. The bill blocks any processes which would substitute other toxic substances for lead, and a fine is to be levied for disregard of the law.

28060

Seidel, Guenther H.

**MAINTENANCE OF CLEAN AIR. THE CONTRIBUTION BY THE MINERAL OIL INDUSTRY.** (Reinhaltung der Luft. Der Beitrag der Mineraloelwirtschaft). Text in German. Energie Tech., 23(1): 6-9, Jan. 1971. 1 ref.

The mineral oil industry is closely linked to the automobile industry, and any measure taken to curb exhaust emissions is reflected in the former. With the introduction of closed crankcase ventilation, the oil industry began production of oils with a five fold increase of alkalinity and which were better able to counteract cold sludge formation. The industry also had to produce new fuel additives for combating carburetor fouling. Presently, the oil industry is hard to work to produce lead-free fuels, but does not appear to be able to accomplish this without some drop in octane number. While the oil industry has succeeded in producing soot suppressing additives for diesel fuels, it has not avoided long term deposition on nozzles and in th combustion chamber. As a consequence, the combustion process is disturbed and more soot is produced than before.

28108

Rayzacher, B.

**PETROLEUM REFINING AND UTILISATION: EFFECTS ON THE ENVIRONMENT.** (Le reffinage et l'utilisation du petrole et l'environnement). Tex in French. Ann. Mines, (Paris), no. 11:45-54, Nov. 1970. 11 refs.

The energy consumption of Western Europe in 1965 amounted to 7.9 trillion kcal. It is estimated that this figure reached 9.4 trillion in 1970 and will be 15 trillion in 1980. In recent decades, petroleum has been replacing coal as a source of power. In 1965, 45.3% of the power used came from coal, and 42.4% from petroleum products. By 1980, it is predicted that petroleum will be the source of 58.8% of the power, and coal only 13.7%. During the same period of time, nuclear power is expected to increase from 0.7% to 10.4%, the latter figure corresponding to an output of 100,000 MW from nuclear generators in 1980. Figures are given of the number of petroleum refineries in Italy, West Germany, France, Great Britain, the Netherlands, and Belgium, together with their total production capacities. The average capacity of the European refinery is 3.73 million tons per year, slightly above that of the United States. The Pernis refinery in the Netherlands, the largest in the world, produces 25 million tons per year. A study of pollution due to escaping odors, in which half the European refineries participated, found that about 85% or more of such odors escaping from storage tanks could be eliminated by proper maintenance of pipe connections. The distillation units are an important source of odors, a condition that can be corrected by installing condensers in new plants, while in existing plants

the situation can be improved by the installation of screens and by the extracting and burning of gases that cannot be condensed. A number of industries have sought a solution to sulfur dioxide pollution by building high smokestacks, 150 meters or more in height. One recently installed European plant built a chimney 213 meters high, costing 4.6 million dollars, which receives the combustion fumes from 24 furnaces and 14 boiler plants. Proper adjustment of carburetor and ignition by individual automobile owners would reduce air pollution from automobile exhaust by as much as 50%. The estimated cost of a new antiknock additive to replace tetraethyl lead in gasoline is 2.1 cents. It has been estimated that Africa alone contains sufficient low-sulfur petroleum sources to meet all the needs of European consumption.

28172

Miura, Mitsugu

**NEW TYPE OF DUST COLLECTING AND DESULFURIZATION EQUIPMENT.** (Shinkeishiki no shujin datsurya sochi). Text in Japanese. Sangyo Kogai (Ind. Public Nuisance), 7(1):12-21, Jan. 1971.

A new gas scrubbing and dust collecting apparatus is described that uses much less water than traditional equipment. The device is a cylinder into which gas is introduced tangentially at 20 m/sec and through which the gas rises at the same speed. As the gas swirls through the cylinder, a film of water at the bottom is dispersed as a fine spray to contact dust and sulfur dioxide contained in the gas. The liquid containing the dust and that containing the SO2 are separated by the motion of the gas. A three-stage version of the device, which is essentially a cyclonic venturi scrubber, reduces the floor space required by an SO2 absorption tower to 1/10 that of conventional towers. The apparatus can also be used with mixed fumes of aluminum chloride, ammonium chloride, hydrogen sulfide and SO2; mixtures of sulfur trioxide and sulfuric acid mist; tar mist; ferrite particulates; oxidized lead fumes, and other exhaust pollutants.

28286

North American Rockwell Corp., Canoga Park, Calif., Atomics International Div.

**DEVELOPMENT OF THE MOLTEN CARBONATE PROCESS TO REMOVE LEAD AND OTHER PARTICULATES FROM SPARK IGNITION ENGINE EXHAUSTS.** Contract CPA 70-3, AI-70-47, 57p., July 8, 1970. 62 refs. NTIS: PB 194132

The effectiveness of a molten alkali carbonate eutectic in removing lead compounds from gaseous mixtures was investigated. Test results showed that the size of the lead chloride particulates produced in laboratory generation experiments approximated those found in automobile exhaust. Increasing concentrations of lead chloride vapor produced particulates of larger average size. Both impingement of the gas on the molten salt surface and contacting the gas with molten salt wetted-mesh scrubbers were effective lead removal techniques, a finding confirmed by field testing on an automobile with a preliminary molten carbonate device. The lead removal efficiency is a wetted-mesh scrubber increased as the gas residence time in the wetted mesh increased, decreased as the gas velocity through the mesh increased, increased as the melt temperature decreased, and was essentially independent of the lead particulate concentration in the gas stream. The results also indicated that the fraction of lead removed after impingement against a molten salt surface increased as the impingement velocity increased and that removal by impingement is more effective as the temperature decreased. Control of lead emissions by this technique would be a technical and an economically feasible (less than 1 cent/gal) alternate to prohibiting the use of leaded gasoline. Has the added advantage of simultaneously reducing inorganic and organic particulates, sulfur oxide and nitrogen oxide emissions. (Author summary modified)

28377

Middleton, John T.

**PLANNING AGAINST AIR POLLUTION.** Am. Scientist, 59(2):188-194, March-April 1971.

Major sources of air pollution and methods used for its measurement and control are summarized. The automobile accounts for more than half the hydrocarbons, nearly half the nitrogen oxides, and two-thirds of the carbon monoxide that are released into the air of the United States each year. It is also the chief source of lead in the atmosphere. Some hydrocarbons are toxic in themselves, and other participate in a series of reactions with the oxides of nitrogen to form 'oxidants'. These products cause eye irritation, allergenic responses, reduced work performance, depressed mitochondrial activity, and destructive effects on vegetation, polymers, and other materials. Pollution control standards for the elimination of automobile emissions are indicated, as well as the efforts of the Clean Air Act of 1967 and its amendments to reduce emissions from stationary sources. The sulfur oxide problem is discussed, and energy-producing techniques are mentioned. By itself, undifferentiated particulate pollution--from parricles under 500 micron in diameter--can injure surfaces within the respiratory system and affect climate, visibility, building materials, textile fibers, and vegetation. Effects of pollution on the weather and the role of meteorological conditions to produce photoehemical smog are reviewed. Simulation modeling is discussed, as well as a zoning plan under study in Chicago, and the broader role of the scientist.

28699

Russell, D. R.

**AIR POLLUTION AND THE MOTOR VEHICLE--WHAT NEXT? Petrol. Rev., 25(291):103-113, March 1971. 59 refs.**

Emission control systems for gasoline powered vehicles follow two basic principles: to prevent the pollutant from forming, and to destroy the pollutant after formation. The first principle entails making various modifications to the induction system and combustion chamber to enable the engine to run acceptably at weak mixtures; the second principle involves injectio of additional air into the exhaust manifold so that the oxygen-deficient gases leaving the combustion chamber undergo further oxidation in the exhaust manifold. Legislation concerning automobile emissions of hydrocarbons, carbon monoxide, and nitrogen oxides is mentioned for both the United States and Europe. Control of blow-by emission is possible using a crankcase ventilation system which feeds the gases back into the induction manifold to be consumed in the engine. Control of evaporative losses when the car is stationary is achieved either by absorption in a charcoal filled canister or by storage in the crankcase where the gasoline vapors can be partially absorbed in the engine oil. Stored vapors are then ducted to the intake manifold where they can be consumed during subsequent engine operation, together with the hydrocarbons evaporated while the engine is running. Exhaust emission control systems may rely on improved mixture distribution, improved combustion conditions, or an exhaust manifold air injection system. Future emission control is discussed, as well as methods to obtain maximum power from the engine. Catalytic devices are mentioned, and particulate control is reviewed. Alternative power sources which are indicated in-

clude turbines and electric cells. Fuel quality and the reduction of lead are cited. Alternative fuel systems being investigated in the U. S. include compressed natural gas, liquefied natural gas, and liquefied petroleum gas.

28730

Yokohama City Health Bureau (Japan)

**AUTOMOBILE EXHAUST GAS COUNTERMEASURE WHICH MADE THE START - ENVIRONMENTAL STANDARD ON CARBON MONOXIDE DETERMINED.** (Ugokitashita jidosha haiki gasu taisaku--Issanka tanso kankyo kijun kimaru). Text in Japanese. Kenko na Hama (Healthy Hama), no. 34, 4p., May 1970.

Automatic exhaust gas monitors will be set up at 4 points in Yokohama City, and the measured concentration of exhaust pollutants will be telemetered to a central station. The environmental standard for carbon monoxide is less than 20 ppm for 8 successive hrs and less than 10 ppm for 24 successive hrs. To maintain these standards, carbon monoxide emissions during idling are set at 5.5% for small cars; 3.0% for light vehicles; and less than 1.5% for LPG cars. Used cars can pass these requirements through carburetor adjustment. The telemeter system in Yokohama will relay information not only on carbon monoxide, but also on hydrocarbons, nitrogen oxides, and dust. At the central station data processing equipment will analyze hourly changes in concentrations, minimum and maximum averages and whether or not the value is within the environmental standard. In addition to the telemeter system, measurement cards will travel around the city, automatically recording four items; carbon monoxide, hydrocarbons, dust, and nitrogen oxides. Sulfur dioxide and wind direction and velocity will also be measured. All the vehicles used by the city, health centers, and hospitals are equipped with catalyst-type exhaust gas purification devices. Since 1966, about 300 privately owned cars have been equipped with exhaust gas purification devices. Pollution rates measured at busy intersections are reported to the Ministry of Health and Welare, which confers with the Ministry of Transportation over the control of emissions of from new and old cars. Some intersections in Yokohama have exceeded the 20 ppm level. However, the environmemtal standard for lead, tentatively 5 micrograms/cu m, is not often exceeded.

28860

Musser, G. S., J. A. Wilson, R. G. Hyland, and H. A. Ashby

**EFFECTIVENESS OF EXHAUST GAS RECIRCULATION WITH EXTENDED USE.** Preprint, Society of Automotive Engineers, Inc., New York, 32p., 1971. 5 refs. (Presented at the Automotive Engineering Congress, Detroit, Mich., Jan. 11-15, 1971, Paper 710013.)

A program was conducted to study the long-term operability and effectiveness of exhaust gas recirculation (EGR) as part of the complete emission control system and its effect on engine durabilit Basically, the recycle gas is taken from the exhaust system immediately before the muffler and introduced into the carburetor just above the throttle plates. Introducing the exhaust gas above the throttle plate results in a relatively constant ratio of recirculated exhaust gas to carburetor inlet air. Recirculation is turned off below about 20 mph cruise and on deceleration; since throttle position is used for control, exhaust gas recirculation is present under all acceleration modes. The amount of recirculation was established by the amount needed to give an initial oxides of nitrogen level below 750 ppm or by the maximum recirculation with acceptable driveability. During the 52,000 test miles, engine wear and cleanliness were normal with exhaust gas recirculation; vehicle performance with EGR did not decay. However, the throttle area and exhaust valves were found to be sensitive to leaded fuels. An observed higher than normal standard deviation of hydrocarbon emissions was probably due to either highly transient exhaust valve leakage or highly transient spark plug bridging. Compatible with air injection and engine modification systems for HC and carbon monoxide control, EGR effectively reduced the NOx levels with no decrease in reduction over the 52,000 miles.

28865

Allen, R. R. and C. G. Gerhold

**CATALYTIC CONVERTERS FOR NEW AND CURRENT (USED) VEHICLES.** Preprint Air Pollution Control Assoc., Los Angeles, Calif., West Coast Section, 45p., 1970. 8 refs. (Presented at the Air Pollution Control Association, West Coast Section, Technical Meeting, 5th, San Francisco, Calif., Oct. 8-9, 1970.)

In the last decade, Universal Oil Products has invested more than $10,000,000 in research and development directed specifically toward the problems of reducing air pollution produced by automobiles. This program has resulted in the development of a number of practical catalytic exhaust converter devices and suitabl catalysts to be used with them. Converters are part of the total vehicle system, however, and each of several parts must be in harmony with the whole to achieve optimum results. The three principal components from the point of view of exhaust emission control are: the UOP catalytic converter with three-component control catalyst, the engine mixture ratio adjusted to an air-fuel ratio centered around stoichiometry, and unleaded gasoline. UOP's catalytic converter reduces the oxides of nitrogen and oxidizes the hydrocarbons and carbon monoxide into water and carbon dioxide in a single unit. Lead removal in and of itself lowers hydrocarbon emissions by 20-50 ppm, and decreases pollution-causing cylinder deposits by approximately 70%. Other advantages are cited, and costs are discussed. The Cost Effectiveness Index for the UOP system is shown to be -$.046 per vehicle over ten years for each equivalent reactive ton of pollutants removed per day.

29058

Yamanaka, Tatsuo

**UTILIZATION OF CATALYST IN AIR POLLUTION CONTROL (3).** (Kogai boshi gijutsu ni okeru shokubai no riyo - 3). Text in Japanese. Kagaku Kogyo (Tokyo), 22(4):534-539, April 1971.

The use of catalysts for removal of nitrogen oxides discharged from nitric acid plants and for air purification purposes and the effects of leaded gasoline on the catalysts are discussed. In connection with the use of a catalyst for removal of NOx, the following points should be given careful consideration: selection of catalyst type (pellet or honeycomb); minimization of oxygen content in gas fuel; selection of a one-stage or two-stage purification process; and desulfurization of fuel to avoid deterioration of the catalyst. The removal efficiency of NOx is higher when the temperature of gas at the exit is high. Therefore, the one-stage process is preferable in NOx only is to be removed from the emission gas. The two-stage process provided with a cooling device between the first and second stages is used when the temperature should not be very high. An example is the nitric-acid tail-gas purification system. For air purification, platinum or palladium catalysts that can function at lower temperatures are used. For removal of hydrocarbons or other organi compounds iron cobalt copper or Manganese oxide with Pt or Pd is used as the catalysts. A heat

exchanger or a damper is incorporated in order to avoid lowering the temperature of the catalyst layer. The basic mechanisms of the catalyst-type air purifier are described. Experimental observations show the Pt or Pd catalyst to be adversely affected by zinc, silver, cadmium, tin, mercury, lead, or bismuth only when water content is present in liquid form, never when in gaseous form. The adverse effects were most conspicuous at low temperture ranging from 50 to 90 C. When the temperature was high, these harmful metals were neutral, producing no adverse effects on the catalyst. In an experimet in which the catalyst was kept in contact with lead at 200-300 C for 5 hours, the catalyst was unaffected This suggests that deterioration of the catalyst used in an automobile can be prevente if the lead compound and water content are immediately driven out by air blown in before the catalyst layer cools after the engine stops.

29126

Rinehart, W. E., S. A. Gendernalik, and L. F. Gilbert

**FUEL FACTORS IN AUTOMOTIVE TAILPIPE EMISSIONS.** Am. Ind. Hyg. Assoc. J., 32(3):179-187, March 1971. 25 refs.

Fuel factors affecting tailpipe emissions are surveyed on the basis of existing published information and unpublished research data. Special emphasis is given to the proposed use of nonlead fuels and the effects of removal of lead antiknocks on tailpipe emissions. A nonleaded low-octane fuel used in low-compression engines adjusted for optimum driveability might be expected to yield, at the tailpipe, 5-10% more carbon monoxide, 10-14% more aldehydes, and 25% less particulate matter. Since automotive particles are only 4% of the total atmospheric particulate load, the overall improvement resulting from the removal of lead antiknocks is of questionable significance. Aromatic-enriched fuels of the present octane number, but without lead antiknocks, will greatly change the character of hydrocarbon emissions. Reactive components will increase by 38%, aromatic aldhydes by 70%. There will also be a large increase in polynuclear aromatics. It is concluded that removal of lead from automotive fuels is not a satisfactory approach to the emissions problem.

29204

Sasaki, Kiyomi, Minao Kurihara, Shigeru Yazaki, and Katsuhiko Aizawa

**EXHAUST GAS PURIFIER MUFFLER FOR INTERNAL COMBUSTION ENGINE.** (Nainenkikan yo haiki joka mafura). Text in Japanese. (Tokyo Roki K. K. (Japan)) Japan. Pat. Sho 46-1203. 4p., Jan. 13, 1971. (Appl. April 8, 1964, claims not given).

An exhaust gas purifier muffler is presented which features the use of two or more separate layers of catalyst, each layer packed in a separate container very close to each other. The device comes in an encased unit and has, for example, two layers of catalyst parallel to each other at the center of the unit. Spaces below and above the catalyst layers are provided for preheating. The exhaust gas is taken in through the intake port under the catalyst layers and flows up through the lower layer and then the upper layer, then the lower layer again, down to the lower preheating chamber, and goes out through the discharge port. With a conventional single-layer system, catalyst balls or pellets deteriorate during activity as a result of the absorption of lead compounds from the exhaust gas. Those still active tend to mix with each other because of the engine vibrations, thus lowering efficiency of the catalyst as a whole. The new device performs oxidation and decomposition of harmful combustibles contained in the exhaust gas first in the first layer and then in the second layer. Since each layer comes in a separate container, the layers will not mix, thus avoiding the above-mentioned defect of efficiency drop. Installed close to each other, the two layers can be kept at practically the same temperature for effective performance. The catalyst in each container can be easily replaced. A compartment containing a chemical to remove lead compounds from the exhaust gas may be provided prior to the first catalyst layer.

29414

Stoefen, Detlev

**WHICH FUEL WILL REPLACE LEAD-CONTAINING GASOLINE? (Welcher Autotreibstoff wird das verbleite Benzin abloesen?). Text in German. Staedtehygiene (Uelzen/Hamburg), 22(4):88-91, 1971. 12 refs.**

Alcohol olefins and aromatic hydrocarbons such as benzene, toluene, and xylene could theoretically be used as antiknock agents instead of the toxic tetraethyl lead. Alcohol slightly increases the antiknocking property. Olefins are good antiknock agents but more expensive than gasoline. Both substances pose little danger to human health. Aromatic hydrocarbons, however, are extremely hazardous. Much higher quantities than tetraethyl lead must be mixed with gasoline. In the Federal Republic of Germany, the tolerance limit for long-term emission concentrations for benzene is 3 mg/cu m; for toluene and xylene, 20 mg/cu m. The Soviet Union has set a maximum emission concentration limit of 0.8 mg/cu m for benzene. Tests on 5 persons showed that a benzene vapor concentration increase from 1 5 to 2 mg/cu m, a toluene vapor concentration increase from 0.6 to 1.0 mg/cu m, and a xylene vapor concentration increase from 0.21 to 0.32 mg/cu m suddenly changed the electroencephalogram. The potentials dropped in the case of benzene and toluene and rose in the case of xylene. The addition of aromatics to gasolines is not tolerable because of their toxicity. Exposure of female rats to 1 mg benzene/cu m changed their pregnancy duration, and affected the number and health of the newborn rats.

29531

Tomizuka, Kiyoshi

**EMISSIONS FROM INTERNAL COMBUSTION ENGINE.** (Nainen kikan no haiki) Text in Japanese. Japan Society of Mechanical Engineering, Tokyo, Proc. Special Symp. Air Pollution, 27th, 1971, p. 43-53. 6 refs. (April.)

Effective solutions to the problems of noxious gas emissions from the internal combustion engine can be found in the prewar technological achievements in the engineering aspects, some of them developed as early as the 1900s. Prior to the use of lead- containing fuel that started only 40 years ago, the internal combustion engine operated successfully. It was recently argued that the de-leading of automotive fuel caused a serious problem of valve recession. The problem is reportedly solved by the use of a valve seat of heat-resistant steel. To check possible performance deterioration due to the octane value drop resulting from gasoline de-leading, one of the most effective solutions is removal of the hot spot from the combustion chamber of the engine. The sleeve valve system which was popular with automobiles up to 1925 and now forgotten by most auto engineers of today should be pointed out as the solution. Another possible solution is the use of mushroom-shaped exhaust valves. It is also feasible to develop a non-emission, non-pollution engine. The principle of this engine is very simple; oxygen and hydrogen are used as heat-generating compounds while an inert gas like argon is used as diluent. However, both oxygen and hydrogen are expensive at present and bulk for carrying, but they can be liquefied and carried in

a vacuum bottle to save bulkiness. Several other suggestions to solve the emission problems were given.

29605

Meyer, W. E.

**TRANSPORTATION EMISSIONS.** Pennsylvania State Univ., University Park, Center for Air Environment Studies. Proceedings of the Annual Conference on Air Pollution Control Engineering Aspects, Allentown, Pa., 1971, p. 1-19. 4 refs. (Paper 202-71.)

As things presently stand, the emissions from all means of transportation other than the automobile are minimal, and even their effects on the environment are negligible, except perhaps in specific locations, such as in the neighborhood of busy airports or railroad switchyards. Exhaust emissions per automobile before controls were 16.8 g/mi hydrocarbons, 125.0 g/mi carbon monoxide, and 4.0 g/mi oxides of nitrogen; the proposed standard for 1976 and the following years calls for 0.46 g/mi hydrocarbons, 4.7 g/mi carbon monoxide, and 0.4 g/mi oxides of nitrogen. All alternatives to the internal combustion engine are going to be significantly more expensive. Blowby and evaporation contribute only hydrocarbons to the atmosphere since no combustion is involved. When the fuel-air mixture is rich, not enough oxygen is available to permit all fuel molecules to oxidize completely, and carbon monoxide and hydrocarbons appear in the exhaust. With lean mixtures some of both will still be present because the mixture is not perfectly homogeneous and because combustion is inhibited when the flame reaches the comparatively cold combustion chamber walls. Various control methods and the problems associated with them are cited. Fuel injection, catalysts, water and alcohol injection, the elimination of lead in fuels, electric propulsion, Wankel engines, and other control methods are included.

29625

Zeitz, A. H.

**FUTURE OF GASOLINE WITH LEAD ANTIKNOCKS.** Mining Congr. J., 57(3):39-45, March 1971. 12 refs.

Lead antiknock compounds are essential ingredients of today s motor gasoline and are used in over 98% of these fuels. The use of lead allows gasoline to be manufactured to today s quality standards at a cost saving of 1 1/2 to 6 cents per gallon at the refinery level. Restrictions of antiknocks would require a substitution which would result in increasing the aromatic content of gasoline in order to maintain octane ratings. Increased concentrations of aromatics in the fuel would increase photochemical smog, as well as increase the eye irritating effect of the exhaust, and perhaps bring about a risk of increasing polynuclear aromatics. Aldehydes decrease in the presence of lead antiknocks, while premature valve damage occurs with unleaded gas.

29628

**LAW-MAKERS SAY: CLEAN UP OR SHUT DOWN.** Can. Chem. Process., 55(4):47-50, April 1971.

The major push by the Canadian government to control air pollution will surely come once Parliament approves Bill C-224, the Clean Air Act. Under the Act, air polluters may be fined up to $200,000 per instance of violating one or more of the emission standards to be set by the Federal government. Also, the Act will empower federal authorities to fine any pollution source regardless of location; this is a major departure from current federal/provincial division of powers. Controlling the fumes from coking is mentioned, as well as regulations pertaining to the emissions from petroleum refineries, lead-in gasoline, automotive emissions, and aircraft exhaust smoke. Processes for the removal of sulfur dioxide are listed tabularly. The British Columbia government has offered a prize of $250,000 for the first individual or company to come up with a device to eliminate air pollution and odor of pulpmills.

29656

Teshirogi, Naohisa, Teiichi Ozaki, Yoshitada Uchiyama, and Nobuyuki Watanabe

**AN EXPERIMENT ON VALVE RECESSION BY NON-LEADED GASOLINE.** (Muen gasorin niyoru barubu riseshon nitsuiteno ichi jikken). Text in Japanese. Kenkyu Happyo Gaiyo (Abstr. Published Res.), p. 5, April 15, 1971.

Non-leaded gasoline, which lessens the public nuisance due to auto exhaust, has a problem of exhaust valve seat recession. Depending upon the engine design and operating condition, the seat wears abnormally and gives rise to an increase in pollutants and engine troubles. An air cooled two cylinder four cycle engine for light automobiles was studied. The exhaust valve was made of 21-4 N steel, and the seat from acicular cast iron. Non-leaded and regular gasoline were fed to each cylinder. At 50 hour intervals during the 130 hour operation, both cylinders were dismantled to check the exhaust valve and seat for abrasion, deposits, and a general pattern of wear. No valve recession was observed.

29664

Homma, Katsunori and Shigeharu Koshi

**COLLECTION EFFICIENCIES OF GLASS FIBER FILTERS FOR EACH SIZE OF LEAD AEROSOLS.** (Garasu sen iroshi no namari-ryushi ni taisuru ryudobetsu hoshuritsu). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc Air Pollution), 5(1):67, 1970. (Presented at the Japan Society of Air Pollution, Annual Meeting, 11th, Japan, 1970.)

The collection efficiencies of glass fiber filters for the sizes 0.22 micron to 0.05 micron of lead were studied. Four leading brand filters were used for the test. Although minor differences in efficiency were observed between these 4 filters, they gave satisfactory results for aerosol sampling ranging 99.7% to 100%.

29898

Yamanaka, Tatsuo

**UTILIZATION OF CATALYST IN AIR POLLUTION CONTROL (5).** (Kogai boshi gijutsu ni okeru shokubai no riyo (5) Text in Japanese. Kagaku Kogyo (Chem. Eng.), 22(6):809-814, June 1971.

Four different types of 2-5 m spherical grain catalysts, impregnated with precious metal, were tested in 8 cars driven in city streets and 8 driven on highways. Each group consisted of 4 gasoline-fueled cars and 4 fueled with liquid propane. Removal efficiency for carbon monoxide and hydrocarbons was measured at the time of installation and when the mileage run reached 20,000 km. The initial and after-20,000 km rates of reduction in the highway tests were 77% and 92% for CO and 77% and 52% for HC with the gasoline-fueled cars; rates in the propane vehicles were 98% and 81% for CO and 71% and 69% for HC. Removal efficiency of the catalyst for both CO and HC is lower after the car has been run for 20,000 km compared with that at the time of installation, although the ability to remove CO drops less than it does for HC. In fact, 8 of the 16 cars tested indicated a CO emission of less than 1% and 5 of the 8 gave a CO emission of less than 0.3%. The highway tests were continued up to 50,000 km and compared with the

urban-area tests. Most of the purification ability was lost with urban-area driving after 10,000 km, in the case of a gasoline-fueled car. It dropped after 40,000 km in highway driving; the purification efficiency was still higher than that after 10,000 km of urban driving. With an LPG car, the efficiency did not drop as much even when the car was driven in the urban area, indicating that deterioration is caused by the lead content of the fuel. Since the toxic action of the lead occurs when liquid water is present, it does not appear at high temperatures, where there is no water. However, at the catalyst temperature of 100 C or lower, as in low-speed driving, both the lead compound and liquid water are present, thus causing poisoning of the catalyst by the lead.

29920

Lowes, Frederick J.

**MUFFLER FOR REMOVING PARTICULATE LEAD FROM EXHAUST GASES OF INTERNAL COMBUSTION ENGINES.** (Dow Chemical Co., Midland, Mich.) U. S. Pat. 3,563,029. 5p., Feb. 16, 1971. 7 refs. (Appl. March 13, 1969, 8 claims).

A muffler adapted to remove particulate lead matter from engine exhausts is described. It comprises a canister commonly used with internal combustion engines, having an inlet port for receiving exhaust gases from the engine and an outlet port for discharging them to the atmosphere. The bottom wall of the canister slopes upward to form a sump portion adapted to contain a flux which is liquid at the temperature range of the exhaust gas stream. Compartments are formed in the canister by a weir and one or more baffles. The exhaust gas flow provides a driving force which continuously splashes the liquid flux against the baffle surfaces and compartment walls. Thus, the surfaces are coated with a flux film which entraps the lead particulate matter in the gases. The flow of the gas-liquid body into adjacent compartments is controlled by a slotted edge on the weir. Sodium hydroxide, potassium hydroxide, oxygen aids of phosphorus, or acid salts of phosphorus are suggested for use as the flux. (Author abstract modified)

30010

Becker, K.

**GASOLINE WITHOUT LEAD. TECHNICAL POSSIBILITIES FOR A NON-LEADED FUEL.** (Benzin ohne Blei. Technische Moeglichkeiten, Kraftstoffe nicht zu verbleien). Text in German. VDI (Ver. Deut. Ingr. Nachr.) (Berlin), 25(18):1-15, 1971.

Three of the various compounds which have been considered as replacements for tetraethyl lead as an anti-knock agent in gasolines are noted: iron pentacarbonyl, manganese carbonyl, and monomethylaniline. The first has been eliminated as an anti-knock agent because its combustion product, ferric oxide, causes extremely high engine wear. Manganese carbonyl has never been used because of its high price. The efficiency of monomethylaniline is about 55 times lower than that of tetraethyl lead. It also forms a large amount of residual matter in the intake system of the engine. One solution although an expensive one, is the production of a lead-free or low-lead gasoline with octane numbers between those of today s normal and super gasolines. This will be feasible within six years, according to the petroleum industry. Secondly, engines with larger piston displacement and less compression must be constructed. The tax based on piston displacement must be abolished to permit construction of larger engines.

30124

**LEAD SMELTING PLANT CONTROLS AIR EMISSIONS.** Environ. Sci. Technol., 5(4):304-305, April 1971.

In a secondary lead smelter where lead from old batteries is remelted and used to make new ones, odors from the smelting process are disposed of by incineration at 2400 F; lead oxide emissions and lead aerosols are trapped by baghouses; and sulfur oxide emissions are scrubbed with a venturi scrubber and mist eliminator. All water and acid from the operation in which the tops of old batteries are sheared off are collected, retained, and subsequently neutralized to eliminate acid before discharge to a water course. Old battery cases are crushed and used as landfill.

30154

Matsumoto, Keishin and Naoomi Yamaki

**STUDY ON THE PROCESSING TECHNIQUE FOR AUTO EXHAUST.** (Jidosha haiki gasu no shori gijutsu nikansuru kenkyu). Text in Japanese. Kokuritsu Kenkyuio no Kenkyu Seika (Researches of Government Research Inst.), no. 1:295-296, Dec. 1969. 7 refs.

Cobalt, iron, copper, manganese, and chromium oxide base catalysts were tested for activity, resistance to heat and lead compounds, and cost. Among the coprecipitated catalysts, copper oxides- magnesia-alumina (?) was found to be the best in the activity and heat resistivity. Among the infiltrated catalysts with an alumina carrier, a platinum or copper oxide base catalyst was effective. Four kinds of catalysts were prepared by blending two kinds of noble metals and were placed in a clarifier attached to 16 passenger cars of 2000 cc. A road test revealed that the performance of the clarifier for carbon monoxide depended on the running condition and fuels used. Drastic degradation of the catalyst was observed for gasoline vehicles, but medium degradation for liquefied petroleum gas for vehicles. A noble metal base catalyst was applicable to LPG vehicles, but the catalyst life must be improved before any catalysts can be applied to gasoline vehicles. The addition of five to 20% methanol to gasoline resulted in a considerable reduction in CO, but on some occasions an accompanying increase in hydrocarbons was observed. More study is needed for blending stability, vapor lock, or carburetor improvement before the methanol blended gasoline is put into practical use. An online data processing method was developed for the continuous gas analysis data obtained from chassis dynamometer tests.

30229

**PURIFICATION OF WASTE GASES IN THE PAINT INDUSTRY.** (Avgasrening vid lackering). Text in Swedish. Koy, vol. 4:30-31, 1971.

Waste gases from paint factories contain such impurities as lead, zinc, manganese, phosphorus, and large quantities of vaporized and cracked solvents. The most effective purification methods involve the oxidation of the waste gases, other methods, such as use of scrubbers, are not applicable. Two basic types of oxidation are used: catalytic and thermal. Catalytic afterburners operate in the temperature range of 250-400 C, depending on the composition of the gases. The most frequently used catalyst is a noble metal such as platinum, coated onto a ceramic base. For calculation purposes, one can assume an average lifetime for the catalyst of 14,000 hours. Approximately one liter of catalyst should be used for each 25 cu m/h gas flow, a figure that can vary depending on the composition of the gases. In cases where the use of a catalyst is undesirable, direct afterburning can be used; higher temperatures, in the range of 600-800 C, are required. It also is necessary for the waste gases to be maintained at such temperatures ofr a period of 0.4-10.0 sec. The catalytic process requires less initial investment in equipment than direct afterburning (about

$4-5./cu m waste gas, compared with $5-6.) Operating costs follow a similar pattern, but accurate figures are not available.

30498

Uchinuma, Kazuo

**ROLE OF ENGINE OILS FOR AUTOMOBILE EMISSION CONTROL.** (Jidosha haishutsugasu taisaku ni okeru enjinyu no yakuwari). Text in Japanese. Sekiyu Gakkai shi (J. Japan Petroleum Inst., Tokyo), 14(5):314-318, May 1971. 37 refs.

Many studies are now underway on possible effects of exhaust gas cleaning devices and the de-leading of gasoline fuel on engine oil, as the introduction of Positive Crankcase Ventilation (PCV) demanded innovations of the engine oil in the 1960 s. The Engine Modification System cannot adversely affect cleaners and the antirust of the engine oil, since the system reduces hydrocarbons and carbon monoxide promoting perfect combustion of the fuel. The problem is that the hydrocarbon emission is less with a higher temperature of the cooling water which naturally results in a higher temperature of the engine oil. Under high temperature viscosity of the engine oil increases due to oxidation. This indicates that, whereas the main problem in the 1960 s was how to improve the low-temperature performance of the engine oil, it will be how to improve the high-temperature performance in the 1970 s. The Manifold Air Injection System and Catalyst Converter System are not thought to adversely affect the engine oil. Exhaust Gas Recirculation System water, nitro,en oxides, and halogenated lead increase so that the cleanliness and antirust effect of the engine oil may be adversely affected. The adverse effect on the cleanliness of the engine oil can be removed by increasing the quantity of engine oil additive or changing the type of additive. Reports on the antirust effect are somewhat conflicting. De-leading of gasoline fuel also affects the engine oil, since the non-lead gasoline is causing abrasion of the exhaust valve seat of the engine. Use of high ash content series No. 3 oil was reported to have been effective in reducing the abrasion. The addition of a phosphorous compound to the gasoline is being studied as a possible solution to the abrasion problem. Studies in the U.S.A. report that de-leading of gasoline is either unaffecting or adversely affecting the engine oil; Japanese studies say the de-leading favorably affects the engine oil. Since the rusting and abrasion of a gasoline engine are chiefly caused by a lead- scavenging agent, the de-leading of gasoline clearly gives a favorable effect in avoiding the rusting and abrasion. In conclusion, more anti-oxidation agent will be added to cope with the engine oil temperature rise, cleanliness of the oil should continue to be maintained. The fuel de-leading makes rust prevention easier, while the addition of a metallic additive should be reduced to minimize deposits in the combustion chamber and deterioration of the catalyst.

30633

Daintry, S. H. and B. R. Brown

**THE COMBAT AGAINST ENVIRONMENTAL POLLUTION IN GREAT BRITAIN.** (Der Kampf gegen die Umweltverschmutzung in Grossbritannien). Text in German. Chem. Rundschau (Solothrun), 24(22):490, June 2, 1971.

The combat against air pollution has been going on for a long time in England. Combustion of mineral coal was prohibited in 1273. Drastic measures were taken only with the Clean Air Act in 1956. The act permits the authorities to measure the dust and soot quantities coming from furnaces. It is not, however, directed against the most noxious of the pollutants, sulfur dioxide. Research in the field of air pollution is primarily financed by public means. Four organizations conduct research in this field: the Warren Spring Laboratories, the Medical Research Council, the Atomic Energy Research Establishment, and the Central Electricity Generating Board. Automatic measurements are being conducted at more than 1200 sites distributed all over the country. The concentration of automobile exhausts in the air is not considered high. Also, the lead contents in the air are not considered high. Also, the lead contents in the air are not considered dangerous. The average concentration of automobile exhausts in the city of London during a typical winter day is about 100 mg/cu m. Smoke development in London has decreased since 1956 by 75% annually. The visibility in winter improved from 2.4 km to more than 7.3 km. The SO2 concentration decreased by 38%. This was achieved mainly by the construction of higher stacks. Sun radiation has increased in the months from November to January by 50%.

30717

Bauerle, George L., Gregg R. Service, and Ken Nobe

**CATALYTIC REDUCTION OF NITRIC OXIDE WITH CARBON MONOXIDE.** Preprint, American Chemical Society, Washington, D. C., 5p., 1971. 3 refs. (Presented at the American Chemical Society, Meeting, Los Angeles, Calif., March-April 1971.)

Heterogeneous catalytic reduction of nitric oxide in the presence of carbon monoxide was investigated. Reactions were conducted in a tubular pyrex reactor, fitted with eight thermowells spaced regularly at equal longitudinal increments. Immediately upstream of the reactor was a preheating chamber filled with pyrex beads and helices. Feed gases were mixed in a manifold equipped with micro-regulating valves and rotameters. Analyses were made using non-dispersive infrared instruments for determination of nitric oxide, carbon monoxide, and carbon dioxide. A flow colorimeter was used for determination of nitrogen dioxide. Gas chromatography was used for determination of oxygen, nitrogen, and nitrous oxide. Catalysts studied were copper-alumina, platinum-alumina, rhodium-alumina, ruthenium- alumina, copper chromate, copper-beta-spodumene, cerium oxide- alumina and sodium tunstate-alumina. Lead was also impregnated on copper oxide catalysts to determined its effect on catalytic activity. The catalysts showed a strong dependence of activity on the pretreatment technique. The presence of lead appeared to promote the CO-NO reaction.

30944

Miyamoto, T.

**SAFETY AND EMISSION CONTROL OF AUTOMOBILE AND SMOG.** (Jidosha no mujiko mukogaika to sumogu). Text in Japanese. Kagaku Kogyo (Tokyo), 22(8):1119-1123, Aug. 1971.

The emission standards for the cars to be produced after April 1973 are: carbon monoxide, less than 11 g/km, hydrocarbon evaporation, less than six g/day, hydrocarbon exhaust, less than 1.7 g/km, and nitric oxide, less than three g/km. A measurement method for black smoke from diesel engines will be developed and decreasing standards will be set. For cars produced after April 1975: the standards will be CO, less than seven grams/km, hydrocarbons less than 0.3 g/km, NO, less than 0.6 g/km, and particulates, less than 0.06 g/km. One method of controlling exhaust gases completes the combustion of fuel to limit the generation of CO, hydrocarbons, nitrogen, oxides, and lead dioxide, another method makes the exhaust harmless before it is released to atmosphere. For CO, the air/fuel ratio is kept at 14:1 so that complete combustion will occur, and hydrocarbons will be converted to carbon dioxide and water. For this, valves, carburetors, and fuel injection

pumps, must be designed and produced. Combustuion temperatures must be decreased to reduce nitrogen oxides emissions. This can be accomplished by exhaust gas recycling devices, water jetting devices, delayed ignition, or a catalyzing converter in exhaust pipe. The storage method and the activated charcoal adsorption method are suggested to decrease hydrocarbon evaporation. Thermal generation for the operation of electric cars will increase air pollution. Therefore, batteries must be improved, or nuclear fusion, direct generation will become necessary. Steam engines, gas turbine engines, rotary piston engines issue less exhaust gas. Exhaust gas cleaning by additives is also being studied.

30950

Yolles, R. S. and H. Wise

**CATALYTIC CONTROL OF AUTOMOBILE EXHAUST EMISSIONS.** CRC Critical Rev. Environmental Control, 2(1):125-146, April 1971. 91 refs.

A number of catalysts have been examined for efficient oxidation of the hydrocarbons and carbon monoxide present in automobile exhaust under different driving conditions. The experimental data for the removal of nitrogen oxides are incomplete. A promising approach to the catalytic control of nitrogen oxides is their reaction with CO in a two-stage catalytic system. Further experimental work is needed in the development of suitable catalysts to meet the progressively more stringent requirements for automobile exhaust control. All the catalytic systems are affected by the composition of the exhaust gases with which they come in contact. Although many of the problems associated with the physical and mechanical properties of the solid catalysts have been partially solved, the chemical interactions due to additives and contaminants require further attention. More effort is needed in the development of adequate procedures for continuous analysis of the gas composition issuing from the catalytic converter. (Author conclusions modified)

31221

Hyman, M. H.

**TIMETABLE FOR LEAD.** Environment, 13(5):14-23, June 1971. 16 refs.

Lead could be eliminated from gasoline by the end of 1973, with a resulting increase in gasoline prices amounting to $10/yr/ automobile. This target date allows for an orderly phaseout of lead and a parallel introduction of revised automotive and petroleum technology to adapt the internal combustion engine to the change. The direct benefits would be development of a wider variety of exhaust control devices, reduced atmospheric haze, and reduced deterioration of engine devices wwhich cntrol other forms of vehicular pollution. Lead-induced deposits within engines and lead in exhaust cause a number of deleterious effects, particularly increased hydrocarbon emissions. Fuels formulated with a high reformate, or aromatic hydrocarbon content, and reduced or zero lead content have a number of advantages. Reformate processing requires pre-treatment to remove sulfur. Therefore, increased processing will slightly reduce the sulfur oxides emitted by automobiles. Valuable by-products, such as hydrogen and propane, can be obtained from reforming. The result of using a low-lead gasoline to the average car owner would be a smooth-running, if slightly less powerful, automobile. It is noted that the reduction in pollution would be relative since internal combustion implies a certain irreducuble level of pollution.

31246

Lee, L., C. Sorensen, and Ken Nobe

**THE EFFECT OF LEAD ON THE CATALYTIC REDUCTION OF NITRIC OXIDE WITH CARBON MONOXIDE ON CU-AL203.** Preprint, American Chemical Society Washington, D. C., Div. of Water, Air, and Waste Chemistry, 5p., 1971. 9 refs. (Presented at the American Chemical Society, Division of Water, Air, and Waste Chemistry, Los Angeles, Calif., March 1971.)

Copper oxide-alumina catalysts with nominal lead levels were reduced with carbon monoxide and tested for their activity in the reduction of nitric oxide by CO. All the catalysts had a significantly higher activity for this reaction than an unleaded sample. In the case of ethylene oxidation, however, a copper oxide-alumina catalyst became deactivated by lead deposits. Leaded and unleaded alumina catalysts, also reduced with CO, possessed no appreciable activity for either the oxidation of ethylene or the NO-CO reaction.

31314

Jo, S. H. and Satoru Kato

**EMISSION CONTROL METHODS IN 4-CYCLE GASOLINE ENGINE.** (Jidoshayo 4-saikuru gasorin engin no haiki seijo gijutsu). Text in Japanese. Kagaku Kogyo (Tokyo), 22(8):1089-1100, Aug. 1971.

Eleven automobile manufacturers and oil companies have participated in the Inter Industry Emission Control Program (IIEC) to make a joint study of automobile emission control. The IIEC adopted a thermal reactor and catalytic converter for hydrocarbons and carbon monoxide; catalytic converter, reduction catalyzer and EGR for nitrogen oxides; and engines able to withstand low-lead or no-lead fuels. The air mixture and ignition period should be changed so that it would be for favorable emission control. Studies are being conducted using concept cars, and at present three types, Package A, Package B, and Package C, have been manufactured. Package A combines a thermal reactor and EGR; Package B is a combination of a hydrocarbon CO catalytic converter and EGR; Package C is a combination of a two layer catalytic converter and EGR. Package A s exhaust level satisfies the IIEC target in the short haul, but is 24% lower in fuel economy. However, if a new reactor is used, the fuel economy drop can be limited to 18%. Package B issues low levels of hydrocarbons and CO. Although the nitrogen oxides level is higher than the IIEC target, the model is being improved, and a durability testing is being conducted. Package C uses a nitrogen oxides catalyzer for the first time. This has advantages over Package A or B: it is possible to minimize the fuel economy drop; there is less heat load on the hydrocarbon CO catalyzers; and the maneuverability of the vehicle improves, since there is less dependence on EGR. The exhaust level of the two layer converter at the start is low, the fuel economy drop is three percent and performance drop is four percent. In the case of Package A, the operation performance and fuel economy must be improved and in Packages B and C, maneuverability must be improved.

31317

Fusamura, Nobuo, Takashi Iwasaki, and Shunji Nagoya

**GENERATING AND CONTROLLING OF LEAD-FUME.** (Namari fyumu no hassei to yokusei). Text in Japanese. Preprint, Safety Engineering Assoc. Tokyo (Japan), Tokyo, p. 40-41, 1971. (Presented at the Safety Engineering Symposium, 2nd, Japan, May 27-28, 1971, Paper 20.)

A method for controlling lead-fume is tested. Sampling lead is put in an iron pot fused by gas burner. The lead fume is extracted by absorption with a pump which uses a milliporefilter. The lead is analyzed by the Dithizone method. A photoelectric colorimeter is used to do the colorimetric determination. The thickness of oxidized film on molten lead is obtained by its relation in proportion to its weight. The density of the lead fume increases following a raise in the fusion temperature of the lead; if the temperature of fused lead is constant, the density decreases following an increase in the thickness of oxidized film. The control of lead fume by calcium carbonate is tested. The surface of the fused lead is covered by various thicknesses of CaCO3 the efficiency of control by the films of CaCO3 is considered. As the thickness of the film of CaCO3 increases, the density of control against the fume lead decreases; CaCO3 is therefore efficient in controlling lead fume. The result indicates that control of the occurrence of the lead fume is possible. First, the oxidation of lead is controlled by absorbing O2 to reach the fused film. Second, the lead fume captured by CaCO3 film is not released outside. Third, 2-calcium oxide lead oxide is obtained by a photochemical reaction on the surface, where CaCO3 is in contact with the fused lead. Therefore, CaCO3 not only itself inhibits physically the lead fume but also captures some of it as 2CaOPbO by a photochemical reaction.

31341

Bierig, J. L. and P. L. Young

**ADSORPTION HELPS TAKE THE KNOCKS OUT OF GASOLINE S FRONT END.** Oil Gas J., 68(43):62-65, Oct. 26, 1970. 11 refs.

As the public presses for unleaded gasolines, there is an increasing need for gasoline blending components that have high octane ratings and volatilities ranging between those of butane and benzene. Among unit refining processes, one that currently seems to be getting close attention from United States refiners is isomerization. The direct scheme is to combine C5-C6 naphtha with the effluent from isomerization, and then pass this combined feed through an IsoSiv adsorption unit. This unit will reject all branched isomers, cycloparaffins, and aromatics to a high octane non-normals product, leaving a concentrated nC5-nC6 stream for feeding the isomerizer. This scheme enables high-octane components of the virgin naphtha such as benzene and naphthenes to be directed to gasoline blending, bypassing the isomerizer. Other schemes and estimated costs are mentioned.

31364

Yoshida, Eiichi

**GASOLINE AND ENGINE OIL.** (Gasorin to engin yu). Text in Japanese. Kagaku Kogyo (Tokyo), 22(8):84-90, Aug. 1971. 20 refs.

More severe control on fuel and lubricating oil for automobiles is expected in the future. To achieve the Muskie standard by 1975, work is underway on pollution control values, engine modification, manifold air jetting systems, the activated coal-canister absorption method for evaporation loss, and the crankcase absorption method. Also being developed are catalyst converters or manifold reactors for carbon monoxide hydrocarbons, and EGR or catalyst converters for nitrogen oxides, and various traps for particulates. Some low-lead or no-lead gasolines have been used in the U. S. since 1970. In Japan, only low-lead gasolines have been permitted since July 1, 1970; after April 1, 1974, all gasolines are to be lead-free. Twenty-five percent of hydrocarbons are said to be crank case gas. PCV s prevent the discharge of this gas, and have been made compulsory since September 1970. Both closed- and shield-types are used. In view of more stringent controls, catalytic converters or manifold reactors will be adopted. Some engines are already equipped with manifold reactors. There are catalytic converters for CO, for HC, and for nitrogen oxides. The problem is that lead in gasoline shortens the catalyst lifetime. The EGR decreases nitrogen oxides by lowering the combustion temperature of fuel-air mixtures through exhaust gas circulation. The activated coal-canister absorption and crankcase absorption methods prevent evaporation losses from the fuel tank. Disadvantages of no-lead gasolines are valve recession and problems of octane level and engine oil function. Methods are available to protect new cards against valve recession; for used cars, a solution by means of gasoline or engine oil is desired. Although increasing the ash content of engine oil is said to reduce valve recession, not much can be expected of this method. Phosphoric gasoline additives have a detrimental effect on catalytic converters, and pollution by discharge of phosphorus compounds must be clarified. The problem of polycyclic aromatics must be studied. No useful additives have been found for minimizing the effect of hydrocarbon emissions. Cobalt and chrome compounds effectively suppress formation of nitrogen oxides, but much work remains to be done.

31390

Zemskov, I. F. and A. S. Stepanov

**MECHANISM OF INTERACTION OF ORGANOMETALLIC COMPOUNDS ON THE SURFACE OF ACTIVATED CARBON.** J. Appl. Chem. (USSR) (English translation from Russian of: Zh. Prikl. Khim.), 43(1):185-188, Jan. 1970. 6 refs.

Organometallic vapors in air-gas mixtures were adsorbed on activated carbon and studied for the nature of their surface interactions. The vapors were tetraethyl lead (TEL), diethylmercury (DEM), tetraethyl tin (TET), and ethylmercuric chloride (EMC). Tetraethyl lead and TET interacted with oxygen of the gaseous mixtures on the activated carbon surface. Adsorbed TEL AND TET underwent mineralization. Treatment of carbon saturated with TEL vapors with oxidants such as chlorine or ozone accelerated mineralization of the adsorbed TEL. Mineralization of TEL increased the activity of activated carbon with respect to TEL vapor. Diethylmercury and EMC vapors did not interact with oxygen on the carbon surface to any appreciable extent. When the vapors were adsorbed in the presence of ozone, the adsorbate content of the carbon increased only in the case of TEL. This was due to the ease with which TEL is oxidized. (Author conclusions modified)

31441

First, Melvin W.

**POSSIBILITIES OF REMOVAL OF SOURCES OF LEAD CONTAMINATION IN THE ENVIRONMENT.** Public Health Service, Washington, D. C., Symp. Environ. Lead Contamination, 1965, p. 87-94. (Dec. 13-15.) (PHS Pub. 1440) NTIS: PB 198104

Emissions of lead to the environment from mining, smelting, refining, processing, and fabricating lead and lead-containing substances and objects may be greatly reduced, both in-plant and out, by the application of well-known control measures. Some of these methods are cited. The remaining principal sources of lead in the environment (lead insecticides, lead-containing surface finishes, lead anti-knock compounds, lead and brass water and waste-water pipes) may be eliminated entirely by prohibiting their further use. Suitable substitutes are available, although they may be more costly and less convenient to use. Even if it can be demonstrated that present levels of lead

in the environment are related causally to a finite number of lead intoxications of some measurable degree of severity, there is no assurance that the population will be willing to make the sacrifices that will be needed to reduce our dependence on lead-bearing products. (Author summary modified)

31496

Kitano, Hisao and Fumio Tanimoto

**FUTURE OF AUTOMOBILE GASOLINE AND MUSKIE ACT.** (Jidosha gasoline no shorai to Muskie ho). Text in Japanese. Kagaku Keizai (Chem. Ind. Econ.), 18(7):28-35, July 1971. 19 refs.

The oil refining capacity in Japan is second to the United States in the free nations sphere and will reach five million barrels in 1973. The number of cars in Japan is expected to reach 26 million in 1973, twice the 1968 figure. In the U. S. there are rigid regulations on exhaust emissions, but in Japan, there is only regulation of the carbon monoxide of exhaust gas. With the passage of the Muskie Bill, in the U. S. exhausts are to be cut by 90% by 1975, almost impossible figures by the present technology of car manufacturing. The quickest way to reach the Muskie standard is the secondary cleaning of automobile exhausts by using catalyst or adsorbing agents. However, lead will obstruct the treatment of CO and shorten the life of catalyst and adsorbing agents. This means lead-free gasoline should be used. No studies were made as to the characteristics of car fuel and the engine which would comply with the Muskie requirements. In Japan, the Ministry of Transport issued new regulations on car exhausts: control will expand to light cars and equipped petroleum gas cars after Jan. 1971; control will be applicable to the new cars after April 1971, and cars produced after Oct. 1971. The CO concentration during idling will be checked after August, 1970. A blow-by reduction device for cars produced after September 1970 to control HC will have to be installed.

31519

Sterba, M. J.

**REFINING TO PRODUCE GASOLINES OF REDUCED LEAD CONTENT.** Public Health Service, Washington, D. C., Symp. Environ. Lead Contamination, 1965, p. 113-130. (Dec. 13-15.) NTIS: PB 198104

The estimated incremental manufacturing cost to the refiner for making an unleaded gasoline of current octane number quality is from 1.1 to 1.5 cents/gal above what it costs to make current gasolines. This incremental cost will vary, both above and below the range indicated, depending on the refinery size, its type, its location, crude characteristics, crude supply situation, products made, price structures, labor costs, accounting methods, and many other factors. The important conclusion is that it is possible to make unleaded gasolines, but at costs that must be passed on to the driving public. (Author summary modified)

31604

Ter Haar, G. L., D. L. Lenane, J. N. Hu, and M. Brandt

**COMPOSITION, SIZE, AND CONTROL OF AUTOMOTIVE EXHAUST PARTICULATES.** Preprint, Air Pollution Control Assoc., Pittsburgh, Pa., 48p., 1971. 15 refs. (Presented at the Air Pollution Control Association, Annual Meeting, 64th, Atlantic City, N. J., June 27-July 2, 1971, Paper 71-111.)

Total particulate composition, size of exhausted lead particulates, and the effects of traps on total lead emitted were described. Work in suspended particulate emission from several vehicles (models 1966-1970), operated on a chassis dynamometer under Federal seven-mode cycle conditions, showed cars vary in the amounts and composition of their particulate emissions. Cold cycle operation gives two to eight more particulates than hot-engine operation, lead compounds represent less than one-third of total particulates, the remainder being carbon compounds along with ammonium and nitrate ions, and carbon emission for stabilized cars using leaded gasoline averages 35% of the total. Suspended particulate emissions are nearly equal with new cars whether or not lead is present. Exhausted lead varies with the condition of the exhaust system. Fuel additives affect the amount of emitted particulates. Also, trapping systems offer potential for greatly reducing the emission of suspended total particulates. A group of 1970-model cars with less than 1000 miles were used to determine exhausted suspended particulates from non-leaded and leaded fuels. Using Federal Cycle operation, the unleaded-fuel cars exhausted an average of 0.165 g/mi, while the leaded-fuel cars exhausted an average of 0.152 g/mi. The size of lead particulates was determined using 26 1966-model cars with stabilized exhaust deposits. About 18% of the lead burned is emitted as fine and 11% as coarse. This is an emission rate of 0.051 and 0.028 g/mi, respectively. (Author abstract modified)

31690

**FANS HELP LABORATORY TO SIMULATE CAR EXHAUST EMISSIONS.** Heating and Ventilating Eng., 45(528):20-23, July 1971.

To cope with the new international legislation requirements on car exhaust emissions, Ford of Britain has designed and equipped what is claimed to be the most technically advanced facility of its kind in Europe. With six different emission checks and 15,000 individual tests a year to carry out, the new laboratory is equipped with six basic cells, each fitted with variable-inertia roller dynamometers. The rollers enable any city or high speed motorway driving cycle in the world to be simulated. In one section of the laboratory, up to 36 cars can be soaked in an atmosphere which can duplicate the climatic conditions in export markets. Three types of gas analysis equipment have been installed: nondispersive infrared, nondispersive ultraviolet, and flame ionization detection. The combustion process, operating variables, and the contaminants which are produced are discussed. These include carbon monoxide, hydrocarbons, nitrogen oxides, oxidants, lead compounds, and carbon dioxide. The Improved Combustion System (IMCO) which Ford utilizes to meet the American regulations is described. A dual diaphragm distributor tailors the advance and retard characteristics of the spark and this, together with a deceleration valve, provides the engine with a more fully combustible mixture under all conditions. A close tolerance carburetor provides improved choke calibration and leaner air-fuel ratios. The IMCO system incorporates a thermostatically controlled air cleaner to provide constant temperature of the air flow through the carburetor so that the engine operates efficiently, and good vehicle performance is retained, at all ambient temperatures. Computers are also an important part of the laboratory program.

31819

Venturini, Peter D.

**THE AIRR CAR -- A LOW EMISSIONS VEHICLE.** California Univ., Berkeley, Thermal Systems Div., NAPCA Grant AP-385-05, 21p., Aug. 1970. 14 refs.

A low emissions vehicles was designed and built. Reduction of air pollutants in the exhaust was accomplished by external modifications to the vehicle s engine. These modifications consist of two exhaust manifold reactors, a platinum-type cata-

lytic muffler, synchronized air injection, exhaust gas recirculation, and unleaded fuel. The vehicle modified was a 1970 Plymouth Belvedere four door sedan. Preliminary testing indicated compliance with 1975 proposed Federal emission standards. The total cost was $728.47 for the control equipment which reduced hydrocarbons, carbon monoxide and nitrogen oxides from the exhaust, crankcase, and fuel system.

31825

Venturini, Peter D.

**THE AIRR CAR -- A LOW EMISSION VEHICLE. PART II.** California Univ., Berkeley, Thermal Systems Div., NAPCA Grant AP-385-05, 52p., Nov. 1970. 9 refs.

A low emissions vehicle was built and entered in the 1970 Cross Country Clean Air Car Race. Modifications to the 1970 Plymouth Belvedere included two exhaust manifold thermal reactors, synchronized air injection, exhaust gas recirculation, a platinum type catalytic muffler, and unleaded gasoline. The vehicle finished fourth in class and exhibited exhaust emissions of hydrocarbons, carbon monoxide, and nitrogen oxides 50% below the 1975 proposed Federal standards during cold start open seven mode testing. A lack of sufficient development time resulted in some problems with the vehicle; however, its overall performance demonstrated the feasibility of its emissions control system as a viable solution to the automotive pollution problem. (Author abstract modified)

31985

Kondo, Masahisa

**EXHAUST GAS PURIFICATION DEVICE MAKING USE OF SUPERSONIC WAVES.** (Choonpa o mochiita haiki gasu no joka bunri sochi). Text in Japanese. (Assignee not given.) Japan. Pat. Sho 46-23101. 4p., July 1, 1971. (Appl. Nov. 30, 1967, 1 claim).

An automobile emission control device is described in which the exhaust gas is purified simultaneously with the removal of particulates. The device is a cyclone type separator equipped with a pressurized water jet nozzle and supersonic oscillator. As pressurized water is jetted through the nozzle, the exhaust gas is sucked into the device and the harmful gases are separated, oxidized, and reduced in the high-tension supersonic cleaner, while gas components are dissolved in water and the particulates absorbed. These harmful gases include carbon monoxide, carbon dioxide, hydrocarbons, lead compounds, sulfurous acid mist, sulfur dioxide, and similar pollutants.

32036

Zapp, John A.

**SUMMARY: CONTROL OF LEAD POLLUTION.** Public Health Service, Washington, D. C., Symp. Environ. Lead Contamination, 1965, p. 167-174. (Dec. 13-15.) NTIS: PB 198104

Articles pertaining to the control of lead pollution which were presented at the Symposium on Environmental Lead Contamination are reviewed. A reduction consumptive lead contamination could be achieved by prohibiting the use of lead in gasoline, and the possiblility of non-leaded gasolines is discussed. The lead content of food and water might be significantly reduced by prohibiting the unnecessary use of lead in food processing and storage equipment, the use of lead in pipes, and the growing of crops near major sources of lead.

32248

Hardison, L. C. and H. R. Herington

**STUDY OF TECHNICAL AND COST INFORMATION FOR GAS CLEANING EQUIPMENT IN THE LIME AND SECONDARY NON-FERROUS METALLURGICAL INDUSTRIES. (FINAL REPORT).** Industrial Gas Cleaning Inst., Inc. Rye, N. Y., Air Pollution Control Office Contract CPA 70-150, 293p., Dec. 31, 1970. 17 refs. NTIS: PB 198137

Members of the Industrial Gas Cleaning Institute collected and formalized information on air pollution control for processes in the lime and secondary non-ferrous smelting industries. The specific process areas covered are: rotary lime kilns, brass and bronze reverberatory furnaces, lead cupolas, lead and aluminum sweating, lead reverberatory furnaces, zinc calcination, and aluminum chlorination. The processes in question are described, as well as the problems special to the processes and the associated air pollution control equipment. Specifications and cost estimates to serve each of the processes are considered. A tabulation of the past installations, and all of the available test data for each of these industries after January 1, 1960, are presented. Control equipment discussed included wet scrubbers, fabric collectors, electrostatic precipitators, and venturi scrubbers. Operating conditions, fuels, and emissions are also mentioned.

32260

Lepsoe, Robert

**HISTORY OF THE TRAIL SMELTING PLANTS.** (Historien om Trail smelteverk). Text in Norwegian. Tidesskr. Kjemi Bergvesen Met., 7(2):22-25, Feb. 1947.

The history of this plant, located in the Canadian province of British Columbia, on the Columbia River just north of the U. S. border is reviewed. The plant produces metallic lead, zinc, cadmium, gold, tin, elemental sulfur, and sulfur dioxide gas (for commercial use). At an earlier period, the company had serious problems with lead poisoning among its workers, but the institution of regular checkups, including blood tests, of workers in contact with lead, combined with proper medical treatments and other personnel policies, has almost eliminated the problem. Extensive research has been done at the plant on the problem of recovering sulfur products from the roasting gases. Among the absorption media tested are zinc oxide, limestone, basic aluminum sulfate, and organic bases. Granulated lead slag has been found extremely effective as an absorbing agent, but at the same time its use is not economically profitable. The basic decision of plant management was to recover sulfur dioxide in a form in which it could be converted to elemental sulfur or sulfuric acid. Reducing SO2 with coke is complicated by the fact that coke is so expensive locally. On the other hand, there is an abundance of carbon monoxide available from thermo electric plants, which can be substituted for the coke.

32319

Konopka, A. P.

**PARTICULATE CONTROL TECHNOLOGY IN PRIMARY NON-FERROUS SMELTING.** Preprint, American Inst. of Chemical Engineers and Inst. Mexicano de Ingenieros Quimicos, 10p., 1970. 9 refs. (Presented at the American Institute of Chemical Engineers and Institute Mexicano de Ingenieros Quimicos Joint Meeting, 3rd, 0Denver, Colo., Sept. 1970.)

The sources and nature of particulate emissions and control technology in the primary smelting of aluminum, copper, lead, and zinc are described. The high dust concentrations generated

by bauxite drying and alumina calcining frequently require multicyclones for preliminary collection, followed by electrostatic precipitation. Installed costs for the combined system are $4.60-$2.30/CFM, at 99+% collection efficiencies. Electrolytic aluminum reduction cells pose a more complicated emission problem: moderate-energy wet scrubbers, glass filter bags, or flushed precipitator installations are used. Representative installed costs for the three methods are $3.00/CFM, $2.00/CFM, and $2.00/CFM, respectively. Dry electrostatic precipitators, preceded by mechanical collectors, are universally applied in copper smelting. Installation costs for the combined equipment are $6.00/CFM for 50,000 CFM flows and $3.00/CFM for 2,000,000 CFM flows. Large lead blast furnaces employ electrostatic precipitators, smaller units use fabric filters. Installation costs of vertical flow pipe-type precipitators in the 100,000 CFM range are $6.00/CFM. Continuous baghouses for smaller volumes cost $5.00/CFM installed. Horizontal flow plate precipitators are used on new zinc sintering machines. Mild-steel construction is common, and installed costs for 50,000 CFM collectors are $3.50/CFM. Emissions from flash roasting of zinc ore are also controlled by plate-type precipitators of mild steel construction. Installed costs are $3.50/CFM.

32355

Agnew, William G.

**AUTOMOTIVE EMISSION CONTROL.** Preprint, General Motors Corp., Detroit, Mich., p. 5-13, 1971. (Presented at the Conference on Progress in Areas of Public Concern, Milford, Mich., Feb. 1971.)

Air pollution due to automotive emissions is examined. Automotive contribution to air pollution, with respect to emission levels of hydrocarbons, carbon monoxide, nitrogen oxides, sulfur oxides, and particulate matter amounted to 39% of the total for 1968. This figure was correlated to particular effects of the pollutants on human health and plant life. When both total tonnage and these health concern issues were considered, transportation was responsible for less than 10% of the total U. S. air pollution problem for 1968. Automotive emission controls are examined, including crankcase controls, evaporative controls, lower compression ratios, and engine design modifications which allow cars to operate on lower octane, low-leaded or unleaded gasoline. Major reductions were made in hydrocarbon and CO emissions. Future research projects on emission control include the development of improved carburetion, electronic fuel injection, a catalytic converter, and alternatives to the spark-ignition engine.

32364

Hirschler, D. A.

**MEETING FUTURE AUTOMOBILE EMISSION STANDARDS.** Preprint, National Petroleum Refiners Association, Washington, D. C., 18p., 1970. 8 refs. (Presented at the National Petroleum Refiners Association Annual Meeting, San Antonio, Tex., April 6-7, 1970, Paper AM-70-5.)

A broad research program being conducted on vehicle emissions and the factors that affect them is described. Ways have been sought to improve the preparation of fuel-air mixtures so that a nearly uniform mixture of fuel and air is available to each cylinder of the engine under all driving conditions. Steady-state, light-load dynamometer engine data are presented that illustrate some of the benefits of lean mixture operation and good mixture preparation. Carbon monoxide, nitrogen oxide, and hydrocarbon emissions are indicated. To enable satisfactory operation at lean mixtures, experimental high-velocity carburetion has been developed. Ignition timing has been modified, and ways to conserve heat in the exhaust system have been developed. Other design improvements are indicated. Emissions standards for particulates and the portion of lead compounds present are discussed, and on-going studies of the feasibility of reducing exhaust particulates by trapping devices are noted.

32392

Sorensen, Lee L. C. and Ken Nobe

**THE EFFECT OF LEAD DEPOSITION ON THE OXIDATION ACTIVITY OF COPPER OXIDE-ALUMINA CATALYST.** Preprint, California Univ., Los Angeles, School of Engineering and Applied Science, 17p., 1971 (?). 11 refs.

The effect of lead deposition on copper oxide-alumina catalysts in the catalytic oxidation of ethylene was investigated. The catalyst was prepared by impregnation of preformed alumina pellets with an aqueous solution of copper nitrate. Catalyst lead contents of approximately 5, 10, and 15% were obtained by further impregnation of the catalyst with an aqueous solution of lead nitrate with subsequent thermal decomposition. The catalytic activity was determined for ethylene concentrations of 300 to 1600 ppm in air, at a gas flow rate of 375 l/hr (25 C, 1 atm) at temperatures of 270 to 400 C. An atomic absorption spectrophotometer was used for analysis of the solutions. Pore volume of the catalysts was determined by displacement of isopropyl and mercury, respectively. Surface areas were determined by nitrogen adsorption at liquid nitrogen temperatures. The catalyst activity was severely reduced by the lead deposits. (Author abstract modified)

32424

Hoegger, D.

**THE PROBLEM OF LEADED GASOLINE.** (Das Problem der Benzinverbleiung). Text in German. Bull. Eidgenoess. Gesundheitsamtes, Beilage B, no. 3:71-104, March 1971.

The Federal Commission for Air Hygiene of the Swiss Department of Health has considered the problem of leaded gasoline by reviewing its effect on humans, animals, and plants and by studying latest published research findings on the problem. As a result, it proposed to the Department of the Interior on October 9, 1970 to order a reduction of the lead content in premium gasoline to 0.57 g/Pb/l and in regular gasoline to 0.54 g Pb/l effective Jan. 1, 1972 and to change the currently valid ordinances accordingly. Increased lead emission by automobile exhaust gases, the contamination Zurich s air, street dust, plant life, and milk, and the effect of lead emission on humans are discussed. The Commission has concluded that while lead from exhaust gases contaminated especially areas adjacent to highways and that while persons exposed to these gases for long periods of time had a somewhat elevated blood lead content, no imminent danger from this source exists in Switzerland for either man, plant, or animal life. In spite of this conclusion, the Commission proposed to put a higher tax on premium than on regular gasoline to discourage its use, to plant green belts along highways, to introduce more frequent drinking water and food quality controls, to limit vehicular traffic in city centers, and to tax powerful engines more heavily than at present to discourage their use.

32633

Littlefield, J. B., Florence L. Feicht, and H. H. Schrenk

**EFFICIENCY OF IMPINGERS FOR COLLECTING LEAD DUSTS AND FUMES.** Bureau of Mines, Pittsburgh, Pa. Gas and Dust Section, Bureau of Mines, Washington, D. C. Health Div., U. S. Bureau of Mines Rept. 3401, 9p., May 1938. 2 refs.

Tests were conducted to compare the efficiency of large and midget impingers for collecting lead dust and lead fume with that of the electric precipitator. The lead dust used consisted of 72% litharge (PbO), 25% red lead (Pb304), and three percent lamp black. The geometric mean of the particle size distribution of the dust was 0.5 micron. The particle size of the lead fume, generated by burning tetraethyl lead, was much smaller than the lead dust. The efficiency of thy impingers agreed reasonably well with that of the electric precipitator. The efficiency of a single large impinger for lead fume ranged from 21-53%, and from 55-60% for two in series. The efficiency tended to increase when the fume was allowed to age. The efficiency of a single midget impinger for lead fume varied from 13-21%.

32760

Schulz, Ulrich and Ulf Richter

**THE INFLUENCE OF TECHNOLOGICAL PARAMETER ON THE COLLECTION EFFICIENCY OF ELECTROSTATIC PRECIPITATORS IN NON-FERROUS METALLURGY.** (Einfluss technologischer Parameter auf den Abscheidegrad von Elektrofiltern in der NE-Metallurgie). Text in German. Neue Huette, 16(7):385-390, July 1971. 13 refs.

Experiments were conducted with a hot gas electrostatic precipitator to determine efficient design criteria for application to the non-ferrous metallurgical industry. A sample flow was drawn through the precipitator from waste gases coming from copper, tin, zinc, and lead furnaces. Dust which had remained in the gas after passage through the precipitator was removed with a glass fiber reinforced asbestos paper filter. Efficiency measurements, resistance determinations, and theoretical considerations revealed that the filter temperature and water content of the gases influence the collection efficiency by relationships which are controlled by the specific electric resistivity of dust. In the case of dusts with a resistivity of less than 10 to th 10th power ohm/cm, temperature and dew point influence the collection efficiency via the breakdown voltage and the gas viscosity, regardless of the dust resistivity.

32822

Fatzer, R.

**POSSIBILITIES OF PROVISORY LEAD ELIMINATION FROM GASOLINE.** (Moeglichkeiten der provisorischen Bleieliminierung aus dem Benzin). Text in German. Protectio Vitae, 16(4):164-165, 1971.

The average concentrations of lead in the atmosphere over cities are 1-3 micrograms/cu m of air. The major source of lead emissions (lead dust and tetraethyl lead) is the automobile. The total elimination of lead from gasoline was proved feasible; the engine of a car driven since 1952 fueled by lead-free gasoline was not damaged. Several possibilities for the elimination of lead from gasolines are reviewed. To prevent knocking, the ignition must be turned down to match the octane consumption of the engine to the lowered octane number of the fuel. For highly compressed engines, the cylinder head must be raised for reduction of compression.

32938

Gupta, D. R. and C. P. Gupta

**AIR POLLUTION BY EXHAUST HYDROCARBON EMISSION FROM AUTOMOBILES.** J. Inst. Engrs. (India) (Calcutta), 51(9):177-183, May 1971. 9 refs.

Carbon monoxide, carbon dioxide, unburned hydrocarbons, oxides of nitrogen, lead salts, polyaromatics, soot, aldehydes, and ketones may be present in automobile exhaust gas. The problem of air pollution by automobile exhaust was first recognized in 1945 when a new type of smog, named photochemical smog, developed over Los Angeles. Concentrations of 30 ppm CO for four hours produce measurable impairment of vision and psychomotor performance. The oxides of nitrogen cause eye and respiratory tract irritation, reduction in visibility, and plant damage. Radiation from the sun can readily dissociate nitrogen dioxide into nitric oxide and atomic oxygen; this reactive oxygen attacks organic matter (unburned hydrocarbons) resulting in the formation of ozone and other oxidation products. Peroxyacyl nitrates and ozone can cause plant damage. Experimental evidence collected by flame photography and sampling techniques supports the hypothesis that wall quenching is mainly responsible for exhaust hydrocarbons under operating conditions other than vehicle deceleration. The effect of vehicle design factors, air-fuel ratio, spark timing, intake air temperature, and compression ratio on hydrocarbon concentrations is discussed. Leaning the air-fuel ratio reduces the total hydrocarbon concentrations, while retarding the spark timing has the reverse effect. A reduction in compression ratio from eight to one to 6.7 to one decreased the hydrocarbon concentration as surface to volume ratio was also decreased, but for compression ratios of 6.7 to one to four to one an increase in hydrocarbon emission was observed.

33157

Belousova, A. E., L. I. Mekler, A. A. Egizarov, and E. A. Simkin

**HYDROMETALLURGICAL TREATMENT OF DUSTS FROM DRY ELECTROFILTERS AT COPPER SMELTERS.** Soviet J. Non-Ferrous Metals (English translation from Russian of: Tsvetn. Metal.), 10(6):37-39, June 1969. 1 ref.

A technology was developed for treating the dusts from dry electrofilters at copper smelters for the production of a sulfide-lead concentrate, a zinc-cadmium intermediate product, a copper-calcium cake, and ammonium perrhenate, thus increasing the comprehensive use of raw material. By sulfidization of the lead cakes, a concentrate which contains over 60% Pb can be obtained. Copper is extracted in the form of an intermediate product, containing 10-15% Cu with a final recovery of about 70%. Rhenium is sorbed from solutions with the subsequent obtainment of ammonium perrhenate and about a 90% recovery. Through precipitation with soda, it is possible to separate from solutions a zinc-cadmium intermediate product which contains 40-45% Zn, 0.7-0.9% Cd, and to 0.008% thallium. (Author conclusion)

33366

Simpson, Bruce H.

**AUTOMOTIVE EMISSIONS CONTROL.** J. Wash. Acad. Sci., 61(2):128-137, 1971. 8 refs.

Motor vehicles account for 38.9% of the total mass of manmade air pollutants in the U. S., according to a recently published nationwide emission inventory. However, when relative harmfulness of individual pollutants is considered, the motor vehicle contribution is reduced to about 12%. Current model motor vehicles emit approximately 83% less hydrocarbons and 70% less carbon monoxide than precontrolled vehicles. By 1976, vehicles are expected to reduce HC emissions by 98%, CO by 97%, and oxides of nitrogen by 90%. Motor vehicle emissions of HC and CO in the South Coast Basin have beeen reduced by 18% and 13%, respectively, from peak values which occurred during the mid-1960 s. The NOx emissions continued to increase until 1971, but are now declining. Total nationwide emissions from motor vehicles are also

declining, in spite of an increasing car population. Automotive power plants for the balance of this decade will be highly refined derivatives of today s internal combustion engines. Exhaust gas recirculation, thermal reactors, and catalytic converter systems are being developed to meet future requirements, although both customer acceptance factors and emission control are not fully acceptable at this time. Lead-free fuel will be required to insure satisfactory component life, to minimize harmful effects of combustion chamber deposits, and to significantly reduce the emission of particulate matter. Major variations of the reciprocating internal combustion engine, gas turbines, Rankine cycle engines, and electric propulsion systems are also being actively developed to meet future needs for virtually emission-free vehicles. (Author abstract)

33386

Jagel, K. I. and F. G. Dwyer

**HC/CO OXIDATION CATALYSTS FOR VEHICLE EXHAUST EMISSION CONTROL.** Proc. Am. Petrol. Inst., Div. Refining, vol. 51:169-185, 1971. 9 refs. (Presented at the American Petroleum Institute, Division of Refining, Midyear Meeting, 36th, San Francisco, Calif., May 12-14, 1971.)

Hydrocarbon and carbon monoxide oxidation catalysts having good catalytic activity, stability, and improved physical durability were developed. Based on laboratory tests, these catalysts are predicted to be able to meet the Inter-Industry Emission Control Program HC and CO emission levels and the durability goals in vehicles in which HC, CO, and oxides of nitrogen goals are achieved simultaneously. The development of these catalysts has been aided by a mathematical model of the catalytic converter, and by some unique experimental techniques. Laboratory tests were complemented by several vehicle durability evaluations which have shown that although the IIEC goals were met initially, they were often exceeded after mileage accumulation. The principal causes for not meeting the goals have been catalyst loss due to inherently low catalyst attrition resistance and inter-particle abrasion caused by inadequate converter design. Improved converter designs and more attrition resistant catalysts have resulted in significant improvements in on-the-road durability of these systems. Laboratory tests predict that some of these catalysts will meet IIEC HC and CO goals for more than 12,000 miles with leaded fuel (3.0 g Pb/gal) and that a larger number will meet these goals for 50,000 miles with low leaded fuel or unleaded fuel. (Author abstract modified)

33388

Jaimee, A., D. E. Schneider, A. I. Rozmanith, and J. W. Sjoberg

**THERMAL REACTOR - DESIGN, DEVELOPMENT AND PERFORMANCE.** Proc. Am. Petrol. Inst., Div. Refining, vol. 51:207-240, 1971. 20 refs. (Presented at the American Petroleum Institute, Division of Refining, Midyear Meeting, 36th, San Francisco, Calif., May 12-14, 1971.)

Thermal reactor systems have been designed to assist in the development of a low emission concept vehicle to meet exhaust emission goals of 0.82 g/mile hydrocarbon, 7.1 g/mile carbon monoxide, and 0.68 g/mile nitrogen oxides established by the Inter-Industry Emission Control Program. The reactor includes design features required for acceptable life characteristics, together with quick warm-up necessary to achieve the emission targets. Exhaust gas recirculation and enriched carburetion are used to reduce the oxides of nitrogen. Associated problems defined during development of several thermal reactor systems are described. The primary problem was achieving durability at the typically high operating exhaust gas temperatures (1600-1800 F) necessary for concurrent HC, CO, and NOx control. Fuel additives such as lead, halogen scavengers, phosphorus, and sulfur were studied extensively under thermal cycling engine operating conditions to determine their effects on material durability. Acceptable corrosion control of potential reactor materials will require the use of an unleaded or low-lead (0.5 g/gal) fuel. (Author abstract)

33403

Meisel, S. L.

**EXHAUST EMISSIONS AND CONTROL.** J. Wash. Acad. Sci., 61(2):91-102, 1971. 32 refs.

The effects of leaded and unleaded gasolines on hydrocarbon, carbon monoxide, particulates, and nitrogen oxide emissions from current and future cars and the costs of emission controls to industry and the consumer are examined. Removal of lead from gasolines does not affect CO and NOx emissions, but decreases hydrocarbon emissions and changes the nature of particulate emissions. The exclusive use of lead-free gasolines could engender exhaust valve recession. The use of thermal reactors and catalytic converters with low-lead (0.5 g/gal) or unleaded fuels would lower the hydrocarbon and CO levels to meet standards. Nitrogen oxides control could be accomplished through decomposition using a catalyst; reduction over a catalyst using hydrogen and CO present in the exhaust; and exhaust gas recirculation systems. Particulate control systems include coalescers, cyclone separators, precipitators, and filters. The systems are examined for efficiency and effect of lead.

33542

Doelling, R. P., A. F. Gerber, and M. P. Walsh

**THE EFFECT OF GASOLINE CHARACTERISTICS ON AUTOMOTIVE EXHAUST EMISSIONS.** Preprint, American Society for Testing and Materials, Philadelphia, Pa., 22p., 1970. 17 refs. (Presented at the American Society for Testing and Materials, Workshop on Effect of Automotive Emission Requirements on Gasoline Characteristics, Toronto, Ontario, June 24, 1970.)

Fuel modifications encompassing composition, volatility, and lead content were investigated as a means of reducing automotive exhaust emissions. Several test programs are summarized. Certain hydrocarbons exhausted by automobiles are known to be more reactive than others in the formation of Los Angeles or photochemical type smog. These more reactive hydrocarbons, notably olefins, are assigned higher weighting values when total engine exhaust hydrocarbon levels are evaluated for their contribution to photochemical air pollution. However, experiments indicated fuel composition to have no significant effect on exhaust hydrocarbon reactivity. Higher boiling components of gasoline also did not have a significant effect on exhaust hydrocarbon or carbon monoxide emission levels. Exhaust hydrocarbon levels of vehicles operated on fuel leaded to 3.13 grams per gallon were significantly greater than the exhaust hydrocarbon levels of vehicles operated on unleaded fuel. Engine operation on leaded fuel (only one-fourth gram of lead per gallon) also increased exhaust hydrocarbon emissions. (Author abstract modified)

33550

Burtner, R. E.

**GASOLINE CHARACTERISTICS AND AIR CONSERVATION--A REVIEW OF API ENGINE FUELS STUDIES.** Preprint, American Society for Testing and Materials, Philadelphia, Pa., 26p., 1970. 16 refs. (Presented at the Amer-

ican Society for Testing and Materials, Workshop on Effect of Automotive Emission Requirements on Gasoline Characteristics, Toronto, Ontario, June 24, 1970.)

Some suggested remedies for pollution of the air by automotive emissions have been changes in volatility and composition of the gasoline and the removal of lead antiknock agents. Several programs have been run under the sponsorship of the American Petroleum Institute to investigate not only whether these changes would clean air through lower emissions, but also the effect on car performance. Elimination of evaporation losses by evaporation loss control hardware is much more effective than any reasonable reduction in volatility, even as low as five pounds RVP, and more effective than removal of all olefins boiling below 220 F from gasoline. Reduction of fuel volatility to the five pound RVP level would be expected to result in degraded warming-up performance in a substantial percentage of new cars in the hands of the customer if the prevailing ambient temperature is 50 F or lower. For cars in poorer condition (or the more average car) degraded performance might be expected at prevailing ambient temperatures at least 10 F above this. A small adverse effect on the amount of exhaust hydrocarbon emissions accompanies a volatility reduction. Mass evaporative losses are unaffected by the presence or absence of lead if volatility is not changed. No important differences could be found in the mass exhaust gas hydrocarbons due to the absence of lead from the tested fuels in cars with typical deposits from commercial gasoline. The pollution effect of unleaded gasolines may be greater than leaded gasolines because of fuel compositional changes required to maintain octane quality, although some reactivity scales show no appreciable increase in the smog potential due to these changes. (Author conclusions modified)

33628

**THE PROBLEMS INVOLVED IN THE NEW LAW FOR REDUCTION OF THE LEAD CONTENT IN GASOLINES.** (Zur Problematik des Benzinbleigesetzes). Text in German. Erdoel Kohle (Hamburg), 24(9):605-606, Sept. 1971. 13 refs.

Beginning in 1971, the lead content in gasolines sold in West Germany may not go over 0.4 g/l, while by 1976 the reduction is to be to 0.15 g/l. Although the lower lead content will reduce the octane number, this should not affect engine performance. However, it is actually thought that the government acted without having conducted a sufficient number of studies concerning the effects of lead on the environment. It is also thought that engine modifications will need be made to operate on the low-lead gasolines. A reduction of the lead content to 0.15 g/l might cause a rise in aromatic compounds which are more dangerous to human health than lead compounds. It is also likely that a lead filter will soon be on the market, thus producing an effect similar to the use of low-lead gasolines.

33657

**ENGINE PERFORMANCE WITH LEAD-FREE GASOLINE IMPROVED BY INDUCTION HARDENING OF INTEGRAL VALVE SEATS.** Ind. Heating, 38(9):1650-1652, Sept. 1971.

Based on the testing experience of one company, induction-hardened valve seats may be the solution to the seat recession problem caused by unleaded gasolines. The seats exhibit 25% of the wear of nonhardened seats and are less expensive to produce than valve seat inserts. Heat transfer impairment is minimal. The induction-hardening equipment is entirely automatic and tied into the head machining line. Each line handles approximately 200-250 heads per hour. The first unit is now going into production.

33741

Mayr, Bertold and Peter Ziermann

**STUDIES ON WATER-COOLED HIGH-POWER OTTO ENGINES.** (Untersuchungen an wassergekuehlten Hochleistungs-Ottomotoren). Text in German. Automobiltech. Z. (Stuttgart), 73(10):376-383, Oct. 1971. 10 refs.

The combustion process and the influence of the shape of the combustion chamber on pollutant emissions by BMW four-cylinder engines was studied. Low-lead fuel (octane number 89) was used with the BMW 2000-tii-engine. A clearly audible knocking sound at a lower number of revolutions occurred. To avoid this, the advanced ignition had to be adjusted to smaller values. Despite this measure, damage of the cylinder head at longer experimental operation and at a fuel/air ratio of lambda equals 0.9 was unavoidable. By means of induced pressure, the effects of low-lead fuel on the engine operation at high rpm were tested. At lambda 1.0, the engine knocking sound occurred most frequently up to 5000 rpm. At lambda 1.1, it went down. At lambda 0.85, where the maximum power is achieved, knocking occurred more frequently, particularly at higher rpm. At lambda 0.7, knocking disappeared at higher rpm entirely; in the lower rpm range, knocking disappeared only at very early ignition. The size of compression areas influenced the emission of unburned hydrocarbons. A reduction of the compression areas by 20% yielded a 35% lower hydrocarbon emission in the partial load range at a low number of revolutions and at stoichiometric mixing ratio. In the full load range, the influence of this measure was not as great. The carbon monoxide emissions were independent of the shape of the combustion chamber.

33932

Gartenmann, E.

**THE POSSIBILITIES OF REDUCING THE LEAD CONTENT IN GASOLINES FOR AUTOMOBILES.** (Ueber die Moeglichkeiten der Herabsetzung des Bleigehaltes in den Benzinen fuer motorische Zwecke). Text in German. Bull. Eidenoess. Gesundheitsamtes, Beilage B, no. 3: 105-144, March 1971.

It is technically possible to produce lead-free high octane gasoline by catalytic reforming of certain petroleum fractions or by isomerization of light gasoline (Europe) and by catalytic cracking of heavy oil and alkylation of olefins (U.S.A.), but while these processes have been operative in the production of special gasolines and for petrochemical purposes for a long time, the equipment is old and the capacity is inadequate should the addition of lead to gasoline cease suddenly. The additional production costs involved amount to two to five Raps/l. The refineries will initially, because of cost and time factors, produce only regular lead-free gasoline. Lead-free gasoline will have a higher content of aromatic hydrocarbons, the benzol content can be kept below the five vol% limit, and the olefin content will be lower. Lead-free gasoline has a 25% higher smog producing tendency, and its exhaust gas contains a higher share of benzanthracene and of other polynuclear aromatic substances but the same amount of benzopyrene. Lead does not only improve the antiknock property of gasoline, but acts also as a lubricant preventing the corrosion of exhaust valve seats. Regular gasoline in the U.S.A., which beginning with 1971 will contain only 0.2 g lead/l, will reduce engine power by 10% which is no problem with high-powered engines. In Europe, however, this is a problem because most European engines with small piston displacement would lose too much power if run on regular lead-free gasoline. For this reason, the reduction of lead content in gasoline in Europe can be introduced only gradually as engines are adapted in the

direction of higher piston displacement. The use of natural or of liquefied gas in automobiles should be encouraged.

33994

Charlson, R. J. and J. M. Pierrard

**VISIBILITY AND LEAD.** Atmos Environ., vol. 3:479-480, 1969. 8 refs.

An estimate is made of how much of an improvement in visibility could result from the control of automotive lead emissions. One approach is to use the recently published linear relationship between aerosol mass concentration and visual range and published values for the fraction of lead in the atmospheric aerosol. Another approach to estimating the fraction of the total mass concentration (and therefore of the visibility degradation) in situations which are dominated by the automotive source is to utilize known relationships between the various pollutants. Both methods are considered, and it is interesting to note the the approximate agreement of the two approaches to the estimation of the percentage of extinction coefficient atributable to lead compounds.

34025

Barron, A. V., Jr.

**PARTICULATE AND SO2 CONTROL TECHNOLOGY FOR THE SMALL AND MEDIUM COAL-FIRED BOILER.** Combustion, 43(4):44-56, Oct. 1971. (Presented at the Industrial Conference, Lafayette, Ind., Oct. 7-8, 1970.)

In firing one ton of coal with two percent sulfur, some 40 pounds of sulfur is burned and released into the flue gas. This 40 pounds of sulfur combines with oxygen to form 80 pounds of sulfur dioxide. The sulfur oxides react with moisture resulting in sulfuric acid, eventually making some 125 pounds of sulfuric acid. The particulates include fly ash, which is the unburnable inert material in fuels; soot, which is the burnable unburned material left from inefficient combustion; and lead, unburnable additive in gasoline. Electrostatic precipitators, bag or fabric collectors, mechanical dust collectors or multiple cyclones, scrubbers or washers, and thermal or catalytic converters are discussed for use in air pollution control. Design criteria are presented, as well as advantages and disadvantages. An SO2 scrubbing system project built to operate as a mobile pilot plant, unique in the Zurn designed particulate-SO2 removal system for the City is discussed. The scrubbing slurry will be a combination of sea water and pulverized native coral marl.

34035

Mikita, Joseph J.

**COMMENTARY AT SESSION ON INTER-INDUSTRY EMISSION CONTROL REVIEW.** American Petroleum Inst., New York, Div. of Refining, Proc. Am. Petrol. Inst., Div. Refining, vol. 51:275-281, 1971. (Presented at the Midyear Meeting, 36th, San Francisco, Calif., May 12-14, 1971.)

Extended tests and the Inter-Industry Emission Control test indicate that properly designed thermal reactors maintain their efficiency for oxidizing hydrocarbons and carbon monoxide for very long periods, close to, or up to, 100,000 miles, and they will do this with leaded gasoline. Catalysts, however, do deteriorate, even with unleaded gasoline. Increases in emissions with mileage are caused most frequently by carburetors going off calibration, changes in ignition timing, and improperly operating choke mechanisms. Metallurgical considerations indicate nickel-based alloys to be satisfactory for construction of the reactor core.

34071

Hashimoto, Haruhiko

**ON TECHNOLOGY OF UTILIZATION OF DUST FROM STEEL MAKING.** (Sangyo haikibutsu dearu seiko enjin no shigenka gijutsu ni tsuite). Text in Japanese. Preprint, Reutilization of Resources Technical Assoc. (Japan), 5p., 1971. (Presented at the Seminar on Reutilization of Resources Technology, 2nd, Japan, July 12-14, 1971.)

A process is described which uses the dust from the production of steel for the smelting of zinc and lead. The dust collected from open hearth or electric furnaces is too fine for reclamation and, if not handled properly, may be the cause of secondary pollution. It contains too many other metals to be suitable for a raw material in the production of steel or nonferrous metals. However, taking advantage of the fact that most of the valuable metals in the dust are oxides and, utilizing the difference in pressure of these metals, zinc and lead have been successfully recovered to avoid secondary pollution. The dust is pelletized, and the appropriate amount of reaction controlling reagent and coking coal are mixed before being charged into a rotating kiln. Foreign bodies such as scrap iron and fire-proof refractory materials should be eliminated from the dust before processing it. A special method is described to eliminate the accretion of materials in the rotating kiln to improve its operating efficiency.

34313

Komissarov, O. G., G. M. Gordon, V. I. Vasilyev, and G. S. Rozhayskiy

**A STUDY ON THE LAWS OF DUST SEDIMENTATION IN HOSE FILTERS WITH STREAM-LIKE BLOW THROUGH.** (Issledovaniye zakonomernostey osazhdeniya pyli y rukavnom filtre so struynoy produvkoy). Text in Russian. Tsvetn. Metal., no. 7:23-27, 1971. 5 refs.

A radioisotope method based on the measurement of decreasing beta radiation intensity when passed through a layer of dust was used to study the dust distribution along the hose filter surface. The filtrating surface of the filter bag was 1.5 sq m. Air samples were dusted with finely dispersed quartz or lead. The initial dust concentration ranged between 200 and 600 mg/cu m. An artificial radioactive isotope consisting of Strontium 90 and Ittrium 90 was the source for beta radiation. The prophilogram reflecting dust accumulation along the filter bag was recorded according to the oscillations in beta radiation intensity, and then it was graphically represented. The upper portion of the filter hose (at the inlet of the dusty air) showed the highest degree of dust accumulation during the filtering process. The dust distribution along the filter hose surface elicited an exponential rather than a linear trend. The prophilogram recorded following regeneration of the filtrating fabric could be considered linear. Thy irregular dust distribution along the filter hose surface should be reflected in the dynamics of the filtering efficiency. This fact will determine the choice of the optimal ratio between the diameter and the length of the filter hose.

34381

Brobeck, William M.

**STEAM VEHICLE POWER PLANT DESIGN AND DEVELOPMENT.** Preprint, Dept. of Transportation, Washington, D. C., Urban Mass Transportation Administration, 4p., 1971. (Presented at the Steam Bus Symposium, Washington, D. C., Nov. 17, 1971.)

Specifications are presented for steam-powered buses and trucks, as well as a diagram of a steam power cycle, in rela-

tion to vehicle emission standards. The steam-powered units will produce 0.2 g/mile hydrocarbons, 1.0 g/mile carbon monoxide, 0.4 g/mile nitrogen oxides, and no lead emissions, which are well under the 1975 California emissions standards.

34457

Conta, Lewis D.

**INTERNAL-COMBUSTION ENGINE AND THE ENVIRONMENT.** Preprint, American Society of Mechanical Engineers, New York, 8p., 1971. 1 ref. (Presented at the American Society of Mechanical Engineers, Winter Annual Meeting, Washington, D. C. Nov. 28-Dec. 2, 1971. Paper 71-WA/DGP-1.)

Regardless of what is done to develop suitable substitutes for the internal combustion engine, and certainly this goal should be vigorously pursued, at least 100 million more engines will be built over the next ten years, and the kind of air we breathe ten years from now will depend more on how these engines are build than on anything else that is done in the vehicular propulsion field. Therefore, research in the area of internal combustion engine emission should be pushed hard and supported adequately. In setting emission standards, two factors should be kept in mind: the standards should be rigorous, but realistic, and other criteria in addition to exhaust composition should be established to insure that all of the improvements are not made at the expense of fuel consumption increases, and the cost of sophisticated add-on gadgetry. Substitutes for the conventional engine include steam engines, electric power (batteries or fuel cells), gas turbines, and diesels. Present engines can be modified with improved carburetors, manifolds, fuel-injection systems, lowering compression ratios, stratified charge operation, and removal of lead from gasoline.

34536

Roth, James F.

**COPPER-BASED AUTO EXHAUST OXIDATION CATALYSTS. DEACTIVATION AND PHYSICAL ATTRITION.** Ind. Eng. Chem. Prod. Res. Develop., 10(4):381-385, Dec. 1971. 11 refs. (Presented at the American Chemical Society, 161st Meeting, Los Angeles, Calif., April 1971.)

Adverse aging effects, such as deactivation and physical attrition, on copper-based auto exhaust oxidation catalysts were investigated in road and laboratory studies of catalysts comprising copper oxides on alumina. Exposure to cyclic oxidation reduction caused physical attrition of poorly dispersed copper-based catalysts in the presence or absence of halides. This chemically induced attrition process was relatively independent of the hardness of the catalyst support. High dispersion of the copper component imparted good attrition resistance even under cyclic conditions. Halides from the lead motor mix contributed significantly to deactivation via depletion of the active component from the catalyst surface. In the absence of halide, little or no deactivation was observed. Exposure of the copper-based catalysts to excessive temperatures also produced deactivation. (Author abstract modified)

34611

Kuehn, Martin

**WILL THE COMBUSTION ENGINE DIE BECAUSE OF EXHAUST GASES? DISCUSSION0 CONCERNING THE EMISSIONS OF AUTOMOBILES.** (Stirbt der Verbrennungsmotor an seinem Abgas? Zur Diskussion ueber die Emissionen von Kraftfahrzeugen). Text in German. VDI (Ver. Deut. Ingr.) Nachr. (Berlin), 25(45):6-7, 1971.

There is no doubt that the combustion engine for automobiles will survive over the next decades. Through electronically controlled fuel injection and accurate carburetor adjustment, it has become feasible to fulfill the regulations which have become effective in the Federal Republic of Germany and in the Common Market Countries on October 1, 1971. Afterwards it was not only feasible to reduce the carbon monoxide concentration in exhaust gases to 4.5% but also to comply with the requirements of the California test which sets a limit concentration of 2.5% CO for small and of 1.5% for large engines. The addition of alcohol as an anti-knock agent is frequently overlooked in the discussion of reducing the lead content of fuels. The facilities for the large-scale production of alcohols are not presently available in any of the Western Countries. But the process has been developed. It is based on the conversion of CO with water vapor on iron catalysts. The same measures which are used for reduction of the CO content can be applied to reduction of the carcinogenic components in the oil mists. The task of limiting the formation of oil mists still remains. Engine lubricants should be selected according to their readiness to decompose by oxidation.

34740

Sood, Sudesh K. and Richard Karuhn

**DEVELOPMENT OF PARTICULATE EMISSIONS CONTROL TECHNIQUES SPARK IGNITION ENGINES. (FINAL REPORT).** IIT Research Inst., Chicago, Ill., Air Pollution Control Agency Contract CPA 22-69-134, APCO Rept. CPA 22-69-134, IITRI Rept. C6186-5, 95p., Feb. 1971. 30 refs. NTIS: PB 198033

The experimental results of two techniques for the removal of particulate contaminants from spark ignition engine exahusts were described. The first technique was based on the thermal deposition of lead aerosol particles in the size range 0.1-0.8 micron in a packed bed. The effect of gas-packing temperature differential, packing material, and gas velocity on collection efficiency of the bed was studied. Experimental results show that collection efficiency of the packed bed device depends primarily on the gas-packing temperature differential. At a gas velocity of 15.5 cm/sec, the collection efficiency of the device exceeded 95% at a temperature differential greater than 200 C. Increasing the gas velocity to 130 cm/sec lowered the collection efficiency of the bed by 10-15%. The second technique was based on the use of sonic waves to increase the collisions between the aerosol particles and the relatively coarse particles of a fluidized bed, and hence increase the collection efficiency. The effect of sound frequency, gas velocity, and power input to the sound driver units was studied. Experimental results showed that there was no significant effect of sound frequency, in the range 250-2700 HZ, on collection efficiency of the fluidized bed. Collection efficiency of the fluidized bed increased sharply with power input to the sound driver units when standing sharp waves were used. The use of travelling sound waves did not enhance the collection efficiency of the fluidized bed significantly. (Author abstract modified)

34846

Shroff, G. L. and J. C. Dickson

**SCHEDULING AND REBLENDING PROBLEMS OF UNLEADED GASOLINE.** Preprint, American Inst. of Chemical Engineers, New York, 22p., 1971. 1 ref. (Presented at the American Institute of Chemical Engineers, National Meeting, 68th, Houston, Tex., Feb. 28-March 4, 1971, Paper (GH-009.)

An attempt has been made to evaluate the loss of flexibility which accompanies the restriction of lead additives for octane improvement. Lead is an independent control; without it, oc-

tane appreciation in gasoline requires variations in all other components of the blend if volume and other limiting properties are to remain constant. With the possible exception of butane as a control on vapor pressure, no such convenient control exists for other properties of motor gasoline. The costliness of a blend characteristic is measured by multiplying the incremental cost of varying the characteristic.

35018

Freude, Hermann

**THE DECONTAMINATED ENGINE.** (Der entgiftete Motor). Text in German. Kosmos (Stuttgart), 67(5):210-211, 213-215, May 1971.

If the mixture entering the cylinders of a gasoline engine contains enough air to ensure that each carbon and hydrogen particle can burn completely, the exhaust gas should, theoretically, consist of carbon dioxide, water vapor, and the residual nitrogen from the air intake. However, this ideal condition is not feasible, since the combustion process is composed of a sequence of complicated reactions, where intermediate products of varying stability are formed depending on the gas temperature which changes rapidly during the combustion cycle. While combustion with somewhat less air intake results in maximum fuel efficiency, some of the carbon oxidizes into carbon monoxide only, not into CO2, and not all hydrogen particles are changed into water vapor, but combine to hydrocarbons in the exhaust gases. The prevailing high temperature of 2200 to 2400 degree C in the combustion zone enhances the formation of nitric oxide. The percentage of the pollutants CO and NO in the exhaust gas can be reduced by operating with excess air intake. By using intake mixtures with five percent excess of combustion air, a practical compromise has been established between efficiency of combustion and reduction of the concentration of pollutants in the exhaust. The reason for adding tetraethyl lead to gasoline is to provide a fuel better suited to increased compression ratios, where knocking due to premature ignition occurs which is detrimental to engine life and must be counteracted. The development of gasolines with new compositions, to replace the noxious lead additives, appears to be imperative. To reduce, or ultimately, if possible, eliminate CO, NO, and HC emissions, a number of methods are being actively investigated, including secondary combustion in exhaust manifolds of special design, secondary catalytic combustion, and direction of all exhaust gases from the crankcase back to the engine intake.

35035

Richter, Ulf

**NEWER ACKNOWLEDGES ON APPLICATION OF ELECTROFILTERS TO PRECIPITATE THE MIXTURE OF PB-ZN-SN OXIDES AT THE EXAMPLE OF A HUNGARIAN FOUNDRY.** (Ujabb ismeretek az olom-, horgany- es onoxidok levalasztasara szolgalo villamos szurok a!kalmazasarol az egyik magyar kohomuben). Text in Hungarian. Energia Atomtech. (Budapest), 23(5):228-229, May 1970.

The flue gases from converters used in scrap copper and copper vitriol works usually need two precipitators: a bag filter and electric precipitator. In Hungary, the precipitation of lead, zinc, and tin oxide particulates exiting from the copper converter is accomplished by an electric precipitator. The electric resistance of these particles is so high between 30 and 350 C that the back-corona effect reduces the precipitation efficiency to 35-75%, which is too low. Efficiencies of 99% can be obtained below 100 C or above 280 C gas temperatures (maximum oxide resistance at 120 C). By adding steam to the flue gas, the dew point can be raised to 65 C. In the present application, 300 C gas was used. Three arrangements are discussed.

35080

Uchida, Sanichiro

**UNLEADED GASOLINE PROBLEMS.** (Gasorin no muenka ni tsuite no mondaiten). Text in Japanese. Nenryo Kyokaishi (J. Fuel Soc. Japan, Tokyo), 50(534):768-777, Oct. 1971. 20 refs.

In Japan, all the lead additives in both premium and regular gasolines are to be removed by April 1, 1974. This will present both technical and economic problems for the refineries, as they seek a suitable octane booster. The manufacturing industry faces problems of valve seat recession and knocking troubles with the older cars. (Author summary modified)

35112

**LEAD-FREE GASOLINE REPERCUSSIONS IN THE PETROCHEMICAL INDUSTRY.** (Essence sans plomb: ses repercussions sur la petrochimie). Text in French. Chim. Actualites, no. 1449:14-15, Sept. 30, 1971.

The elimination of lead from gasoline will increase the demand for aromatic hydrocarbon fractions because they will principally be used to increase octane rating. Lead-free gasoline will thus contain 20-25% more aromatic hydrocarbons than leaded gasoline. In the U. S., this resulted in an increase in the cost of these fractions by about $15 per ton due to the rigidity of refining processes in America. The abandonment of lead in gasoline will have its biggest effect on olefins which, in the form of butylene and propylene, will also be used to increase octane rating. Producers of tetramethyl- and tetraethyl lead, whose production in Europe amounts to $150 million would lose their market, should this additive be banned.

35166

Yanagihara, Shigeru

**AIR POLLUTION AND AUTOMOTIVE ENGINES (1).** (Taiki osen to jidoshayo kikan (1). Kikai No Kenkyu (Science of Machine), 22(8):1101-1106, 1970. 4 refs. Translated from Japanese. Leo Kanner Assoc., Redwood City, Calif., 26p., Aug. 1971.

The effects of automotive exhaust emissions on air pollution are reviewed with respect to maximum allowable concentrations, environmental emission standards, regulation of engine exhausts, and various control methods. Automobiles emit carbon dioxide, carbon monoxide, hydrocarbons, soot and lead particulates, aldehydes, and odors as combustion gas from exhaust pipes, crankcase blowby gas, and fuel tank or carburetor vapors. Control methods included engine design modifications, improvements of the air inlet and ignition systems, air-fuel ratio, exhaust, air injection and fuel injection systems, and prevention of evaporation loss.

35223

Bernstein, L. S., K. K. Kearby, A. K. S. Raman, J. Vardi, and E. E. Wigg

**APPLICATION OF CATALYSTS TO AUTOMOTIVE NOX EMISSIONS CONTROL.** Preprint, Society of Automotive Engineers, Inc., New York, 17p., 1971. 10 refs. (Presented at the Automotive Engineering Congress, Detroit, Mich., Jan. 11-15, 1971, Paper 710014.)

Nickel-copper alloys, marketed under the name Monel, are extremely active oxides of nitrogen reduction catalysts. At temperatures above 1300 F, and under net reducing conditions, Monel will catalyze the removal of 90% or more of the nitric

oxide in automotive exhaust at space velocities of up to 100,000 v/v/hr. On unleaded fuel, Monel catalysts have shown good activity maintenance in mileage accumulation runs as long as 31,000 miles. Catalyst life is limited by physical deterioration of the catalyst which causes increases in exhaust back pressure. The presence of lead in the fuel substantially increases the rate of Monel deterioration. When Monel is used as part of a dual-bed catalyst system, two problems arise which appear to be generic to dual-bed catalyst systems. First, under normal operating conditions, roughtly 10% of the nitric oxide in the untreated exhaust reacts with hydrogen to form ammonia in the Monel bed. The NH3 thus formed can be oxidized in the oxidation bed. Ammonia formation can be decreased by careful control of exhaust composition. Alternatively, the concentration of NO in the untreated exhaust can be lowered by exhaust gas recycling, so that even with ammonia formation, the nitric oxide concentration in the treated exhaust will be low enough to meet low emissions standards. Second, placing Monel or any other NOx reduction catalyst ahead of the oxidation catalyst slows the warm-up of the oxidation catalyst. This problem has been attacked by placing the catalyst system close to the exhaust ports and modifying the exhaust system to conserve exhaust gas sensible heat. (Author abstract modified)

35296

Ichijo, Michio

**JAPAN TODAY: POLLUTION-FREE METALLURGY.** Mining Mag. (London), 125(5):471-474, Nov. 1971. 10 refs.

A pollution-free process for recovery of various metals from Kuroko ore is described. The ore is first separated by a flotation process to produce copper, lead, zinc, iron, and slime bulk concentrates, plus tailings. The copper concentrate is then treated by a dry method for extraction of crude copper. Iron concentrate is treated by the Kohwa process to obtain hematite pellets. Lead and zinc dust from the copper concentrate and vaporized copper, lead, and zinc chlorides from the iron concentrate are treated in a gas-absorbing neutralization tank and then separated from the transparent solution by precipitation. Lead and zinc concentrates and slime bulk concentrates are oxidized and leached with ferric chloride solution, separating the precipitate from the transparent solution. Sulfur is precipitated as elemental sulfur, then the leached residue is recycled to the flotation process. The transparent solution, after leaching with ferric chloride, contains copper, lead, zinc, and other metallic ions. High purity metals are obtained by amalgam phase exchange in combination with amalgam electrolysis.

35303

Cattelain, Claude

**METHOD FOR TREATING ZINC BLAST FURNACE GASES.** (Metallurgical Processes Ltd., Nassau (Bahamas) and Imperial Smelting Corp. Ltd., London (England)) U. S. Pat. 3,592,631. 4p., July 13, 1971. 8 refs. (Appl. April 11, 1968, 2 claims).

A method is presented for conveying zinc blast furnace exit gases from a condenser to a scrubbing tower by means of a dry crossover duct. Prior practice was to use a crossover duct in the form of a downcomer to link the top of the condenser with the bottom of the scrubbing tower. This crossover duct was irrigated with water to attempt to minimize accretion of lead and zinc oxides. However, accetions were still a problem. In the present process, the duct is sloped upward towards the scrubbing tower to return liquid metal to the condenser. The scrubbing tower includes sprays for cooling and saturating the gases in order to avoid accretion at the end of the duct or tower. (Author abstract modified) 0

35342

White, W. F.

**CENTRIFUGAL SEPARATIONS -- WATER CLARIFICATION VIA CENTRIFUGE.** Chem. Eng. Progr., 67(9):45-48, Sept. 1971. 2 refs.

The use of centrifuges for dewatering sludges collected from wet scrubbers in basic oxygen furnace shops is discussed. in a typical shop with a capacity of 16,000 tons/day, approximately 3000 gal/min of water is used in the scrubbing system. The water discharged to the water-clarificaton system is normally one and a half percent to three percent solids. A preclassification system will remove approximately 20-40% of the dust; the remainder going to the clarifier will be essentially minus 100 mesh, with most of the discreet particles less than two micron. This extremely fine material settles fairly readily: underflow from the thickener will generally be 15-35% solids. Continuous solid bowl centrifuges are successfully used to dewater this underflow. The machines range in size from small 24 by 38 in machines handling two tons/hr of solids to 36 by 74 or 96 in machines handling up to five to 10 tons/hr. Maintenance on the larger equipment is about 12-15 cents ton. The centrifuge systems can be designed for use with polyelectrolyte flocculants. Other areas of application of solid bowl centrifuges are electric furnace plants and furnaces used for lead-scrap recycling. Lead oxide dust can cause problems in the system by caking and clogging the centifuge.

35352

Grantham, L. F. and S. J. Yosim

**REMOVAL OF LEAD FROM GASES WITH MOLTEN ALKALI METAL CARBONATES.** Am. Chem. Soc., Div. Petrol. Chem., Preprints, 16(2):E88-E99, March/April 1971.

Laboratory experiments to remove lead-containing vapors and particulates from automobile exhaust gases using molten alkali metals (lithium, sodium, and potassium) are examined. Techniques whereby the gas was impinged on the molten salt surface and contacted on a mesh scrubber wetted with molten salt were used to test lead removal. Apparatus, test procedure, particulate size, and experimental results are discussed. Lead removal efficiency by impingement of the gas containing lead halides increased as impingement velocity increased, with gas temperature, flow rate, residence time, and lead concentration as effective parameters. The percent of lead particulates remaining in the gas phase increased as the gas velocity through the mesh increased but decreased as gas residence time in the wetted wash increased.

: 76

Henson, C. G.

**POLLUTION FROM BOILER STACKS AND ENGINE EXHAUSTS - THE CHEMISTRY OF AIR POLLUTION AND ITS SOLUTION BY THE PROFIT FACTOR.** Clean Air, 1(3):22-28, Autumn 1971. 9 refs.

Pollutant emissions from boiler stacks and engine exhausts are examined with respect to chemical interactions, effects on materials, emission levels, control measures, fuel additives, and effects on human health. Gaseous products of combustion from boiler stacks or engine exhausts include carbon dioxide, carbon monoxide, smoke, sulfur oxides, sulfuric acid, nitrogen oxides, unburned hydrocarbons, acid smut, particulates, and fly ash. The use of lead as an anti-knock agent in petrol engines also contributes to noxious emissions. Remedial measures consider such factors as combustion engineering, operating variables (excess air supply), electrostatic precipitators, scrubbers, filters, and fuel content. Fuel additives such as manganese can also reduce smoke and other emissions.

35478

Aizenberg, B. Sh., A. G. Belikov, D. L. Bukhanovskii, G. M. Gordon, V. P. Kovalev, G. A. Matrakhin, Ya. V. Mishurin, and V. N. Tsessarskii

**OPERATION OF A BAG FILTER WITH AIR JET FABRIC CLEANING.** Soviet J. Non-Ferrous Metals (English translation from Russian of: Tsvetn. Metal.), 42(8):44-48, Aug. 1969. 1 ref.

The operation of bag filters with air jet cleaning to control the dust content of waste gases was tested on lead smelting shop exhaust gases in a pilot plant study. Components of the system, operating procedures, and variable operational factors were examined. Test results and design criteria are included. The experimental filters produced dust outputs of 3.20-7.50 mg/n cu m, 2.0-3.6 mg/n cu m, and 4.3-7.3 mg/n cu m under different conditions.

35535

Szczeniowski, Boseslaw

**THE PROBLEM OF LEADED GASOLINE.** Eng. J. (Montreal), 54(11):22-24, 27, Nov. 1971. 21 refs.

Redesigning the engine for lower compression ratios does not appear to be the best approach to the problem of tetraethyl lead in gasoline. Tetraethyl lead, in which there is about 64% lead by weight, is the most effective antiknocking agent discovered to date. The most effective substitute antiknock substance among liquids that may be contemplated as an additive to gasoline with practical hope is ethanol, more than twice as effective as benzene. Moreover, experience has shown that the addition of ethanol to gasoline reduces combustion chamber deposits concurrently. The problem of avoiding the use of tetraethyl lead in fuel is considered, as well as the conflicting opinions of the industry and researchers involved.

35540

Yocom, J. E. and W. A. Cote

**INDOOR/OUTDOOR AIR POLLUTANT RELATIONSHIPS FOR AIR-CONDITIONED BUILDINGS.** ASHRAE (Am. Soc. Heat. Refrig. Air-Cond. Eng.) Proc., vol. 77::61-71, 1971. 13 refs.

The quality of indoor atmospheres is a complex function of a number of variables which include outdoor levels of pollutants, indoor generation of pollutants, permeability of the building, meteorology, and type of ventilation or air conditioning system and its method of operation. A 20-month study of indoor/outdoor air pollutant relationships was conducted at a number of buildings in and around Hartford, Conn., and an analysis is presented of the results obtained in two air conditioned office buildings. Total and respirable suspended particulate matter, soiling particulate matter, carbon monoxide, and sulfur dioxide were measured. Suspended particulate matter inside the buildings was only about one-half that measured outside when makeup air rates were low, indicating that roughing filters used in air conditioning systems are effective in the removal of relatively large particles. Air conditioning systems were not especially effective in the removal of that portion of particulate matter which contains the benzene soluble organic material, the inorganic lead, or which accounts for the soiling properties. As might be expected, carbon monoxide was not affected by air conditioning components.

35688

Sorem, S. S.

**EFFECTS OF FUEL FACTORS ON EMISSIONS.** Preprint, Society of Automotive Engineers, Inc., New York; American Chemical Society, Washington, D. C.; American Inst. of Aeronautics and Astronautics, New York; American Inst. of Chemical Engineers, New York; and American Society of Mechanical Engineers, New York, 9p., 1970. 34 refs. (Presented at the Bay Area Air Pollution Symposium, Menlo Park, Calif., Sept. 21-22, 1970, Paper 710364.)

Possibilities for reducing automobile emissions through changes in gasoline composition are discussed. Small benefits are achievable by limiting front-end volatility and light olefin content; California has already passed legislation limiting these fuel properties. Fuel hydrocarbon type, octane number, and lead antiknock content are interrelated. Maintenance of octane number while removing lead can be achieved by increasing aromatic content, but with a resulting increase in exhaust reactivity. Alternatively, lead can be removed without changing hydrocarbon composition if engine octane number requirement is reduced. While these changes may reduce exhaust hydrocarbons, they will lower engine efficiency, and thus increase exhaust flow rates. The net effect on pollutant emission s is in doubt. Gasoline additives, other than lead, have little direct effect one engine exhaust. They do perform functions that minimize the deterioration of engine emission characteristics. (Author abstract modified)

35703

Koepernik, Karl Hermann

**A METHOD OF PRODUCING A CATALYST OF LOW SENSITIVITY TO LEAD FOR OXIDISING THE EXHAUST GASES OF MOTOR CARS.** (Kali-Chemie A. G., Hannover (West Germany)) Brit. Pat. 1,143,823. 4p., Feb. 26, 1969. 3 refs. (Appl. Sept. 21, 1966, 8 claims).

A method of producing a catalyst of low sensitivity to lead is presented for oxidizing exhaust gases of automobiles. A pseudoboehmite with an ignition loss of 24 to 30% and a sodium monoxide content below 500 ppm is made into a paste with a solution of an ammonium salt of a volatile acid and with acetic acid, hydrochloric acid, or nitric acid. It is then extruded, dried at 50 to 70 C, calcined at 800-900 C, and impregnated with a solution containing 0.5 to 3 gram atoms each of copper and chromium per liter, dried, and finally activated at 750 to 850 C. The pseudoboehmite can be obtained in various ways, for instance by precipitation from the reaction of an aluminum nitrate solution with nitric acid, or by the hydrolysis of aluminum alcoholates or glycolates.

35778

Adams, W. E., H. J. Gibson, D. A. Hirschler, and J. S. Wintringham

**MEETING FUTURE EMISSION STANDARDS WITH LEADED FUELS.** J. Automotive Eng., 2(10):12-16, Nov. 1971. 8 refs.

Since exhaust emissions are now measured on a mass basis, the smaller mass of emissions with a higher compression ratio becomes a very important consideration. Furthermore, the higher compression ratio can permit operation at leaner air/fuel ratios and allow the use of higher rates of exhaust gas recycle. Both these advantages of high compression are used in the lean-reactor car program of the Ethyl Corporation. Hydrocarbons, carbon monoxide and nitrogen oxides can be minimized. A three-venturi carburetor was developed to produce a lean air/fuel ratio. Reaction in the exhuast system is improved by conserving heat in the exhaust ports by lining them with stainless steel tubes insulated from contact with the cooled walls of the exhaust ports. Further reaction is promoted by substituting larger than normal exhaust manifolds

of thin stainless steel for the conventional cast iron manifolds. The very stringent standards for nitrogen oxides require exhaust gas recycling, while lead particulates can be agglomerated by cooling the exhaust gases. The gases are then passed through a cyclone to precipitate particulates. An experimental car was produced which is close to meeting 1975 emission standards. The lean-reactor car has eliminated 95% of the unburned hydrocarbons, 90% of the CO, and 80% of NOx.

35814

Roth, James F.

**COPPER-BASED AUTO EXHAUST CATALYSTS: MECHANISMS OF DEACTIVATION AND PHYSICAL ATTRITION.** Am. Chem. Soc., Div. of Petrol. Chem., Preprints, 16(2):E53-E58, March [illegible]. 11 refs. (Presented at the [illegible] geles Meeting, March 28-April 2, 1971.)

The physical attrition of copper-based exhaust catalysts on alumina supports was studied in road tests and in synthetic laboratory atmospheres. The road tests resulted in a marked depletion of copper from catalyst surfaces and appreciable deposition of lead on surface and subsurface layers. The laboratory tests identified cyclic oxidation-reduction as the cause of physical attrition of poorly dispersed copper-based catalysts in leaded or nonleaded atmospheres. Halides introduced into auto exhaust from the lead motor mix contributed significantly to deactivation via depletion of the active component from the catalyst surface. Highly dispersed catalysts had good attrition resistance even under cyclic conditions. The degree of dispersion of the copper component depends in part on copper content, support properties, and method of deposition of copper on the support. Mechanical properties of the support, beyond minimal levels of crushing strength, have little or no bearing on the attrition resistance of coper-based catalysts. (Author conculsions modified)

35816

Hyman, M. H. and W. R. Pyle

**GASOLINE LEAD ADDITIVES -- A BALANCED VIEWPOINT.** Am. Chem. Soc. Div. of Petrol. Chem., Preprints, 16(2):E107-E112, March 1971. 7 refs. (Presented at the Los Angeles Meeting, March 28-April 2, 1971.)

Increasing aromatics content with reformate is an economic path to boosting lead-free octanes. However, increased aromatics content can cause fuel sensitivity to be worse. Gasoline blended without lead should contain enough branched-chain paraffins to cancel this effect. Among the environmental benefits of increased reformate manufacturing are less sulfur in gasoline; more hydrogen (a reformate by-product) available for desulfurizing other fuels; more availability of natural gas (otherwise consumed in hydrogen manufacturing); and more availability of high-octane liquefied petroleum gas (another reformated by-product). The main disadvantage is higher crude oil consumption. However, this may be offset by sales of compact cars with high fuel economy. Other benefits of withdrawal of lead additives from gasoline are less atmospheric haze, less corrosion of vital auto parts, and the ability to use a wider variety of control devices.

35821

**ROTARY ENGINE EXHAUST EMISSIONS.** SAE Australasia, 31(5):187, Sept.-Oct. 1971.

Because its high surface/volume ratio permits combustion to be carried out at a comparatively low temperature, the rotary engine emits fewer nitrogen oxides than a reciprocating engine. Emissions of carbon monoxide are similar for the two engines and emissions of hydrocarbons a little higher for the rotary engine. A specific advantage of the rotary engine in exhaust emission control is that it can accomodate control devices, such as thermal reactors, air injectors, and thermal reactors, much more readily than present reciprocating engines. With their superior knocking resistance and no valves, rotary engines can also operate satisfactorily on lead-free gasoline.

36081

Lindsay, R., A. Thomas, J. A. Woodworth, and E. G. Zeschmann

**INFLUENCE OF HOMOGENEOUS CHARGE ON THE EXHAUST EMISSIONS OF HYDROCARBONS, CARBON MONOXIDE, AND NITRIC OXIDE FROM A MULTICYLINDER ENGINE.** Preprint, Society of Automotive Engineers, Inc., New York, 14p., 1971. 23 refs. (Presented at the Society of Automotive Engineers, Mid-Year Meeting, Montreal, Quebec, June 7-11, 1971, Paper 710588.)

A fuel-air mixture generator has been developed which allows a vehicle to be run on a chassis dynamometer under both transient and steady-state conditions on premixed homogeneous gasoline-air mixtures using conventional nonleaded gasoline. Under these conditions, cylinder-to-cylinder variations of air/fuel ratio and of carbon monoxide emission from a 90-cu inch four-cylinder engine were virtually eliminated, and variations of nitric oxide emissions were greatly reduced. However, variations in hydrocarbon emission were scarcely affected. With the premixed charge the vehicle could be run on an extremely lead air/fuel mixture, while retaining good driveability. At an air/fuel ratio of 22.5/1, CO and NO emissions over the U.S. Federal cycle according to the 1970 test procedure were 2.7 and 0.4 g/mile, respectively. However, unburned hydrocarbon emissions exceeded current legislative requirements. (Author abstract)

36144

Giles, William

**VALVE PROBLEMS WITH LEAD-FREE GASOLINE.** Preprint, Society of Automotive Engineers, Inc., New York, 9p., 1970. 7 refs. (Presented at the Society of Automotive Engineers, Mississippi Valley Section Meeting, Oct. 22, 1970, Paper 710368.)

High exhaust valve recession rates were observed in light duty engines operating on lead-free gasoline. Recession proceeded 10-20 times faster than with leaded fuel, and occurred on the integral cylinder head sets. The reddish deposits covering recessed valves had a high iron concentration and a low zinc concentration. Adhesive wear was the most common type of wear phenomenon, and the only type present in all cases of surface contact. An equation developed for predicting volume of material lost through adhesive wear identifies the parameters which should be modified to reduce valve seat recession. Engine tests showed valve seat angle and cylinder head seat hardness and/or structure are the most significant factors in reducing wear. Coatings, wide seats, and improved valve train stability by themselves are insufficient to stabilize wear rates. Wide seats, use of seat inserts, and lower seat angles resulted in shortened valve burning life in engines run with leaded gasoline. Induction-hardened cylinder head seats reduced wear with no effect on valve durability.

36145

Gallopoulos, N. E.

**PROJECTED LUBRICANT REQUIREMENTS OF ENGINES OPERATING WITH LEAD-FREE GASOLINE.** Preprint, Society of Automotive Engineers, Inc., New York, 9p., 1971. 47 refs. (Presented at the Society of Automotive Engineers, Mid-Year Meeting, Montreal, Quebec, June 8-11, 1971, Paper 710585.)

Changes in compression ratio, spark timing, exhaust gas recirculation, catalytic converters, crankcase and evaporative controls, modifications in air-fuel ratio, and emission controls in engines burning unleaded gasoline will reduce the concentration of nitrogen oxides in blowby gas, blowby gas flow rate, and reduce other emissions. With proper engine cooling systems, engine oil temperatures may not be affected. The consequences of these changes for engines using high quality (SE) oils at current drain intervals are virtual elimination of rust; reduction of sludge; no effect on wear and oil thickening; and possible worsening of varnish. Therefore, extension of the drain interval with SE engine oils may be possible, but final decisions will depend on research findings in the areas of engine wear and varnish and oil thickening. A desirable property of future oils is low metallic content. (Author abstract modified)

36453

Black, E. N., IV, W. E. Askey, J. R. Smith, and J. W. Stephens

**REDESIGN OF EXISTING CATALYTIC REFORMING UNITS FOR OCTANE IMPROVEMENTS.** Preprint, American Inst. of Chemical Engineers, New York, 21p., 1971. (Presented at the American Institute of Chemical Engineers, National Meeting, 68th, Houston, Tex., Feb. 28-March 4, 1971.)

Recent announcements by major petroleum companies have indicated a decrease in the amount of lead alkyls used in gasoline. This trend is expected to accelerate and refiners today must consider alternate methods of octane improvement. Redesign of existing catalytic reformers for higher octane and/or hiher throughput is discussed. These redesigns require more severe operating conditions with the attendant higher coke make which can be accommodated by changing to the new coke tolerant catalysts that contain not only platinum but also an additional metal such as rhenium (bimetallic catalysts), or by conversion of a semi-regenerative plant to fully regenerable (cyclic) operation. Several proposed conversions from semi-regenerative operation using conventional platinum-alumina catalyst (platinum catalyst) to either semi-regenerative operating using bimetallic catalyst or cyclic operation are presented. The cases that are presented are based on feasibility studies of actual commercial units. Costs are cited. (Author introduction modified)

36523

Nelson, Edwin

**CONTROL OF AUTOMOTIVE AIR POLLUTON.** J. Environ. Health, 34(3):304- 310, Nov./Dec. 1971. (Presented at the Annual Education Conference, 35th.)

Progress made by General Motors in controlling automotive emissions and company plans for producing an essentially pollution-free vehicle are discussed. Between 1960 and 1971, the company achieved an 80% reduction in hydrocarbon emissions and a 65% reduction in carbon monoxide emissions from its cars. All 1971 models meet the California standards for nitrogen oxides. Advanced control techniques under evaluation include improved carburetion, electronic fuel injection, exhaust gas recirculation (EGR), manifold reactors, and catalytic converters. Availability of unleaded gasoline on a nation-wide basis should permit the company to translate some features of these techniques into production cars meeting 1975 standards. Alternate power plants such as turbines and steam engines are also mentioned.

36578

Bernstein, L. S., K. K. Kearby, A. K. S. Raman, J. Vardi, and E. E. Wigg

**APPLICATION OF CATALYSTS TO AUTOMOTIVE NOX EMISSIONS CONTROL.** Preprint, Society of Automotive Engineers, Inc., New York, 17p., 1971. 10 refs. (Presented at the Automotive Engineering Congress, Detroit, Mich., Jan. 11-15, 1971, Paper 710014.)

Nickel-copper alloys, marketed under the name of Monel were extremely active nitrogen oxides reduction catalysts. Monel is usually used in catalytic afterburners. At temperatures above 1300 F, and under net reducing conditions, Monel will catalyze the removal of 90% or more of the nitric oxide in automotive exhausts at space velocities of up to 100,000 v/v/hr. On unleaded fuel, Monel catalysts show good activity maintenance in mileage accumulation runs as long as 31,000 miles. Catalyst life is limited by physical deterioration of the catalyst which causes increases in exhaust back pressure. On unleaded fuel, Monel in its present form will last approximately 10,000 miles at 1700 F (60 mph) before back pressure begins to rise rapidly. The presence of lead in the fuel substantially increases the rate of Monel deterioration. When Monel is used as part of a dual-bed catalyst system, two problems, which appear to be generic to dual-bed catalyst systems, arise. First, under normal operating conditions, roughly 10% of the NO in the untreated exhaust reacts with hydrogen to form ammonia in the Monel bed. This ammonia can be oxidized to NO in the oxidation bed. Ammonia formation can be decreased by careful control of exhaust composition. Alternatively, the concentration of nitric oxide in the untreated exhaust can be lowered by exhaust gas recycling so that even with ammonia formation, the nitric oxide concentration in the treated exhaust will be low enough to meet low emissions standards. Placing Monel or any other NOx reduction catalyst ahead of the oxidation catalyst slows the warm-up of the oxidation catalyst. This problem was attacked by placing the catalyst system close to the exhaust ports and modifying the exhaust system to conserve exhaust gas sensible heat. (Author abstract modified)

36721

Lindsay, R. and A. Thomas

**POLLUTION FROM ROAD VEHICLES. (A) RECENT DEVELOPMENTS IN THE CONTROL OF EXHAUST EMISSIONS FROM PETROL ENGINES.** Nat. Soc. Clean Air, Proc. Ann. Conf., p. 118-136, 1970. 7 refs. (Presented at the National Society for Clean Air, Annual Conference, Southport, England, Oct. 20-23, 1970.)

Types of pollutants from the three main sources of undesirable automotive emissions (the crankcase, fuel tank/fuel system, and engine exhaust) and associated control technology are summarized. The technical problems of limiting crankcase and evaporative emissions are well under control, but much further progress is required in reducing exhaust emissions. Thermal reactor/exhaust gas recirculation and catalytic treatments are discussed as future exhaust emission control methods. Fuel composition, detergent additives, and ignition control additives have some effect in reducing emissions. There is an enormous cost involved in removing lead additives from fuel; however the technology exists if the community decides to pay the

extra cost in money and material resources. Alternative fuel (liquefied gases) and alternative automotive power sources are noted. A joint research program by the automotive and oil industries is underway. A packaged emission control system and improved vehicle maintenance are major approaches to controlling emissions in cars already in use. The costs of emissions control are discussed; these increase substantially with decreasing emissions levels. The legislative requirements for vehicle emissions in several countries are summarized.

37042

Hancock, E. E., R. M. Campau, and R. Connolly

**CATALYTIC CONVERTER VEHICLE SYSTEM PERFORMANCE: RAPID VERSUS CUSTOMER MILEAGE.** Preprint, Society of Automotive Engineers, Inc., New York, 25p., 1971. 6 refs. (Presented at the Automotive Engineering Congress, Detroit, Mich., Jan. 11-15, 1971, Paper 710292.)

Two types of catalysts were tested in a fleet of 24 1969 vehicles operated in customer-type urban driving regimes, on both leaded and nonleaded fuels over a period of one and one-half years. The two catalyst types, and the converter systems chosen for this evaluation, were selected on the basis of information obtained from an earlier test program involving four cars durability-tested on a more rapid test track mileage accumulation cycle, indicating that operation on leaded fuel would seriously affect the life of the catalyst. However, the 6000-mi. average emission objectives were met for the fleet. The 24-car fleet demonstrated that many other problems, such as catalyst attrition with resultant converter plugging, must be solved. Converter designs should incorporate optimum exhaust flow distribution through the catalyst to minimize exhaust velocity effects. Catalyst size, shape and physical integrity, and/or support play an important part in overall catalyst life. If stringent emission targets are to be met, converters must be designed for fast warm-up and be located close to the engine exhaust outlets. Secondary air is required, and the use of spark retard on warm-up is advantageous. A means of diverting the exhaust gas around the catalyst bed is necessary to prevent catalyst damage from over-temperature during some operating modes and during periods of engine malfunction. The 24-car fleet was equipped with a programmed protection system designed to protect the catalysts from such damage. The use of nonleaded fuel during road operation extends the life of catalyst emission reduction systems.

37116

Kaneko, Yasuo, Hiroshi Kuroda, and Kazuyuki Tanaka

**SMALL ENGINE - CONCEPT EMISSION VEHICLES.** Preprint, Society of Automotive Engineers, Inc., New York, 19p., 1971. 5 refs. (Presented at the Automotive Engineering Congress, Detroit, Mich., Jan. 11-15, 1971, Paper 710296.)

Three Japanese automobile manufacturers are engaged in research and development work on thermal reactor-exhaust gas recirculation (EGR) and catalytic converter systems for small engine vehicles. The companies are participants in the Inter-Industry Emission Control Program which aims at developing a virtually emission-free vehicle. Specific emission targets are 0.82 g/mile for hydrocarbons, 7.1 g/mile for carbon monoxide, 0.68 g/mile for nitrogen oxides, and nil loss from the crankcase. The emission levels of three concept vehicles developed by the Japanese companies meet the IIEC goals at low mileage. Control packages for the vehicles are a thermal reactor plus EGR, using leaded or unleaded gasoline; a hydrocarbon-carbon monoxide converter plus EGR, using unleaded or low-lead gasoline; and a hydrocarbon-carbon monoxide catalytic converter, using unleaded gasoline. Each package will require further research for improvement in fuel economy, durability, and driveability, as well as the establishment of good maintenance characteristics.

37150

Faust, W. J. and M. J. Sterba

**MINIMIZING EXHAUST EMISSIONS - A REALISTIC APPROACH.** Am. Soc. Testing Mater. Spec. Tech. Publ., no. 487:36-53, 1971. 13 refs.

Piston engines will be the dominant vehicular power plant for the next 20 years. Although modifications to engine design and operating conditions will reduce exhaust emissions substantially, catalytic exhaust gas converters will be required to reach the extreme low levels of emission desired. Lead-free gasoline will be required to permit the catalyst to function properly for the desired mileage. The initial drop in gasoline octane number, due to omission of lead, will be recovered gradually by refinery process changes. Gasoline will become more aromatic, more isoparaffinic, and less olefinic, while being reduced in sulfur content. The total content of polynuclear aromatics in the exhaust gas is shown to be not affected by a substantial increase in thy aromatic content of the gasoline. Polynuclear aromatics in the exhaust are oxidized almost completely by catalytic converters. Governmental actions, statements by the automotive industry, and statements by the petroleum industry are cited. (Author abstract)

37173

Schwarzenbek, Eugene F.

**CATALYTIC REFORMING.** Advan. Chem. Ser., no. 103:94-112, 1971. 5 refs. (Presented at the American Chemical Society and the Canadian Society for Chemical Engineering Joint Conference, Toronto, Canada, May 24-28, 1970.)

The role of the catalytic reforming process in meeting the future demand for high octane lead-free gasoline is discussed. An increase in the severity of reforming is needed to produce aromatic-rich fractions with octane numbers as high as 110. Octane improvement in catalytic reforming is a result of the dehydrogenation reaction to form aromatics and a hydrocracking reaction to convert higher-boiling paraffins to lower-boiling higher octane material. Pressure is the operating variable controlling the relative amounts of these two reactions. Hydrocracking is promoted by high pressure, dehydrogenation by low pressure. Higher pressures increase gas and butane production, while lower pressures show a greater advantage in liquid product yield. The new platinum-rhenium catalysts show improved stability and will allow the design of low-pressure semiregenerative systems without the requirement of high-investment regeneration facilities. The economics of a semiregnerative unit operating at 200 psig are detailed. Even at this pressure, the selectivity is more for hydrocracking than dehydrocyclization, so further improvement in catalyst formulation is needed. (Author abstract modified)

37195

Matsumoto, Kiyoshi

**PRESENT STATE OF COUNTERMEASURE FOR EXHAUST GAS FROM GASOLINE ENGINES.** (Gasorin kikan ni okeru haishutsu gasu taisaku no genjo). Text in Japanese. Preprint, Japan Society of Mechanical Engineering, Tokyo, 13p., 1971. 9 refs. (Presented at the Seminar on Environmental Pollution by Internal Combustion Engine and its Countermeasure, Tokyo, Japan, Nov. 29-30, 1971.)

Automotive exhaust emission standards and studies made in the United States and Europe are reviewed; the countermeasures in Japan are discussed. Since the lead pollution episode in Tokyo in May 1970, lead additives in gasoline have become an object of study. Complete omission of lead from gasoline is scheduled to be legalized in April 1974. However, by subsequent investigation, it became clear that non-lead gasoline caused problems of valve recession, wearing the valve seat severely. Research is being conducted for developing an engine that can use non-lead gasoline and for additives that can replace lead. Already lead additives in gasoline 0have been reduced to 0.7 - 0.9 g/gal in premium gasoline and to 0.5 g/gal in regular gasoline. Inprovements are being made on cars by attaching idle limiters, in carburetion in the intake manifold, in thermostatic air cleaners, and fuel jet engines. For control of hydrocarbons, improvements are being made on the shape of the combustion chamber by reducing surface/volume ratio and increasing stroke/bore ratio, or preventing knocking. Some other improvements that have been suggested are delay of spark timing, increased of air supply at the time of idling, use of a throttle positioner or opener, use of a dash pot, or decrease of the fuel supply in case of a fuel injection engine. In order to control the amount of nitric oxide emissions, lowering the compression ratio, delaying ignition time, enlarging the valve overlap, using a lower air/fuel ratio, or suction of inactive gas or water are suggested.

37222

Grantham, LeRoy F., William A. McCollum, Jr., and Dennis C. Gehri

**PROCEDURE FOR THE REMOVAL OF NITROGEN OXIDES AND OTHER IMPURITIES FROM GAS MIXTURES.** (Verfahren Entfernung von Stickstoffoxyden un anderen Verunreinigungen aus Gasmischungen). Text in German. (North American Rockwell Corp., El Segundo, Calif.) W. Ger. Pat. 2,108,059. 74p., Aug. 19, 1971. (Appl. Feb. 19, 1971, 31 claims).

Power-plant waste gases and automobile exhaust containing nitric oxide, carbon monoxide, halogens, halides, metal oxides, or fly ash were purified by bringing them into contact with alkali metal carbonates or mixtures containing lithium carbonate 45 plus or minus 5, sodium carbonate 25 plus or minus 5 mole% on a metal wire-lattice of stainless steel, nickel, or copper-nickel-iron alloys at 350-600 deg. Passage of automobile exhaust at 395 deg through a 20-liter vessel containing a stainless steel grating net with molten alkli metal carbonate resulted in removal of up to 95% of the lead in the exhaust and 15-50% of the NO. The degree of removal depended on driving speed and contact time.

37234

Oelert, Henning H.

**GASOLINE WITHOUT LEAD. TECHNICAL AND HYGIENIC ASPECTS OF LEAD EMISSION BY OTTO ENGINES.** (Benzin ohne Blei. Technische und hygienische Aspekte der Bleiemission von Ottomotoren). Text in German. Umwelt (Duesseldorf), 1(6):36-39, Dec. 1971.

The lead emitted by automobiles produces emissions which are clearly below the maximum allowable concentration. To date, no physical damages on humans through the lead emission into street air are known. However, not much is known yet about long-term effects. The law in the Federal Republic of Germany requires a reduction of the lead content in gasolines to 0.4 g/l beginning in 1972 and to 0.15 g/l in 1976. Lead-free and low-lead gasolines with sufficient octane number can be produced by familiar methods with an acceptable cost increase. The operation with lead-free gasoline has a general emission preventing effect. Damages on the engine were observed only in rare cases. Lower lead emissions improve the possibility for catalytic afterburning. Tests with lead-free fuel which contained 60 to 80% paraffin showed that the hydrocarbon concentration in the exhaust gas was slightly raised. The fuel composition had no influence on the emitted concentration of polycyclic aromatics. The quantity of polynuclear hydrocarbons emitted is determined by the air/fuel ratio and the rpm. In the future all efforts will be directed toward a reduction of the hydrocarbon emissions to zero. Catalytic afterburning reduces the carcinogenic polynuclear aromatics by 98%, even after longer operating times.

37275

Tinard, Henri

**THE 1972 AUTOMOBILE (CONTINUATION). THE FIGHT AGAINST AIR POLLUTION: A COMPLEX PROBLEM.** (L automobile 1972 (suite). La lutte contre la pollution: un probleme complexe). Text in French. Concours Med. (Paris), no 45:7961-7964, Nov. 1971.

Perfect combustion can be approached by improvements in carburetors, fuel-air adjustment, and spark plugs. Settings made factorially are temporary only. Fuel injection providing uniform fuel distribution is applied in relatively expensive cars only. Catalytic and afterburning methods are expensive, and the catalytic effect is deteriorated by lead additives. To make catalysts more effective, the use of lead should be discontinued. The absence of lead in fuels could be compensated for by expensive refinery processes, lowered compression ratios, or increased stroke volumes. Improvements of carburetion, injection, and ignition air points of main concern at the present time. For city traffic, the electric car would be an ideal solution. West European and Japanese 1972 car models are reviewed.

37408

**PRECIOUS METALS IN MODERN TECHNOLOGY.** (Edelmetalle in der modernen Technik). Text in German. Metall. Berlin, 26(1):72-73, Jan. 1972.

The stepped-up measures against environmental pollution have called for a lead-free gasoline. In order to achieve the same antiknocking properties in lead-free gasolines as in leaded ones, a larger quantity of reforming catalyst is needed. An increase of the platinum consumption is thus expected. Automobile exhaust gases from engines driven with lead-free gasoline can efficiently be cleaned by Pt catalysts. There is a tendency though to replace these calalysts by non-precious metal catalysts. For afterburning of toxic and odorous waste gases from other sources, precious metal catalysts are preferably used. (Air pollution discussed on p. 73.)

37468

Research Committee for Automobile Fuels (Japan)

**REPORT OF THE COLLABORATIVE STUDY ON EXHAUST VALVE SEAT RECESSION.** (Haiki barubu shiito risesshon kyodo kenkyu hokoku). Text in Japanese. 53p., Sept. 1971.

Field and laboratory tests were conducted from Dec. 1970 in order to achieve comprehensive and high-degree purification of automobile exhaust gases. The tests involved evidence of the occurrence of valve seat recession; effect of valve seat recession on exhaust gases; and development of a preventive technique such as preventive agents for valve seat recession. Four kinds of cars having engine exhaust gas amounts of 360 cc, 1.3 l, 1.5 l, and 1.9 l and three kinds of trucks with loading

capacities of 350 kg, 2 t, and 3.5 t were used for the experiments. The experiments were performed with non-lead gasoline, lead gasoline (TEL 0.2 cc/gal and 0.5 cc/gal), and phosphor added gasoline (P 0.7 g/cal). The influence of exhaust valve recession on exhaust gases and the effect of lead and phosphor compounds were also studied. The more the cars accelerated and the smaller the amount of engine exhaust gas, the more valve seat recession occurred. The exhaust of non-combustion hydrocarbons caused by the exhaust valve recession was apt to increase in proportion to the number of recessions. Phosphor compounds for prevention of valve seat recession was tested in different engines. It proved to be efficient, but the examination was not carried out concerning added amounts of phosphor compounds and air pollution caused by phosphor compounds.

37619

Forster, E. J. and L. E. Stinson

**CARS NEED MORE OCTANE WITHOUT LEAD.** Hydrocarbon Process., 49(12):97-99, Dec. 1970. 2 refs.

The octane number requirements of 29 unleaded-fuel cars using unleaded reference fuels were compared with the requirements of 29 leaded-fuel cars using leaded reference fuels. The cars included 23 1965 model cars and six 1968 model cars, each tested for an average of 56,000 miles. The octane requirement was surprisingly higher for all cars run on unleaded fuels, i.e., 4.6 RON higher for cars run on premium lead-free gasolines and 6.3 RON higher for cars run on regular lead-free gasolines. The higher requirement of unleaded cars was influenced to a large extent by greater deposit accumulation in the combustion chambers. The results indicate that new cars may have to be designed with lower octane requirements or that unleaded-fuel quality must be higher than 91 RON.

37750

Schulz, Ulrich and Ulf Richter

**INFLUENCE OF TECHNOLOGICAL FACTORS ON THE DEGREE OF SEPARATION OF ELECTRIC FILTERS IN NON-FERROUS METALLURGY.** (Einfluss technologischer Parameter auf den Abscheidegrad von Elektrofiltern in der NE-Metallurgie). Text in German. Neue Huette, 16(7):385-390, July 1971. 13 refs.

The flying dust generated in non-ferrous metallurgical furnaces is mostly composed of oxidized particles of zinc, lead, tin, antimony, and arsenic. Sheet-type filters and electrostatic precipitators are used for removal and recovery of these dust types. Due to the generally high specific electric resistance of the dust, the process can be carried out effectively only by adhering to certain values of precipitation temperature and water content of the gas phase. To establish design parameters for the construction of precipitators for the non-ferrous metal industry, the precipitation rate of waste gases derived from various metallurgical furnaces for copper, zinc, tin, and lead was measured by a laboratory-type electrostatic precipitator. The influence of precipitation temperature and water content of the gas phase on the precipitation rate was investigated. The results of measurements of precipitation rates and electric resistance of the separated dust material, in combination with theoretical considerations, lead to the conclusion that with dust of a specific electric resistance of less than 10 to the 10th ohm cm, the precipitation rate is influenced by temperature, dew point of gas, viscosity of gas, and voltage of electric field, independent of the specific electric resistance of the dust. Above 10 to the 10th and up to 10 to the 11th ohm cm, the precipitation rate is related to the specific electric resistance of the dust.

37845

Kimberley, J. L.

**LEAD IN GASOLINE. AN EVALUATION OF THE SITUATION IN THE UNITED STATES IN SEPTEMBER 1971.** (Blei im Benzin. Eine Betrachtung der Lage in den USA im September 1971). Text in German. Metall (Berlin), 26(1):65-67, Jan. 1972.

There has been much talk about lead elimination in gasolines. Many argue that the lead has to be removed first from the gasoline in order to clean the exhaust gases by catalysts. There are several factors, however, which speak for the keeping lead in gasolines. The lead concentration in the atmosphere is at the moment still far below 4 micrograms/cu m in most cities. Despite seemingly increasing lead content of the atmosphere over large cities, no reliable proof exists that the lead content in the blood of the population is on the rise too. A study, concluded in Dec. 1969, revealed that the women in Pasadena had less lead in the blood than women living in Rittenhouse Square in Philadelphia, although the lead concentration in the air over Rittenhouse Square is just half as high as that in Pasadena. The inexpensive catalysts for cleaning the exhaust gases could not be realized. The costs rose to $500 by now. Systems with lead, with thermal reactors for carbon monoxide and hydrocarbon removal, and with waste gas recirculation for the elimination of the nitrogen oxides with particle collection seem so much better. There is a growing belief that lead-free gasolines will lead to an earlier wear of valves which might cause a massive increase of exhaust gases. There are continuous efforts to find new catalysts resistant to lead.

37938

Rixmann, W.

**THE DEVELOPMENT OF THE TWO-DISK-NSU-WANKEL ENGINE IN THE MODEL RO 80.** (Zur Entwicklung des Zweischeiben-NSU-Wankelmotors im RO 80). Text in German. Automobiltech. Z. (Stuttgart), 73(12):476-478, Dec. 1971. 3 refs.

The hydrocarbon emission by the RO 80-NSU-Wankel engine is twice as large as that of the conventional piston engine. Through the higher exhaust gas temperature (100 to 150 C above that of conventional engines), thermal afterburning can be easily and efficiently carried out. The hydrocarbons can be eliminated almost entirely. The carbon monoxide emission depends only on the fuel/air ratio. Afterburning also reduces the CO drastically. The nitrogen oxides concentration in the exhaust gas of the RO-80 engine is far below that of the conventional engine to begin with. It is only 30% of that of the conventional engine. Thus the engine meets the legal requirements set in the U. S. Moreover, the engine can be driven with normal gasoline. It still functions properly at an octane number of 90. The reduction of the lead content in the fuel will pose no problems for this engine.

38287

Welbergen, Johannes

**OPTIMUM SOLUTION OF THE PROBLEM AUTOMOBILE EXHAUST GAS DECONTAMINATION THROUGH UNLEADED FUEL.** (Optimale Loesung des Problems der Kfz-Abgasentgiftung ist der bleifreie Kraftstoff). Text in German. Erdoel Kohle (Hamburg), 24(11):713-715, Nov. 1971. (Presented at the Deutschen Akademie fuer Verkehrswissenschaft, Internationalen Verkehrswissenschaftlichen Kolloquium, Hamburg, West Germany, Oct. 18, 1970.)

Traffic contributes 60% of the total pollutant emissions. The Federal Republic of West Germany had 15.1 million passenger cars in 1971. This number will rise to 17.4 million cars in 1975

and to 19 million cars in 1980. The total carbon monoxide from cars will be 8 million tons for 1969. The passenger cars alone emitted more than 5 million tons of pollutants in 1970. A first step toward reduction of such emissions would be monitoring of the carburetor adjustment. Development of the conventional carburetor including the suction system should be contemplated. Such measures are only of a temporary nature, however. For a long-range solution of the problem the following measures seem to be quite promising: thermal reactors for the oxidation of CO and hydrocarbons plus waste gas return for prevention of high nitrogen oxide concentrations; a thermal reactor plus a catalyst for reduction of NOx in the exhaust gas; a thermal reactor plus a catalyst for oxidation of CO and CH plus exhaust gas return; oxidation catalyzation plus exhaust gas return; and a two-bed catalyst plant for reduction and oxidation. The fully catalytic exhaust gas treatment plus the use of unleaded gasoline is the solution with the lowest costs. The investment costs would cost the consumer $120, the current costs are $50/yr.

38614

Kaji, Katsuhisa

**AUTOMOTIVE EXHAUST GAS CLEANER.** (Jidosha yo haiki gasu seijosochi). Text in Japanese. (Nisshin Kogyo Co., Ltd. (Japan)) Japan. Pat. Sho 47-5331. 5p., Feb. 15, 1972. (Appl. Sept. 30, 1969, 1 claim).

Both a muffler with a self-contained catalyst designed to remove carbon monoxide, unburned hydrocarbons, and other impurities of the automotive exhaust gas and a lead filter to remove tetraethyl lead which becomes lead bromide, they are usually of a design so that the exhaust gas may flow through them all the time, regardless of the engine mode. It is well known that the quantity of harmful substances contained in the exhaust gas differs with driving modes and that these cleaning devices are not required at all under certain modes. Continuous exposure to exhaust gas naturally shortens the devices life span, especially that of the catalyst. This cleaner is designed so the exhaust gas may flow through the catalyst and the lead filter only when the exhaust gas has to be cleaned with them. To achieve this, it is equipped with the flow-channel control valve. The control valve installed in the exhaust gas channel consists of the electromagnetic valve (stop valve) synchronized with the negative pressure generated in the intake manifold of the engine and with opening of the carburetor s throttle valve controlling this negative pressure and the centrifugal positioner operating according to the rpm of the engine.

38727

Kniprath, Elmar and Wilhelm Goralczyk

**PROCEDURE FOR THE OXIDATION OF ARSENIC.** (Verfahren zur Oxydation von Arsenik). Text in German. (Norddeutsche Affinerie, Hamburg (West Germany)) W. Ger. Pat. Appl. 2,020,308. 8p., April 25, 1970. (2 claims).

A process for the oxidation of arsenic to recover arsenic acid from the dust in flue gases emitted by a nonferrous metal foundry is presented. Previous methods for the oxidation of arsenic used strong oxidizing agents, primarily nitric acid, which caused heavy corrosion. The regeneration of the nitrose-containing waste gas was also a problem. Based on the present process, 4 l of slurry from the washing of converter waste gases of the foundry containing 126 g/l arsenic, 24.4 g/l lead, 18.35 g/l copper, 1.8 g/l antimony, 3.0 g/l tin, 20.0 g/l selenium, 52.0 g/l sulfates and sulfides, 650.0 g/l sulfuric acid, 65.0 g iron, and 0.7 g hydrogen chloride was stirred for 2 hr at 130 deg and 10 atm to give a solution containing 492.4 g of arsenic at 99% conversion to arsenic acid, 64.0 g copper, 222.1 g iron, 2800 g sulfuric acid, and 1054 g of a residue containing 10.5 g arsenic, 6.3 g copper, and 51.6 g iron. The sulfuric acid contained iron, chlorine, and copper arsenide and/or copper antimonide as reaction promoters.

39272

Sood, Sudesh K. and Richard Karuhn

**DEVELOPMENT OF PARTICULATE EMISSIONS CONTROL TECHNIQUES FOR SPARK IGNITION ENGINES. (FINAL REPORT).** IIT Research Inst., Chicago, Ill., Air Pollution Control Office Contract CPA-22-69-134, IITRI Proj. C6186, Rept. C6186-5, 96p., Feb. 1971. 30 refs. NTIS: PB 198033

Two techniques for the removal of particulate contaminants from spark ignition engine exhausts are examined. The first technique was based on the thermal deposition of lead aerosol particles in the size range 0.1-0.8 micron in a packed bed. The effect of gas-packing temperature differential, packing material, shape, size, contamination buildup, and gas velocity on collection efficiency of the bed was studied. The prime factor was the gas-packing temperature differential. At a gas velocity of 15.5 cm/sec, the collection efficiency of the device exceeds 95% at a temperature differential greater than 200 C. Increasing the gas velocity to 130 cm/sec lowered collection efficiency by 10-15%. The second technique was based on th use of sonic waves to increase the collisions between the aerosol particles and the relatively coarse particles of a fluidized bed. The effect of sound frequency, gas velocity, and power input to the sound driver units was studied. Collection efficiency increased sharply with power input to the sound driver units when standing sound waves were used. Analytical techniques used during the studies included a reflectometer and polarographic and colorimetric methods. (Author abstract modified)

39275

Seegall, M. I., J. C. Napier, and W. A. Compton

**CATALYTIC CONTROL OF NOX EMISSIONS FROM MOBILE SOURCES. (FINAL REPORT).** International Harvester Co., San Diego, Calif., Researc Labs., Office of Air Programs Contract EHS 70-114, Rept. RDR 1700, 143p., Dec. 1971. 26 refs. NTIS: PB 204011

The catalytic approach toward the control of nitrogen oxide emissions from motor vehicle exhaust was investigated. Rate earth oxide catalysts were investigated and compared with selected transition metal and noble metal catalysts, i.e., Monel 400, Solar Monel 400 Mod and Core, copper dichromate, a platinum catalyst, and a palladium catalyst. The initial criteria for the catalyst were high effectivity for nitric oxides reduction, reduction, resistance to permanent damage by lead oxide and lead bromide compounds in the exhaust, physical stability, and economy. The design of experimental equipment for the gas reaction process for the investigation of physical and chemical properties of the rare earth oxide catalysts was studied. Also included were a theoretical NO equilibrium analysis, a reaction kinetics study, and a study in concentration of NO, carbon monoxide, and carbon dioxide as a function of several reaction parameters of the catalytical gas reaction. The data were analyzed by nondispersive infrared analysis for the three gases and by titration for the measurement of ammonia generated. The Monel 400 catalysts were substantially more efficient than all others for NO reduction and minimum ammonia formation. The noble metal and copper dichromate catalysts were in the same NO reduction efficiency range; however, ammonia formation for the palladium and platinum catalysts were well beyond acceptable limits. (Author abstract modified)

39333

Iida, T., C. H. Ruof, N. V. Messina, H. J. Gibson, R. A. Sholts, J. Ikeda, H. Minamiya, T. Mori, S. Jo, N. Yamaki, H. Katayama, M. W. Munsell, J. H. Blakney, L. E. Coleman, M. T. White, Jr., T. Niskihara, N. Watanabe, T. Saito, T. Sakurai, R. Hirokawa, and M. Ishimaru

**FUEL OIL AND LUBRICANT IN AUTOMOTIVE EXHAUST EMISSION CONTROL.** (Jidosha no haiki kogai boshi taisaku to nenryo, junkatsuyu). Text in Japanese. Sekiyu Gakkai-shi (J. Japan Petroleum Inst., Tokyo), 15(4):2-7, April 1972.

The minutes of a round-table talk on automotive exhaust emission control are presented. The talk included discussion on the proposed classifications of crankcase oil and gear oil. Evaluation of gasoline requirements should include appraisal of antiknock performance, exhaust emission control system compatibility, introduction system cleanliness, and driveability performance. The antiknock index suggested as representative of the antiknock performance is obtained by subtracting Motor Octane Value from the Research Octane Value and then dividing the balance by 2. Correlation between exhaust gas control devices, (such as catalyst converters and thermal reactors) and lead content and composition of gasoline is still under review. An evaluation method on the cleanliness of the carburetor, intake manifold, and intake valve is yet to be developed. Volatility of the gasoline has something to do with the driveability performance. Poisoning of the muffler catalyst caused by leaded gasoline was also discussed. The present criterion of 0.07 g/gal lead content for the poisoning might result even with 0.02 g/gal. Effects of the lead content of gasoline and the ash content of lubricants on the octane requirement increase (ORI) was also discussed. In a CRC test, ORI was 2.3 with leaded gasoline and 2.0 with the unleaded. Tested with the oil containing 1 wt% ash content and with that containing no ash, ORI was about the same. Other topics included unleaded of gasoline, cleanliness of engine, exhaust gas control devices, temperature of engine oil, and effect of the lubricant s ash content on abrasion of the exhaust valve.

39404

Gartenmann, E.

**THE POSSIBILITIES OF REDUCING THE LEAD CONTENT IN GASOLINE FOR AUTOMOBILES.** (Ueber die Moeglichkeiten der Herabsetzung des Bleigehaltes in den Benzinen fuer motorische Zwecke). Text in German. Bull. Eidgenoess. Gesundheitsamtes, Beilage B, no.3:37-76, March 1971.

It is technically possible to produce high-octane lead-free gasoline in sufficient quantities. In Western Europe deep catalytic reforming of certain distillation fractions and isomerozation of light gasolines is prevalent; in the U. S. the costly catalytic cracking of gas and of heavy oils and olefin alkylation are the principal processes used to produce high-octane lead-free gasoline. Some plant capacity is available (for special gasolines and petrochemical products) but it is insufficient and the equipment is old. To substitute all leaded gasoline with high-octane lead-free gasoline would require a 5% higher volume of crude oil and a fifty-fold quantity of platinum. In the U. S. the necessary investment would run to $4 billion, the European investment would be comparable. In Switzerland the necessary investment would be $2 billion. High-octane lead-free gasoline will contain more aromatic hydrocarbons, less olefins, and less than 5% benzol. Smog formation from lead-free gasolines would increase by 25%, emission of the carcinogenic benzopyrene would not increase. Engine power loss with low-lead gasoline (0.2 Pb/l) is 10%. Small European cars which rely on a high compression ratio require high-octane gasoline and cannot be run on regular gas. Thus the reduction of lead in gasoline in Europe must occur gradually with a simultaneous adjustment of engines by the manufacturers. The development in Switzerland must of necessit follow that of its neighbors from whom it imports 60% of its gasoline. The tax structure will have to be adjusted to the change in piston displacement dictated by the transition.

39492

Lacy, G. A.

**VEHICLE EMISSIONS - HOW WE ARE WINNING THE WAR ON AIR POLLUTION.** Preprint, Society of Automotive Engineers, Inc., New York, 7p., 1970. (Presented at the Society of Automotive Engineers, Indianapolis Section, Oct. 15, 1970, Paper 710365.)

Several systems are briefly described for controlling automotive emissions by modifying many of the factors affecting the engine combustion process, for controlling evaporative hydrocarbon losses, and for reducing carbon monoxide emissions. Control of nitrogen oxides is discussed. The technique depends on reducing the peak combustion temperature; however, the same conditions that help to lower hydrocarbon and CO emissions simultaneously help form nitrogen oxides. Aspects of lead particulate control and the purported need for unleaded gasoline are evaluated. Electric, steam, and gas turbine engines are briefly considered as alternative power sources. The requirement for the stringent controls proposed for 1975 is questioned.

40411

Gupta, C. P. and P. K. Goel

**AUTOMOTIVE VEHICLE EMISSIONS.** J. Inst. Engrs. (India) (Calcutta), 52(5):150-151, Jan. 1972.

Automobile emissions, consisting of exhaust, evaporative, crankcase emissions, account for about 60% of the total pollutants in the air. In an attempt to reduce hydrocarbon exhaust emissions, two basic approaches have been tried: devices to oxidize certain components of fuel in the exhaust system and modification of engine design. Oxidation of fuel components in the exhaust can be achieved with catalytic and thermal reactors; in the case of catalytic reactors, problems involving lead poisoning of the catalyst and suitable materials for fabrication have been encountered. Regarding engine design approaches, there exists Chrysler s Clean Air Package System and Ethyl s recommendations for leaning idle mixture, homogenizing the air/fuel mixture, and retarding the spark advance at idle and low speeds. In an effort to reduce nitrogen oxide exhaust emissions, the following methods have been tried: exhaust gas recirculation, water injection into inlet manifold, exhaust manifold reactor with recycling, catalytic reduction, and lean operation. With evaporative emissions there are three types of losses from carburetor and fuel tank: diurnal, hot soak, and those during engine operation. Two popular methods of reducing these emissions are: (1) Esso s Charcoal Systems in which a charcoal canister collects and holds gas vapors from the fuel tank and carburetor until a purge valve opens to deliver the vapor into the manifold and (2) the Chevrolet Evaporative Control whereby gas vapors are routed from tank and carburetor to storage modules. Regarding crankcase emissions consisting mainly of blowby gases which comprise 70 percent 80 percent fresh air/fuel mixture and 20 percent 30 percent combustion products, several positive crankcase ventilation (P.C.V.) systems have been fitted to vehicles in the U.S.A. since 1963, completely eliminating these emissions. A table of present and future automobile emission control levels in the U.S.A. is supplied by the author.

40709

Powell, H. E., H. Fukubayashi, L. W. Higley, and L. L. Smith

**RECOVERY OF ZINC, COPPER, AND LEAD-TIN MIXTURES FROM BRASS SMELTER FLUE DUSTS.** Bureau of Mines, Rolla, Mo., Rolla Metallurgy Research Center, Rept. Investigations 7637, 12p., 1972. 6 refs. GPO: 707-697:319

The smelting of brass and bronze generates a dust composed primarily of zinc oxide, with lesser amounts of other metal oxides, such as copper, lead, and tin. The small quantity of this waste generated by individual smelters and the relatively low unit value of the contained metals, suggests the desirability of reclaiming the metals onsite or at some nearby point. A process that fits these requirements was developed, which consists of dissolving zinc and copper from the dust with sulfuric acid, recovery of copper by cementation, recovery of zinc as zinc sulfate crystals, and recovery of lead and tin as a salable residue. Alternatively, zinc may be recovered by electrodeposition. Free acid is recycled and no major pollution problems are generated by the process. (Author abstract modified)

40723

Vernet, Daniel

**POLLUTION: A MARKET FOR CHEMISTRY.** (Pollution: un marche pour la chimie). Text in French. Chim. Actualites, no. 1476:25-31, May 1972.

The role of the chemical industry in environmental protection is outlined. The chemical industry, a chief source of pollution, is at the same time in the position to offer solutions to pollution control problems. The major contributions of the chemical industry lie in the areas of waste water treatment, waste recycling, air pollution control, and in the development of new biodegradable and photodegradable plastics. Catalysts reducing the carbon monoxide, nitrogen oxides and urburned hydrocarbons in automotive exhausts are being developed. Such catalysts should be of minimum volume, resistant to both sudden temperature changes and vibrations, and have a life of 80,000 km. Studies of chemical additives, capable of replacing lead in gasoline, are in progress.

40785

Aerospace Corp., El Segundo, Calif., Office of Corporate Planning

**THE EFFECT OF LEAD ADDITIVES IN GASOLINE ON EMISSION CONTROL SYSTEMS WHICH MIGHT BE USED TO MEET THE 1975-76 MOTOR VEHICLE EMISSION STANDARDS. (FINAL REPORT).** Office of Air Programs Contract F04701-71-C-0172, Rept. TOR-0172(2787)-2, 209p., Nov. 15, 1971. 142 refs. NTIS: PB 205981

Studies of the effects of lead additives in gasoline on emission control systems planned for 1975-76 for light duty vehicles show that lead additives and scavengers are toxic to catalytic materials, but effects on other major system components may be overcome by material selection and design techniques. All control systems now planned incorporate a catalytic converter. Lead effects are toxic enough to prevent achievement of a 50,000 mi lifetime for control systems. Sulfur and phosphorous also have toxic effects. Lead traps or exhaust scrubbers are not felt to have adequate lead removal capacity. Some systems have demonstrated approaching the 1975 standards at low mileage but compliance with the 1976 nitrogen oxide standards would require the addition of an NOx catalyst and would render them sensitive to lead. Several combination systems have met the NOx standards for 1976. Durability tests over 10-15,000 mi have not been reported. Estimated overall costs to the consumer are approximately $860 above 1970 vehicle costs on a system using a dual bed catalytic converter, a low grade rich thermal reactor, and exhaust gas recirculation. Most development has been with gasoline at lead levels of 0.02-0.23 g/gal. This level is below the proposed A.S.T.M. specification for unleaded gasoline of 0.07 g/gal.

41112

Pless, Loren G.

**SOME EFFECTS OF EXPERIMENTAL VEHICLE EMISSION CONTROL SYSTEMS ON ENGINE DEPOSITS AND WEAR.** Preprint, Society of Automotive Engineers, Inc., New York, 13p., 1971. 20 refs. (Presented at the Society of Automotive Engineers, International Mid-Year Meeting, Montreal, Canada, June 7-11, 1971, Paper 710583.)

Passenger car tests were conducted to evaluate the effects on deposits and wear of three types of vehicle emissions control systems intended to reduce either evaporative emissions, oxides of nitrogen in the exhaust, or crankcase emissions. These tests used 1965-1970 model cars, operating with leaded commercial gasolines and 13 different engine oils, in several kinds of service. A crankcase storage evaporative emissions control system increased engine rusting in short trip service, and increased sludging and valve train wear in low speed, stop-and-go service. Reducing the crankcase purging rate to overcome hot starting and driveability problems with crankcase storage caused even larger deposit and wear increases. Engine rusting in short trip service was increased with exhaust gas recirculation; in other tests, heavy lead-salt deposits accumulated in the recirculation system. Doubling the positive crankcase ventilation valve idle air flow rate greatly reduced engine rusting in short trip service, and reduced engine deposits and oil oxidation in mixed city-suburban-expressway service. (Author summary modified)

41544

Schwind, Gene F.

**ENGINE CRANKCASE EMISSION CONTROL: MORE THAN CLEANER AIR.** Mater. Handling Eng., 27(4):106-108, April 1972.

The engine ventilation/filtration system used in fork lift trucks has wide applicability in industry. The unit is a filter/condenser metering unit that takes the place of positive crankcase ventilation. A condensation filter jar separates the crankcase vapors into steam, light ends of oil, and unburned fuel for recycling through the intake manifold. Sulfur trioxide, lead sulfate, iron oxide, ash, and fine metal powder are collected. The location of the input between the carburetor and the engine produces a very lean mixture and low emissions during idle and provides benefits in top end lubrication, removing carbon deposits, reducing nitrogen oxides, reducing carbon monoxide 70 to 90%, promoting longer sparkplug life, more compression, and sometimes an increase in power. Installing engine ventilation on old engines has often resulted in a return to design specifications.

41608

Gross, George P.

**THE EFFECT OF FUEL AND VEHICLE VARIABLES ON POLYNUCLEAR AROMATIC HYDROCARBON AND PHENOL EMISSIONS.** Preprint, Society of Automotiv Engineers, Inc., New York, 20p., 1972. 29 refs. (Presented at the Automotive Engineering Congress, Detroit, Mich., Jan. 10-14, 1972, Paper 720210.)

Exhaust emissions of polynuclear aromatic hydrocarbons and of phenols were studied with a variety of test fuels, using cyclic tests in five vehicles including one with emission control, two with engine modification control, and two with experimental very low emission systems. The experimental systems both reduced phenol emissions to less than 0.5% and polynuclear aromatic hydrocarbon emissions to about 1% of the levels observed in the vehicles without emission control. Phenols were reduced 30% by one engine modification control vehicle, while polynuclear aromatic hydrocarbons were reduced by 70% in both engine modification control vehicles. Fuel composition influenced emissions both directly and through engine deposits, although these direct effects of fuel composition generally decreased in the emission controlled vehicles. High polynuclear aromatic hydrocarbon emissions occurred with deposits from a fuel containing lead and phosphorus; an unleaded fuel, of different hydrocarbon composition and without phosphorus, gave low emission deposits, but this same fuel, with lead added at 0.5 g/gallon, still gave low emission. Sampling procedures are mentioned. The control systems included carburetion variations, thermal and catalytic afterburners air- fuel ratio changes, and a spark-retard system. Emissions of carbon monoxide benzo(a)pyrene, benz(a)anthracene, hydrocarbons, and nitric oxide were measured. (Author abstract modified)

41793

Graven, Richard G.

**PRODUCTION OF LEAD FREE GASOLINE.** (Mobil Oil Corp., New York) U. S. Pat. 3,649,520. 8p., March 14, 1972. 6 refs. (Appl. March 13, 1970, 3 claims).

The yield of lead free gasoline product can be increased when upgrading low octane gasoline boiling material by a combination of process steps generally known in the prior art. These petroleum refining operations include hydrogenation, reforming, aromatic recovery, isomerization, and product separation steps arranged in a combination which is particularly effective for producing gasoline products of desired octane rating. The present method particularly emphasizes the upgrading of relatively low octane C6 hydrocarbon components, as well as the removal of low octane C7 paraffins.

41922

*Palma, Ted V. De and Robert S. Carleton*

**CATALYTIC CONVERTER FOR EXHAUST GASES.** (Universal Oil Products Co., Des Plaines, Ill.) U. S. Pat. 3,644,098. 7p., Feb. 22, 1972. 4 refs. (Appl. Sept. 18, 1969, 8 claims).

An efficient catalytic converter is described that is located in close proximity to the exhaust ports of the engine, thereby eliminating the need for insulated pipes and/or heating of secondary combustion air. This prevents deactivation of the catalyst particles by tetraethyl lead and other metals. The catalytic converter is constructed in such a manner that its various components are capable of expanding and contracting relative to each other as the temperature of the apparatus fluctuates. The converter encases a removable catalyst retaining cartridge which permits easy placement and removal of the subdivided catalyst particles.

42131

Wetch, Joseph R, Seymour Sudar, and Louis L. Bienvenue

**MUFFLER DEVICE FOR REMOVING IMPURITIES.** (North American Rockwell Corp., Canoga Park, Calif.) U. S. Pat. 3,647,394. 8p., March 7, 1972. 4 refs. (Appl. Feb. 20, 1970, 14 claims).

A muffler is described which comprises a liquid scrubbing medium that will remove lead from the exhaust gas. In previous muffler systems which used catalysts, one of the most prevalent problems was lead poisoning on the surface of the catalyst. The present device can also be used to preclean exhausts before they are recirculated to the engine inlet manifold for nitrogen oxides control, thus alleviating many of the operating problems of that system. the muffler device incorporates a packing material which is preferably comprised of a finely divided surface which can serve for filtering impurities and/or a means for providing chemical reactive sites. The packing can also serve as a demister to remove entrained liquid from the gas stream. A reservoir of a material which is molten or liquid at least at the operating temperatures of the engine is part of the device, and a venturi is provided for conducting the liquid from the reservoir into the exhaust gas stream prior to contacting the exhaust gas with the packing.

42166

Frybourg, M.

**AUTOMOBILES AND NUISANCES.** (Automobiles et nuisances). Text in French. Pollut. Atmos. (Paris), 14(54):159-162, April-June 1972.

Nuisances caused by automotive emissions as well as emission control measures are reviewed. The cumulative effect of the exhaust components has not been euly investigated. Nitrogen oxides create the most difficult and expensive control problems of all components. While research is mainly centered on improving combustion, catalytic reactors still present quality problems. New solutions such as gas turbine, steam, electric, or external combustion engine is a potentiality, and traffic regulations and modifications to avoid congestion, and thus reduce emissions, may be of value. An average increase sf $1000 in the purchase price of z976 U. S. car model, due to the exhaust emission kontrol measures envisaged, is predicted. While the health hazards of lead in gasoline have not been duly substantiated, low-lead rather than no-lead gasoline should be required. No-lead gasoline would cause increase carcinogenic hydrocarbon emissions, but it would eliminate the problem of catalyst poisoning.

42290

Pattison, John N.

**MOTOR VEHICLE POLLUTION CONTROL NEWS. PROS AND CONS FOR LEAD IN GASOLINE.** J. Air Pollution Control Assoc., 21(6):354-355, June 1971. 5 refs.

An attempt is made to explain why lead is added to gasoline, the consequences of it on the environment, and the potential consequences of its removal. The higher the compression ratio of the engine, the hotter the mixture will get due to the heat of compression, and the more likely any given compound will be to preignite. This can be prevented by using a gasoline that has compounds that do not ignite readily such as aromatics, by adding volatile lead compounds which stop these undesired flames, or by using a low compression ratio engine. Since all lead compounds have some toxicity, there is a potential hazard if too much is in the air. Other disadvantages in the use of lead are that it clogs the engine and may produce corrosive products. Lead removal may result in exhaust valve recession which leads to increased exhaust hydrocarbon emissions and expensive repairs, as well as increased gasoline costs. Increased aromatics used to compensate for the removal of lead may be worse than the lead, since the photochemical reactions of most aromatics can lead to the formation of peroxybenzoyl nitrate and its derivatives which are extremely potent eye irritants.

42300

Rogers, Joe E.

**SMOG CONTROL DEVICE FOR INTERNAL COMBUSTION ENGINE.** (Assignee not given.) U. S. Pat. 3,656,460. 4p., April 18, 1972. 8 refs. (Appl. Sept. 17, 1970, 8 claims).

While the prior devices for controlling emissions from internal combustion engines have been partially successful, they have suffered from several deficiencies. First of all, many of the devices of the prior art operate only at either high or low engine vacuum, but not at both, thus giving incomplete emission control. It also has been necessary to include valves and other moving parts in engine smog control devices, thus making their initial cost high and creating a maintenance problem. A smog control device for an internal combustion engine is described which utilizes a first conduit which communicates the engine crankcase with the suction head of the engine to draw gases accumulating in the crankcase when the suction head is maximized. A second conduit which communicates the engine crankcase with the air passage leading into the engine draws gases accumulated in the crankcase in response to the flow of air through the air passage. A third conduit communicates the engine crankcase with the atmosphere to supply a flow of fresh air to the crankcase whenever gases are flowing through either of the first or second conduits to thereby prevent any vacuum or crankcase pressure balance in the engine. The conduits are arranged to cooperate in maintaining a perfect pressure balance in the engine at all times without the need for any valves or other moving parts. To promote the efficient combustion of fuel and thereby further reduce the accumulation of gases in the engine crankcase, a fuel additive in the form of burned exhaust gases is introduced into the engine at the inlet of the air passage. This additive also permits the engine to run on unleaded gasoline. (Author abstract modified)

42330

Blackmore, D. R.

**AUTOMOTIVE EMISSIONS--THE BACKGROUND ACTIVITY.** Petrol. Rev., 26 (305):169-174, May 1972.

While it is relatively easy to identify pollutants in the exhaust gas from a motor car which are known to be toxic to human life at high concentrations, it is extremely difficult to identify any harmful effects as a consequence of human exposure to dosages prevalent under normal living and working conditions. The different levels that different countries have enacted for vehicle emissions are indicated for the present and for the next few years. These emissions include hydrocarbons, carbon monoxide, and nitrogen oxides. Legislation concerning lead in gasoline is also considered. Some possible solutions comprise alternative power units, internal combustion engine design modifications, alternative fuels, and the reduction of lead in gasoline. Air injection systems, catalytic oxidation, exhaust gas recirculation, and lead traps are mentioned, as well as the Wankel engine and the stratified charge engine.

42702

Fuchs, E. J.

**UNLEADED VERSUS LEADED FUEL RESULTS IN LABORATORY ENGINE TESTS.** Preprint, Society of Automotive Engineers, Inc., New York, 29p., 1971. 19 refs. (Presented at the Society of Automotive Engineers, National West Coast Meeting, Vancouver, British Columbia, Aug. 16-19, 1971, SAE Paper 710676.)

A test program was conducted using a wide variety of laboratory oil and fuel performance test procedures in order to compare effects of unleaded versus leaded fuel. In the area of engine deposits, unleaded fuel shows a consistent pattern of allowing more varnish deposits and slightly less sludge deposits compared with leaded fuel when using the same crankcase oil. This was true even when exhaust gas recirculation was used with both fuels. Engine rust is expected to diminish with use of unleaded fuels. Although exhaust gas recirculation may reverse this somewhat, high quality crankcase oils will be able to counteract any deleterious effects of exhaust gas recirculation of rust. Spark plug life is expected to increase with future use of unleaded fuels. Exhaust valve seat wear and wear of some other engine components such as cylinder bores were exhibited with unleaded fuel. Oil thickening caused by severe oil oxidation was shown to be much less severe with unleaded fuel, even when using exhaust gas recirculation. Octane requirement increase at full throttle conditions may pose problems for unleaded fuels in low compression engines. The use of exhaust gas recirculation at part throttle decreases octane requirements to very low values where no spark knock problems with unleaded fuels would be likely. Long duration tape-controlled road simulator tests using unleaded fuels on a moderate duty type driving cycle indicated no severe deposit or wear problems. (Author summary modified)

42817

Leikkanen, Henry E. and E. W. Beckman

**THE EFFECT OF LEADED AND UNLEADED GASOLINES ON EXHAUST EMISSIONS AS INFLUENCED BY COMBUSTION CHAMBER DEPOSITS.** (CRC Project CAPE-3-68). Preprint, Society of Automotive Engineers, Inc., New York, 28p., 1971. 7 refs. (Presented at the Society of Automotive Engineers National Combined Fuels and Lubricants, Powerplant and Truck Meetings, St. Louis, Mo., Oct. 26-29, 1971, Paper 710843.)

To assess how lead antiknock compounds in gasolines influence combustion chamber deposits and exhaust emission levels, an intensive state-of-the-art review was made, and data submitted by 18 different companies were analyzed. These studies ranged in scope from single-cylinder engine investigations to a 122-car consumer test program. Based on this review, it was concluded that cars operated on leaded gasolines have higher equilibrium hydrocarbon emissions than those operated on unleaded gasolines, and that mileage accumulation conditions exert a major influence on the magnitude of the hydrocarbon net lead effect. The combustion chamber deposit effect under consumer-type driving conditions is about 7%, and under rapid mileage accumulation conditions it is about 20%. The presence of lead in gasoline has no effect on carbon monoxide emission levels. (Author abstract modified)

42819

Doelling, Ralph P.

**AN ENGINE S DEFINITION OF UNLEADED GASOLINE.** Preprint, Society of Automotive Engineers, Inc., New York, 7p., 1971. 14 refs. (Presented at the Society of Automotive Engineers National Combined Fuels and Lubricants, Powerplant and Truck Meetings, St. Louis, Mo., Oct. 26-29, 1971, Paper 710841.)

The effect of leaded gasoline on hydrocarbon exhaust emissions due to combustion chamber deposits and on valve recession was studied at very low lead levels. Similar fuel lead contents at which these deposit effects are exhibited. An engine operated on fuel containing less than 0.06 g Pb/gal did not exhibit exhaust HC emission increases associated with lead engine deposits, while emissions increased when the engine was operated on fuels containing 0.07 g/gal or higher concentrations of lead. Valve recession was not experienced when an

engine was operated on fuels containing 0.07 and 0.13 g Pb/gal, but was experienced with fuel leaded to 0.04 g/gal. Similar increases in exhaust HC levels resulted from engine operation of fuels leaded to 2 and 3 g/gal. Reduction in fuel lead content to 1 and to 0.5 g/gal increased exhaust HC increases. Thus fuels containing 0.04 g Pb/gal or less may be considered unleaded, while fuels containing 0.07 g/gal and greater levels of lead must be considered leaded. Additional measurements would be necessary to determine the precise lead level between 0.04 and 0.07 g Pb/gal at which lead deposit manifestations occur. The need for exploring other factors, octane requirement increase in particular, is discussed.

42829

Pahnke, Alden J. and Wilfred E. Bettoney

**ROLE OF LEAD ANTIKNOCKS IN MODERN GASOLINES.** Preprint, Society of Automotive Engineers, Inc., New York, 32p., 1971. 68 refs. (Presented at the Society of Automotive Engineers, National Combined Fuels and Lubricants, Powerplant and Truck Meetings, St. Louis, Mo., Oct. 26-29, 1971, Paper 710842.)

The role of lead antiknocks in modern gasolines is discussed in terms of engine-fuel relationships. Exhaust emission characteristics of leaded and unleaded gasolines are compared in terms of both gaseous and particulate constituents. The effect of removing lead from gasoline on engine cleanliness, exhaust valve seat recession, octane requirements, and octane requirement increase is assessed. Overall, the effect of leaded fuel on deposit-induced hydrocarbons emissions is an increase of about 7%. Exhaust particulate emissions on a grams/mile basis are higher for operation of leaded fuel than on unleaded fuel. On a volume basis, the amount of particulate emitted with leaded fuels is less than that emitted with unleaded fuels. Since atmospheric visibility and soiling are probably dependent on the volume of particulate present, a shift from leaded to unleaded gasoline would be expected to decrease visibility and increase soiling. Laboratory and field tests have shown this to be the case. The octane requirement increase associated with the use of unleaded gasoline is equal to or perhaps slightly greater than that associated with leaded fuels. A shift from leaded to unleaded gasoline might discernibly increase the formation of sludge and varnish deposits. Data developed in an owner-driven, 122-car service test over a period of 4.7 years show a maintenance cost disadvantage for leaded fuels over unleaded fuels of 0.052 cent/mile, or 0.72 cent/gal at a fuel economy of 13.8 miles/gal.

42886

Ruof, C. H., N. V. Messina, H. J. Gibson, R. A. Sholts, H. Ikeda, H. Minamidani, T. Mori, E. Jo, N. Yamaki, T. Iida, H. Katayama, M. W. Munsell, J. H. Blakney, L. E. Coleman, M. T. White, Jr., T. Nishihara, N. Watanabe, T. Saito, T. Sakurai, R. Hirokawa, and M. Ishimaru

**CONTRIBUTION OF FUELS AND LUBRICANTS TO AUTOMOTIVE EMISSIONS REDUCTION.** (Jidosha no haiki kogai boshi taisaku to nenryo junkatsuyu). Text in Japanese. Sekiyu Gakkai-shi (J. Japan Petroleum Inst., Tokyo), 15(4):256-261, April 1972.

The contribution of fuels and lubricants to automotive emission control is discussed. The major topics include new trends in oil and gasoline classifications with respect to antiknock and emission performance; poisoning of catalytic emission control devices by minimal amounts of lead; the effects of lead additives in gasoline and of sludge dispersants in lubricating oil on octane requirement increase; unleaded gasoline and engine cleanliness; engine oil temperature and antipollution devices; exhaust gas recycling; and future trends in sludge dispersant levels.

43333

Schwing, Richard C.

**THE EFFECTS OF TEL ON OXIDATION IN AN EXHAUST MANIFOLD REACTOR: A SINGLE-CYLINDER ENGINE STUDY.** Preprint, Society of Automotive Engineers, Inc., New York, 14p., 1971. (Presented at the Society for Automotive Engineers, National Combined Fuels and Lubricants, Powerplant and Truck Meetings, St. Louis, Mo., Oct. 26-29, 1971, Paper 710844.)

In rich-exhaust manifold reactors, complete oxidation of carbon monoxide and hydrocarbons, generally characterized by luminous conditions and high temperatures, is desirable. Some of the conditions necessary for luminous oxidation in an insulated exhaust reactor have been explored with a single-cylinder engine using both leaded and unleaded isooctane. Tetraethyl lead inhibits slow oxidation reactions. Threshold-reactor air-injection rates required for luminous oxidation in the reactor were determined for engine air-fuel ratios between 11.2 and 14.1. Leaded isooctane produced higher unburned HC concentrations in the exhaust than unleaded isooctane when injection air was introduced as well as when no air was added. In addition, oxidation of CO in the reactor was hindered in the tests with leaded isooctane. During one set of experiments, conditions were such that luminous oxidation in the reactor was achieved with the unleaded fuel, but was not achieved with the leaded fuel. In warmup studies, a longer time was required to reach luminous conditions in the reactor when leaded isooctane was used in the engine than when unleaded isooctane was used.

43515

Kistler, Jules

**TWO MODERN METHODS FOR ABATING AIR POLLUTION IN FOUNDRIES AND IRON AND STEEL WORKS.** (Zwei moderne Verfahren zur Bekaempfung der Luftverunreinigung in Giessereien sowie in der Eisen- und Stahlindustrie). Text in German. Giesserei (Duesseldorf), 43(13):333-340, June 1956.

General problems of dust in foundries and iron and steel works as well as two methods of dust separation are described. Fine dusts, particularly when containing crystalline silicic acid, kieselguhr, chalk flint, aluminum, manganese dioxide, Thomas slag, or chromium compounds, are most dangerous since they can cause silicosis. Dust emissions are highest during mold opening and sandblasting. Finest foundry dust contains 2-15%, and courser dust, above 10 micron, 50-75% of silicon. More than 90% of foundry dust is made up of fine fractions. The maximum iron, zinc, and lead contents in dusts lie at 10.0, 15.0, and 0.15 mg/cu m. The dust concentration in foundries lies in a range of 4.4- 5.8 mg/cu m, corresponding to 5-7 kg/ton of iron, while the respective value for Siemens-Martin furnaces is 2.75 g/N cu m. Dust problems in foundries can be effectively solved by two different types of equipment. Pease-Anthony venturi scrubbers apply gas flow rates of 60-120 m/sec to agglomerate dust particles with finely dispersed water. Such scrubbers can be also applied to sulfur dioxide and sodium sulfide. The efficiency for open-hearth and blast furnace gases lies at 98-99%. Elex- Schneible type centrifugal wet separators, with low water consumption, can be used for cupola furnaces as well. The water is dispersed by turbine blades to form a curtain of fine droplets. Exhaust hoods installed in foundry facilities are a basic means of abating dust concentrations. The temperature difference between the ambient and the fresh air should not exceed 6 C.

43575

California Air Resources Board, Technical Advisory Committee

**RATIONAL PROGRAM FOR CONTROL OF LEAD IN MOTOR GASOLINE.** 17p., March 12, 1970.

The removal of lead additives from gasoline in an ordered and considered manner could hasten the attainment of minimum exhaust emissions from present and future motor vehicles. It is proposed that starting in 1971 one grade of gasoline be offered whose lead content is no greater than 0.5 g/gal and research octane number no less than 90. In addition, starting in 1971, the lead content in no gasoline shall be more than 2.0 grams per gallon. In 1974 one grade of gasoline will be lead-free and in January 1977 no lead whatsoever should be used in any grade. The basis for these determinations involves many factors. Principal among them is a limitation which the presence of lead in gasoline places on development of low-emission vehicles. Secondly is the effect which lead has in increasing emissions from presently existing vehicles. Another consideration is the consumption of natural resources involved in producing high octane number fuels and in burning lead as a fuel additive. Encouragement to lower vehicular emissions should be provided by incentives for automobile companies, oil companies, and the motoring public to strive for operation on fuels with reasonable octane number and with progressive elimination of lead as an additive.

43937

Barnard, Paul G., Aaron G. Starliper, Waldemar M. Dressel, and Morris M. Fine

**RECYCLING OF STEELMAKING DUSTS.** Bureau of Mines, Washington, D. C. and IIT Research Inst., Chicago, Ill., Proc. Miner. Waste Util. Symp., 3rd, Chicago, Ill., 1972, p. 63-68. 15 refs. (March 14-16.)

Methods are described for upgrading steel furnace dusts to produce high-iron pellets for recycling. These dusts contain impurities such as zinc, lead, and copper which reflect the character of the feed to the furnace and the operation of the furnaces. Treatment procedures investigated for the removal of these impurities and the recovery of an iron-bearing product include pelletizing and roasting in a reducing atmosphere to produce an iron material low in zinc and lead; sulfating dust with sulfuric acid and leaching to remove zinc and copper, followed by pelletizing and reduction to remove lead, thus yielding a high-iron pellet and allowing for copper and zinc recovery from the leach solution; gaseous sulfating with sulfur dioxide and water leaching to remove copper and zinc, followed by pelletization and reduction roasting to remove lead and residual zinc; and, roasting of pelletized mixtures of various types of steel furnace dusts such as high-zinc electric furnace dust with high-carbon blast furnace dust to produce an iron product low in lead, zinc, and carbon.

44003

Shirai, Tsugumi

**AUTOMOBILE EMISSION CONTROL SYSTEM.** (Jidoshayo kogai taisaku kiki). Text in Japanese. Mitsubishi Denki Giho (Tokyo), 46(5):545-551, May 1972. 10 refs.

Outlines of automobile exhaust control devices are given. There are three modes of automobile exhaust, about 25% of the hydrocarbons as blow-by gas, 20% as evaporated gas, and gas from the exhaust pipe which includes 55% of the total hydrocarbons, carbon monoxide, nitrogen oxides, and lead compounds. By using a crankcase emission control valve, the blow-by gas is returned to the intake manifold for recombustion. A purge control valve, which uses the adsorption-desorption characteristic of charcoal, was developed for the control of evaporated hydrocarbons. The flow characteristics of the purge control valve are such that the amount of flow increases as the negative pressure of the venturi increases. A heated intake air system, which consists of a vacuum control, thermo-valve, and shutter, is used for the control of the exhaust gas. An exhaust control system for a rotary engine and many other devices for exhaust control are also described.

44283

Turner, T. Henry

**CLEAN AIR TUNNELS.** Clean Air, 1(5):4-6, Spring 1972.

The English Channel Tunnel will link the European continent with the United Kingdom. Responsibility for planning the English Channel Tunnel is shared by both the British and French governments and the contractors involved. The problems to be solved will be complex, the most essential one being providing clean air. Engine fumes could be reduced by transporting all road vehicles on special electrically hauled railway flat cars. Ventilation of steam railway tunnels is very complicated. Natural ventilation may give an upward draft in winter and a downward draft in summer. Either may be completely upset by normal changes in wind speeds and directions. If road vehicles use their own engines in the tunnel, carbon dioxide, carbon monoxide, lead, nitrogen oxides, asbestos debris from brake shoes, and rubber debris from tires will need consideration in the confined conditions of the tunnel. Much research has been conducted, and its results will be very helpful when planning the English Channel Tunnel. The following hazards must be taken into consideration when building a tunnel: dust and fire risks coming from porous noise-absorbing materials used for lining; noise which builds up in confined spaces by echoing; odors of nitrogen oxides produced by electrical sparking; fire risks from any fixed or mobile sources; humidity, which, when excessive, will shorten the useful life of electrical components; and temperature variations, which should be avoided as much as possible for the sake of passengers and maintenance staff. The salt from the sea air will greatly increase corrosion of essential components. The possibility of using steam engines should be completely excluded because of noxious emissions and the danger of not seeing an approaching engine in the dense fog generated.

44341

Malschaert, F. P.

**AIR POLLUTION BY INTERNAL COMBUSTION ENGINES AND METHODS FOR ITS CONTROL.** (Luchtverontreiniging door benzinemotoren en middelen t bestrijding). Text in Flemish. Ingenieursblad, 40(15-16):417-428, Aug. 1971. 6 refs.

Different methods for controlling automotive exhaust emissions and related developments and studies are reviewed. The influence of the air-fuel ratio on exhaust carbon monoxide, hydrocarbon, and nitrogen oxide contents is shown. Criteria for minimum CO, hydrocarbon and nitrogen oxide emissions are summarized. Good fuel distribution requires carburetors with at least two venturi tubes, heated air for the carburetor, and intake pipes with reduced diameter and smooth surface. A transmission-controlled spark advance system is described. Both nitrogen oxides and hydrocarbons can be reduced by retarded ignition, while idle adjustment constitutes a basic means of controlling CO emissions. Thermal afterburning of exhaust gases in the exhaust manifold at 700-750 C results in reduced CO and hydrocarbon emissions. A platinum catalyst reactor with programmed by-pass for controlling CO and hydrocarbons is shown. Partial recirculation of exhaust gases between carburetor and nozzle results in increased CO and

hydrocarbon emissions due to increased fuel consumption. An experimental catalytic reactor for nitrogen oxides emission control has been developed. Lead emissions are reduced by means of cyclones, which require cleaning at regular intervals. Positive crankcase ventilation represents the basic means of controlling crankcase gas emissions.

44470

Burtner, R. E.

**GASOLINE CHARACTERISTICS AND AIR CONSERVATION--A REVIEW OF API ENGINE FUELS STUDIES.** Am. Soc. Testing Mater. Spec. Tech. Publ., no. 487:102-133, 1971. 15 refs. (Presented at the American Society for Testing and Materials, Annual Meeting, 73rd, Toronto, Ontario, June 21-26, 1970; includes a discussion.)

Some suggested remedies for pollution of the air by automotive emissions have been changes in volatility and composition of the gasoline and the removal of lead antiknocks. Several programs have been run under the sponsorship of the American Petroleum Institute to investigate not only whether these changes would benefit cleaner air through lower emissions, but also the effects on car performance. These programs are summarized. Variations in volatility and its effect on emissions and starting and warm-up of the car are discussed. Different olefin concentrations are evaluated for their influence on total emissions and the reactivity of these emissions. The effects on emissions of removing lead antiknocks from gasoline, while maintaining performance qualtities as defined by octane and volatility parameters, are analyzed. Elimination of evaporation losses by evaporation loss control hardware is much more effective than any reasonable reduction in volatility, even as low as 5 lb RVP, and more effective than removal of all olefins boiling below 220 F from gasoline. The pollution effect of unleaded gasolines may be greater than leaded gasolines because of fuel compositional changes required to maintain octane quality, although some reactivity scales show no appreciable increase in the smog potential due to these changes. Two additional studies are mentioned in a discussion following the article: one was designed to estimate the effect of reducing fuel volatility on emissions in the Los Angeles atmosphere, and the other was designed to develop a method of characterizing the evaporative emissions tendency of a fuel. (Author abstract modified)

44473

Faust, W. J. and M. J. Sterba

**MINIMIZING EXHAUST EMISSIONS -- A REALISTIC APPROACH.** Am. Soc. Testing Mater. Spec. Tech. Publ., no. 487:36-53, 1971. 13 refs. (Presented at the American Society for Testing and Materials, Annual Meeting, 73rd, Toronto, Ontario, June 21-26, 1970; includes a discussion.)

Although modifications to piston engine design and operating conditions will reduce exhaust emissions substantially, catalytic exhaust gas converters will be required to reach the extreme low levels of emission desired. Lead-free gasoline will be required to permit the catalyst to function properly for the desired mileage. The initial drop in gasoline octane number, due to omission of lead, will be recovered gradually by refinery process changes. Gasoline will become more aromatic, more isoparaffinic, and less olefinic, while being reduced in sulfur content. The total content of polynuclear aromatics in the exhaust gas will not be affected by a substantial increase in the aromatic content of the gasoline. Polynuclear aromatics in the exhaust are oxidized almost completely by catalytic converters. Governmental actions, statements by the automotive industry, and statements by the petroleum industry are cited. (Author abstract modified)

44614

Kent, W. L. and F. T. Finnigan

**THE EFFECT OF SOME FUEL AND OPERATING PARAMETERS ON EXHAUST VALVE SEAT WEAR.** Preprint, Society of Automotive Engineers, Inc., New York, 9p., 1971. 7 refs. (Presented at the Society of Automotive Engineers, National West Coast Meeting, Vancouver, British Columbia, Aug. 16-19, 1971, Paper 710673.)

The potential engine damage in the form of exhaust-valve seat wear which could result from operating passenger cars and trucks on lead-free gasolines is illustrated. Comparison of photomicrographs of exhaust valves and exhaust-valve seats run with zero-lead and 0.5 g leaded gasolines permits speculation on the mechanism responsible for exhaust-valve seat wear in engines fueled with zero leaded gasoline. As little as 0.5 g of lead/gal in gasoline can provide complete exhaust-valve seat wear protection under relatively severe conditions of speed and load. Inclusion of phosphorus in zero-lead gasoline is not a complete solution to the exhaust-valve seat wear problem. (Author abstract modified)

44660

Communications Dept., Stockholm (Sweden), Guidance Group Concerning Development Work in the Field of Motor Vehicle Exhaust Gas

**CRANKCASE GASES. REPORT AND SUGGESTED MEASURES PRESENTED BY THE COMMUNICATIONS DEPARTMENT S GUIDANCE GROUP FOR AUTOMOTIVE EXHAUST STUDIES.** (Vevhusgaser. Utredning med forslag till atgarder av Kommunikationsdepartementets ledningsgrupp rorande utvecklingsarbete pa bilavgasomradet). Text in Swedish. 11p., March 31, 1967. 4 refs.

The chemical composition and the contribution to total automotive emissions of crankcase gases are examined, and control measures to be introduced in Sweden are suggested. The volume of crankcase gases was dependent on such factors as the size, design, load, and speed of the engine. Crankcase gas contains 17.7-19.3% oxygen; 1.0-2.2% carbon dioxide; 0.5% carbon monoxide, accounting for about 0.3% of total CO emission; and 0.55-1.0% hydrocarbons, equaling about 15-30% of total hydrocarbon emission. Approximately 85% of crankcase gas consists of air-fuel mixture, but volatile organic lead compounds and oil vapors are also present; about 2.5% of the fuel consumed is present in crankcase gas. Positive crankcase ventilation, a relatively inexpensive and reliable solution, results in considerable reduction of hydrocarbon emissions (by 15-30%) and in elimination of lead and odorous emissions from the crankcase area, while CO emission is nearly unaffected. Although there is no immediate need in Sweden for positive crankcase ventilation, it should be introduced possibly for 1969 models in view of the increasing number of cars. Positive crankcase ventilation for diesel engines however, creates operational problems and is of little effect.

44742

Drake, John F., Theodore G. Kennard, and W. A. Saylor

**CONTROL OF CUPOLA STACK EMISSIONS.** Iron Age, vol. 163, p. 88-92, April 7, 1949.

Cupola emission standards for particulate matter, lead, zinc oxide, sulfur compounds, and smoke are discussed. Control methods include operation with a closed top to confine the gases and prevent combustion in the stack, removal of large particulate matter in a dry dust catcher, washing the gas adequately to reduce the particulate matter to less than 0.4 grains/cu ft, and combustion of the cooled and cleaned gas to reduce smoke. The effect of the regulations on the foundry in-

dustry and costs of installing new equipment are considered. Data is given on the operation and performance of a cupola with a closed-top charging device, a dry dust catcher, and a gas washer.

44750

Mortstedt, Sten-Erik

**INVESTIGATIONS OF THE EXHAUST EMISSIONS IN STUDSVIK.** (Bilavgasundersokningar i Studsvik). Text in Swedish. Aktiebolaget Atomenergi (Sweden), Rept. BIL-58, 32p., April 27, 1970.

Automotive exhaust emissions were examined to gather data aimed at elaborating materials for legislative purposes. A permanent laboratory in Studsvik and two mobile laboratory vans in Stockholm were established. Traffic pattern studies in Stockholm and Goteborg and tests performed in the permanent laboratory contributed to the elaboration of the ECE test method. Basic studies were centered on existing cars and system cars; the effect of idling adjustment on exhaust; crankcase gases; exhaust after cold start; possibilities of controlling carbon monoxide emissions from old cars at idling; testing cars equipped with exhaust control device; controlling diesel smoke and dust; odor investigations; nitrogen oxides in exhaust gases; use of liquefied petrol gas as fuel; organic lead in exhaust gases and street air; and testing inventions. Carbon monoxide, sulfur dioxide, dust, soot, nitric oxide, nitrogen dioxide, and organic and inorganic lead concentrations were continuously monitored in Stockholm over several three-week test periods. Emission standards are already imposed on crankcase ventilation, diesel smoke, carbon monoxide, hydrocarbons, and emissions during idling; standards for nitrogen oxides, particulate emissions, and gaseous diesel exhausts are expected soon.

44853

Larson, Gordon

**SMOG: RESOURCE OR NUISANCE?.** West Ind., 1951:27-30, July 1951.

By directing attention to the needs of air pollution control, industrial research and developments in the Los Angeles area have resulted in finding processes that produce more or better products or in finding markets and values in the stack discharges. Major oil companies in the area sell their hydrogen sulfide wastes to chemical companies. One such chemical company produces over 80 tons of sulfur daily from these sources. The pressure for odor control resulted in three Long Beach fish canneries installing low-temperature gas dehydration equipment to eliminate release of odors to the air. As a result, gas consumption was cut as much as 10% and maintenance costs were reduced. All three companies reported a general improvement in the quality of their fish meal. Emission control work at a brass foundry resulted in considerable savings in fuel and horsepower and an increase in furnace capacity by the use of ingots in place of scrap metal charging. A paint company installed fume burners on its varnish cookers and greatly increased the efficiency of its personnel when the irritating fumes were thus reduced. Many foundries are promoting extensive research to ascertain which of the materials they can collect from their stacks will have market value or will be useful in their respective operations. Over 50% of the substance recovered in secondary lead smelting collection systems is lead oxide which may be sold or recharged to furnaces. Collection of fines at a grain mill cut production costs appreciably.

44882

Roensch, Max M.

**THE AUTOMOBILE ENGINE--TODAY AND TOMORROW.** Preprint, Society of Automotive Engineers, Inc., New York, 17p., 1971. 26 refs. (Presented at the Society of Automotive Engineers, National Combined Fuels and Lubricants, Powerplant and Truck Meetings, St. Louis, Mo., Oct. 26-29, 1971, Paper 710845.)

Automotive engine output and efficiency have greatly improved over the years due to the combined efforts of the automotive and petroleum industries. As compression ratios and octane ratings of fuels have increased, the automotive engineer has been able to give the customer more for his money in economy, performance, or a combination of both. A brief history of these developments serves to point to the problems of the future, since octane requirements of the 1971 models generally have been reduced to enable the automobile manufacturer to meet stringent exhaust emission standards. Since lead antiknocks are the most economical and widely used method of increasing the octane rating of gasoline, their effects on engine parameters such as durability and emissions are compared with lead-free gasolines. The economic impact of the change from the 94 and 100 octane number fuels to a 91 octane lead-free gasoline is presented. Consideration is given to the question of how much control from automobiles is really needed to achieve a satisfactory level of ambient air quality. The future of the piston engine, as well as possible substitutes such as electric propulsion and the gas turbine, is discussed in view of the stringent emission controls proposed for 1975 and 1976. A critical review of both the ambient air quality and emission standards indicates the need for revisions and a careful evaluation of the cost-benefit ratio, so that the passenger car buyer will not be needlessly penalized with both high initial costs and high operating costs. The potential waste of our national resources must also receive consideration. An appendix includes a comment on the proposed national ambient air quality standards for carbon monoxide, with particular reference to the Beard-Wertheim time discrimination test concerning CO toxicology. (Author abstract modified)

44906

Mills, G. Alex

**CATALYSIS FOR CONTROL OF ENVIRONMENTAL POLLUTION.** Preprint, American Chemical Society, Washington, D. C., Div of Industrial and Engineering Chemistry, 15p., 1971. 1 ref. (Presented at the American Chemical Society, National. Meeting, 161st, Los Angeles, Calif., April 13, 1971.)

The application of catalysis for the control of environmental pollution is discussed. Major pollutants from the power-producing industries and from transportation include carbon monoxide, particulates, sulfur oxides, hydrocarbons, and nitrogen oxide. Catalysts can be used to decrease pollution from the automobile by catalytic refining of petroleum to produce high octane lead-free gasoline, and by using a catalytic muffler to eliminate almost all of the CO, hydrocarbons and nitric oxide. Isomerizations of paraffins in gasolines and catalytic reforming to make more aromatics are significant in catalytic petroleum refining. Catalytic removal of potential pollutants in the power-producing industries include petroleum desulfurization, and stack gas removal of SOx and NOx. Catalytically produced clean-burning synthetic fuels are considered.

# C. MEASUREMENT METHODS

00056

C.L. Chakrabarti, J.W. Robinson, P.W. West

**THE ATOMIC ABSORPTION SPECTROSCOPY OF LEAD.** Anal. Chim. Acta Vol. 34:269-277, 1966

Lead can be determined by atomic absorption spectroscopy at 3 wavelengths. The relative sensitivities are 1:1.5:300. No interferences were found from the cations studied. Anionic interferences were numerous and extensive, but were removed by adding EDTA. The use of a 'T'-piece increased the sensitivity of atomic absorption when flame atomizers were used. However, extreme care was necessary in controlling flame conditions both with respect to oxygen-fuel ratio and the type of solvent used. The absorption by combustion products in the flame was high, and in many cases, much greater than that of the lead itself. The most sensitive conditions for the determination of lead appeared to be as follows: wavelength, 2170 A; solvent aqueous or organic; flame, oxy-hydrogen, with the hydrogen atomizing the sample (reversed from normal). A flame adapter enabled detection limits of 0.013 p.p.m. to be reached. (Author)

00125

R. L. Blanchard

**RAPID DETERMINATION OF LEAD-210 AND POLONIUM-210 IN ENVIRONMENTAL SAMPLES BY DEPOSITION ON NICKEL.** Anal. Chem. 38, (2) 189-92, Feb. 1966.

A procedure for determining Po-210 and Pb-210 simultaneously in environmental samples was developed by finding the optimum conditions for the spontaneous deposition of Po-210 and Bi-210 on nickel from an HCl solution. The effects of HCl concentration, hydrazine concentration, temperature, time of deposition, surface area of the planchet, and the presence of the HClO4 used to ensure oxidation of environmental samples were studied. Recoveries of Po-210, Bi-210 and Pb-210 were determined for various environmental samples spiked with a (Pb-210 Bi-210 Po-210) standard. The Po-210 concentrations were determined by alpha counting. The Pb-210 concentrations were determined by beta counting the Bi-210 daughter. An aluminum absorber was used to eliminate the Po-210 alpha and Pb-210 beta particles. (Author)

00855

F.L. Ludwig, D.M. Coulson, E. Robinson

**SIZE DETERMINATION OF ATMOSPHERIC SULFATE AND CHLORIDE PARTICULATES (FINAL REPT.).** Stanford Research Inst., Menlo Park, Calif. Feb. 1966. 77 pp.

The sulfate aerosol sampling program for 1964 and 1965 has provided a total of 74 size distributions using the aerosol spectrometer technique developed for this program. A typical size distribution for these data has a mass mean diameter of about 0.35 micron, a lower quartile of about 0.1 micron, and an upper quartile at about 1.0 micron. However, as is to be expected, the individual tests show a considerable degree of variation about these figures. The size distributions reflected changes in humidity, time of sample collection, and sampling location. When size distributions were grouped and averaged according to the prevailing relative humidity for the test, there was a definite tendency for larger sizes to accompany higher humidities. Chloride size distributions are available from a total of 36 tests, all run during the 1965 season. These data indicate an average size distribution with a mass median equivalent diameter of about 0.3 micron, a lower quartile of 0.15 micron, and upper quartile greater than 1.5 micron. This average size distribution is bimodal. The distribution mode at smaller sizes is similar to sizes of lead aerosols reported by Robinson and Ludwig (1964), while the mode at larger sizes is in the range reported by Junge (1963) for a typical continental aerosol. Since automobile exhausts are believed to contain aerosols composed of complex salts of lead, chlorine, bromine, and oxygen, a similarity between lead and chloride aerosols is not surprising. Further studies of these two materials might provide an interesting insight into urban aerosol interactions and sources. Analytical methods used for micro-sulfur determinations were improved in various ways as the program developed and more experience was obtained in its operation. One of the more important changes involved thermostating the titration cell, which improved baseline stabilization. Another change in technique provided for the evaporation of the sample in a stream of clean heated nitrogen instead of in the open laboratory atmosphere. Both of these changes improved the reliability of the sulfur determinations.

01230

N. L. Soulages

**SIMULTANEOUS DETERMINATION OF LEAD ALKYLS AND HALIDE SCAVENGERS IN GASOLINE BY GAS CHROMATOGRAPHY WITH FLAME IONIZATION DETECTION .** Anal. Chem. 38, (1) 28-33, Jan. 1966.

A gas chromatographic method with flame ionization detection for the determination of lead alkyls and scavengers in gasoline is described. These compounds are separated in a partition column and hydrogenated using a nickel catalyst, and the resulting methane and/or ethane is separated from gasoline hydrocarbons on an absorption column. The equipment employed and its application to the continuous analysis of leaded gasolines are discussed. The reliability of results and the lack of interferences are verified with both laboratory-prepared and commercial samples. (Author abstract)

01249

C. R. Hosler and L. B. Lockhart, Jr.

**SIMULTANEOUS MEASUREMENTS OF RN222, PB214, and BI214 IN AIR NEAR THE GROUND .** J. Geophys. Res. 70, (18) 4537-46, Sept.15, 1965.

Measurement of the rate of decay of Pb214 plus Bi214 beta-activity collected on a filter provides a means of determining the extent of secular equilibrium between radon and its daughter products in the air; the extent of equilibrium is expressed by the derived atom concentration ratio rho equals Bi214/Pb214 in the air. This parameter is used to obtain a correction factor for relating the beta-counting rates on the filter to radon concentration, by comparing the total (corrected) beta-count against a

known beta-count from 100 pc of radon per unit volume. To obtain a calibration of this counting technique simultaneous air sampling, over 20-min durations, for Pb214 plus Bi214 beta-activity by filtration and for radon by alpha-counting of grab samples, was conducted at elevations of 1 and 91 m above the ground. The comparative sampling indicates that for normal weather conditions, by applying a rho correction for indicated equilibrium departure, the beta-counting technique yields radon concentrations equivalent to those obtained by grab samples at an elevation of 91 m; for the 1-m elevation computed concentrations are about 80% of those obtained by grab sample. The depletion of radon daughter product beta-activity from the air stream, through impaction or electrostatic effects by polyethylene tubing, is shown to be negligible. Natural atmospheric scavenging processes and dust-loading on filters are discussed as possible mechanisms leading to errors in the comparison of beta-counting rates with directly measured radon concentrations. (Author abstract)

01607

W.H. Hill

**APPLICATION OF CHROMATOGRAPHY TO ANALYTICAL PROBLEMS IN INDUSTRIAL HYGIENE AND AIR POLLUTION (PROGRESS REPT.).** Pittsburgh Univ., Pa., Dept. of Occupational Health. (NIH Research Grant No. GR-4924(C-2) (Rept. No. 4, 1959). Apr. 30, 1959. 12 pp.

Two sets of neutron bombarded paper pieces with traces of tnallium were evaluated, showing promising results but need for more work. Continuous electrophoresis of urine on the Spinco instrument was given a thorough study. Failure of this method for concentration of trace metals is intrinsic in the design and purpose of the instrument. The use of ion exchange resin for the concentration of trace amounts of lead in urine gave good recoveries and correlated with the use of polarography for determination of lead in one ml. samples.

01608

W.H. Hill

**APPLICATION OF ELECTROCHROMATOGRAPHY TO ANALYTICAL PROBLEMS IN INDUSTRIAL HYGIENE AND AIR POLLUTION (PROGRESS REPT.).** Pittsburgh Univ., Pa., Dept. of Occupational Health. (NIH Research Grant No. RG-4924(C1) (Rept. No. 3, 1958). Mar. 10, 1958. 18 pp.

The objective was to design and perfect methods for the detection and determination of micro quantities of toxic metals, notably lead, and mercury in blood, urine, air, etc., by electrochromatographic means. The electrophoresis of lead, dust spots, and thallium dust was studied as well as indicators for thallium, ionophoresis of wine and neutron bombardment for estimating trace quantities of metals.

02164

R. S. Brief, A. R. Jones, and J. D. Yoder.

**LEAD, CARBON MONOXIDE AND TRAFFIC - A CORRELATION STUDY.** J. Air Pollution Control Assoc. 10, (5) 284-8 & 413, Oct. 1960. (Presented at the 53rd Annual Meeting, Air Pollution Control Association, Cincinnati, Ohio, May 22-26, 1960.)

Atmospheric levels of lead and carbon monoxide were studied at 6 locations in a northeastern U.S. city with traffic densities ranging from 0-99 vehicles/min. Sampling site: 30-50- feet from nearest traffic, 4 feet above ground level. Sampling method for CO: ambient air at 100 cc/min., filtered through a silical gel trap and then into 3 commercially available CO indicator tubes in parallel. Sampling schedule: The program was operated 5 days a week, Thursday through Monday, during a 3-week period in July and August, 1959. Sampling started at 10:30 AM and continued through 6:30 PM each day. Each of the sampling locations was used 5 times. Traffic density was averaged from seventeen 5-10 min. counts during the 8-hr. day. CO concentration correlated with traffic density at 99% significance; CO (ppm)=0.281 + 0.136T (vehicles/min.). Range of CO concentrations: (1) LIGHT TRAFFIC (0-5 VEHICLES/MIN.) 0-1 PPM. (2) MODERATE TRAFFIC (3-22 vehicles/min.) 0-6 ppm, and (3) Heavy traffic (16-99 VEHICLES/MIN.) 0-47 PPM.

03034

Hara, N.

**THE RAPID DETERMINATION OF LEAD ON FILTER PAPER.** Ind. Health (Japan), 3(3-4):101-106, 1965.

In alkali solution, diphenylcarbazide reacts with lead and produces a water soluble complex of deep red. This method allows 1-50 micrograms lead to be determined and read from the length of the colored part of the filter paper. The limit of identification by this method is about 0.01 microgram lead, the limit of determination about 0.1 microgram.

03037

K. Homma, S. Koshi, and H. Sakabe

**THERMAL PRECIPITATOR FOR MEASUREMENT OF PARTICLE SIZE DISTRIBUTION BY MEANS OF ELECTRON MICROSCOPE.** Bull. Nat. Inst. Indust. Health (Kawasaki, Japan) 7, 25-30, 1962

A new thermal precipitator is described, based on the Wright precipitator, which concentrates the number of particles on an electron microscope grid to the level at which they can be conveniently counted, and particle size distribution determined. The modification involved keeping the temperature of the collecting plate constant during the entire sampling time and thus being able to increase the sampling time. An example is given of particle sizes and distributions of lead oxide fumes sampled at a lead smelter.

03770

R. Mappes

**THE SIMULTANEOUS DETERMINATION OF LEAD CONTENT IN THE AIR OF A WORKING PLACE BY FOUR LABORATORIES.** STAUB (English Transl.) (Dusseldorf) 26, (9) 15-8, Sept. 1966. Ger (Tr.)

Four laboratories have checked the reliability of their analytical methods by carrying out, at the same time and place, determination of lead present in the air. After taking into account many possible errors, in spite of the fact that different instruments and analytical methods were used, it has been possible to measure lead dust concentrations below the MAK value (200 microgram Pb/m3) with deviations upto plus or minus 15% (49 out of 51 values). In the case of concentrations below the MAK value the disparities were only slightly higher. This accuracy is quite sufficient for most problems of industrial hygiene. (Author summary)

05243

Saunders, Jr.

**FILTER PACK TECHNIQUE FOR CLASSIFYING RADIOACTIVE AEROSOLS BY PARTICLE SIZE .** Part 2. Isotopic Fractionation with Particle Size. Naval Research Lab., Washington, D. C. Chemistry Div. (NRL Rept. No. 6164.) Oct. 28, 1964. 14 pp.

An evaluation of the relative distribution of some long-lived airborne fission products among several ranges of particle sizes has been carried out by the radiochemical analysis of individual air filters exposed in a pack. The relative quantities of radioactivity deposited on each of the filters in the packs has been found to vary considerably throughout 1963; however, each of the individual isotopes behaves in much the same manner so that the fractionation of isotopes relative to one another is slight. Though isotopic fractionation by filters of different characteristics has not been found to be of great significance, there are indications that a more sensitive separating procedure may show more difference between particles in the extreme size ranges. The observed differences have been small and variable, rather than organized, but the variations are too large to be accounted for by experimental error. The long-lived natural radioisotope Pb210 has a distribution very similar to that of the fission products, but with some preferential concentration in the smaller size range. The differences are not sufficient to invalidate the use of collections made on less than perfect filters for estimating the relative fission product concentrations in the air or for the approximate age determination of bomb debris.

05456

Roschig, M. and Matschiner, H

**INVERSE POLAROGRAPHIC DETERMINATIONS OF TRACES OF LEAD IN MIXTURES OF TECHNICAL HYDROCARBONS.** Inverspolarographische Bestimmung von Bleispuren in Technischen Kohlenwasser-Stoffgemischen. Chem. Tech. (Berlin) 19(2):103-104, Feb. 1967. Ger.

A method is described in which lead in benzene in concentrations of 1 to 100 ppb can be determined. After reducing the tetraethyl lead with bromine, the lead is extracted with 0.1N HNO3 and determined in an inverse polarographic cell. The threshold of detection of 0.8 ppb of lead depends on the purity of the reagents used. The method is fast, requiring about 45 min. with a standard deviation of plus or minus 7 percent.

05787

West, P. W., Weisz, H., Gaeke, G. C.,Jr., and Lyles, G.

**TRANSFER, CONCENTRATION, AND ANALYSIS OF COLLECTED AIR-BORNE PARTICULATES BASED ON RING OVEN TECHNIQUES.** Anal. Chem. 32 (8), 9 6 (July 1960).

A procedure has been developed for the analysis of the particulate material, including aerosols, collected from a very small air sample (1 cu meter). A number of standard atmospheric sampling devices have been used for the collection of the samples. The ring oven and associated spot tests were then used for the concentration and final determination (qualitative and/or quantitative) of the various constituents present in the mixture. Techniques have been developed for the direct transfer of the sample from various filter media used in the sample collection devices to the special paper required in the ring oven. As little as 2 or 3 micrograms of a constituent in a total air sample of 1 cu meter can be quickly and conventiently determined with good accuracy. (Author abstract)

05977

Browett, E. V.

**ANALYTICAL METHODS.** Ann. Occupational Hyg. (London) 8, (1) 21-8, Mar. 1965. (Presented at the 16th Conference, British Occupational Hygiene Society, Apr. 7-8, 1964.)

Techniques of performing 'spot' tests for the presence of metallic or metal-containing contaminants in atmospheres are reviewed briefly. The procedures for more accurate determination of the concentration of atmospheric contaminants and for the determination of the metal content of blood and of urine are treated as comprising three steps: collection, pre-treatment and analysis. Methods for the collection and pre-treatment of various amples are are described. Colorimetric and polarographic methods of analysis Methods for the collection and pre-treatment of various samples of prepared sample solutions are discussed with particular refer- ence to the determination of trace amounts of lead and attention is drawn to various precautions that must be taken in order to obtain reliable results. (Author abstract)

06045

D. L. Adamson, J. D. Stephens, and W. M. Tuddenham

**APPLICATION OF MINERALOGICAL PRINCIPLES AND INFRARED SPECTRA IN DEVELOPMENT OF SPECTROGRAPHIC TECHNIQUES.** Anal. Chem. 39(6):574-578, May 1967. (Presented at the Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, March 5, 1965.)

Correlation of infrared spectra of spectrographic arc residue beads with emission data revealed that samples yielding beads containing olivine and pyroxene group minerals evolved volatile elements in the arc most rapidly and produced the highest elemental line intensities for the volatile elements and the lowest intensities for iron. The hypothesis was developed that combination of iron with silca to form linked ionic groups within the melt decreased iron evolution. The resulting increase in arc temperature intensified excitation of the volatile elements. Exclusion of extraneous ions from these ionic groups also appeared to be a factor in the acclerated evolution of volatile elements. Methods were developed for determination of volatile elements--antimony, arsenic, bismuth, cadmium, gallium, germanium, indium, lead, mercury, tellurium, thallium, and zinc--in a wide variety of materials, including iron oxides, limonite, magnetite, pyrite, chalcopyrite, manganite, silca, and silicate minerals in general. (Authors' abstract)

06072

L. J. Snyder

**DETERMINATION OF TRACE AMOUNTS OF ORGANIC LEAD IN AIR.** (Composite sample method). Anal. Chem. 39 (6), 591-5, May 1967.

A composite sampling method was developed for measuring trace quantities of organic lead in ambient air. The mean error of the method is plus 0.001 microgram/cu m and the precision (standard deviation of the difference between the quantities found and present in known samples) is plus 0.004 microgram/cu m of air. The method consists of collecting a large air sample (100 cu m to 200 cu m) by passing it through an activated carbon scrubber for a period of 2 to 4 days. Organic lead collected in the activated carbon is decomposed, extracted from carbon, and colorimetrically measured by a single extraction dithizone method. Interference from particulate lead is eliminated by effective filtration prior to collecting organic lead. The average quantity of organic lead found in ambient air in Los Angeles for a six-week period of time was 0.078 microgram/cu m, or approximately one one-thousandth of the maximum allowable limit of 75 microgram/cu m of air for an 8-hour exposure. The method is of sufficient accuracy to detect changes in the organic lead content of the atmosphere at this low level. (Author's abstract)

06107

Gilardi, E. F. and R. M. Manganelli

**A LABORATOR STUDY OF A LEAD ACETATE-TILE METHOD FOR THE QUANTITATIVE MEASUREMENT OF LOW CONCENTRATIONS OF HYDROGEN SULFIDE.** J. Air Pollution Control Assoc. 13, (7), 305-9 (July 1963). (Presented at the 55th Annual Meeting, Air Pollution Control Association, Chicago, Ill., May 20-24, 1962.)

Laboratory studies of factors influencing the quantitative use of a lead-acetate-tile method for H2S were undertaken. These studies included the preparation of H2S test atmospheres, the determination of the darkening effect of these atmospheres on lead-acetate-coated tiles, and investigations on the stability of the PbS color produced. The following conclusions resulted: (1) 0Exposure Units,0 which is the product of H2S concentration and exposure period, mg.hr/cu m, is a useful parameter in representing H2S exposure. A regression equation utilizing this parameter accounts for 98.6 percent of the variation in absorbance values. (2) Average concentrations of H2S between 0.15 and 1.5 mg/cu m can be determined by the measurement of the surface absorbance of a lead- acetate coated tile. The standard error of estimation was plus or minus 001515 absorbance units in a laboratory-prepared darkening curve. (3) The tile-darkening curve was approximated by a parabola. A distinct maximum in absorbance was also observed in tile darkening data. (4) Whether or not a tile absorbance value within the usable range is on the ascending, defined portion of the darkening curve may be determined by a consideration of the reflectance spectrum of the particular tile. (5) The darkening effect of a given exposure to H2S was increased by increased air turbulence. (6) Methyl mercaptan, dimethyl sulfide, and dimethyl disulfide, in concentrations much higher than normally present in the outdoor atmosphere, had no significant effect on the H2S sulfide darkening of lead-acetate-coated tiles. (7) Fading of darken tiles was accelerated both by air turbulence and light. (8) Periods of exposure of lead-acetate-coated tiles are limited by H2S concentration level and fading of the PbS color. The higher the H2S concentration, the smaller the exposure period which will result in a surface absorbance beyond the usable range. The fading in a louvered, light-proof chamber places an upper limit of approximately 8 hr. on outdoor exposure periods. (authors' summary modified)

06112

Tada, O.

**MEASUREMENT OF AIR POLLUTANTS.** Bunseki Kagaku (Japan Analyst) (Tokyo) pp. 110R-7R. 1966. Jap.

Important papers published in Japan Analyst in 1964 and 1965 are summarized. The subject is limited to measurement methods of air pollutants known to be toxic to health. Pollutants from stacks and automobile exhausts are covered, including many cyclic hydrocarbons, aldehydes, sulfur oxides, nitrogen oxides, ozone, carbon monoxide, carbon dioxide, fluorine compounds, hydrogen sulfide, lead compounds, and offensive odors. Various sampling methods are described, especially using filtering with glass wool filters, electric dust collectors, gas absorbers, and portable samplers containing silica gel. The pollutants can be measured by electroconductivity methods, colorimetric measurement recorder, gas chromatographic analysis, electron capturing detector, and hydrogen ion detector. The papers summarized do not include those dealing with industrial or occupational environment or mining.

06643

G. M. Morgan

**TECHNIQUE FOR DETECTING LEAD PARTICLES IN AIR.** Nature, 213 (5071), 58-9 (Jan. 7, 1967.

A new method of detecting lead particles, based on the activity of lead iodide as an ice nucleating agent, underwent preliminary testing. Air entering the acoustical particle counter is first passed through a small mixing chamber containing iodine crystals. The resulting lead iodide ice nuclei are then detected. Laboratory and field trials suggest that this technique may be useful in monitoring air pollution.

06881

Razamov, V. A., and T. K. Aidarov

**COMPARATIVE EVALUATION OF CERTAIN METHODS FOR THE DETERMINATION OF LEAD AEROSOLS.** ((Stravnitel'naya otsenka rnetodov opredeleniya aerozolei svintsa v vozdukhe.)) Hyg. Sanit. (Gigiena i Sanit.), 30(1):48-50, Jan. 1965. Translated from Russian. CFSTI: TT 66-51033

Industrial-sanitary chemistry is making a continuously increasing use of rapid and objective instrumental methods (physical and physicochemical) in addition to purely chemical analytical methods. Regrettably, no published comparative data are available on the employment of (different) instrumental methods for analysis of the same substances, including lead. The authors decided to fill this gap by investigating the advantages and disadvantages of the spectrographic, spectrophotometric, polarographic and photocolorimetric methods in the analysis of lead. In order to reveal the maximum possibilities of these methods, the tests for lead in air samples were preceded by determinations of its trace amounts in pure solutions. The results for analyses of identical lead concentrations in pure solutions show that the spectrographic and colorigraphic determinations are fairly close to one another, while the spectrophotometric and phototurbidimetric and analytical errors are somewhat smaller. Under their experimental conditions, the minimum detectable concentrations of lead were 0.000005% with the spectrographic method, 0.00008% with the polarographic method, and 0.0002% with the spectrophotometric and phototurbidimetric methods. Comparative data on the determination of lead in air by the same method show certain quantitative differences in the analytical results. This probably should be explained by the different chemical preparation of the samples for analysis. Therefore, in determining lead in air by any of the methods under consideration, account must be taken of the accuracy of the method calculated from actual samples. Before actual use of any specific method one must carry out preliminary work to achieve maximum sensitivity and to reduce the error according to the actual analytical objects. Of the methods tested, preference is given to the spectrographic method which is the most sensitive and rapid; the number of elements to be determined simultaneously must also be considered.

06894

Razumov, V. A., and T. K. Aidarov

**A FAST METHOD FOR DETERMINING LEAD IN THE AIR.** ((Uskorennyi metod opredeleniya svintsa v vozdukhe.)) Hyg. Sanit. (Gigiena i Sanit.), 30(3):392-394, Mar. 1965. Translated from Russian. CFSTI: 66-51033

In a number of cases there is a need for rapid and accurate determination of the lead aerosol content in the air. The usual chemical and physicochemical methods applied for this purpose are rather lengthy and labor-consuming. The most advantageous is color reaction on paper without any previous

working of the ground. The fullest response to all requirements is afforded by the color reaction with tetrahydroxy-p-benzoquinone. Here a legible scale is obtained for microgram parts of lead on paper, the pink coloring lasts for up to six months, and the reagent solution itself is stable for up to 4 months. Antimony, bismuth, zinc, copper, iron, arsenic, chromium and calcium, also cadmium (in equal concentrations with lead) do not interfere with determination. The air sample was taken out with an aspirator plant at a rate of 3 1/min onto filter paper (blue band). When the lead content is within the normal limits, 10-15 1 of air have to be taken. A disk of paper 17 mm in diameter was placed in a plexiglas holder of the proper dimensions, and a drop (0.05 ml) of reagent was applied to the filter in the holder; after it had dried, samples were taken, and then a drop (0.05 ml) of buffer solution was applied. The pink coloring appeared at once. Then the filter was taken out of the holder and was placed on clean filter paper (with the coloring upward) to dry. After a few seconds, the coloring was compared with the scale on the paper obtained by the analogous method for certain lead concentrations. The sensitivity of the method was 0.015 ug in the drop (0.05 ml). For more reliable results, it is better to make two parallel (in the worst case, successive) determinations. The duration of one determination is not more than seven minutes, if the air contains lead in more than the normal amount.

06920

G. Lambert, B. Ardouin, M. Nezami and G. Polian

**POSSIBILITIES OF USING LEAD 210 AS AN ATMOSPHERIC TRACER.** Tellus (Uppsala) 18 82), 421-6 (1966). (Presented at the CACR Symposium, Atmospheric Chemistry, Circulation and Aerosols, Visby, Sweden, Aug. 18-25, 1965.)

A method for measuring the concentration of lead-210 on Antartic continent neves was discussed. The high sensitivity of the lead-210 measurement through the polonium-210 enables to date the neve layers of the Antartic continent. Thus, appear some correlations between the concentration of lead-210 in the snow and the solar activity. The study of the atmospheric concentration of lead-210 above the oceans having proved the stratospheric origin of this nuclide in these regions, the former correlations are therefore due to a possible action of the sun's corpuscular radiations on the stratosphere-troposphere transfers.

08130

Vigdorchik, E. A.

**DETERMINATION OF AIR DUSTINESS ACCORDIHG TO OWEN'S METHOD.** In: Survey of U.S.S.R. Literature on Air Pollution and Related Occupational Diseases. Translated from Russian by B. S. Levine. National Bureau of Standards, Washington, D. C., Inst. for Applied Tech., Vol. 3, p. 1-12, May 1960. 13 refs. CFSTI: TT 60-21475

The Owens method was tested in order to determine its possible use in routine sanitary inspection for the determination of air dustiness in manufacturing plants. On the basis of tests to which Owens apparatus was subjected in the dust chamber and under manufacturing plant conditions, it can be stated that the method and apparatus present a considerable advance in the problem of dust study. Particularly valuable characteristics of the instrument are: a. Particles suspended in the air measuring 0.3u and above in diameter can be reliably counted; b. Diferential particle counts can be made simultaneously; c. The dusts studied microscopically remain unchanged because of the special method used in making the preparations; d. Differences in duplicate readings do not exceed the limits of experimental error; e. Sample collecting is not time consuming; f. As a consequence to the rapidity of sampling, the dynamics of the dust-laden air can be studied reliably; g. The apparatus is of small size and is easily portable.

08145

Gernet, E. V.

**A COMPARATIVE STUDY OF THE RETENTION CAPACITY OF DIFFERENT FILTERS USED IN THE GRAVIMETRIC DETERMINATION OF SMOKE SUSPENDED AEROSOLS.** In: Survey of U. S. S. R. Literature on Air Pollution and Related Occupational Diseases. Translated from Russian by B. S. Levine. National Bureau of Standards, Washington, D. C., Inst. for Applied Tech., Vol. 3, p, 78-86, May 1960. 7 refs. CFSTI: TT 60-21475

Cotton fiber, paper filters, porous glass filters and liquid absorbers were evaluated to determine the best suited filtering material for the gravimetric determination of a dispersed phase of toxic aerosols. The results of the investigation showed that determination of concentrations of highly dispersed smoke (particles of which ranged between 0.1 - 1.5 microns) could be satisfactorily accomplished by aspiration of air samples through ash-free filter paper of the makes tested, or through glass filter plates Nos. 2 and 3. Filter paper has the additional advantage of combustibility thereby reducing to a minimum loss due to adsorptive retention by the filtering material. Cotton filters, glass filter plates No. 1 and liquid absorber apparatus of the type of Gernet-Rykhter are not recommended for use in the study of aerosols (smokes) of high dispersion.

08661

Zimmer, Charles E. and George B. Morgan

**AN INTERLABORATORY COMPARISON OF LEAD EMISSIONS.** Preprint, Public Health Service, Cincinnati, Ohio, National Center for Air Pollution Control, ((19))p., 1967. 1 ref. (Presented at the 60th Annual Meeting, Air Pollution Control Assoc., Cleveland, Ohio, June 1967, Paper No. 67-152.)

A recent study of atmospheric lead concentrations provided an opportunity to evaluate the degree of reproducibility attainable by competent, well-run laboratories. Further, it permitted examining such results for the existence of a laboratory bias which could seriously affect the imterpretation of the data from a study. The results of an interlaboratory comparison of lead determinations involving three laboratoies are presented. Each laboratory used the dithizone method of determining lead, modified slightly according to its own experience and judgment. The data presented show that one laboratory yielded values approximately 10 percent lower and another laboratory was 10 percent higher than the average for the three laboratories. In addition, the data show that even under ideal conditions the precision of an individual lead determination can range from 7 percent to nearly 30 percent for a given laboratory. (Authors abstract)

09333

Lial W. Brewer, (ed.)

**ANALYTICAL PROCEDURES FOR THE ENVIRONMENTAL HEALTH LABORATORY. Sandia Corp., Albuquerque, N. Mex., Industrial Hygiene Lab., SC-M-3044, 147 p., Feb. 1968. 13 refs.**

This is a manual compiled of thirty-nine analytical procedures used by an industrial hygiene laboratory. The procedures for the following substances in air are included: The Determinaton of Acetone, Acid and Alkali Contaminants; Benzene, Toluene, and Other Aromatics; Beryllium (Spectrographic Method); Beryllium (Morin Method); Cadmium; Chromic Acid, Chro-

mates, and Dichromates; Formaldehyde; Lead; Methanol; Nitrogen Dioxide; Oil Mist; Ozone (Colorimetric Method); Ozone (Titration Method; Phosgene; Silica (Colorimetric Method); Sulfur Dioxide; Thallium; and Zinc.

09476

P. M. Giever

**NEEDS FOR REMOTE SENSING DATA IN THE FIELD OF AIR AND WATER POLLUTION CONTROL.** In: Proceedings of the Fourth Symposium on Remote Sensing of Environment, 12, 13, 14 April 1966, Michigan Univ. Ann Arbor, Willow Run Labs., Contract NRnr 1244(44), 4864-11-X, p. 21-23, June 1966. CFSTI, DDC; AD 638919

One of the greatest needs is for instrumentation that will accurately evaluate the several oxidants, such as NO, NO2, NO3, and O3 in the range od parts per hundred million. These devices are needed for evaluation of stack gases, and for the ambient atmosphere. Nondispersing infrared has been used for many years for evaluating carbon monoxide but interference from water vapor has not been satisfactorily controlled. The use of infrared with complete accuracy in evaluating CO would be very helpful and the hydrogen sulphide generation in sewage sludge digesters and remote sensing instrument would be very useful as sentinals or its removal from digester gas. (Authors' summary) alarms. Remote sensing of SO2 with the data fed into a central point would be helpful. Accurate identification and quantifica- tion of polynuclear aromatic hydrocarbons in general atmosphere without sampling and laboratory analysis is needed. Evaluating automobile exhaust in the atmosphere, separating the constituents of interest and analyzing each quantitatively would be a major aid to this area of air pollution control. Sensing devices to evalu- ate odors would be particularly helpful. There is a need for means of determining the effective stack height, levels of in- version layer, and of remote temperature sensing. Instrumentation is needed for accurately determining the moisture content of stack gases, new and accurate equipment is needed for the evalua- tion of rate of flow of effluent in a discharge stack. Determina- tion of solids in a stack and in the general atmosphere by direct reading devices would be a major contribution. Instrumentation which will give accurate reproducible results in the sizing or counting of the entire spectrum of size (and shapes) of solid particulate is needed. New instruments and techniques to provide fast, accurate analysis for fluorine, lead, hydrocarbons and many others, each having long periods of extraction or reaction and many intermediate steps are also needed.

09888

Flesch, Jerome P.

**CALIBRATION STUDIES OF A NEW SUB-MICRON AEROSOL SIZE CLASSIFIER.** Preprint, Public Health Service, Cincinnati, Ohio, National Center for Air Pollution Control, 17p., 1967. 12 refs. (Presented at the 153rd Meeting, American Chemical Society, Miami Beach, Florida, April 10-14, 1967.)

The size-fractionating characteristics of a new aerosol classifier operating in the size range 0.015 to 0.5 micron were investigated with homogenous aerosols of zinc ammonium sulfate, polystyrene latex spheres, and solium chloride cubes. Size analyses were carried out by electron microscopy. Characteristic deposition curves were nearly identical in the small-particle collection zone and agreed with data for methylene blue spheres. For the zone above 0.2 micron the curves differed significantly, probably because of charging differences of the various aerosols. Preliminary application of the classifier to ambient air sampling has yielded size distribution data for lead in urban Cincinnati. (Author's abstract, modified)

09953

Perin, G.

**THE GAS CHROMATOGRAPHIC DETERMINATION OF TETRAETHYL LEAD IN THE ATMOSPHERE.** ((La determinazione gas cromatografica del piombo tetraetile nell'atmosfera.)) Text in Italian. Med. Lavoro (Milan), 58(10):624-631, Oct. 1967.

A gas chromatographic apparatus for the detection and quantitative analysis of tetraethyl lead in air samples is described. Using known samples of tetraethyl lead (3-400 microgram/cu m). recovery was excellent and ranged from 93-99%. Techniques of air sampling and analysis, according to the sample concentration, are described. This gas chromatographic method is fast, precise, and thought to be of value for routine determinations.

09983

Ubl, Z.

**UNIFIED METHODS FOR THE ANALYSIS OF POLLUTANTS IN THE FREE ATMOS- PHERE.** Acta Hygienica, No. 1, Suppl, 1966. 84p. 24 refs.

Methods for the analysis of pollutants in the air are presented with precise and complete notes dealing with procedure, apparatus, reagents, and possible problems. Procedures are given for determining the following compounds in the air: SO2, CO, NO2, NOx, sulfuric acid aerosols, Cl2, H2S, Pb compounds, CS2, phenol, As, F2, NH3, soot, Mn compounds, SiO2, and formaldehyde. Also discussed are methods of air sampling, calibration methods, calculations, sensitivity and error in the determinations interferences from other compounds, and the principle involved in the method.

10528

Matson, Wayne Reimer

**TRACE METALS, EQUILIBRIUM AND KINETICS OF TRACE METAL COMPLEXES IN NATURAL MEDIA.** Thesis (Ph.D), Massachusetts Inst. of Tech., Cambridge, Dept. of Chemistry, Contract Nonr-1841(74), Proj. DSR-74913, 258p., Jan. 1968. ((61)) refs. CFSTI, DDC: AD 666554

A composite mercury graphite electrode (CMGE) has been constructed and has been shown to follow the theoretical behavior for thin film electrodes. Its physical structure has been studied, and correlated with its electrochemical behavior and stability. An analytical system capable of performing multiple analysis of metal ions has been built using the CMGE and the analytical precision has been investigated over the range of 10 to the minus 7th power to 10 to the minus 10th power M. Anodic stripping techniques using the CMGE have been developed for obtaining information on the complicated distributed of the trace elements Zn, Cd, In, Pb, Cu, Bi, in samples from the environment, and for obtaining parameters related to the formation constant K, and the rate constants for naturally occurring trace metal complexes of these metals and several others - Fe, Mg, Co, Ni, U. Techniques have been developed for separating molecular weight fractions of complexes and complexing agents in water samples. A portion of the trace metals atmospheric samples have been shown to be bound to particulate material of greater than one micron diameter. A ubiquitous nonlabile trace metal component has benn identified in all fresh waters. A quantitatively and qualitatively different nonlabile components is present in some

sea water samples. Up to eight different nonlabile complexing agents have been identified in one sample. The data indicate that the high molecular weight complexes are at least in part humic acid type compounds. Estuarine and surface mechanisms whereby nonlabile materials can be removed have been studied briefly. A complicated distribution of strong labile complexes which is apparently associated with biological activity has also been identified in many waters. (Author's abstract)

10556

Lahmann, Erdwin and Manfred Moller

**THE DETERMINATION OF LEAD AND DUST IN THE ATMOSPHERE.** ((Die Bestimmung von Blei und Staub der atmospharischen Luft.)) Text in German. Gesundh. Ingr. 88(6):182-186, 1967. 20 refs.

A method for the determination of lead in atmospheric dust is described. A high volume sampler (about 80 cu m air/hr.) with glass fiber filters is used, followed by photometric determination using the dithizone method. A one-hour sample yielded 1.7-10.3 microgram Pb/cu m air, from 0.12-0.63 mg. dust/cu m. This long-term monitoring with one-hour sampling periods indicates definite variations in the Pb content of the air from a well traveled street. The sampling and analytical techniques used are described, as well as tests of the methodology.

10561L

G. Machata

**CHEMICAL INVESTIGATION OF LEAD DUST IN LEAD PROCESSING PLANTS, WITH SPECIAL REFERENCE TO PARTICLE SIZE DISTRIBUTION OF AIRBORNE DUST. ((Uber die chemische Untersuchung von Bleistaub in bleiverarbeitenden Betrieben. Unter besonderer Berucksichtigung der Korngrossenverteilung des anfallenden Staubes.)) Text in German. Mitt. Oesterr. Sanitatsverwaltung (Vienna), 67(9):220-221, 1966.**

In connection with efforts to detect the lead content in dust and the proportion of lead dust entering the lungs, a new, simple method for the size distribution of airborne dust particles is reported. Dust samples collected on a filter are secured on a photomicroscope and are photographed, and the resultant pictures are then enlarged ten- or twentyfold. Each photo is examined by means of a particle size counter, which permits the determination of particles of different sizes according to size classes, and teh statistical evaluation of the countrd particles. The results can be expressed graphically and the percentage graphically and the percentage of a certain size-range (e.g. of a size which will enter the lungs) can be shown. The implications of this method for lead particle size determinations in lead dust obtained from occupational exposure are discussed.

11042

C. L. Luke

**NEW X-RAY METHOD FOR THE DETERMINATION OF TRACE ELEMENTS IN AIR.** Preprint, Bell Telephone Labs., Murray Hill, N. J., ((12))p., 1968. 3 refs. (Presented at the 61st Annual Meeting, Air pollution Control Association, St. Paul, Minn. June 23-27, 1968, Paper 68-68.)

A new accurate, sensitive and almost universally applicable X-ray method for the determination of trace elements in inorganic and organic materials has recently been developed. This method should be equally useful for the determination of trace elements such as S, Cl, Pb, Zn, Cd, As, etc. in water and air. In constrast to the problems that exist in the X-ray determination of trace elements in metals, alloys and other inorganic samples one is not confronted, in air analyses, with the difficulties that arise from absorption and enhancement effects due to the presence of large amounts of matrix elements. Instead, after a proper sampling of the air has been made the only problem that remains is to obtain the trace elements in a suitable environment so that they can be determined with the greatrst accuracy and sensitivity nby X-ray analysis. Tests have shown that trace elements collected from air can be obtained quantitatively on small filter paper disks for X-ray analysis by classical precipitation and filtration separations, provided that precautions are taken to insure complete precipitation by the use of a suitable coprecipitant. Since the X-ray spectrograph is a specific tool and since several elements can be determined on a single paper disk it is evident that the proposed new method will be much less time consuming than the chemical or instrumental methods heretofore used. It is seldom necessary to completely isolate the element to be determined. Suitable procedures have been developed for the separation and determination of microgram amounts of 68 of the 72 elements that are customarily determined with an X-ray spectrograph. As little as 20 nanograms of Ni, Ti, and Sc, 0.1 microgram of S, Ca, Cu, Fe, Co and Zn and 1 microgram of most of the other elements can be separated and determined. A complete analysis can be made in less than 15 minutes.

11626

Brune, D., S. Mattsson, and K. Liden

**APPLICATION OF A BETATRON IN PHOTONUCLEAR ACTIVATION ANALYSIS.** Aktiebolaget Atomenergi (Stockholm), AE-333, 1968. 19 refs.

Determinations of iodine in pharmaceuticals and of fluorine, lead, and mercury in pure compounds were made by photonuclear activation analysis, with a betatron accelerator used as the irradiation facility. The accelerator yields a lower photon flux density than a linear accelerator but has great flexibility with regard to beam direction. Uniform irradiation of the samples was achieved by inserting a rotating sample holder device in the brehmstrahlung beam of the betatron. The detection limits obtained for iodine, fluorine, lead, and mercury were 50, 3, 400, and 15 micrograms, respectively. It is concluded that the betatron has practical applications in the field of pharmacy but is unsuited for lead analyses in pollution studies of air, water, and food. It could be used for the determination of mercury in various biological materials, though better results are expected to be obtained by conventional neutron activation techniques.

12943

Chow, Tsaihwa J., John L. Earl, and Carrie F. Bennett

**LEAD AEROSOLS IN MARINE ATMOSPHERE.** Environ. Sci. Technol., 3(8):737-740, Aug. 1969. 11 refs.

Procedures for the shipboard sampling of marine air and the analysis of its lead content by the isotope dilution method are discussed. Marine air collected over the north and central Pacific Ocean between California, Midway Island, and American Samoa showed a lead concentration range of 0.0003 to 0.0015 micro g/cu m. This lead concentration range shows that marine air is the least polluted of the north temperate atmospheres. Because of the difficulty in evaluating the individual random sampling contamination due to the ship's exhaust plume, the marine air samples were treated as a suite to determine their representative lead aerosol concentrations. A lead blank of 0.08 micro g was subtracted from each sample and observed lead concentration in each filter was plotted against the volume of air filtered to obtain the sample.

12993

Walker, Alfred O.

**METHOD AND APPARATUS FOR DETERMINING THE PRESENCE OF VOLATILE ORGANIC LEAD COMPOUNDS IN THE ATMOSPHERE.** (Nalco Chemical Co., Inc., Chicago) U. S. Pat. 3,453,081. 3p., July 1, 1969. 1 ref. (Appl. July 23, 1965, 3 claims).

A method for determining the presence and quantities of volatile organic lead compounds in the atmosphere is described. A regulated stream of the air to be sampled is passed over iodine crystals long enough to sublime at least one half of the crystals, but not all of them. The sublimed crystals carry with them the reaction product of the iodine and the volatile organic lead compounds. The lead compounds are collected on a porous substrate. The substrate is developed, preferably by passing a quantity of air over it, to remove any remaining free iodine. The resulting yellow color of the substrate serves as an indicator of the presence of volatile organic lead compounds in the air sampled. The amount of lead contained in the air sample can be determined by color compariosn with similar porous substrates which have been treated with known quantities of lead-iodine containing compounds.

13122

Otto, J.

**APPLICATION OF COMPLEXOMETRY IN METAL DETERMINATIONS FOR LABOR HYGIENIC PURPOSES. I. DETERMINATION OF LEAD IN INDOOR AIR. (Uber die Anwendung der Komplexometrie bei Metallbestimmungen fur arbeitshygienische Zwecke. I. Mitteilung: Bestimmung von Blei in der Raumluft).** Text in German. Z. Ges. Hyg. (Berlin), 15(5):323 325, May 1969. 15 refs.

The method of complexometric micro titration for measurement of indoor airborne lead compounds is described. The complexometric method surpasses the photometric method in ease and speed. The method sufficiently accomplishes the measurement of the low concentrations admissible in occupational health and industrial hygiene. Disturbing ions and their elimination are discussed. (Author summary modified)

14758

Jungreis, E. and P. W. West

**MICRODETERMINATION OF LEAD BY THE RING-OVEN TECHNIQUE APPLICABLE TO AIR POLLUTION STUDIES.** Israel J. Chem., 7(3): 413-416, 1969. 3 refs.

The normal average of lead concentration in a permissible working atmosphere is 0.15 mg/cu m. The toxicity of the various lead compounds appears to depend on their solubility in body fluids and the fineness of the particles, with the solubility increasing in proportion to the fineness of the particles. As a result, the metallic lead fumes, the carbonate and the monoxide, are considered more toxic than the coarser lead dust, and phosphate, sulfide, and chromate compounds. A method for the microdetermination of lead which differentiates between the two groups of compounds by the ring-oven technique is described and is believed applicable to lead analysis of air pollution samples collected on sequential tapes. The method consists of fixing a filter paper on a ring-oven maintained at 100-105 C, adding the sample solution and then washing it out of the ring with 1 N nitric acid or acetic acid 1:5 solution. After completely drying the paper and evaporating the acid, 10 microliters of sodium molybdate solution is washed out; the dried paper is then placed in a malonic acid bath, boiled twice, dried, coated with a diphenylcarbazide reagent solution, and fumed with concentrated hydrochloric acid for about 5 min. The appearance of a blue ring indicates the presence of lead. As the colored background turns slowly from red to yellow, one hour should elapse before comparison with standard rings. The method for calculating the concentration of the unknown sample is given. The lower limit for lead determination was 0.05 micrograms; the upper limit for accurate estimation was 2 micrograms. Interference by other metals is briefly considered. It is concluded that two parallel determinations using nitric acid and acetic acid to dissolve lead particles will give basic information as to their hazardous or less hazardous nature, the first one marking the total lead value, the second the 'hazardous' one.

15562

Tonomura, Masaharu, Minoru Nanjo, and Shizuo Kano

**A STUDY ON THE AMOUNT OF LEAD IN THE HAIR OF REGIONAL INHABITANTS.** (Kankyo-eisei kara mita tohatsu-chu no namari-ryo ni tsuite). Text in Japanese. Eisei Shikensho Hokoku (Bull. Natl. Inst. Hyg. Sci., Tokyo), vol. 83:81-82, 1965. 8 refs.

The quantity of lead contained in the hair of regional inhabitants was measured in an attempt to compare the degree of air pollution caused by automobile exhaust gas, which contains lead as well as carbon monoxide. Three groups of subjects were selected for this study: residents of the Shinjuku district and policemen from the Yodobashi police station where traffic is busiest; workers at a pharmaceutical plant research laboratory where the traffic is minimal; and residents of Honjo city where the traffic is medium. The amount of lead in the hair was measured after decomposition of the hair by nitric acid. Higher concentrations of lead were observed in the hair of subjects who lived or worked where the air was polluted by automobile exhaust gas. In general, the hair of females contained more lead than the hair of males in the same district.

15563

Kettner, H.

**COMPARATIVE DETERMINATIONS OF LEAD IN DUST PRECIPITATIONS BY THE DITHIZON AND ATOMIC ABSORPTION SPECTROPHOTOMETRIC METHODS.** (Vergleichende Bestimmungen von Blei im Staubniederschlag nach der Dithizon- und der Atom-Absorptions-Spektral-Photometer-Methode). Text in German. Schriftenreihe Ver. Wasser Boden Lufthyg., no. 29:55-62, Oct. 1969. 2 refs.

By the use of atomic absorption spectrophotometry, 380 determinations were made in less than three hours. The method was reproducible, selective, and easy to calibrate. Calibration measurements using 10 micrograms lead per ml showed that the standard deviation was less than 2%. Cations such as Fe(3+), Al(3+), Ca(2+), Mg(2+), and Na(+), which occur in concentrations 100 to 1000 times that of lead, did not interfere with the analysis. The samples used for the analyses were prepared as follows: the dust sample was boiled with 50 ml dilute HCl and several drops of nitric acid. After cooling it was diluted to 250 ml. The clear solution which separated was used for the analyses. The results of the determinations by both chemical and spectrophotometric methods are listed in a table. Calculation of the correlation coefficients showed that atomic absorption spectrophotometry is applicable to the determination of small lead concentrations; correlation with the dithizone method is 99.6%.

15734

Roebisch, Gerhard

**THE PHOTOMETRIC DETERMINATION OF TRACES OF LEAD BY TREATMENT WITH 7-(ALPHA-(O-CAR-**

**BOMETHOXYANILINO)BENZYL)-8-HYDROXYQUINOLIN.** (Die Photometrische Bestimmung von Bleispuren unter Verwendung von 7-(alpha-(o-Carbomethoxyanilino)benzyl)-8-hydroxychinolin). Text in German. Anal. Chim. Acta, 47(3):539-546, 1969. 18 refs.

Traces of lead were extracted and spectrophotometrically determined by treatment with 7-(alpha-(o-carbomethoxyanilino)benzyl)-8-hydroxyquinolin). The molar absorptivity was 4500 at 410 nm. The determination is highly selective in the presence of suitable masking agents. The influence of Al, Bi, Ca, Cd, Co, Cu, Fe, In, Mg, Mn, Ni, Tl, and Zn was examined. Bismuth was co-extracted by the reagent. It was concluded that lead can be determined by a modified, less sensitive procedure. (Author summary modified)

16123

Crump, N. L. and T. T. Bartels

**TOXIC GAS CONTAMINANTS IN ENCLOSED ENVIRONMENTS.** Contamination Control: Current and Advanced Concepts in Instrumentation and Automation, 9(1):20-25, Jan. 1970. 2 refs.

Techniques were developed for collecting samples of toxic gases from enclosed atmospheres and quantitatively determining the concentration of these contaminants by analytical instrumentation. A gas sampling flask was developed which was conveniently used in the laboratory where danger of breakage during testing is at a minimum. However, since some test programs required sampling at remote areas or under conditions that increased the probability of breakage, a larger, more durable container was required. A sampling unit was described which was portable, capable of withstanding shock, capable of containing the sample for extended periods of time, and durable enough to be shipped to and from remote test sites. The design of the sampling unit permitted either manual collection of a sample in each flask by opening and closing the needle valve by hand, or automatic collection through a solenoid-valve control. Three sets of sample of aircraft cabin air were collected. The samples were analyzed chromatographically for carbon monoxide and carbon dioxide; colorimetrically, for the oxides of nitrogen; and polarographically, for lead. More sensitive detection capabilities were required for the gas chromatography than usually obtained. Improved detection limits for carbon dioxide and carbon monoxide were attained by modifying the gas chromatographic instrumentation. The most important change was in the detection system. When a thermistor detector was used, detection limits were improved from 90 ppm CO2 and 150 ppm CO to 14 ppm CO2 and 12 ppm CO. The effect of temperature on the thermistor was also determined. The sensitivity at 30 C was many times greater thant that at 250 C.

16367

Fitzek J. and H. J. Einbrodt

**THE CHEMICAL ANALYSIS OF AIRBORNE DUST.** (Die chemische Analyse von Luftstaubproben). Text in German. Arch. Hyg. Bakteriol. (Munich), 149(5/6):394-400, 1965. 11 refs.

The quantitative microchemical analyses of silicon, aluminum, iron, calcium, sulfur, and lead in airborne dust sampled over large cities are described. The dust samples were transferred into a platinum vessel either in a dry state (in which case a brush was used) or they were flushed off the sampler with deionized water. In the latter case, evaporation and a two-hour drying process at 120 C followed; the former case, drying alone sufficed. Part of the dried dust was used for the SiO2 analysis. The remainder was decarbonized at 400 C and subsequently treated in the Simon-Mueller oven for 4 hours at 700 C. After ashing, the SiO2 was evaporated with 2 ml hydrofluoric acid and 8 N HCl was added. Of this suspension, 10 ml were evaporated in a quartz bowel for Pb analysis. The remaining 15 ml was passed through an infrared analyzer where iron, aluminum and calcium were separated. The substance was collected in a 400 ml quartz glass after rinsing with 80 ml 8 N HCl and evaporated. The residue was washed with 0.5 ml 4 N HCl and replenished to 25 ml in a graduated flask. The iron was washed out from the exchange with 0.1 N HCl replenished to 100 ml, and directly analyzed. From the 25 ml flask aliquote, parts were taken for $t^+$ calcium and aluminum analyses. A step by step description for each of the analyses is given. The method is suitable for concentrations of 2 mg.

16382

Kehoe, Robert A.

**CRITERIA FOR HUMAN SAFETY FROM THE CONTAMINATION OF THE AMBIENT ATMOSPHERE WITH LEAD.** Proc. Intern. Congr. Occupational Health, 15th, Vienna, 1966, vol. 3:83-98, Sept. 19-24, 1966. 3 refs.

In an attempt to appraise the quantities and significance of lead in the ambient air, laboratory experiments were initiated for following the respiratory intake and output of airborne lead on the background of alimentary intake and output. In a preliminary experiment, two human subjects were observed daily for over a year for their metabolic pattern of lead intake from food and beverages and output in feces and urine. They were then exposed to air containing 150 micrograms/cu m of lead as the sesquioxide in particles ranging up to 0.18 micron diameter and having 0.05 micron mean diameter. Starting with an exposure period of 16 weeks for 10.5 hours weekly, the period was increased by 10.5 hours every 16 weeks. During each successive 16-week period of constant exposure conditions, the concentration of lead in urine and blood rose to a certain point and then continued at an essentially constant level; each incremental increase in the weekly duration of the exposure lead to a further increase of the same proportions in the output and concentration of lead in the urine and in the concentration in the blood. A line connecting the points representing the final blood concentration levels was extended to a point corresponded to continuous exposure (168 hours weekly). It is noted that, although intermittent exposure at a certain level results in an equilibrated response, this factor is inoperative under conditions of continuous exposure from the general environment. Human safety, therefore, lies in the avoidance of a persistent level of alimentary and respiratory dosage that will result in a measurable accumulation of lead in the bodies of exposed persons during a lifetime. Final results from further experiments, involving respiratory exposure to 10 micrograms/cu m of lead, are not yet available. However, it is concluded that the physiological response to graduated severity of exposure, measured by lead excretion in urine and lead concentration in the blood, is a reliable criterion for measuring lead absorption.

17048

Robinson, J. W., C. Woodward, D. M. Hailey, and H. M. Barnes

**THE POTENTIAL DETECTION OF POLLUTANTS IN THE ATMOSPHERE USING A REMOTE SENSING DEVICE.** Preprint, Am. Chem. Soc., Pittsburgh, Pa., Div. Water, Air Waste Chem., 7p., 1969. 4 refs. (Presented at the American Chemical Society, 158th National Meeting, Division of Water, Air, Waste Chemistry, New York, Sept. 1969.)

Tentative experimental results indicated the possibility of remote sensing by means of laser induced fluorescence for the qualitative and quantitative identification of gaseous air pollutants. The wavelength of the fluorescent bands of organic molecules, such as sulfur dioxide, nitrogen dioxide, and tetrathyl lead in the gas phase, coincided closely with the infrared absorption spectrum of the molecules, thereby permitting identification of each component by its spectral analysis. The intensity of the fluorescence was found to be proportional to the concentration of the fluorescing molecule present, thereby allowing a means for quantitative determination. In order for this method to become a reliable analytical tool, the effects caused by quenching and enhancement on the fluorescence intensity must be examined. Further work is in progress.

17179

Mueller, P. K.

**CHARACTERIZATION OF PARTICULATE LEAD IN VEHICLE EXHAUST - EXPERIMENTAL TECHNIQUES.** Environ. Sci. Technol., 4(3):248-251, March 1970. 12 refs.

A substantial advance in the technology of sampling particles from motor vehicle exhaust is represented by a sampling tunnel that permits a complete evaluation of particulate emissions. This technique provides the means to obtain numerical guides relating lead emissions from cars to atmospheric lead contamination. The capability is now available to relate not only the quantity of lead additive to total emissions, but also to the particle size distribution and composition as a function of particle size. The validity of the numerical guides that should be developed will depend on how the information is treated. From the urban pollution viewpoint, it would be unwise to include in lead-bearing particle distributions the size groups which settle out quickly. The major air pollution load would come from particles about 10 micron or smaller. Particle size distribution can be conveniently expressed in terms of parameters derived from an assumption of log normality. However, the plotting of data on log probability paper can easily lead to complacency about the assumption. Because the car exhaust aerosol is generated by both mechanical and chemical processes, it is also important to examine size distributions by means of histograms.

17180

McKee, Herbert C.

**CHARACTERIZATION OF PARTICULATE LEAD IN VEHICLE EXHAUST: EXPERIMENTAL TECHNIQUES.** Environ. Sci. Technol., 4(3):252-253, March 1970. 5 refs. (Presented at the American Chemical Society Symposium 'Air Quality and Lead,' Minneapolis, Minn., April 14-15, 1969.)

An experimental system for studying motor vehicle exhaust is described that should provide valuable data on the contribution of engine exhaust to urban air pollution. The design of the system allows for isokinetic sampling, avoidance of water condensate, and other factors that make it difficult to obtain a truly representative sample. As indicated by propane tracer tests, the sampling system achieves uniform flow conditions and adequate mixing. However, the data obtained to date may be limited by material deposited by settling, since these particles fall immediately to the ground and are not an important source of air pollution. Future studies should concentrate on the smaller particles collected by the system. Further study is necessary to learn more about the lead content of exhaust particulate matter and about the acid, olefin, and carbonyl content of the high molecular weight organic fraction. If lead additives are to be drastically reduced, the aromatic content of a fuel has to be increased. Such an increase would increase the polynuclear aromatic content of the exhaust. Therefore, cutting down the lead content of fuel to reduce a suspected but unknown and unproved health hazard might increase another health hazard that is suspected, but equally unknown and unproved.

17771

**QUANTITIVE DETERMINATION OF TETRAETHYL LEAD IN GASOLINE OF DIFFERENT TRADE MARKS AND IN KEROSENE.** U.S.S.R. Literature on Air Pollution and Related Occupational Diseases, vol. 8:64-69, 1963. (B. S. Levine, ed.) CFSTI:63-11570

A method for the determination of small quantities of tetraethyl lead in gasoline used as solvents and automobile fuel, and in kerosene was described. Tetraethyl lead is decomposed by iodine and the lead ion is determined as lead chromate. The sensitivity of the method is 0.00156 micrograms of tetraethyl lead per analyzed volume of the solution. The method consists of adding a few crystals of iodine to 50 ml of filtered gasoline in a procelain dish. The solution is evaporated and the dry residue is dissolved in 4-6 ml of 3% ammonium acetate and centrifuged. Two and a half ml of the clear solution is placed in colorimetric tubes, and 3% ammonium acetate is added until a total volume of 5 ml is reached. To all the tubes, 0.1 ml of 3% potassium chromate is added and after standing for 15-20 minutes, the solutions are nephelometrically compared against a dark background.

18007

Burnham, Carole D., Carl E. Moore, Eugene Kanabrocki, and Don M. Hattori

**DETERMINATION OF LEAD IN AIRBORNE PARTICULATES IN CHICAGO AND COOK COUNTY, ILLINOIS, BY ATOMIC ABSORPTION SPECTROSCOPY.** Environ. Sci. Technol., 3(5):472-475, May 1969. 12 refs.

A simple precise procedure for determining the lead content of suspended particulate samples collected from the air uses atomic absorption spectroscopy. It is necessary to utilize the standard additions technique to overcome matrix effects. Analyses of 38 samples collected in the Chicago and Cook County area on March 31, 1966, as a part of the National Air Sampling Network, yielded values from 0.10 to 3.18 micrograms of Pb per cubic meter of air. Results obtained by the referee method of polarography showed substantial agreement with atomic absorption values. Possibilities of employing atomic absorption for the determination of other metals found in suspended particulates are currently being investigated. (Author's Abstract)

18302

Ruhling, Ake, and Germund Tyler

**AN ECOLOGICAL APPROACH TO THE LEAD PROBLEM.** Botaniska Notiser, 121:321-342, 1968. 7 refs. Translated from Swedish.

A considerable accumulation of lead was measured both in plants and soil within a distance of 50-100 m from large roads. However, the accumulation of lead in this belt was only equal to the quantities spread by the cars on these roads during 7-15 months. Mosses proved to accumulate air-borne lead to an exceptional extent. To get a measure of the regional lead pollution, samples of three common woodland mosses were collected far away from roads in southern and central Scandinavia. A distinct NE-SW gradient was revealed with the decrease towards the NE. The lead concentration of the

mosses increased with precipitation and with decreasing distance to large population centres. At least in southwestern Gotaland a considerable part of the lead which is brought down by the rain will originate from areas outside Sweden. Analyses were also performed on samples collected in Skane 1860-1968. From values of about 20 ppm in the years 1860-1875 the concentration of lead was more than doubled between 1875 and 1900. During the first half of the 20th century no measurable changes were observed, but after about 1950 there was a new strong increase to a present average of about 80-90 ppm. Very low lead concentrations were measured in samples from northern Scandinavia, indicating that the 'natural' amounts of lead in mosses are very small and that the concentrations measured in this regional and historical study principally reflect the influence of human activity.

19276

Thilliez, G.

**QUANTITATIVE ANALYSIS OF METALS BY ATOMIC ABSORPTION IN INDUSTRIAL MEDICINE: I. APPLICATION TO QUANTITATIVE ANALYSIS OF ORGANIC LEAD IN THE AIR OF WORKSHOP ENVIRONMENTS.** (Dosage des metaux par absorption atomique en Medicine du Travail. I. Application au dosage du plomb organique dans l'air des milieux de Travail). Text in French. Arch. Maladies Profess. Med. Trav. Securite Sociale, 31(3):133-140, March 1970. 1 ref. (Presented at the Societe de Medecine et d'Hygiene Meeting, Feb. 10, 1969.)

The method of quantitative analysis by flame photometry of atomic absorption utilizes the fact that when an atom of a given species in its fundamental state at the energy level E1 collides with a photon of frequency nu, it absorbs this photon and due to the jump of an electron from its subshell into another, passes into an 'excited' state at the higher energy level E2, provided that nu equals (E2-E1)/h, that is, it is a characteristic frequency of that atomic species, h being Planck's constant. The design of such a device is described for continuous monitoring of the concentration of lead as an indicator of the concentrations of the very toxic tetramethyl lead and tetraethyl lead in the air of two shops in which they are produced. It incorporates a T-shaped fused-silica tube formed of a 20 cm long. 2 cm dia vertical segment provided with a water-cooled gas burner at the bottom and a butting at the top on the middle of a 100 cm long, 1 cm dia horizontal segment open at both ends. A mixture of hydrogen and fresh or either kind of contaminated air fed, as desired, to the burner burns with a smokeless flame dissociating into atoms and flows through both halves of the horizontal segment escaping through its ends. Optically focussed light from an arc lamp traverses lengthwise the entire horizontal segment and is optically focused on the inlet slit of a 'Spectralux 1800' spectrophotometer equipped with a 2160 - line grating and a 'Graphispot GRT VAJ' recorder, which measures the intensity of the received light of the wavelength of 283.3 nanometers. The response time of the device is less than 2 minutes, the least measurable lead concentration is 1 microgram per cubic meter. Its stability is demonstrated by the fact that its initial calibration has not required any modifications since the beginning of its use 4 years ago.

19313

Webb, J. C., J. C. Kinchen, and J. E. Scarberry

**AERIAL SAMPLING BY HELICOPTER USING A HIGH VOLUME SAMPLER.** J. Air Pollution Control Assoc., 20(7):453-455, July 1970. 8 refs.

A method of sampling the atmosphere for particulate matter at various elevations above an urban area is described. Tests were conducted using a high-volume air sampler mounted on a helicopter. The glass fiber filters, used to collect the aerosols, were analyzed for total particulates, benzene solubles, and the metals lead, copper, iron, and zinc. At 400 ft, the amount of aerosol pollutant was 20% of the ground level average. At 800 ft, the particulate concentration was 8% of the ground level average. At 800 ft, the particulate concentration was 8% of the ground average. Iron, lead, copper, and zinc were found in measurable quantities at each sampling level. This indicates that metal compounds of aerosol size and originating from ground sources are transported to the upper air by the atmospheric diffusion process. These tests show that a high-volume air sampler, mounted on a helicopter, can be used to obtain the data needed to evaluate the air quality and to control the air pollution over an urban area.

19501

Kumazawa, Y. and Y. Nogami

**DETERMINATION OF *HEAVY METALS IN AIR* BY FLUORESCENT X-RAY ANALYSIS (I).** (Keikoh X sen boonseki hoh ni yoroo taiki chu jukinzokoo no sokootei). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 4(1):106, 1969. 2 refs. (Proceedings of the Japan Society of Air Pollution Annual Meeting, 10th, 1969.)

The measurement of air-borne heavy metals by means of the fluorescent x-ray spectrometry, which can analyze without spoiling samples is presented. Through a high-volume air sampler, iron, copper, lead, and manganese are collected on a Gelman type A filter paper, and zinc on a GB-100 filter paper; the former filter involves Zn in itself in a noticeable amount. Analytical conditions are as follows: target, W or Cr; 50 kv, 40 mA; detector, S.C.; crystal, LiF; path, vacuum for solid and air for liquid; spectrum; and Fe-K apha, Cu-K alpha, Pb-K alpha, Mn-k alpha, and Zn-K alpha. Calibration curves are first obtained by analyzing half of the filter paper by means of fluorescent X-ray spectrometry and the other half, by means of atomic absorption spectrophotometry or emission spectroscopy. Next, the other calibration curves are made from fluorescent X-ray spectroscopy of filter papers, to which are added internal standards of metal chelate compounds, such as complex salts of acetyl acetone with iron, copper, lead, and zinc. The analytical values from both curves agree satisfactorily.

19857

Chernousova, K. G.

**SPECTRAL METHOD OF DETECTING AEROSOLS OF LEAD, ARSENIC, AND ZINC IN AIR OF INDUSTRIAL PREMISES.** (Spektral'nyy metod opredeleniya aerozoley svintsa mysh'yaka i tsinka v vozdukhe promyshlennykh pomeshcheniy). Text in Russian. Nauch. Rab. Inst. Okhr. Tr. Vses. Tsent. Sov. Prof. Soyuzov, no. 48:77-82, 1967. 8 refs.

A method for simultaneous detection of lead, arsenic, and zinc to a relative accuracy of plus or minus 12% using a single instrument was developed. Zinc can be detected at the 3345.06 A line with the presence of as much as 0.5% calcium in the sample. Determinations of lead, arsenic, and zinc are not prevented by the presence of iron or copper in amounts of up to 1%, or magnesium up to 0.5%.

20891

Maienthal, E. J.

**ANALYSIS OF AIR POLLUTANTS.** National Bureau of Standards, Washington, D. C., Microchemical Analysis Section, TN-505, p. 34-36, Oct. 1969.

To check the applicability of polarographic techniques to trace analyses, air particulate samples were collected from November to February and analyzed. The samples were collected on acid-washed membrane filters located in a laboratory and at outdoor sampling sites in residential and rural areas. For the samples taken in the laboratory, the house vacuum line was connected to the sampler and a 10 l/min limiting orifice was placed at the outlet connector of the filter holder. The sampler was placed 2 ft above the laboratory bench and the amount of air sampled varied between 28-80 cu m. A pump was used for outside sampling to provide an average flow of 25 l/ min; the flow was checked by attaching a rotometer flow meter to the filter holder. All samples were ashed in a low-temperature asher, dissolved in hydrochloric acid, and measured in an oxalic acid-ammonium hydroxide supporting electrode. Iron, copper, lead and cadmium were measured concurrently. The tabulated results, which represent the average of about 12 determinations, are generally in agreement with those obtained for similar sites in different localities. This shows that polarography is very suitable for determining metallic atmospheric contaminants.

20945

**QUANTITATIVE DETERMINATION OF LEAD AND ITS COMPOUNDS IN THE AIR.** U.S.S.R. Literature on Air Pollution and Related Occupational Diseases. vol. 8:34-38, 1963. (B. S. Levine, ed.) CFSTI: 63-11570

A method for the determination of lead and its compounds in the air in industrial premises for sanitary control purposes was described. The method is based on the fact that the degree of turbidity formed by the interaction between lead ions and potassium chromate increases with the increase in the lead ion concentration. The air sample is aspirated through ash-free and lead-free filter paper, or through lead-free perchlorvinyl fiber filters placed in an adapter at a rate of 20 l/min. The paper or perchlorvinyl filter is removed from the adapter, placed into a porcelain dish or crucible, moistened with 1-2 ml of H2SO4 and HNO3 mixture, and heated over a sandbath until a solid residue is formed. The porcelain dish or crucible is placed into a muffle furnace at a temperature of 450-550 degrees. At the end of incineration, the dish is covered and allowed to cool to room temperature. Four to six ml of 3% ammonium acetate is added until the ash is completely dissolved. The ash solution is poured into a centrifuge tube and centrifuged lightly. The supernatant should be clear and colorless. Two to five ml of the solution is removed with a graduated pipette and placed into a colorimetric tube. The standard scale is prepared. To all the tubes, 0.1 ml of 1% potassium chromate solution is added and allowed to stand for 15-20 minutes. The tubes are then compared colorimetrically against a dark background. The sensitivity of the method is 1 mg of lead in the analyzed solution volume. The method is not specific in the presence of barium salts.

21338

Yamate, Noboru, Toshiro Matsumura, and Masaharu Tonomura

**AUTOMATIC CONTINUOUS ANALYZER OF LEAD IN THE ATMOSPHERE.** (Taikichuno namari no renzoku jidosokuteiki nitsuite). Text in Japanese. Eisei Shikensho Hokoku (Bull. Natl. Inst. Hyg. Sci., Tokyo), no. 87:28-31, Dec. 1969. 6 refs.

An automatic analyzer for lead determinations utilizes the principl of square wave polarography. Sample air is passed through an absorbing bubbler containing 30 ml of 0.1 N nitric acid for 46 min at 22 l/min. Subsequently, nitrogen is passed through the absorbing bubbler for 3 min to remove oxygen from the solution. The sample solution is then transferred to an electrolytic cell. A high-sensitivity polarograph is employed, together with a program, to record square-wave polarograms from -0.6 to -0.85 V Hg pool. Wave heights of the recorded polarogram are converted to lead concentration (micrograms /cu m), using prepared lead calibration curves. This procedure can be repeated every hour. Th detection range of the analyzer is 0 to 15 micrograms /cu m of lead The standard lead solution for calibration is made by dissolving 159.8 mg of lead nitrate in 1 l of 0.1 N nitric acid. Linearity an reproducibility of the calibration is satisfactory.

21459

Zweibaum, Frederic and James Moorhead

**A MULTI-ELEMENT ATOMIC ABSORPTION ANALYZER.** Atomic Absorption Newsletter, 6(6):134, Nov.-Dec. 1967.

A multi-element atomic absorption analyzer can determine four selected elements simultaneously while retaining the accuracy and sensitivity of the single-element form. This system was primarily designed for the continuous monitoring of several elements concentrated from the atmosphere into a small volume air stream. The air stream with enriched sample content is fed directly and continuously into the burner nebulizer. A block diagram of the system is presented. The four individual element lamps are grouped into pairs, and each pair uses the dual beam path of the instrument simultaneously. A 20 cps chopper chops the light from the hollow cathode lamps. The light from each pair of lamps is then reflected by a flat mirror through a lens onto a 1200 cps, multi-blade chopper. Every blade is a mirror on both sides. Light reflected to one toroid from one pair of lamps forms the reference beam, while the light transmitted from a second toroid forms the sample beam. The reverse is true for the other lamp pair, resulting in four double-beam systems 45 deg out of phase with each other. The beams are recombined with a beam splitter, which consists of a quartz plate onto which aluminum dots are evaporated covering half of the surface. There are two photomultipliers, ahead of which are pairs of exit slits which pass the two wavelengths for the elements being determined. Toxic elements, such as lead and beryllium at industrial facilities can be monitored with this system, and it has been successfully tested with bismuth, nickel, lithium 6 and 7.

21862

Koshi, S.

**EFFECTS OF THE SAMPLING TUBE ON THE AEROSOL DETECTION.** (Dohkan no aerosol nohdo ni oyobosoo eikyo). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 4(1):35, 1969. (Proceedings of the Japan Society of Air Pollution Annual Meeting, 10th, 1969.)

The effects of the sampling tube on aerosol measurements are examined; the knowledge on this aspect is less than that on collectors and detectors themselves. Lead particles of 0.3 and 0.7 micron in size generated in a high frequency oven are diluted appropriately and go through detector-I (s type digital dust meter), a sampling tube to be tested (5.8 mm and 10.5 mm inside diameter, vinyl chloride,) detector-II, a flow meter and a pump, in that order, with the flow rate of 2 to 35 l/min. The sampling tube is coiled ten times around a pipe (23 cm in diameter) to simulate bends in actual usage (7.24 m in total length). For both particles the particle transmission rate of the sampling tubes shows the maximum values at 20 l/min for the

10.6 mm tube and 10 l/min for the 5.8 mm one; the values for 0.3 micron particle are always larger than the ones for 0.7 micron. If these transmission rates are plotted against air velocities, both maximum rates occur around 4 to 6 m/sec. Lower rates at the higher velocities would be due to the inertia of particles. But lower values at the lower velocities are not likely to be explained by particle sedimentation. This experiment points out the important effect of the sampling tube on the sampling procedures.

21948

Chow, Tsaihwa J.

**LEAD ACCUMULATION IN ROADSIDE SOIL AND GRASS.** Nature, 255(5229)· 295-296, Jan. 17, 1970. 4 refs.

Studies on lead isotopes in samples of roadside soil and grass are reported. Lead was isolated by an ion exchange technique, and converted to a sulfide form; its concentrations were determined by isotope dilution. Due to the direction of the prevailing winds, the lead content in the surface soils along the east side of the roads was higher than that of the west side. The isotopic compositions of lead at the surface and at depth of soil are characteristically different. Lead in the soil 10-15 cm below the surface had an isotope composition averaging Pb(206)/Pb(204) equals 18.77, Pb(206)/ Pb(207) equals 1.197, and Pb(206)/Pb (208) equals 0.4827; that of the surface soil averaged Pb(206)/Pb(204) equals 18.41, Pb(206)/Pb(207) equals 1.178, and Pb(206)/Pb (208) equals 0.4817. Comparison of the surface soil lead with that of gasoline shows that these two kinds of lead are identical. This indicates that the excess lead in the surface soil can be attributed to automobile exhausts. The isotopic composition of lead in the grass is similar to that of the surface soil, indicating that the grass derived its lead from this source. Part of this lead may come from the direct fallout of lead aerosols onto the grass.

22927

Prietsch, W., N. Jaskulla, and E. Huenigen

**CONSTRUCTION, EQUIPMENT AND TASKS OF A MEASURING VEHICLE FOR ASCERTAINING THE IMMISSION AND EMISSION OF THE COMPONENTS OF EXHAUST GAS FROM COMBUSTION MOTORS.** (Aufbau, Einrichtung und Aufgaben eines Messfahrzeuges zur Ermittlung von Immission und Emission von Abgasbestandteilen aus Verbrennungsmotoren.) Text in German. Verkehrsmed. Grenzgebiete, 15(8): 525-545, 1968. 27 refs.

A mobile air pollution test station especially for the recording of exhaust gas components of motor vehicles is described. The station is employed to determine the air pollution caused by combustion motors in city streets and congested industrial areas, in halls, garages, tunnels, and in open-cast mining. The equipment also enables the carrying out of emission measurements. A fundamental task of the station is the compilation of data for the clarification of the connections between emission and immission On the basis of that data, toxicological-economical limits for the permissible emission of injurious substances by motor vehicles can be legally fixed. The station measures carbon monoxide and dioxide, nitrogen dioxide, smoke density, sulfur dioxide, and lead. During the measurement of immission, meteorological data are recorded. (Author abstract modified)

22975

Sachdev, Sham L. and Philip W. West

**CONCENTRATION OF TRACE METALS BY SOLVENT EXTRACTION AND THEIR DETERMINATION BY ATOMIC ABSORPTION SPECTROPHOTOMETRY.** Environ. Sci. Technol., 4(9):749-751, Sept. 1970. 9 refs.

Conditions are described for extracting various metal ions into an 8-quinolinol-ethyl propionate solution. By combining dithizonate, oxinate, and acetyl acetonate extractions into ethyl propionate, as many as ten different metal ions (Ag (+), Al (2+), Be (2+), Cd (2+) Cu (2+), Fe (2+), Ni (2+), Pb (2+), and Zn (2+) can be concentrated by a single extraction step for subsequent determination by atomic absorption spectrophotometry. As determined by a study of the interference effects of 34 diverse ions and compounds, the procedur is highly selective. With the exception of aluminum, all the metals can be determined at the ppb level in an aqueous solution. Sensitivity for aluminum is 0.1 microgram per ml. The procedure is well suited for environmental studies because it includes the majority of the inorganic carcinogens. (Author abstract modified)

23096

Vittori, Ottavio

**RESEARCH IN CHEMICAL COMPOSITION OF SOME FORMS OF ATMOSPHERIC PARTICLES.** Chicago Univ., Ill., Dept. of Meteorology, NIH Grants RG-4521 and S-12(C), TN-5, 54p., Dec. 15, 1956. 16 refs.

Procedures are described for identifying the chemical composition and size of airborne particles. The basic technique involves the capture of the particles in a specially treated gel. Reagents in the gel produce a physico-chemical reaction known as the Liesegang reaction. The products of the reaction precipitate in the form of rings. Identification of the particles is made by one or more of three factors: the character of the pattern of the precipitate, the color of the precipitate, or its change of color. Tests were developed for particles containing the following substances: chlorides, soluble iodide, soluble sulfide, soluble ferrocyanide, soluble sulfates, nitrates, potassium ion, soluble silver, fluorides, lead and all heavy metals. Details are given for the preparation of the gels to be used for specific tests, and techniques for the capture of particles are discussed. (Electrostatic precipitation, impactor, and millipore filter). Experiments conducted to study the production of sulfate particles by the burning of wood or coal are discussed briefly, and a technique for the capture of small water droplets and analysis of the salt which may be dissolved in them is described. (Author abstract modified)

23571

Robinson, J. W.

**DETERMINATION OF LEAD IN GASOLINE BY ATOMIC ABSORPTION SPECTROSCOPY.** Anal. Chim. Acta, vol. 24:451-455, 1961. 2 refs.

A procedure was developed for the direct determination of lead in gasoline by atomic absorption spectroscopy. Time for complete analysis, including calculation, is approximately 10 min, and the equipment is relatively inexpensive. Interference from metals normally present in this type of sample is not encountered, nor do the sulfur and nitrogen content and variation in the carbon/hydrogen ratio cause problems. At 2833-A, the degree of absorption was so intense that the useful range of analysis was limited to between 0 and approximately 70 ppm of lead. To accommodate this limited range, it was necessary to dilute all samples ten-fold. For this dilution, iso-octane was used. Modulation in the equipment was also necessary in order to eliminate difficulties arising from the emission line of lead which occurs at the same wavelength as the absorption line. Standard solutions of tetraethyl lead are made up by dissolving in iso-octane.

23596

Zatek, J. E.

**INSTRUMENTS FOR MEASURING HAZARDOUS ATMOSPHERES.** Fire J., 64(5):76-80, 87, Sept. 1970.

A number of commercially available instruments, both portable and of the continuous or permanently installed type, have been developed for specific analysis of environmental contaminants. The basic principle of operation of hot-wire indicators is a change in the electrical resistance of hot platinum filament that is caused by the heat of combustion of a sample of the gas-air mixture passing over the filament. Several styles of combustible gas indicators have been designed to be calibrated to measure specific combustibles. To test vapors of leaded gasoline, the manufacturers boosted the voltage across the detector to maintain a sufficiently high filament temperature to prevent decontamination. The indicators are equipped with specially designed heavy-duty flashback arresters to test atmospheres that may contain mixtures of acetylene or hydrogen with more oxygen than is normally found in air. Since the threshold limit value for many gases and vapors represents a very small fraction of the lower explosive limit concentration, other models are equipeed with a dual-scale meter graduated from 0 to 100% and 0 to 10% of the lower explosive limit. Checking devices are also available to verify the performance of a hot-wire instrument. Limitations of the instrument are cited. During the past decade, equipment manufacturers developed detector tubes in which a bed of sensitive chemical confined between two porous plugs responds to a specific material by length of color change or stain proportional to the atmospheric concentration. Another important instrument uses the heat-of-combustion principle to measure carbon monoxide, while oxygen detection is accomplished with a primary galvanic cell consisting of a zinc and hollow carbon electrode in a special electrolyte. Diffusion head instruments are available for central monitoring of combustible gases at multiple remote locations up to 5000 ft from the control unit or in single-point instruments constructed for general purpose use or explosion proof applications. Another extremely sensitive means for measuring hydrocarbons is based on the ionization of carbon atoms in a hydrogen flame.

23646

Windom, Herbert Lynn

**ATMOSPHERIC DUST RECORDS IN GLACIAL SNOWFIELDS: IMPLICATIONS TO MARINE SEDIMENTATION.** California Univ., San Diego, Thesis (Ph.D.), Ann Arbor, Mich., Univ. Microfilms, Inc., 1968, 105p. 53 refs.

Contributions of atmospherically transported solids to marine sediments were considered by an investigation of the dust accumulation in glacial snowfields. Seven snowfields, including the Antarctic and Greenland ice sheets and five associated with temperate glaciers, were studied. Lead-210 geochronology was used to ascertain rates of snow accumulation and of dust fallout, while semiquantitative mineralogical and size analyses were carried out on the particulate matter in the ice samples. Results indicate that the dust comes from material derived from local and distant (global) sources. Composition of the global component is dependent on sources under its wind system, while that of the local component is dependent on the regional geology and physiography of the sampling area. The accumulation rates of the global dust component range from 0.1 to about 1.0 mm per 1000 years. Comparison of the accumulation rate, mineralogy, and size distribution of the globall transported dusts with those of the adjacent marine sediments of the North and South Pacific and Central Atlantic oceans, suggests that these areas receive as much as 25-75% of their detrital phases from atmospheric dust fallout. (Author abstract)

23657

Tufts, Barbara J.

**A METHOD FOR IDENTIFYING PARTICULATE FLUORIDE COMPOUNDS.** Anal. Chim. Acta, vol. 23:209-214, 1960. 13 refs. (Presented at the American Chemical Society, Air Pollution Symposium, Sept. 1959.)

A method is described for identifying particulates containing fluorides and other complex fluorine compounds such as fluosilicate in samples collected on membrane filters. The filter is treated with lead chloride to precipitate lead chlorofluoride at each fluoride-containing spot, and this microspot is identified by examination in a light microscope. Sulfate and phosphate, which also precipitate if present, can be distinguished and do not interfere. The fluoride precipitates are best seen as anisotropic white crystals in the optical microscope with crossed polars. They show polarization colors, which are especially distinctive in precipitates greater than 10 micron in diameter. Calibrations are given for the fluorides and the more insoluble salts, relating the original particle size to the reaction site size. Thus the mass of the particles can be calculated. Results of some field tests in an area of fluoride pollution are given, and compared with standard testing procedures. Samples containing hydrogen fluoride cannot be shipped or stored but must be reacted immediately after collection. (Author summary modified)

24119

Brandt, Manuel and R. H. Vanden Berg

**DETERMINATION OF TETRAETHYLLEAD IN GASOLINE BY TITRATION WITH (ETHYLENEDINITRILO) TETRAACETATE.** Anal. Chem., 31(11):1921, Nov. 1959. 6 refs.

Serious interferences have been reported for the end point obtained in the procedure described by Milner and Shipman for the determination of tetraethyl lead in gasoline. In this procedure, lead is separated from the gasoline sample by hot hydrochloric acid extraction and the lead ion is titrated with disodium (ethylenedinitrilo)tetraacetate using Eriochrome Black T as indicator. The interferences have been attributed to iron, gasoline dye, and organic compounds extracted from the gasoline. However, an EDTA method using copper-PAN (1-(2-pyridylazo)-2- naphthol) indicator accurately determines the tetraethyl lead content of gasoline in about 2 hours. A combination hot plate and magnetic stirrer are required to maintain the lead solution at 90-100 C. The tetraethyl lead is first decomposed and the organic material is oxidized in the hydrochloric acid extract. In 200 ml of water, thy lead salt is dissolved, and approximately 0.2 gram of sodium potassium tartrate is added. The solution is heated to boiling, the pH is adjusted to 10 with ammonium hydroxide using Hydrion paper as indicator, and 5 ml in excess are added. Three drops of copper sulfate-EDTA solution are added, then eight drops of PAN indicator solution. Using 50 ml of iso-octane instead of the gasoline sample, determine the reagent blank, and subtract the volume of titrant used for the blank from that obtained for the sample.

24337

Snyder, L. J., W. R. Barnes, and J. V. Tokos

**DETERMINATION OF LEAD IN AIR.** Anal. Chem., 20(8):772-776, Aug. 1948. 8 refs.

To aid in rapidly detecting and avoiding dangerous concentrations of tetraethyl lead air, a field micromethod was developed, which consists of collecting an air sample through a specially constructe scrubber containing an iodine-potassium iodide solution. This dithizone method is essentially a single-

color method which differs from the conventional single-color methods in that repeated extraction with an ammoniacal solution is not necessary to remove the excess dithizone from lead dithizonate. The solution containing the lead is drained from the scrubber into a comparator tube containing a alkaline reducing solution; the aqueous mixture is shaken with a dithizone solution and the resulting color is compared with permanent glass color standards in a Hellige comparator. All the equipment is contained in two portable cases, so that an air sample may be collected and analyzed on the spot. The method requires approximately 10 minutes and is accurate to better than 1 microgram of lead per cu ft of air. (Author abstract modified)

24617

Ishii, Takeshi and Soichro Musha

**ALTERNATING CURRENT POLAROGRAPHIC ANALYSIS OF LEAD IN AUTOMOBILE EXHAUST GAS.** (Jidosha haikigasuchuno namari no koryu porarogurafu bunseki). Text in Japanese. Bunseki Kaguka (Japan Analyst) (Tokyo), 19(10):1364-1370, Oct. 1970. 16 refs.

A method for the alternating current polarographic determination of lead in automobile exhaust gas is established. Lead in automobile exhaust gas was extracted for 60 sec with 20 ml of 1.2 F hydrochloric acid in an extraction apparatus. The extract was cooled at room temperature and transferred into a 25 ml measuring flask and then diluted to the mark with 1.2 F HCl. The alternating current polarogram in the region of applied potential from -0.1 volt to -0.8 volt against the mercury pool anode after bubbling for 5 min with nitrogen is recorded, and lead is determined by referring to a calibration curve. This method is rapid and simple; the time required for analysis is about 20 min.

24618

Ishii, Takeshi and Soichiro Musha

**RAPID ANALYSIS OF LEAD IN AUTOMOBILE EXHAUST GAS.** (Jidosha haikigasuchuno namari no jinsoku bunseki). Text in Japanese. Bunseki Kagaku (Japan Analyst) (Tokyo), 19(10):1436-1437, Oct. 1970. 3 refs.

The lead content in automobile exhaust gas can be determined by atomic absorption measurement. A sample is directly injected into an air-hydrogen flame by an atomizer burner, and the spectral line of lead is measured at 2833 A. The method is rapid and simple; the time required for an analysis is about 5 min.

24644

Yamate, N.

**MEASURING METHOD OF AIR POLLUTANTS DUE TO AUTOMOBILE EXHAUST.** (Jidosha haishutsu gasu ni yoru taiki osen busshitsu no sokuteiho). Text in Japanese. Sangyo Kogai (Ind. Public Nuisance), 6(9): 532-538, Sept. 25, 1970. 28 refs.

Pollutants in auto exhaust can be measured by continuous analysis or by manual analysis (discontinuous). The former uses an automatic gauge to evaluate the pollution situation over a long period of time; the second method is applied when many sites are to be sampled for short-term periods. Various methods of collectin exhaust samples are described. They include impingers, bags or vacuum collecting glass vessels, low-temperature condensation methods, normal temperature adsorption methods, and low-temperature condensation methods, normal temperature adsorption methods, and low- and high-volume samplers. Manual methods (using detector tubes, infrared absorption or gas chromatography) and continuous methods (infrared absorption, the oxidized mercury method) of determining carbon monoxide are described. Nitrogen oxides can be manually analyzed by both the Saltzman and Jacob methods and also continuously analyzed by the Saltzman method. For hydrocarbon determinations, gas-chromatography is used for manual analysis and hydrogen flame ionization for continuous analysis. A chromatropic acid method is used for manual analysis of HCHO along with an acetylacetone method that is also suitable for continuous measurements. Sulfur dioxide in manually analyzed by the rozaniline method and continuously by the Thomas autometer method. For manual analysis of ozone and general oxides, there are the phenolphthalein and iodated kalium methods, for continuous analysis there are the Crone method and the method of gauging the light absorbed by iodine. Measurements for PAN, lead compounds, and aromatic hydrocarbons are also described.

24719

Smith, Garland W. and Alton K. Palmby

**FLAME PHOTOMETRIC DETERMINATION OF LEAD AND MANGANESE IN GASOLINE.** Anal. Chem., 31(11):1798-1802, Nov. 1959. 14 refs. (Presented at the Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, Pittsburgh, Pa., March 1959.)

Rapid and accurate flame photometric methods are described for determining lead and manganese in gasolines. In each method, the sample is burned in an oxyhydrogen flame. In the lead method, base stock effects are eliminated by using an incremental addition of lead for calibration. In the manganese method, base stock effects are reduced sufficiently by diluting the sample at least twentyfold with iso-octane. Lead naphthenate and tetraethyl lead are equally satisfactory reference materials for determining tetraethyl lead; manganese naphthenate is satisfactory for determining organomanganese additives. Burner fouling, a major source of error, is eliminated by periodically aspirating acetone through the burner. The determinations are accurate to about 2% of the amount present for lead, and to about 3% for manganese. Approximately 40 lead or 80 manganese determinations can be made per man-day. (Author abstract modified)

25013

Ishii, Takeshi and Soichiro Musha

**ALTERNATING CURRENT POLAROGRAPHIC DETERMINATION OF LEAD IN GASOLINE.** (Koryu porarogurafi niyoru gasorin chuno namari no teiryo). Text in Japanese. Bunseki Kagaku (Japan Analyst) (Tokyo) 19(10):1360-1363, Oct. 1970. 14 refs.

A method for the alternating current polarographic determination of lead in commercial gasoline is established. Lead in 5 ml of sample was extracted for 30 min with 10 ml of hydrochloric acid in an extraction apparatus and then cooled at room temperature. The extract was transferred into a 100-ml measuring flask and then diluted to the mark with water. The alternating current polarogram in the region of applied potential from -0.1 volt to -0.8 volt against the mercury pool anode after bubbling for 5 min with nitrogen was recorded, and lead was determined by referring to a calibration curve. The method was rapid and the accuracies were nearly comparable to those attained by the conventional ashing method.

25015

Mitsugi, Hidekatsu, Nobuhiro Takata, Mineyuki Motoyama, Makoto Akamatsu, and Genzo Hashizume

**DETERMINATION OF ZINC AND LEAD IN SUSPENDED PARTICULATES BY FLUORESCENT X-RAY SPECTROMETRY.** (Keiko xsen niyoru fuyujinaichun aen oyobi namari no bunseki). Text in Japanese. Bunseki Kagaku (Japan Analyst)(Tokyo), 19(10):1383-1388, Oct. 1970. 18 refs.

Non-destructive determination of zinc and lead in suspended particulates was investigated by using 'filter paper method' and 'briquet method'. The samples collected on the filter paper by using a high volume air sampler were determined non-destructively and rapidly by the filter paper method. The samples collected by an electric precipitator were diluted with boric acid and then determined by the briquet method. To prepare the standard samples zinc oxide, lead oxide, or lead nitrate were diluted to a given concentration with kaolin which was regarded as a typical constituent of suspended particulates. Ferric oxide and hydrated calcium sulfate were added to the standard samples for checking up the matrix effect. The calibration curves were obtained by using scattered X-rays from W-tube as an internal standard to correct matrix effect. The quantitative ranges were above 1 microgram for Pb by the filter paper method and above 0.5 microgram for Zn and 5 microgram for Pb by the briquet method, respectively. Analytical results of Zn and Pb in suspended particulates by this procedure agreed with those by the atomic absorption method.

25222

Tyler, Germund

**MOSS ANALYSIS--A METHOD FOR SURVEYING HEAVY METAL DEPOSITION.** Preprint, International Union of Air Pollution Prevention Associations, 19p., 1970. 11 refs. (Presented at the Internationa Clean Air Congress, 2nd, Washington, D. C., Dec. 6-11, 1970, Paper SU-30F.)

Analysis of bryophytes, particularly carpet-forming mosses, has proved to be a suitable and sensitive method for measurements of the deposition of heavy metals. These organisms have no ability to sorb minerals from the substrate but are reduced to the supply from the atmosphere by wet and dry deposition. The cation exchange capacity of their tissues is great, and stable complexes are formed with various heavy metal ions. Unlike lichens, certain moss species may develop and survive without damage in densely inhabited or industrialized areas. Heavy metal concentrations of entire moss carpets are usually reliable measures of the accumulated deposition during the previous 5-7 years. The concentration gradients in and around industrial or urban areas are usually so regular that isarithmic maps may easily be drawn. In the close vicinity of metal-works the regional basic level of certain heavy metals may be exceeded several hundred times. Minor sources of heavy metal emission are also detected and the state of pollution may be measured over vast areas in a rapid way. Diffuse dispersion patterns, often characteristic of lead and vanadium in urban areas, may also be mapped with this method. The sensitivity of the method enables the measurement of long-distance atmospheric transports from large population centers. The basic levels of Pb and cadmium in southwestern Sweden and southern Norway are more than ten times higher than in northern Scandinavia, whereas no differences exist between different parts of Scandinavia in calcium magnesium, and potassium, elements which are deposited naturally in large amounts with precipitation. It is possible to use herbarium mosses for the study of historical changes in the deposition of heavy metals. In southern Sweden Pb concentration of mosses has increased from about 25 ppm in 1860-75 to the present average of 90-100 ppm. (Author abstract)

25431

Aughey, Henry

**A RAPID MOBILE ANALYZER FOR MINUTE AMOUNTS OF LEAD IN AIR.** J. Opt. Soc. Am., 39(4):292-293, April 1949. 2 refs.

A mobile instrument of extreme sensitivity is described which furnishes a rapid indication and an approximate assay of localized relatively high concentrations of lead, combined or elemental. Samples are drawn through a condensed spark discharge adjusted to minimize air lines and to excite the lead spectrum which is photographed with a small quartz instrument. Visual examination of a series of exposures provides data on lead concentration as a function of time and location. A sensitivity of better than one part in 20 million can be maintained in routine operation. Instanteous response realized by substitution of a specially- designed photoelectric Geiger counter for the photographic plate. The technique is not yet developed to a point where continuous quantitative measurements are available over periods of many hours or days. Although tried only for lead, similar sensitivity for mercury is expected. The high energy of the spark source permits excitation of materials present both in elemental and combined forms and offers in addition a rapid analysis when extreme sensitivity is not needed, as for dusts involving such elements as arsenic, barium, and beryllium. (Author abstract modified)

25432

Koppius, O. G.

**DETECTION OF LEAD IN AIR WITH THE AID OF A GEIGER-MUELLER COUNTER.** J. Opt. Soc. Am., 39(4):294-297, April 1949. 10 refs.

A mobile, direct reading, semi-quantitative detector of lead in air is described. It uses a spark source for the excitation of the lead spectrum, a small quartz spectrometer for the dispersion, and a quartz Geiger-Mueller counter for detection of the ultraviolet radiation. The lower limit of detection is of the order of 20 microgram of lead per cubic foot of air, determined chiefly by the erratic behavior of the spark discharges, which emits a continuously changing background radiation. The accuracy of the analytical curve leaves much to be desired, but since the principal function of the instrument is to locate areas of high lead concentrations, the absolute accuracy of the results is considered of secondary importance; high-concentration areas can at least be compared qualitatively.

25440

Fugas, Mirka, Ranka Paukovic, Vlatka Vadic, and Janko Hrsak

**A NEW METHOD FOR THE DETERMINATION OF LEAD IN SMOKE SAMPLES.** Preprint, International Union of Air Pollution Prevention Associations, 12p., 1970. 1 ref. (Presented at the International Clean Air Congress, 2nd, Washington, D. C., Dec. 6-11, 1970, Paper CP-2E.)

A fast, simple, and inexpensive method for determining lead in air is represented by a ring-oven technique that is applied directly to 0.5 in. diameter smoke samples collected in a high-volume sampler. The relatively insolubility of lead sulfate is used to separate lead from metals forming soluble sulfates, and the selective solubility of lead sulfate in a saturated ammonium acetat solution to separate lead from insoluble sulfates. Lead, concentrated in the ring zone, is precipitated as chromate and the concentration is estimated by comparing the

color intensity of the sample ring with a set of standard rings. The comparative determination of lead in high-volume samples by the ring method and atomic absorption spectrophotometry yielded very satisfactory agreement between the two methods. The ring method can therefore, be recommended for large-scale surveys.

25535

Sugawara, V. and V. Yamazaki

**THE DETERMINATION OF HEAVY METALS IN DUST-FALL BY ATOMIC-ABSORPTION- SPECTROPHOTOMETRY. (Genshi kyuko bunsekiho niyoru koka baijinchuno junkinzoku no teiryo). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 4(2):182-187, Nov. 1970. *14 refs.***

Atomic-absorption-spectrometry was used for the determination of metals in several materials. In one application, the elements of iron, copper, lead, and zinc in dustfall (ash) were determined. For this purpose, the extraction or addition of organic solvents or dilutants was used, since analysis sensitivity is enhanced. The results of a dilution experiment are presented. Dustfall was treated with nitric, hydrochloric, and perchloric acids and mixtures of the acids. Treatment with hydrochloric acid was the most successful. Experiments involving alkali fusion are discussed. The two detection methods adopted were the calibration curve method and the standard addition method. The calibration method is easier to operate, but the addition method is more reasonable to protect against interference. Metal absorption is measured by the addition method was not always high. (Author abstract modified)

25793

Silverman, Leslie and John F. Ege, Jr.

**A FILTER PAPER METHOD FOR LEAD FUME COLLECTION.** J. Ind. Hyg. Toxicol., 25(5):185-188, May 1943. 11 refs.

A study on the efficiency of high retention analytical filter papers for collecting airborne lead fumes showed that the efficiency was high (87%) and constant at high flow rates. Lead fume concentrations were produced in a large dust cabinet by burning a lead tetraethyl solution in alcohol, and they were kept in suspension by means of a circulating blower and an anemostat. A sampling device was made from two inexpensive tin-plated funnels and galvanized sheet iron. The results obtained with two filter papers in series for various papers, filtering velocities, and lead fume concentrations are presented tabularly; the absolute efficiencies for several concentrations, kinds of papers, and filtering velocities are also presented. The method is applicable to zinc, magnesium, and iron fume particles. (Author summary modified)

25932

Harrold, G. C., S. F. Meek, and F. R. Holden

**A PRACTICAL METHOD FOR THE RAPID DETERMINATION OF LEAD WHEN FOUND IN THE ATMOSPHERE.** J. Ind. Hyg., 18(10):724-732, Dec. 1936. 22 refs.

Modifications of the dithizone analysis for lead are described that should permit rapid and accurate determination of up to 700 mg of lead per 10 cu m of air or less than 0.001 mg of lead in 10 cu m of air. The determinations are based on variations in tint produced by the addition of excess dithizone. The procedures require no colorimeter and only an air sampler and impinger for collection. A detailed description is given of the preparation of unknown samples and the standard solutions on which analyses are based. Results obtained with the modificated procedures are shown in tables.

25979

Shikhvarger, F. D.

**USE OF ELECTROLYSIS TO DETERMINE TRACE AMOUNTS OF LEAD, COPPER, AND ZINC IN STUDIES OF THE ATMOSPHERE.** (Primeneniye elektroliza dlya opredeleniya mikrokolichestv svintsa, medi i tsinka pri issledovaniyakh vozdushnoy sredy). Text in Russian. Zavodsk. Lab. (Moscow), 15(10):1165-1171, 1949. 6 refs.

A laboratory arrangement for electrolytic separation of trace metals collected in air samples is described. This arrangement features a rotating (500-700 r/m) electrolyte (2% nitric acid) with stationary electrodes. Experiments were performed with an anode current density of 2.0-5.0 ma/sq m (anode area -- 52 sq m) a cathode current density of 1.0-3.0 ma/sq m (cathode area -- 26 sq cm), and a total current not exceeding 20-50 ma at 2.2-2.6 volts. Electrolysis was performed at 50-20 C over a period of 30-40 min. The metal thus collected is washed from the electrodes and determined colorimetrically or nephelometrically. Analysis of air samples taken at industrial installations has demonstrated the superiority of this method over conventional chemical analysis.

26145

Keenan, Robert G. and Lawrence T. Fairhall

**THE ABSOLUTE EFFICIENCY OF THE IMPINGER AND OF THE ELECTROSTATIC PRECIPITATOR IN THE SAMPLING OF AIR CONTAINING METALLIC LEAD FUME.** J. Ind. Hyg. Toxicol., 26(7):241-249, Sept. 1944. 8 refs. (Presented at the American Industrial Hygiene Association, Annual Meeting, 5th, St. Louis, Mo., May 1944.)

Investigation of various means of collecting oxide-free metallic lead fume has demonstrated the conditions which must be fulfilled for maximum efficiency of sampling. Means were devised for measurement of absolute efficiencies by direct comparison of the amounts of lead retained by a given sampling device with the total amount of lead drawn through the apparatus. An apparatus was devised for the formation of lead fume and the true metallic nature of the latter was shown by microchemical tests and by comparison of its X-ray diffraction pattern with that of pure lead. Microscopic measurements of the particle size of this fume were made. A collecting device for lead fume which depends upon surface contact with glass wool was devised and was found to be 100% efficient for collecting freshly formed lead fume This device was used for the estimation of the absolute efficiency of both the impinger and the electrostatic precipitator. The efficiency of an AC electrostatic precipitator of the type described varies with the voltage imposed at lower voltages, but that at 25,000 volts it is fully efficient for metallic lead fume. An improved all-glass type of precipitator tube with sealed-in electrode was devised for air sampling. It presents certain advantages over the usual type of precipitator tube. The large impinger is efficient for aged lead fume at low rates but inefficient for fresh fume at these rates. The efficiency of the large impinger increases with rate of air flow and is nearly 100% efficient for the collection of freshly formed metallic lead fume at the highest rate of air flow and maximum negative pressure. Its efficiency is independent of the atmospheric concentration of lead. (Author summary modified)

26274

Lohs, Karlheinz

**TASKS AND PROBLEMS OF INDUSTRIAL TOXICOLOGY FROM THE VIEWPOINT OF TECHNICAL CHEMISTRY.** (Aufgaben und Probleme der Industrietoxikologie aus der Sicht der technischen Chemie). Text in German. Chem. Tech. (Berlin), 17(1):38-41, Jan. 1, 1965.

Industrial toxicology faces two complexes of problems. The first are problems arising from the manufacture and processing of toxic raw, intermediary, and primary materials; the second complex encompasses problems which the manufacturing process poses for the biosphere. Hydrocyanic acid, tetraethyl lead, and some very toxic insecticides (organic derivatives of phosphoric acid) are examples of the first category. While industrial analytical instruments working on the principle of chemical reactions or their physical manifestations have an accuracy of around 0.1 ppm, some toxicologically dangerous chemicals require a detection accuracy of the order of 0.001 ppm which requires biochemical and biophysical detection methods. Another problem are the periodic clinical checkups of employees because in some cases toxic manifestations have appeared in the form of secondary manifestation without acute symptoms. Lack of knowledge and information complicates the setting up and enforcement of hygienic norms. Toxic emissions posing problems are industrial dusts, ash and smoke oxides of sulfur and of nitrogen, hydrocarbons, aldehydes, acids, ammonia, tars, ketones, peroxides, nitroolefines, and carbon monoxide. Catastrophies caused by smog are known from Europe as well as from North America when aerosol concentrations reached levels exceeding 2 mg/cu m as against the 100 microg/cu m level of normal industrial pollution. The London smog is as a result of high humidity characterized by a high content of sulfur trioxide in addition to sulfur dioxide, a highly irritating combination. The most toxic component of photochemical smog resulting from the action of ultraviolet irradiation on smog is peroxyacetyl nitrate which is highly toxic to humans and plants at very low concentrations. Other problems are exemplified by fluoride dusts and emanations from the manufacture of polyethylene.

26275

Chatigny, M. A., J. C. Craig, J. C. Edinger, G. Forester, J. E. Gill, W. D. MacLeod, R. C. Maninger, T. Schneck, Jr., E. R. Stephens, K. G. P. Sulzmann, and H. W. Wolochow

**POLLUTANT MEASUREMENT AND MONITORING INSTRUMENTATION TASK FORCE ASSESSMENT.** In: Project Clean Air. California Univ., Berkeley, Task Force 6, 170p., Sept. 1, 1970. 237 refs.

Instrumentation concepts and devices for the measurement and monitoring of air pollutants have been subdivided into three principle categories of application: ambient air and emission source monitoring for regulatory purposes and for control, vehicle emission monitoring and control, and research in pollution chemistry and laboratory analysis of pollutants. Currently available instruments are discussed, including oxidant analyzers, electrochemical analyzers, chromatography, spectroscopy, photoelectric devices, and particulate and gas samplers, while research needed is indicated. An instrument is needed for quantitative plume capacity measurements, to measure ambient air concentrations of hydrogen sulfide with a sensitivity and accuracy of 1-3 ppb over a range of 1-100 ppb, and a simple instrument is needed for measurements of the total aldehyde concentration, as well as lead, mercury, and chlorine. Improvements in the area of light and laser applications are also indicated. There is a need for rapid and valid verification methods for the proper functioning of present and future car emission control devices. Low-cost instruments and systems are needed in the study of urban diffusion processes. There is a need to devise ways for using the electron microscope. Various other projects are cited.

26336

Yamamoto, Tadato, Reiji Aizawa, and Sadao Matsuzawa

**THE TESTING METHODS OF LEAD IN MOTOR GASOLINE.** (Jidosha gasorinchu no enbun teiryoho ni tsuite). Text in Japanese. Kogai (Hakua Shobo) (Pollution Control), 5(5):27-31, 1970. 2 refs.

Thirteen samples each of two gasolines were tested for their metallic lead (g/l) and tetraethyl lead (ml/l) content by the gravimetric method specified by the Japanese Industrial Standards, polarography, and atomic absorption spectrophotometry. Average values found by the gravimetric method were 0.25 for metallic lead and 0.238 for tetraethyl lead. Polarographic and spectrophotometric determinations yielded, respectively 0.261 and 0.279 metallic lead and 0.248 and 0.264 tetraethyl lead. A comparison of the calculated reliability of each method indicated that polarography is more reliable than the gravimetric method. While atomic absorption spectrophotometry gave higher values than polarography, cost factors and problems connected with the selection of measuring conditions are likely to arise when this method is applied to commercially marketed gasolines containing different types of lead. Based on test results, the polarographic method is recommended for inclusion in the Japanese Industrial Standards.

26467

Bourbon, P. and P. Dorbes

**AN INVESTIGATION OF LEAD POLLUTION.** (A propos d'une enquete de pollution par le plomb). Text in French. Pollut. Atmos. (Paris), 40(10):234-235, Oct.-Dec. 1968.

The study concerns the risk of pollution from the emissions of a plant where lead is recovered from storage batteries. Samples were taken at distances of 400, 500, and 750 meters from the source by two methods. One involved bubbling the air through a nitric acid solution; the other made use of cellulose acetate filters with a pore diameter of 0.8 micrometers. Analysis was by colorimetry and polarography. Lead pollution from the use of tetraethyl lead in motor fuel was also tested along an important transportation route. In the latter case, the average finding was 2 micrograms per cubic meter. The results of the lead recovery plant measurements are tabulated. The use of the paper filter method of collecting samples proved adequate for the purpose and the polarography method of determination was found to be more sensitive and more consistent than colorimetric determination.

26503

Kendler, J. and C. Heitner-Wirguin

**CONCENTRATION OF LEAD TRACES IN ATMOSPHERIC SAMPLES USING PHOSPHONIC RESINS.** Israel J. Chem., vol. 7:175, 1969. (Presente at the Israel Chemical Society, the Israel Crystallography Society, the Israel Biochemical Society, and the Israel Institute of Chemical Engineering, 39th Meeting, Jerusalem (Israel), Sept. 29- Oct. 1, 1969.)

The chelating resin Bio Rex-63 with phosphonic functional groups was employed in the concentration of lead from dilute solutions of atmospheric lead samples, prior to their colorimetric determination using the dithizone method. Sulfate determination in the lead peroxide candle method was improved similarly by prior separation of lead traces. The ion exchange concentration method is simple, rapid, and improves lead recovery by 6 to 10% as compared with the former evaporative method. In the lead peroxide candle method for the determination of total sulfurous compounds, separation of lead by ion exchange on the phosphonic resin improves the analytical results by 2.5 to 10%. (Author abstract modified)

26505

Laveskog, Anders

**DETERMINATION OF ORGANIC LEAD COMPOUNDS IN EXHAUST GASES AND AMBIENT AIR.** Preprint, National Environment Protection Board (Sweden), 3p., Sept. 13, 1970.

A new method for the individual determination of organic lead compounds is based on the concentration of the compounds by a freeze out technique, their separation by gas chromatography, and their analysis by mass spectrometry. The limit of detection is 10 to the minus 11th power g Pb corresponding to an ambient air concentration of 0.01 microgram Pb/cu m in a sample volume of 1 liter. The method was applied to determinations of tetramethyllead (TML) and tetraethyllead (TEL) in ambient air and automotive exhaus gases. In Stockhom, ambient air concentrations of TML and TEL were 0.02-2 microgram/cu m; concentrations in exhaust gases were 5-5000 microgram/cu m, depending on engine temperature.

26698

Air Hygiene Foundation of America, Inc., Pittsburgh, Pa., Preventive Engineering Committee

**DETERMINATION OF LEAD IN THE AIR.** Bull-2, Part 6, 9p., June 1938. 4 refs.

Wherever lead is used in any form, the possibility of air contamination by its dusts or fume should be considered. Procedures for collecting and analyzing dust samples from air are outlined. For the collection of lead dusts and mists, an impinger is satisfactory; for lead fumes, an electric precipitator is preferred. Fairhall's chromate-volumetric method enables the routine determination of 0.1 micrograms or more of lead in 30 cu ft of air. In this method, lead is freed of interfering materials and precipitated as chromate. Indirect determination of the lead is made by solution and iodimetric estimation of the chromate ion. The dithizone colorimetric method is satifactory where lead concentrations are 0.1 micrograms or less. In this method, lead is extracted from a solution of controlled alkalinity with a chloroform solution of dithizone. Dithizone forms colored metallo-organic compounds with several heavy metal ions. By proper control of alkalinity and cyanide concentration, interfering ions are eliminated and the cherry-red lead compound segregated in solution, the intensity of the color depending on the amount of lead present. The presence of absence of lead in dust samples, raw materials, and exreta is qualitatively determined by a microscopic method in which the lead iodide is precipitated from a drop of solution and identified microscopically by its form and color.

26707

Saltzman, Bernard E.

**REPORT ON INTERSOCIETY COMMITTEE FOR DEVELOPMENT OF MANUAL OF METHODS FOR AMBIENT AIR SAMPLING AND ANALYSIS.** J. Assoc. Offic. Anal. Chemists, 52(2):349-350, 1969.

The major activity of committee and subcommittee meetings of the Association of Official Analytical Chemists during the past year has been concerned with a manual of methods for ambient air sampling and analysis. After final editorial revisions for format and style, methods will be available for publication as follows: arsenic, silver diethyldithiocarbamate method; benzo(a)pyrene, thin layer chromatography, spectrophotofluorometric determination, and spectrophotometric determination; benzo(a)pyrene and benzo(k)fluoranthene, column chromatography and spectrophotofluorometric determination; chloride, mercuric nitrate titration; fluoride, autoanalyzer and lanthanum-alizarin; fluoride, manual and titrimetric and spectrophotometric procedures; nitrogen dioxide manual spectrophotometric procedures; lead-210, beta counting of bismuth-210 daughter; radon-222, filter paper, alpha and beta counting, charcoal adsorption, alpha and gamma counting. Twelve additional methods which are in the final stage of approval by the Intersociety Committee deal with carbon monoxide, chlorine, formaldehyde, aromatic hydrocarbons, lead, and sulfur dioxide.

26848

Kubo, Kiyoshi

**ON SUSPENDED PARTICULATES IN THE METROPOLITAN AMBIENT ATMOSPHERE.** (Toshi taikichu no fuyu funjin ni tsuite). Text in Japanese. Nagoya Eisei Kenkyujoshoho (Rept. Nagoya Munic. Inst. Public Health), no. 15:79-81, 1968. 3 refs.

In order to know the atmospheric particulate size distribution, various method of measuring particle sizes such as membrane filter methods were compared. Furthermore, membrane filters, hi-vol samplers, and para-rosaniline methods were combined in order to investigate the relationship between the atmospheric particle size distribution, metallic content of the particulates, and sulfur dioxide gas. There was a close relationship between sulfur dioxide gas and the average particle size measured by the membrane filter. The correlation between particulate quantity and the average particle size was larger, probably due to particulate coagulation. There was not much correlation between lead and particulate quantity, apparently because of the wind direction and the location of observation. Thus it can be concluded that sulfur dioxide gas is prevalent at atmospherically stable conditions; when there is a large amount of suspended particulates, the average size becomes large.

26955

Bogen, Donald C. and Martti V. Kantelo

**DETERMINATION OF LEAD IN ENVIRONMENTAL AND BIOLOGICAL SAMPLES.** Preprint, American Chemical Society, Washington, D. C., 12p., 1969. 4 refs. (Presented at the American Chemical Society, 157th National Meeting, Minneapolis, Minn., April 13-18, 1969.)

Lead in bone and blood, food, water, and air filters was determined by extracting lead as an iodide complex into methyl isopropyl ketone (MIPK) with subsequent direct measurement by atomic absorption spectrophotometry. Recovery in the solvent extraction and subsequent steps was monitored with Pb-212 tracer. The sensitivity of the method was 0.15 ppm for 1% absorption and the detection limit was 0.02 ppm at the 283 resonance line. Recovery averaged better than 95%, while precision of analysis was plus or minus 10%. There was no interference from cations that co-extract with lead. The effects on recovery of varying iodide and acid concentrations in the aqueous phase discussed as is that of varying the ratio of MIPK volume to aqueous volume.

27075

Carlson, Gary D. and Wayne E. Black

**DETERMINATION OF TRACE QUANTITIES OF METALS FROM FILTERED AIR SAMPLES BY ATOMIC ABSORPTION SPECTROSCOPY.** Preprint, Air Pollution Control Assoc., Pittsburgh, Pa., 21p., 1970. 14 refs. (Presented at the Air Pollution Control Association, Annual Meeting, 63rd, St. Louis, Mo., June 14-18, 1970, Paper 70-62.)

Few air pollution control agencies have adopted ambient air quality standards for trace metals. However, the presence of such airborne substances may be as important if not more so from a health standpoint compared to other air contaminants presently receiving wide attention. A rapid procedure was

developed which allows the use of atomic absorption spectroscopy as an instrumental technique to determine trace quantities of lead, iron, zinc, cadmium, manganese, and copper in suspended airborne particulate matter. The method of sample preparation involves extraction of suspended ariborne particulate matter collected by the hi-volume sampler technique with 50% nitric acid, filtration, concentration, and solubilization of metal salts. Precision and recovery data are presented as well as results from samples collected and analyzed during 1969. The procedure described was convenient, satisfactorily reliable, and readily adaptable for routine analysis of particulate matter collected by hi-volume samplers. The observed results from samples collected during 1969 compared with data from the United States Public Health Service Interstate Study for 1963 and 1964 indicate a general increase in levels of trace metals in the air. (Author abstract modified)

27106

Kleinman, Michael T. and Herbert L. Volchok

**THE QUALITY OF RADIOCHEMICAL ANALYSES IN THE HASL SURFACE AIR SAMPLING PROGRAM DURING 1969.** Atomic Energy Commission, New York Health and Safety Lab., Fallout Program Quart. Summ. Rept., I-58 to I-62, Jan. 1, 1971. 5 refs. NTIS: HASL-239

Data are presented on the quality control phase of a program for th systematic sampling and radiochemical analysis of particulate matter for radioactive components and stable lead. With each set of samples for analysis, three control samples are submitted. A weighted aliquot of a standard solution of a nuclide to be analyzed is added to two filters and a third filter serves as a blank. Measured blank values indicate low levels of contamination for most of the nuclides. Although deviations for plutonium isotopes are high, the generally satisfactory results of analyses on standard samples are indicative of the accuracy of radiochemical analyses.

27294

Stern, A. C., A. D. Brandt, P. M. Giever, L. Greenburg, E. R. Hendrickson, J. V. Crable, B. E. Saltzman, G. J. Kupchik, and M. Katz

**ABSTRACTS OF TENTATIVE METHODS ADOPTED BY THE INTERSOCIETY COMMITTEE ON MANUAL OF METHODS FOR AMBIENT AIR SAMPLING AND ANALYSIS.** J. Assoc. Offic. Anal. Chemists, 54(1):223-237, Jan. 1971.

Tentative methods adopted by the Intersociety Committee for the analysis of air samples are abstracted from the following issues of Health Laboratory Science: vol. 6, no. 2(1969) and vol. 7, no. 1 (1970). The methods concern the arsenic content of atmospheric particulate matter; the chloride, fluoride, lead-210, nitrogen dioxide, radon-222, and sulfur dioxide content of the atmosphere; the continuous monitoring of atmospheic oxidant with amperometric instruments; through C5 atmospheric hydrocarbons; polynuclear aromatic hydrocarbon content of atmospheric particulate matter; microanalysis for benzo(a)pyrene in airborne particulates and source effluents; chromatographic analysis for benzo(a)pyrene and benzo(k)fluoranthene in atmospheric particulate matter; spectrophotometric analysis for benzo(a)pyrene in atmospheric particulate matter; preparation of carbon monoxide standard mixtures; carbon monoxide, formaldehyde, antimony and selenium content of the atmosphere; gross alpha radioctivity of the atmosphere; gross beta radioactivity of the atmosphere; and iodine-131 content of the atmosphere.

27358

Kusumoto, Masako, Toshio Toyama, and Hiroshi Momotani

**USE OF THE CASCADE CENTRIPETER (HOUNAM AND SHERWOOD) IN THE MEASUREMENT OF PARTICULATES OF RESPIRABLE DUST.** In: Histo- pathological Study on Contamination of Human Lungs Caused by Air Pollution. 1967. 7 refs. Translated from Japanese. Franklin Inst. Research Labs., Philadelphia, Pa., Science Info. Services, p. 178-197.

Results are given of tests of the cascade centripeter, a device for trapping and measuring air particulates which consists of four stages: a nozzle for particle acceleration, a second nozzle which classifies the accelerated particles, glass filters, and a membrane filter. Successively smaller particles are trapped in each stage as an air stream passes through the instrument. Accuracy of the method was tested with three kinds of particles of different diameter, distribution, and density, using an Effective Cut-off Diameter as a parameter of effectiveness in collecting particles suspended in an air current by inertia. This measure was found superior to others, for example Mass Median Diameter, for determining the accuracy of a particle weight distribution gauge. The device was also tested for measurement of particle diameters in factory and ambient Tokyo atmospheres. Results showed its applicability to measuring weight distribution of aerosol particulates and, as a dust sampler, for separating diameter groups Since it does not cause any physical or chemical changes in the trapped particles, it is useful for making chemical analyses of the particulates, particularly when used in comination with the Ring Oven method for such elements as manganese, cobalt, and lead. Other advantages are its relatively low cost, rapidity, and ease of handling.

27556

Tada, Osamu

**ON THE MEASUREMENT OF LEAD.** (Namari no sokutei ni tsuite). Text i Japanese. Rodo Kagaku (J. Sci. Labour, Tokyo), 25(10):36-39, Oct. 1970. 7 refs.

The measurement of lead in air and in blood or urea is reviewed. An outline of widely-used analytical methods is given along with comments on general problems in measurement. The analytical methods cited include the dithizone method, polarography, atomic absorptiometry, and emission spectral analysis. Fundamentals and characteristics, detection limits, and advice on the preparation of samples are summarized for each method. In addition, examples of analytical results are presented. Lead exists in air in the form of particulates, fumes, or tetralkyl vapors. Impingers, electric precipitators, or filters are used for the collection of particulates; glass fiber or millipore filters for fumes; and activated carbon or absorption by iodo (crystal) for tetralkyl lead vapors. Analysis of lead in blood or urea requires pretreatment of samples by incineration to remove organic ingredients. Incineration, which is classified as wet or dry, can be adapted to any analytical method. More simple methods can be used in the case of atomic absorptiometry, however. Among them are the albumin removal method, blood corpuscle separation, or the extraction of lead from urea.

27681

Tanaka, Katsuhiko, Katsuhisa Fukaya, Kikyoku Kasutani, Shozo Fukui, and Saburo Kanno

**ATOMIC ABSORPTIONMETRY OF LEAD IN GASOLINE.** (Gasorinchu no namari no bunsekiho to ganyuryo no suii). Text in Japanese. Preprint, Kyoto Univ. (Japan), Disaster Prevention Research Inst., 2p., 1971. (Presented at the Kyoto

University Research Institute for Disaster Prevention Conference, 11th, Kyoto, Japan, Jan. 22-23, 1971.)

A new, expedient method of checking the variation in the amount of tetraalkyl lead added to gasoline uses atomic absorption spectrophotometry. The key to the method lies in comparing the absorption coefficient of lead obtained by the atomic absorption analysis of two types of standard solutions containing lead. One type of lead is derived from tetramethyl or tetraethyl lead as a standard substance, and the other is obtained from lead nitrate. Lead in tetraethyl or tetramethyl lead is extracted by methylisobutyl ketone (MIBK); that in lead nitrate is extracted in MIBK after the lead has been changed into metal chelate by means of sodium diethyldithiocarbamate (DDTC). Since the absorption coefficient for the two types of lead are in agreement, lead nitrate can be used as the standard substance instead of dealing with the dangerous tetraalkyl lead.

27829

Honma, K.

**SAMPLING OF HEAVY METAL FUMES BY FILTRATION.** (Jukinzoku fyumu no rokahoshu). Text in Japanese. Preprint, Japan Society for Safety Engineering, Tokyo, 2p., 1970. (Presented at the National Symposium on Safety Engineering 1st, Tokyo, Japan, May 1970.)

Lead was chosen as the model for Uranium and Plutonium in testing the filtration capturing of radioactive heavy metal aerosols in order to confirm applicability of the results evaluated by 0.3 micron DOP. Collection rate was measured for various types of filters with textile-loaded layers by generating standard monodisperse aerosols of metallic lead. The filtration mechanism was studied for heavy metallic fumes in the low wind-velocity range. The monodisperse aerosol generator was a high-frequency induction heating type using nitrogen gas as carrier, and the aerosol sizes ranged from 0.05 to 0.7 micron. Even at a low wind- velocity range, the effect of the specific weight of aerosols became obvious beyond 0.3 micron. For lead fumes, the finer the filter fibers and the faster the filtration wind velocity, the smaller the minimum particle size for capture.

28017

Webster, S. H.

**CHEMICAL METHODS OF LEAD ANALYSIS.** Public Health Bulletin, no. 262:111-122, 1941.

Chemical analyses were carried out for the determination of the lea content of varied types of samples. Some 300 samples of air containing lead dust and fumes were obtained in the field as were a number of samples of drinking water. In addition, about 800 specimens of urine and a similar number of single blood specimens were obtained. In general, the evaluation necessitated the following procedures: (l) sampling and collection of samples; (2) ashing and concentration; and (3) isolation and determination of the lead content. The last step was carried out using the volumetric chromate method for most impinger samples and the two- color diphenylthiocarbazone (dithizone) method for the control of urine and blood specimens. Each step is described in detail and the accuracy of the analytical values is assessed.

28126

Fukui, Shozo

**MEASUREMENT OF DELETERIOUS GAS.** (Yugai gasu no sokuteihoho). Text in Japanese. Preprint, Society of Electro-Chemistry, Tokyo (Japan), Kanto Div., 24p., 1971. (Presented at the Seminar on Air Pollution, Tokyo, Japan, Feb. 3-4, 1971, Paper 5.)

The photometric determination of deleterious gases is considered, as well as the analysis of heavy metals in the atmosphere by an atomic absorption method, and the determination of atmospheric concentrations of organic solvents by gas chromatography. Accordin to the type of gas to be measured, sampling and preparation of test chemical solutions are indicated. Measuring procedures are presented for hydrogen sulfide, sulfur dioxide, ammonia, hydrogen fluoride, nitrogen dioxide, nitrogen dioxide plus nitric oxide, hydrogen chloride, chlorine, oxidants and ozone. The chemical analyses of heavy metals includes the determination of mercury, lead, cadmium, zinc, copper, iron, and manganese. For example, mercury vapor is absorbed in a sulfuric acid potassium permanganate solution and heated slowly for 30 min. A hydroxilamine solution is added to decolor the potassium permanganate, and a stannous chloride solution is added to reduce the mercury. Vaporized by circulating air, the mercury is absorbed by an absorption cell and measured at 253.7 millimicrons. The gas chromatograhic method is introduced for the measurement of acetone, chloroform, carbon tetrachloride, cyclohexene, tetrachloroethane, phenol, and other organic solvents in the atmosphere.

28621

Nakano, Kinji and Toshio Odairo

**MEASUREMENT METHOD FOR AMBIENT AUTOMOTIVE EXHAUST GAS CONCENTRATIONS.** (Kankyo taikichu jidosha haiki gasunodo no sokuteiho). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 5(1):243, 1970. (Proceedings of the Japan Society of Air Pollution, Annual Meeting, 11th, 1970.)

By using the advantages of bag-sampling, a multiple-point-average sampling device for the continuous sampling of automobile exhaust gases was developed. It can be made to record either a 15-minute average of three locations, 30-minute averages of six locations, or 60-minute averages of 12 locations. Chemical techniques for the analysis of the samples for lead in suspended particulates are described for use with glass-fiber filters and membrane filters. Atomic absorption spectrophotometry is utilized with the calibratio line of 2833 A.

28755

Tanaka, Katsuhiko, K. Fukaya, Kiyoshi Yoshitani, S. Kanno, and Shozo Fukui

**A FEW PROBLEMS ON DETERMINATION METHOD OF LEAD IN AUTO-EXHAUST GAS. (Jidosha haiki gasuchu no namari no teiryoho no mondaiten). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 4(1):252, 1970. (Proceedings of the Japan Society of Air Pollution, Annual Meeting, 11th, 1970.)**

Methods of determining lead in automobile exhaust gas were studied. When gasoline is burned in an engine, tetraethyl lead antiknock additives react with lead reducing agents to form various lead compounds. In addition, water in the exhaust gas condenses in the exhaust pipe, resulting in water droplets containing lead. When the end of the exhaust pipe was heated by a ribbon heater and impingers containing a nitric acid absorptio liquid were used, atomic absorption spectrophotometry of the sample gas showed that the first-stage impinger could not capture all the lead in water droplets. Large amounts of lead was also collected in the second impinger. Even the collection of exhaust gas behind the ribbon heater by means of a vacuum bottle and subsequent shaking of the gas with nitric acid solu-

tion showed that there are large variances in the concentration of lead measured. This indicated that not only water, but also dusts affect the reproducibility of the experiment.

28895

Loftin, H. P., C. M. Christian, and J. W. Robinson

**THE CONTINUOUS DETERMINATION OF LEAD IN AIR.** Spectrosc. Lett., 3(7):161-174, 1970. 45 refs.

A new atomic absorption technique for determining lead in the atmosphere achieves increased analytical sensitivity by utilizing hot carbon rods to reduce lead compounds to the atomic state and by taking advantage of long path absorption tubes to accumulate atoms in the light path. In this method, air samples are continuously passed over the white-hot carbon rods. The neutral atoms are then passed into the heated absorption chamber, where their concentration is measured. The lower limit of sensitivity of the method was observed to be about 3 times 10 to the minus 11th power g of lead. The method appears to be applicable to a wide variety of metals and their determination is currently under investigation.

29133

Steinke, Irmhild

**CONTRIBUTION TO THE DETERMINATION OF TRACES OF ALIEN SUBSTANCES (LEAD) IN LIGHT GASOLINE.** (Beitrag zur Bestimmung von Fremdstoffspuren (Beli) in Leichtbenzin). Text in German. Gas Wasserfach (Munich), 112(4):189-191, 1971.

While the dithizone method is suitable for determining very small quantities of lead in gasoline, dithizone is not specific for lead. With many other heavy metals, it forms colored dithizonates. The measures necessary to eliminate these metals make the method rather time-consuming. Interferences can be avoided by measuring the atomic absorption of lead, an analytical method that is to be preferred over all dithizone methods. Atomic absorption requires not more than about one hr, while the dithiozone method requires about three hrs. For atomic absorption, the lead must be converted to the aqueous phase which is evaporated to 5 ml. This method permits lead concentration above 10 ppb to be determined with a standard deviation of plus or minus 5 ppb. The method was used to determine the presence of lead at the points where gasoline passes through a cracking plant. Of the 20 ppb lead in the gasoline before it entered the plant, 290 remained in the plant. About 20 g lead were found in the gasoline evaporator, 5 g on the hydration contact, and 200 g on the Nimox contact. Eighty % of the lead brought into the plant was found.

29226

Hwang, J. Y.

**LEAD ANALYSIS IN AIR PARTICULATES SAMPLES BY ATOMIC ABSORPTION SPECTROMETRY.** Can. Spectr., 16(2):43-45, March 1971. 10 refs. (Presented at the Spectroscopy Symposium of Canada, 16th, Montreal, Quebec, Oct. 1969.)

Atmospheric particulate samples were collected on organic membranes for the analysis of lead by atomic absorption spectrometry. In order to maximize the sensitivity and to improve the accuracy of the analysis, various parameters were investigated: flame conditions, flame profiles, and chemical interferences in air- acetylene and argon-entrained air-hydrogen flames. Because of severe chemical interferences from the matrices, argon-entrained air-hydrogen flame was useless in the analysis of lead in air particulate samples in spite of slight improvement of the detection limit of lead in this flame environment compared to air-acetylene flame. In air-acetylene flame, no serious cationic interferences were found, but anionic interferences of sulfate and silicate were significant in the lead analysis. (Author abstract modified)

29297

Groffman, D. M. and R. Wood

**REVISION OF A FIELD METHOD FOR THE DETERMINATION OF TOTAL AIRBORNE LEAD.** Analyst, 96(1139):140-145, Feb. 1971. 6 refs.

An improved field method is described for determining airborne lead at concentrations up to 0.8 mg/cu m. After collection on a membrane filter, the lead is dissolved in nitric acid-hydrogen peroxide solution and complexed with dithizone. The lead dithizonate is extracted into 1,1,1-trichloroethane and the color intensity of the complex is compared visually with standards. The apparatus used is simple to operate and the time required for a complete determiniation is about 15 min. Although designed specifically as a field test, the method can be used to determine lead accurately if a spectrophotometer is employed. (Author abstract modified)

29419

Tanaka, Katsuhiko, Katsuhisa Fukaya, Noriyoshi Ashiya, Shozo Fukui, and Saburo Sugano

**ANALYSIS OF LEAD IN GASOLINE AND TRANSITION OF THE LEAD CONTENT.** (Gasorin chu no namari no bunsekiho to ganyuryo no suii). Text in Japanese. Preprint, Safety Engineering Society of Japan, Tokyo), 3p. 1970. (Presented at the Safety Engineering Society, Research Presentation Meeting, 3rd, Tokyo, Japan, Dec. 9-10, 1970, Paper 22.)

An atomic light absorbency analysis device was used to determine quantitatively the tetraethyl lead contained in gasoline without the extraction required for the gravimetric method. Using methyl isobutylketone (MIBK) as a solvent, the sample gasoline is diluted for a 1 to 20-100 dilution (D). Using this solution as the test solution, its absorbency (A) is measured. Meanwhile, a specified amount of the standard lead solution produced from lead nitrate (dissolved in 10% nitric acid) is adjusted to PH 7-9 and added to a diethyl dithiocarbamic acid sodium (DDTC). The test solution is extracted from this solution by means of MIBK, and then its absorbency (A sub s) is measured. Also measured in a blank test solution are the absorbency of MIBK (A sub o) and that of the 10% nitric acid solution (A sub so). The quantity of lead in gasoline can then be calculated by the formulas: C (lead in terms of g/l) equals 10D(A-A sub o/1000 (A sub s-A sub so) and C prime (tetraethyl lead in ml/l) equals C (1/1.056).

29464

Hasegawa, Toshio and Akiyoshi Sugimae

**METAL COMPONENTS OF FLOATING DUST.** (Fuyu Funjin chu no kinzoku seibun). Text in Japanese. Preprint, Japan Chemical Society, Tokyo, 1p., 1971. (Presented at the Japan Chemical Society, Annual Meeting, 24th, Tokyo, 1971, Paper 3343.)

Using a tape air sampler, dust was trapped hourly and lead and manganese were analyzed. Graphite electrodes were immersed in a silicone-carbon tetrachloride liquid and dried to be made waterproof. At the bottom of the electrodes, filter paper was attached and a 30 ppm indium solution was titrated and dried. A buffer powder was added. When the filter paper is treated with a direct arc discharge, there is an extreme background, since the filter paper burns. The spectrogram becomes weak and the metals may be scattered. Therefore,

the filter paper was inserted at the bottom of electrodes, and on top of it, buffer powder added; the effect of the buffer on spectrogram intensity was examined. The buffer powders tested were graphite and NaCl, NaF, NaHCo3, Na2CO3. Graphite produced a large background which decreased when sodium was added. A buffer powder of graphite and NaSCO2 is concluded to be the best buffer.

29512

Korn, M. and L. Rolf

**PARTICLE SIZE MEASURING WITH THE TELEVISION MICROSCOPE QUANTIMET FOR SIZES MINUS 4 MICRONS.** (Korngroessenmessungen mit dem Fernsehmikroskop Quantimet im Bereich kleiner als 40 Mikron). Text in German. Aufbereitungs-Technik, 21(3):154-160, 1971. 29 refs.

The Quantimet for measuring size distributions of fine particles consists essentially of a microscope, a TV camera with monitor, and an electronic computer. The microscope provides a picture of the sample. As this picture is scanned by the TV camera, electric pulses are produced whose height indicates the half tone and whose width the size. The accuracy and reproducibility of Quantiment measurements were tested in experiments with pure quarzite (99.9% SiO2), pure limestone (98.5% CaCO3), and lead sulfide (82.6% Pb) with grain sizes from 0 to 36 micron. The results were comparable to those for conventional methods. The rapid and exact measurement of grain sizes from 1 micron on, makes the method suitable for control measurements in metallography and medicine.

29595

Manita, M. D.

**NEW METHODS OF DETERMINING AIR POLLUTION.** (Neue Methoden der Bestimmung von Luftverunreinigungen). Text in German. Wiss. Z. Humboldt Univ. Berlin Math. Naturw. Reihe, 19(5):527-528, 1970.

A number of new and improved methods of quantitative determination of atmospheric pollutants are described. Most prominent among them are photometric methods. For example, a method for the determination of polycyclic aromatic hydrocarbons (e.g., benzpyrene in dust involves evaluation of the fine structure of fluorescence spectra, based on the Shpolski effect. The essence of this effect is the phenomenon in which the spectra of the polycyclic hydrocarbons show increased clarity of individual lines when hydrocarbons dissolved in n-hexane, n-heptane and n-octane are being frozen. Photometric methods of light absorption of pigmented test solutions are being employed for determination of both aerosols and gases. The use of filters for aerosol tests, silica gel for gases and vapors, and water-soluble chemical absorbents for trapping gases and vapors are also discussed. Spectrometric and chromatographic methods for studying the composition of automobile exhaust gases, using equipment with flame ionization detectors, are mentioned briefly.

29810

Isizaki, Masanori

**STUDIES ON LEAD CHROMATE OBTAINED FROM TETRAALKYL LEAD IN LEADED GASOLINE. I. X-RAY DIFFRACTION TESTS OF THE LEAD CHROMATE CRYSTALS.** Mem. Def. Acad. Japan, 10(3):389-392, Dec. 1970. 3 refs.

Besides tetraethyl lead, recently some other lead alkyls, including tetramethyl lead, trimethyl-monoethyl lead, dimethyl-diethyl lead, and monomethyl-triethyl lead, have been used as antiknock agents for high octane motor gasolines. For analysis of these lead alkyls, they are converted to lead chromate, and the weight of the lead chromate is put into the formula: A equal to 12.79 G(1 plus 0.0012(t-15)), where A represents the content of metallic lead in gasoline at sampling, and 0.0012 the expansion coefficient of gasoline. The constant 12.79 was determined using the so-called empirical factor for converting lead chromate to metallic lead (0.6394). Crystal data of four kinds of lead chromate were checked by Debye-Sherrer s method. The lattice distance and the relative intensity of the crystals of lead chromates from three kinds of leaded gasoline, as well as a standard fused lead chromate, agree with each other.

30113

Goodman, Gordon T. and T. M. Roberts

**PLANTS AND SOILS AS INDICATORS OF METALS IN THE AIR.** Nature, 231(5301):287-292, June 4, 1971. 40 refs.

A study was conducted in Swansea, Wales to obtain some relative estimates of the total aerial burden of metals presumed to originate indirectly from former industry and directly from present day urban-industrial sources. Sampling and analysis were conducted for zinc, lead, cadmium, copper, nickel, and magnesium in the moss Hypnum cupressiformi, the grass Festuca rubra, and in surface soils. Three transects, the Gower, Swansea, and Neath transects, were sampled along with the Gwendraeth Valley. The results show similar geographical trends for the metals examined. The concentrations of metal compounds increased in soils, Festuca, and Hypnum downwind of the Swansea urban industrial complex. The values in the two rural transects, Gower and Gwendraeth, contrasted sharply with the values of the Swansea transect. The results indicate that surface soils, Festuca, and Hypnum can be used as indicators and integrators of aerial metallic pollutants. Some applications of this method of sampling for agriculture and medicine are discussed.

30290

Guicherit, R.

**AUTOMATIC MEASUREMENT OF POLLUTANTS.** (Het automatisch meten van luchtverontreinigende stoffen). Text in Dutch. Chem. Weekblad, 67(9):18-23, Feb. 26, 1971. 12 refs.

Types of instrumentation for use in automatic measurement of air pollution from carbon monoxide, sulfur dioxide, nitrogen oxides, ozone, hydrocarbons, soot, dust, heavy metals such as lead, and polynuclear aromatic compounds such as 3,4-benzopyrene are described, including instruments for colorimetric, potentiometric, and physical-chemical detection. The measurement of aerosols is not discussed since automatic readings for this type of pollutant is considered beyond the competence of present technology. The tendency in developing measuring methods has been from exclusive use of wet chemical processes (colorimetry) to electrochemical methods to the exclusive use of physical measuring methods. Data are given illustrating the results of measurement by such methods, including a comparison of pollutants created by human activity with those from natural emission sources. Human activities are responsible for the release of more than 200 million tons of CO per year, compared with 30 million from natural sources. From human activities also produce 58-70 million tons per year of SO2 about 4-5 times as much as nature normally produces. For all other pollutants, the human output was lower than natural emissions. Total emissions in the Netherlands and in the U. S. are compared, excluding natural sources. In both countries, automotive traffic is responsible for 90% of the CO emissions. In the U. S., automotive traffic is responsible for

63% of hydrocarbon pollution and 46% of the nitrogen oxides, compared with 45% and 15%, respectively, in the Netherlands.

30360

Japan Environmental Sanitation Center, Tokyo

**A REPORT OF INVESTIGATION AND ANALYSIS OF SUBSTANCES OF AIR POLLUTION.** (Taikiosenbusshitsu no chosa bunseki hokokusho). Tex in Japanese. 23p., March 1968. 12 refs.

The technical problems of the NASN measurement method for analyzing metallic elements in atmospheric dust was studied. Hydrochloric acid was superior to nitric acid for abstracting chromium and copper. This method made the background of the spectrum become dense, and its sharpness decrease. Lithium chloride, which is used as a buffer in electrode manufacturing, absorbs humidity. The application of sodium chloride was examined, but a satisfactory result was not obtained. The application of indium, strontium, and platinum as internal standard substances was examined; platinum was found to be unsuitable. Four changes were added to the NASN method based on these results. Metallic elements were analyzed in floating dusts sampled from April, 1967 to March, 1968 at five national stations of air pollution. The following suggestions were made: use strontium as an internal standard substance; exclude the absorption of humidity by LiCl by electrode heating equipment and continue the preliminary electric discharge for three seconds. An average per year measurement of elements in soots and dusts was as follows (unit of weight - microgram/cc m): total quantity of soots and dusts - 208, quantity of organic substances - 12.0. The quantity of water soluble substances was: phosphorus - 6.8, sulfates - 17.5, and nitrates - 3.2; the quantity of metallic elements was: titanium - 0.148, vanadium - 0.129, chromium - 0.008 manganese - 0.163, iron - 6.14, nickel - 0.045, copper - 3.03, lead - 0.96, beryllium - less than 0.001, and cadmium - less than 0.001.

30593

Tonkelaar, W. A. M. den and Martha A. Bikker

**MICRODETERMINATION OF LEAD ON TAPES OF AN A.I.S.I. AUTOMATIC AIR SAMPLER BY ATOMIC ABSORPTION SPECTROSCOPY.** Atmos. Environ., 5(5):353-356, May 1971. 11 refs.

A sensitive, fast, routine procedure is described for the determination of lead in air borne particulate samples collected on tapes of an AISI automatic air sampler using atomic absorption spectroscopy. After punching the spot out of the aper tape and adding a small volume of dilute nitric acid, the absorbance can be read after 30 min by spraying the extract into the flame. A detection limit of less than 0.1 micrograms lead/spot has been reached. The lead content of a blank filter is negligible and the calibration curve is scarcely affected by matrix effects. In this manner, over 800 two-hour samples, collected near a highway over a two year period, were analyzed, yielding results of less than 0.1-9.1 micrograms lead/cu m of air. The pattern of the diurnal particulate lead concentration reflected the morning and afternoon rush hour traffic. (Author abstract modified)

30635

Kanno, Saburo

**MICROANALYSIS OF HEAVY METAL IONS IN THE ENVIRONMENT AND THE PROBLEMS AT ISSUE.** (Kankyochuno biryo jukinzoku no bunsekiho to mondaiten). Text in Japanese. Preprint, Society of Electro-chemistry, Tokyo (Japan), 34p., 1970. (Presented at the Society of Electrochemistry Industrial Public Nuisance Control Seminar, Tokyo, Japan, Dec. 2-3, 1970, Paper 7.)

Representative methods for the microanalysis of mercury alkyl, total mercury, cadmium, lead, copper, zinc, and arsenic, and lead in the atmosphere and gasoline were discussed by describing the test procedures for each method. For the analysis of mercury alkyl, gas chromatography was described, while listing the test chemicals, apparatus, preparation of the test sample, and the test procedures. Procedures for the microanalysis of total mercury by an atomic absorption analysis method were described, including the test apparatus, test chemicals, prepartion of the samples, and the testing. The additional remarks included: How to prevent mercury from volatilizing during decomposition of the sample; quality of the absorption cell body, selection of desiccative, absorbency against quantity of stannous chloride solution added, effect of coexisting ions; calibration curve and reproducibility, plotting in chart, effect of temperature, recovery test of mercury, and arresting mercury from air. Atomic absorption analysis procedures for the microanalysis of cadmium, lead, copper, and zinc were also described. For the microanalysis of arsenic, procecures of the silver diethyl thiocarbamate method were described. Atomic absorption analysis procedures for analysis of lead in the atmosphere and gasoline were also given. Attached as enclosures were the Environmental Criteria Concerning Water Pollution and the Results of Analysis of the Tokyo Bay s Bottom Sludge.

30707

Hwang, Jae Y., Paul A. Ullucci, and Charles J. Mokeler

**TRACE ANALYSIS OF ATMOSPHERIC POLLUTANTS BY SOLVENT EXTRACTION-- FLAMELESS ATOMIC ABSORPTION SPECTROMETRY.** Preprint, Air Pollutio Control Assoc., Pittsburgh, Pa., 17p., 1971. 6 refs. (Presented at the Air Pollution Control Association Annual Meeting, 64th, Atlantic City, N. J., June 27-July 3, 1971.)

Trace elements of silver, cadmium, zinc, and lead in atmospheric particulate samples were determined by solvent extraction- flameless atomic absorption techniques. Air particulate samples were collected on organic membranes by a low volume air sampler. The membranes with the samples were pretreated with acetone before acid extraction. Sample solutions, thus prepared, were further extracted into organic solvents. The final organometallic complexes in organic solvents were then dried, pyrolyzed, and atomized in an enclosed chamber under an inert gas atmosphere for atomic absorption measurements. To improve the accuracy of the analysis, a thorough investigation into the chemical interferences was made and the interferences were compared between the present and conventional atomic absorption techniques. This technique is simple and runs with good sensitivity and precision. It is ideal for the trace analysis of atmospheric particulate samples for a short-term variation study. (Author abstract modified)

30786

Tanaka, K., K. Fukaya, K. Yoshitani, S. Kanno, and S. Fukui

**DETERMINATION OF LEAD IN GASOLINE BY ATOMIC ABSORPTION PHOTOMETRIC.** Text in Japanese. Kogai To Taisaku (J. Pollution Control), 5(1):66, 1970. (Proceedings of the Japan Society of Air Pollution, Annual Meeting, 11th, 1970.)

Tetramethyl and tetraethyl lead were diluted with methyl-isobutyl ketone (MIBK), respectively, and measured by atomic absorption photometry. The values obtained were identical with that of vegadex (DDTC) chelate in MIBK prepared from Ph(NO3)2. To prepare the lead standard solution, Pb(NO3)2, in 10% HNO3, was chelated with DDTC at PH-7 followed by extraction with MIBK (absorption As). Gasoline was diluted to approximately two % with MIBK and tested (absorption A) (multiple D) Ao2 and Ao1 for absorptions of MIBK and 10% HNO3 respectively. Methods of calculating the lead concentrations are presented and experimental results summarized in tabular and graphic form.

30928

Fletcher, K.

**DIRECT DETERMINATION OF LEAD IN PLANT MATERIALS BY ATOMIC ABSORPTION SPECTROPHOTOMETRY.** J. Sci. Food Agr., 22(5):260-261, May 1971. 10 refs.

A hydrogen lamp continuum source was used to measure and correct for background absorption in atomic absorption spectrophotometric analyses of lead in plant materials. For lead concentrations of 20 ppm and above, the corrected values were in reasonable agreement with values obtained colorimetrically. This suggests that relatively higher values recently reported for atomic absorption spectrophotometric determinations were due to the phenomena of background absorption.

31258

Lundgren, Dale A.

**AEROSOL SAMPLING FOR DETERMINATION OF PARTICULATE MASS CONCENTRATION, CHEMICAL COMPOSITION AND SIZE DISTRIBUTION.** In: Aerosol Measurements in Los Angeles Smog, Vol. I, Section IV. Minnesota Univ., Minneapolis, Particle Technology Lab., Particle Lab. Pub. 141, Air Pollution Control Office APTD-0630, 15p., Feb. 1971. NTIS: PB 198816

A Lundgren Impactor together with a total particulate filter were used to determine the size distribution, concentration, and chemical composition of particulate matter in the air. The procedure involved obtaining size fractionated samples of the aerosol over desired time periods, collecting out the particulate matter in such a way that it is amenable to analysis, and analyzing the particulate samples by techniques capable of providing the required information. To illustrate the type of data obtained from use of the instrument 10 samples were taken. The particulate weight distribution was determined; the water soluble fraction was extracted and analyzed for sulfate and nitrate by standard wet chemical methods; and the nitric acid fraction was extracted and analyzed by atomic absorption spectrophotometry for lead and iron.

31304

Hasegawa, Toshio and Akiyoshi Sugimae

**STUDIES ON HEAVY METALS IN ATMOSPHERIC PARTICULATES - ON THE SIZE DISTRIBUTIONS -.** (Fuyu funjin chu no kinsoku seibun no kenkyu - ryukei bunpu o chushin to shite). Text in Japanese. Kuki Seijo (Clean Air J. Japan Air Cleaning Assoc., Tokyo), 9(1): 1-9, April 1971. 13 refs.

The size distribution of heavy metals, including iron, lead, manganese, vanadium, and copper, in atmospheric particulates were studies. The particulates were collected on a glass-fiber filter in four fractions, depending on particle size, by a cascade centripeter. The samples were separated from the filter, decomposed by hydrofluoric acid, and the heavy metals determined spectrographically. The diameters of 90% of the lead, 80% of the vanadium, and a large portion of the manganese and copper particulates were less than two micron. The size distribution of iron showed the characteristic curve, having a specific maximum peak at eight micron. The mass median diameters were estimated to be one micron for iron, 0.5 micron for manganese, 0.1 micron for vanadium, and 0.3 micron for copper. (Author summary modified)

31933

Akashi, Nobuko

**SIMULTANEOUS QUANTITATIVE ANALYSIS OF ATMOSPHERIC HEAVY METALS BY SQUARE-WAVE POLAROGRAPHY.** (Kukeiha poraroguraf i ni yoru taikichu jukinzoku no doji teiryo). Text in Japanese. Bunseki Kiki (Analysis Instr.), 9(7):10-18, July 1971. 44 refs.

A polarographic analysis was made of the copper, lead, cadmium, zinc, and iron content of suspended dust in the atmosphere. The dust was sampled with a glass fiber filter and high-volume air sampler, with one-fourth of the filter paper used for analysis. The sampled dust was incinerated at 100 C. The filter paper was immersed in a 20% hydrogen chloride solution and heated for three hours in a hot bath to separate the metals. Then the sample was then filtered, evaporated, dissolved in a 10% HCl solution and quantitatively analyzed by square wave polarography. The effects of the HCl concentration on the peak height of the Cu, Pb, Zn, and Cd polarograms was studied. Similar results were obtained with atomic absorption spectrometry and square wave polarography.

32058

McKee, H. C. and P. D. Holmes

**HIGH MOLECULAR WEIGHT COMPOUNDS IN VEHICLE EXHAUST: STATE-OF-THE- ART.** Coordinating Research Council, Inc., New York, Study Sub- Panel on High Molecular Weight Compounds, CRC Proj. CK-4-58, CRC-R-429, 15p., March 1967. 23 refs.

A summary is presented of the state-of-the-art regarding measurement methods and analytical methods for high molecular weight compounds found in automobile exhaust. Many carcinogenic materials of the polynuclear aromatic hydrocarbon type are suspected of causing cancer in humans. High molecular weight compounds may also be involved with atmospheric reactions which cause eye irritation, vegetation damage, or photochemical reactions. Properties of various hydrocarbons including pyrene, Benzo (a) and (e) pyrene, perylene, benzo(ghi)perylene, anthanthrene, coronene, anthracene, phenanthrene, and fluoranthene are listed. Blowby and exhaust automobile emissions have been investigated. Carbon monoxide and lead in exhaust gas were used to estimate the percentage of polynuclear aromatic hydrocarbons which could be attributed to vehicle traffic; the mean contributions based on lead were 18% of the total at a freeway, 5% in a downtown commercial area, and 42% in a suburban area; the mean contributions based on CO were twice these figures. Diesel engines may be another source. The exact mechanism which produces polynuclear aromatic compounds in the combustion zone is not known; however, their formation cannot be eliminated by fuel additives, engine design changes, or combustion changes. Particulate samples have been collected by filtering. Then they can be separated and identified by sublimation, distillation, solid-liquid extraction, liquid-liquid extraction, and column, paper, thin layer, and gas chromatography. Quantitative measurements and identification can be made by absorption, fluorescence, and phosphorescent spectra and by gas chromatography. A bioassay method can also be used to determine benzo(a)pyrene, based on the photodynamic toxicity

of this compound to Paramecium. Also, these different methods can be combined.

32169

Pines, Ignacy

**LEAD DETERMINATION IN THE AIR OF PLANTS (PHOTOMETRIC METHOD).** (Oznaczanie olowiu w powietrzu w zakladach pracy (metoda fotometryczna)). Text in Polish. Med. Pracy (Lodz), 19(3): 299-307, 1968. 31 refs.

A simplified analytical procedure for the determination of lead in air is described in which filter paper within glass beakers was put in a sylite oven at 400-450 C. The dithizone photometric method was simplified by removing heavy metals and lead from the chloroform layer during one lead extraction at pH 11-11.5. The dithizone excess is also removed during the extraction. The method makes possible the direct determination of 1-500 micrograms of lead in a solution by the use of a dithizone solution in ammonia, absorption cells with different thickness of the absorbing layer (0.5 and 0.1 cm), and measurement of the absorption value up to 2.0.

32474

Omang, Sverre H.

**THE DETERMINATION OF LEAD IN AIR BY FLAMELESS ATOMIC ABSORPTION SPECTROPHOTOMETRY.** Anal. Chim. Acta, 55(2):439-441, July 1971. 12 refs.

The use of flameless atomic absorption spectrophotometry is described in a simple, rapid, and extremely sensitive method, combined with the collection of lead particulates on millipore filters from air volumes down to 10 cu dm. Air contaminants were collected on 37-mm diameter MF-millipore filters AA (0.8 micron), made of mixed cellulose esters; these filters were connected to a small portable battery-operated pump, calibrated to 2.7 cu dm air/min. A Perkin-Elmer Model 303 atomic absorption spectrophotometer equipped with a Perkin-Elmer graphite cell HGA 70, an automatic recorder readout accessory, and a Hitachi-Perkin-Elmer Recorder Model 159 were used. Two separate heat treatment stages, drying and charring, are used to remove any solvent, organic material, or other unwanted components before sample volumes are atomized in the graphite tube. Lead samples are collected by aspirating air for 10 min through the millipore filters. The filters are then soaked in 2.0 ml of one plus one nitric acid in a 50 ml beaker and gentle heat is applied. After five minutes, this is decanted into a 10 ml volumetric flask and the filters are washed with successive two ml portions of warm distilled water. Then they are diluted to volume with distilled water and five to 50 ml of 0.1 ppm lead standard solution is injected into the graphite tube. The lead absorption peak is registered at program four with a five V atomization voltage and a 30 sec sequence time. Problems with light scattering are mentioned. The proposed method was used in the analysis of a number of air particulate samples collected in Oslo in November 1970, one m above street level.

32476

Fukui, Shozo

**METHOD OF MEASUREMENT OF HARMFUL MATTERS IN AIR.** (Kuki chu no yugaisei busshitsu no sokutei hoho). Text in Japanese. Bunseki Kiki (Analysis Instr.), 9(8):43-59, Aug. 1971. 1 ref.

Various measurement methods of harmful matter in the atmosphere are examined. The orthotolidine method is described for chlorine determination, but there is no reliable method for a high incidence of pollution by chlorine gas. The neutral iodine potassium method for ozone and oxidants; the atom light absorption method for cadmium; the pyridine pyrazole and palladium quinolinol methods for hydrogen cyanide; the dithizone and atom light absorption methods for mercury; and the diazotation and Saltzman methods for nitrogen oxides are reviewed. The atom light absorption method is generally used for lead and zinc, since it is simple and accurate. Sulfur dioxide is trapped with sodium chloride and mercuric chloride in solution; rosaniline formaldehyde is then added, and the mauve color is determined. Fluorides or hydrofluorine are measured by colorimetry, i.e., the lanter-alizarin complexion method. The 3-methyl-benzo-thiazolon- hydrazone method, which is most sensitive, and the chromotropic method are used to measure formaldehyde. Hydrogen sulfide is determined by the methylene blue method, the molybdenum blue method, and the starch iodine method. The methylene blue method gives a unique reaction and involves less obstruction. A new method for trapping sulfides is examined.

32534

Fujinaga, Taichiro and Mutsuo Koyama

**ENVIRONMENTAL POLLUTION ANALYSIS -- ESPECIALLY ON THE BASIC APPROACH TOWARD IT.** (Kogai bunseki -- Tokuni sono kangaekata ni tsuite). Text in Japanese. Bunseki Kiki (Analysis Instr.), 9(7):3-9, July 1971. 13 refs.

The basic characteristics of an environmental pollution analysis are discussed to clarify the basic approach required for an analysis that is usually of complex nature. Often organic and inorganic analyses must be performed simultaneously. Moreover, an analysis is more than simply qualitative or quantitative. A qualitative analysis intended simply to detect a polluting element in air or water is often meaningless; very often the toxicity of a particular element depends on its chemical state. Therefore, microanalysis or, more properly, trace analysis is required to detect extremely toxic substances. If possible, pollution should be continuously monitored and analyzed. The most dependable of current measuring devices are, theoretically, those employing ion-selective electrodes. Sampling, pretreatment, and measurement methods, together with measurable range and references, are tabulated for different air pollutants. The methods are as follows: dust (particulates), reflection factor or transmittivity measurement; sediment, gravimetric analysis; precipitation density, X-ray, light-dispersion, and gravimetric. X-ray microprobe analysis, fluorescent X-ray analysis, radiometry, emission spectrochemical analysis, atomic absorption spectrochemical analysis, absorption photometry, polarography, and gas chromatography are used for metals and other noxious elements. For carbon monoxide or carbon dioxide measurements, conductometry, coulometry, visible absorption photometry, and ultraviolet absorption photometry are used. Turbidimetry, coulometry, and conductometry are used for hydrogen sulfide measurements. Coulometric titration and absorption photometry are used for oxidant measurements. Nitrogen dioxide or nitric oxide measurements use visible radiation absorption photometry. Organics are measured by gas chromatography. Ammonia, aldehydes, fluorine, phenyl acetate, mercury, tetraethyl lead and hydrogen cyanide use visible radiation absorption photometry.

32718

Fujiwara, Toshizo, Hideo Okashita, and Hiroshi Tsukiyama

**X-RAY FLUORESCENCE ANALYSIS OF SPECIMENS RELATED TO ENVIRONMENTAL POLLUTION.** (Kogai kankei shiryo no keiko X-sen bunseki). Text i Japanese. Shimazu Hyoron (Shimazu Rev.), 28(2):87-91, June 1971. 5 refs.

X-ray fluorescence spectrometry was used to analyze aqueous solutions, heavy oils, dusts, and various deposits, as environmental pollutants. The sensitivity was improved by enhancing the peak-to-background ratio, and the interference of bubbles in liquid samples was eliminated. Examples of determination of mercury and arsenic in an aqueous solution and of sulfur in heavy oil are given. Dust was analyzed by adsorption and trapping on filter glass, with special attention to the background of the glass filter. A sample of mud accumulated at the bottom of the sea was dried and crushed for analysis; it contained barium, zirconium, bromide, lead, zinc, iron, and manganese. Detection sensitivity was improved by condensing the aqueous solution samples.

32829

Oura, Masahiro

**CURRENT REVIEW OF MOTOR VEHICLE EXHAUST EMISSION ANALYSIS.** (Haiki gasu busekikeiei no genjo). Text in Japanese. Jidosha Gijutsu (Automobile Eng.), 25(7):824-834, July 1971. 22 refs.

Depending upon research objectives, sampling methods for the measurement of the harmful components of automobile exhaust emissions will vary. A constant volume sampling method was developed to simulate operating conditions. Analytical instruments are required to be highly selective and sensitive. Nondispersive-infrared analysis is being used to determine carbon monoxide, while hydrocarbons are now determined with a fiame ionization detector. Nondispersive-infrared analysis or chemical luminescence may be used to determine oxides of nitrogen. Lead compounds are also often determined. Iodimetric and ultraviolet spectrometry is also used to detect CO.

32833

Yamate, Noboru

**AUTOMATIC CONTINUOUS ANALYZER OF LEAD IN THE ATMOSPHERE.** (Taikichu no namari no renzoku jido sokuteikei ni tsuite). Text in Japanese. Kuki Seijo (Clean Air - J. Japan Air Cleaning Assoc., Tokyo), 9(2):55-57, June 1971. 6 refs.

An automatic continuous analyzer, based on square wave polarography, for determining lead in the atmosphere is examined. The sample air was passed through an absorbing bubbler containing 30 ml of 0.1 N nitric acid for 46 min at a rate of 22 l/min. Nitrogen was then passed through the bubbler for 3 min. The solution was transferred to the electrolytic cell and the square wave polarograms were recorded. The full scale of the analyzer was 0-15 micrograms/cu m of lead.

32892

*Hasegwa, Toshio and Akiyoshi Sugimae*

**EMISSION SPECTROGRAPHIC DETERMINATION OF TRACE METALS IN AIRBORNE PARTICULATES.** (Hakko bunko bensekiho niyoru fuyu funjinchu no kinzoku seibun no teiryo). Text in Japanese. Bunseki Kagaku (Japan Analyst) (Tokyo), 20(7):840-845, July 1971. 10 refs.

A method was developed for the spectrographic determination of iron, manganese, lead, vanadium, tin, nickel, and copper in airborne particulates. Particulates, collected on a glass fiber filter, were placed in a mixture of sodium fluoride and graphite powder packed into the crater of a graphite electrode. A definite volume of nitric acid solution containing 30 ppm of indium and palladium as internal standards was added, and the glass fiber was decomposed by hydrofluoric acid produced by the hydrolysis of sodium fluoride. The electrode was then subjected to direct current arc excitation. Spectral line intensity was determined, with sodium fluoride as the spectroscopic buffer. The coefficient of variation was approximately 1.3-13.1%.

32975

Schrenk, H. H. and Florence L. Feicht

**BUREAU OF MINES MIDGET IMPINGER.** Bureau of Mines, Information Circ., no. 7076:1-7, June 1939. 4 refs.

A light, compact, self-contained, portable and easily hand-operated midget impinger was described. The instrument is based on impingement and wetting of the dust particles by drawing air through a nozzle at high velocity onto a smooth surface under a bubbling column of liquid. The dust particles are retained in the liquid. The complete apparatus, including a number of impinger tubes in a convenient carrying case, need not weigh more than 10 lbs. The device was tested with silica dust, lead dust, lead fume, catoctin greenstone, and siliceous schist dust. Results agreed well with those obtained with the large impinger. Satisfactory results were obtained for lead dust when compared with the electric precipitator. The efficiency of the midget as well as the large impinger for collecting fumes was low. The instrument is commercially available and a number of devices are in use.

33042

Wainerdi, R. E., L. E. Fite, and W. E. Kuykendall

**NUCLEAR ANALYTICAL METHODS AND SYSTEMS FOR THE MEASUREMENT OF TRACE CONSTITUENTS IN THE ENVIRONMENT.** International Atomic Energy Agency, Vienna (Austria), Nucl. Tech. Environ. Pollut., Proc. Symp., Salzburg (Austria), 1970, p. 459-480. 81 refs. (Oct. 26-30, Paper IAEA-SM-142a/28.)

Nuclear and other methods of microanalysis can provide important information about the normal and abnormal concentration levels of trace elements in living systems and in their environment. Activation analysis, especially using gathered samples returned to well-equipped central laboratories, can provide extensive elemental and isotopic information, especially when automated analytical spectrometers and computer data processing are employed. Isotope dilution, radiation reflection, and other nuclear methods can also provide additional important information about the normal levels of trace elements in the ecosystem and their dispersion and about the magnitudes of environmental effects caused by such materials. Many materials of known toxicity, such as mercury, silver, bromine, and lead, lend themselves to microanalysis using neutron, charged particle (proton), or photonuclear activation analysis. A summary is given of trace analyses of aerosols, marine aerosols, particulates, rain and snow, water from rivers and bays,, tissues, fish, and tobacco, performed by neutron activation analysis.

33055

Mott, W. E.

**ISOTOPIC TECHNIQUES IN THE STUDY AND CONTROL OF ENVIRONMENTAL POLLUTION.** International Atomic Energy Agency, Vienna (Austria), Nucl. Tech. Environ. Pollut. Proc. Symp., Salzburg (Austria), 1970, p. 3-46. 151 refs. (Oct. 26-30, Paper IAEA-SM-142a/1.)

Work performed with isotopes in the environmental pollution area in the United States is identified and described for the last five years. Applications of activable tracers and isotope ratio techniques to the dispersion and fate of oxides of sulfur, miscellaneous gases and aerosols, and ground-level distributions of emissions are considered. Tracer studies have been

made of municipal wastewater treatment and discharge, viruses and bacteria in wastewater effluents, refinery effluents, pulp and paper mill effluents, oil spillage, agriculture wastes, transfer of pollutants in ecosystems, and the movement of sediments. Radioisotope instruments include the strontium-90 ozone generator, turbidity monitor for water treatment plants, density gages in wastewater treatment plants, automated primary productivity instruments, an eggshell strength gage, suspended sediment concentration gages, and various instruments for determination of the sulfur content of fossil fuels. X-ray fluorescence analysis may be used to determine lead in the atmosphere, paint, and blood. Neutron activation analysis and radiometric techniques may be used to determine trace elements in the atmosphere, the hydrosphere, and in plants and animals. Automobile exhaust and sulfur dioxide in stack gases can be determined by radio-release and chemical substitution. Mossbauer spectrometry is discussed, as well as the radiation treatment of municipal and industrial wastes.

33178

Roschig, Manfred, Hermann Matschiner, and Helmut Fritzsche

**THE DISTRIBUTION AND DETERMINATION OF LEAD TRACES IN MINERAL OIL PRODUCTS.** Die Verteilung und Bestimmung von Bleispuren in Produkten der Erdoelverarbeitung). Text in German. Chem. Tech. (Berlin), 23(9):544-549, Sept. 1971. 24 refs.

Decomposition with bromium and the subsequent extraction with diluted nitric acid proved to be a suitable method for the determination of the lead content of alkyl lead compounds in the ppb and ppm range. The analysis of lead in olefin-rich hydrocarbons is much more difficult. Mineralization and extraction with hydrochloric acid is recommended if the majority of the organic products can be removed by chloroform extraction. Knowledge of the total lead content is not always sufficient, as sometimes it is necessary to determine the volatile fractions present. Photometric methods with the aid of organic reagents only indicate the substitution products present, rather than tetraethyl or tetramethyl lead.

33255

Zuliani, G., G. Perin and G. Rausa

**DETERMINATION OF ORGANIC LEAD COMPOUNDS IN THE PRESENCE OF INORGANIC LEAD IN THE ATMOSPHERE CONTIGUOUS TO GASOLINE DISTRIBUTION PLANTS.** (Determinazione del piombo organico in presenza di piombo inorganico nell atmosfera circostante i distributori di carburante). Text in Italian. Med. Lavoro (Milan), 57(12):771-780, 1966. 36 refs.

A new method of obtaining atmospheric samples for polarographic determinations of tetraethyl and tetramethyl lead is recommended as offering high sensitivity, accuracy, reproducibility, practicality, and rapid performance. The filtering equipment consists of a triple-thickness Seitz filtering disc, 140 mm in diameter. After sampling, the filters are submitted to a stream of nitrogen and passed through two Drechsel apparatuses containing a solution of ethylene glycol in hydrochloric acid. The absorption system is in turn connected to a flow meter, a precision Brunt counter, and an electromagnetic aspirating pump. Analysis is conducted with a polarographic oscillograph with a photographic recording mechanism.

33338

Berman, Eleanor

**APPLICATIONS OF ATOMIC ABSORPTION SPECTROMETRY TO TRACE METAL ANALYSES OF TOXICOLOGICAL MATERIALS.** Progr. Chem. Toxicol., vol. 4:155-178, 1969. 44 refs.

The instruments, principles and procedures used in atomic absorption spectrometry are described. This method has become an important tool for the determination of various metals during toxicological investigations and is the routine technique for analyses of lead, cadmium, thallium, mercury, and arsenic. Atomic absorption spectrometry can be used to determine the presence of lead, mercury, copper, gold, and iron in blood, urine, and body tissue. The trace analyses of cadmium, thallium, arsenic, antimony, bismuth, cobalt, chromium, lithium, manganese, nickel, tin, and zinc are also explained.

33731

Pierce, J. O. and J. H. Meyer

**SAMPLING AND ANALYSIS CONSIDERATIONS IN EVALUATION LEVELS OF ATMOSPHERIC LEAD.** Atmos. Environ., 5(9):811-813, 1971. 5 refs.

Experiments were conducted to ascertain the accuracy and precision with which the total quantities of lead could be determined when only segments of the membrane filters used to collect the samples are employed for the analyses. A total of 160 segments from 36 filters were analyzed by the atomic absorption spectrophotometry and wet chemical (dithizone) methods. The estimated range of the quantities of lead per filter was from 274 to 4168 micrograms. Statistical analysis of the data determined that the precision was inconsistent from one filter to the next, and could lead to 95% confidence limits as narrow as 97-103% or as wide as 67-150%, depending on whether the lower or upper 95% limit of the estimated variance was applied. Where conclusions have to be drawn from a single filter or from a limited number of filters, the whole filter membrane rather than segments thereof should be analyzed. The relative accuracy of the atomic absorption method was better than that of the wet chemical method. (Author abstract modified)

34017

Hasegawa, Toshio and Akiyoshi Sugimae

**EMISSION SPECTROGRAPHIC DETERMINATION OF LEAD AND MANGANESE IN AIR BORNE PARTICULATES.** (Hakko bunsekiho ni yoru fuyu funjin-chu no namari oyobi mangan no teiryo). Text in Japanese. Bunseki Kagaku (Japan Analyst) (Tokyo), 20(11):1406-1411, Nov. 1971. 11 refs.

Lead and manganese in airborne particulates were collected on sequential filter tape once every hour and analyzed spectrographically. Preparation of the electrodes is discussed. Moving-plate studies indicated that no vaporization of lead and manganese occurred during the first 15-sec period when the background was high; then the vaporization be an and continued during the next 30 sec of arcing. Linear calibration lines were obtained over a range of 0.3-6.0 micro rams lead/cu m air and 0.06-1.20 micro rams manganese/cu m air. Variation coefficients for lead and manganese were 14.5 and 8.1, respectively. (Author abstract modified)

34106

Cate, J. L., Jr.

**DETERMINATION OF LEAD IN AIR SAMPLE FILTERS BY X-RAY FLUORESCENCE ANALYSIS.** California Univ.,

Livermore, Lawrence Radiation Lab., Atomic Energy Commission Contract W-7405-Eng-48, UCRL-51038 TID-4500, UC-4 Chemistry, 7p., April 23, 1971. 5 refs. NTIS: UCRL-51038

A silicon(lithium) detector was tested for the most efficient exciter-collimator combination for analysis of lead on filter papers and calibrated with Pb (24) standards. The maximum signal two-to-background (S2/B) ratio was achieved using an americium(241) exciter and counting only the Pb L alpha line. The minimum detectable quantity of lead for a 10-min count was 0.206 microgram/sq cm, or a total of 1.36 microgram on standard 2.9-cm-diameter filter disks. Calibration results show the sensitivity of the detector is about 160 counts/min at low Pb concentrations.

34407

Dittrich, Thomas R. and C. Richard Cothern

**ANALYSIS OF TRACE METAL PARTICULATES IN ATMOSPHERIC SAMPLES USING X-RAY FLUORESCENCE.** J. Air Pollution Control Assoc., 21(11):716-719, Nov. 1971. 25 refs.

Trace metals collected on filter paper by a high-volume air sampler were analyzed using x-ray fluorescence. A bremsstrahlung exciting source, used to produce the x-rays, was more efficient than the gamma ray exciting source. Metals detected in the samples included titanium, iron, copper, zinc, lead, cadmium, and tin. Elements in the periodic table between titanium and cesium had a sensitivity limit of 0.5 micrograms/cu m of air. Experimental and operational procedures of x-ray fluorescence are reviewed. (Author abstract modified)

35396

Chow, Tsaihwa J.

**ISOTOPE ANALYSIS OF SEAWATER BY MASS SPECTROMETRY.** J. Water Pollution Control Federation, 40(3):399-411, March 1968. 67 refs. (Presented at the Water Pollution Control Federation Control Annual Conference, 40th, New York, Oct. 8-13, 1967.)

Mass spectrometric analysis of microconstituents of seawater is reviewed. Operational procedures of the spectrometer, with respect to sampling, spiking, chemical separation, isobar interferences and laboratory contamination; isotope dilution; and scope of isotope-dilution analysis are examined. Lead isotopes dispersed in the oceans were analyzed to determine lead profiles and establish the applicability of mass spectrometry.

35494

Lundgren, Dale A.

**DETERMINATION OF PARTICULATE COMPOSITON, CONCENTRATION AND SIZE DISTRIBUTION CHANGES WITH TIME.** Atmos. Environ. (London), 5(8):645-651, Aug. 1971. 2 refs. (Presented at the Symposium on Advances in Instrumentation for Air Pollution Control, Cincinnati, Ohio, May 26-28, 1969.)

A method for determining timewise fluctuations in size, concentration, and chemical composition of atmospheric particulates 0is described. The method is based on sampling, at flow rates from 0.5 cu ft/min to five cub ft/min, with a four-stage impactor. Particles are collected by inertial impaction on a rotating drum coated with a thin film material, preferably Teflon. Film deposits can be examined by techniques such as infrared absorption spectroscopy or X-Ray diffraction. Deposit density changes or composition changes can sometimes be read directly off the film, thus giving composition or concentration changes as a function of time within each of the various particle size ranges. Normally, particulate matter is removed from the film for analysis. Water is used, for example, to determine the presence of sulfates, nitrates, acid, or elements such as lead or iron. Electron microscope grids can also be attached directly to the drum for subsequent viewing, or for analysis of individual particles by electron microscope or particulate crystals by electron diffraction. Analytical results for total particulate, sulfate, nitrate, lead, and iron are given for 10 separate impactor samples. Estimates of each sample mass mean diameter and geometric standard all data are reasonably accurate.

35695

McCrone, Walter C.

**MICROSCOPY AND POLLUTION ANALYSIS.** Am. Lab., 1970:8-10, 12, July 1970.

The use of microscopy in the identification of particulate pollutants is discussed. Single particles of almost any size can be identified by the trained microscopist. The lower limit is about one picogram with the light microscope, one femtogram with the scanning electron microscope, one attogram with the transmission electron microscope, and even smaller with the ion probe. The size, shape, color, transparency, homogeneity, polarization colors, and refractive indices are used as the basis for identification. Automobile exhaust contains traces of lead identifiable as specific lead compounds in a matrix of engine-wear debris, partly burned fuel and oil, and oil additives. The microscopist can isolate these lead compounds using the microprobe to determine the anion involved and the stoichiometry. The use of microscopy in water pollution is also discussed. The microscopist is the only analyst able to analyze a general pollution sample, particle by particle, or to identify a ppb of asbestos dust or quartz in any sample. This is the background needed to solve pollution problems, since only when the pollutants can be identified and traced to their respective sources can pollution be controlled.

36588

Oikawa, Kikuo

**ANALYSES OF HEAVY METALS.** (Jukinzoku no bunseki). Text in Japanese. Tokyo, Kodansha, 1971, 186p. 40 refs.

A comprehensive study of analytical methods for heavy metals is presented primarily for the purpose of analyses of heavy metals contained in the suspended particulates. The present state of air pollution in Japan with regard to lead and cadmium concentrations in urban and industrial areas in particular, concentrations of other metals in main cities of Japan, and the influences of heavy metals on human health are discussed. Methods of sampling the air and settling particles, and measuring dusts at emission sources in the flue and stack gases are reviewed. The preparations and pretreatment for analyses and analytical methods are described in detail. The methods discussed include: the atomic absorption analysis, the emission spectroscopy analysis, the radioactive tracers method, the X-ray analysis, and the ring-oven method. The methods for sampling particles include the hi-volume sampler method, the lo-volume sampler method, the dust tube method, and the glass fiber filter method. Methods for measuring the particle size distributions in the suspended air and in the flue gas are also included.

36698

Oikawa, Kikuo

**METHODS OF ANALYSIS.** (Bunseki no hoho). Text in Japanese. In: Analyses of Heavy Metals. Tokyo, Kodansha, 1971, Chapt. IV, p. 123-186. 23 refs.

Various methods of analysis of metals are examined in detail. The methods discussed are: atomic absorption analysis, emission spectroscopy, radioactive tracers, x-ray analysis, and the ring oven method. Atomic absorption analysis is relatively simple and reliable. Care must be taken to check the stability of the holo-cathode lamp, the evenness of the jet spray, and the cleanliness of the burner. When the test material is the suspended particulates in the air, the influences of coexisting elements and ions and the high concentration acid s influences on elements such as iron, copper, manganese, and chromium must be cautioned against. Such influences may be eliminated by the precipitation method, the ion exchange resin method, and the solvent extraction method. The standard analytical methods for cadmium in the air designated by the Ministry of Health and Welfare, and the United States NASN method are described. In the emission spectroscopy analysis, the reliability of the quantitative analysis depends on the material and shape of the supplementary and opposite electrodes, the matrix effect, the buffer and the carrier, the internal standard, the preparations of the standard solution and the test solution, and the preparations and operation of the test electrodes. The radioactive trace method is fast, free of influences from the formation of elements or the types of compounds, highly sensitive, and an analysis is possible without decomposition. On the other hand, beryllium, bismuth, cadmium, lead, molybdenum, tin, and titanium are hard to analyze by this method; the precision accuracy is relatively low and the error rate is about 10%; sympathetic reactions often occur; and the compound formation changes during the irradiation.

36703

Oikawa, Kikuo

**PREPARATIONS AND PRE-TREATMENT FOR ANALYSES.** (Bunseki no junbi to zenshori). Text in Japanese. In: Analyses of Heavy Metals. Tokyo, Kodansha, 1971, Chapt. III, p. 84-122. 2 refs.

For accurate analyses of metal concentration in the air samplings, cautious and thorough preparations are highly important. Pure reagents must be prepared. Sulfuric acid and perchloric acid often used are frequently found to contain metal impurities. Hydrochloric acid and acetic acid are relatively easy to distill, and quartz glass distillation apparatus after a thorough cleansing must be used. The use of pure water, completely uncontaminated vessels and instruments, and a dust free room is most important. When the metal solution is concentrated before analyses in a draft, the air in the draft must be absolutely clean. The outdoor air is filtered through a net, and 70% of particles larger than 0.1 micron are collected by an electrostatic precipitator. The air is then passed through another net filter. and is sent to the upper portion of the draft, where it goes through a glass asbestos filter. An electric furnace is used for burning organic material in the test material at 500-700 C. However, this method destroyed more than 50% of lead, cadmium, zinc, and antimony in the test material. The low temperature burning using oxygen and high frequency retains close to 100% of these metals.

36840

Honma, K., K. Oikawa, K. Himi, T. Muramatsu, T. Tanaka, and R. Ogawa

**THE CHARACTERISTICS OF THIMBLE-FILTER FOR MEASURING METAL CONTENT IN STACK GAS NO.2 COLLECTION EFFICIENCY OF THIMBLE FILTER.** (Endo haigasu-chu kinzoku seibun bunsekiyo ento roshi no tokusei, dainiho, kakushu ento roshi no ryudobetsu roka tokusei ni tsuite). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 6(1):79, 1971. (Presented at the National Council Meeting of Air Pollution Studies, 12th, Nagoya, Japan, Oct. 27-29, 1971.)

Filtering characteristics of thimble filters for determining cadmium and lead in flue gas provided in JISK0097 were examined. Using the suction velocity for a sampling nozzle, 7.5 to 20 l/min, corresponding to 5 to 20 m/sec, flow velocity of the flue gas, the initial pressure drop and filtering collection efficiency by fineness for lead fume with a particle diameter range from 0.07 to 0.25 micron were measured. As a rule, thimble filters made of quartz glass fiber are recommended since they show lowest pressure drop and good collection efficiency. The one made of cellulose is not recommended.

36841

Oikawa, K., K. Himi, T. Muramatsu, T. Tanaka, K. Honma, and R. Ogawa

**THE CHARACTERISTICS OF THIMBLE-FILTER FOR MEASURING METAL CONTENT IN STACK GAS. NO. 1 STUDY ON THE IMPURITY METAL IN THIMBLE FILTER.** (Endo haigasu chu kinzoku seibun bunsekiyo ento roshi no tokusei, daiippo, kakushu ento roshi no kinzoku seibun ni tsuite). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 6(1):78, 1971. (Presented at the National Council Meeting of Air Pollution Studies, 12th, Nagoya, Japan, Oct. 27-29, 1971.)

Thimble filters of three different materials (which are presented in JISK0097 for the analysis of cadmium and lead in flue gas) were examined in order to meet the requirement that they should include the least possible metals as impurities). Cellulose fiber, available for chemical analysis, borosilicate glass fiber and silica glass fiber were examined. The second and last ones are made after treating both glass fibers with dilute hydrochloric acid for one full day. Metal ingredients in these filters were analyzed by means of atomic absorption spectroscopy after low temperature ashing and heated extraction by hydrochloric acid and oxygenated water of the filters. Physical properties, such as weight, thickness, air penetration rate, tensile strength, and yield stress were examined.

37175

Sciaraffa, P. L. and C. A. Ziegler

**AUTOMOBILE EXHAUST ANALYSIS FOR LEAD USING A NUCLEAR TECHNIQUE.** Isotop. Radiat. Technol., 8(2):163-164, Winter 1971.

An x-ray fluorescence analyzer for determining airborne lead concentrations is decribed. The instrument consists of an electric console and a probe containing a radioactive source that emits radiation only in the direction of the sample, i.e., particles collected on a Millipore filter. The characteristic X-rays emitted in turn by the sample pass through the window of an X-ray detector that resolves X-ray energies and produces voltage pulses. The pulses are sorted and counted by the electronic console, and the number of pulses is displayed digitally on the console. This number is then used in conjunction with a calibration chart to obtain the amount of lead in the sample. Typically, air-sampling times of 6-12 hr in urban areas provide enough lead sample for measurement. Without filters for canceling out background radiation, the minimum quantity of lead detectable with the instrument is 5 micrograms. With filters, the amount is 15-20 micrograms.

37514

Oka, K. and T. Fujii

**ON THE CONTENTS OF ATMOSPHERIC ORGANIC LEAD IN URAN AREA.** (Taikichu no yukien no sokutei). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution),

6(1):97, 1971. 1 ref. (Presented at the National Council Meeting of Air Pollution Studies, 12th, Nagoya, Japan, Oct. 27-29, 1971.)

A method to determine atmospheric organic lead, such as tetraethyl lead used as an anti knock agent was examined. Samples were collected at 10 l/min for 5 to 7 days to suck approximately 100 cu m, of the air into activated carbon of 30 to 60 mesh in a scrubber. Inorganic lead particles were eliminated by glass fiber and membrane filters with a pore size of 0.45 micron. After wet oxidation extraction, lead was determined by the dithizone-benzene method. When lead fume, which is released by heating metal lead, was applied to this sampler, glass fiber and membrane filters collected 100% of particulate lead. The collection of organic lead by these two filters was negligible when the air involving organic lead, which is made from lead added to gasoline, was tested. An example of the measurements in Tokyo is given.

37608

Okubo, Y., K. Oikawa, and J. Kimura

**ANALYSIS OF INORGANIC PARTICULATE MATTER NO. 3. MEASUREMENT OF ATMOSPHERIC PARTICULATE MATTER AND ITS METAL CONTENTS.** (Taikichu muki seibun ni kansuru kenkyu. Daisanpo. Fiyu funjin sokuteiho betsukinzoku seibun nodo ni tsuite). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 6(1):93, 1971. (Presented at the National Council Meeting of Air Pollution Studies, 12th, Nagoya, Japan, Oct. 27-29, 1971.)

A short time collection method by a high volume air sampler was compared with a long term collection method by low volume sampler in order to find a better method to determine metal content in air- borne dust and to establish pollution patterns in an area. Samples were collected for 30 days; 24 hour collection by low volume sampler and 10 day collection by high volume sampler were performed. Filter papers on which samples were taken, were ashed in low temperature and underwent several acid treatments to produce sample solution, which were analyzed by means of atomic absorption spectrophotometry for cadmium, lead, manganese, and copper. Using the average values of 10 days for samples obtained by the high volume samplers, the amount of dust collected was higher in the samples by the high volume sampler. However, the concentration percentage of metals to the amount of dust was higher with the low volume sampler.

37689

Taguchi Keisuke and Nobuko Akashi

**SIZE DISTRIBUTION OF ATMOSPHERIC PARTICLES BY ANDERSEN AIR SAMPLER.** (Andasen sanpura ni yoru taikichu fuyu funjin no syudo bunpu). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 6(1):83, 1971. 2 refs. (Presented at the National Council Meeting of Air Pollution Studies, 12th, Nagoya, Japan, Oct. 27-29, 1971.)

Size distribution of dust and heavy metals in the air was determined by means of an Andersen sampler. The sample was collected at a velocity of 1 cfm for 3 to 7 days from March to July, 1971, into separators with 8 steps. Size distribution of dust was determined by weighing. Metals, expecially lead, cadmium, and copper were determined by atomic absorption spectroscopy after treating the sample with acid. Size distribution of both dust and heavy metals showed a logarithmic normal distribution. Respirable dust (less than 3.3 micron) ranged from 50 to 70%, and the heavy metals occupied approximately 70 to 80% of the respirable dust.

37693

Yamashita, Eiji and Shunsaku Jikihara

**RESEARCH ON MEASUREMENT OF THE PARTICULATES, REPORT II.** (Taikichu fuyu funjin sokutei ni kansuru kenkyu II). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 6(1):89, 1971. (Presented at the National Council Meeting of Air Pollution Studies, 12th, Nagoya, Japan, Oct. 27-29, 1971.)

The FKS type low-volume air sampler as a collection device for air-borne particulates was examined. The amount collected by this sampler was compared with that collected by a filter-holder type-C to find a relationship between them. When several of these samplers were used at the same time, variation in the total air flow rate was 1.7 to 2.6% and measured value of dust varied from 2.6 to 5.4%. Using this sampler, total dust and metals, such as iron, copper, manganese, and lead in the dust were determined at several points in Amagasaki-city.

37971

Kastien, Heinz

**THE CHROMATOGRAPHIC DETERMINATION OF LEAD IN AIR DUSTS.** (Die chromatographische Bestimmung von Blei in Luftstaeuben). Text in German. Helv. Chim. Acta, 53(264):2231-2233, Dec. 1970. 2 refs.

A thin-layer chromatographic method for the determination of lead in air dust samples, is described. The chromatograms were prepared on foils with silica gel and cellulose powder. After drying on air, the first chromatogram was besprinkled with a 0.2% aqueous solution of potassium rhodizonate; the appearance of blue spots indicated the presence of lead. The other chromatogram was sprayed with a 1%-solution of sodium sulfide. A calibration curve was plotted from four strips of lead acetate solutions containing 0.1; 0.05; 0.033 and 0.25% of Pb. Four peaks were obtained. The lead content in a dust sample separated from air by means of electrostatic filter was determined by dissolving 10 g of dust in concentrated hydrochloric acid of 50 ml. The result obtained was 0.435%. The error was 5 mg/100 ml of Pb-containing solution, and the deviation for two determinations of the same unknown Pb-solution was found to be + or - 1.15%.

38165

McNesby, J. R., R. Byerly, Jr., Charles M. Hunt, and Barry C. Cadoff

**INDOOR AIR POLLUTION.** Natl. Bur. Std. (U. S.) Tech. Note, no. 711:24-25, 73, Jan. 1972. 12 refs. GPO: C 13.46:711

A simple model of an air-conditioned building with forced air ventilation was developed for computation of the steady-state ratio of indoor to outdoor pollutants and the rate at which steady state is approached. The model also provides a basis for analyzing the effects of changing parameters, such as the relative amounts of recirculated and fresh air or the efficiency of an air-cleaning system, on indoor/outdoor pollutant relationships. A tracer technique using sulfur hexafluoride and an electron capture detector is being evaluated as a tool for measuring flow rates in buildings and elsewhere. Preliminary indoor-pollution measurements indicated the constant presence of lead as a trace element in indoor dust, the presence of ammonium sulfate, and the differences in the infrared spectra of indoor and outdoor dust.

38670

Kanagawa Prefecture, Yokohama (Japan), Public Nuisance Prevention Center

**ANALYSIS METHODS APPLIED TO POLLUTANTS.** (Kogai kankei no bunsekiho to kaisetsu). Text in Japanese. 122p., Feb. 1972.

Various methods of analyzing heavy metals in the air, stack gases, water, and soil are reviewed. With regard to stack gas tests, atomic absorption spectrophotometry is explained for measuring cadmium, lead, and chromium. For measuring chlorine, the use of orthotolidine as a reagent is discussed. For analyses of fluorine, hydrogen fluoride, and other fluorides, lanthanum-alizarin complex ion method is discussed. For analyses of hydrogen and other cyanides, the pyridine-pyrazolone method and iron electrode method are discussed. The rosaniline test is explained for measuring sulfur dioxide and for detecting sulfur oxides in general the neutralization method, arsenazo III method, and chloranil acid barium test are discussed. The naphthylethylenediamine method is explained for the analyses of nitrogen oxides and nitrogen dioxide. For hydrogen sulfide, the methylene blue method, and for ammonia, the indophenol method and Nestler method are discussed. Gas chromatography is used for analysis of benzenes, toluenes, xylenes, trichloroethylene, phenols, mercaptans, monosulfides, disulfides, and aliphatic acid amines. For measuring formaldehydes, the chromotrope acid method and acetylacetone method are used. The tetra-aminoantipyrine method is also used for phenol measurement, and the p-aminodimethylanilyn method is used for mercaptans. For measuring aliphatic amines, picric acid may also be used.

38682

Imai, Sakingo and Kiyoshi Ito

**EMISSION SPECTROPHOTOMETRIC DETERMINATION OF TRACE ELEMENTS IN AIR POLLUTANTS.** (Hakko bunko bunseki-ho ni yoru taikichu biryo genso no teiryo). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 6(3):322-328, Dec. 1971. 11 refs.

Emission spectrophotometry was used for the analysis of tin, vanadium, titanium, molybdenum, copper, manganese, lead, zinc, and iron in air pollutants. The trace elements were leached out twice with 50 ml 6 M hot hydrochloric acid from the glass fiber filter on which the particulates were collected. The sample solution was then filtered and diluted to approximately a 150-ml volume with twice-distilled water. A 10-milligram quantity of indium as carrier and 10 micrograms of palladium as internal standard were then added, along with 10 ml of 10% oxine-acetic acid solution, 4 ml of 1% thionalide-gracial acetic acid solution, and 4 ml of 10% tannic acid aqueous solution. The pH of the resulting solution was adjusted to 5.2 with ammonium hydroxide or acetic acid, and the solution was allowed to stand overnight to ensure complete precipitation. The precipitate was then filtered, ashed at 450 C for about 10 hr, added to a high purity graphite powder of half-fold versus ashweight, and mixed. The mixture was loaded into a carbon electrode and arced for 2 min.

38755

Malin, H. M.

**PROJECT THRESHOLD: TESTING THE TESTS.** Environ. Sci. Technol., 6(1):23-24, Jan. 1972.

Project Threshold was launched early in 1971 by the American Society for Testing Materials to look at some 35 different methods for measuring various atmospheric pollutants, in order to test their accuracy and precision. Phase I is designed to evaluate seven test methods for measuring sulfur dioxide, nitrogen dioxide, lead, sulfation rate, and dust fall. These include the Griess-Saltzman reaction, the lead peroxide candle, the West-Gaeke method, and the optical density of the filtered deposit. Phases II and III will focus on methods for some hydrocarbons, nitric oxide, hydrogen sulfide, mercaptans, and certain particulate matter. After the project committee has decided on the best procedure for a given test, several cooperating independent laboratories will make separate analyses of a split sample, following the committee s written procedure letter by letter. By comparing results among laboratories, ASTM can determine statistically valid accuracy and precision parameters which give some frame of reference for subsequent test results. The sampling sites for Phase I are indicated, as well as the experimental procedures.

38778

Frigieri, Paolo, Renato Trucco, Renato Anzani, and Eraldo Caretta

**SPECTROSCOPIC ANALYSIS OF ELEMENTS PRESENT IN AIRBORNE MATERIALS.** (Analisi spettroscopica di elementi presenti nel pulviscolo atmosferico). Text in Italian. Chem. Ind. (Milan), 54(1):12-17, Jan. 1972. 8 refs. (Presented at the Seminar on Spectrochemistry, 16th, Sirmione, June 9-12, 1971.)

X-ray fluorescence spectrometry was applied to develop a procedure for the direct quantitative analysis of airborne dusts. Dust samples were collected by volume measuring aspirators on millipore filters. Qualitative analysis revealed the presence of vanadium, chromium, lead, manganese, aluminum, iron, titanium, nickel, zinc, silicon, sulfur, sodium, calcium, bromine, potassium, chlorine, and copper in the above samples. Calibration curves for quantitative X-ray fluorescence spectrometry were developed using external standards and taking into account the variation of spectral response with the dust layer thickness (for same amount of analyzed element). Related background corrections (blank) were made. Standard samples for quantitative emission spectrography were prepared mixing spectroscopically pure oxides of the related elements with Ringsdorff graphite and gallium oxide as an internal standard. Analytical samples were prepared by dissolving the millipore filter, carrying the dust sample, in acetone. An aliquot of the centrifuged particulate matter phase was then treated with graphite and Ga2O3. A graphite rod was used as an opposite electrode. Comparison of the two analytical methods indicated X-ray fluorescence spectrometry to be a valid technique to be applied for the direct analysis of air pollution.

38914

Pierce, J. O. and J. H. Meyer

**SAMPLING AND ANALYSIS CONSIDERATIONS IN EVALUATING LEVELS OF ATMOSPHERIC LEAD.** Atmos. Environ., 5(9):811-813, Sept. 1971. 5 refs.

An investigation was undertaken to ascertain the accuracy and precision of estimating the total quantity of lead on membrane filters by analyzing only a segment of each filter and mathematically calculating the total amount. Relative accuracies of the atomic absorption spectrophotometry and the wet chemical (dithizone) method in analyzing for concentrations of lead in the presence of other contaminants from the urban environment were determined. Experiments were conducted with samples of filters obtained from sampling stations in rural and urban areas. The estimated range of the quantities of lead per filter was from 274-4168 micrograms. Statistical analysis of the data led to the conclusion that the precision with which the quantity of lead on a filter may be estimated from the analysis

of one segment is inconsistent from one filter to the next. From the evidence at hand it could not be concluded that the estimate based on one 50% segment is more precise or more accurate than that based on one 10% segment from a filter. The average relative response of the method of atomic absorption compared with the wet chemical method varied between 0.92 and 0.98, and the observed precision of the method of atomic absorption was better than that of the wet chemical method. Where conclusions have to be drawn from a single filter or from a limited number of filters, the whole filter membrane should be analyzed rather than segments of it. When comparison of the performance of different analytical laboratories is the purpose, separate sections from a single filter paper should not be used to compare analytical accuracies. (Author summary modified)

38973

Kneip, T. J., R. S. Ajemian, J. R. Carlberg, J. Driscoll, H. Freiser, L. Kornreich, K. Kumler, and R. J. Thompson

**TENTATIVE METHOD OF ANALYSIS FOR INORGANIC LEAD CONTENT OF THE ATMOSPHERE.** Health Lab. Sci., 9(1):79-83, Jan. 1972. 8 refs.

Lead ion reacts quantitatively with diphenylthiocarbazone (dithizone) in the absence of chelating agents in the 8.5-11.5 pH range to form red lead dithizonate which is extractable with organic solvents, e.g., chloroform. The red color, which is proportional to the amount of lead present, can be measured spectrophotometrically at 510 nm. Range and sensitivity, interferences, precision and accuracy, apparatus, reagents, procedure, standards and calibrations, calculations, and the effects of storage are given.

39069

Hayakawa, Kiyoko

**MICRODETERMINATION AND DYNAMIC ASPECTS OF IN VIVO ALKYL LEAD COMPOUND. PART 1. ANALYTICAL METHODS.** Nippon Eiseigaku Zasshi (Japan. J. Hyg.), 26(4):377-385, Oct. 1971. 14 refs.

A method for the microdetermination of alkyl lead compounds especially for biological samples was studied using a simple process of direct gas chromatography. A glass column and an electron capture detector (ECD) were used. Analytical conditions of gas chromatography such as temperature, length of column, flow rate of the carrier gas, and column packing material were investigated as the basis of retention time, separating state, peak shape (sharpness of response peak), and peak height (sensitivity). As for the analysis of biological samples, a method for removing admixtures from the samples was studied before extraction to avoid the confusion of peaks similar to those of alkyl lead compounds. Extractions were done with reference to the Bolanoswska Method. As a result, 7% Apiezol-L for tetramethyl lead (4EL), 1.5% SE-30 for tetraethyl lead (4EL), and 1.4-BDS for trimethyl and triethyl lead chloride (3ML and 3EL) were applicable for column packing. The flow rate of nitrogen as a carrier gas was 35 ml/min for 4ML and 4EL and 110 ml/min for 3ML and 3EL. Detection limits were 1 times 10 to the minus 9th power g for 4ML and 1 times 10 to the minus 11th power g for 4EL, 3ML, and 3EL, respectively. Extraction from biological samples were made using organic solvents after the sample had been acidified using hydrochloric acid. Tetraalkyl lead was extracted three times by benzene and trialkyl lead was extracted three times using ethyl acetate. In the case of 3ML and 3EL which contained various substances, extraction by 1% nitric acid was applied, trialkyl lead was transferred into the water and then re-extraction was made. It was possible to purify the samples by this method.

39136

Kanagawa Prefectural Government (Japan), Dept. of Pollution Countermeasures

**ANALYTICAL METHOD RELATED TO ENVIRONMENTAL HAZARD.** (Kogai kankei no bunsekiho to kaisetsu). Text in Japanese. 122p., Feb. 1972.

Analytical methods which were adopted by the Center of Public Nuisance in Kanagawa Prefecture were explained. The analysis of soil, biological samples, exhaust gases, and metallic components in air were discussed. Items for analysis differed more or less by samples. In drainage, soil, and biological samples, the analysis of lead, cadmium, mercury, copper, zinc, iron, manganese, nickel, fluoride, chromium, arsenic, cyanide, and phenol and measurements of BOD, COD, and pH were discussed. In exhaust gases, the analysis of Cd, Pb, Cr, F, chlorine, CN(-), sulfur dioxide, total sulfur, hydrogen chloride, nitrogen oxides, ammonia, hydrogen sulfide, benzene, toluene, xylene, trichloro-ethylene, phenol, mercaptans, organic sulfides, and amines were discussed. The analysis of metalic components such as Cd, Cu, Pb, Mn, Ni, and Fe in air samples by the atomic absorption method was explained. It was emphasized that the above mentioned methods were adopted based on the experiments. Basic theories of simple methods of analysis were explained for beginners at the end of the report.

39168

Lorenz, G.

**DETERMINATION OF AEROSOLS BY MEANS OF SCINTILLATOR SPECTRAL ANALYSIS.** (Aerosolbestimmung nach dem Verfahren der Szintillations-Spektalanalyse). Text in German. Dechema Monograph., 67(1222-1263):255-264, 1971.

The Sartorius scintillation spectrum particle counter for quantitative and, under certain conditions, qualitative aerosol analysis is examined. The aerosol particles are heated to excitation temperature in a special chamber; they then emit a flash of light, the intensity and spectral composition of which are characteristic of the diameter and chemical composition of the particle. The theoretical basis and experimental confirmation of the instrument are discussed. Calibration curves for sodium, lithuim, calcium, strontium, lead, and uranium particles are determined. The measurement results obtained with the counter include a digital readout of mass concentration in mg/cu m and particle concentration in particles/cu cm; and the number of particles as cumulative frequency values in ten different size intervals. 0

39516

**NOTIFICATION NO. 984. MEASUREMENT METHODS TO BE DETERMINED BY THE GOVERNOR AS SPECIFIED.... (Kokuji). Kanagawa-Ken Koho (Off. Gaz. Kanagawa Prefec.), no. 81:1-12, Nov. 10, 1971. Translated from Japanese. 57p.**

Measurement methods for use under the Enforcement Regulations of the Kanagawa Prefecture Environmental Pollution Prevention Ordinance are presented. Atomic absorption photometry is described for the measurement of cadmium and lead compounds. The pyridine- pyrazolene method is described for measurement of cyanogen, as well as an ion-electrode method. A diphenylcarbazide method is outlined for the determination of chromium, and a silver diethyldithiocarbamate method is indicated for arsenic. A reduction vaporization method of atomic absorption photometry is cited for total mercury, and gas chromatography with an electron capture-type detector can be used for measuring mercury alkyl contents. Phenol contents can be determined by a 4-aminoantipyrine method; copper, zinc, iron, and manganese by atomic absorption photometry; and chromium by the diphenylcarbazide

method. Nickel can be determined by atomic absorption photometry, and a lanthanum-alizarin method can be used to measure fluorine content.

39762

Haut, Hans van

**DETECTION OF SOME AIR POLLUTANTS BY MEANS OF KALE (BRASSICA OLERACEA ACEPHALA) AS INDICATOR PLANT.** (Nachweis mehrerer Luftverunreinigungskomponenten mit Hilfe von Blaetterkohl (Brassica oleracea acephala) als Indikatorpflanze). Text in German. Staub, Reinhaltung Luft, 32(3):109-111, March 1972. 18 refs.

Air pollutants such as fluorine, chloride, sulfur, and lead were determined by means of the kale (Brassica oleracea acephala) used as plant indicator in nine localities in the Ruhr area. The plants, exposed over a succession of years in the periods from early August until mid-November, showed no visible symptoms of damage. Leaf tissue samples were analyzed for all pollutants. The leaf fluorine content, determined by an electrometric method, was slightly to considerably elevated with 12-10 mg/100 g of dry substance, compared with a natural content of 3 mg/100 g. Chloride content, determined by the potentiometric titration method, was up to four times higher than normal. The sulfur determination, carried out according to Stratmann s microanalytic method, revealed a maximum of 1.83% of S, compared with the normal value of 0.97-1.33%. This may be the result of persistent, fairly low sulfur dioxide concentrations. The lead concentrations, determined by an inverse-polarographic method, were highly elevated in all but two cases. A value of 116 ppm in a plant near a highway was measured. Besides the above pollutants, many aromatic hydrocarbons such as benzo(a)pyrene can be identified by means of kale.

40407

Mizuno, Kouichi and Hajime Shiio

**X-RAY FLUORESCENT ANALYSIS OF ALKYL LEAD IN AIR WITH ACTIVE CARBON.** (Kasseitan ni yoru kukichu no arukiru namari no keiko ekusu sen bunseki). Text in Japanese. Bunseki Kagaku (Japan Analyst) (Tokyo), 21(2):271-273, Feb. 1972. 2 refs.

Gasoline vapor containing alkyl lead can be absorbed on active carbon and the amount of lead content quantitatively analyzed by an X-ray fluorescent method. For briqueting carbon powder, stealic acid was a suitable binder, and the employed mixing ratio of carbon and binder was 3:2. The results were quite consistent with the calibration curve which was obtained by an impregnation method of a lead standard solution over the range from 0.1 mg to 0.5 mg Pb/3 g carbon.

40631

Stever, H. Guyford

**NATIONAL SCIENCE FOUNDATION. CERTAIN MATERIALS RELATING TO INSTRUMENTATION FOR ENVIRONMENTAL MONITORING. NOTICE OF AVAILABILITY.** Federal Register, 37(88):9181, May 5, 1971.

The National Science Foundation has engaged the Environmental Instrumentation Group of the Lawrence Berkeley Laboratory to conduct a survey of instrumentation for environmental monitoring. Instruments being investigated are those useful for measurements of air, water, radiation, and biomedicine related to environmental research and monitoring. Consideration is given to instruments and techniques presently in use and to those developed for other purposes with possible applications to this work. The results of the survey include descriptions of the physical and operating characteristics of available instruments, critical comparisons among instrumentation method, and recommendations for the development of new instruments and of promising methodology. The survey material is compiled in four looseleaf volumes which will be periodically updated. Volume one, which will be available in April 1972, covers sulfur dioxide monitoring; additional sections on nitrogen oxides, photochemical oxidants, mercury, lead, beryllium, and asbestos will be issued during the year. Volume two will be available in late 1972. Volume three, which will be available in April 1972, covers ionizing radiation, including: accelerators, calibration methods, gamma radiation, X-rays, and neutrons. Microwaves, lasers, and ultraviolet radiation are also included. Additional sections on reactors, dosimeters, radionuclides, and infrared will be issued during the year. Volume four is expected to be available in late 1972.

40724

Bowman, Harry R., John G. Conway, and Frank Asaro

**ATMOSPHERIC LEAD AND BROMINE CONCENTRATION IN BERKELEY, CALIF. (1963-70).** Environ. Sci. Technol., 6(6):558-560, June 1972. 8 refs.

Lead and bromine aerosols collected in downtown Berkeley, California, for 1-week periods over the past 8 years, were analyzed using nondispersive x-ray fluorescence analysis. Typical analyses times were 2 min. The technique is nondestructive so that the filter papers can be reanaalyzed if needed or saved for future reference. With an increase of less than an order of magnitude in the airflow and the excitation source and no folding of the filter paper, results comparable to those reported here would be obtained with 2-hour collections and 24-hour counts. A system of continuous air monitoring could be installed in which data from many remote locations could be fed to a single central computer. As the equipment is easily made portable, temporary stations could also be established. Seasonal lead variations similar to those found in the San Diego area were observed and appear to be correlated to data for wind and wind direction. The ratio of bromine-to-lead collected on filters appears to be higher in Berkeley than in six other cities previously reported. (Author abstract modified)

41016

Rolla, A.

**X-RAY FLUORESCENCE USED IN THE DETERMINATION OF PARTICLE COMPONENTS COLLECTED ON SAMPLING FILTERS FROM THE MILAN CITY AIR. COMMUNICATION I - DETERMINATION OF LEAD, IRON, AND VANADIUM.** (Determinazione mediante fluorescenza dei raggi X di elementi nelle particelle raccolte su filtri dall atmosfera della citta di Milano. Nota I - Determinazione di piombo, ferro e vanadio). Text in Italian. Riv. Combust. (Milan), 26(4):156-163, April 1962. 10 refs.

The Stazione sperimentale per i Combustibili (Fuel Research Station is engaged in a systematic survey of air pollution in the city of Milan, with a view to assessing sulfur dioxide and particles contributed by winter heating systems. In order to gain a better insight into the source of pollution and to correlate pollution levels to the specific emitters, the most significant elements have been determined in dust collected in filters. Various methods of analysis are available, and the choice in this case fell on X-ray fluorescence. A general discussion of the problems attending analysis is presented. The procedure followed in determining lead, iron and vanadium is described.

41138

Woodriff, Ray and Jerome F. Lech

**DETERMINATION OF TRACE LEAD IN THE ATMOSPHERE BY FURNACE ATOMIC ABSORPTION.** Anal. Chem., 44(7):1323-1325, June 1972. 9 refs.

The determination of trace lead in the atmosphere can be accomplished by furnace atomic absorption. A graphite crucible is placed in a Teflon adapter and 100-500 cc of air are drawn through it using a plastic disposable syringe attached to the side arm with a piece of surgical tubing. If one is in the field, the graphite crucible can be stored in a titanium holder in a desiccator until one is able to perform the determinations. The amount of lead in the crucible is then determined by inserting it into a graphite tube furnace with an internal temperature of 1800 C and recording the absorbance. Field tests are described, which indicate that the levels of lead are consistent with observed traffic flows. The extreme sensitivity of the method of analysis combined with the sampling technique should make it valuable for spot checks as well as for determining the background levels in places where the concentrations would not be expected to be very high.

41490

Parry, Edward P. and Don H. Hern

**PULSE STRIPPING ANALYSIS: A TECHNIQUE FOR DETERMINATION OF SOME METALS IN AEROSOLS AND OTHER LIMITED SIZE SAMPLES.** Preprint, American Chemical Society, Washington, D. C.; American Inst. of Aeronautics and Astronautics, New York; Environmental Protection Agency, Washington, D. C.; Inst. of Electrical and Electronics Engineers, New York; Instrument Society of America, New York, N. Y.; National Aeronautics and Space Administration; and National Oceanic and Atmospheric Administration, 6p., 1971. 13 refs. (Presented at the Joint Conference on Sensing of Environmental Pollutants, Palo Alto, Calif., Nov. 8-10, 1971, Paper AIAA 71- 1119.) Pulse polarography is an electrochemical technique for the determination of lead concentration down to a nanogram. The metal species is preconcentrated in a mercury drop. Many metal ion species, reducible to metal at an electrode, are equally determinable. The sensitivity of pulse polarography is almost two orders of magnitude greater than ordinary polarography. Resolution and interference characteristics are improved. Pulse polarography shows that the ignition process commonly used in metals determination can result in 20 to 40% loss in lead. (Author abstract modified)

41612

Araktingi, Y. E., N. S. Bhacca, W. G. Proctor, and j. W. Robinson

**ANALYSIS OF AIRBORNE PARTICULATES BY ELECTRON SPECTROSCOPY FOR CHEMICAL ANALYSIS (ESCA).** Spectrosc. Lett., 4(10/11): 365-376, Oct.-Nov. 1971. 9 refs.

Particulate pollutants present in the atmosphere can be identified in their different chemical forms by the use of ESC without prior treatment of the air sample. By using the ESC method, oxygen, aluminum, iron, silicon, sulfur, lead, chlorine, carbon, calcium, and nitrogen were identified. Virtually no sulfur dioxide was detected. The nitrogen 1s signal appeared to be composed of peaks generated by at least two chemical forms of nitrogen; however, it was not possible to identify the exact nature of the nitrogen compounds involved. Similarly, broad doublet s appearing at 139 and 144 eV suggested that the signals were caused by more than one lead compound. The compounds were identified as lead halide and lead oxide, but no accurate quantitative analysis of their ratio was possible.

41719

Tsuda, Satoru and Akira Yokohata

**ANALYSES OF POLLUTANTS AND PROBLEMS.** (Osen busshitsu no bunseki to sono mondaiten). Text in Japanese. Bunseki Kiki (Analysis Instr.) 10(5):371-327, May 1972. 7 refs.

Analytical methods for the determination of sulfur oxides, carbon monoxide, chlorine, hydrogen chloride, fluoride, nitrogen oxides, cadmium, and lead are reviewed. Flame photometric detectors for sulfur dioxide analysis were studied. The sample was mixed with oxygen, and then burned with hydrogen flame, and the intensity of the absorbed light of wavelength at 394 millimicron was measured. By this method, the SO2 can be determined as low as the ppb levels. Flame ionization detection for CO and carbon dioxide determination as methane is also considered. The limits for chlorine discharge, hydrogen chloride, and fluoride emissions are set at 30, 80, and 1-20 mg/cu m, respectively; methods for determinations of these pollutants at or below these levels are included. Although no regulations are established for odorous compounds, the list will include ammonia, methyl mercaptan, ethyl mercaptan, dimethyl sulfite, diethyl sulfite, hydrogen sulfite, methyl amine, ethylamine, trimethylamine, butylene, butyric acid, acetone, and acrolein.

41763

Tsuchihira, Kazuyoshi

**MEASUREMENT METHODS IN PUBLIC NUISANCE--ESPECIALLY ON MEASUREMENT METHODS PROVIDED BY THE REGULATIONS FOR PUBLIC NUISANCE.** (Kogai sokuteiho--Kogaiho kankeihoreichu no kensaho o chushin ni site) Text in Japanese. Nippon Eiseikensa Gishikai Zasshi (Jap. J. Med. Technol.), 21(5):524-532, May, 1972.

Measurement methods are divided into two types. One for measuring environmental factors and the other for examining man s health. Pollutants are classified into dust, soot, suspended particulate matter, dust fall, sulfur oxides in smoke, sulfur oxides in air, harmful substances such as cadmium and its compounds, bases, hydrogen chloride, fluorine, hydrogen fluoride, silicon fluoride, lead and its compounds, nitrogen oxides, carbon monoxide, lead compounds, nitrogen oxides contained in automobile exhaust gases, oxidants, and 28 special deleterious substances including ammonia, hydrogen sulfide. Measurement methods for each pollutant are discussed based on the Air Pollution Control Law. As for dust fall and special deleterious substances, measurement methods have not been settled. Measurement methods of noise level based on the Noise Regulation Law are stated.

41825

Cogbill, Everett C. and Marcus E. Hobbs

**TRANSFER OF METALLIC CONSTITUENTS OF CIGARETTES TO THE MAIN-STREAM SMOKE.** Tobacco, vol. 144:24-29, 1957. 15 refs.

Using conditions approximating human smoking, about 150 micrograms of metallic constituents/cigarette were found in the main-stream smoke of five representative brands of cigarettes on the domestic market. Of this quantity, approximately 90% was potassium and 5% sodium. The remaining metallic constituents, at least twelve in number, include traces of aluminum, arsenic, calcium, chromium, copper, iron, lead, magnesium, manganese, strontium, titanium and zinc. Vaporization of the more volatile metal compounds, or of the

volatile reduced metal itself, appear to be the essential mechanisms of transfer from the cigarette to the smoke. Mechanical transfer by erosive or related processes probably accounts for less than one per cent of the transferred materials. The influence of these findings for other smoke components is discussed. (Author summary

41908

Lander, D. W., R. L. Steiner, D. H. Anderson, and R. L. Dehm

**SPECTROGRAPHIC DETERMINATION OF ELEMENTS IN AIRBORNE DIRT.** Appl. Spectry., 25(2):270-275, 1971. 2 refs.

An emission spectrographic method is described to determine the concentrations of aluminum, cadmium, calcium, chromium, copper, iron, lead, magnesium, nickel, silicon, tin, and zinc in airborne dirt. A measured volume of air is drawn through a 1-inch filter paper. The filter is analyzed by a direct reading emission spectrograph using a push-up technique to introduce the sample into the analytical gap. Calculations and report writing are performed by a computer. Computer programs aid the data interpretation by annotating the results and by the preparation of summaries and graphs. The precision is approximately plus or minus 25% of the amount present at the 3-microgram level. Analysis time is about 5 min/sample. (Author abstract)

41968

Grajpel, Andrzej

**SPECTROGRAPHIC ANALYSIS OF BLAST FURNACE DUSTS.** (Analiza spectrograficzna pylow z piecow martenowskich). Text in Polish. Chem. Anal. (Warsaw), 16(6):1225-1231, 1971. 11 refs.

Blast furnace dusts were spectrographically analyzed to determine contents of iron, zinc, silicon, aluminum, calcium, magnesium, lead, copper, manganese, and chromium. Analysis curves were based on a set of synthetic standards. Both the samples and the standards were fused with potassium pyrosulfate and diluted with graphite powder. Palladium was used as an internal standard. The relative standard deviation of the determinations varied from 0.044% for lead oxide to 0.106% for copper oxide.

42020

Ishii, Takeshi

**POLAROGRAPHIC ANALYSIS OF AIR POLLUTANTS - (1) ANALYSIS OF INORGANIC MATERIALS.** (Porarogurafu ho o mochiiru taiki osen bunseki - Sono 1) Muki seibun no bunseki). Text in Japanese. Kogai to Taisaku (J. Pollution Control), 8(6):565-572, June 1972. 61 refs.

A general discussion on the analyses of inorganic substances in air by polarography is presented. The characteristic of the polarogram of sulfur was that it showed easily detectable reduction curves which had rapid declination at right sight of its two unsymmetrical waves. The AC polarogram and oscillo polarogram of lead and copper in exhaust gas at four engine conditions of idling, acceleration, constant speed, and deacceleration are given. Organic manganese compound was decomposed by a bromine-carbon tetrachloride solution, and the basic solution for AC polarography was prepared by using triethanolamine and potassium hydroxide. The polarographic determination of copper, lead, cadmium, iron, and zinc content in air could also be performed simultaneously. The quantitative determinations of Cu, Pb, and Cd were carried out at 0.20, -0.47, -0.65 V versus Hg-pool respectively. Cobalt of 0.08% concentration could be detected with 3% accuracy. Detections of ions such as nitrate, sulfite, iodate, and bromate were also briefly described.

42043

Oka, Kenji

**DETERMINATION OF ORGANIC LEAD VAPOUR IN AIR.** (Taiki-chu no yukien no sokutei). Text in Japanese. Osaka-fu Kogai Kanshi Senta Chosa-Shitsu Kenkyu Hokoku (Proc. Res. Sect. Osaka Environ. Pollution Control Center), no. 2:5-7, Dec. 1971. 7 refs.

Air samples were collected by a glass fiber filter, membrane filter, and activated carbon. They were sampled 10 l/min and collected about 100 cu/m through one week. After the activated carbon was added to perchloric acid and nitric acid, and heated, filtered, concentrated, the amount was measured by colorimetry by the dithizone benzene method. In activated carbon, 1.6 micron/g lead was found. The lead was added to the activated carbon in the same method and the efficiency of collection was measured. It was about 90.1% (standard error 4%). The collection efficiencies of activated carbon scrubbers were studied. The efficiencies of first scrubbers were 50-60%. The collection efficiencies of one scrubber and two series scrubber were compared.

42084

Cohen, E.

**DETERMINATION OF TRACES OF HEAVY METALS IN AIR BY POLAROGRAPHY AND ANODIC STRIPPING.** (Determination de microquantites de metaux lourds dans l air par polarographie par redissolution anodique). Text in French. Bull. Soc. Chim. France, no. 1:416-419, Jan. 1972. 11 refs.

Instrumentation and techniques were developed for voltametric simultaneous analyses of toxic metals in air, including lead, cadmium, copper, and zinc. The evaporated nitric acid extract of the aerosol sampling filter is dissolved in hydrochloric acid and subjected to preelectrolysis, during which the metals form amalgams at the mercury drop. A linear potential sweep then yields individual peaks which result from the oxidation of each amalgamated metal and whose heights are proportional to the original metal concentration. In the 0.5 to 10 microgram/cu m range, the method is accurate to within 5 to 15%.

42137

Kerin, Zarka, Danimir Kerin, and Dusan Djuric

**LEAD CONTAMINATION OF ENVIRONMENT IN MEZA VALLEY. LEAD CONTENT OF THE SOIL.** Int. Arch. Arbeitsmed., 29(2):129-138, June 1972. 7 refs.

Since 1896 the lead smelting plant in Meza valley, Slovenia, Yugoslavia, has contaminated the environment with lead aerosols. Since 1968 a broad ecological and epidemiological study on environmental contamination and human exposure has been conducted. Determinations of lead in the soil represent a major part of these investigations. On 33 sampling spots along the valley the soil and plant samples were taken every year in July and October. The results of the total lead content of the soil for 1968 and 1969 are presented, together with data about quantitative distribution in the valley. However, investigations on adsorption coefficient (soil: plant) revealed that the total lead content does not represent a reliable parameter for such calculations. Therefore, determinations of lead in the acetate: lactate extract of the soil were made. This parameter is showing, in some cases, a better correlation between lead in soil and underground parts of plants. It seems that determination of AL-soluble lead from the soil represents

a step forward in the determination of the absorbable part of the lead. (Author abstract modified)

42139

Kometani, Thomas Y., John L. Bove, Benjamin Nathanson, Stanley Siebenberg, and Martha Magyar

**DRY ASHING OF AIRBORNE PARTICULATE MATTER ON PAPER AND GLASS FIBER FILTERS FOR TRACE METAL ANALYSIS BY ATOMIC ABSORPTION SPECTROMETRY.** Environ. Sci. Technol., 6(7):617-620, July 1972. refs.

Particulate air pollutants collected on paper filters can be dry ashed at 500 C without serious loss of trace metals by volatilization. Conversion of metal salts to sulfates by the addition of sulfuric acid prior to dry ashing ensures virtually complete recovery of the metals tested. Losses reported during dry ashing of particulate matter collected on glass fiber filters are not necessarily ascribable to volatilization as has commonly been supposed. Metals such as lead, zinc, copper, and cadmium react to varying extents with glass at high temperatures to form insoluble metal silicates. Comparative studies of particulate matter collected on paper filters in New York City indicate that the results obtained by dry ashing compare favorably with those of accepted methods such as wet ashing and low-temperature ashing. Good recoveries of Pb, Cu, Zn, and Cd from New York City samples were obtained by dry ashing at 500 C for one hour, even without the prior use of H2SO4.

42160

Chow, Tsaihwa J. and John L. Earl

**LEAD ISOTOPES IN NORTH AMERICAN COALS.** Science, 176(4034):510-511, May 1972. 7 refs.

The lead contents of 143 coal samples, which contain an average of 11 ppm of lead, were determined. Some 21 samples were selected analyzed for their lead isotopic composition. The isotope ratios show that coal leads are equally or much more radiogenic than the average lead in the continental crust. By comparing the isotopic composition of the lead in North American coals with that of the lead in gasoline additives, it is found that, except for coal 101 and the Houston gasoline, there is a distinct difference between these two sources of lead pollutants. The Houston gasoline contains some anomalous J-type lead, which is characteristic of the Mississippi Valley lead ore, and coal 101 is from a Montana coal mine that is not a major producer. Therefore, it is practicable to distinguish between gasoline and coal leads by examining their isotopic composition.

42312

Reusmann, G. and J. Westphalen

**AN APPARATUS FOR AUTOMATIC ANALYSIS BY STRIPPING VOLTAMMETRY.** (Anordnung zur automatischen Ausfuehrung von inverspolarographischen Bestimmungen). Text in German. Fresenius Z. Anal. Chem., 259(2):127-128, 1972. 1 ref.

An apparatus for automatic analysis by stripping voltammetry, including a flow cell, plastic capillary, and a pump with a throughput of about 1 ml/min is described. The sample to be analyzed is sent, together with nitrogen, through a thermostatically controlled, water-cooled glass coil where the bulk of the oxygen is removed, and a preset solution temperature is reached. After the nitrogen is separated, the solution is sent into a flow cell containing a capillary, from which one drop of mercury is transferred into an automatically controlled displacement burette. Timing adjustment and automatic range selection are provided. The above apparatus with process control has been successfully applied to routine determinations of lead, cadmium, and zinc in plant materials.

42360

Tani, Manabu

**DETERMINATION OF METALS IN ATMOSPHERIC ENVIRONMENT AND THE PRACTICE OF METHODS.** (Kankyo taikichu no jukinzoku no sokuteiho to sono shuho no jisasai). Text in Japanese. Kogai to Taisaku (J. Pollution Control), 8(6):551-556. June 1972. 15 refs.

Phosphorescence spectrophotometry and atomic absorption spectrophotometry were used for the analyses of trace metal content in air. A high volume sampler equipped with a glass fiber filter was used for sampling air at a suction rate of 1.4 cu m/min for 24 hr. Due to the complicacy of the spectra of metal content in air, a phosphorescence spectrophotometer of high dispersibility was required. A 110 V DC arc source was used, and the exposure time was 30 sec. This method was applied for the analyses of cobalt, copper, iron, manganese, nickel, tin, and vanadium. Atomic absorption spectrophotometry showed higher sensitivity on metal analysis, and it was applied to the analyses of cadmium, lead and zinc. The detection wavelength was 2288 A for Cd, 2833 A for Pb, and 2138 A for Zn. The metal concentrations in air of 11 cities in Japan measured by these two methods are listed. The limits of detection of the two methods on 13 metals are compared.

42437

Cate, J. L., Jr.

**DETERMINATION OF LEAD, ARSENIC, CADMIUM, MERCURY, AND SELENIUM IN AIR SAMPLE FILTERS BY X-RAY FLUORESCENCE ANALYSIS.** California Univ., Livermore, Lawrence Radiation Lab. Contract Atomic Energy Commission W-7405-Eng-48, 13p., Nov. 15, 1971. 5 refs. NTIS: UCRL-51038 Rev. 1

X-ray fluorescence offers a quick, accurate, sensitive, and nondestructive means of assaying the lead burden of air-sample filter papers. A radioisotope source of low energy photons (or other ionizing radiation) is used to ionize the constituent atoms of the sample. These atoms then emit characteristic (fluorescent) x-rays. These x-rays are detected by an energy-sensitive detector; their energy is unique for each element, and their intensity is related to the concentration of each species in the sample. Since the air-sample filters used in a local sampling program were of constant size (6.6 sq cm.), severe collimation to define the irradiated area was not needed. Consequently, the original collimator assembly was redesigned to improve system sensitivity. Three sets of test specimens were prepared; each set included a filter containing 0, 1/2, 1, 2, 5, 10, 50, and 100 micrograms lead/sq cm. Each of the 24 standards was counted at least 15 times for a period sufficient to accumulate at least 1000 (and generally greater than 3000) total counts. The calibration results from these lead standards are presented in both tabular and graphical form. The data represent an artificial situation: a filter containing lead without any of the other materials normally present in an air sample. These other materials may affect the measurement by altering the scattered radiation or by direct interference. By judicious selection of techniques, most interferences can be circumvented, although perhaps with some loss of sensitivity. New data for the determination of arsenic, cadmium, mercury, and selenium are given in the appendix.

42775

Pursall, B. R. and C. D. Swann

**AIR POLLUTION IN VEHICULAR ROAD TUNNELS.** Tunnels Tunnelling, 4(4): 340-345, July 1972. 23 refs.

Air pollution caused by the combustion products from the exhausts of gasoline and diesel driven vehicles can be serious in a long road tunnel if the ventilation system is not designed to reduce the concentrations of the various gases and compounds to acceptable levels. The toxic effects of carbon monoxide, nitrogen oxides, lead compounds, sulfur oxides, and organic compounds, are summarized. The applicability of various methods of gas analysis to tunnel measurements is examined. Carbon monoxide detectors include infra-red analysers, catalytic analysers, and polarographic cells. A chemical-colorimetric detector was deemed less useful than an electrochemical analyser for detection of nitrogen oxides. Measurements of CO and nitrogen oxides were made in two tunnels. Typical emissions rates for diesel and gasoline vehicles are discussed.

42928

**CHEMICAL PROCEDURES.** In: Air Pollution Manual. Part I. Evaluation. Detroit, American Industrial Hygiene Assoc., 1960, Chapt. 10, p. 111-131. 234 refs.

The analysis of particulate matter collected from the atmosphere involves consideration of aspects other than chemical content; for instance, one of the most important indices followed in air pollution assessment is the atmospheric loading/unit of surface area and/unit of volume. The introduction of new techniques, such as electron microscopy, has made it possible to carry out more searching assessment of the morphology and other physical properties of particulates. Aluminum and aluminum oxide may be determined spectrographically and colorimetrically, while procedures based on the formation of molybdenum blue or reactions with silver diethyldithiocarbamate in pyridine can be used to determine arsenic. Spectrographic, fluorometric, and colorimetric procedures can be used to identify beryllium, while a spectrographic and an electrochromatographic technique are available for boron determinations. Analytical methods are also indicated for the determination of calcium, cadmium, carbon monoxide, chlorine, chromium, fluorine, iron, lead, magnesium, manganese, nickel, the nitrogen oxides, ozone, peroxides, and other oxidants, silicon dioxide and silicates, sulfur dioxide, sulfur trioxide, sulfuric acid, hydrogen sulfide, and zinc. The identification and quantitative determination of organic substances is discussed, with particular reference made to organic acids, aldehydes, amines, hydrocarbons, ketones, phenols, proteins, quinones, and sulfur compounds.

43448

Mitsugi, Hidekatsu, Nobuhiro Takata, Muneyuki Motoyama, Makoto Akamatsu, and Genzo Hashizume

**DETERMINATION OF ZINC AND LEAD IN SUSPENDED PARTICULATES BY FLUORESCENT X-RAY SPECTROMETRY.** (Keiko X sen ni yoru fuyujinai chu no aen oyobi en no bunseki). Text in Japanese. Bunseki Kagaku (Japan Analyst) (Tokyo), 19(10):1383-1388, Oct. 1970. 18 refs.

Nondestructive determination of zinc and lead in suspended particulates was investigated by using the filter paper method and the briquet method The samples collected on the filter paper by using a high-volume air sampler were determined nondestructively and rapidly by the filter paper method. The samples collected by an electric precipitator were diluted with boric acid and then determined by the briquet method. To prepare the standard samples, zinc oxide, lead dioxide, or lead nitrate were diluted to a given concentration with kaolin which was regarded as a typical constituent of suspended particulates. Ferric oxide and calcium sulfate were added to the standard samples to check the matrix effect. The quantitative ranges were above 1 microgram for Pb by the filter paper method and above 0.5 microgram/g for Zn and 5 microgram/g for Pb by the briquet method, respectively. Analytical results of Zn and Pb in suspended particulates by this procedure agreed with those by the atomic absorption method.

43587

Duke, Charles R. and Boong Y. Cho

**DEVELOPMENT OF A NUCLEONIC PARTICULATE EMISSION GAUGE. (FINAL REPORT).** Industrial Nucleonics Corp., Columbus, Ohio, Federal Systems Div., Environmental Protection Agency Contract 68-02-0210, APTD-1150, 62p., Feb. 25, 1972. NTIS: PB 209954

The principles of operation, design criteria, filter selection, and field test data for a beta gauge and filter sampler for the measurement of particulate emissions from automobile exhaust are examined. The system has a minimum sensitivity of 125 micrograms/cu m with no specified upper limit; is capable of operation in either a manual or automatic mode; and has a filter collection system with an efficiency of at least 99.9% using a dioctyl phthalate aerosol. Carbon-14 was selected as the optimum isotope, and a filter cassette was used to collect the particles. The effect of moisture absorption by various types of filter media was investigated. The system was tested on automobiles using leaded, low-lead, and non-leaded fuels. Results from the leaded and low-lead fuel tests were in good agreement with gravimetric measurements; less desirable results were obtained with the no-lead fuels. Complete operating procedures and variables and test results are included.

43720

Renshaw, G. D., C. A. Pounds, and E. F. Pearson

**VARIATION IN LEAD CONCENTRATION ALONG SINGLE HAIRS AS MEASURED BY NON-FLAME ATOMIC ABSORPTION SPECTROPHOTOMETRY.** Nature, 238(5360) 162-163, July 21, 1972. 4 refs.

Hair grows at a rate of approximately 1 cm/mon, accumulates lead, and thus forms a permanent record of lead content in the body which may be used to estimate the time and length of lead exposure. Trace elements in hair may also indicate the environmental level of other elements which could be hazardous to health, including arsenic, cadmium, copper, and zinc. It is possible to obtain a detailed record of lead exposure from analysis by non-flame atomic absorption spectrophotometry on sections of a single hair. Analyses were performed on a Perkin-Elmer 303 atomic absorption spectrophotometer equipped with an HGA-70 furnace atomizer. The absolute detection limit for lead with this system is 5 times 10 to the minus 11th g. The lead concentration in hair increases significantly from the root to the tip of the hair, suggesting that lead has entered the hair by deposition on its surface, followed by diffusion into the hair structure. By analysing several sections of single hairs from the same head at regular time intervals, sudden exposures to lead should be readily detected, especially if a proximal section of the hair shows a sharp increase in lead concentration over its neighboring section. Other metals, such as thallium, zinc, cadmium, copper, and iron, may also be monitored in a similar manner.

43737

Perry, R., J. R. Majer, and M. J. Reade

**THE ESTIMATION OF PICOGRAM QUANTITIES OF METAL COMPOUNDS PRESENT IN THE ATMOSPHERE.** International Union of Air Pollution Prevention Associations, Proc. Int. Clean Air Congr., 2nd, Washington, D. C., 1970, p. 357-359. 12 refs. (Dec. 6-11, Paper CP 2D.)

Use of mass spectrometric technique in the estimation of tetraethyl lead is described, and methods are indicated by which other trace metals can be similarly determined following conversion to volatile complexes. The mass spectrum of the metal alkyl or chelate is first recorded by evaporating microgram quantities of the pure material directly into the ion source of the mass spectrometer. With materials of high volatility, it is advantageous to freeze the probe by dipping it into liquid air, before introducing the sample into the mass spectrometer. An ion characteristic of the metal is chosen from the mass spectrum for use in the quantitative analysis. Calibration graphs in the weight range required are prepared by making up standard solutions of tetraethyl lead or the appropriate metal chelate. A measured volume is then introduced in the same probe containing the chromatographic material. This after freezing is transferred to the vacuum system of the mass spectrometer where the solvent is evaporated prior to pushing the probe down into the heated source. Here the calibration facilities of the instrument are used to follow the rise and fall of the ion current during the evaporation process. The area under this curve is characteristic of the metal compound and is a quantitative measure of the amount introduced into the probe.

43763

Tominaga, Hiroshi

**RADIOISOTOPE INSTRUMENTS IN ENVIRONMENTAL POLLUTION CONTROL.** (Kogai to RI riyo kiki). Text in Japanese. Genshiryoku Kogyo, 17(8):32-36,53, Aug. 1971. 29 refs.

The applications of x-rays and gamma-rays to the concentration analysis of element in a certain sample are described. A sulfur meter is used for the determination of sulfur in heavy oil by measuring the transmission ability of x-rays emitted from T/Ti. This is an accurate and time-saving method. Other sources of x-rays are also used. Sources such as cadmium-109 (22.2 KeV x-ray), and Americum-241 are used for a turbidimeter. High energy gamma-rays such as cesium-137 and cobalt-60 are practical for use in a mud densitometer. Analyses of cadmium, iron, copper, lead, and bromium content in air by fluorescence x-rays using polonium-238 as a source on three air samples confirm the effectiveness of the method. The limits of detection of the above metals are 0.036, 0.071, 0.036, 0.035, and 0.026 micrograms/sq cm at a counting time of 600 seconds. Californium-252 has been applied to quantitative analysis of sulfur in coal and oil.

44129

Kashiki, M., Seigo Yamazoe, and Shozo Oshima

**QUANTITATIVE ANALYSIS OF LEAD IN GASOLINE BY UNIFIED STANDARD ATOMIC ABSORPTION ANALYSIS.** (Toitsu hyojun genshi kyuko bunsekih ni yoru gasorin chu no teiryo bunseki). Text in Japanese. Japan Petroleum Inst., Tokyo, Proc. Symp. Japan Petroleum Inst., 15th, 1972, p. 9-12. 5 refs. (July 10-11.)

When atomic absorption analysis was first applied to the quantitative determination of lead in gasoline, isooctane was used as the solvent and tetraethyl lead as the standard lead. Subsequent investigators have varied the analytical procedure by using tetramethyl lead and mixed lead alkyls in addition to TEL, or by using methyl ethyl ketone as the solvent and lead nitrate or 8-hydroxyquinolinate as the standard lead. Since the absorbance differs with the type of lead used, these methods yield different values. Another problem involving the methods is the tailing phenomenon. A new method has been designed to solve all these problems and give satisfactory results. In this method, the sample gasoline (TEL, TML, or MLA s) is dissolved in methyl isobutyl ketone (MIBK), to which a specific amount of iodine is added, and then led to the flame. The operating conditions for lead determination were: wavelength (nm), 283.3; lamp current (mA), 8; air flow (l/min), 23.8; acetylene flow (l/min, 3.3; burner height (mm), 8.0 (0 division); response time (sec), 1; noise suppression, 1; scale expansion, 1; slit width (mm), 1. Various alkyl lead compounds had an identical absorbance when about 3 mg of iodine/50 ml of MIBK was added to the sample. The addition of iodine also solved the tailing phenomena problem, as did the addition of bromine or other halogenated compounds. The halogen effect remained the same even when other types of solvent were used. The calibration curve prepared (when iodine was added) showed a sufficiently linear relation between absorbance and concentration. This method can be applied to trace analysis of up to 0.0005 g Pb/l.

44165

Innes, William B.

**CONTINUOUS ANALYSIS OF REACTIVE ORGANICS BY SELECTIVE COMBUSTION.** Environ. Sci. Technol., 6(8):710-715, Aug. 1972. 23 refs.

The selective combustion method for analysis of hydrocarbons, involving thermocatalytic oxidation effects in a vanadia-alumina catalyst bed, can be used for rapid continuous analysis of a wide range of organics providing the ratio of catalyst volume to flow rate is low, and proper steps are taken to prevent condensation and sorption effects in the inlet system. Under such conditions, response increases and selectivity decreases with temperatures up to 400 C on a variety of organics. Response passes through a maximum with flow rate, the flow rate maximum decreasing with the ease of oxidation. Reversible deactivation from aromatics can be neglected above 350 C, but is significant at lower temperatures. Idle exhaust derived from leaded fuels does not deactivate the catalyst over prolonged periods under 400 C. Liquids containing organics including exhaust condensate can be analyzed after evaporation in dry air. A substantial fraction of the total response to vehicle exhaust is associated with the condensible fraction. Responses at optimum conditions on gasoline vehicle sources would be expected to be essentially additive, linear, and give good correspondence with photochemical reactivity. Actual comparisons of smog effects vs. instrument responses are needed to prove the correspondence. (Author abstract modified)

44210

Guinn, Vincent P.

**ACTIVATION ANALYSIS IN ENVIRONMENTAL POLLUTION STUDIES (INCLUDING HG, PB, AND PESTICIDES).** (Kankyo osen (Hg, Pb oyobi sacchuzai o fukumu) no kenkyu no tame no hoshaka bunseki). Text in Japanese. Radioisotop. (Tokyo), 20(11):612-619, Nov. 1971. 24 refs.

A general discussion on the studies of harmful particulates in air and harmful metals and pesticides in waste water and food by neutron activation analysis is given. Vanadium pentoxides from power plants are collected and detected by irradiation

with a hot neutron stream of 2.5 times 10 to the 12th power n/sq cm/sec for one minute, cooled for one minute, and measured with a gamma-ray spectrometer for one minute. The induced gamma-ray is mainly from V(52). The vanadium content in heavy oil ranges from 0.1 ppm to 1000 ppm, depending on the sources. Determinations of many other metals, including zinc, magnesium, aluminum, chromium, cobalt, nickel, and mercury in air by neutron activation analysis have been successfully conducted. The analysis of lead by this method is somewhat difficult due to the extremely short half-life of the induced radiation.

44479

Wesolowski, J. J., W. John, and R. Kaifer

**LEAD SOURCE IDENTIFICATION OF MULTI-ELEMENT ANALYSIS OF DIURNAL SAMPLES OF AMBIENT AIR.** Preprint, California Univ., Livermore, Lawrence Radiation Lab., 32p., Dec. 21, 1971. 9 refs.

A method was developed for determining the existence and nature of non-automotive lead sources in a given area from ambient air particulate samples. The method consists of first measuring the diurnal variations of the bromine/lead ratio using x-ray fluorescence to determine those days on which the non automotive lead source is operating. For the episodal days, the diurnal concentration patterns of about 20 metals are measured using neutron activation analysis. The correlation of these patterns with the lead pattern characterizes the source. The method was tested near San Francisco California, and successfully established the existence of a nonautomotive lead source in that area and characterized the source as a smelter. (Author abstract modified)

44995

Zhigalovskaya, T. N., R. I. Pervunina, V. V. Yegorov, E. P. Makhonko, and A. I. Shilina

**PROCEDURE FOR DETERMINING THE CONTENT OF TRACE ELEMENTS IN PRECIPITATED WATER.** In: American Institute of Crop Ecology Survey of USSR Air Pollution Literature. Technical Papers from the Leningrad International Symposium on the Meteorological Aspects of Atmospheric Pollution. Part III. M. Y. Nuttonson (ed.), Vol. 14, Silver Spring, Md., American Institute of Crop Ecology, 1972, p. 59-68. 11 refs. Translated from Russian. (Also: Meteorologisheskie Aspekty Zagryazneniya Atmosfery, Glavnoe Upravlenie Gidrometeorologicheskoy Sluzhby Pri Sovete Ministrov SSSR, p. 310-319, 1971.) NTIS: PB-209945 A sensitive spectral method for the simultaneous content determination of some important microelements, such as lead, chromium, vanadium, manganese, cadmium, nickel, cobalt, molybdenum, copper, zinc, bismuth, aluminum, and titanium, in samples of precipitation and cloud water is described. Since the content of microelements in atmospheric water is usually too low to be evaluated in a direct way, possible means of sample enrichment are discussed in detail and their use evaluated. To concentrate microelements in liquid samples, methods of extraction, evaporation, and ion-exchange resin are mainly used. The examination and analysis of different methods of micro-element concentration in samples of rain and cloud water showed that the concentration method must be chosen in accordance with the initial sample volume. When the value is more than one liter, it is necessary to use the ion-exchange resin method; the evaporation method is recommended when the sample volume is less than 500 ml, but more than 100 ml. For a sample volume of less than 100 ml, an elaborate method of concentrating by electrolytic precipitation is proposed, which consists of isolating the microelements from the samples on a carbon electrode serving as a cathode. The extraction method is inconvenient for atmospheric water analysis. In the spectral analysis method proposed, atmospheric water samples are analyzed spectrally without their conversion into dry residue by three standard methods. As an excitation source, the alternating- current generator is used. The spectra of determined elements excited in the alternating-current arc are obtained with the help of a quartz spectrograph and are registered on high-sensitive aerofilm. Analytical curves of determined element content are evaluated on a microphotometer. The means of putting the sample on the electrode and introducing it into the charge are described and the applicability of simultaneous definition of spectral microelements contained in the samples evaluated. The proposed method of chemico-spectral determination of microelement concentration allows analysis in a concentration range from 1 to 100 micrograms/l, with the mean relative error not more than 20%. The mutual effect of the elements is practically absent. (Author abstract modified)

45235

Rabinowitz, Michael B. and George W. Wetherill

**IDENTIFYING SOURCES OF LEAD CONTAMINATION BY STABLE ISOTOPE TECHNIQUE.** Environ. Sci. Technol., 6(8):705-709, Aug. 1972. 11 refs.

Investigations were undertaken to use naturally occurring variations in stable lead isotope abundances to determine the sources of lead in specific environments. In southeastern Missouri, measurements of lead in gasolines, topsoils near a freeway, and air in urban traffic showed similar compositions; while lead ores, refined metal, and topsoils and dust near smelters displayed another distinctive set of values. The separation between these groups was about three times the variability within each group and about 12 times the experimental error. Also, near Benicia, Calif., the sources are isotopically distinguishable, as seen in roadside soil, air, and grasses on the one hand, and refined lead and grass near the smelter on the other. Smelter lead was traced to nearby pasture grass and in aerosols and dust some 20 mi downwind from the smelter. Horses which died of lead poisoning contained approximately equal parts of smelter and gasoline lead. The sampling procedure and experimental technique are described. Lead concentrations were measured by atomic absorption flame photometry of the acid solutions, except in air samples in which isotope dilution with a calibrated lead-208 solution was used. Then aliquots were extracted with dithizone to yield purified lead for mass spectrometry. (Author abstract modified)

# D. AIR QUALITY MEASUREMENTS

00005

S. Hochheiser, S. W. Horstman, and G. M. Tate, Jr.

**A PILOT STUDY OF AIR POLLUTION IN BIRMINGHAM, ALABAMA (WIDE-ANGLE VIEW OF BIRMINGHAM FROM VULCANS STATUE).** Public Health Service, Cincinnati, Ohio, Div. of Air Pollution. May 1962, 68p.

Air samples were collected for measurement of dustfall, suspended particulates, smoke shade, sulfur dioxide, nitrogen oxides, total oxidants, carbon monoxide and hydrogen sulfide. Air pollution data obtained during the summer phase of the study can be considered as representative. Mean values of gaseous pollutants were: SO2, 0.01 ppm; nitrogen oxides, 0.04 ppm; oxidants, 0.03 ppm; CO, 1.8 ppm. Maximum levels measured were: SO2, 0.18 ppm; nitrogen oxides, 0.14 ppm, oxidants, 0.14 ppm; CO, 12.5 ppm. Mean values for particulate pollutants, measured during the fall study, were: dustfall, 76 tons/sq.mi./mo.; smoke concentration, 1.5 cohs/1000 linear ft.; suspended particulates, 113 micrograms/cu.m. Maximum levels were: dustfall, 121 tons/sq.mi./mo.; smoke concentration, 6.2 cohs/1000 linear ft.; suspended particulates, 279 micrograms/cu.m. Mean values measured during the summer study were: dustfall, 49.3; smoke concentration, 0.6; suspended particulates 106. Maximum levels were: dustfall 95.6; smoke concentration, 3.0; suspended particulates, 206. Substantially higher levels of particulate and gaseous pollutants were recorded in the fall, indicating that emissions resulting from the combustion of fuels for industrial, commercial and domestic space heating contribute significantly to over-all air pollution during the heating season.

00017

**AIR QUALITY DATA. (ANNUAL REPORT FOR 1962) (NATIONAL AIR SAMPLING NETWORK).** Public Health Service, Cincinnati, Ohio Div. of Air Pollution, 52p.

This report contains summaries of air quality data for particulate and gaseous pollutants obtained from samples collected by stations of the National Air Sampling Network during 1962. Included also are data obtained by the analysis of selected particulate samples collected during the period 1958-1961. For the first time data from State Air Sampling Network report. This is a logical step, as procedures are standard and data are comparable. The following state networks provided data for inclusion in this 1962 report: Maryland, Massachusetts, Montana, Texas, and Washington. (Author)

00261

V. I. Baranov and V. D. Vilenskii

***PB-210 IN THE ATMOSPHERE AND IN FALLOUT.*** Soviet J. At. Energy (English Translation), 18(5):645-648, May 1965.

Data are given for the intensity of Pb-210 fallout in the Moscow area during 1961-1963. The intensity of Pb-210 fallout ordinarily increases with increasing amounts of precipitation. The average Pb-210 concentration in fallout is not related to the amount of precipitation, and rises sharply only in dry periods. The intensity of Pb-210 fallout is practically constant in the spring, summer, and fall, and decreases in the winter only by a factor of 2-2.5. The average concentration of Pb-210 in fallout is practically independent of season. The mean annual intensity of Pb-210 fallout in the Moscow area is about 2.8 nCi/sq m. The Pb-210 concentration in the surface layer of the atmosphere above the Pacific and Indian Oceans varies within wide limits (0.0001 - 0.00160 nCi/cu m), and, apparently is chiefly determined by meteorological factors. The Pb-210 content in the troposphere above the oceans is probably only slightly less than the content in the troposphere above dry land. The variations in Pb-210 concentration in the surface layer of the atmosphere above land and ocean can evidently be used for studying the meteorological factors responsible for the transport of radioactive isotopes within the troposphere and for their deposition on the surface of the earth. (Author)

00697

L. DuBois, T. Teichman, J. M. Airth, and J. L. Monkman

**THE METAL CONTENT OF URBAN AIR.** J. Air Pollution Control Assoc. Vol. 16(2):77-78, Feb. 1966. (Presented at the 58th Annual Meeting, Air Pollution Control Association, Toronto, Canada, June 20-24, 1965.)

Polarographic measurements were made of the lead concentrations in eight (8) cities in Ontario, Canada. Approximately 3000 samples were analyzed and Toronto was found to have the highest concentration of lead. Future studies will be undertaken with nickel and zinc.

00969

P. A. Leighton

**MAN AND AIR IN CALIFORNIA.** Preprint. (Presented at the Statewide Conference on Man in California, 1980's, Sacramento, Calif., Jan. 27, 1964.)

Author discusses polluted air in respect to automobile emissions and projects the concentrations that can be expected by 1980. Presented are charts and tables which easily delineate the salient points of the article.

00974

**AIR POLLUTION MEASUREMENTS OF THE NATIONAL AIR SAMPLING NETWORK (ANALYSES OF SUSPENDED PARTICULATES 1957-1961) Public Health Service, Washington, D.C., Div. of Air Pollution. 1962. 222p.**

The objectives of the National Air Sampling Network include the determination of the extent and the nature of air pollution as well as the study of trends in the levels of various atmospheric contaminants and the investigation of relationships between air pollution and socioeconomic, geographic, topographic, -eteorological, and other factors. The data acquired are useful in planning epidemiological investigations and also provide the background against which more intensive community and statewide studies of air pollution can be conducted. This report is limited to presenting and discussing the measurements made on the suspended particulate matter for the years 1957 to 1961.

00976

F.L. Ludwig E. Robinson

**SIZE DISTRIBUTION STUDIES USING THE AEROSOL SPECTROMETER.** J. Air Pollution Control Assoc. 15, (3) 102-5, Mar. 1965.1965. (Presented at the Sixth Conference on Methods in Air Pollution Studies, California Dept. of Public Health, Berkeley, Calif., Jan. 6-7, 1964.)

The aerosol spectrometer is able to determine, apparently with reasonable accuracy, the size distribution of particles in the atmosphere. Field tests covering urban lead aerosols have shown that size distributions cna be determined for particles of a particular type even though other kinds of particles are present in vastly larger quantities. These field tests on lead aerosols have also indicated that the sensitivity threshold required of the analytical methods is about 10% of the cubic-meter concentration, if a sampling period of about four to ten hours is used. This concentration was generally exceeded for lead in urban areas.

00985

R.E. Waller, B.T. Commins, P.J. Lawther

**AIR POLLUTION IN A CITY STREET.** Brit. J. Ind. Med. (London), Vol. 22:128-138, 1965.

Measurements of the concentrations of smoke, lead, and five polycyclic hydrocarbons in the air have been made in the City of London in the middle of a busy street and at two control sites. Samples were taken only throughout the daytime hours on weekdays to enable us to assess the maximum contribution made by traffic to the pollution in the street. The results showed that during these periods the air in the middle of the street contained three times as much smoke, four times as much lead, and 1.7 times as much 3:4-benzpyrene as were present in the general atmosphere of the City of London as estimated from samples taken at the control sites. One of these sites was chosen because it was only 150 feet from the street; analyses yielded no evidence that the traffic contributed to the pollution sampled there. Sulphur dioxide concentrations were determined in the early part of the study and the results showed that traffic appeared to add little to the background level. The concentrations of lead found were below those held to be safe by many authorities. Carbon monoxide concentrations, reported in greater detail elsewhere, sometimes reached the accepted industrial maximum allowable concentration of 100 ppm. (Author abstract)

01089

V. J. Konopinski and L. J. Schafer

**ORGANIC LEAD - CINCINNATI 1964.** Preprint. 1964.

The U.S. Public Health Service and Kettering Laboratory cooperated in making this study to obtain additional data on the concentration of alkyl lead compounds in the atmosphere by varying the sample air volumes. Two different locations in Cincinnati were used to obtain ambient air samples. Particulate lead was removed from the air by millipore filters while scrubbers filled with iodine crystals served to separate out the organic lead compounds. Analysis for organic lead was by wet-chemistry techniques. Results corroborated the findings of Cholak and associates that organic lead compounds are present in the air in very small concentrations.

01315

J.H. Ludwig, D.R. Diggs, H. E. Hesselberg, J.A. Maga

**SURVEY OF LEAD IN THE ATMOSPHERE OF THREE URBAN COMMUNITIES: A SUMMARY.** Am. Ind. Hyg. Assoc. J. Vol. 26:270-284, June 1965. (presented at the 26th Annual Meeting, American Industrial Hygiene Association, Houston, Tex., May 7, 1965.)

A joint study of the concentrations of lead in the atmospheres of three cities was conducted furing the period June 1961 through May 1962. The annual average concentrations at various locations ranged in Cincinnati from 1 to 2 microgram/cu m, in Philadelphia from 1 to 3 microgram/cu m, and in Los Angeles from 2 to 3 microgram/cu m, with overall averages respectively of 1.4, 1.6, and 2.5 microgram/cu m. In heavy traffic, concentrations averaged from 14jto 44 microgram/cu m in various locations. Blood and urine samples analyzed for lead were within the 'normal' limits, except for a few persons with occupational exposures. (Author abstract)

01355

L.B. Lockhart, Jr., R.L. Patterson, Jr., A.W. Saunders, Jr.

**THE SIZE DISTRIBUTION OF RADIOACTIVE ATMOSPHERIC AEROSOLS.** J. Geophys. Res. 70(24):6033-6041, Dec. 15, 1965.

Atmospheric air containing natural and fission product radioactivity was passed successively through a series of filters of increasing retentivity for small particles. The size distribution of the radioactive particles in the atmosphere has been deduced from the relative amounts of radioactivity collected on the various filters and a knowledge of the retention characteristics of the filters as a function of particle size. This method has demonstrated that the short-lived radon daughter products (pb214 and Bi214) are associated primarily with particles less than 0.3 micron in diameter, whereas fission products from the stratospheric source of old bomb debris on arrival at ground level are associated with particles averaging between 0.5 and 1.0 micron diameter. Large, apparently random, changes in size distribution often occur from one collection to another. Radiochemical analyses indicate little fractionation of one isotope relative to another except during late October and early November 1964, when the shorter-lived radioisotopes from the Chinese atomic test were found to be associated with the largest particles. (Author abstract)

01673

C.J. Conlee, P.A. Kenline, R.L. Cummins, V.J. Konopinski

**MOTOR VEHICLE EXHAUST STUDIES AT THREE SELECTED SITES.** Arch. Environ. Health 14, (3) 429-46, Mar. 1967.

Air quality was studied in relation to motor vehicle densities at three selected sites: the Sumner Tunnel between Boston and East Boston, Massachusetts; the International Peace Bridge across the upper Niagara River between Fort Erie, Ontario, and Buffalo, New York; and Laidlaw Avenue near the Air Pollution Research Facility in Cincinnati, Ohio. Pollutant concentrations and meteorological findings are presented for each site. Concentrations of pollutants known to be associated with auto exhaust were greater at sites of higher traffic density. A comparison or particulate pollution levels at the Sumner Tunnel operated as a one-way tube in 1963 with the tunnel carrying two-way traffic in 1961, indicates a definite decrease in pollutant levels. Other pollutants were assumed to be dispersed in air in the same way as carbon monoxide in determing the contribution by motor vehicles to ambient air for the Sumner Tunnel. Auto exhaust appears to be a prime contributor (greater than 50%) for carbon monoxide, aliphatic aldehydes, benzene-soluble particulate, and oxides of nitrogen. Lead, benzo(g,h,i)pyrene, and coronene may also be assumed to be important pollutants from auto exhaust, but they do not

meet the requirements for contribution calculations. (Author abstract)

02133

R. Baumann, E. Kadan, J. A. Schedling, and G. Wagner

**(SOME MEASUREMENTS OF THE CONCENTRATIONS OF SOLID AND GASEOUS AIR POLLUTION IN THE VIENNA AREA.) Uber einige Messungen der Konzentrationen fester und gasformiger Luftverunreinigungen im Raum von Wien. Radex Rundschau (Austria) (4) 240-57, 1966.**

Results of measurements of air pollution in the Vienna area during a two year period are reported; dust concentration was measured at one point, lead concentration was measured at various points in the city with approximately 50 random samples. Samples were also obtained at the same stations for the determination of sulfur dioxide and nitrogen oxide fumes. Dust concentration was higher during the winter months; maximum values during these periods were also much higher. Comparison with average monthly values in other European cities showed that Vienna has higher concentrations than Hamburg, Geneva and Copenhagen. The dust was analyzed chemically for its carbon and lead content, and figures compared with data from the USA. Concentration of gaseous air pollution decreased with distance from traffic lanes.

02750

V.J. Konopinski

**COMMUTER LEAD EXPOSURE.** Preprint. 1963

Atmospheric lead levels for commuter exposure in the cities of Cincinnati, Los Angeles, and San Francisco were obtained by means of a mobile sampler. The samples were taken on representative traffic arteries in each city during the morning and afternoon traffic rush and during the midday. Mean concentrations of particulate lead ranged from 9 micrograms/cu.m. to 38 micrograms/cu.m. for downtown and freeway sampling routes. Samples from rural roads ranged from 2.8 to 5.8 micrograms/cu.m. Stationary samples taken in Cincinnati and Los Angeles were similar, the mean particulate-lead concentration being about 20 micrograms/cu.m. In Los Angeles on the Hollywood and Harbor Freeways and at the 'stack' 11 out of 14 samples had concentrations greater than 40 micrograms/cu.m. The maximum value found for a single filter was 71.3 micrograms/cu.m. The concentration of organic lead in Los Angeles ranged from 0.2 to 2.7 micrograms/cu.m. The mean value of all the samples was 1.0 micrograms/cu.m. The sample volume of air was small and the organic lead obtained was close to the detectable limit of the analytical method. (Author summary)

03410

**A STUDY OF AIR POLLUTION IN MONTANA JULY 1961 - JULY 1962.** Montana State Board of Health, Helena Division of Disease Control. 1962. 110 pp.

The principal pollutants in the air were determined with the staff and analytical equipment available to the State Board of Health and some idea as to the carcinogenic potential of the materials in the air in the various cities as well as the over-all characteristics in each of the cities were determined as a baseline for future reference. Emission inventories are included.

03441

**CLEAN AIR FOR CALIFORNIA (INITIAL REPORT OF THE AIR POLLUTION STUDY PROJECT, CALIFORNIA STATE DEPT. OF PUBLIC HEALTH).** California State Dept. of Public Health, San Francisco. Mar. 1955. 60 pp.

This is an early survey report of the air pollution situation in California. The body of knowledge, available at that time, on the growing problems of polluted air is discussed and a plan for action outlined. Attention is focussed on the air pollution problem in the Los Angeles area, where eye irritation, plant damage and other harmful effects, such as discomfort, decreased visibility and nuisance occur most frequently. Recommendations to State and local Governmental authorities, to universities and other research organizations, to the industry and public are made.

03526

P. Stocks, B. T. Commins, K. V. Aubrey

**A STUDY OF POLYCYCLIC HYDROCARBONS AND TRACE ELEMENTS IN SMOKE IN MERSEYSIDE AND OTHER NORTHERN LOCALITIES.** Intern. J. Air Water Pollution 4, (3/4) 141-53, 1961.

Smoke samples collected continuously for one or more years by filter in Merseyside conurbation and elsewhere in northern England and Wales were analysed for 7 polycyclic hydrocarbons and 13 trace elements. The locations included seaside and riversie, small and large towns, a smokeless zone, the Mersey Tunnel, bus and motor car garages, an office and a steelworks. The amount of coronene in smoke varied little in town or country but the higher levels in tunnel smoke and in the motor garage were sucha s to suggest its usefulness for measurement of air pollution by motor traffic. In country places amounts of smoke and of the hydrocarbons were 2 1/2 times as great in the autumn-winter half of the year as in the spring- summer half, but in Merseyside, whilst the seasonal ratio for total smoke was similar, for the hydrocarbons it was about 5 to 1. Indoor office air was less polluted than that outside in winter, the hydrocarbons showing a seasonal ratio about 4 to 1. Trace element concentrations in air were all higher in urban than in country places but only for antimony, vanadium and molybdenum was the excess relatively greater than for total ash. Mersey tunnel air contained very much greater amounts of lead than did the entering air, and in a motor garage the air contained more lead and vanadium than the air outside. In the smokeless zone trace elements were present in smaller amount than at the town centre. In the rolling-mill shed and melting-shop of the steelworks, concentrations of all the elements, particularly of copper, were largely, increased. (Author abstract)

04646

J. W. Winchester, W. H. Zoller, R. A. Duce, and C. S. Benson

**LEAD AND HALOGENS IN POLLUTION AEROSOLS AND SNOW FROM FAIRBANKS, ALASKA.** Atmos. Environ. 1, (2) 105-19, Mar. 1967.

The composition of lead halide pollution aerosol particles was studied in the Fairbanks area during January and February, 1965. At this time of the year the sun is above the horizon for less than 4 hr and prolonged cold spells (surface air temperature below -40 deg C) are accompanied by strong (gradients of 20-30 deg C per 100m) surface inversions which severly restrict the dilution volume for air pollutants. Lead was determined by inverse polarography in aerosol particles collected on Millipore filters. Measured values ranged from 6.0 g of lead per cu m of air in center city to 0.19 outside the city. Halogens were determined by neutron activation analysis of material in the aerosols and in ground-lying snows, revealing two components: a pollution component derived from automotive ethyl fluid combustion and a low-level natural component. In the pollution aerosol component, the weight ratio chlorine/lead

averages close to the ethyl fluid value of 0.34, but bromine/lead is up to four times less than the ethyl fluid value of 0.39. Bromidechlorine of the pollution in the snows is only 15-30 per cent of the ethyl fluid value and exhibits the lower values further from center city. Thus the interpretation is supported that lead halide particles suffer loss of bromine by oxidation and volatilization. (Author abstract modified)

04938

J. M. Colucci and C. R. Begeman

**THE AUTOMOTIVE CONTRIBUTION TO AIR-BORNE POLYNUCLEAR AROMATIC HYDROCARBONS IN DETROIT.** J. Air Pollution Control Assoc. 15, (3) 113-22, Mar. 1965.

The aim was to determine the contribution by automotive vehicles to the polynuclear aromatic hydrocarbons in city air. Sampling of particulate matter at the rate of 140 cu m/min 5000 cfm) was carried out at two heavily-trafficked sites in Detroit and one suburban site in Warren, Michigan. Carbon monoxide was determined continuously, and particulate matter was analyzed for 'tar,' polynuclear aromatic hydrocarbons, lead, vanadium, and sulfates. Polynuclear aromatic hydrocarbons in automobile exhaust gas are assumed to be dispersed in air along with carbon monoxide or lead from automobiles. It is further assumed that automobiles are the sole source of carbon monoxide and lead in the atmosphere. Concentrations of carbon monoxide and lead in exhaust gas and in the air are utilized to estimate the percentage of polynuclear aromatic hydrocarbons in the air attributable to automobiles. The mean automobile contributions to benzo(a)pyrene in the air, based on lead concentrations, were 18% at a Freeway Interchange, 5% in a downtown commercial area, and 42% in suburban Warren. The average concentrations of benzo(a)pyrene at the sites were 6 micrograms/1,000 cu m, 7 micrograms/1,000 cu m and 1 microgram/1,000 cu m, respectively. Mean contributions based on carbon monoxide concentrations were approximately twice the levels based on lead concentrations. Benzo(a)pyrene and benz(a)anthracene in air were not statistically related to carbon monoxide or lead in air, but were higher in winter than in summer, probably because of the higher levels of these materials emitted in space heating combustion in winter. (Author abstract modified)

04996

M. Katz

**SOURCES OF POLLUTION.** Proc. Natl. Air Pollution Symp., 2nd, Pasadena, Calif., 1952. pp. 95-105

The wind and cloud conditions in the Detroit River area for five years are summarized. Sulfur dioxide was measured by antometers. Hydrogen sulfide, chlorine, oxides of nitrogen, and ammonia were sampled. Suspended particulates were collected. The distribution of dust fall components is tabulated. About twenty metallic elements were identified by x-ray diffraction of suspended particulates. Community health surveys covering morbidity and mortality records and accounting for ethnic and socioeconomic factors are outlined.

05167

Public Health Service, Cincinnati, Ohio, Div. of Air Pollution. 263 pp. (1958). (PHS Publication No. 637.)

**AIR POLLUTION MEASUREMENTS OF THE NATIONAL AIR SAMPLING NETWORK (ANALYSIS OF SUSPENDED PARTICULATE SAMPLES COLLECTED 1953-1957).**

This report on the first five years of operation of the U.S. Public Health Service's National Air Sampling Network has been designed to present basic data on suspended particulate matter in the air over the United States. Much of its content consists of tables which present this information. Planning is currently under way for the comprehensive analysis of these raw data with the aim of determining trends and patterns of air pollution in the United States. The various text sections reflect the second purpose of this report: to provide the technical information necessary for the establishment of similar or identical sampling stations in community, area, or State Networks throughout the United States by appropriate agencies. Another major goal is the presentation of non-technical information to assist the public- spirited citizen in the understanding of this relatively new environmental problem. The tabulations are based on data obtained from particulate samplings of urban, non-urban and suburban atmospheres. (Author introduction modified)

05260

S. Y. Shamirzayev, and D. K. Nurullayev

**POLLUTION OF THE ATMOSPHERIC AIR OF THE CITY OF TASHKENT AND WAYS FOR ITS REDUCTION .** (Aagryaznennost' Atmosfernogo Vozdukha Goroda Tashkenta i Puti Yeye Snizheniya.) Med. Zh. Uzbekistana (9), 20-5 (Sept. 1960). Usss. (Tr.) (Translated as JPRS 9863.)

The dust and gas suspension exceed the maximum permissible concentration, in various places, by 2 - 100 times. During the winter period approximately 15,000 tons of coal is consumed daily in the city and more than 80,000,000 cu m of flue gas and 600 tons of ashes are discharged into the air (the burning of 1 kg of coal liberates 5.5 cu m of flue gas at an average coal ash content of 20 percent). On the average 240 tons of oil is burned daily. There is discharged every hour 60,000 cu m of flue gas into the atmospheric air, or 1,500,000 everyday. Of the twenty samples tested for lead fumes, eight were found to have exceeded the maximum permissible limits; of the 30 samples tested for carbon monoxide, 14 exceeded the maximum permissible limits. Soot was found in 20 samples; in some of them the maximum permissible limits were exceeded four times. At other posts, carbon monoxide exceeds the maximum permissible limits 2 - 5 times (from 14 to 29 mg/cu m, at a norm of 6 mg/cu m); concentrations of lead, 12 to 13 times greater than the maximum permissible limit (at a norm of 0.0007 mg/cu m, samples were found to contain from 0.014 to 0.0096 mg/cu m). The concentration of soot exceeded the maximum permissible limits six times (content of 0.9 mg/cu m). In the area of the asphalt and bituminous plant the dust suspension in the air proved to be 52 times greater than the maximum permissible limit (26 mg/cu m was found at a permissible concentration of 0.5 mg/cu m); the suspension of sulfur dioxide was 80 times greater (40 mg/cu m instead of 0.5).

05277

B. J. Steigerwald, L. W. Weinberger, and D. A. Lynn

**AIR IONS IN URBAN ATMOSPHERE.** A.I.Ch.E. (American Inst. Chemical Engineers.) Preprint. (Presented at the Symposium on Particulates and Air Ions, 55th Annual Meeting, American Inst. of Chemical Engineers, Chicago, Ill., Dec. 2-6, 1962.)

Air ions (charged molecules, molecular aggregates, or small particles in air) are a constituent of all natural atmospheres. Many qualitative observations have been reported of differences in the atmospheric ion content of rural and urban air. The investigation reported in this paper attempted to better define the difference in air ion characteristics between urban and rural locations and to relate ion differences quantitatively to type, degree, and source of air contamination. Results in-

dicate that urban air contains high concentrations of intermediate and large ions and very low concentrations of small ions compared to rural air. The concentration of positive large ions was used to study quantitatively the relationship between air contaminants and atmospheric ions. The data were analyzed statistically by correlation and regression methods. Variations observed in temperature, humidity, and SO2 at ambient concentrations had no effect on large ions. Large-ion concentrations correlated only slightly with particulate concentration as determined by reflectance measurements but correlated very strongly with variations in atmospheric lead concentration, used as an indicator of automobile exhausts. It appears that in complex urban atmospheres air contamination from automobile exhaust is the dominant factor in the alteration of natural atmospheric ion levels.

05551

McMullen, Thomas B., Fensterstock, Jack C., Faoro, Robert B. and Smith, Raymond

**AIR QUALITY AND CHARACTERISTIC COMMUNITY PARAMETERS.** J. Air Pollution Control Assoc., 18(8):545-549, August 1968. (Presented at the 60th Annual Meeting, Air Pollution Control Association Cleveland, Ohio, June 11-16, 1967, Paper 67-26.)

Statistical correlations between all pairs of 16 selected air quality measurements and 13 selected community parameters for 66 standard metropolitan statistical areas have been calculated, tested for significance, and reviewed for meaningful relationships. Of special interest are the correlations between the sulfate fraction of suspended particulate matter and the use of sulfur- containing fuels (r equal 0.66), between ambient sulfur dioxide and the use of sulfur containing fuels (r equal 0.85), between the lead fraction of suspended particulates and annual purchases of gasoline (r equal 0.71), and between vanadium in suspended particulates and the percent residual fuel oil used in a community (r equal 0.69). Several of these relationships are given more definitive description with mathematical equations that describe how the ambient pollutant concentration varies as a function of a related community parameter. The geographic distribution of high and low pollutant levels is also discussed.

05573

L. B. Hitchcock, W. L. Faith, M. Neiburger, N. A. Renzetti, and L. H. Rogers

**AIR POLLUTION SITUATION IN LOS ANGELES - AN AEROMETRIC SURVEY.** Proc. Natl. Air Pollution Symp., 3rd, Pasadena, Calif., 1955. pp. 12-23.

This paper summarizes the methods, the results, and some preliminary indications and conclusions employed in the survey. A major purpose of the survey was to monitor presumably important variables so as to provide a more adequate basis for diagnosis of the general problem. Pinto beans were used to measure the plant damaging effects of smog. Also measured were oxidants, nitrogen dioxide, hydrocarbons, carbon monoxide, aldehydes, sulfur dioxide, particulates, and meteorological factors. Some of the recommendations derived from the survey are that more complete meteorological measurements be obtained, that plant damage as a measure of smog be given more extensive study, and that a minimum of 14 monitoring stations be established in the Los Angeles Basin.

05623

E. C. Tabor and J. E. Meeker

**EFFECTS OF THE 1956 STEEL STRIKE ON AIR POLLUTION LEVELS IN SEVERAL COMMUNITIES.** Proc. Air Pollution Control Assoc., 51st, Philadelphia, Pa., 1958. pp. 24/1-24/20.

This paper reports the results of a study conducted in several steel producing communities during and immediately following the steel strike of July, 1956. The study was limited to the following communities: Homestead, McKeesport, Pittsburgh, and Donora, Pa.; East Chicago, Ind.; and Birmingham, Ala. A continuous sampling program for the collection of suspended particulate matter was set up in all communities. Lower levels were found while the steel mills were shut down as a result of the strike than after the mills resumed operation. No differences in levels of Sb, Ba, Be, Co, molybdenum, and nitrate were observed during the two periods. Statistical analysis of data for iron, zinc, manganese, lead, sulfates and copper demonstrated that significantly lower values were found during the strike period in the following instances: Fe and Zn in all communities; Mn in Birmingham and Donora; Pb in Donora and East Chicago; sulfates in Allegheny County and Donora; Cu in none of the communities. In Donora, it was found that the soiling power of the air during the strike period was half that of the post strike period. The occurrence of occasional high levels of pollutants during the strike period indicates that there are sources contributing to pollution of the air which may not be obvious in the presence of an industry which is frequently looked upon as the major offender.

05820

C. Xintaras

**A STUDY OF LEAD LEVELS IN AIR WITH PRINCIPAL EMPHASIS ON THAT DUE TO AUTOMOBILE EXHAUSTS (Progress Rept.). Preprint. 1960.**

The program involved in this study is reviewed. Basic objectives tentatively agreed upon were: (1) determination of maximum levels of atmospheric lead to which appreciable population segements are exposed; (2) appraisal of lead body burden if any induced by atmospheric lead concentrations. An attached bibliography of items related to this study comprises one phase of the undertaking. Existing data on the subject is reviewed. Related investigations covered the contribution of lead to the atmosphere by industrial and other 'non-vehicle' sources. Sampling and research programs concerned with lead pollution here and abroad (Germany) are reviewed briefly. A reivew of and plans for sampling and analysis are outlined. Available data (Jan 1960) do not indicate any noticeable trends in atmospheric lead levels. Extreme fluctuations have been recorded.

06148

Tada, O, T. Sawano, and K. Nakaaki

**AIR POLLUTION BY AUTOMOTIVE EMISSIONS ON THE *TOLL ROAD AND IN THE PARKING PLACE.*** Text in Japanese. Rodo Kagaku (J. Sci. Labour, Tokyo), 42(6):463-468, June 1966.

An investigation was made of air pollution at five toll booths in city and suburbs and four underground parking garages from 1962 through 1965 during the winter when pollution is at its heaviest. The number of cars passing through the toll booths was from 500 to 1600 per hour. Two of the underground garages held over 300 cars; the other two were beneath a department store and a bank, respectively. The air pollutants measured and the methods of measurement are as

follows: CO (Kitagawa-type tester), CO-Hb (pyrotannic acid method, from blood samples of toll gate attendants), CO2 (Kitagawa-type tester), SO2 (rosaniline formaldehyde method), NO2 (naphthylethylene diamine method), HCHO (phenyl hydrazine method), dusts (Roken filter paper method), Pb (dithizone method), and O3 (phenolphthalein method). Graphs and tabulations of hourly variations of the concentrations of SO2, NO2, and dusts are given. The concentrations of HCHO were higher in the underground garages than at the toll booths. Other pollutants were found in about the same concentrations in both areas. Although the concentration of each pollutant was below the individual maximum allowable concentration, the total combination of polluting elements was quite serious.

06760

N. Saruta

**AIR POLLUTION IN NORTHERN KYUSHU.** Kuki Seijo (Clean Air - J. Japan Air Cleaning Assoc., Tokyo) 4, (2) 35-45, July8 1966. Jap.

A preliminary investigation of air pollution in northern Kyushu was started in 1952 and studies on existing conditions have been carried out since 1959. The yearly and monthly amounts of dust fall and SO2 in the five wards of northern Kyushu are tabulated for 1959 through 1965. The results show decrease in dust fall (from 26.49 to 20.73 tons/sq. cm./month) and in increase in SO2 (from 0.25 to 0.64 mg/100 cc/day). Tabulations of dust fall and SO2 are given for the industrial, business, and residential sections. The Fe2O3 present in red smoke has also been measured and averages between 2.0 and 2.8g/sq. m/month. Measurements of 3,4-benzopyrene and components of automobile exhaust such as CO, SO2, Pb, NO, and NO2 are also tabulated for the five wards.

06788

**(STUDIES OF AIR POLLUTION IN THE DEPARTMENT OF THE SEINE IN 1965. PART 3. CONDITIONS AT ORLY AIRPORT.) Etudes de Pollution Atmospherique dans le Departement de la Seine en 1965. Troisieme Partie. Operation 'Aerodrome d'Orly.' Laboratoire Municipal de la Prefecture de Police, Paris, France. (Apr. 1966.) pp. 1-2, 9, 11, 13-7. Fr.**

The results of an air pollution study made at Orly Airport at the request of the medical services at the airport are given. The survey covered the exposure to ground personnel and an investigation of the components of the fuel and emissions from jets. The investigation was conducted by a mobile air pollution laboratory located at the field during the study. In general, the pollution was neglible, the emissions from the jets were not a matter of concern, but there was a nuisance hazard to workers on piston planes. The carbon monoxide was determined by infra-red absorption with an average reading recorded every 15 min. The averages ranged from 0.5 to 18 ppm. The other contaminants that were determined included carbon dioxide, nitric oxide, nitrogen dioxide, sulfur dioxide, aldehydes, lead, 3,4- benzopyrene, toluene, xylene, and benzene, and in all cases the results were much lower than those obtained in various stations in Paris. Both on the basis of analyses made on ambient air and on emissions from jets there is little evidence of air pollution at Orly Airport in Paris.

07198

Y. Kawanami

**AIR POLLUTION IN TOKYO.** Kuki Seijo (Clean Air - J. Japan Air Cleaning Assoc., Tokyo) 4(2):11-22 (July 1966). Jap.

A definition of smog is given as the restriction of visibility to less than 2 km in the city and vicinity, excluding the restriction by rain. Out of 154 days when smog occurred in Tokyo in 1965, 64 were caused by heavy fumes and 90 by mist or haze. The differences in times of occurrence of heavy fume-type smog and mist or haze-type smog is discussed. The yearly variation of the number of 'smog days' is graphed indicating seasonal influences. Smog decreases in winter but increases in summer and fall. The current status of air pollution in Tokyo is also covered with respect to dust and soot fall, floating dust, sulfuric acid, nitrogen oxides, hydrocarbons, and lead compounds. Measurement of dust and soot fall in Tokyo began in 1955 and yearly variations are graphed through 1965. Dust fall reaches a peak between February and May and then again in August and September. These peaks are related to the meteorological influence of strong winds in spring and large amounts of rain in spring and late summer. Therefore, July and December are considered the best times to investigate air pollution without meteorological influence. Lengthy discussion is given to daily and hourly variations of pollution peaks in urban, industrial, and suburban areas.

07600

Robinson, Elmer and F. L. Ludwig

**PARTICLE SIZE DISTRIBUTION OF URBAN LEAD AEROSOLS.** J. Air Pol- lution Control Assoc., 17(10):664-669, Oct. 1967. 10 refs.

Size distributions of lead aerosols were obtained for 61 test periods in five urban and two remote areas of the United States. The tests were carried out under a variety of weather conditions in downtown, industrial, and residential locations of Los Angeles, the San Francisco Bay area, Chicago, Cincinnati, Philadelphia, and remote sites in Oklahoma and Arizona. Samples were obtained with a modified Goetz Aerosol spectrometer. Various fractions of the collected samples were analyzed by the dithizone method for lead and the size distributions were calculated on the basis of the chemical determinations. Size distributions were generally similar at the several sampling sites covered in the study. (Authors' abstract)

07649

Thilliez, Georges

**DETERMINATION OF TRACES OF LEAD IN AIR BY ATOMIC ABSORPTION SPECTROMETRY.** Anal. Chem., 39(4):427-432, April 1967. 6 refs.

Direct supply of air samples from the atmosphere to the burner of an atomic absorption spectrophotometer allows the rapid determination of certain elements such as lead. The method described has been in service in the tetraethyl-and tetramethyllead production installations of our Paimboeuf plant, since November 1965, with general satisfaction. It allows continuous monitoring of the lead concentration in the environments where the organic derivatives of this element are manufactured or handled. It permits the detection of slight leaks in the apparatus, and improves safety. The limit of detection is .000001 gm/cu m. The sensitivity and accuracy are of the same order as those of discontinuous methods, which require from some hours to a day per analysis. This method is also applicable to determination of other elements in air, particularly mercury. (Author's summary)

07985

Lee, Robert E., Jr., Ronald K. Patterson, and Jack Wagman

**PARTICLE SIZE DISTRIBUTION OF METAL COMPONENTS IN URBAN AIR.** Preprint, Public Health Service, Cincinnati, Ohio, National Center for Air Pollution Control,

(10)p., (1967). 12 refs. (Presented at the American Chemical Society Meeting, Miami Beach, Fla., April 1967.)

Concentration and particle-size distribution of six suspended metals (iron, lead, cadmium, chromium, magnesium, and copper) were measured in downtown Cincinnati and in Fairfax, a Cincinnati suburb. Particulate was collected and size-fractionated in cascade impactors; the metals were extracted with acids and analyzed by atomic absorption spectrophotometry. Samples obtained from the two locations exhibited different particle-size distributions; at both locations, however, only lead was predominantly submicron. Concentrations of the metals were typically 3 to 5 times higher in Cincinnati than in Fairfax; magnesium concentrations were about 17 times higher. (Authors' abstract)

08275

A. Petrova, Y. Dalakmanski, D. Bakalov

**STUDY OF CONTAMINATION OF THE ATMOSPHERE BY INJURIOUS ROAD. (TRANSPORT AND INDUSTRIAL PRODUCTS.) J. Hyg. Epidemiol., Microbiol., Immunol. (Prague), Vol. 10, p. 383-391, 1966. 9 refs.**

The concentration of lead was determined at 23 locations in the atmosphere of Sofia from 1962 to 1963, and the carbon monoxide concentration from May to December 1963. Two hundred and six single samples of lead, including 10 controls, were collected by the aspiration technique and tested by the chromate method. Lead emanating from factories and road transport was found in mean concentrations of 4.25 plus or *minus 0.27 microgram/cu m. Carbon monoxide concentration* distributed throughout the city was detected in a mean concentration of 10.88 plus or minus 3.01 microgram/cu m. This is five times the rate found six years previously and ten times the maximum permissible concentration. The noxious effect of lead was determined from the urine coproporphyrin level in kindergarten children five to seven years of age. Coproporphyrinuria was found more frequently and its levels were higher in city children than in children of the same age living in the suburbs. Suggestions to improve the air in the city include iron carbonyl additives to gasoline as an anti- knock agent instead of the toxic compound tetraethyl lead, and the installation of equipment to eliminate smoke from factories.

08279

Everett, J. L., C. L. Day, and D. Reynolds

**COMPARATIVE SURVEY OF LEAD AT SELECTED SITES IN THE BRITISH ISLES IN RELATION TO AIR POLLUTION.** *Food Cosmet. Toxicol. (London)*, Vol. 5, p. 29-35, 1967.

A study of lead concentration in the air was undertaken in 33 areas (grouped in five regions) in England, Scotland and Wales, using privet leaves as indicators. The areas selected represent both districts of high industrialization, and those of rural character. In each area two sites were chosen, one along a main highway (Site I) and the other in 'clean' surroundings (Site II). From each site a top soil sample was taken at the beginning and end of the study. Collections of privet cuttings were made each month on the same day and duplicate spectrograms of each sample were analyzed for lead concentration. The soil lead levels showed comparable distribution on a regional basis except in southwest England which contains lead mines. Details of both the lead concentration of privet taken from Site I and Site II in each area and the mean monthly variations in lead concentration of the leaves at each site were evaluated statistically and tabulated. When the density of the population was plotted against the mean annual concentrations of lead found in the leaves at all sites, it was shown that in areas of high population the Site II lead is higher than in sparsely populated areas. Along a main highway (Site I) the lead content of the leaves in each regional group was fairly uniform, but in 'clean' surroundings (Site II) a range of 22.9 - 72.5 ppm was obtained, showing that the difference in lead content between Site I and II is due to air pollution derived from intense industrialization. A strong case is made for determining the lead content of foods grown for human consumption in hazardous areas, particularly near highways.

08438

Berdyev, Kh. B., Pavlovich, N. V., and Tuzhilina, A. A.

**EFFECT OF MOTOR VEHICLE EXHAUST GASES ON ATMOSPHERIC POLLUTION IN DWELLINGS AND IN A MAIN STREET.** ((Vliyanie vybrosov avtotransporta na zagryaznenie vozdukha zhilykh pomeshchenii i ulichnoi magistrali.)) Hyg. Sanit. (English translation of: Gigiena i Sanit.) 32(4-6):424-426, April-June 1967. 1 ref. CFSTI: TT 67-51409/2

Considerable concentrations of carbon monoxide, nitrogen oxides, lead compounds and dust were measured in the atmosphere of the main street and in the living premises, exceeding the maximum permissible concentrations. The 50 percent increase in the density of vehicular traffic in 1963 in comparison to 1961 (from 780 to 1,200 vehicles per hour) increased only the carbon monoxide concentration in the street air (by 50 percent), all other indices remaining at the previous level. A comparison of the concentrations of health hazards at different levels revealed the highest concentration of carbo n monoxide in the living rooms of the third story and those of dust and lead in the first story. The concentrations of nitrogen oxides were the same in the street, in the first and the third stories.

08502

Einbrodt, H. J., Reploh, H., and Winck, W.

**SUSPENDED DUST EXAMINATION IN THE RESIDENTIAL AREA OF AN INDUSTRIAL CITY IN THE RUHR AREA.** ((Schwe estaubuntersuchungen im Wohnge- biet einer Industriegrossstadt des Ruhrgebiets.))Text in German Arch Hyg. Bakteriol. (Munich), 150(1-2):92-99, 1966. 5 refs.

The airborne dusts found in a residential area of a large industrial city in the Ruhr area of Germany were compared with those found during a previous examination in a large residential town 80 km. away. The dust was collected electrostatically between February and June 1965 and examined for humidity at 150 deg. C, loss on ignition at 400 and 750 deg.C, silicon, aluminum, iron, calcium and lead. Wind direction, velocity, barometric pressure, air temperature and amount of precipitaiton were also registered. The tabulated results show that the lowest concentrations obtained are similar in the residential area of an industrial city and a large residential city, but in general the fine dust quantities are twice as high in the former. In the industrial city the suspended dust has a more constant composition with a higher concentration of soot, and more iron, calcium and lead. Silicon and aluminum concentrations were higher in the residential city.

08568

Chovin, P.

**CARBON MONOXIDE: ANALYSIS OF EXHAUST GAS INVESTIGATIONS IN PARIS.** Environ. Res., 1(2):198-2168 Oct. 1967. 3 refs.

Using a motor car sampler, ambient air samples from Parisian streets were taken at 317 locations. The content of CO in un-

ventilated tunnels as well as streets was measured with infrared analyzers. Yearly maps of vehicular pollution (CO levels) were drawn; differences in maps from 1959 through 1966 were found to be insignificant. In tunnels, there was a good correlation between tunnel length and CO level. A 24-hr curve of street CO level shows CO level and traffic intensity to be directly correlated. A close correlation is found between average CO level (for 10 hrs.) and average lead content in the air, suggesting the two pollutants have the same origin. There is no correlation between CO and benzo(a)pyrene levels. Automobile exhausts are responsible only for 10-20 percent of benzo(a)pyrene air pollution. A technique for reducing the CO content of exhaust gases during idling by means of a carburetor adjustment is mentioned. It is used on all police cars, with a resultant reduction of CO levels (from 97-150 ppm to 24-38 ppm) in the police garage. In the blood of traffic policemen, tested before and after dury, carboxyhemoglobin (COHb) levels increase in nonsmokers, but may decrease in smokers, dur to high levels achieved before duty. Car drivers, when driving in traffic, tend to have higher COHb levels than workers exposed to CO, traffic pollicemen, or private individuals with suspected accidental CO exposure. Underground parking garages can have astonishingly high levels of CO: a new one in Paris was found to have levels above 200 ppm for as long as 20 min. and average CO levels often reached 90-100 ppm. The adoption of air quality standards for garages is now in force in Paris.

08591

Yamaki, N.

**SEVERAL PROBLEMS ON CONTROL OF MOTOR VEHICLE EXHAUST POLLUTION.** Text in Japanese. J. Japan. Petroleum Inst. (Tokyo), 8(9):686-696, Sept. 1965. 31 refs.(

Effedcts of Automobile exhaust gases upon air pollution in Tokyo and Osaka are evaluated. Numbers of vehicles, population density of automobiles,and average amounts of gasoline consumption per square kilometer per day for Tokyo,Osaka,and Japan are tabulated Average and maximum amounts of carbon monoxide and lead concentrations in Tokyo and in Japan are discussed, with reference to those of Los Angeles. Smogs are more frequent in Tokyo and Osaka during winters and they have been known to be caused by stack gases and smokes from factory chimneys. The effects of automobile exhaust gases upon smogs for both cities have not been clarified. The frequencies and distributions of smogs, year to year, in Tokyo and Osaka have been changing in recent years, as petroleum fuels have replaced coal. Subjects such as quality of auto exhaust gas for different driving conditions, actual field survey of exhaust gases, exhaust control devices, and other activities being conducted in the United States, are reviewed.

08810

Marraccini, L., A. Spinazzola, G. Devoto, and S. Zedda

**DISTRIBUTION OF SEVERAL VOLATILE TOXIC PRODUCTS WHICH ARE INDICATORS OF AIR POLLUTION IN THE CITY OF CAGLIARI. NOTE IV. LEAD.** ((Studio sul comportamento di alcuni prodotti tossici volatili quale indice di inquinamento atmosferico nella citta' di Cagliari, Nota IV. Il piombo.)) Text in Italian. Folica Med. (Naples), 49(9):649-658, Sept. 1966. 8 refs.

Monitoring stations were set up in 18 locations on streets, street corners, and piazzas of Cagliari. Measurements of atmospheric lead were made by passing 60 l./hr. through a tube filled with 30 cc of twice-distilled water and then testing for the presence of lead. Average values taken from three days' measurement at 8:00-10:00 A.M., 12:00 A.M. to 2:00 P.M., and 6:00-8:00 P.M. are graphed. Levels found range from traces to 34.4 micro grams/cu m. Lead levels are higher (16.26-24.40/micro grams/cu m average) in those streets where automobile traffic is interrupted by traffic lights than is those where traffic flows continuously (below 3 micro grams/cu m).

08812

Muller, T. H.

**AIR POLLUTION FROM AUTOMOTIVE EXHAUSTS. OBSERVATIONS IN BASEL.** ((Die Verunreinigung der Atmosphare durch die Abgase der Motorfahrzeuge. Beobachtungen in Basel.)) Text in German Z. Praeventivmed., 11(2):157-160, March-April, 1966. 5 refs.

CO level was sampled in air taken from 8 areas of dense traffic during the period 1961-1964. Levels found ranged from 0 to 45 p.p.m., with occasional peaks to 90 p.p.m. These levels were about the same each year, in contrast to the sharp increase in the number of automobiles during that period. No conclusions are drawn from this observation, but the ambient air concentration of other exhaust gas components is pointed out as also significant. Averages are given for ammonia, SO2, NO2, and aldehyde. In order to clarify the possibility of eventual harm from lead additives in gasoline, urine samples from all traffic policemen were examined in 1965. There was no evidence of lead accumulation in any of the samples.

08821

Truffert, L., J. Lebbe, and P. Chovin

**ATMOSPHERIC POLLUTION IN PARIS FROM EXHAUST GASES OF AUTOMOBILES.** ((La pollution de l'atmosphere de la region parisienne par les gaz d'echappement des vehicules automobiles.)) Text in French. Z. Praeventivmed., 11(2):134-143, March-April, 1966.

Studies undertaken by the Municipal Laboratory of the Police Department in Paris are described. A truck-laboratory was used to sample the street air, with the finding that 53.0-90.2% of the samples taken from 1960 to 1964 contained 5-30 ppm. of CO. The modal level was 10-20 or 20-30 ppm. for these years. A tabulation of the levels found in the 20 districts of Paris shows that the most pollution is found in the first, second, third, eighth, ninth, and tenth districts. Similarly, 13 underground traffic passages were studied; average pollution is roughly proportional to the length of the tunnel. The number of automobiles which pass and the effect of wind are discussed as factors in determining the level of pollution. Air samples taken in six places indicate that the level of CO increases with the number of cars which pass in a 15-min. period. Blood COHb levels increase in nonsmokers after exposure to CO, but may actually decrease in smokers due to the initially high level found before exposure. Both groups have lower COHb levels than automobile drivers. Lead and 3,4-benzopyrene levels were also measured.

09240

Petrova, A., Y. Dalakmanski, and D. Bakalov

**INQUIREIES INTO THE ATMOSPHERIC AIR POLLUTION IN THE CITY OF SOFIA WITH HARMFUL WASTE PRODUCTS OF MOTORVEHICLE TRAFFIC AND INDUSTRY.** n auchni Tr. Visshiya Med. Inst. Sofiya (Sofia), 44(3):51-57, 1965. 9 refs.

The mean level of atmospheric Pb in Sofia, monitored from June 1962 to Dec. 1963 at 23 control posts, was 4.25 plus or minus 0.27 gamma/cu. m. This level is similar to those found in other countries and indicates a massive Pb pollution of the

air, about 6 times the permissible concentration (0.7 gamma/cu. m.). Lower levels were found at a nearby mountain and in the suburbs. Average Pb levels 1.5 m. above ground were twice as high as those at 20 m. Pb levels are directly related to the amount of automobile traffic and result from the use of ethylated gasoline which was introduced in Sept. 1963. Fall and winter levels are higher than those in spring and summer. Mean levels of CO measured from May to Dec. 1963 were 10.88 plus or minus 3.01 mg./cu. m., which is more than 10 times the maximum permissible limit (1 mg./cu. m.), and which is a large increase over the 1957 level of 2 mg./cu. m. No statistically significant difference was found in CO levels at 1.5 and 20 m. above ground. CO is not found at a nearby mountain; CO levels are lower in the suburbs and increase significantly during the autumn and winter. Sofia children (48; aged 5-7), and rural children, had mean urine coproporphyrin levels of 40.3 and 32.6 gamma/24 hr., respectively.

09432

Dubois, L., T. Teichman, R. S. Thomas, and J. L. Monkman

**SULPHUR COMPOUNDS IN URBAN AIR.** In: Air Pollution. Proceedings of the Symposium on the Physico-chemical Transformation of Sulphur Compounds in the Atmosphere and the Formation of Acid Smogs. Organisation for Economic Cooperation and Development, Paris, Directorate for Scientific Affairs, Paper 8, Dec. 1967, p. 63-73. 6 refs.

Three sampling stations were set up using glass fiber filters. All filters were carefully washed to reduce the relevant blank levels as much as possible. Measurements were made of dust loading, lead, polycyclics and sulphate. Using hot aqueous extraction, sulphate blank values were determined on a larger group of glass fiber filters. Sulphate blanks on organic filter media are much lower than for the glass fiber type. Suitably low blanks have only been achieved for polycyclic, lead and sulphate blanks. Results currently being obtained for sulphate in air are shown in histograms. The effect of wind direction has been applied to the results. There seems to be a rough correlation between the three stations. Peaks tend to occur on weekends. Dust and sulphate air loadings are given in tables. Values are summarized for three months, with some average values for the same months obtained 10 years previously in the same city at another location one mile distant. Glass fiber sheet appears to be quite unsuitable for the measurement of sulphate or sulphuric acid in air since it is analytically unsound to try to measure sulphate if the total sulphate blank is as large, or larger, than the quantity being measured.

09726

Langmann, R., and H. Kettner

**THE PROBLEM OF CHRONIC CO INTOXICATION AND INVESTIGATION OF CO POLLUTION IN LARGE CITIES.** ((Die Problematik einer chronischen Intoxikation durch Kohlenoxyd und Untersuchungen seiner Immis- sionen in Grossstaedten.)) Text in German. Offentl. Gesund- heitswesen (Stuttgart), 30(1):7-11, Jan. 1968.

In contrast to the common agreement on the danger of high CO concentrations, opinion is divided on the risks of human exposure to low concentrations of this gas. The literature on this subject is briefly reviewed. Some 114 different samples were measured at 30 points of heavy traffic flow in Muelheim (Ruhr) during the morning and evening rush hours; an infrared absorption device meas- ured CO levels. About 90% of the samples exhibited 25 p.p.m. CO or less, with the mean value at 14.5 p.p.m. These figures can be compared to the continuously high level of 200 p.p.m. found in large parking garages. Meteorological conditions had a signi- cant effect, hazy weather almost doubling the mean CO levels. Levels of lead and hydrocarbons paralleled those of CO at the locations sampled. The significance of CO measurements and pollution abatement measures are briefly discussed.

10380

W. Kozlowski, and J. Rzepka

**COMPARISON OF THEORETICALLY ESTABLISHED AIR POLLUTION DATA WITH MEASUREMENTS IN AN INDUSTRIAL CITY. PART I.** (Porowanie teoretycznego obliczenia zanieczyszczenia atmosfery w miescie przemyslowym z pomiarami. I. czesc artykulu.) Text in Polish. Ochrona Powietrza (Warsaw), 1(3):1-9, 1967.

While studying the effect of air pollution on the health of Chorzow school children, the ambient air pollution of the Chorzow Stary city district was determined theoretically and empirically. Chorzow, located in the Upper Silesian Industrial District, is a city of 150,000 and has a population density of 4,688 per sq km, the highest in Poland. There are nine large industrial combines within the city limits, which employ 68% of the total city population. Data for theoretical pollution estimates, obtained directly from 16 industrial enterprises located in the Chorzow Stary city district and within a 5 km radius, are mapped and graphed. The type of enterprise, existence of dust collectors and their efficiency, number and height of stacks with their outlet diameter, volume and temperature of gases, type of dust, its concentration and presence of toxic components were investigated. Dust fractions below 20 microgram diameter were calculated using estimates for various emission sources: steel furnace dust having 100% such particles; mechanically fractionated dust behind dust chambers, 40%; and boiler burners with dust traps, 15%. The density of dust with a predominating mineral content was set at 2 g/cc; for zinc oxides, 3 g/cc; iron oxides, 4 g/cc; and for lead oxides, 9 g/cc. Meteorological data were obtained from stations in Warsaw and Katowice. The value of average annual pollution concentration at ground level was determined by the 'box method', assuming that the upward wind movement was blocked by inversion. Pollution concentrations at ground level were determined based on the spread of polluted air from known emission sources, using Bosanquet formulas and electronic computers. Total annual emissions from industrial sources within a 5 km radius of Chorzow Stary established theoretically were: 86,000 tons of SO2, 123,000 tons of dust (of which 85,000 tons had particles less than 20 microgram in diameter), 193 tons of zinc dust and 15 tons of lead dust. Results of concentrations calculated according to Sutton's formula are graphed and compared with empirical data.

10554

Lahmann, Erdwin and Manfred Moller

**AIR POLLUTION IN CITIES FROM DUSTS CONTAINING LEAD.** ((Luftverunreinigung in Stadten durch bleihaltige Staube.)) Text in German. Bundesgesundheitsblatt (Berlin), 1967(17):261-264, 1967. 27 refs.

Measurements on a well-travelled street in Berlin indicate that lead levels parallel the traffic density, with morning and evening peaks. About 36.6% of these lead levels fall between 5-10 microgram/cu m and the highest measurement was 13.4 microgram/cu m. A series of 24-hr. measurements taken biweekly yielded a mean level of 3.8 microgram Pb/cu m. Measurements were taken at three other sites in Berlin and the data tabulated. Means of 0.44-0.48 microgram/cu m were found. Data from 18 published sources are tabulated. The ground level of atmospheric lead in various German, French, Swiss, English, Italisn, Russian, and American cities appears to be about 0.5 microgram Pb/cu m.

10595

Coghi, L. and E. Bellelli

**RESEARCH ON AIR POLLUTION BY LEAD FROM MOTOR VEHICLES IN THE CITY OF PARMA.** (Ricerche sull'inquinamento atmosferico da piombo causato da veicoli a motore nella citta' di Parma.) Text in Italian. Nuovi Ann. Igiene Microbiol. (Rome), 18(1):1-16, Jan.-Feb. 1967. 18 refs.

This study utilized 56 samples of air taken in four zones of concentrated motor traffic during rush hours from June 1964 to June 1965; polarography and titrimetry were used with similar results. The concentration of lead in samples varied from 10 to 88.7 mg in different periods of the year. The concentration was generally higher in spring or summer than in winter, for the same traffic conditions. Since the first symptoms of saturnism can appear after the concentration of lead in the blood exceeds 70 mg/100 g. blood, the danger of air pollution by lead from motor vehicles and industries using that metal is evident, as shown in similar studies performed in America, Switzerland, and Germany.

10612L

J. M. Colucci, C. R. Begeman, and Kathleen Kumler

**LEAD CONCENTRATIONS IN DETROIT, NEW YORK AND LOS ANGELES AIR.** Preprint, General Motors Research Labs., Fuels and Lubricants Dept. and General Motors Industrial Hygiene, Dept., Warren, Mich., 24p., 1968. 18 refs. (Presented at the 61st Annual Meeting of the Air Pollution Control Association, St. Paul, Minn., June 24-28, 1968. Publication GMR-773, Paper 68-90.)

The concentrations of lead in air at 12 sites in Detroit, New York, and Los Angeles are reported. Sampling was carried out by filtration using a large 'absolute' filter and equipment contained in a step-van truck. A portion of the filter was macerated in nitric acid and the lead determined spectrographically. The combined annual average lead concentration for four sites in metropolitan Los Angeles was approximately 40% higher than the combined averages of either the five sites in metropolitan New York or the three sites in metropolitan Detroit Concentrations ranged from 0.4 micrograms /cu m at coastal Santa Monica, to 18.4 micrograms/cu m at a Los Angeles freeway interchange. Concentrations were generally highest in freeway areas, intermediate in commericial areas. and lowest in residential areas, and were about 40% higher in daytime than at night. Average lead concentrations were highest during autumn in New York and winter in Los Angeles reflecting an inverse relationship with wind speed. Correlation coefficients between lead and carbon monoxide, at all sites, were statistically non-zero with 99% confidence, and varied from 0.75 to 0.96. Lead levels in road dirt were also measured and discussed. (Authors' abstract, modified)

10634

Kurcatova, G. and V. Andrev

**ATMOSPHERIC POLLUTION IN SOFIA.** ((Kharakteristika zagryazneniya atmosfernogo vozdukha sofii.)) Hyg. & Sanit. (English translation of: Gigiena i Sanit.), 33(1-3):224-247, Jan.-March 1968. CFSTI: TT 68-50449/1

Extensive studies of atmospheric pollution were under taken in Sofia. The investigations were conducted over the three-year period 1963 - 1965. They included determinations of sulfur dioxide, sulfuric acid aerosol, dust (by sedimentation at the beginning of 1963 and in 1964, and gravimetrically in 1965), copper and lead in deposited dust, soot (1963 and 1965), carbon monoxide (1964-1965), formaldehyde, nitrogen oxides (1965) and lead aerosol (1964-1965). The samples were taken in different districts of Sofia and in trunk roads with heavy traffic. They were five permanent air sampling stations in 1963 and 1964 and 7 in 1965. In addition, there were three such stations in streets with heavy traffic.

10756

Joshi, L. U., and T. N. Mahadevan

**SEASONAL VARIATIONS OF RADIUM-D (LEAD-210) IN GROUND LEVEL AIR IN INDIA.** Health Phys., 15(1):67-71, July 1968.

Measurements of Pb-210 concentrations in ground level air at two stations in India, viz., Bombay and Sringagar, are presented. Sampling of the atmospheric particulates was done using Hollingsworth and Vose H-70 filter papers and powerful blowers; soil samples were also taken. Radiochemical separation of 210 Pb from the air-filter collection was carried out after ashing of the filters at 250 degrees C. The samples were counted in low-level end-window G.M. counters using he 1.17 MeV betas of daughter product 210 Bi both for activity estimation and for checking the radiochemical purity of the samples. The measurements at Bombay are from October 1961 to March 1966 and at Srinagar from March 1962 to March 1966. It can be seen from the results that the activity concentrations varied from 6 micro-micro curies per 1000 m3 to 60 micro-micro curies per 1000 m3. The presence of a seasonal variation in concentrations with maximum in winter and minimum in summer of each year is also observed. The likely causes for these variations and their differences with the seasonal variation of Cs-137 and other fission products are discussed. (Authors' abstract, modified)

11028L

Colucci, Joseph M. and Charles R. Begeman

**CARCINOGENIC AIR POLLUTANTS IN RELATION TO AUTOMOTIVE TRAFFIC IN NEW YORK.** Preprint, General Motors Research Labs., Warren, Mich., Dept. of Fuels and Lubricants, RP-GMR-777, 32p., 1968. 33 refs. (Presented at the 61st Annual Meeting, Air Pollution Control Association, St. Paul, Minn., June 23-27, 1968, Paper 68-71.)

Sampling for particulates and carbon monoxide was carried out at tions of certain polynuclear aromatic hydrocarbons (benzo(a)pyrene and benz(a)anthracene) to automobile traffic. Carbon monoxide and lead were determined as indicators of air pollution from auto- motive combustion sources. Sampling equipment was contained in a step-van truck. Particulate matter was collected on a large 'ab- solute' filter. The benzene extract (tar) was analyzed for Benzo (a)pyrene and Benz(a)anthracene utilizing column and reversed- phase paper chromatography in combination with ultraviolet spectrophotometry. The average concentrations of all pollutants were highest at Herald Square in central Manhattan, and lowest in suburban Scarsdale. Concentrations of benzo(a)pyrene ranged from 0.1 micrograms/1000 cu m to 9.4 micrograms/1000 cu m, were higher in daytime than at night, and were highest in autumn and winter. For all sites considered together, the correlation coefficient of benzo(a)pyrene with carbon monoxide was 0.65, with lead, 0.74, and vanadium 0.54; all three correlations were statistically non-zero with 99% confidence. At individual sites, however, some of these correlation coefficients were significant and others were not. Benzo(a)pyrene, in air, even in areas of greatest automobile traffic, appears related with both automotive and non-automotive sources (space heating). Benzo(a)pyrene concentrations at the Manhattan sites in New York were lower than previously measured in central Detroit, even though traffic was greater at the New York sites. BaP in New York was lower than reported for most U. S. cities, and more than reported for several European cities.

11184

Winchester, John W.

**COMPOSITION OF LEAD HALIDE POLLUTION AEROSOLS.** Michigan Univ., Ann Arbor, Dept. of Meteorology and Oceanography, 23p., Aug. 15, 1968. 25 refs.

The study of the composition of lead halide pollution aerosols has begun with an approach of environmental sampling and high sensitivity chemical analysis designed to reveal effects related to chemical reactivity of the particles in the atmosphere. Laboratory facilities have been developed for the determination of lead anodic stripping voltammetry (ASV) and of the halogens by neutron activation analysis (NAA). Atmospheric sampling of particles has been carried out with cascade impactors by Scientific Advances, Columbus, Ohio, and Andersen Sampler, Provo, Utah, and the latter have been found to be the most satisfactory for this investigation from the standpoint of cost, ease of sampling, and ease of recovering the sample for replicate analysis. Samples are now being taken mainly in three locations in the Great Lakes Basin: (1) Ann Arbor, Michigan, to search for the influence of Detroit 45 miles to east as a pollution source; (2) Stations in Chicago and Gary determine the composition of aerosols from this source region and any areal variation within it; and (3) Over waters of southern La Michigan from shipboard to search for the influence of Chicago and Gary to the southwest. Elements being determined in all samples are lead, copper, and cadmium by ASV and chlorine, bromine, and iodine by NAA. Preliminary results indicate dis- tinctive particle size distributions for these elements. (Au-

11202

Lee, Robert E., Jr., Ronald K. Patterson, and Jack Wagman

**CONCENTRATION AND PARTICLE SIZE DISTRIBUTION OF METALS IN URBAN AND RURAL AIR.** Preprint. Public Health Service, Cincinnati, Ohio, National Air Pollution Control Administration, ((10))p.$ 1967. 7 refs.

Metal components suspended in air were fractionated and collected with cascade impactors simultaneously in downtown Cincinnati and at the Indian Creek Wildlife Preserve about 45 miles away. Although daily variations were observed at both locations, the average metal concentrations were remarkably similar. Lead and iron concentrations were highest; nickel was lowest. Only lead was predominantly submicron-sized in both atmospheres. The concentration and size data indicate that diffusion and other mixing forces in the atmosphere tend to bring about a broad dispersion of metal aerosol components. Variations in the aerosol parameters for magnesium and cadmium indicate characteristically different urban and rural sources of these components. (Authors' abstract)

12049

Lee, R. L. Jr., R. K. Patterson, and J. Wagman

**PARTICLE-SIZE DISTRIBUTION OF METAL COMPONENTS IN URBAN AIR.** Environ. Sci. Technol. 2(4):288-290, Apr. 1968. 12 Ref.

Concentration and particle-size distribution of six suspended metals (iron, lead, cadmium, chromium, magnesium, and copper) were measured in downtown Cincinnati and in Fairfax, a Cincinnati suburb. Particulate was collected and size-fractionated in cascade impactors; the metals were extracted with acids and analyzed by atomic absorption spectrophotometry. Samples obtained from the two locations exhibited different particle-size distributions; at both locations, however, only Pb was predominantly submicron. Concentrations of the metals were typically three to five times higher in Cincinnati than in Fairfax; Mg concentrations were about 17 times higher. (Author's Abstract)

12099

J. Bullock, and W. M. Lewis

**THE INFLUENCE OF TRAFFIC ON ATMOSPHERIC POLLUTION. THE HIGH STREET--WARWICK.** Atmos. Environ., 2(5), 517-534, Sept. 1968. 5 Ref.

The High Street at Warwick is congested and carries a large number of both private and commercial vehicles. Measurements of air pollution in this thoroughfare show smoke levels 4 to 5 times greater and lead levels 4-1/2 to 6 times greater than in parts of the borough not specifically affected by vehicle exhausts. Even so, the concentration of atmospheric lead is not high enough to be a health hazard. From the ratios of the mean value of smoke and lead at mid-week and weekend it is deduced that diesel consuming traffic is 50 per cent higher in mid-week. Petrol consuming vehicles constitute 60 per cent of the mid-week traffic. (Author's Abstract)

14762

Heller, A. and H. Kettner

**RESEARCH ON LEAD IN THE AIR AND IN DUST PRECIPITATIONS.** (Forschungsarbeiten ueber Blei in der Luft und in Staubniederschlaegen). Text in German. Schriftenreihe Ver. Wasser Boden Lufthyg. (Berlin), no. 29, 61p., 1969. 3 refs.

To determine the lead content in atmospheric air a total of 245 samples were taken in the cities of Muelheim (Ruhr Valley), Duesseldorf, Neuss and Rhine, Duisburg, and Wuppertal. Staplex high volume samplers were set up in busy streets and squares and samples were taken at 1 m above the pavement. One sampling station in each city was located in a quiet, traffic-free area; all used the discontinuous method with a sampling time of 1 hr. Glass fiber was used as filter material and analysis of the samples was performed by the dithizone method. The lead concentrations fluctuated between 0.5 and 12.5 micrograms/cu m; the median was 3.2. Weather conditions and size of roads and squares strongly influenced the lead content of the air. The control reference stations also showed considerable amounts of lead in the surrounding atmosphere. The dust content, which was also measured, was found to reach 1.72 mg/cu m at 1 m above ground. The lead content of the dust was generally below 1%. Comparison of the dithizone and the atomic absorption spectrophotometric methods showed that both are suitable for such analyses.

15175

Yamate, Noboru and Toshiro Matsumura

**LEAD CONTAMINATIONS OF AIR ON STREET IN ELEVEN MAJOR CITIES IN JAPAN (JULY-NOVEMBER, 1967).** (Wagakuni 11 toshi no gairo taiki n namari osen ni tsuite (1967 nen 7 gatsu - 11 gatsu). Text in Japanese. Eisei Shikensho Hokoku (Bull. Natl. Inst. Hyg. Sci., Tokyo), no. 86:189-190, 1968. 1 ref.

Lead concentrations of air were determined at crossings and roadsides in eleven major cities in Japan (Yokohama, Sendai, Aomori, Niigata, Kanazawa, Fukuoka, Kagoshima, Osaka, Kyoto, Nagoya, and Tokyo) from July to November, 1967. The average values of the lead concentrations during the daytime were between 1.70 and 13.58 micrograms/cu m. These values were higher than those obtained from July to October, 1966. (Author abstract modified)

15314

Yamate, Noboru, Tosiro Matsumura, and Masaharu Tonomura

**LEAD CONTAMINATION OF AIR ON STREET IN ELEVEN MAJOR CITIES IN JAPAN.** (Wagakuni 11 toshi no gairo taiki no namari osen ni tsuite). Text in Japanese. Eisei Shikensho Hokoku (Bull. Natl. Inst. Hyg. Sci., Tokyo), no. 85:158-160, 1967. 4 refs.

Lead concentrations in the atmosphere on crossings and roadsides in eleven major cities in Japan (Sendai, Aomori, Niigata, Kanazawa, Fukuoka, Kogoshima, Osaka, Kyoto, Yokkaichi, Nagoya, and Tokyo) were determined. The lead compounds were collected with fiberglass filters (Gelman type A) and polarographically analyzed. Lead concentration in the daytime was between 0.78 and 11.17 micrograms/cu m. The lead concentration at route 20 in Tokyo was the highest, and at Sasashima in Nagoya and Yayoikan in Yokkaichi, the values were the lowest. The lead concentration was influenced by traffic density, traffic stagnation, and road conditions, and meteorological and geographical conditions. (Author abstract modified)

15573

Heller, Arnold and Helmut Kettner

**SAMPLING AND ANALYSIS OF TRACE AMOUNTS OF LEAD IN THE AIR.** (Probenahme und Bestimmung kleinster Bleimengen in der Luft). Text in German. Schriftenreihe Ver Wasser Boden Luft-hyg. (Berlin), no. 29:3-50, 1969.

For the lead analysis of air, samples were taken intermittently with a high-voltage sampler. Fiberglass was used as the filter medium and sampling lasted one hour. From the weight increase of the filter and the average air throughput, the dust concentration was calculated. The loaded fiberglass filter was boiled in nitric acid for 10 min, and the lead and part of the dust were dissolved. The solution was filtered and analyzed; the prepared sample was adjusted to the proper pH and mixed with 2 ml of a dithizon (diphenylthio carbazone) solution and vigorously shaken for 20 sec, after which the phases were separated. This process was repeated a maximum of two times. The excess dithizon was removed and the lead dithizonate was photometrically analyzed. With this method, lead quantities from 10 to 80 microns can be analyzed well. The standard deviation at 10 microns was 5.7% and 1.5% at 60 microns. To determine the lead content of atmospheric air in the cities Muelheim (Ruhr), Duesseldorf, Neuss, Duisburg and Wuppertal, a total of 245 samples were taken and analyzed by this method. The samples were taken 1 m above the pavement and 50 cm to the side of the road. The measure lead concentrations fluctuated between 0.5 and 12.5 micrograms/cu m. Most concentrations were between 1 and 4 micrograms/cu m. No correlation between the lead concentration and traffic density was found.

15575

Lehmann, E. and J. Westphal

**RELATIONSHIP BETWEEN MOTOR TRAFFIC DENSITY AND AIR POLLUTION IN A METROPOLITAN STREET.** (Beziehungen zwischen Kraftverkehrsdichte und Luftverunreinigungen in einer Grossstadtstrasse). Text in German. Strassenbau (Duesseldorf-Oberkassel), no. 6: 4p., 1968. 4 refs.

In the years 1966 and 1967, extensive air quality measurements were made on a busy street in Berlin. The relationships between the traffic density and the carbon monoxide, hydrocarbons and lead concentrations in the air above the street were determined. The CO was continuously measured with an infrared analyzer over a period of 12 months. The air samples were taken 75 cm above the pavement. Half-hourly averages were obtained from the continuously recorded CO concentrations. The hydrocarbon (CH) concentration was continuously measured with a flame ionization detector. The lead content was determined intermittently at a height of 3 m. Analysis of the precipitated dust for leadwas performed by the dithizon method. Simultaneously with the lead concentration measurements, traffic counts were conducted between 6 a.m. and 8 p.m. The correlation coefficients were determined for the relationship between traffic density and the CO, CH and lead concentrations. These were 0.90, 0.85, and 0.78, respectively. A correlation between the CO, CH, and lead content of the air and the traffic density was found when long-term averages were used for the comparison. Comparison of the measured results of just one day showed no correlation. The meteorological influence was stronger in this case than that of the traffic density. Concentrations of the various exhaust components were generally interdependent. In this way, measurement of just one substance is sufficient to obtain general information on air composition.

15610

Odaira, Toshio

**AIR POLLUTION FROM MOTOR VEHICLE GASES IN TOKYO AND OSAKA.** (Dai toshi ni okeru jidosha haiki gas ni yoru taiki osen no jittai). Text in Japanese. Kogai to Taisaku (J. Pollution Control), 5(5):337-353, 1969. 17 refs.

Various pollutant concentrations were determined near highways and surrounding areas in Tokyo and Osaka. A large amount of carbon monoxide was found near the highways, and gradually decreased in the surrounding areas. The difference in the height of the pollutant between the highway and surrounding areas could not be measured to 100 m if the wind was slow and natural convections occurred. The carbon monoxide concentration was found to be related to traffic density. The four pollutant patterns differed from each other in the dust content, sulfur dioxide and nitrogen dioxide content, carbon monoxide and nitric oxide content, and ozone content. The average CO was 3 to 8 ppm/yr; however, 40 to 50 ppm/hr was not rare. In the middle of the city, over 10 ppm/hr was measured 27% of the time. In the districts that were 100 to 200 yards from the highway, the monthly average was 5 to 6 ppm, but 30 to 50 ppm/hr sometimes occurred. In winter, this became serious. Nitric oxide concentrations were 0.05 to 0.25 ppm along the highway; NO2 was estimated to be less than 0.05 ppm. For the surrounding districts, NO was 0.05 to 0.15 ppm in winter and 0.01 to 0.05 ppm in summer. Hydrocarbons averaged 2 ppm/mo along the highway. Carbon monoxide, NO, and the hydrocarbon concentration curve changed during the day. Oxidants averaged 0.02 to 0.06 ppm/mo and sometimes 0.14 to 0.25 ppm/hr. These measurements reveal that photochemical smog is important in Tokyo. Lead was 3 to 9 mg/cu m along the highway and 0.7 to 5 mg/cu m in the surrounding districts.

15789

Einbrodt, H. J., W. Klosterkoetter , and H. Reploh

**STUDIES OF THE QUANTITY AND CHEMICAL COMPOSITION OF AIRBORNE DUST IN A LARGE RESIDENTIAL AREA.** (Untersuchungen ueber Menge und chemische Zusammensetzung des Schwebestaubes in einer Wohngrossstadt). Text in German. Arch. Hyg. Bakteriol (Munich), 149(5/6):401-407, 1965. 32 refs.

In the city of Muenster, fust fall was measured with an electrostatic precipitator from June to November 1963. The samples were taken 10 m above the ground. The silicon, alu-

minum, iron, calcium, lead, and sulfur contents of the dust samples were determined, as well as the ashing loss at 360-400 C. Dust concentrations of more than 0.150 mg/cu m were rare and occurred only at low wind speeds; temperature and brief periods of precipitation had no influence. The lowest dust concentrations were measured with winds from NW to NE. An average concentration of 0.125 mg/cu m with winds from the S to W (Ruhr area) was measured. The highest dust concentrations was measured when the winds came from the center of the city, namely from NE to SE (0.148 mg/cu m). The most frequent ashing loss was 40 to 60%. The absolute SiO2 content per cu m air was more than 30 micrograms. The absolute Al2O3 content was between 10 and 20 micrograms/cu m air. The SiO2:Al2O3 ratio was not constant. The Fe2O3 content was on the average one-third that of SiO2 content. When CaO was found, it was in the concentration range of the Fe2O3. The lead content fluctuated greatly; the maximum was 2.65 micrograms/cu m with the majority of measured concentrations ranging from 0.3 to 1.4 micrograms/cu m. The total sulfur content fluctuated between 2.5 and 8.5 micrograms/cu m (this included SO2 and SO3). No dependence of the sulfur content on the wind direction could be found.

15823

Einbrodt, Hans Joachim and Rudolf Liffers

**COMPARATIVE LEAD OXIDE ANALYSES IN AIRBORNE DUST OF WEST GERMAN CITIES.** (Vergleichende Bleioxidbestimmungen im Schwebestaub Westdeutscher Gross-Staedte). Text in German. Staedtehygiene (Uelzen/Hamburg), vol.8: 4p., 1967. 15 refs.

Dust measurements were taken in Muenster, Hannover, and Oberhausen. The last city is located in the industrial center of the Ruhr Valley; the other two cities are primarily residential areas with some medium-sized industries. Three measurement series were taken. In addition to the lead concentration, the following areas were determined; the airborne dust concentration; the moisture content at 150 C; the ashing loss at 400 and 750 C; and the silicon, aluminum, iron, and calcium concentrations. However, only the results of the lead analysis and the dust concentration measurements are discussed. The highest suspended dust concentration was measured in Oberhausen as 0.46 mg/cu m. The most frequent concentrations were 0.1 to 0.2 mg/cu m (on 41% of the total measuring days). The maximum dust concentration in Hannover was 0.3 mg/cu m, the most frequent concentrations were between 0.05 mg/cu m and 0.1 mg/cu m air. In Muenster, the maximum concentration was 0.233 mg/cu m. The same sequence was observed for lead concentration in these cities. Thus it can be assumed that the traffic density decreases in like manner. The maximum PbO concentration measured in Oberhausen was 3.0 micrograms. In Hannover, the absolute PbO quantities fluctuated between 0.13 microgram/cu m and 2.25 micrograms/cu m. No lead was measured on 62% of the measuring days in Muenster; 20% of the measured concentrations fluctuated between 1 and 1.5 micrograms/cu m. No relationship could be found between the dust and lead concentrations.

16345

Biersteker, K.

**POLLUTED AIR. ORIGIN, MEDICAL SIGNIFICANCE AND COMBATING OF POLLUTED OUTSIDE AIR.** (Verontreinigde Lucht. Ontstaan, medische betekenis en bestrijding van verontreinigde buitenlucht). Assen, Van Gorcum, 1966, 214p., 339 refs. Translated from Dutch. Franklin Inst. Research Labs., Philadelphia, Pa., Science Info. Services, 275p., July 29, 1969.

Factors affecting emissions are considered, together with trends in emissions in the Netherlands and Rotterdam. The qualitative and quantitative significance of air pollutants as potential disease agents in Rotterdam is evaluated. The maximum sulfur dioxide concentration so far recorded in Rotterdam is 1600 micron cu m; the maximum smoke concentration, 500 micron/cu m. No epidemiological significance is attributed to measured concentrations of fluorides, nitrogen dioxide, carbon monoxide, or lead. Concern is shown for the role of benzpyrene and other carcinogens in the etiology of lung cancer. Distinctions are made between acute, sub-acute, and chronic air pollution. During acute air pollution, SO2 and smoke concentrations in Rotterdam show five- fold increases. Sub-acute pollution occurs when wind speeds drop below 2 m/sec. Chronic air pollution is present on all other days, especially in winter. Though the effects of pollution can also be categorized as chronic, acute, and sub-acute, the level of air pollution is still too weak to cause illness. Methodologies employed in determining the relationship between air pollution and human mortality and morbidity are reviewed, and hypotheses developed to describe the effects of pollution on illness and death in Rotterdam. Refinements in analytical methods are urged so that the factors influencing increased chronic nonspecific lung disease mortality and lung cancer mortality can be identified. It is also suggested that emission standards be supplemented by regulations making it possible to restrict emissions when meteorological data and monitoring station readings point to certain dangers.

16539

Sone, Akira

**THE SITUATION AND CONTROL OF AUTOMOTIVE EXHAUST EMISSIONS IN THE MIDDLE CITY (II) IN SENDAI CITY.** (Chutoshi ni okeru jidosha haikigasu to sono taisaku (II) Sendai shi ni okeru ichirei). Text in Japanese. Kogai to Taisaku (J. Pollution Control), 4(7):437-440, July 15, 1968.

Sendai city is a business and industrial center in northeastern Japan with a population of more than 500,000. The rate of increase of automobiles has nearly doubled since 1963, the total number in 1968 being 130,000. Present heavy traffic and automotive exhaust emissions are attributed to poor city and residential planning. Interstate highways run through the city and the total number of cars on the highways averages 13,000 per day. In a traffic survey conducted from 1961 to 1967, the average number of cars was found to be 1700 per hour. The increase in auto traffic has been accompanied by a proportional increase of CO, Pb, NO2, and dust fall. The effects of engine exhausts became apparent when the number of cars reached 2000 per hour. Carbon monoxide concentrations exceeded the emission standard of 5 ppm of Miyagi Prefecture. The maximum concentration was 31 ppm and the average, 8 to 13.5 ppm. The maximum Pb concentration was 4.26 gamma/cu m, far beyond the emission standard. Maximum dust fall was 6.8 mg/cu m, exceeding the emission standard of 2.0 mg/cu m. Before the survey, Sendai city was more concerned with industrial pollutants such as smoke and dust. The survey indicates that the effect of engine exhausts is more severe than that of industrial pollution.

16576

Yamate, Noboru, Tosiro Matsumura, and Masaharu Tonomura

**LEAD CONTAMINATION OF AIR ON STREET IN ELEVEN MAJOR CITIES IN JAPAN.** (Wagakuni 11 toshi no gairo taiki no namari osen ni tsuite). Text in Japanese. Eisei Shikensho Hokoku (Bull. Natl. Inst. Hyg. Sci., Tokyo), no. 85:158-160, 1967. 4 refs.

Lead concentrations in the atmosphere were determined at crossings and road sites in eleven major cities. The lead compounds were collected with a glass fiber filter and analyzed polarographically. The lead concentrations in the daytime were between 0.78 and 11.17 micrograms/cu m. The lead concentration at Route 20 in Tokyo was the highest; and the lowest was found at Sasashima in Nagoya and at Yayoikan in Yokkaichi. The lead concentrations in the atmosphere at crossings and road sites were influenced by traffic density, traffic stagnation, road condition, meteorological and geographical conditions. (Author abstract modified)

16684

Chovin, P.

**AIR POLLUTION STUDIES IN PARIS AND OUTLYING DISTRICTS IN 1967. 1. OPERATION 'CARBON MONOXIDE', 2. OPERATION 'GARAGES', 3. OPERATION 'MONTPARNASSE, RAILROAD STATION', 4. OPERATION 'LOOP OF THE SEINE'.** (Etudes de pollution atmospherique a Paris et dans les departements peripheriques en 1967. 1 - Operation 'Monoxyde de Carbone', 2 - Operation 'Garages', 3 - Operation 'Gare Montparnasse', 4 - Operation 'Boucle de la Seine'). Text in French. Prefecture de Police, Paris (France), Lab. Central, Rept. 58,337/D-PA, 80p., June 1968. 10 refs.

Results are reported of field studies of CO-pollution of air due to exhaust gases from motor vehicles in 1) central Paris, France (operation 'Carbon Monoxide') and 2) at air inlets and outlets of three underground parking garages (operation 'Garages'); 3) of air pollution by a variety of pollutants in the motor taxi hall of the new Montparnasse station in Paris (operation 'Gare Montparnasse'); as well as 4) of dust settling near the ground in the Seine river bend between Nanterre and Villeneuve-la-Garenne in the north-west part of the Departement de la Seine (operation 'Boucle de la Seine'). In 1), a total of 15,216 air samples were collected at 317 sites shown on the city map; 235 (1.54% of all) samples had a carbon monoxide content of more than 100 volume ppm at 129 of the sites. The average CO-concentration in the year 1967 was 25.9 volume ppm (a rising trend since 1960). In 2), in addition to the study of the0 effect of the presence of the garage ventilating system on the CO-concentration in its neighborhood, a search for the most representative locations of air sampling stations at different levels of an underground garage was undertaken. In 3), continuing a study begun in 1966, a laboratory van was stationed on July 29, 30, and 31, 1967 in the central part of the hall and the CO-, NO2- and NO- concentrations in air, and the Pb-content of dust collected in fitered were determined analytically and the concentration of benzo-3,4pyrene in this dust was determined fluorospectroscopically As a result of a modification of the originally installed ventilating system of the hall made after the 1966 tests, air pollution had diminished. In 4), continuing a study begun in 1959, dust from air was collected on 30 cm diameter settling dishes, at 22 sites. The material collected by a dish during one month consisted of water, insoluble dust particles (cinders and benzo-3,4pyrene) as well as water soluble dusts (sulfates, chlorides, and calcium compounds). The amounts of these were determined and referred to an area of 100 sq m per month. The average monthly total amounts of dust collected at the 22 sites are shown. The results are evaluated statistically and are presented in the form of monthly averages and histograms. At one site the amounts of benzo-3,4pyrene were consistently exceptionally high; 7 new settling dishes installed at sites close to and surrounding a suspected source had four times higher amounts of benzo-3,4pyrene than any of the 21 other sites. This pinpointed a charcoal and asphalt processing plant as the most probable source.

16791

Atkins, P. R.

**LEAD IN A SUBURBAN ENVIRONMENT.** J. Air Pollution Control Assoc., 19(8):591-594, Aug. 1969. 14 refs.

The lead content of air, rainfall, and dry-fallout samples taken at several sites in Palo Alto, California, are reported and discussed. The high-speed high-density freeway traffic in the area appears to be the major source of lead pollution. The natural atmospheric cleansing processes of sedimentation and raindrop scavenging remove large quantities of lead particulate matter. It is suspected that nucleation occurs on the submicronic lead compound particles in the exhaust stream, producing droplets which may impact on the larger airborne particles. This could explain the wide range of size distributions reported in the literature as well as the large amounts of lead found in the samples analyzed. (Author's Abstract)

16839

Landau, Emanuel, Raymond Smith, and David A. Lynn

**CARBON MONOXIDE AND LEAD - AN ENVIRONMENTAL APPRAISAL.** J. Air Pollution Control Assoc., 19(9):684-689, Sept. 1969. 7 refs.

The present status of ambient levels of lead and carbon monoxide in the air to which the population may be exposed, the concentrations that exist, and the variations over time and space are discussed. The sources of atmospheric Pb are emissions of Pb as fumes and dusts from industries using Pb and from the combustion of gasoline or other fuels containing Pb. Automobile emissions are the major source of Pb. Data obtained from the National Air Surveillance Network and from a Three-City Study (Cincinnati, Los Angeles, and Philadelphia) are discussed in some detail. Automobile emissions are also a major source of CO in the ambient air. The Continuous Air Monitoring Program has measured CO, NO, NO2, SO2, total hydrocarbons, and total oxidant in the downtown of six selected cities. The data relating to CO are discussed. Because of the common source Pb and CO values in the atmosphere tend to behave in a similar manner. Diurnal variations in these two pollutants show a pattern related to motor vehicle traffic flow. (A discussion related to this topic is presented by George D. Clayton).

17058

Bove, John L. and Stanley Siebenberg

**AIRBORNE LEAD AND CARBON MONOXIDE AT 45TH STREET, NEW YORK CITY.** Science, 167(3920):986-987, Feb. 1970. 4 refs.

Lead and carbon monoxide concentrations at a site 6 m above street level on East 45th Street were monitored for a ten-week period by a sequential tape recorder and a nondispersive infrared analyzer, respectively. The average two-hr concentration between 8:00 am and 6:00 pm was 9.3 micrograms for lead and 18 ppm for carbon monoxide. Daily averages were 7.5 micrograms/cu m for lead and 13 ppm of carbon monoxide. Curves obtained by plotting the concentrations against traffic volume demonstrated strong correlations between lead and traffic and lead and carbon monoxide. During an overlapping 10-wk period, lead concentrations were also determined for a 12-m elevation in Central Park and a 30-m elevation on Second Avenue. The daily average for Central Park was 0.97 micrograms/cu m and for Second Avenue, 1.57 micrograms/cu m.

17106

Endo, Ryosaku, Tetsutaro Kohgo, Tatsunori Oyake, Naoki Sugawara, and Toshiko Sakamoto

**STUDIES ON THE URBAN ATMOSPHERIC POLLUTION BY AUTOMOTIVE EXHAUST GAS IN THE CITIES OF HOKKAIDO. (PART 2). ON THE INVESTIGATION IN OTARU CITY.** (Hokkaido no toshi ni okeru jidosha haiki gasu no taiki osen ni tsuite (dai 2 ho) otarushi ni okeru chosa kekka ni tsuite). Text in Japanese. Hokkaido-ritsu Eisei Kenkyushoho, no. 18:143-149, June 1968. 11 refs.

The urban atmospheric pollution caused by automotive exhaust gas in Otaru was investigated. The measurement of dusts, carbon monoxide, sulfur dioxide, nitric oxide, nitrogen dioxide, lead, and 3,4-benzopyrene and the number of vehicles were carried out at 4 places along the roadside. The road at points A and B was narrow, at points C and D, it was wide. It was cloudy and calm at points A and B, and was clear and windy at points C and D. More vehicles passed by points A and B, with a maximum of 2000/hr at B. The concentration of all the pollutants were higher at point B with the exception of SO2. The maximum concentrations were listed. It was concluded that the atmosphere at the point B was more contaminated than points in the cities of Kushiro and Asahikawa which were previously investigated. (Author abstract modified)

17340

Kneip, Theo. J., Merril Eisenbud, Clifford D. Strehlow, and Peter C. Freudenthal

**AIRBORNE PARTICULATES IN NEW YORK CITY.** J. Air Pollution Control Assoc., 20(3):144-149, March 1970. 10 refs.

Seasonal and source effects on the particulate contaminants of New York City atmosphere were identified and the concentrations of these contaminants were related to the tissue concentrations in residents of New York City. Continual weekly samples of particulates were collected at three stations in New York City area on 8 by 10 in. glass fiber filters at a flow rate of 20 cfm. The sample was ashed and leached with nitric acid. Metals analyzed by the atomic absorption method include Pb, V, Cd, Cr, Cu, Mn, Ni, and Zn. Lead-210, total particulate, and benzene and acetone soluble organic material were also determined. The data were related to various meteorological parameters over a one year period to define significant seasonal and source influences, as well as site to site variations. Very significant inverse correlations to temperature were obtained for suspended particulates, vanadium, and nickel at both the Manhattan and Bronx sites. Particulates show a less significant inverse correlation to temperature in lower Manhattan. Oil-fired space heating sources appeared to account for as much as 50% of the particulates in the Bronx at the peak demand period. Lead, copper, and cadmium show a general inverse correlation to average wind speed, and a direct correlation to temperature. The latter is most likely due to an inverse relation between wind speed and temperature. The heating season imput for particulates, vanadium, and nickel was so great as to overcome most of the dilution effect due to winds. The other elements having more constant nonseasonal inputs, definitely reflected, the effects of the wind. The most significant site effect occurs with cadmium, which has a concentration in lower Manhattan three times that of the Bronx over a period of six to seven months in the summer and fall. The differences observed for cadmium and particulates may be explained by emission source factors which were not studied. (Author abstract modified)

19144

Hansell, William A.

**THE GEORGIA STATE AIR QUALITY CONTROL PROGRAM.** Vanderbilt Univ., Nashville, Tenn., School of Engineering, Tennessee Stream Pollution Control Board, and Tennessee Dept. of Public Health, Proc. Conf. Environ. Water Resources Eng., 8th Ann., Nashville, Tenn., 1969, p. 179-190. 4 refs. (June 5-6.)

Air quality legislation enacted in Georgia in 1967 gave the state Board of Health the power to establish air quality standards for Georgia; to prescribe for the prevention, control, and abatement of air pollution; and to require the registration of all persons engaged in operations which may result in air pollution. Within the Air Quality Control Branch there are two groups, each headed by a director: the Air Pollution Control Service and the Air Quality Evaluation Service. The former has six pollution control specialists on its staff; the latter, four. Included in the article are data on thermal inversions over Georgia; average concentrations (1962-1967) of oxidants, nitrogen dioxide, sulfur dioxide, and suspended particulates in seven Georgia communities; and yearly composites (1965-1968) for the Georgia Air Sampling Network of suspended particulates, beta radioactivity, lead, and benzene solubles.

19433

Bravo, H. and L. Corona T.

**ATMOSPHERIC CONTAMINATION AND ITS RELATION WITH VEHICULAR FLOW IN MEXICO CITY.** Universidad Nacional Autonoma de Mexico, Mexico Cit Facultad de Ingenieria, 1969. 7 refs. Translated from Spanish. Belov and Associates, Denver, Colo., 27p., March 12, 1970.

A study was conducted to determine the degree of contamination expected in the air over Mexico City during the period of the 19th Olympic Games. Measurements were conducted through November 1968 in order to establish immediate comparison with the Olympic period. Recognizing that vehicular activity would be greatest in the areas adjacent to the games and other tourist attractions, the study attempted to obtain a correlation between the number of vehicles in circulation and the degree of contaminant concentration. At the same time, meteorological parameters that influence concentrations were measured. A set of analyses made on air filter samples during October and November 1968 is presented. Concentration of carbon monoxide and methane in the air samples and the total of suspended particulate matter and lead in the filters was also obtained. The concentrations of detected contaminants were correlated with transit parameters (velocity, flow, and vehicle concentration), taking into account the residual variables relative to meteorological phenomena. A regression equation to compute ppm carbon monoxide as a function of temperature, vehicle flow, and the amount of methane was derived. Contaminant concentrations indicated that a critical condition exists in Mexico City.

19822

Magno, P. J., P. R. Groulx, and J. C. Apidianakis

**LEAD-210 IN AIR AND TOTAL DIETS IN THE UNITED STATES DURING 1966.** Health Phys., 18(4):383-388, April 1970. 22 refs.

The average lead-210 concentration in air particulates for 1966 differed significantly between locations and ranged from 4.8 to 26.1 fCi/cu m, while the concentration in total diet was not significantly different between locations and averaged 0.80 pCi/kg. A portion of a sample of air particulates representing approximately 200-1000 cu m of air was obtained daily from

selected sampling stations by drawing air through dust filters at high velocity. Total diet samples were also obtained from selected stations. Lead-210 concentrations exhibited seasonal variations for samples collected at Springfield (Ill.), Salt Lake City, New Orleans, Los Angeles, and Winchester (Mass.), but showed no seasonal variations at Honolulu, San Juan, and Anchorage. Locations affected by air masses which have passed over ocean waters (and hence lower in radon-222) appear to have lower lead-210 concentration than inland locations. It was estimated that an average of 0.15-0.21 pCi/day of lead-210 reaches the blood stream of inhabitants of the United States, and that about 70-90% of this amount comes from iingestion. (Author abstract modified)

20191

Cross, Frank L. Jr., Ronald J. Drago, and Harold E. Francis

**METALS IN EMISSIONS FROM INCINERATORS BURNING SEWAGE SLUDGE AND MIXED REFUSE.** Preprint, National Air Pollution Control Administration, Research Triangle Park, N.C., Office of Manpower Development and Connecticut State Dept. of Health, Hartford, 15p., 1969. 3 refs.

The metals and particulates content in the atmospheric emissions from a 300-ton-per-day incinerator burning mixed refuse and sewage sludge were investigated. Three isokinetic samples were collected while the system was burning refuse and three while burning mixed refuse and dried sludge. The emissions from burning refuse plus sludge were 1.7 times greater than burning refuse alone. The emissions of metals while burning refuse ranged from 0.007 lbs/hr (Cd) to 1.5 lbs/hr (Pb), and when burning refuse and sludge from 0.007 lbs/hr (Cd) to 2.13 lbs/hr (Zn). The incinerator charging rate was determined during the tests, and emission factors were calculated in terms of pounds of metals discharged from the stack per ton of fuel charged to the incinerator. Emission factors ranged from 0.00077 to 0.15 lbs/ton while burning mixed refuse and from 0.00057 to 0.18 lbs/ton while burning refuse and sludge. The ratio of refuse to sludge in the charges during these tests was approximately 3.5 to 1. The burning rate during these tests averaged 85% of the rated capacity of the incinerator. The removal and recovery of metals from incinerator stack gases is a problem for the design engineer; the effect of the airborne metals on the environment a problem for the ecologist.

20642

Just, J., S. Maziarka, and H. Wyszynska

**SANITARY EVALUATION OF DUST CONTAIN IN AMBIENT AIR OF SOME CITIES IN POLAND.** (Sanitarna charakterystyka i ocena zapylenia powietrz atmosferycznego niektorych miast w Polsce). Text in Polish. Gaz, Woda Tech. Sanit. (Warsaw), 44(3):96-100, 1970. 23 refs.

Samples of atmospheric aerosols were systematically collected in ten towns. The contents of dust, tar, some polycyclic aromatic hydrocarbons, lead, and beryllium were determined. The level of atmospheric pollution was evaluated on the basis of existing standards and toxicological literature. High contents of particulate matter in the air were found in all the towns studied; the highest levels were found in Zabrze, Katowice, and Krakow. In several towns, the level of airborne carcinogenic hydrocarbons was also very high. It is believed that the metal content would cause no harmful effects.

21015

Hasegawa, T. and A. Sugimae

**TRACE METALS IN SUSPENDED PARTICULATES IN OSAKA PREFECTURE. PART I.** (Osaka ni okeru fuyufunjinchu no kinzokuseibun (1). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 4(1):143, 1969. (Proceedings of the 10th Annual Meeting of the Japan Society of Air Pollution, 1969.)

Suspended dust particles in air from several locations in the Osaka area were studied over a six-month period with particular emphasis on metal elements in the particles. The dusts were collected for 24 hrs by high-volume air samplers, and were accumulated on glass fiber filters. Without prior treatment, the particles were quantitatively analyzed for metallic elements by means of spectroscopy, which was a much more direct and easier method to use than the time-consuming NASN method. In heavy oil combustion, vanadium was found in a much larger quantity than other metals, and iron and manganese proliferated around the cupola furnaces. Lead was extracted from auto exhausts. The correlation between sulfur compounds and vanadium in heavy oil combustion gas was good but on rainy days, the linear relationship went askew, apparently because rain decreases the concentration of sulfur oxides in air. Relationships between various metals were investigated in connection with location, daily variations, and meteorological factors.

21684

Parungo, Farn P. and J. Owen Rhea

**LEAD MEASUREMENT IN URBAN AIR AS IT RELATES TO WEATHER MODIFICATION.** J. Appl. Meteorol., 9(3)468-475, June 1970. 8 ref

Results from measurements made to study the behavior of lead aerosols in Denver urban air as latent ice nuclei are discussed. In the study, use was made of three independent measuring systems: 1) an NCAR continuous ice nucleus counter with a capacity to convert suspended lead compounds to lead iodide particles prior to passage through the cloud chamber and counting unit, 2) an atomic absorption spectrophotometer for analysis of lead content in collected air and rain water samples, and 3) the use of Tufts' spot test for obtaining lead particle concentration and size distribution from collected Millipore filters. Both ground and airborne measurements were made. Pertinent findings included: 1) good qualitative agreement among the three types of measurements; 2) lead content of rain water an order of magnitude greater than silver concentration in seeded snow samples which were collected in a weather modification seeding target area using silver iodide as the seeding agent; and 3) 10-300 lead particles (latent ice nuclei)/liter existing up to 9000 ft above the surface when unstable temperature stratification existed and which were converted into active ice nuclei (lead iodide particles) when passed through an iodine vapor chamber. (Author abstract)

21869

Tairafune, K., M. Takahashi, and A. Sato

**STUDIES ON CHEMICAL CONSTITUENTS OF FREE DUST IN IWATE PREFECTURE.** (Iwate-ken ni okeru fuyubaijin no kagakuteki seibun ni tsuite). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 4(1):3, 1969. (Proceedings of the 10th Annual Meeting of the Japan Society of Air Pollution, 1969.)

An analysis of dust particles in the atmosphere has been conducted since 1968 in Kamaishi, Miyako, Ofunato, Higashiyama-cho and Morioka in Iwate Prefecture. Except for Morioka, chosen as a control area, the other locations are mainly engaged in steel and iron production, metal refining, and cement production. The collection of dust particles and

their chemical analysis were performed according to the methods used by NASN of the U. S. Public Health Service. Major items of interest were concentration by weight, pH, sulfates, nitrates, and benzene-soluble organic matters. Metallic components were analyzed by means of atomic absorption tests. In order to observe the possible effect of pollution on the local residents, hair from 1000 persons was collected and analyzed by atomic absorption tests. Large amounts of copper, manganese, lead, iron, calcium, and magnesium were extracted, indicating that dust particles do have an effect on people.

21906

Wagman, Jack

**AEROSOL COMPOSITION AND COMPONENT SIZE DISTRIBUTIONS IN URBAN ATMOSPHERES.** Preprint, California State Dept. of Public Health, Berkeley, California Air Resources Board, Los Angeles, California Univ., Berkeley, Public Health Service, Washington, D. C., National Air Pollution Control Administration, 19p., 1970. 10 refs. (Presented at the Conference on Methods in Air Pollution and Industrial Hygiene Studies, 11th, Berkeley, Calif., March 30, 31, and April 1, 1970.)

Data for chemical components in atmospheric aerosols were obtained by the use of cascade impactors. Of the components studies, sulfate, nitrate, chloride, ammonium, and lead were consistently found in association with sub-micron sized particles. These particles are highly respirable and include the aerosol fraction that is most effective in scattering light. Phosphate and such metals as iron, nickel, and copper are contained in larger particles. More emphasis should be placed on determining particulate compounds and not merely elements, for it is primarily as compounds that particulate matter either cause or fail to cause health or economic damage. Atmospheric aerosols have been characterized primarily by measuring their bulk properties and very rarely by studying the nature of individual particles; yet, it is as individual particles that aerosols exert their pollutant effects. (Author conclusions modified)

22290

Japan Environmental Sanitation Association

**STUDIES ON THE ANALYSIS OF CONTAMINATING SUBSTANCES IN THE ATMOSPHERE.** (Taiki osen busshitsu no bunseki ni kansuru kenkyu). In: Studies on the Measurements of Trace Metals in the Atmosphere. Emission Spectroscopic Analysis. (The Report of Inquiries and Studies on the Public Nuisance in the Commission of the Ministry of Welfare in 1966.) 19p., March 1967. 7 refs. Translated from Japanese. Franklin Inst. Research Labs., Philadelphia, Pa., Science Info. Services, 35p., Oct. 21, 1969.

The results of an investigation of the quantity of metallic contaminants in ambient air are given. The analysis is conducted spectrophotometrically on samples from a high-volume sampler, taken at three locations over a six month period. The metals measured include vanadium, manganese, nickel, chromium, lead, iron, and beryllium. A detailed description of the methods used is provided, including luminous, spectral, and photometric conditions, and sample electrodes. The analytical accuracy and internal standards of the method are verified. A result of this study is the establishment of an analytical procedure for conducting quantitative investigations.

22553

Volchok, H. L. and M. T. Kleinman

**RADIONUCLIDES AND LEAD IN SURFACE AIR.** In: Health and Safety Laboratory Fallout Program Quarterly Summer Report. Appendix. Atomic Energy Commission New York, Health and Safety Lab., p. 1-6, 78-81, July 1, 1970. CFSTI: HASL-227

Since January 1963, the Atomic Energy Commission Health and Safety Laboratory has been conducting the Surface Air Sampling Program, the primary objective of which is to study the spatial and temporal distribution of nuclear weapons debris and lead in the surface air. From late 1965 through March 1969, samplers were placed on four Atlantic Ocean weather ships to extend the surface air study over the marine environment. Approximately 1400 cu m of ambient air per day are drawn through a 20 cm diameter Microsorban filter for the land stations; at the ocean stations, about 2200 cu m of air per day are filtered with 20 by 25 cm Microsorban filters. The gamma activity of half of the monthly composites are obtained with an 8 by 4-in. sodium iodide crystal. The other halves of the monthly composites are sent to a contractor laboratory for radiochemical analyses. Tables are presented for stable lead concentrations in surface air for 1966, 1967, 1968, and 1969.

22829

Lundgren, Dale A.

**ATMOSPHERIC AEROSOL COMPOSITION AND CONCENTRATION AS A FUNCTION OF PARTICLE SIZE AND OF TIME.** J. Air Pollution Assoc., 20(9):603-60 Sept. 1970. 3 refs.

As a step toward better understanding of the reactive Los Angeles air basin atmosphere, studies were conducted at Riverside to determine the composition and concentration of atmospheric particulate matter as a function of particle size and time. The study involved developing a method for obtain size-classified, time-fractionated aerosol samples amenable to chemical and physical (including microscopic) analysis. During a 15-day period, samples were obtained over four-hr periods and subsequently analyzed for nitrate, sulfate, iron, and lead. Concentration of six gaseous pollutants, total aerosol light scattering, and several meteorological measurements were simultaneously recorded and averaged over the four-hr intervals. A strong relationship between gaseous peroxyacetyl nitrate, particulate nitrate, and aerosol light scattering was found. High concentrations of ammonium nitrate particles, mainly in the 0.5-2 micron diameter range, were found in the atmospheric particulate samples collected on days of very high smog. The data obtained is presented graphically to show diurnal variation in the relationship among gaseous, particulate and meteorological measurements. (Author abstract modified)

23388

Laamanen, Arvo

**TRACE METAL PROFILES AS ENVIRON-CHEMICAL MEASURES OF URBAN AIR IMPURITY IN FINLAND.** Work-Environ.-Health, 6(1):31-40, 1969. 19 refs.

Investigations of nuisance phenomena and research on health effects caused by air pollution are directing special attention to a growing list of particulates containing inorganic substances that occur especially in the air of populated communities, originating at point and area sources. An evaluation of the presence of trace metals in ashed samples in the air of Finland is presented. The elements measured are zinc, copper, lead, manganese, chromium, vanadium, nickel, titanium, and tin. Monthly and site-to-site variations are discussed. Seasonal distributions of minimal and maximal city averages are deter-

mined; most of the minimums are observed in the winter, while the maximums are more variable. Whenever possible, the particulates are related to the probable point or area source in the vicinity. The samples are obtained by the standard dustfall method in five Finnish cities, and are analyzed spectrographically.

23658

Chow, Tsaihwa J. and M. S. Johnstone

**LEAD ISOTOPES IN GASOLINE AND AEROSOLS OF LOS ANGELES BASIN, CALIFORNIA.** Science, vol. 147:502-503, Jan. 29, 1965. 10 refs.

The isotopic composition of lead isolated from antiknock gasolines and the aerosols of the Los Angeles basin was determined. By refluxing with concentrated hydrochloric acid for several hours, lead in the gasoline and in the air filtrate was extracted, and then isolated and purified by dithizone extraction. Mass spectrometric analyses were then performed. Comparison indicates that these two kinds of lead are identical within the limits of measurement error, and represent a typical 'tertiary' age lead which is less radiogenic than that of the common 'modern' lead. The isotopic composition of lead in the 1963 winter rural snow is also similar to that of the Los Angeles basin aerosols; the difference between the rural snow and the aerosols with respect to the ratio of Pb-206 to Pb-207 was about 0.8%. Contamination from the leaded gasoline alone at Lassen Volcanic National Park is calculated to be 1.1 micrograms per kilogram of precipitation. Since the advent of antiknock gasoline in 1923, more than 2.6 times 10 to the 12th power grams of lead in the form of lead alkyls have been marketed and combusted.

23864

Kruger, Paul

**PB210 IN SURFACE AIR ALONG THE SLOPES OF MAUNA LOA VOLCANO, HAWAII. (FINAL REPORT).** Stanford Univ., Calif., Dept. of Civil Engineeri AEC Contract AT(04-3)-326-PA16, SU TR-117, 22p., Sept. 1969. CFSTI: SU 326-PA-16-3

During one-week periods in the summers of 1966 and 1967, atmospheric aerosols were collected in high-volume samplers located at ground-level sites in Hawaii and along the slopes of volcanoes. The samples were analyzed for Pb210 and Sr90. At one site, air samples were collected in evacuated bottles and analyzed for radon. The general concentrations of Pb210 in Hawaii surface air are by no means low compared to concentrations over continental land masses. The comparatively large values suggest that little Pb210 is removed from the atmosphere during wind transport over the open ocean. Unlike Sr90 concentrations, which were essentially constant at all heights, the Pb210 concentrations decreased up to about the altitude of normal trade wind inversions and showed a marked increase above inversion height. The negative gradient of Pb210-Sr90 concentration ratios suggests a contribution to the Pb210 concentration by decay of Rn222 from local sources. The mean residence time of Rn222 was 0.5 hrs in 1966 and 3.75 hrs in 1967.

23971

Ruhling, Ake and Germund Tyler

**REGIONAL DIFFERENCES IN THE DEPOSITION OF HEAVY METALS OVER SCANDINAVIA.** (Regionala skillnader i nedfallet av tungmetaller oever Skandinavien). Text in Swedish. Lund Univ., Sweden, Inst. of Ecological Botany, Rept. 10, 23p., Feb. 1970. 7 refs.

The metal content in a common sort of moss is investigated, revealing an evident difference between southern Sweden and northern Scandinavia. A distinct increase in lead is observed in the southern regions of the study, indicating that lead must be transported from Western Europe by air. The greatest industrial sources of lead in Sweden are in the north. Concentrations of calcium, cadmium, cobalt, chromium, copper, iron, potassium, magnesium, manganese, sodium, nickel, lead, and zinc are measured. A distinct correlation between rainfall and metal concentration is observed.

24162

Thom, Norman G.

**AIR POLLUTION FROM MOTOR VEHICLES IN NEW ZEALAND.** SAE-Australasia, 30(4):136-142, July-Aug. 1970. 6 refs. (Presented at the Vehicle Exhaust Symposium, Auckland, New Zealand, April 15, 1970.)

Air pollution monitoring in New Zealand, particularly in Auckland, has indicated that levels of pollution originating from motor vehicles are comparable with those of similar sized cities in developed countries. Carbon monoxide affects the body by combining with the hemoglobin of the blood to form carboxyhemoglobin, thus decreasing the ability of the blood to carry oxygen to body cells. The maximum two hour concentration measured in Auckland would result in approximately 3% of a person's hemoglobin being combined with CO if he were a non-smoker and stayed in the area where the measurements were taken for two hours. The major significance of the oxides of nitrogen in air pollution is the role they play in the formation of photochemical smog. Average 24 hour concentrations in Auckland range from 0.4 pphm in the outer suburbs to 9.0 pphm in the city streets. Hydrocarbons no doubt include many of the gases which give rise to traffic odors, while some of the ring shaped compounds are known carcinogens. The main significance of the hydrocarbons emitted in the exhaust gases is that they contain many unsaturated compounds which are very reactive in the processes which give rise to photochemical smog. However, Auckland has neither the topography nor meteorology likely for promoting this type of phenomenon. Values of airborne lead range from peak concentrations of 6.0 micrograms/cu m in city streets to an average 0.6 micrograms/cu m in residential areas Lead is to some degree a cumulative poison in the human body. Generally, a well maintained diesel that is not overloaded gives rise to less air pollution than an equivalent gasoline vehicle. Control of air pollution from automobiles is also mentioned.

24316

Volchok, H. L. and M. T. Kleinman

**RADIONUCLIDES AND LEAD IN SURFACE AIR.** In: Health and Safety Laboratory. Fallout Program. Quarterly Summary Report. Appendix. Atomic Energy Commission, New York, Health and Safety Lab., C1-C90, Oct. 1, 1970. 2 refs. NTIS: HASL-237

An air sampling program designed to sample and analyze radioactivity and lead in the surface air is described. In additio to samplers on land investigating the possible effects of elevation, longitude, and proximity to coastlines, these are four samplers on Atlantic Ocean weather ships. Samplers consist of 20 cm Microsorban filters. They are analyzed by gamma counting, spectrometry, and radiochemistry. Since there were no major weapon test series during the time of this investigation, only the longer-lived artifically produced radionuclides were present in the filters. They describe the general distribution in surface air of all previous nuclear weapon debris which

was transferred from the lower stratosphere to the troposphere during the collection period of this report. Other tracer nuclides can be associated with debris from a single detonation or series of detonations. The activity concentrations of all the radionuclide, gross gamma, and stable lead analyses are presented in tabulated form.

24351

Laamanen, Arvo and Timo Partanen

**FACTOR ANALYSIS OF GENERAL AND SPECIFIC COMPONENTS OF PARTICULATES IN THE AIR OF FOUR FINNISH CITIES.** Work-Environ.-Health, 6(1):50-54, 1969. 9 refs.

Interrelations between air contaminants are of interest when grouping contaminants and when establishing compact impurity profiles for different areas, especially if emission data or its effects on air composition are scarce. The information provided by inter-component correlations may also be used in source tracing; a certain impurity profile may give clues to the polluting source. An analysis of the factor pattern of deposited impurities in Finland is presented, using a set of 17 components of particle fall, both general and specific. Observed values of pH, ash, combustible organic matter, water soluble matter, calcium ion, chlorine ion, sulfate ion, titanium, vanadium, copper, nickel, chromium, manganese, lead, benzene soluble organic matter, and other organic matter from 27 sites are recorded. Upon analysis of the interrelations, three source factors can be extracted. They represent oil heating and internal combustion engine effects, specific industrial sources, and general industrial sources.

24414

Daines, Robert H., Harry Motto, and Daniel M. Chilko

**ATMOSPHERIC LEAD: ITS RELATIONSHIP TO TRAFFIC VOLUME AND PROXIMITY TO HIGHWAYS.** Environ. Sci. Technol., 4(4):318-322, Apr 1970. 16 refs. (Presented at the American Chemical Society, Division of Water Air and Waste Chemistry, Symposium on Air Conservation and Lead, National Meeting, 157th, Minneapolis, Minn., April 1969.)

Minimum, maximum, and average values are presented for a two-year sampling of atmospheric lead at various distances from U. S. Route 1. The sites represent traffic densities ranging from 19,800 to 58,000 vehicles per 24 hrs. The data make it clear that automobile traffic contributes to the lead in the atmosphere and also that traffic density and distance from the highway affect the lead levels that occur. Lead levels decreased over 50% between 10 and 150 ft from the highway, then slowly and quite uniformly between 150 to 200 and 500 ft. The lowest lead values were obtained from February through May or June and the highest in September, October, and November--the months when wind velocity and atmospheric mixing depths were at a minimum. Accompanying particle size determinations indicate that over 65% of the lead in the air from 30 to 1750 ft from a well-traveled highway consists of particles under two micron, with over 85% consisting of particles under 4 micron in diameter.

24463

**AIR'S LEAD LEVEL IS ACCEPTABLE.** Oil Gas J., 63(18):68, May 3, 1965

A government-industry study of air samples taken in Cincinnati, Los Angeles, and Philadelphia indicates that existing lead concentrations pose no threat to public health. The mean concentration of lead ranged from 0.014 mg/cu m on Cincinnati streets to 0.025 mg/cu m on Los Angeles freeways. Blood concentrations ranged from a mean of 0.011 mg/100 g in suburban nonsmokers in Philadelphia to 0.038 for garage mechanics in Cincinnati.

24952

Atkins, P. R.

**LEAD IN A SUBURBAN ENVIRONMENT.** J. Air Pollution Control Assoc., 19(8):591-594, Aug. 1969. 14 refs.

The lead content of air, rainfall, and dry fallout samples taken at three sites in Palo Alto are reported and discussed. Airborne lead concentrations as high as 10 micrograms/cu m were observed near an expressway during periods of peak traffic flow. The concentrations appear to be related to traffic density and atmospheric turbulence. During morning hours, when turbulence was at a minimum, lead concentrations were nearly proportional to traffic flow; in the afternoon, when mixing increased, the concentrations were considerably reduced. The dry fallout data indicate that a large amount of lead is removed from the atmosphere by sedimentation and suggest that nucleation on submicron lead particles in exhaust streams can produce droplets that impact on larger particles. The rainfall samples contained lead pollutants from 1.0 mg/l to less than 0.004 mg/l. The lead appears to have entered the rainfall by scavenging near the surface where the airborne lead concentrations varied widely. Since scavenging is inefficient for particles less than one micron, the removal of lead by rainfall further indicates that some lead particles become attached to larger particles.

25055

Laveskog, Anders

**A METHOD FOR DETERMINATION OF TETRAMETHYL LEAD (TML) AND TETRAETHYL LEAD (TEL) IN AIR.** Preprint, International Union of Air Pollutio Prevention Associations, 86p., 1970. 12 refs. (Presented at the International Clean Air Congress, 2nd, Washington, D. C., Dec. 6-11, 1970, Paper CP-37D.)

A series of field experiments conducted in Sweden to detect and determine the amount of organic lead compounds in automobile exhaust gases and in street air is described. Previous studies indicated that available methods of analysis were unreliable and lacked the sensitivity that was required for a problem as dubious in nature as the one to be undertaken. The organic lead compounds analyzed were tetraalkyl lead compounds, and among them tetramethyl lead, TML, and tetraethyl lead, TEL, have occurred most frequently and are often the only ones present. The method of analysis that was developed is based upon enrichment of air samples; separation in a gas chromatograph; and detection with a mass spectrometer. The time required for sampling is short, 10-15 minutes for street air and between 5 seconds and one minute for atuomobile exhaust gases. TML and TEL are analyzed separately and from other organic lead compounds. The sensitivity of the method is high, 10 mg/cu m of air. Analyses of automobile exhaust gases show that the amount of TML and TEL varies between 5 and 5000 micrograms/cu m of exhaust gas and that this difference seems to depend on the working temperature of the motor, with higher quantities found at lower temperatures. Analyses of street air show that the quantity of TML and TEL varies between 0.02 and 2 microgram/cu m of air. An average of 0.25 microgram/cu m for 24 hours was measured during November and December 1969, in major streets in Stockholm. There seems to be only a slight connection between the occurrence of tetraaklyl lead and other pollutants in street air but some relation can be connected with the intensity of traffic load. (Author abstract modified)

25089

Wieser, P. H., and F. Woerner

**ARTIFICIAL RADIOACTIVITY IN SURFACE AIR, PRECIPITATION, AND DUST IN STUTTGART-HOHENHEIM IN THE YEARS 1963 to 1968.** (Kuenstliche Radioaktivitaet von bodennaher Luft, Niederschlag und Staub in Stuttgart-Hohenheim in den Jahren 1963-1968). Text in German. Meteorol. Rdsch., 23(4):99-101, 1970. 7 refs.

Samples of wet and dry precipitation (rain and dust) were collected in vats of 1 sq m area, artificial radioactive aerosol from air adjacent to the ground was separated by an aerosol filter and total beta- activity and Sr-90 activity data obtained from Dec. 1962 through Dec. 1968 were recorded. The recorded monthly data of both total beta activity and of Sr-90 activity manifest a decreasing tendency from 1962 to 1967 but the seasonal variations with distinct maxima which vary from year to year are preserved. The decrease in atmospheric radioactivity is due to radioactive decomposition and to atmospheric elimination processes of radioactive nuclides generated by American and Soviet nuclear test explosions in 1961 and 1962. Total beta activity in 1968 is markedly higher than that measured in 1967 which is due to Chinese nuclear test explosions. The Chinese tests made it impossible to follow the decrease of artificial atmospheric radioactivity over a long period of time. Also recorded were monthly Pb-210 levels.

25107

Bravo, H., Thomas Stanley, Rebecca Nulman, and Lloyd Monkman

**CONCENTRATIONS OF LEAD, BAP AND BKF IN THE ATMOSPHERE OF THREE MEXICAN CITIES.** Preprint, International Union of Air Pollution Prevention Associations, 13p., 1970. 9 refs. (Presented at the International Clean Air Congress, 2nd, Washington, D. C., Dec. 6-11, 1970, Paper Su-30C.)

Concentrations of benzo(a)pyrene (BaP) and benzo(k)fluoranthene (BkF) in Mexico City were determined by both Canadian and American analytical methods, while concentrations for two smaller Mexican cities were determined only by the Canadian procedure. The results show the need for control of combustion sources in Mexico City. The BaP and BkF values reported are comparable with concentrations in Cincinnati, Birmingham (Ala.), and Los Angeles; higher than those in Ottawa; and lower than those in Paris. Data are also presented on lead concentrations at two sampling sites in Mexico City. The high values are attributed to the uncontrolled concentration of antiknock lead compounds in Mexican gasoline. International standardization of sampling and analytical techniques is suggested.

25635

Vittoria, Ottavio and P. Mandrioli

**LEADED PARTICLES IN URBAN AREAS.** J. Rech. Atmospheriques, no. 6:457-462, Oct.-Dec. 1966. 5 refs.

Particulate matter in several localities in Bologna was collected on Millipore filters and analyzed for lead by the colorimetric Dithizone method. Results are presented for the lead content of winter and summer air samples taken in the immediate vicinity of a small square characterized by dense day-time traffic. They show no adverse lead levels resulting from the large amount of exhaust gas released in the area. Moreover, lead concentrations were not markedly affected by conditions of atmospheric stability prevailing during some winter sampling periods. Microchemical analysis of particles showed that, at high humidities and low temperatures, large leaded water droplets are produced by the condensation of water in exhaust. Thus a powerful mechanism for removing lead particles exists in such meteorological conditions.

25758

Oki, Iwashiro and Sachiko Tamura

**GAMMA RAY SPECTROMETRY OF THE NATURAL RADIOACTIVITY IN THE AIRBORNE DUST.** J. Radiat. Res., 10(2):78-82, June 1969. 2 refs.

By means of gamma ray spectrometry, a qualitative variation in the diurnal variation of the natural radioactivity in the airborne dust was observed. The radioactive decay rate of the total natural radioactivity in the airborne dust collected during the day was higher than that collected during the night. The ratio of radioactive lead (Th B) gamma activity to the total gamma activity was higher in the night and lower in the day; on the other hand, the ratios of radioactive lead (Ra B) and radioactive bismuth (Ra C) were a little higher in the day than in the night. From the observation, it was concluded that the quantitative diurnal variation of the natural radioactivity in the airborne dust was associated also with the qualitative variation derived from the variation in the abundance ratio of nuclide. (Author abstract modified)

25881

Kobayashi, Yoshitaka, Masahiro Hori, and Kenzaburo Tsuchiya

**HORIZONTAL AND VERTICAL DISTRIBUTION OF LEAD PARTICULATES IN AIR AROUND A BUSY ROAD IN YOKOHAMA CITY.** (Shigaichi ni okeru shadoshuhen no taikichu namari no bunpu). Text in Japanese. Nippon Koshu Eisei Zasshi (Japan J. Public Health), 17(6):307-312, June 15, 1970. 10 refs.

Investigation of lead concentrations of air around a road having heavy motor traffic in Yokohama city was reported. The air samples for lead determination were collected by means of a high-volume air sampler. Lead particles collected on the filters of the sample were analyzed by a polarographic method after a simplified pre-treatment. Concentrations of lead in the air over the sidewalk of the road were 2 to 5 micrograms per cubic meter. At a sampling station 100 meters from the road, the average annual concentration was 1.1 to 1.3 micrograms per cubic meter. This value was as low as that of the average in residential areas of the city. The pattern of the average diurnal concentrations of lead showed a peak in the morning and another in the evening, coinciding with the rush hours of urban motor vehicle traffic. Concentrations of lead in air decreased with the distance from the road as far as 100 meters, but became constant further from that point. The vertical concentrations of lead were almost constant at 20 meters above ground at a point 100 meters away from the road. Concentrations of lead were generally the highest during winter and the lowest in summer. The average concentration for 7 years was 0.75 micrograms/cu m, lower than that of Los Angeles, Philadelphia, and Cincinnati, corresponding to the suburban areas of these cities The reason could not be determined at the present stage. Cadmium concentration was about 1/100 of lead concentration (average for September and October was 0.009 micrograms/cu m). No correlation between cadmium and lead concentration could be observed, probably because the sampling was not of sufficient number, but it may also be that the source of cadmium is not the automobile exhaust gas. Further studies will be made to determine whether or not lead concentration of the above magnitude would accumulate in human bodies.

26044

Yokohama Municipal Office (Japan), Bureau of Public Health and Kawasaki City Office (Japan), Bureau of Public Health

**THE INVESTIGATION OF THE ACTUAL CONDITION OF AIR POLLUTION. 1.1 AIR POLLUTION IN THE KEIHIN INDUSTRIAL DISTRICTS.** (Taikiosen no jittai chosa. 1. Keihin-kogyo chitai no taikiosen(1)). Text in Japanese. Kanagawa-Ken Taiki osen Chosa Kenkyu Hokoku (Tech. Rept. Air Pollution Yokohama-Kawasaki Ind. Area), no. 12:5-24, Nov. 1969.

The amount of the falling soot and dust were measured using a deposit gauge; the concentration of sulfur dioxide was measured by the PbO2 method since 1957 in Yokohama and Kawasaki Cities, Kanagawa Prefecture. The results of the measurements for one year from January to December 1968 are reported. Falling soot and dust was measured at 34 places; 26 spots in Yokohama and eight spots in Kawasaki; results were 48 t/sq km/month at the maximum, and 4.5 t/sq km/month at the minimum. The obtained numerical value was a crablike condition in comparison with that of the previous year. Sulfur trioxide was measured at 48 places; 38 spots in Yokohama and 10 spots in Kawasaki; sulfur trioxide increased 14.2 % at the industrial district and decreased at the other places in Yokohama in comparison with that of 1967. It had a tendency to increase a little at the industrial district, and to decrease or move sidewise at the other places in Kawasaki. Among the 48 measuring places, three places showed the average concentration for one year as more than 4 mg SO3/day/100 sq cm in terms of PbO2. Among the three places, the average concentration for the year showed 5.00 mg SO3/day/100 sq cm in terms of PbO2 at the maximum.

26054

Ministry of Health and Welfare, Tokyo (Japan), Public Nuisance Section

**REPORT OF THE SURVEY OF AIR POLLUTION OF ANNAKA AREA IN GUNMA PREFECTURE.** (Gunma-ken Annaka chiku kankyo osen chosa kkeka hokoku-sho). Text in Japanese. 108p., June 1970.

In May and October in 1969, oxidized sulfur, suspended dust, metallic ingredients, and meteorological conditions (only in May) were surveyed. In Annaka, a zinc smeltery is located on a steep slope, and the lay of the land is complicated; the air current there is considerably disorderly, and ordinary diffusion equations such as Sutton and Bosanquet's cannot be applied. Also, atmospheric temperature of the plateau and the basin goes into reverse; this influences atmospheric pollution conspiciously in winter. The highest amount of sulfur dioxide was 0.04 ppm; less than 0.03 ppm was measured at most of the stations. The hourly average of 8 daytime hours was a maximum of 0.1 ppm at a spot withi 500 meters on the south side of the zink smeltery. One of the characteristics of this area is that a high level of pollution for a short period occurs frequently. The possible cause of this is that the smoke producing equipment is not in good condition for emission and diffusion. Pollution did not always correspond with the amount of smoke emitted. As to the extension of the polluted area, the south side of smoke emitted. As to the extension of the polluted area, the south side of the smeltery showed a remarkably low level 600-700 m from the smeltery; but on the east side, a considerably high level of pollution remained more tha 1 km from the smeltery. The average of total amount of suspended dust was 214 micrograms/cu m, the highest measured at the measuring stations was 365 micrograms/cu m, and the daily highest was 639 micrograms/cu m. The average amount of cadmium was 0.10 micrograms/cu m (May) and 0.04 micrograms/cu m (October). The average amount of lead was 1.13 micrograms/cu m (May) and 0.68 micrograms/cu m (October); the amount of lead at several measuring stations was remarkably higher than that of the other cities and towns. The amount of cadmium and lead decreased in October. No relation was found between the hourly changes of dust and SO2, but some relation of the changes of the hourly average of the two during the 8 daytime hours was recognized.

26287

**RESEARCH ON THE ACTUAL CONDITION OF AIR POLLUTION. 4. INVESTIGATION OF AIR POLLUTION CAUSED BY AUTOMOBILE WASTE GASES IN THE SEISHO NATIONAL HIGHWAY.** (Taiki osen no jittai chosa. 4. Seisho kokudo ni okeru jidosha haiki gasu ni yoru osen no chosa). Text in Japanese. Kanagawa-Ken Taiki Osen Chosa Kenkyu Hokoku (Tech. Rept. Air Pollution Yokohama-Kawasaki Ind. Area), no.11:41- 60, Feb. 1969. 14 refs.

In 1967, the determinations of carbon monoxide, nitrogen dioxide, and lead in the air were done twice on October 24 and November 7, in order to study air pollution caused by automobile waste gases along the national highway and the Seisho by-pass of the national highway in Oiso and Ninomiya areas in Kanagawa. The detector tube method for carbon monoxide, and the Saltzman method and the alkali filter paper method for nitrogen dioxide were used. The polarographic method and the dithizone carbon tetrachloride method were used for lead after collecting lead on filter paper using the high-volume air sampler and dissolving it into nitric acid. The value of carbon monoxide on the national highway, 30 ppm (maximum), was higher than that of the Seisho by-pass, 15 ppm (maximum). The traffic on the national highway in the Ninomiya area was heavy, and the concentration of carbon monoxide there was higher than that of Oiso area. Judging from the diffusion of carbon monoxide from the national highway to its branch-roads in the Ninomiya area, the influential range was considered to be around 20 m or so. The pollution caused by automobile waste gas was the road-side air pollution. With respect to lead, 0.37 - 2.8 micrograms/cu m were detected along the national highway and the Seisho by-pass. In thi case, the value of the latter was higher than that of the former. The maximum value of nitrogen dioxide using Saltzman method was 0.036 ppm. In the urbanized areas of Kawasaki and Yokahama cities, the maximum values in both areas had been determined as more than 0.1 ppm, and every value measured this time fell far short of those values. The reason why the air remains comparatively clear may depend on the fact that the Seisho by-pass is located in an opening area of seaside. The close relationships between the concentration of nitrogen dioxide and the traffic volume was estimated from the results of measurement using alkali filter paper methods.

26387

Burenin, N. S. and B. B. Goroshko

**STUDY OF POLLUTION OF CITY AIR BY INDUSTRIAL DISCHARGES.** In: American Institute of Crop Ecology Survey of USSR Air Pollution Literature. Effects of Meteorological Conditions and Relief on Air Pollution; Air Contaminants--Their Concentration, Transport, and Dispersal. M. Y. Nuttonson (ed.), Vol. 5, Silver Spring, Md., American Inst. of Crop Ecology, 1970, 9p. 9 refs. (Also: Tr. Glav. Geofiz. Observ. (Leningrad), no. 238:136-144, *1969.*)

The collection and analysis of samples taken over a wide network of points located in different parts of a city permit the establishment of the spatial distribution of noxious substances in the city air. Such a survey was carried out in a major industrial center of the Soviet Union where 355 tons of dust, 274

tons of sulfur dioxide, and 470 tons of carbon monoxide are discharged daily. The city is situated in a hilly area where the elevations rise 50-70 m above the low points. Meteorological observations included measurements of temperature and air humidity, wind velocity and direction, turbulence factors, and the recording of particular weather phenomena. Sampling was done for the following emissions: dust, sulfur dioxide, nitrogen dioxide, carbon monoxide, phenol, sulfuric acid aerosol, chromium, manganese and lead. Analysis of the fields of concentrations within the city area permits the identification of zones with high air pollution values. Sources for these higher variations are considered.

26535

Kuroki, Masato, Mitsuo Kiboku, and Takeo Matsutomi

**THE QUANTIFICATION ANALYSIS FOR THE INFLUENCE OF EXHAUST GAS ON THE AIR POLLUTION.** (Jidosha haikigasu no suryoka bunseki. I.). Text in Japanese. Kinki Daigaku Rikogakubu Kenkyu Hokoku (J. Fac. Sci. Technol. Kinki Univ.), no. 3:105-122, March 1969. 1 ref.

Automobile exhaust gas pollution was investigated in Kure. The basic chemical data obtained at three locations in the city were analyzed statistically so that the correlation structures between various factors could be explained and future pollution could be predicted. The factors taken into consideration were traffic volume, temperature, humidity, existence of wind, wind speed, and weather. The hydrocarbon concentration was set at 0.01 ppm throughout, and the pollutants investigated were sulfur dioxide, carbon monoxide, nitrogen dioxide, lead, and dusts. Regression lines were drawn for the concentrations of various pollutants and the individual factors, so that the condition of pollution at the three locations of Kure can be explained in detail.

27096

Caporossi, Joseph C., Eric W. Mood, and Marjorie A. Drucker

**AN EPIDEMIOLOGICAL STUDY OF THE RELATIONSHIP BETWEEN DELTA- AMINOLEVULINIC ACID AND AIRBORNE LEAD EXPOSURE IN SELECTED CONNECTICUT LOCALITIES.** Preprint, Air Pollution Control Assoc., Pittsburgh, Pa., 16p., 1970. 10 refs. (Presented at the Air Pollution Control Association, Annual Meeting, 63rd, St. Louis, Mo. June 14-18, 1970, Paper 70-21.)

With the increasing use of leaded gasoline and the greater number o high speed expressways and high traffic density urban areas, much concern exists that undesirable concentrations of lead in the ambient air may result. Because of its specificity for lead and it measurement of a pathological manifestation of lead intake, the urinary aminolevulinic acid concentration was employed to assess th effects of average annual airborne lead concentrations found in Connecticut. Lead has been suggested to inhibit delta-ALA dehydrase, the enzyme which converts ALA to porphobilinogen, thereby resulting in a feedback mechanism leading to the buildup and subsequent excretion of increased amounts of ALA. Utilization of the Connecticut Air Sampling Network yielded four sampling areas representing a wide range of average annual lead concentrations in air of 0.23 microgram/cu m, 0.14 microgram/cu m, 0.06 microgram/cu m, and 0.02 microgram/cu m, respectively. Twenty-four children in the 10-12 year old age group, equally divided according to sex, were chosen from the elementary school closest to each of the four air sampling sites for urinary ALA determinations. When an ion exchange spectrophotometric technique was used to analyze the urine samples for ALA content, no significant differences in urinary ALA concentrations were observed from site to site. A probable factor that contributed to this uniformity was the narrow range of airborn lead concentrations found in Connecticut. The following recommendations are made: to study the relationship of urinary ALA concentrations to airborne lead exposure in areas which exhibit higher lead concentrations than those found in this study; to include observations of the amount of lead ingested with food, that this source can be differentiated from the effects of the airborne lead source. (Author abstract modified)

27105

Volchok, H. L. and M. T. Kleinman

**RADIONUCLIDES AND LEAD IN SURFACE AIR.** Atomic Energy Commission, New York, Health and Safety Lab., Fallout Program Quart. Summ. Rept., App.-C, 1-8, 87-91, Jan. 1, 1971. 3 refs. NTIS: HASL-239

Since January 1963, the Health and Safety Laboratory of the Atomic Energy Commission has conducted a program for sampling and analysis of radioactivity and lead in surface air. The primary objective of this program is to study the spatial and temporal distribution of nuclear weapons debris and lead in surface air. Data tabulations are presented for the international activity concentrations of all radionuclide, gross gamma, and stable analyses completed to date. All data are reported in units of disintegrations/min/100 standard cu m except for lead, which is reported in units of mg/1000 standard cu m.

27174

Schroeder, Henry A.

**A SENSIBLE LOOK AT AIR POLLUTION BY METALS.** Arch. Environ. Health, 21(6):798-806, Dec. 1970. 35 refs.

Annual averages, daily intakes, and contents in lungs are derived for essential trace metals, nontoxic metals, and metals with innate toxicity in the air of 58 cities and 29 nonurban areas. Of the 27 metals considered, only seven are more or less toxic of themselves and four of these are rarely or infrequently found in air: beryllium, antimony, bismuth, and tin. The other three, lead, cadmium, and nickel represent potential or real public health hazards. The 12 cities most polluted with nickel have concentrations of 0.03-0.2 micrograms/cu m. Cadmium is found in th air of 27 cities, of which 17 had concentrations of 0.01-0.37 micrograms/cu m. All cities and all nonurban areas except one have lead in air, the cities from 0.1-2.3 micrograms/cu m. Cadmium in air can be minimized or abolished by abatement of zinc, from which it comes. Lead can be virtually eliminated by abolition of alkyl lead additives to gasoline. Nickel dust can be controlled by the usual methods for removing particulates. Nickel carbonyl must be treated to compose it. Nickel additives to gasoline should be prohibited and methods developed for removing it from diesel engine exhausts. Control of these three toxic metals would diminish particulate matter in air.

27187

Yokohama Pharmacists Assoc. (Japan) and Yokohama School Pharmacists Assoc. (Japan)

**RESEARCH REPORT FOR 1969.** (Kenkyu chosa hokokushu IX- Showa 44 nendo). Text in Japanese. 128p., 1970.

A collection of reports is presented, including the following: Kanagawa Prefectural Pollution Center on the standard and diffusion of air pollution; Yokohama City School Pharmacists on the survey made on school room environment after construction work to prevent pollution; the joint report by Yokohama City School Pharmacists Association, Yokohama

City Pollution Center, and Yokohama National University on the survey of pollution from automobile exhaust gas in the city. The last two are the major reports in the collection. The others concern the examination of detector tubes to measure carbon monoxide on the street, conducted by Kanagawa Prefecture School Pharmacists Association; distribution of automobile exhaust gas in a tunnel during rush period, conducted by Yokosuka-Miura are Pharmacists Association; and six reports concerning school meals. The first of the two major reports concerns air-conditioning work constructed at a junior high school to supply clean air and to prevent noise penetrating to the school rooms, which are situated i an industrial area and at a busy intersection of highways. The other report is the survey made on carbon monoxide, lead, and floating dust in the atmosphere near a busy highway. The team conducted the survey for eight years. This time, the survey, conducted between 10 am and 10 pm showed that when the number of vehicles exceeded 4700 an hour, at a wind velocity of 0-0.1 m/s, average CO concentration was 12 ppm (4.5-19 ppm); lead concentration, 6.7 micrograms/cu m (4.7-10.4 micrograms/cu m); dust concentration, 1.7 micrograms/cu m (0.51-3.4 micrograms/cu m); with 1700 vehicles an hour, 1-3 m wind velocity, from 10 pm to 10 am the next day, CO concentration was 4 ppm (1.8-16 ppm); lead concentration, 3 micrograms/cu m (0.9-6.9 micrograms/cu m); dust, 0.25 micrograms/cu m (0.17-0.52 microgram/cu m). Carbon monoxide concentration remained at 10-20 ppm for a long time and lead concentration reached 5-10 times that of commercial areas (100 m inside the main highway).

27188

Iki, Sadao, Shunichi Yoshinaga, Tanetomo Nishimura, and Masaru Matsumoto

**THE CONTENTS OF HEAVY METALS IN THE ATMOSPHERIC DEPOSITS IN KITAKYUSHU CITY.** (Kitakyushushi niokeru koka baijin chuno kinzok seibun nitsuite). Text in Japanese. Kyushu Sangyo Daigaku Kogakubu Kenkyu Hokoku (Kyushu Ind. Coll. Res. Rept.), vol. 7:1-26, June 1970. 4 refs.

Quantitative analysis of heavy metals contained in atmospheric deposits was performed in February, October, and December, 1968, at 30 locations distributed in Kitakyushu city. Manganese, zinc, nickel, cobalt, copper, chromium, cadmium, and lead analyzed by atomic absorption, first by way of total burner consumption and later by laminar flow burner. The atmospheric deposit contained a large amount of Zn, Pb, titanium, and Mn (2534-1434 ppm), medium quantity of Cu, vanadium, and Cr (448-240 ppm), and a little Ni, Co, and Cd (66.9-8.9 ppm). The solubility of the metals, the ratio of the amount dissolved to total was large for Cu, Zn, and Mn (64.05-26.17%), small for Ni and Pb (1.10-1.05%), and nearly zero for Ti, Co, Cr, V, and Cd. The proportion of the metal components in the deposit varied from ward to ward, but differed very little among industrial, commercial or residential areas. On the average, coal ashes contained a large amount of Ti. Petroleum ashes contained an especially large amount of V, Zn, Ni, and Cu. Since neither coal nor petroleum ashes contain Mn or Pb, these metals in the deposit were considered to come mainly from plants and automobiles. The fact that the petroleum ashes contained a much larger quantity of metals, except Ti, than the coal indicated the future increase of metal contents with the changeover to petroleum from coal. In the future, dusts will be collected from other sources, and tin, beryllium, arsenic, and mercury will also be determined.

27191

**SURVEY ON AIR POLLUTION BY EXHAUST GAS OF AUTOMOBILES. (THE 1ST REPORT).** (Jidosha haigasu ni yoru taikiosen chosa hokokusho. (D 1 po)). Text in Japanese. Fukui-Ken Eisei Kenkyusho Kenkyu Hokoku (Rept. Fukui Prefect. Inst. Public Health), no. 3:24-45, March 1969

Surveys on air pollution by exhaust gas from automobiles and noise caused by car traffic were conducted on the 27th of October in Fuku city, on the 30th of October in Sabae city, and on the 2nd of November in Tsuruga city, at three main junctions. Meteorological observation (I), carbon monoxide (II), carbon dioxide (III), floating dust (IV), amount of lead (V), amount of traffic (VI), and noise (VII) were measured. The 27th of October was rainy, and the temperature was around 12 C; the 30th was a fine day, and temperature was 7.4 - 22 C; and the 2nd of November was cloudy, and temperature was 17 - 25 C. The average figure of (II) in Fukui cit was 11.3 ppm; Sabae city, 8.5 ppm; and Tsuruga city, 3.6 ppm; the peak of pollution measured by hours successively was twice (morning and evening) in Fukui city and Sabae city; in Tsuruga city, it was just once from 5:00 to 6:00 pm. The estimated value of (III) was 0.03% - 0.04% in all three places. The average figure of (IV) was in Fukui 501.6 micrograms/cu m; Sabae, 1045.7 micrograms/cu m; and Tsuruga, 506.8 micrograms/cu m. Lead was 7.8 micrograms/cu m in Sabae city and 7.2 micrograms/cu m in Tsuruga city. In Fukui city, an estimation was not possible due to the rain. The average number for (VI) were Fukui, 606 cars/hr; Sabae, 341 cars/hr; and Tsuruga, 374 cars/hr. The estimated figure of noise was 80 - 83 phons, 80 - 87 phons, and 79 - 82 phons respectively.

27241

Burnham, C. D., C. E. Moore, T. Kowalski, and J. Krasniewski

**A DETAILED STUDY OF LEAD DETERMINATIONS IN AIRBORNE PARTICULATES OVER MORTON GROVE, ILLINOIS BY ATOMIC ABSORPTION SPECTROSCOPY.** Appl. Spectry., 24(4):411-414, July-Aug. 1970. 18 refs. (Presente at the Mid-American Symposium on Spectroscopy, Chicago, Ill., May 1969.)

Careful examination of an analytical method for the determination of lead concentrations in atmospheric particulates has confirmed that a low temperature ashing technique is preferable to the ashing of organic matter in a muffle furnace when preparing samples for metals analysis, and that use of the standard additions technique for the avoidance of interferences in the analyses by atomic absorption spectroscopy is justified. A Perkin-Elmer model 303 double-beam spectrophotometer, fitted with a three-slot Boling burner and connected by an automatic null recorder readout accessory to a Sargent multirange recorder, was used for the analyses. Analyses of some 600 samples collected from the air over Morton Grove, Illinois, from 1964 through 1967 revealed average suspended particulate concentrations but rather high lead concentrations for urban areas. Monthly mean lead contents, which were highest in the fall months, showed a gradual increase over the four years. (Author abstract modified)

27257

Hashimoto, Hiroshi, Hiroshi Muranaka, Kazuo Araki, Kozo Akamatsu, Akira Yamamoto, Hiroyoshi Yoshida, Yoshio Watanabe, Kikuo Yamamoto, Saiji Matsuho, Kan Mizuhara,

Akira Miyagawa, Shoichi Kuwata, Ikuhiro Ogiwara, Hiroshi Ikeda, Tsutomu Inoue, Junzo Toyoda, and Gan'ei Aisaki

**HUMAN EFFECT SURVEY ON AUTOMOBILE EXHAUST GASES ALONG THE OSAKA HIGHWAY 26. PART 1. BACKGROUND OF SURVEY AND ENVIRONMENTAL CONDITIONS.** (Osaka kokudo 26 go sen endo ni okeru jidosha haishutsugasu jintai eikyo chosa. Sono 1. Chosa haikei to kankyo chosa). Text in Japanese. Seikatsu Eisei (J. Urban Living Health Assoc.), 14(5):126-131, Oct. 1970. 9 refs.

Environmental conditions were examined and consciousness and health examinations were conducted on 9 days from the 7th to the 23rd of October 1969 from 9:00 am to 5:00 pm. The survey included 6 spots of exposed road-side areas in Naniwa, Nishinari, and Sumiyoshi wards along Osaka Highway 26, and 3 spots in non-exposed areas separated about 100 meters from the highway. The average figure of a 1 hour average for 6 hours of the exposed area (hereafter, the figures indicated were obtained by the same calculations; figures in parenthesis indicate those in non-exposed areas) were as follows: carbon monoxide, 13.7 ppm (4.7 ppm); nitric oxide, (0.309 ppm (0.015 ppm); nitrogen dioxide, 0.115 ppm (0.069 ppm); total hydrocarbons, 1.29 ppm (0.50 ppm); ozone, 0.040 ppm (0.026 ppm); sulfur dioxide, 0.110 ppm (0.054 ppm); total amount of dust, 0.67 mg/cu m air (0.30 mg/cu m air); permeability by car for measurement of air pollution, 77.7% (90.0%); and lead in dust, 8.6 micrograms/cu m air (6.51 micrograms/cu m air). Lead in air in the area located close to the elevated expressway indicated the figure of 14.3-12.6 micrograms/cu m.

27429

Loucks, Ronald H. and John W. Winchester

**POLLUTION CONTRIBUTIONS OF THE ATMOSPHERIC INVENTORY OF CHLORINE AND BROMINE IN AEROSOLS OVER CONTINENTAL U.S.A.** Missouri Univ., Columbia, Environmental Health Center and Missouri Univ., Columbia, Extension Div., Proc. Missouri Univ. Third Annu. Conf. Trace Substances Environ. Health, Columbia, 1969, p. 233-250. 29 refs. (June 24-26.)

Continental aerosols in the U. S. contain halogens derived from both pollution and natural sources. Particle size distributions of pollutant chlorine and bromine in continental aerosols, determined by sampling with cascade impactors and analyzing by neutron activation, show marked differences from fresh marine aerosols. A calculation of major sources shows most of the Cl in continental aerosols to be derived from the sea, but most of the Br appears to be derived from the combustion of ethyl fluid. About 95% of total U. S. bromine production, about 100,000 metric tons/yr, is converted to ethylene dibromide and burned with tetraethyl lead. Most of the Br contained in the lead halide aerosol appears to be volatilized in the atmosphere and, possibly, to react further, e.g., by bromination of organic materials. The toxicological significance of these reactions is no yet known. (Author abstract modified)

27621

Harrison, Paul R. and John W. Winchester

**AREA-WIDE DISTRIBUTION OF LEAD, COPPER, AND CADMIUM IN AIR PARTICULATES FROM CHICAGO AND NORTHWEST INDIANA.** Preprint, Air Pollution Control Assoc., Pittsburgh, Pa., 29p., 1970. 9 refs. (Presented at the Air Pollution Control Association, Annual Meeting 63rd, St. Louis, Mo., June 14-18, 1970, Paper 70-118.)

As a first attempt to examine the area-wide distribution of specifi chemical elements in aerosol particles along the southwest shore of Lake Michigan, lead, copper, cadmium, and bismuth were determined in 24-hr average samples collected on glass fiber filters at 50 stations throughout the region. Samples from most of the stations were obtained from local air pollution control organizations for 6 different days from May to Aug. 1968 and were analyzed electrochemically by highly sensitive anodic stripping volumetry. Throughout the area the small variation of lead, generally a few micrograms per cubic meter of air, did not exceed that expected from the distribution of automobiles, the major source. Cadmium wa generally 200 times lower without marked local variations and was close to the expected concentration if coal combustion is the major source. Copper was generally 20 times lower than lead throughout Chicago as expected if coal combustion is the major source of copper. However, certain stations in the northwest Indiana area showed reproducible anomalies where copper was 100 times greater than in Chicago and several times greater than lead at the same stations. The source of this anomalous copper has not been determined. Results were compared with data from the National Air Sampling Network stations in the area for 1963. Cadmium falls within the variability presented by the NASN data, as does bismuth. Lead and copper are both higher than the NASN data, for unknown reasons. Area-wide studies are useful in revealing the general exposure level of pollutants, previously unknown contaminants and sources, and better locations for monitoring stations. (Author abstract modified)

27648

Nagata, Masanobu, Shigeru Yamada, Fujio Tomoto, and Jun Fukuda

**THE AMOUNTS OF FLOATING AND FALLING DUSTS, AND ANALYSIS OF THEIR MENTAL COMPONENTS IN KAWASAKI CITY.** (Kawasaki-shi ni okeru fuyufunjinryo to kinzoku seibun no bunseki kekka). Text in Japanese. Nippon Koshu Eisei Zasshi (Japan J. Public Health), 17(12):551, Oct. 1970. (Proceedings of the Japanese Society of Public Health, Annual Meeting, 28th.)

In three districts in Kawasaki city (A; industrial area, B: commercial area; and C: residential and commercial area), floating dust was collected by high-volume air samplers and was measured during the period from December 1969 to May 1970. Metal components in floating dusts were analyzed by atomic absorption spectrometry. The mean value of floating dusts per month was generally high in all districts: 409 micrograms/cu m in A; 316 micrograms/cu m in B; and 276 micrograms/cu m in C. Falling dusts in B area were 1.3 times higher than those in C area (8 t/sq km/month); in A area, they were 3 times higher than those in C area. The number of days when floating dusts were less than 150 micrograms/cu m was zero in A, 1 day in B, and 2 days in C. The minimum values were recorded in rainy days in all areas. Levels of iron, lead, manganese, zinc, cadmium, copper, and chromium were measured. The levels of all these metals were high in A area; especially iron showed a high level. The values in A area were 2 - 3 times higher than those in B and C areas.

27672

Takasago Municipal Office (Japan), Economic and Social Dept.

**AIR POLLUTION.** (Taiki osen). Text in Japanese. In: The Outline of Pollution. Kogai no gaikyo. Takasago, Takasago Municipal Office, July 1970, Chapt. 1.

In order to grasp the reality of air pollution in Takasago city, Hyogo Prefecture, investigations on the levels of atmospheric dust fall, sulfur dioxide (period of investigation: 1964-1969),

airborne dust, exhaust gas from motor cars (1969), atmospheric conditions, and fuel consumption were carried out. The levels of atmospheric dust fall in the city recorded highest in 1966, marking a yearly average level of 8.5 t and was decreasing henceforth; but in 1969, the levels showed 6.2 t which was a 10% increase compared with the previous year. The levels of sulfur dioxide measured by the PbO2 method decreased since 1965; the yearly average level in 1969 was 0.49 mg. As to the levels of sulfur dioxide measured by the electroconductivity method, the yearly average level of 1969 was within 0.025-0.028 ppm. High levels were observed in winter and summer. The comparison of the PbO2 method with the electroconductivity method is as follows: ppm equals 0.053 times mg SO3 (1 ppm equals 18.9 mg) (standard variation: 0.016). A relationship was observed between the frequency of (significant) wind direction and the daily average level of sulfur dioxide, except for one sampling station. Concerning the levels of air borne dust measured by digital method, the yearly average level of 1969 recorded 0.24 mg/cu m. A significant relationship was presumed between the levels of air borne dust and the levels of sulfur dioxide. The quantities of the fuel consumed were as follows: coal - 1,140,000 t, crude petroleum - 339,000 t, which when compared with the previous year are three times as much and a 20% increase respectively. In July 1969, horizontal aerial current was investigated using small balloons and vertical aerial current was investigated by applying pilot balloons. As to the exhaust gas from motor cars, the levels of CO, nitric oxide, nitrogen dioxide, SO2, atmospheric dust fall, and compounds of lead were measured at two sampling stations.

27675

Iki, Sadao

**AIR POLLUTION IN KITAKYUSHU CITY.** (Kitakyushu shi no taiki osen chosa - Showa 42 nen no jokyo -). Text in Japanese. Kyushu Sangyo Daigaku Kogakubu Kenkyu Hokoku (Kyushu Ind. Coll. Res. Rept.), vol. 4:41-61, May 1967.

Results of a survey on air pollution during the period 1966-67 in Kitakyushu City, carried out by the Municipal Sanitation Bureau, are reported. The atmospheric deposits were monitored by the deposit gauge method, and sulfur oxides, by the lead peroxide candle method. Thirty locations were chosen for monitoring divided equally between industrial, commercial, and residential districts. The amount of atmospheric deposits decreased and sulfur dioxide increased this year, as was the case from the beginning of the present survey program in 1959. The measurement of SO2 by an automatic continuous recorder showed that SO2 concentration in the air exceeded 0.2 ppm, particularly in the Wakamatsu and Tobata areas in winter and early in the morning and at midnight. Auto exhaust was also monitored at a traffic intersection at Uomachi in Kokura ward. Meteorological data, the amount of traffic, and gas components of carbon monoxide, SO2, nitric oxide, nitrogen dioxide, and lead were measured. Carbon monoxide was monitored by a Kitagawa detector, SO2 by the rosaniline-formaline method, NO2, by Saltzman, NO by modified Saltzman, and Pb by dithiozone. A continuous automatic gas sampler and a high-volume air sampler were used. The auto exhaust concentration in Kitakyushu, monitored by the station in Kokura, was low and was decreasing in spite of the ever increasing traffic. The concentration never exceeded 10 ppm. Cooperation from industry is badly needed for controlling environment pollution.

27831

Noushi, Hiroshi, Takahiro Seto, Kyoji Yamazaki, and S. Izumigawa

**ANALYSIS OF METALLIC COMPONENTS OF SUSPENDED DUSTS BY ATOMIC ABSORPTION SPECTROSCOPY AND THE RESULTS OF MEASUREMENTS CONDUCTED IN TOKYO.** (Genshi kyukobunsekiho ni yoru fuyu jinaichu no kinzokuseibunbunseki ni taisuru jakkan no kento to tonai ni okeru sokuteikekka ni tsuite). Text in Japanese. Tokyo-toritsu Eisei Kenkyusho Kenkyu Hokoku (Rept. Tokyo-to Lab. Med. Sci.), no. 20: 115-118, 1968. 3 refs.

The concentrations of elements such as iron, manganese, nickel, lead, zinc, copper, chromium, and cadmium were measured in Tokyo. The apparatus used included a Perkin Elmer atomic absorption spectroscope and a Staplex hi-volume sampler. The data obtained from the measurements are tabulated and compared to the values obtained by the Ministry of Health and Welfare at Japan Environmental Sanitation Center using photo-emission spectroscopy. Considering the maximum allowable concentration of heavy metal elements in the environment as one-hundredth that of the working environment, calculations showed that lead was closest to the maximum allowable concentration. This is probably due to automobile exhaust emissions.

27880

Sato, Akira, Masanao Takahashi, and Tetsuo Kudo

**STUDIES ON ATMOSPHERIC POLLUTION IN IWATE PREFECTURE. NO. 8. HEAV METAL CONTENT IN SETTLING DUSTS. PART I.** (Iwate-ken no kogai ni kansuru kenkyu. Dai-8-po. Kokabaijinchu no jukinzokuganryo. I). Text in Japanese. Iwate-Ken Eisei Kenkyusho Nenpo (Ann. Rept. Iwate Inst. Public Health), no. 12:44-70, 1968. 9 refs. PART II. Ibid., no. 12:71-99, 1968.

Measurements were conducted on settling dusts, suspended dusts, and sulfur dioxide since 1960 in the cities of Kamaishi, Kuni, and Higashiyama which form the industrial areas of Iwate Prefecture. The insoluble components of dusts were soaked in HCl; the residues were treated with HF and subsequently dissolved in HCl to obtain a 500 ml solution. The analytical methods used were ETA titration for iron, diethyldithiocarbamate for copper, polarographic analysis for zinc, photoelectric colorimetry by KIO4 for manganese, and Gutzeit process for arsenic. The data were obtained over 20 months at 13 locations with deposit gauges in the above-mentioned cities. Differences were found in the components of dusts depending on the types of industries in the cities, and Fe, SiO2, Mn, Pb, and As were prevalent in the iron and steel cities; for cement areas, no special characteristics were found except for the regular components such as Ca and Mg.

28097

Schedling, J. A.

**THE MEASURING AND ANALYSIS OF ATMOSPHERIC POLLUTION.** (Ueber Messungen und Analysen von Luftverunreinigungen). Text in German. Arch. Hyg., 154(4):349-357, 1970. 5 refs.

The tendency prevails not to limit the measuring of atmospheric pollution to the determination of a single pollutant like to sulfur dioxide because the assumption that the level of an indicato substance is a characteristic measure of the sum of all pollutants is valid only to a limited extent, if at all. Five hundred dust fall measurements performed over a period of two years (1962-1963) in a center city site in Vienna and 2000 dust fall measurements performed in 1965 and 1966 and continued

at the same site in 1969 by means of a dust collection filter device at 1 and 9 m above ground were evaluated and the levels of lead, of benzopyrene and of fluorine compounds were determined. Lead compounds were determined polarographically; benzopyrene, spectrometrically; and fluorine compounds, by means of an ion-sensitive electrode. The present air pollution monitoring program in the city of Vienna will have to be extended to include nitrogen oxides and hydrocarbons and later also asbestos dust and oxidants. The pollution levels will have to be evaluated on the basis of internationally agreed air quality criteria not only for their immediate toxicity but for their hygienic implications in the overall pollution picture as seen by the WHO.

28178

Resch, W.

**THE LEAD CONCENTRATION BEFORE A TRAFFIC LIGHT OF AN INTERSECTION.** (Ueber die Bleikonzentration in Stauraum einer Kreuzung). Text in German. Arch. Hyg., 154(4):367-370, 1970. 7 refs.

The emission levels of solid lead compounds in a street in center city Vienna were determined by polarographic determination of 639 filters exposed for three hours each to the atmosphere polluted by heavy traffic. The mean value of all tests was 2.5 micron/cu m; the peak value measured, between 12.00 and 15.00 hours on a Monday was 14 micron/cu m; and the lowest value was 0.2 micron/cu m on a Wednesday between 0.00 and 3.00 hours at night An analysis of the concentration values revealed that 68% of them did not exceed 3 micron/cu m. Four three hour periods were recorded when the concentration exceeded 10 micron/cu m. The correlation between lead concentration and traffic is obvious. The order of magnitude of the lead pollution levels recorded in Vienna are comparable with those recorded in German, French, Italian, and American cities.

28233

Endo, Ryosaku, Tetsutaro Kohgo, Naoki Sugawara, Yutaka Matsumoto, and Tatsunori Oyake

**STUDIES ON URBAN AIR POLLUTION BY AUTO EXHAUST IN HOKKAIDO (PART 4): RESULTS OF SURVEY IN TOMAKOMAI CITY.** (Hokkaido no toshi no okeru jidosha haishutsu gasu no taikiosen ni tsuite (dai 4 po) Tomakomaishi ni okeru chosa kekka ni tsuite). Text in Japanese. Hokkaidoritsu Eisei Kenkyusho-ho, vol. 19:197-201, 1969. 6 refs.

Concentrations of airborne dust, carbon monoxide, nitric oxide, nitrogen dioxide, lead, and 3,4-benzopyrene were monitored, together with the number of vehicles passing by, at two roadside locations in Tomakomai. One observation point (A) was located in front of the railroad station, the other (B) at the intersection of the national highway. Traffic was heavier, the road wider, and the wind stronger at point B. With the exception of dust, measured pollutant values were a little higher at A. Respective maximum concentrations of dust, carbon monoxide, sulfur dioxide, an nitrogen oxides (NO plus NO2) were 295 microgram/cu m, 16.6 ppm, 0.096 ppm, and 0.278 ppm. Concentrations of lead and 3,4-benzopyrene were 0.26-0.90 microgram/cu m and 3.23-17.30 microgram/1000 cu m, respectively. In comparison with other cities in Hokkaido having equally heavy traffic, air pollution by auto exhaust is concluded to be low in Tomakomai. The sulfur dioxide values recorded are attributed to the fact that buildings are less dense in the city.

28326

Murata, Motohide, Hiroshisa Shima, T. Matsui, Hiroshi Hirobe, Tsuyoshi Kanamaru, and Kuniaki Naka

**AIR POLLUTION IN YOKKAICHI CITY. PART II. RESULT OF INVESTIGATION OF SUSPENDED DUSTS.** (Yokkaichi no taiki osen. Dai-2-ho. Fufyufunjin no chosakekka ni tsuite). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 5(1):198, 1970. (Proceedings of the Japan Society of Air Pollution, Annual Meeting, 10th, 1970.)

Suspended dusts in Yokkaichi were analyzed for metallic elements and their general distribution. Items studied were average, maximum, and minimum values (micrograms/cu m) of total suspended dust, the sulfate ion, the nitrate ion, iron, manganese, lead, copper, titanium, vanadium, and phosphorus. The nitrate ion was not found in sufficient quantity to be of concern. The nitrate ion was not found in sufficient quantity to be of concern. Lead averaged 0.4 micrograms/cu m in the area of heaviest traffic volume. Phosphorus had only one emission source and was convenient for observing distribution. In general, concentration decreased with distance from the source. The sulfate ion and vanadium had a similar distribution, and both were relatively high in one location, the vicinity of a petrochemical complex.

28369

Kettner, H., R. Langmann, and W. Maassen

**DEPOSITION OF LEAD FROM THE ATMOSPHERE.** (Die Bleideposition aus de atmosphaerisichen Luft). Text in German. Fortschr. Med., 89(5):179-180, 202, 1971. 23 refs.

The lead content in the blood of Americans has for 3 decades fluctuated between 10 and 4 micron Pb in 100 g blood without an appreciable increase. The harmfulness of lead can be demonostrated only when certain levels of lead in the atmosphere can be identified with certain symptoms of the organism as outlined by the WHO guidelines by a 4-step procedure. Lead deposit data are few. In 32 American cities, median daily lead fall was 0.5 mg/sq m/day. At a distance of 8 miles from a turnpike, the daily lead deposit was 0.36 mg/sq m/day and in its vicinity, 1.4 mg/sq m/day. The share of lead in dust deposits in the German cities of Wuppertal was 0.165; in Neuss/Rh, 0.22; in Duesseldorf, 0.31; in Muehlheim/Ruhr, 0.558; and in Duisburg, 4.83 mg/sq m/day (1965). Irrespective of the difference of opinion about the harmfulness of lead in the atmosphere, its presence in the air is in principle undesirable. By October 1975, all gasolines manufactured in the USA will be lead-free. Other trace elements in the atmosphere that should be controlled include vanadium, copper, zinc, manganese, cobalt, and nickel.

28528

Kawase, Yoshikazu, Taku Kitano, Seiichiro Yuge, and Seiichiro Ito

**MEASURING METHODS AND RESULTS OF LEAD OF AUTOMOBILE EXHAUST GAS.** (Jidosha haigasuchu no namari no sokuteiho to kekka ni tsuite). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 5(1):255, 1970. (Proceedings of the Japan Society of Air Pollution, Annual Meeting, 10th, 1970.)

Lead concentrations were measured at five high-volume traffic intersections in Saitama and at distances of 10 and 100 m from each intersection. Measurements were taken four times a day at different time periods. Three methods were used: sampling by a high-volume air sampler and analysis by atomic absorption spectrophotometry; sampling by midget impinger and analysis by atomic absorption spectrophotometry; and air-in-

duction through a 5-cm polyethylene filter, then absorption by a gasuabsorption tube, and analysis by atomic absorption spectrophotometry. The lead concentration was highest with filter and absorption tube together and lowest with the absorption tube alone. Various data are given for different locations at different time intervals, together with the carbon monoxide concentrations.

28620

Ito, Eiichi, Kiyoshi Kubo, Kazunori Kamakura, Akio Wada, and Juji Takeuchi

**ON AIR POLLUTION BY LEAD FROM VEHICLE EXHAUST.** (Jidosha no haishutsu gasu ni yoru namari osen ni tsuite). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 5(1):254, 1970. (Proceedings of the Japan Society of Air Pollution, Annual Meeting, 11th, 1970.)

Atmospheric lead concentrations were measured in Nagoya. Samples were taken at busy traffic intersections with a high-volume air sampler, and analysis was done by atomic absorption spectrophotometry and polarography. The average lead concentration was 2.4 micrograms/cu m. An average of 5.4 micrograms/cu m was the highest among the daily averages at ten locations. Concentrations were usually highest in the morning and in the evening. The amount of lead in suspended particulates varied, expecially according to the weather, but the average lead content was about 0.7%. On rainy days the content was as high as 2% at some locations. Lead concentrations decreased with distance from the road, but on rainy days the decrease with distance was not significant. When determining lead by atomic absorption spectrophotometry, the interference by sodium was very significant, as has been reported in other studies. It is necessary to establish accurate correction values for sodium.

28629

Hasegawa, T., A. Sugimae, and J. Fujii

**TRACE METALS IN SUSPENDED PARTICULATES. PART IV.** (Fuyu funjinchu no kinsoku seibun. Dai-4-ho). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 5(1):211, 1970. (Proceedings of the Japan Society of Air Pollution, Annual Meeting, 11th, 1970.)

Suspended dusts were collected with a high-volume air sampler and analyzed by spectrophotometry for metals such as iron, lead, manganese, vanadium, tin, nickel, and copper. A good correlation between the concentration of vanadium emitted during heavy-oil combustion and sulfur oxides was obtained. The daily variation of vanadium concentration and suspended particulates shows that wind direction and wind speed have a large bearing on the vanadium particles. Gooc correlation was also seen between the concentration of iron and the total particulates concentration: for the total particulates concentration of 100 micrograms/cu m, there were 1-7 micrograms/cu m of iron. The reason for the relationship is not really clear because there are so many sources of iron emissions. Forty percent or more iron particles were over 8 micron in size and 80-90 percent of the vanadium and lead particles were below 2 micron in size. Furthermore, a good correlation was seen between iron and manganese.

28634

Otsuka, Yukio, Nobuaki Kadoya, Katsuhiko Tanaka, Katsuhisa Fukaya, Noriyoshi Yoshitani, and Saburo Kanno

**SURVEYS ON ENVIRONMENTAL POLLUTION BY AUTO-EXHAUST GAS.** (Jidosha haiki gasu ni yoru taiki osen no chosa). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 5(1):223, 1970. (Proceedings of the Japan Society of Air Pollution, Annual Meeting, 11th, 1970.)

Carbon monoxide, nitrogen oxides, lead, meteorological factors, and traffic volume were measured along the main highways in Kanagawa Prefecture. Carbon monoxide and nitrogen oxides were measured by nondispersive infrared analysis and the Saltzman method, respectively, at 2.8 m above the sidewalk. Lead in air was measured by collecting suspended dusts in high-volume air samplers at 1.5 m above ground and analyzing them by atomic absorption spectrophotometry. Traffic volume was calculated as hourly values based on counting for five minutes on the hour. Carbon monoxide was at a maximum in front of the Kawasaki Racetrack, where the 24-hr value was 9.7 ppm. For nitrogen oxides, the total averages were nitric oxide, 0.08-0.22 ppm and nitrogen dioxide, 0.11 ppm. The diurnal variation of carbon monoxide, nitrogen oxides, suspended particulates, and lead showed remarkable similar patterns, and a correlation between Pb and CO could be inferred.

28635

Nakano, Kinjii and Toshio Odairo

**ENVIRONMENTAL AUTOMOTIVE EXHAUST GAS CONCENTRATIONS IN TOKYO.** (Kankyo taikichu no jidosha haiki gasu sokutei kekka). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 5(1): 244, 1970. (Proceedings of the Japan Society of Air Pollution, Annual Meeting, 11th, 1970.)

In Tokyo, carbon monoxide was measured at four traffic intersections and lead in air at seven locations. Sampling for carbon monoxide was done with mylar bags at 1.2-1.5 m, above the ground; lead was sampled at the same heights with glass fiber or membrane filters. Carbon monoxide was analyzed by NDIR URA-2 and APMA-1 and lead by atomic absorption spectrophotometry. There were correlations between the average CO concentrations at 100 m away from and behind intersection areas, and concentrations were generally highest at the intersections. However, the correlation between traffic volume and average CO concentration at an intersection was not significant. Lead concentrations were no more than 5 micrograms/cu m, even at intersections. In unpolluted areas, the concentrations were 0.1-0.6 micrograms/cu m. There was a high correlation between lead and CO concentrations.

28650

Hasegawa, Toshio, Akiyoshi Sugimae, Junko Fujii, Yuzuru Matsuo, and Yoshinobu Okuyama

**TRACE METALS IN SUSPENDED PARTICULATES. PART II.** (Fuyufunjinchu no kinzokuseibun. Dai-3-po). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 5(1):210, 1970. (Proceedings of the Japan Society of Air Pollution, Annual Meeting, 11th, 1970.)

Suspended particulates were sampled at 12 stations in Osaka. The actual sampling was conducted at the altitude of 10 m for 24 hours every day by means of a high-volume air sampler and cascade centripetor. The particulates were collected on Whatman GF-81 glass fiber filters and the lead contained in them was determined by spectrophotometry. The concentration range for lead was 0.25 to 10.9 micrograms/cu m, with a mean of 2.0 micrograms/cu m. From the cascade centripetor measurements, it was discovered that most of the lead particulates are under two micron in size, and 90% or more can enter the alveoli when breathed with air. In Osaka, there is a maximum of 9.8 micrograms/cu m of respirable lead suspended in the air. Further studies indicated that there is a negative correlation

between lead concentration and wind speed in February, but not in June. Apparently meteorological conditions affect the lead concentration much more than wind speed, together with factors such as automobile traffic volume.

28653

Kiyoura, Raisaku, Toru Kuramoto, Milton Munidasa, Gunji Kawasaki, Naotake Naito, and Yoshisuke Uenishi

**CHARACTERISTICS OF HEAVY METALS IN AIRBORNE PARTICULATES IN INDUSTRIAL COMPLEXES AND URBAN AREAS.** (Wagakuni no toshi, knobinato nado no fuyu funjinchu no jukinzoku seibun no hikakukento). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 5(1):233, 1970. (Proceedings of the Japan Society of Air Pollution, Annual Meeting, 11th, 1970.)

Suspended dust in urban air was analyzed for heavy metals. Dust was collected with a high-volume air sampler, and the glass fiber filter was cut up to one-tenth of the original size and placed in a 100 ml platinum evaporation dish. It was then washed in 5 ml nitric acid, followed by 15 ml hydrofluoric acid, and the resulting solution was evaporated on a sand bath. Another 10 ml of hydrochloric acid followed by 10 ml of perchloric acid was added and dried again. The resulting product was dissolved in 1 N hydrochloric acid, filtered, and 100 ml of the filtrate was accurately measured. The analysis was conducted with an atomic absorption spectrophotometer. Various resonance lines in Angstroms for iron, lead, manganese, nickel, copper, zinc, cadmium, and chromium are listed, together with the lamp amperage.

28785

Ito, Eiichi, Kiyoshi Kubo, and Akio Wada

**STUDY ON POLLUTION BY LEAD ON THE IMPORTANT PLACES FOR TRANSPORTATION.** (Kotsu yochi ni okeru namariosen no mondaiten ni tsuite). Text in Japanese. Nagoya-shi Eisei Kenkyushoho (Ann. Rept. Nagoya City Health Res. Inst.) no. 16:115-118, 1969. 3 refs.

The results of lead estimation concentrations in the air at nine important places for transportation and three contrast places in Nagoya City and the analytical method of lead in the air are described. The investigation was made from February to March, 1970 for contrast places and in June for the important places for transportation. Sampling was made continuously from 9:00 am to 4:00 pm and a high sensitive polarography (I) and atomic absorption analytical method (II) were used for the analysis of lead in suspended particulate material. Average and maximum values of lead quantity at the important places for transportation were 2.38 micrograms/cu m and 5.40 micrograms/cu m, respectively. Lead quantity decreased according to the distance from the important places for transportation. Lead quantity was also found as suspended material all over the city, for it was also detected at contrast points (average value 0.75 micrograms/cu m). As a result of the comparison of analytical values of lead by analytical methods (I) and (II), values by method (I) were higher than those by method (II). The atomic absorption analyzer was affected by various materials (especially sodium) contained in the filter used for lead sampling. Therefore, method (I) was more correct than method (II) when sampling was carried out using filters.

28920

Lininger, Ronald L., Robert A. Duce, John W. Winchester, and Wayne R. Matson

**CHLORINE, BROMINE, IODINE, AND LEAD IN AEROSOLS FROM CAMBRIDGE, MASSACHUSETTS.** J. Geophys. Res., 71(10):2457-2463, May 15, 1966. 10 refs.

Aerosol particles in Cambridge, Massachusetts, were collected by cascade impactor and analyzed for chlorine, bromine, and iodine by neutron activation and for lead electrochemically. The Casella four-stage impactor selected particles of radius greater than about 0.2-0.5 micron, and two sampling sites were chosen on the M.I.T. campus--on the roof of the 90-meter-high Green Center for Earth Sciences and at the curb by a busy street. The ranges 1 to 6 microgram Cl/cu m STP and 2 to 10 ng I/cu m STP are in good agreement with observations in unpolluted Hawaii air, but the range 20 to 800 ng Br/cu m STP stands an order of magnitude higher and agrees with observations in Washington, D. C., polluted air. Lead concentrations are 0.1 to 2.2 micrograms Pb/cu m STP and are strongly correlated with high Br concentrations during hazy weather and/or curb-site sampling. The data suggest that the initial exhaust product is a particulate lead halide which suffers loss of Br in the atmosphere. (Author abstract)

29152

Himi, Yasuji and F. Muramatsu

**ANALYSIS OF HEAVY METALS IN ATMOSPHERIC SUSPENDED DUST (REPORT 1). DETERMINATION OF FE AND PB BY FLUORESCENT X-RAY ANALYSIS USING VACUUM-EVAPORATED STANDARDS.** (Fuyubaijinchu no jukinzoku no bunseki. Dai-1-po. Shinku jochaku hyojunskiryo o mochiita Fe, Pb no keiko X-sen bunseki). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 5(1):58, 1970. (Proceedings of Japan Society of Air Pollution, Annual Meeting, 11th, 1970.)

Fluorescent X-ray spectrometry was used to analyze heavy metals in the atmosphere. Samples of iron and lead in dusts were prepared by the vacuum evaporation method in which a uniform metallic film is formed on the filter. The filter used was a Gelman A type. Determination of Fe and Pb was accomplished by the o-phenanthroline and dithizone methods. The general technique was applied to suspended particultes in Kanagawa Prefecture, and calibration curves were drawn for Pb and Fe. Subsequent analysis by fluorescent X-ray spectrometry showed that the results corresponded very well to those obtained by chemical analysis.

29153

Ishinishi, N. and Nobuyasu Shigemori

**A SEASONAL VARIATION OF THE CONCENTRATION OF HEAVY METAL IN SUSPENDED DUST ON THE MAIN STREETS.** (Kosaten, fuyubaijinchu, jukinzokuryo no kisetsuteki hendo). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 5(1):62, 1970. (Proceedings of Japan Society of Air Pollution, Annual Meeting, 11th, 1970.)

Lead, iron, manganese, and cadmium in suspended dust collected at main traffic intersections in Kitakyushu and Fukuoka were analyzed. The dusts were collected by a high-volume air sampler and analyzed by atomic absorption spectrophotometry. Wavelength, lamp current, load voltage, hydrogen pressure, air pressure, and scale magnification data are listed for Pb, Fe, Mn, and Cd. The results indicate no special trends according to the season or the year. Iron concentrations, however, were the highest in Yawata District of Kitakyushu, an iron and steel production town.

29191

Watanabe, Hiroshi, H. Mitsuki,, T. Koyama, Yoshihiro Nakagawa, and N. Takada

**ON THE METALLIC COMPONENTS IN SUSPENDED PARTICULATE AND ITS LOCAL CHARACTERISTICS.** (Fuyu biryushichu no knzoku sibun to chiiki tokusei). Text in

Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 5(1):60, 1970. (Proceedings of the Japan Society of Air Pollution, Annual Meeting, 11th, 1970.)

Dusts, iron, lead, copper, cadmium, vanadium, zinc, and manganese were measured in the neighborhood of an iron works and other plants. High-volume air samplers, low-volume air samplers, and cascade centripeters werw used for sampling. Dusts were measured by gravimetry and metals by atomic absorption spectrophotometry. In the area of the iron-producing plant, 80% of Pb, V, and Cd, but only 44% of Fe existed as fine particulates in air. Almost 100% of Cd was under 0.7 micron; over 90% of Pb was under 2 micron; and over 80% of Fe, Mn, and Cu was under 7 micron. Comparison of the amount of metallic content of the dusts collected in two areas by a high-volume sampler with a cyclone showed that the proportion of Fe is higher in the neighborhood of the iron-producing plant.

29382

Hishida, Kazuo

**PRESENT STATE AND CONTROL OF POLLUTION BY SMOKE.** (Nensho kogai no genjo to kogai boshi taisaku). Text in Japanese. Nippon Kikai Gakkai-Shi (J. Japan Soc. Mech. Engrs. Tokyo), 74(626): 215-216, March 1971. 11 refs.

Pollution from combustion is principally air pollution. It is considered in two forms, wide area and local. Sources of wide area pollution are sulfur oxides and automotive exhausts. These are also causes of smog, local contamination stems from particulates, metallic and carbonaceous. Sulfur oxide concentrations and distribution have both increased significantly since 1965. The National Standard for SO2 is less than 0.05 ppm/hr urban and industrial areas exceeding this limit are shown. Sulfur trioxide was identified as a source of acid-smut, however, recently sulfuric acid mist has replaced it in the public notice. Ring contamination by sulfuric acid mist was observed at Suginami, Tokyo in 1970 where it averaged 20 micrograms/cu m. for 24 hrs. Suspended particulates measured 461 micrograms/cu m. Sulfate in the dust was 95 microgram/cu m (20%). The catalytic effect of metallic particulates is considerd a cause of the formation of SO3 which reacts with water vapor to form sulfuric acid mist. Heavy metal particulates are common in industrial areas. Automotive exhaust pollution is a salient feature of todays large cities and it is increasing. The provisional standard for airborne load (5 microgram/cu m/day is exceeded at 7 stations. Lead contamination is reported to agree with carbon monoxide concentration. Nitrogen oxides and hydrocarbons data are sparce, but these compounds are chiefly responsible for photochemical smog. Oxidants concentration is a function of the hydrocarbon/nitrogen oxides ratio, hydrocarbon activity, and weather conditions. Local contamination by smoke and other particulates is decreaseing with the expanded use of dust collecting equipment.

29385

Kiyoura, Raisaku, Yoshisuke Uenishi, Milton Munisada, Masaya Iguchi, Toru Kuramoto, Gunji Kawasaki, and Naotake Naito

**INTERRELATIONSHIP OF HEAVY METALS SUCH AS LEAD IN SO2, NO2 AND FLOATING DUST IN THE URBAN ATMOSPHERE.** (Toshi taiki chu no SO2, NO2, fuyu funjin chu no Pb to jukinzoku sogo no kankei). Text in Japanese. Preprint, Japan Chemical Society, Tokyo, 1p., 1971. (Presented at the Japan Chemical Society Annual Meeting, Tokyo, March 1971, Paper 3346.)

Measurements of heavy metals such as lead in suspended dust and0 of sulfur dioxide in nitrogen dioxide, and inorganics, are reported. Suspended dust was measured using a high volume sampler; heavy metals in dust were analyzed by atomic light absorption, and inorganics by conventional wet-type techniques. NO2 was measured by the Saltzman method and SO2 by electroconductivity analyzer and P-rosaniline method. The average for NO2 in October was about 0.025 ppm, lower than the 0.035 ppm for SO2. The average suspended dust was 210 micrograms/cu m. There was a consistency in the change of concentrations of NO2 and SO2. The concentration of suspended dust also had a high correlation with NO2 and SO2. If the pollution from NO and NO2 from suspended dust and automobile exhaust gas is the basis of urban air pollution, the pollutants from the surrounding industrial areas would be added to this base to further increase urban pollution levels. There is very high correlation between Pb in dust and the water-soluble NO3 ion, the higher the traffic load, the higher the concentration of Pb and NO3 in the dust. Therefore, these are considered to be the indicators of pollution from automobile exhaust. Such heavy metals as manganese in dust are presumed to play the role of catalysts in the oxidation reaction of SO2 and NO.

29416

Hishida, Kazuo

**ON ACTUAL CONDITION OF AIR POLLUTION -CENTERING AROUND CASE OF TOKYO.** (Taikiosen no genjo ni tsuite - Tokyo-to no baai o chushin to shite). Text in Japanese. Japan Society of Mechanical Engineering, Tokyo Proc. Special Symp. Air Pollution, 27th 1971, p. 1-22. 31 refs. (April.)

In 1964, air pollution by sulfur oxides was a local problem confined to some specific regions, but today it has become a common national problem. In Tokyo (except its suburban area), the density of sulfur dioxide and trioxide was a record high of 0.054 ppm in 1967 and has since lowered to a record of 0.045 ppm in 1970. With 1964 taken as 100 when the entire metropolitan district showed an average of 0.038 ppm and the legal criteria was 0.05 ppm, it was 134 for 1965; 137 for 1966; 142 for 1967; 137 for 1968; 137 for 1969; and 118 for 1970. In the current winter (December 1970 through March 1971), the smog alarm was issued only three times compared with seven times in the preceding winter and 16 times in winter before that. The legal control measures set forth to curb the air pollution caused by sulfur oxides were inadequate for Tokyo. The effective chimney height and other specified criteria in the regulations cannot reduce pollution unless the total emission of SO2, and SO3 is reduced. In fact, of Tokyo s 10,500 installations surveyed, only 79 failed to meet the legal criteria, and their total sulfur oxide emission was estimated to account for only 0.8% of the Toky-wide total. Carbon monoxide density of automatic emissions was studied at a number of intersections in Tokyo in relation to quantity of traffic and hours of day. The mechanism of photochemical smog and oxidant was also discussed. A lead- carbon monoxide correlation diagram was analyzed covering the period from May 26, 1970 to June 3, 1970 for Yanagi-cho, Shinjuku, Tokyo, where the accident involving lead air pollution occurred. Settled and suspended dust and soot were discussed with statistics showing its trend for several years past. Measures were urged to cope with hydrogen chloride (hydrochloric acid) gas generated by incineration of plastics. Other noxious gases were discussed such as ammonia, hydrogen sulfide, and hydrochloric acid.

29465

Tokyo Metropolitan Environmental Pollutions Research Inst. (Japan)

**REPORT ON LEAD POLLUTION SURVEY.** (Namari kogai chosa kokoku). Text in Japanese. 54p., March 1971.

The urine and blood of people in the neighborhood of 11 busy intersections in Tokyo, were tested for lead concentration; carbon monoxide and lead concentrations in the atmosphere were also measured. The samples were collected for 10-14 hours. The average lead concentration at the intersection was 100, ppm (?), the area along the road averaged 84.4 ppm (?), the hunterland averaged 44.8 ppm (?). Although the relationship between CO and lead varied depending upon traffic, the recurrent coefficient varied from 1.6-3.4, with a tendency to increase. The correlation between CO and lead concentration was significant in every area, with a minimum of 0.670. The indoor lead concentration is influenced by the atmospheric concentration unless there is any source of lead generation inside the building.

29515

Hellwig, A. and H.-D. Schulze

**STUDY OF THE SUSPENDED PARTICULATES AND LEAD CONCENTRATION IN THE AIR WITHIN THE CITY LIMITS OF MAGDEBURG.** (Untersuchungen ueber den Schwebstaub- und Bleigehalt der Luft im Stadtgebiet Magdeburg). Text in German. Z. Ges. Hyg. Grenzg. (Berlin), 17(2):101-106, 1971. 20 refs.

Atmospheric dust and lead concentrations were measured at four crucial points in Magdeburg. The sampling probe was a brass head with a membrane filter. Suspended dust was measured gravimetrically, lead concentrations were colorimetrically determined by the dithizone method. While little dust and hardly any lead were measured in a suburban residential area, a close connection between both pollutants and traffic density was observed. At a busy thoroughfare in downtown Magdeburg (3000 passenger cars/hr), the annual average dust concentration was 0.47 mg/cu m and the annual average lead concentrations 2.92 micrograms/cu m. The tolerance limits of 0.50 mg/cu m dust and 0.7 micrograms/cu m lead were exceeded 35% and 92% of the time. In the newly created city center, (0.20 mg/cu m dust, 0.69 micrograms/cu m lead) annual average concentrations remained below the maximum allowable concentrations.

29647

Fukuoka, Saburo

**LEAD POLLUTION AND PHOTO-CHEMICAL SMOG IN TOKYO.** (Tokyoto ni okeru namari kogai oyobi kokagaku sumoggu ni tsuite). Text in Japanese. Jidosha Gijutsu (J. Soc. Automot. Engrs. (Japan), 25(3):290-297, March 1971. 9 refs.

A survey of the concentration of lead compounds in the atmosphere of urban communities of Tokyo from September 1969 to March 1970 at locations showed a concentration extending from 1.22 to 3.15 micrograms/cu m recorded near Setagaya and Koto respectively. The average concentration of lead at and around 10 intersections, extends from 1.4 to 4.7 micrograms/cu m. The concentration recorded at daytime is higher than at night. The concentration measured at four corners of an intersection is higher not only of that measured at an area near the roadway leading to the intersection but also that measured at an interior area away from the corner. The relation between the concentration of lead and carbon monoxide was a reciprocity coefficient of 0.668 to 0.7. Since decreasing lead in gasoline is urgent because of its harmful effects upon the human body, it was decided that gasoline containing over 1.1 ml/gal would not be put on the market after August 1970. Ultraviolet volume of lead is four times as much in the summer as in the winter. The summer is a rainy season in Japan; therefore the ultraviolet volume is higher than any other season. The continuous measurement of oxidant reveals that there were about 10 days on which the oxidant concentration was more than 0.15 ppm/hour within a three-year period beginning in 1967.

29655

Giever, Paul M. and W. E. Ruch

**STATISTICAL ANALYSES OF AIR POLLUTION SAMPLING FREQUENCY IN AN EPIDEMIOLOGIC STUDY.** Am. Ind. Hyg. Assoc. J., 32(4):260-266, April 1971. 6 refs.

A five year air pollution profile of particulate and gaseous contaminants was obtained for the area of the Tecumseh Community Health Study, a comprehensive longitudinal study of the health of the entire population in this area. Data on the solid particulate matter were collected and analyzed for total weight and for metallic ions present in sufficient concentration to be determined by the emission spectrograph. A special period of study for airborne lead was also conducted. Although the major source of contamination is considered to be the automobile, equipment for that type of analysis was not available. Using the analytical instrument that was available, carbon monoxide was evaluated over an extended period. The evaluation of data collected over a period of five years served to establish the threshold of contamination in the atmosphere for future comparisons of changing pollution concentrations. A four year period of bimonthly sampling of particulate matter was conducted and the analyses of these data showed that this type of information would provide accurate data on yearly pollution levels. (Author conclusions modified)

29744

Kobayashi, Yoshitaka

**URBAN POLLUTION BY AUTOMOBILE EXHAUST GAS.** (Jidosha hai-gasu ni yoru toshi osen). Text in Japanese. Preprint, Association of Safety Engineering, Yokohama (Japan), 22p., 1970. (Presented at the Association of Safety Engineering Seminar, 17th, Yokohama, Japan, Feb. 1970.)

The toxicity of carbon monoxide and lead in exhaust gas is described. In urban areas, the CO concentration is very high on busy roads. Pollutants in the atmosphere can be classified into four groups; sulfur dioxide, nitrogen dioxide, CO and nitric oxide, and ozone, each having a different pollution pattern. The CO concentration around the highways averages 3-6 ppm annually, but sometimes the hourly figure reaches 40-50 ppm. In the center of town, 10 ppm CO an hour appears 27% of the total hours a year. In such cities as Osaka and Tokyo, when the wind velocity is less than 0.5-1 m/sec, a high concentration is seen even in the areas away from highways. In winter, the CO concentration averages 5-6 ppm monthly even in the hinterland. Near highways, the NO concentration is 2-3 times higher than that of NO2, about 0.05-0.25 ppm monthly. The concentration of NO2 is very often less than 0.01-0.05 ppm monthly. In the hinterland area, NO is higher in winter about 0.01-0.05 ppm monthly. Carbon monoxide, NO and hydrocarbon levels around highways are low in the morning and high in the afternoon. Lead compounds along the highways measure 3-9 micrograms/cu m and 0.7-5 micrograms/cu m in the hinterland. Photochemical smog is explained. The non-dispersive infrared analyzer, the detecting tube method, oxidized mercury method, gas chromatography, and I2O5 method are described for measuring pollutants. Such

purification methods as slow adjustment, purification equipment, and change in engine models are explained. New cars are to emit less than 3% CO, for over 361 ml gasoline type of cars. The CO concentration in the atmosphere is to be less than 20 ppm an hour for eight continuous hours, or less than 10 ppm an hour for 24 continuous hours. The present total of 13 monitoring stations will be increased to 20 along the highways. Overall improvement in the traffic situation must take place and unnecessary idling and acceleration, must be drastically decreased by making the flow of vehicles smooth, widening the roads and providing freeways.

29814

Yoneyama, Etsuo, Y. Endo, T. Kawamura, T. Fukushima, T. Ohno, K. Saruta, K. Ohmori, and S. Yamaga

**LEAD CONCENTRATION IN YOKOHAMA AIR.** (Kukichu no namari nodo). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 5(1):65, 1970. (Presented at the Japan Society of Air Pollution, Annual Meeting, 11th, Japan, 1970.)

The lead concentration at busy streets in Yokohama was determined from March 1966 to June 1970 by means of polarography with nitric acid extracts from collected dust. The concentrations varied from a trace amount to 11.76 microg/cu m in proportion to the traffic. These values decreased on rainy and windy days.

29918

Kobayashi, Yoshitaka, Hori Masahiro, and Kenzaburo Tsuchiya

**DISTRIBUTION OF LEAD IN THE AIR NEAR CITY ROADS.** 20 p., 1970 (?). 10 refs.

Results are presented for measurements of airborne lead at various points along a main road in Yokohama. Sampling with a high-volume sampler was conducted every 24-73 hrs from November 1967 to October 1968. Analysis was by high-frequency polarography. Lead concentrations decreased remarkably with distance from the road up to 100 m, but were constant beyond that point. The vertical distribution of lead concentrations at a site 100 m from the road was almost constant at 1.1-1.3 microgram/cu m up to 20 m above ground. There was a correlation between lead concentrations in the vicinity of the road and the number of vehicles passing by; the former showed two peaks, one at 7:00 am and the other at 6:00 pm. Hourly variations were greatest at sites near the road. The highest value of the average diurnal concentrations of lead at 100 m from the road was 3.3 g/cu m; the lowest was 0.1 g/cu m. The former was obtained in December, when there was little rainfall, and the latter in summer, when there was much rain.

30025

Ishinishi, S. and N. Shigemori

**SEASONAL VARIATION OF THE CONCENTRATION OF HEAVY METALS IN SUSPENDED DUST ON THE MAIN STREETS.** (Kosaten fuyujin chu jukinzokuryo no kisetsuteki hendo). Text in Japanese. Nippon Eiseigaku Zasshi (Japan J. Hyg.), 26(1):135, April 1971. (Presented at the Japanese Society for Hygiene, Annual Meeting, 41st, Tokyo, April 3-4, 1971.)

An analysis of lead, iron manganese, and cadmium in suspended dust was made at two main street intersections in Kitakyushu (an industrial town) and in Fukuoka (a commercial town) from May 1966 to March 1970. The suspended dust was collected by a high volume air sampler. The mean values of metal composition for 4 years were as follows: in Kitakyushu, Pb, 2.91 - 4.68 micrograms/sq m; Fe, 45.3 - 78.9 micrograms/sq m; Mn, 2.05 - 1.91 micrograms/sq m; and Cd, 0.131 - 0.141 micrograms/sq m; in Fukuoka, Pb, 3.58 - 3.74 micrograms/sq m; Fe, 53.1 - 58.6 micrograms/sq m; Mn, 1.22 - 1.61 micrograms/sq m; and Cd, 0.131 - 0.153 micrograms/sq m. Lead showed a tendency to increase in the fall and winter. The correlation between Fe and Mn was fairly significant but that between Fe and Pb was slightly significant at only two points. No correlation was found between Fe and Cd.

30182

Kawai, Senzo, Toshio Sasaki, Susumu Takada, Shinobu Ashida, Toyoko Nonomura, Yasunori Takenobu, and Susumu Kitazawa

**ON THE CONTENTS OF POLYCYCLIC AROMATIC HYDROCARBONS AND METAL COMPONENTS IN FLOATING DUSTS UNDER DIFFERENT PARTICLE SIZES.** (Fuyufunjin no ryukeibetsu takan hokozoku kagobutsu oyobi kinzoku seibun ganyuryo ni tsuite). Text in Japanese. Nippon Koshu Eisei Zasshi (Japan J. Public Health), 17(2):168, Oct. 1970. (Presented at the Japanese Society of Public Health, Annual Meeting, 28th.)

The levels of dust in the air, the size distribution of dust, the metallic components in the dust, and the levels of PAHC (polycyclic aromatic hydrocarbon) were determined on the roof of a building in Kyoto City for 27 days in February and March 1970. A high volume air sampler and a hi-vol sampler with a cyclone (Cy-HV), a digital indicator, and a cascade centrifuge were used. Although the levels of airborne dust usually vary with the measurement method in this case with the exception of the digital indicator, there was little difference. Large dust decreased remarkably on rainy days. The levels of metallic components in airborne dust showed high levels of cadmium and lead in small dust particles and iron, nickel, manganese, chromium, and copper in large dust. The levels of PAHC in small sized dust were three to 20 times as high as those in large sized dust. The levels of PAHC in the soot from chimneys were lower than those in airborne dust and were higher for coal than other fuels.

30326

Hirafune, Kiyohiko, Masanao Takahashi, and Akira Sato

**STUDY ON THE ENVIRONMENTAL POLLUTION AT IWATE PREFECTURE. NO 13. METAL COMPONENTS IN ATMOSPHERIC PARTICULATE MATTER (ON THE RESULTS OF MEASUREMENT AND THE REGIONAL CHARACTERISTICS OF SEVERAL CITIES IN THE PREFECTURE).** (Iwate-ken no kogai ni kansuru kenkyu. Dai 13 ho. Taikichu fuyu funjin no kinzoku seibun (kennai shotoshi no sokutei kekka to sono chiikitek tokusei ni tsuite). Text in Japanese. Iwate-ken Eisei Kenkyusho Nenpo (Ann. Rept. Iwate Inst. Public Health), no 13:86-98, 1969. 22 refs.

Results are given for measurements of metal components (iron, manganese, copper, lead, cadmium, calcium) in atmospheric particulate matter in several cities of Iwate Prefecture) (Morioka, Miyako, Kamaishi, Ofunato, and Higashiyama. The regional characteristics of each city are stated. High volume air samplers continuously measured for 24 hrs atomic spectrometry analyzed the metal components. For Morioka, which is non- industrial with no particular pollution source, the metal concentration, on the whole was low and Cd was hardly detected. Miyagi, an industrial and fishing city and site of a metal refinery, showed high concentrations compared with the other cities: Mn, 0.68-5.80 microgram/cu m; Cu, 0.10-0.39 microgram/cu m; Pb, 0.42 - 3.67 microgram/cu m; Cd, 0.24-

0.143 microgram/cu m. Kamaishi, an iron and steel Center, showed high Fe concentration, and the Matsubara district, adjacent to the pollution source, was locally polluted with Fe (68.51 to 89.73 microgram/cu m) and Mn(0.95 to 6.73 microgram/cu m). In Ofunato and Higashiyama which contain cement factories, Ca concentration was especially high (16.23 to 54.66 microgram/cu m in Ofunto, adjacent to the source, and 25.22 to 82.94 microgram/cu m in Higashima within 0.5 km from the source).

30410

Hayafuku, Masataka, Kinshi Nakano, Hiroshi Yamazaki, and Rinko Nagata

**ON NOX VARIATION BY ALTITUDE AS OBSERVED AT TOKYO TOWER.** (Tokyo tawa ni okeru chisso sankabutsu no kokobetsu henka ni tsuite). Text in Japanese. Tokyo-to Kogai Kenkyusho Nenpo (Annu. Rept. Tokyo Met. Res. Inst. Environ. Prot.), vol. 2:20-27, March, 1971.

Nitric oxide, nitrogen dioxide and suspended particulates of lead were measured at three different altitudes, (25 m, 125 m, and 225 m) during August 5-18 and December 1-15, 1969. Sampling was done every hour daily. The concentration (pphm) measured at each altitude for the summer period ranged from 30.0 to 1.0 average 4.6, at 25 m; 9.0 to 0.4, average 2.1, at 125 m; and to 7.8 to 0.7 average 2.2 at 225 m. The NO2 density ranged from 20.0 to 2.0 and averaged 5.5 at 25 m; 9.6 to 0.5 average 3.5, at 125 m; and 19.0 to 1.1, average 5.1 at 225 m. Winter measurements also given, as well as the hourly variations for August 9-10 and 11-12 and December 2-3 and 9-10. The relationship between NO or NO2 and Pb was also studied, and the effects of wind direction and velocity on NO and NO2 levels were analyzed. NO is higher at each altitude in winter than in summer while NOs is higher in summer than in winter. In winter, both NO and NO2 tend to decrease as altitude increases. This trend is not conspicuous in summer, possibly due to the instability of the atmospheric station. There appears to be a considerable correlation between NO or NO2 and Pb, although more winter surveys are needed. NO and NO2 levels of 5.1 pphm or higher occurred more frequently when the wind was southerly or calm than when northerly for the summer, while it occurred irrespective of wind direction during winter. NO tends to increase with a lower wind velocity but this is not necessarily so for NO2.

30493

Tokyo Metropolitan Environmental Protection Research Inst. (Japan) Atmosphere Div.

**SURVEY OF SUSPENDED PARTICULATES IN THE ATMOSPHERE 1969.** (Showa-44-nendo fuyu biryushi chosa). Text in Japanese. (Tokyo-to Kogai Kenkyusho Nenpo Annu. Rept. Tokyo Met. Res. Inst. Environ. Prot.), vol. 2:112-118, March 1971.

The gross dust quantity and heavy metal particulates (lead, chromium, nickel, vanadium, cadmium, manganese, copper, and iron) were measured at nine stations and analyzed. The average value minimum values and maximum values (all in microgram/cu m) and the weight percentage (gross dust quantity taken as 100) for each measurement and location are given.

30494

Nagata, Rinko, Tetsundo Komechi, and Kinshi Nakano

**ATMOSPHERIC DENSITY OF LEAD AND CARBON MONOXIDE AT 11 INTERSECTIONS IN METROPOLITAN TOKYO.** (Tonai 11 kosaten ni okeru namari nodo to issankatanso nodo). Text in Japanese. Tokyo-to Kogai Kenkyusho Nenpo (Annu. Rept. Tokyo Met. Res. Inst. Environ. Prot.), vol. 2:44-61, March 1971.

The concentration of suspended lead particulates and carbon monoxide and the number of automobiles were measured at 11 selected intersections in Tokyo for 3 to 7 consecutive days in May, June, July, August, and September 1970. The average lead value by individual intersections ranged from 1.4 to 4.73 microgram/cu m while that measured 100 m away and along the street ranged from 0.3 to 4.16 microgram/cu m. The average value some distance away from the intersection and the streets was 0.3-2.39 microgram/cu m. Generally, the value was higher in daytime than at night except behind a few intersections, where it was higher at night. The correlation between Pb and CO levels was high for all the intersections surveyed, the coefficient ranging from 0.670 to 0.893. Since it is known that automobile emissions are the source of CO at intersections; the high correlation between CO and Pb is assumed to indicate that the automotive emissions are again the source of Pb particulates.

30656

Japan Environmental Sanitation Center, Tokyo

**SURVEY AND INVESTIGATION ON AIR POLLUTANTS.** (Taiki osenbusshitsu no chosa kenkyu hokokusho). Text in Japanese. 31p., April 1969.

Suspended dust was collected twice a month for a year by high volume air samplers at seven national sampling stations. The total amount of dust, organic substances, soluble substances, and metallic components in the collected dust were analyzed. The mean value of the total amount of dust in the seven stations was 24.2 microgram/cu m; the average in Kawasaki City showed the highest value of 420 microgram/cu m. In Sapporo, the amount of organic substances was high, but sulfate and lead contents were low. In Tokyo and Osaka, all the values were almost same as the average values of the seven stations. The values of each component fluctuated with the total amount of dust. Kawasaki city showed the highest value in all items and had especially high amounts of SO4, manganese, iron, and copper. Manganese, iron, and nickel contents were high in Amagasaki, and iron was slightly higher in Kita-kyushu. The total amounts of dust and metallic components in Ube were less than in other cities. To check the accuracy of emission spectroanlysis, which was applied for this study, the limit of determination was investigated by the strontium internal standard method.

30858

Kahl, Hermann and Walter Muschter

**THE SITUATION IN THE HYGIENE OF THE AIR OVER THE CAPITAL OF THE GDR.** (Zur lufthygienischen Situation der Hauptstadt der DDR). Text in German. Wiss. Z. Humboldt Univ. Berlin Math. Naturw. Reihe, 19(5):535-537, 1970.

Dust fall in East Berlin was measured from 1961 to 1968 by 100 measuring stations, thereafter the number of stations was reduced to 36. The results were divided into five concentration categories and plotted on a map. A median dust fall of 10-25g/sq m/30 days characterizes center city Berlin, Johannisthal, and Adlershof. The neighborhood near the gas works and the industrial areas of Lichtenberg and Rummelsburg had a dust fall of 30 to 90 g/sq m/30 days. In districts with heavy pollution, the dust fall level of 20 g/sq m/30 days was exceeded in 50 to 100% of the instances. Over an eight year period 23% of all monthly averages exceeded the maximum permissible emission value. The peak dust fall for all of East Berlin was reached in 1963 with 27 g/sq m/30 days. Sulfur

dioxide emissions were measured from 1966 to 1968 by 40 measuring stations every 15 minutes between 800 and 1600 hours. Results were evaluated for the entire three year measuring period for the use of domestic heating. Sulfur dioxide concentrations during the heating period were divided into five categories; peak emission was in center city. A close correlation existed between SO2 emission and population density. The MIC sub D value was exceeded during the heating period in 62% and during summer in 20% of the instances. The MIC sub K value of 0.5 mg/cu m was exceeded in winter in 7.5% and in summer in 0.5% of the instances. Daily SO2 emission averages, suspended dust, and dust lead content were measured in 10 stations. Suspended dust was, during the heating period, 50% above that of the summer. The mean daily SO2 levels were about half the short-time measurement levels. Both SO2 and suspended dust concentrations decreased from center city towards the periphery. Lead concentrations of three to six mcg/cu m were found in heavily polluted areas.

30860

Murphy, R. P.

**AIR POLLUTION CONTROL IN NEW SOUTH WALES.** Preprint, Dept. f Public Health, Sydney (Australia), Air Pollution Control Branch, 20p., 1970 (?).

All Australian state governments, with the exception of Tasmania, have passed air pollution legislation. The federal Clean Air Act established an Advisory Committee, fees, administration, regulations setting up emission standards, and licenses. An Air Pollution Control Branch was established with 10 engineers, four chemists, two technical officers, seven field assistants, and one laboratory attendant to implement the Act, monitor pollution, and research the problem. Stacks were sampled and analyzed by chemistry, spectroscopy, chromatography, and other means. New monitors have been developed including a sulfur dioxide colorimeter and a portable gas calibration apparatus. Three Clean Air Conferences have taken place, and a Clean Air Society was formed. Air pollution was monitored in Sydney and nearby cities. Dust fall improved over the years, while smoke density and sulfur dioxide concentrations have varied. Insoluble solids ranged from four tons/sq mi/month at purely residential sites to up to 60 tons sq mi/month at industrial sites. Average daily values of SO2 and smoke density were determined by hydrogen peroxide and paper tape clamps, respectively, at a series of monitoring stations. Also, continuous SO2 monitors were installed operating on the conductivity principle, but these were unsatisfactory for low concentration measurements. Hourly smoke haze results between 1960 and 1967 showed a reduction in the frequency of smoggy days and in the maximum hourly and daily values. Automobile exhaust was monitored close to Sydney traffic lanes; carbon monoxide ranged from .2% to 10% and could be lowered by adjusting the idling speed; aldehydes (formaldehyde), nitric oxide, nitrogen dioxide, lead, hydrocarbons (as methane), and other particulates were also measured. The cost of air pollution control in New South Wales was determined by a survey of various industries. The total expenditure for five years (1963-1968) was 39,910,000. Iron and steel companies spent 34.2% of the total and electric power suppliers spent 28.2%. The cost per person per year was $1.89. Other industries included boilers, cement, metallurgical, milling, chemical, oil refining, and gas. Various factors influencing pollution dispersion were studied including inversions, seasons, topographical interactions, and so on. The effect of weather conditions on smoke in the Sydney area was studied; air pollutants emitted to the west of Sydney during inversions increased the maximum values recorded at Sydney or extended the period during which high values occurred. Various analytical instruments are listed.

30892

Akiyama, J., T. Takishima, and I. Hukushima

**INVESTIGATION ON THE AIR POLLUTION IN ANNAKA DISTRICT.** (Gunmaken Annaka chiku no taiki osen ni tsuite). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 5(1):200, 1970. (Proceedings of the Japan Society of Air Pollution, Annual Meeting, 11th, Tokyo, Japan, 1970.)

Suspended dust particles and metal composition of the atmosphere were analyzed in three to 13 locations near the zinc refinery in Annaka City, Gunma Prefecture, during February 10-15, May 23-30, and October 10-17, 1969. Sulfur dioxide was captured every hour by an air auto sampler and measured by the rosaniline formalin method. Suspended dust particles were collected by a high-volume air sampler for two to eight hours during the test period and analyzed by atomic absorption spectrophotometry. Sulfur dioxide was more than 0.03 ppm for six days during the period of 15 days; the highest day average was 0.048 ppm. The particulate concentration was more than 300 micrograms/cu m for three days during the test period. Analyses showed an average of 0.03-0.19 micrograms/cu m of cadmium; 0.29-3.57 micrograms/cu m of lead; 1.37-12.16 micrograms/cu m of zinc; and 0.08-0.7 micrograms/cu m of copper. Leeward areas of the factory (south and east) were heavily polluted throughout the test period. Particulates showed heavy metal composition, but the concentration of Cd was lower than the environmental standard (0.08 micrograms/cu m).

31014

Kobayashi, Yoshitaka, Masahiro Hori, and Takeshi Meguro

**HEAVY METALS IN THE URBAN ATMOSPHERE.** (Toshi taikia chu no jukinzoku ni tsuite). Text in Japanese. Preprint, Japan Society for Safety Engineering, Tokyo, p. 84-85, May 1970. (Presented at the National Symposium on Safety Engineering, 1st, Tokyo, Japan, May 1970, Paper No. 42.)

Iron, lead, and cadmium in both suspended and settling dusts were measured in two areas in Yokohama, a commercial-residential and an industrial area, respectively. Sampling was done by high-volume air samplers, and analyses were performed by polarography and atomic absorption spectrophotometry. The average annual concentration in the commercial-residential district was 5.5, 0.82, and 0.011 microgram/sq m for Fe, Pb, and Cd, respectively. In the industrial area, the concentrations were 17, 2.57, 0.048 microgram/sq m for Fe, Pb, and Cd, respectively. Sampling of the dusts along the main automobile thoroughfare showed that the concentration of Pb declines with distance from the road, whereas Fe and Cd are independent of distance. Lead concentrations, but not those of Fe and Cd, correlated with the amount of automobile traffic. Lead was concentrated more in suspended dusts, thus Pb is mainly contained in aerosols that do not settle as fast as other larger particulates.

31325

Volchok, Herbert L. and Donald Bogen

**TRACE METALS--FALLOUT IN NEW YORK CITY.** In: Health and Safety Laboratory Fallout Program Quarterly Summary Report. Atomic Energy Commission, New York, Health and Safety Lab., p. I-91-107, April 1, 1971. 6 refs. NTIS: HASL-242

The trace metals, lead, copper, chromium, zinc, cadmium, manganese, vanadium, and nickel were analyzed in monthly fallout samples from New York City for about one year. The analytical procedures are shown to be sufficiently accurate and precise for the concentration encountered, and except for zinc, the reagent and sampling blacks are negligible. The results indicate that for most of the metals, the major part of

fallout is not associated with precipitation, and this portion is probably from local sources. A winter peak in nickel and vanadium fallout is possibly correlated with local fuel oil consumption. In general, the levels of fallout of these trace metals in New York City (except for manganese) approach or exceed the maximum values reported for U. S. measurements. A comparison of the washout ratios for lead and strontium-90 show good agreement, on the average, but wide variability in the lead values, apparently due to the effect of local meteorology. (Author abstract modified)

31332

Volchok, H. L. and M. T. Kleinman

**RADIONUCLIDES AND LEAD IN SURFACE AIR.** In: Health and Safety Laboratory. Atomic Energy Commission, New York, Health and Safety Lab., p. C1--9, C-89-93, April 1, 1971. 4 refs. NTIS: HASL-242

An air sampling program has been undertaken to study the spatial and temporal distribution of nuclear weapons debris and lead in the surface air. For the routine program, approximately 1400 cu m of ambient air per day are drawn through a 20 cm diam Microsorban filter for the land stations. At the ocean stations, about 2200 cu m of air per day are filtered with 20 by 25 cm Microsorban filters. Samplers are split into equal aliquots, one for gamma counting and spectrometry and the other for radiochemistry.

31396

Grosser, J., K. Horn, and A. Knauer

**SOME RESULTS OF AIR HYGIENE RESEARCH IN THE GERMAN DEMOCRATIC REPUBLIC AND THEIR PRATICAL APPLICATION.** (Ueber einige Ergebnisse der Lufthygienischen Forschung in der DDR und ihre Anwendung in der Praix). Text in German. Z. Ges. Hyg. Ihre Grenzgebiete (Berlin), 17(6):396-399, June 1971. 23 refs.

East Germany is gradually establishing an emissions-monitoring system. Emission measurements were taken in Berlin, Halle, Magdeburg, Schwerin, and in the Erz Mountains. Sulfur dioxide and dust were identified as the major air pollutants; hydrogen chloride, hydrogen sulfide, chlorine, HCOH, fluorine, arsenic, lead, carbon monoxide, and polycyclic and other hydrocarbons were present to a lesser extent. Several measurements showed high nitrogen dioxide levels in some but not all areas of the country. In the center of East Berlin, monthly average values were 0.007-0.032 NO2 mg/cu m. Comparative measurements with continuous monitors indicated a close relationship between SO2 and dust concentrations. A 90% value of the sum frequency of 0.28 mg/cu m and 0.19 mg/cu m was calculated for dust and SO2, respectively. The high dust and SO2 concentrations found in East Germany are due to the fact that 89.2% of power plants are still fired with soft coal. Based on comparison of death certificates for a rural area and an industrial area, mortality rates due to respiratory disease and heart ailments are higher in the latter area: 4.78/1000 for women and 5.78/1000 for men. For the rural area, the respective rates are only 3.6/1000 and 3.85/1000.

31669

Matsuoka, Cho, Toshio Kitamura, Isao Tahara, Heiichiro Kondo, Mitsugu Kondo, and Kimio Takeda

**REASEARCH ON AUTO EXHAUST GAS POLLUTION AND TRAFFIC NOISES IN TOKUSHIMA CITY AND ITS OUTSKIRTS.** (Tokushima shinai oyobi sono shuhen ni okeru jidosha haiki gasu ni yoru kankyo osen oyobi kotsu soon no jittai chosa ni tsuite). Text in Japanese. Tokushima-ken Eisei Kenkyusho Nenpo (Ann. Rept. Tokushima Pref. Inst. Public Health), no. 10:67-76, 1971. 4 refs.

Seven main highway crossings in Tokushima City and its outskirts were surveyed for number of cars, carbon monoxide, particulate matter, lead, and noise. Traffic was heaviest at the crossing in front of the Prefectural Office, with 5600 cars counted during rush hours and 3657 during off hours. The numbers represent an increase of 12.5% and 11.6%, respectively, over 1968 values. Mean CO levels at three points in the city were 11.8 ppm during rush hours and 3.6 ppm in periods of light traffic. The first value is 3.2 ppm higher and the second 1.8 ppm higher than in 1968. A peak value of 21.7 ppm was observed at 8:20 am in front of the Prefectural Office, an increase of 3.1 ppm over the highest 1968 value. At no site did values exceed the environmental criteria. At 2.30 microgram/cu m, maximum lead content was below the 5.0 microgram/cu m specified in the environmental criteria. Morning and noontime noise levels exceeded those specified in Prefectural noise-control legislation.

31775

Ter Haar, Gary L. and Michael A. Bayard

**COMPOSITION OF AIRBORNE LEAD PARTICLES.** Nature, 232(5312):553-554, Aug. 20, 1971. 5 refs.

Airborne particulate lead compounds were physically identified by using an electron microprobe. Samples were taken near and at a distance from a busy highway, in a rural area, immediately after automobile exhaust was discharged into a black bag, and in the bag 18 hours later airborne particulates were collected on membrane filters. The chief reaction products of the sample taken from the road and from the automobile exhaust after 18 hours were lead carbonates, oxycarbonate, and oxides. Very little bromine remained. The results from the black bag in the absence of light make it impossible for photolysis to account for the loss of halogen. In the black bag, the primary reaction appears to be a simple acid-base reaction with carbonate or hydroxide ion displacing the bromide ion and, in some cases, the chloride ion from the lead halides initially exhausted. Thus, lead oxide, lead carbonate, basic lead carbonate, or a mixture of these would be a good choice for experimental studies of the health effects of lead in the atmosphere.

32055

Murphy, R. P.

**THE PROBLEM OF AIR POLLUTION.** Preprint, Dept. of Public Health, Sydney (Australia), Air Pollution Control Branch, 8p., 1969.

Air pollution has now reached especially significant levels in industrial cities. Smog episodes and health studies of bronchitis, mortality, and respiratory diseases have increased the urgings for pollution legislation. Therefore, Australian state, federal, and local governments have passed control legislation. The New South Wales Clean Air Act of 1961 established an advisory committee, licenses, and fees. Certain meteorological conditions can increase air pollution to the degree that illness and death can occur. An organization of engineers, chemists, and laboratory assistants was set up to implement the Clean Air Act. Emission limits were set after chemical and dust emission tests were made in exhaust flues. The main sources of air pollution are boilers, kilns, and furnaces which produce smoke, fly ash, and sulfur dioxide. Chemical plants, metallurgical processing, grinding, and milling also produce some contaminants like metal fumes and dust. Motor vehicle exhaust and smoke from shipping contribute as

well. Air pollution was automatically monitored daily in Sydney, Newcastle, Port Kembla, Lithgow and Wollongong (dust fall, smoke haze, and SO2). Continuous recorders were also used to monitor hydrogen sulfide, nitrogen oxides, total oxidants, suspended inert dust, iron, copper, and lead. In Sydney, SO2 concentrations were usually lower than that for British cities, but high values sometimes occurred. A peak value of 270 ppm was recorded in 1967 with a maximum daily average of 57 ppm. Since crude oil and natural gas are being increasingly used, air pollution by sulfur gases should be reduced in the future. Surveys of motor vehicle exhaust showed slight oxidant content (an indicator of photochemical pollution), and some carbon monoxide, aldehydes, hydrocarbons, nitrogen oxides, suspended dust, and lead in congested traffic areas near the center of the city. The CO concentration reached a peak of 80 ppm, and the average value was 50 ppm. Adjustment of the idling speed reduced CO. Natural gas is replacing older fuels, but few Australian plants are eager to improve their existing plants and reduce pollution.

32350

Winchester, J. W. and R. A. Duce

**NEUTRON ACTIVATION ANALYSIS OF LEAD HALIDE POLLUTION AEROSOLS.** International Atomic Energy Commission, Vienna (Austria), Proc. Symp. Nucl. Activ. Tech. Life Sci., Amsterdam, Netherlands, p. 631-643. 20 refs. (May 8-12.)

Iodine, bromine, and chlorine were determined by neutron activation analysis in atmospheric samples of both natural and polluted origin. A comparison of the two sources provided the basis of a technique for determining the composition and possible source of lead halide pollution aerosols. The activation analysis consisted of reactor neutron irradiation of aqueous samples and comparators for 20 min followed by radiochemical separation of iodine, bromine, and chlorine. Also, beta radioactivity from solid silver halide sources was automatically counted. The determination of lead by anodic stripping voltammetry (inverse polarography) consisted of the deposition of lead radicals from the solution onto a composite paraffin-impregnated graphite and mercury electrode at -1.00 volts versus the standard calomel electrode, and then stripping by continuously increasing the potential. Ethyl fluid, a mixture of organic lead, bromine, and chlorine compounds, burns to form inorganic lead halide particles. In Cambridge, Massachusetts, analyses of cascade impactor aerosols were compared with similarly collected samples from the unpolluted air of Hawaii. The bromine component ranged from 0.4 to 0.1 or less of the lead concentration, indicating that in most cases the source was automotive lead with a bromine deficiency or a mixture of lead from automotive and other sources. In Fairbanks, Alaska, during the winter, atmospheric conditions favored high local concentrations of air pollutants. Aerosols collected by Millipore filters showed that chlorine pollution averaged very nearly the value predicted from the observed lead and the known composition of ethyl fluid; the source was indicated as automobiles. Bromine, however, was less than predicted, and the bromine deficiency was about the same in Fairbanks and in Cambridge. These results imply that ethyl fluid combustion is the major source of atmospheric lead in Cambridge and Fairbanks, and the observed bromine and chlorine pollution come predominantly from the same source.

32727

Endo, Yoko, Minoru Kitazume, and Etsuo Yoneyama

**HEAVY METALS IN DUST FALL.** (Koka baijin chu no jukinzoku). Text in Japanese. Kanagawa-ken Koshu Eisei Gakkaishi (Bull. Kanagawa Prefect. Public Health Assoc.), no. 17:4, March 1970. (Presented at the Kanagawa Prefecture Public Health Association Annual Meeting, 17th, Nov. 20, 1970.)

The distribution of lead, copper, and cadmium in the atmosphere and the correlation with dust fall in Yokohama City were studied. Rainfall, collected at 18 sites within the city in a one-month period, were analyzed by spectrophotometric methods. The mean value of the metals in kg/sq km/month were: 13.03 for lead, 4.89 for copper, and 0.650 for cadmium. The maximum and minimum values respectively, measured in kg/sq km/month were 15.2 and 6.06 for lead, 6.39 and 1.83 for copper, and 0.757 and 0.207 for cadmium. The correlation coefficients were 0.67 for lead and 0.64 for copper; no correlation was determined for cadmium. The proportion of the metals contained in the soluble and insoluble constituents of dust fall were 84.8 and 15.2% for lead, 89.9 and 10.1% for copper, and 98.0 and 2.0% for cadmium. The rate of cadmium in the soluble matter ranged from 96.1-99.5% without regard for region. Regional differences were determined in copper (80-98%) and lead (64-96%). Thy maximum value of lead and cadmium was determined in the rural area; copper was most concentrated in the commercial and residential areas.

32883

Yoneyama, Etsuo, Yoko Endo, and Minoru Kitazume

**ON PREVENTIVE MEASURES AGAINST ATMOSPHERIC POLLUTION BY EXHAUST GAS FROM AUTOMOBILES.** (Jidosha haiki gasu niyoru taikiosen boshi taisaku ni tsuite). Text in Japanese. Kanagawa-ken Koshu Eisei Gakkai-shi (Bull. Kanagawa Prefect. Public Health Assoc.), no. 17:1, March 1970. (Presented at the Kanagawa Prefecture Public Health Association Annual Meeting, 17th, Nov. 20, 1970).

The maximum allowable concentration of lead in the air for an average of eight to 24 hours is 1.5-5 micrograms/cu m. Air quality measurements using high volume air samplers and atomic absorption spectrophotometry were taken in Yokohama City. The maximum lead concentration in Yokohama was 11.13 micrograms/cu m; maximum values exceeding the standard were determined in five other spots throughout the city. At Isezaki-cho, where traffic was temporarily banned in 1966, the lead concentration decreased from 2.67 micrograms/cu m to 0.3 micrograms/cu m. The maximum and mean values further decreased with an increase in trafficless days.

32912

Kanagawa Prefectural Government (Japan)

**KANAGAWA PREFECTURAL AIR POLLUTIONS SURVEY AND RESEARCH REPORT.** (Kanagawa-ken taiki osen chosa kenkyu hokoku). Text in Japanese. Rept. 13, 109p., Feb. 1971. 49 refs.

Reports were compiled on surveys conducted in Kanagawa Prefecture. Atmospheric concentrations of dust, sulfur dioxide, nitrogen dioxide, carbon monoxide, carbon dioxide, lead, chlorine, sulfur trioxide, nitrogen oxides, and automobile exhaust gases were measured. Air pollution and meteorological conditions in the Tokyo-Yokohama industrial belt, and effects of air pollution on humans and trees were also studied. Enforcement procedures based on the Air Pollution Control Law are examined. Air pollution forecasting and some examples of control methods are discussed. Research reports on mercury determination by the atom light absorbing method, nitrogen oxides measurement, gas sampling, and measuring carbon monoxide by detection tubes are included.

32945

Georgii, H. W. and D. Jost

**SHORT COMMUNICATION ON THE LEAD-CONCENTRATION IN AN URBAN AEROSOL.** Atmos. Environ., 5(8):725-727, Aug. 1971. 9 refs.

Dust samples collected in a residential section of Frankfurt on the Main from June 1969 on were analyzed for lead by atomic absorption spectrophotometry. The dust samples were taken at a distance of three m from the street and 0.5 m above street level in an area where rush-hour vehicle frequency is 1000 cars/hr. The tabulated monthly average lead concentrations show only a weak annual variation in concentration. The average lead concentration was 0.8 microgram/cu m. The 97% value of the cumulative frequency distribution was 5.5 microgram/cu m. Lead values as high as 38 microgram/cu m were recorded during inversions. Correlation coefficients between lead and simultaneously measured carbon monoxide were significantly non-zero at all sites studied, indicating the extent to which automobile exhaust gases are present in urban air. Lead concentrations calculated on the basis of recorded CO levels showed that the recommended lead emission concentration of two microgram/cu m is frequently exceeded in Frankfurt.

33114

Nishida, Konosuke, Tsuneo Honda, Takashi Suzuka, and Tadao Ando

**ON ACTUAL CONDITION OF POLLUTION DUE TO AUTOMOBILE EXHAUST GASES AT TOLL STATIONS OF HIGHWAY.** (Kosokudoro no ryokinshuno ni okeru haikigasuosen no jittai ni tsuite). Text in Japanese. Kankocho Kogaisenmon Shiryo (Public Nuisance Gaz.), 6(3):65-80, May 1971. 23 refs.

Concentrations of carbon monoxide, nitric oxide, nitrogen dioxide, sulfur dioxide, lead, aldehydes, and floating dust were determined at four toll stations on the Meishin Highway using an automatic measuring system. The results were correlated with traffic volume, wind speed, and the ventilation system within the stations. The mean traffic volume was 216-415 vehicles/h. Wind velocity at the Kyoto east and south stations was 0-7.2 m/sec, with windless conditions (under 0.2 m/h) prevailing 52.4-75.6% of the time. Scattering or dilution of exhaust gases was minimal. Carbon monoxide concentrations in the stations were 0.2-12.1 ppm/h and sometimes attained 50 ppm/h. Floating dust content in the vicinity was 0.6-2.22 mg/cu m, and lead concentrations were 10.2-46.6 micrograms/cu m. Concentrations of NO, NO2, and SO2 were 10-100 pphm, 2.0-10 pphm, and 2.0-8 pphm, respectively. Wind velocity at the Otsu and Ritto stations was 0-3.8 m/sec. Carbon monoxide concentrations in the vicinity of these stations were 1.0-3.6 ppm and 3.0-9.0 ppm, respectively. The amount of floating dust was 0.42-2.22 mg/cu m, and the lead concentration was 12.6-75.5 micrograms/cu m. Lead concentrations were extremely high at the Ritto station, and aldehydes were detected at both the Otsu and Ritto stations. Generally, e.g. exhaust gases released in the vicinity of the stations stagnated at ground level (0-3.5 m).

33576

Hyogo Prefecture (Japan), Dept. of Living

**PUBLIC NUISANCE IN HYOGO PREFECTURE.** (Hyogo-ken no kogai). Text in Japanese. 197p., Nov. 1970.

The degree of air pollution in most cities in Hyogo Prefecture has stayed on the same level or increased slightly in recent years, except for Himeji and Akashi cities. Prevalent pollutants in Hyogo cities are carbon monoxide, nitrogen oxides, hydrocarbons, and oxidants created by the photochemical reactions of these material. Standard permissible and actual counts of sulfur oxides, CO, NO, NO2, suspended and settling particulates, lead, and fluoride, compounds are presented in description, tables, and graphs. Average amounts of settling particulates in Hyogo Prefecture run between 5.30 t to 14.52 t/k sq m/month; the highest figure is for Amagasaki city. Kobe city is the next most polluted; measurements at four locations all indicate more than 10 t/month average. The annual average for Kobe in 1967 was 12.78 t; in 1968, 12.54 t and in 1969, 12.87 t. At the highest point in an industrial area of Kobe, settling particulate averaged as high as 17.95 t/month. The annual average of sulfur oxides in Amagasaki in 1968 was 0.083 ppm/hr and in 1969, 0.084 ppm, representing a much higher figure than the maximum permissible amount of 0.05 ppm. Carbon monoxide concentration is 5.0-9.0 ppm/day in Kobe, 2.7-5.8 ppm in Himeji, and 2.3-6.8 ppm in Itami. Monthly averages of NO concentration in Kobe are 80-142 ppb and of NO2, 33-37 ppb. Figures in Himeji, Kakogawa, and Itami are much lower than those of Kobe. Western Hyogo around Akashi, Kakogawa, and Himeji are relatively unpolluted. The Himeji area has especially shown a marked improvement since dust collectors were installed in electric furnaces of iron foundries in 1967. The annual average of settling particulates of 11.12 t/k sq m/month in 1966 decreased to 7.92 in 1967, 6.54 in 1968, and 5.64 in 1969.

34008

Dimitriev, M. T.

**A STUDY OF ATMOSPHERIC POLLUTIONS AND PHYSICOCHEMICAL PROCESSES PREVAILING IN THE ATMOSPHERE OF THE DDR.** (Ieucheniye atmosfernyk zagryazneniy i fizikokhimicheskikh protsessov, proiskhodyashchikh v atmosfernom vozdukhe GDR). Text in Russian. Gigiena i Sanit., 36(7):84-87. 1971.

The main trends in the assessment and control of air quality in the Deutsche Democratische Republic are reviewed. Sulfur dioxide, sulfur trioxide, sulfuric acid, hydrogen sulfide, nitrogen dioxide, ozone, carbon monoxide chlorine, hydrogen fluoride, tetraethyl lead, benzo(3-4)pyrene, dust and soot levels constitute the main pollutants measured during continuous monitoring. The SO2 concentrations range from 0.03 mg/cu m, in the summer, to 0.32 mg/cu m in winter in the city of Berlin; these fluctuations are due to domestic heating. Automotive exhaust gases constitute the main source for NO2 pollution which reaches 0.5 mg/cu m during the morning and evening peak traffic hours. There are 16 stations for systematic monitoring of atmospheric ozone, SO2, dust, and radioactivity. Maximum ozone levels occur during May and June along with other peak photooxidant concentrations related to air pollution. Photochemical generation of ozone, formaldehyde, and other photochemical oxidants in the polluted air constitute an important research area. The popularity of the two-stroke vehicle in the DDR increases the amount of pollutants due to exhaust gas. Thus, benzo(3,4)pyrene and formaldehyde are 30 to 50 and three to five times higher, respectively, than emissions from four stroke vehicles The exhaust gases from two-stroke vehicles contain 50 mg/cu m lead and the air in the urban areas contains 0.3 to 0.5 microgram/cu m Pb in the DDR. Dust levels vary from 0.1 to 3.0 g/sq m in the cleanest rural areas to between 25 and 120 g/sq m in the industrial areas, with an average of 13 g/sq m in Berlin. Interactions between aerosols and the solubility of these carcinogens in blood serum constitute another area of air pollution research in the DDR. The main research institutes are indicated.

34805

Volvhok, H. L. and M. T. Kennman

**RADIONUCLIDES AND LEAD IN SURFACE AIR. C.** In: Appendix to Health and Safety Laboratory Fallout Program Quarterly Summary Report. Atomic Energy Commission, New York, Health and Safety Lab., HASL-243, p. 1-9, 88-92, July 1, 1971. 4 refs. NTIS: HASL-243

The spatial and temporal distribution of nuclear weapons debris and lead in the surface air was studied. Samplers were placed on four Atlantic Ocean weather ships to extend the surface air study over the marine environment. Most of the original Naval Research Laboratory sites grouped grouped along the 80th Meridian (West) were used. For the routine program approximately 1400 cu m of ambient air per day were drawn through a 20 cm diameter Microsorban filter for the land stations. Each sample was split into equal aliquots, one for gamma counting and spectrometry and the other for radiochemistry. Daily pump pressure drop and temperature readings were also submitted along with samples to compute the volume of sampled air. The activity concentrations for all the radionuclide, gross gamma, and stable lead analyses completed to date are tabulated.

34933

Jutzi, W.

**LEAD CONTENT IN STREET DUST AND IN THE STREET AIR OF THE CITY OF ZURICH IN THE SPRING OF 1970.** (Bleigehalt des Strassenstaubs und der Strassenluft in der Stadt Zuerich im Fruehjahr 1970). Text in German. Bull. Eidgenoess. Gesundheitsamtes, Beilage B, no. 3:145-151, March 1971. 2 refs.

Street dust was collected by means of a brush, particles of a diameter exceeding 0.15 micron were separated, and the lead content of the fine residual dust was determined by emission spectrography. The atmospheric lead content in suspended dust was determined by drawing 40 cu m air/h through a paper filter, mineralizing the filter with the dust, and determining lead content by atomic absorption spectrometry. The tests were performed where identical tests were performed seven years earlier in 1963. A comparison of test results (median level of 0.106% lead in street dust in 1970 against 0.204% in 1963, median level of 3.8 micron lead/cu m in 1970 against a median level of 2.7 microns Pb/cu m in air in 1963) disclosed that, while on one hand atmospheric lead content increased on all sites, the lead content in street dust decreased, also on all sites. The first change can be attributed to the increased number of automobiles in street traffic. There is no explanation for the second change other than that a seasonal low in the spring and the heavy rains preceded the measurements in 1970.

35010

Ruhling, Ake and Germund Tyler

**REGIONAL DIFFERENCES IN THE DEPOSITION OF HEAVY METALS OVER SCANDINAVIA.** J. Appl. Ecology., 8(2):497-507, Aug. 1971. 8 refs

Mosses were used as indicators of fallout of airborne heavy metals to determine regional differences in the deposition of heavy metals over Scandinavia. Total calcium, cadmium, cobalt, chromium, copper, iron, potassium, magnesium, manganese, sodium, nickel, lead, and zinc were analyzed by atomic absorption spectrophotometry after wet combustion of the samples. Mean concentrations of Cd, Co, Cr, Cu, Ni, Pb, and Zn from southern Sweden were larger in the southwest than in the northeast. Concentrations of Pb and Cd was more than ten times larger in southwest Sweden than in northern Norway. The deposition of heavy metals/hectare/year was calculated. The regional basic concentrations reflected the fallout from an atmospheric pool to which both neighboring and remote sources contributed. (Author summary modified)

35025

Ministry of Health and Welfare (Japan)

**POLLUTION CONTROL MEASURES.** (Kogai taisaku). Text in Japanese. In: White Paper on Health and Welfare: Children and Society. (Kosei hakusho: kodomo to shakai). p. 304-328, 1971.

The results of continuous monitoring of sulfur oxides in 1969 show that 130 monitoring locations (61%) in Japan met the environmental standard and 82 locations (39%) failed to meet the standard. In 1968, 62 (40%) of the 155 same monitoring locations failed to meet the standard and 64 (41%) failed in 1969. Seventeen cities in Japan had locations which failed to meet the standard for three consecutive years. In all six locations in Tokyo, where carbon monoxide concentration was continuously monitored since 1964, average concentration of CO increased considerably between 1964 and 1969. Nitrogen oxides measurements in Tokyo also steadily increased for the same period, varying anywhere from 20% to three times over. Settling particulates have markedly decreased since about 1960, due to the installation of dust collectors in various factories and to the change of fuel from coal to petroleum. For instance, in Kawasaki city which was notorious for its soot, settling particulates decreased from 55.6 ton/k sq m/month of 1961 to 29.7 ton in 1969. Most of other cities showed the same tendency for the same period, but Kitakyushu city area seemed to worsen gradually. The average daily amount of suspended particulates in 1968 was 175-425 micron g/cu m, and 140.7-361 micron g/cu m for 1969. The highest daily average was 370-905 micron g/cu m in 1968 and 284-665 micron g/cu m for 1969, showing a slight improvement. Lead seems to have increased in all cities. Health effects of pollution vary from chronic damages to respiratory system, eyes, nose, and skin. Lead poisoning from automotive exhaust gas and photochemical smog effects have occurred in Tokyo. As of June 1971, patients who have been diagnosed as pollution victims are 4052 in all Japan, among which, those who are victims of air pollution are 443 in Kawasaki, 687 in Yokkaichi, 1853 in Osaka, and 1069 in Amagasaki.

35407

Kennedy, William R., William D. Purtymun, and Harry F. Schulte

**LOS ALAMOS ENVIRONMENTAL MONITORING PROGRAM. JULY THROUGH DECEMBER 1970.** California Univ., Los Alamos Scientific Lab., N. Mex., Atomic Energy Commission Contract W-7405-eng-36, Rept. UC-41, 9p., July 1971. 7 refs. NTIS: LA-4672-MS

The Environmental Monitoring Program in Los Alamos County is designed to determine the effect of the operations of the Los Alamos Scientific Laboratory on the surrounding area. Sixty stations throughout the county monitor emissions of gamma radiation; particulates emitting gross alpha, beta, and gamma radiation; tritium, plutonium, and americium in the air; and various air pollutants, e.g., suspended particulates, benzene-soluble matter, beryllium, lead, dust fall, soiling index, and visibility. Water and soil samples are also collected. The measurement results are presented for July-December 1970.

35489

Harrison, Paul R., Wayne R. Matson, and John W. Winchester

**TIME VARIATIONS OF LEAD, COPPER AND CADMIUM CONCENTRATIONS IN AEROSOLS IN ANN ARBOR, MICHIGAN.** Atmos. Environ. (London), 5(8):613-619, Aug. 1971. 7 refs.

Air samples in Ann Arbor, Michigan, were analyzed by anodic stripping voltammetry (ASV) with a composite graphite electrode for the average mass distribution with particle size of lead, copper, and cadmium. The samples were collected with a modified seven-stage Andersen cascade impactor with a glass backup fieter at two-hour intervals over a 42-hr period from April 26-28, 1969. Average particle size distributions were similar for the three elements over the radius range covered by the impactor stages which sort particles into factor of two radius intervals (0.1 less than or equal to r less than or equal to 10 micron). Lead, however, showed a significantly greater proportion of its total concentration in particles caught by the filter (radius less than or equal to 0.1 micron) than did Cu or Cd. Variations of each of the elements of over a factor of 10 were seen within any 24-hr period during the 42 hours. Two prominent maxima were observed at 0200-2400 EST, suggesting a wind shift from north to east. The results imply that some of the Cu and CD, and much of the Pb, at the maximum times, came from the Detroit sector by easterly winds and that a two-hour sampling program is adequate for correlating changes in the environment with mesoscale meteorological parameters. (Author abstract modified)

35725

Jernigan, Eva L., Barbara J. Ray, and Robert A. Duce

**LEAD AND BROMINE IN ATMOSPHERIC PARTICULATE MATTER ON OAHU, HAWAII.** Atmos. Environ., 5(10):881-886, Oct. 1971. 20 refs.

Atmospheric particulate lead and bromine concentrations were determined for samples collected in and around urban Honolulu, Hawaii. The samples were collected during periods of tradewind weather which should cause a maximum dispersion of pollutants. The average urban curbside concentrations of lead and bromine were 7.7 micrograms/cu m and 1.60 micrograms/cu m respectively, similar to or higher than concentrations reported for mainland cities. The coefficient of correlation between the bromine and lead concentrations was 0.97, suggesting a common source for both pollutants. Although the most probable source is automobiles, the Br/Pb ratio for urban curbside samples was 0.22 plus or minus 0.04, lower than the ethyl fluid ratio of 0.39. This may indicate that bromine is lost from the particles after emission to the atmosphere. The consistency of the ratio, compared to previous studies, is probably a result of the persistent meteorological conditions during tradewind periods. (Author abstract)

35861

Moyers, Jarvis L., William H. Zoller, Robert A. Duce, and Gerald L. Hoffman

**GASEOUS BROMINE AND PARTICULATE LEAD, VANADIUM, AND BROMINE IN A POLLUTED ATMOSPHERE.** Environ. Sci. Technol., 6(1):68-71, Jan. 1972. 18 refs.

Air quality in Cambridge, Mass. was monitored with activated charcoal and membrane filters to determine concentrations of atmospheric gaseous bromine and particulate lead, vanadium, and bromine. Concentrations in micrograms/cu m as determined by neutron activation analysis were within 0.12-0.45 for gaseous bromine; 0.12-0.94 for particulate bromine; and 0.08-1.32 for particulate vanadium. Lead concentrations were 0.4-3.7 micrograms/cu m as determined by atomic absorption spectroscopy. All particulate species were significantly correlated with each other, indicating atmospheric interrelationships largely explained by meteorological conditions. The correlation of lead with both particulate and total bromine was exceptionally good since lead and bromine came from the same source; however, atmospheric concentrations of bromine were less than supected from the amounts of bromine added to gasoline in ethyl fluid. The lower concentrations could be explained by different residence times for bromine and lead or that some bromine exists in a chemical form not collected by filtration or activated charcoal adsorption. (Author abstract modified)

35940

Laamanen, Arvo and Timo Partanen

**CROSS-CORRELATIONS IN TIME SERIES OF SOME PARTICLE FALL COMPONENTS ON RELATION TO URBAN AREA TYPE.** Suom. Kemistilehti B, 44(11):361-366, 1971. 3 refs.

Factor analysis was applied in patterning time series of various components of outdoor particle fall at four stations in Helsinki and one station in Tartu. The stations were located in a residential area, an urban background area, a mixed industrial area, an outdoor bus terminal, and near an iron ore processing plant. The particulates were examined for calcium (+), chlorine (-), sulfate ion, titanium, vanadium, copper, nickel, chrome, lead, tin, and manganese. The factor matrix for each station is presented and interpreted. Indirect information about emissions is included in three cases in the form of fuel consumption, industrial production figures, and traffic volume at major effective sources.

36009

Hasegawa, Toshio and Akiyoshi Sugimae

**TRACE METALS IN AIR BORNE PARTICULATES. I. SURVEY OF LEAD IN THE ATMOSPHERE.** (Fuyu funjin-chu no kinzoku seibun (daiippo) namari ni yoru kankyo osen). Text in Japanese. Eisei Kagaku (J. Hyg. Chem.), 17(6):404-411, Dec. 1971. 12 refs.

The concentration of lead in the atmosphere was measured at 12 sampling sites in Osaka (commercial, residential industrial, and rural) every day in June (1969), October (1969), and February (1970). Lead in samples collected by High Volume Air Sampler, Cascade Centripeter, and Tape Air Sampler was determined by emission spectrographic analysis. The monthly average concentration at various locations ranged from 0.11 to 4.44 micrograms/cu m, with an overall average of 2.03 micrograms/cu m. Distribution of lead content in airborne particulates formed a distribution of approximately logarithmic normal type. Its mean value was 0.63% and the upper limit was 1.9% at the one-side significant level of 5.0%. Size distribution of lead particulates in the atmosphere was also investigated; the distribution curves at every sampling site were almost alike and 81-98% of the lead particulates were less than one micron in diameter. An inverse correlation was found between lead concentration in the atmosphere and wind velocity. The slope of the regression line, representing the ratio of lead concentration to wind velocity was greater in heavy traffic area than in a residential area. Diurnal variation of lead concentration, determined continuously every hour by the Tape Air Sampler, was also inversely correlated with wind velocity. In addition, correlation between lead and carbon monoxide concentration in the atmosphere was also studied. 0

36195

Tepper, L. B.

**SEVEN-CITY STUDY OF AIR AND POPULATION LEAD LEVELS. AN INTERIM REPORT.** Cincinnati Univ., Ohio, Dept. of Environmental Health, Air Pollution Control Office Contract PH 22-68-28, 8p., May 1971.

In 1968, the Department of Environmental Health at the University of Cincinnati initiated a study which was designed to examine air lead levels at a number of locations in Cincinnati, Los Angeles, and Philadelphia. Instrument stations were re-established at the original sites of a previous study made in 1961-1962; identical equipment and filter media were used. Additional sites were located in Okeana, Ohio; Ardmore and Wynnewood, Pennsylvania; and Los Alamos, New Mexico. Blood samples were collected from volunteers from church and civic groups who had lived within a prescibed area for a period of at least five years. In association with the collection of the blood samples, subjects were interviewed with respect to age, place of residence, food and water supply, local travel, occupation and place of work, tobacco consumption, and health history. Rural and urban (commercial, residential, and industrial) areas were studied.

36288

Tomida, B., T. Fukuda, H. Inoue, N. Hamamura, K. Ishida, M. Noma, Y. Shimizu, K. Nakamura, M. Hayakawa, and S. Watanabe

***THE METAL CONTENT IN THE AIR OF CITIES IN AICHI PREFECTURE.*** (Aichi-kenka shuyo toshi no okeru taikichu no jukinzoku seibun ni tsuite). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 6(1):213, 1971. (Presented at the National Council of Air Pollution Studies, 12th, Nagoya, Japan, Oct. 27-29, 1971.)

To investigate the effect of the Nanbu industrial district and rapidly growing Kinuura industrial district on the surrounding area in Nagoya, the atmospheric concentrations of heavy metals were measured at 12 locations from November 4, 1970 to January 12, 1971. Samples collected using a high-volume air sampler by 24- hour sampling were analyzed by the atomic absorption method. The average concentrations at five districts were in the following range (in micrograms/cu m): suspended particulate matter, 0.203-0.774; iron, 6.2-29.1; zinc, 1.0-5.5; copper, 0.10-5.1; manganese, 0.27-1.75; lead, 1.1-5.1; and cadmium, 0.011-0.034; the metallic concentrations were the highest in Nanbu district, followed by Kinuura district, however, the concentrations were significantly lower in other districts.

36449

Teer, Ellis H.

**ATMOSPHERIC LEAD CONCENTATION ABOVE AN URBAN STREET.** Washington Univ., St. Louis, Mo., Dept. of Civil and Environmental Engineering, Thesis (M.S.), Jan. 1971, 74p. 43 refs.

The concentration of lead in particulates in the atmosphere above an urban street in St. Louis was measured by high-volume sampler and determined through atomic absorption spectrophotometry. The results were correlated with traffic volume, wind speed and direction, and elevation, and the total was regressed using multiple regression analysis. Lead concentration decreased with increasing elevation and was influenced by high-rise buildings. Traffic volume did not have as pronounced an effect on atmospheric lead concentration as was anticipated. (Author abstract modified)

36474

Kubo, Kiyoshi, Eiichi Ito, and Masaru Kitase

**ON CONTENTS OF SUSPENDED PARTICULATES IN THE ATMOSPHERE OF URBAN AREA.** (Toshi taiki-chu ni okeru fuyu funjin seibun ni tsuite). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 6(1):210, 1971. (Presented at the National Council Meeting of Air Pollution Studies, 12th, Nagoya, Japan, Oct. 27-29, 1971.)

The vertical concentration distributions and hourly concentration variations of heavy metals in the atmosphere were measured in Nagoya City. Samples were collected by one hour sampling at ground level, 26, 50, 70, and 100 m above the ground from 8:00 to 20:00 on May 20 and 21, and June 8 and 9, 1971, and analyzed by the atomic absorption method. The vertical distribution of lead concentration is very similar to that of the suspended particulate matter, while the concentration distribution of iron, manganese, and copper was independent of the particulate matter. The concentration of Fe and Mn showed very similar distribution patterns. The cadmium concentration was almost constant, regardless of the altitude. The time variation of concentration showed higher values at rush hours, indicating the effect of auto exhaust. The effect of wind on the vertical distribution is also discussed.

36486

Nakamura, M., K. Saruta, Y. Endo, and E. Yoneyama

**TRACE METALS IN SUSPENDED PARTICULATES.** (Fuyu funjinchu no kinzoku). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 6(1):214, 1971. (Presented at the National Council Meeting of Air Pollution Studies, 12th, Nagoya, Japan, Oct. 27-29, 1971.)

The metallic content in suspended particulate matter was measured at seven locations in Yokohama from May 10 to 18, 1971. Samples collected using a high-volume air sampler by 24-hour sampling were analyzed by the atomic absorption method. The concentrations of eight metals determined were in the following range micrograms/cu m: vanadium, 0.023-0.156; copper, 0.035-0.158; lead, 0.243-0.458; manganese, 0.211-0.529; cadmium, 0.119-0.079; nickel, 0.023-0.350; chromium, 0.016-0.105; and iron, 19.9-44.3. The Pb concentration attributable to auto exhaust was generally lower than that of the previous year. The nickel concentration was extremely high in the Tsurumi industrial district, almost ten times of that in the residential district. Vanadium and all the other metal concentrations were highest in Tsurumi district.

36503

Tada, Osamu and Kenji Nakaaki

**ON THE AIR POLLUTION IN SUBTERRANEAN PARKING PLACE.** (Chika shushajo no kuki osen ni tsuite). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 6(1):235, 1971. (Presented at the National Council Meeting of Air Pollution Studies, 12th, Nagoya, Japan, Oct. 27-29, 1971.)

The carbon monoxide, nitrogen dioxide, sulfur dioxide, and lead compounds in subterranean parking lots A and B, and CO in the exhaled air and Pb in the urine of attendants were determined in June and February, respectively. At parking lot A, the CO concentration was 13 - 31 ppm, NO2 was 0.05-0.09 ppm, SO2 was 0.02-0.07 ppm, and Pb was 4.5-12.4 micrograms/cu m. At parking lot B, the CO concentration was 7.0-40 ppm, NO2 was 0.01-0.05 ppm, SO2 was 0.03-0.08 ppm, and Pb was 0.3-1.1 micrograms/cu m. The CO in the exhaled air tended to increase with the duration of working. The average Pb concentration in urine was 28 micrograms/l and 20 micrograms/l at A and B, respectively.

36562

Yocom, John, William L. Clink, and William A. Cote

**A STUDY OF INDOOR-OUTDOOR AIR POLLUTANT RELATIONSHIPS. (VOLUME I. SUMMARY REPORT).** Research Corp. of New England, Hartford, Conn., NAPCA Contract CPA 22-69-14, Rept. APTD-0592, p. 1-122, May 1970. NTIS. PB195338

Suspended particulates, soiling particulates, carbon monoxide, and sulfur dioxide were measured simultaneously for a two week period at three pairs of buildings (older public buildings newer air-conditioned offices, and private homes) during the summer 1969, fall 1969, and winter 1970 in the Hartford, Conn. area. The major components of each of two self-contained portable instrument trailers constructed for the study included a central vacuum pump for the particulate sampling filters, paper-tape soiling samplers, analyzers for SO2 and CO, and a master control unit for cycling the sampling through the two outside and two inside measurement points for each building. Particle-sizing instruments were operated sequentially in separate packages. The organic fraction of suspended particulates readily penetrated all structures and significant quantities may have been generated indoors; the lead fraction outdoors depended strongly on traffic and penetrated structures only marginally better than the parent particulates. Suspended particles readily penetrated private homes in summer; but penetration was more on the order of 50% in other buildings and seasons and measured levels depended greatly on normal daily activity, traffic and seasonal factors both outdoors, and to a lesser extent, indoors. Carbon monoxide readily penetrated all the structures, although concentrations could be altered by proper ventilation adjustments. Also, CO measurements showed little detectable influence of a submerged roadway or underground parking garage on air-rights buildings or surface air-conditioned buildings. Generally, 50-100% of outdoor SO2 penetrated the structures when it existed in measurable quantities. Comparative indoor/outdoor ratios of the measured pollutants are discussed. (Author summary modified)

36688

Oikawa, Kikuo

**AIR POLLUTION BY HEAVY METALS.** (Jukinzoku ni yoru taiki osen). Text in Japanese. In: Analyses of Heavy Metals. Tokyo, Kodansha, 1971, Chapt. 1, p. 1-31. 4 refs.

The present state of air pollution in Japan by various heavy metals such as lead, cadmium, manganese, chromium, and iron is reviewed, and their influences on human health are discussed. According to the July-October 1966 measurements of suspended particulates in highways of main cities, the high-volume sampling collection and polarography measurements reveal that the concentration on highways during the day ranged from 0.78 to 11.17 micrograms/cu m. The highest was on the Koshu Road in Tokyo, which averaged 7.33 micrograms/cu m (ranged 4.39-11.17 micrograms/cu m). When accompanied by these particles, sulfur dioxide enters the respiratory system more easily. Of the total lead particles in the air, 70% are smaller than one micron and 50% are smaller than 0.3 micron. These less than one micron particles tend to enter deeper into human alveoli and settle there. Since the specific gravity of lead chloride is 5.85, the rate of settling is extremely high. Cadmium concentration among the main cities of Japan was the highest in Tokyo, averaging 0.044 micrograms/cu m (ranged from 0.009-0.518) and the lowest was in Sapporo, averaging 0.007 micrograms/cu m (ranged 0.001 0.026). The highest individual concentration was detected in Annaka city, which was 1.12 micrograms/cu m. Higher concentrations of iron, manganese, and chromium were found in the industrial areas along the Tokyo Bay.

36806

Tairafune, K., A. Sato, W. Nakano, and M. Takahashi

**INVESTIGATION ON THE AIR POLLUTION IN MIYAKO DISTRICT.** (Kwateken Miyako chiku no taiki osen ni tsuite). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 6(1):191, 1971. (Presented at the National Council Meeting of Air Pollution Studies, 12th, Nagoya, Japan, Oct. 27-29, 1971.)

The concentrations of sulfur dioxide, nitric oxide, nitrogen dioxide, hydrogen fluoride, suspended particulate matter, and its metal components (cadmium, manganese, copper, and lead) were measured at six locations in Miyako City for seven days in Aug. 1970. The maximum SO2 concentration was 0.095 ppm, however, 98% of the measured value was less than 0.05 ppm. The mean NO and NO2 concentration was 0.01 ppm except at one location, which was presumably attributable to the effect of wind direction. The mean HF concentration was 1.6 ppb, and the mean concentrations of metallic components were (in micrograms (cu m): Cd, 0.11-0.15; Mn, 0.11-1.11; Cu, 0.10-0.84 Pb, 0.06-0.93.

36820

Kobayashi, Yo., M. Hori, N. Hashimoto, and Y. Furukawa

**URBAN AIR POLLUTION BY LEAD - YOKOHAMA AND VICINITY.** (Toshi taiki no namari osen ni tsuite - Yokohamashi o chushin to shite). Text in Japanese. Preprint, Association of Safety Engineering (Japan), p. 39-44, 1971. (Presented at the Association of Safety Engineering, Technical Meeting, 4th, Tokyo, Japan, Dec. 9-10, 1971.)

Air pollution by lead in the commercial-residential mixed areas of Yokohama was investigated with data collected since 1967, and comparisons were made with the records of less polluted areas. The lead concentration in the air was measured and relationships with other heavy metal pollutants were examined. Lead was measured by hi-vol samplers for 24 to 72 hr, and the chlorine solution of the collected lead was analyzed by polarograph and atomic absorption. The sampling location was on a 20 m high roof, 100 m from the main street of the city with an average traffic of 40,000 cars/day. Examination of the past records showed that the yearly average of Pb had been decreasing since 1968. Even during August through December when Pb concentration was expected to rise, it was relatively low, and the 1971 concentrations of Pb, copper, nickel, chromium, manganese, iron, and cadmium were all approximately half the amounts from the corresponding periods in 1970. This was probably the result of the Japanese Industrial Standard reducing the use of tetraethyl lead additive in high octane gasoline from 0.8 ml/l to less than 0.3 ml/l. The low lead content in all gasolines was noted since June 1970. The lead concentration in the air of the main street of relatively unpolluted Hachijo Island (average traffic 700 cars/day) was taken and was compared with that of Yokohama city. The former was 0.023 plus or minus 0.009 micrograms/cu m, and the latter was 0.33 plus or minus 0.096 micrograms/cu m. The correlation between Pb and Cd was high while that between Pb and Fe was low.

36909

Umehara, Koichi, Mineo Umezawa, Takehiko Suzuki, Taturo Asaoka, and Mituru Endo

**AIR POLLUTION CAUSED BY EXHAUST GAS OF AUTOMOBILES IN SHIZUOKA PREFECTURE.** (Shizuoka ken ni okeru jidosha haigasu ni yoru taiki osen chosa kekka). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 6(1):230, 1971. (Presented at the National Council Meeting of Air Pollution Studies, 12th, Nagoya, Japan, Oct. 27-29, 1971.)

The concentration of carbon monoxide, nitrogen oxides and lead compounds and traffic volume were analyzed at intersections in six cities in Shizuoka Prefecture. The samples collected from 9:00 to 17:00 hours were analyzed by gas chromatography and the atomic absorption method. The concentration of CO was 2.5-12.3 ppm, NOx was 0.011-0.064 ppm, and Pb was 1.66-4.75 micrograms/N cu m. The equations expressing the relationship between the CO concentration and traffic volume were derived.

37026

Alkire, H. L. and Carl R. York

**AIR POLLUTION IN ALLEGANY COUNTY MARYLAND.** Maryland State Dept. of Health and Mental Hygiene, Baltimore, Div. of Air Quality Control, and Allegany County Dept. of Health, Cumberland, Md., 209p., July 1970. 19 refs.

Results are reported for measurements of dust fall, suspended particulates, soiling index, and sulfur oxides made in Allegany County, Maryland, between spring/summer 1967 and March 1969. Much of the data concerns the heavily polluted Cumberland and Westernport-Luke regions of the county. Meteorological factors and topographical characteristics conducive to high air pollution episodes in these areas were also determined. Suspended particulates were analyzed for total concentrations, variation with wind and seasons, iron, chromium, and lead content, benzene solubles, and gross beta activity. Sulfur dioxide values measured with the Davis instrument are reported as daily, weekly, annual, and seasonal averages. Measurements obtained with lead peroxide candles are reported as monthly sufonation rates. Also given are the results of measurements of the effects of pollution on steel corrosion, silver tarnishing, and fabric color changes. Major single sources of pollution in Allegany county are described together with fuel use patterns and refuse disposal practices.

37191

Nagata, R., T. Hirono, H. Yamazaki, K. Asakuno, and T. Odaira

**ON HEAVY METALS IN SUSPENDED PARTICULATE AND LOCAL CHARACTERISTICS IN TOKYO.** (Tokyo ni okeru jukinzoku osen ni tsuite). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 6(1):217, 1971. (Presented at the National Council Meeting of Air Pollution Studies, 12th, Nagoya, Japan, Oct. 27-29, 1971.)

The heavy metal concentrations at eight locations in Tokyo were surveyed from August 1969 to March, 1970. The lead, vanadium, chromium, nickel, cadmium, iron, manganese, and copper concentration in the particulate matter collected using a high-volume air sampler by 24 hour sampling were determined by the atomic absorption method. Of eight elements analyzed, the results of Pb and V determination are shown. The distribution pattern of Pb attributed to auto exhaust is quite different from that of V related to heavy oil combustion. The heavy metal concentrations during 1970 are almost the same as those in 1969.

37202

Murata, M., K. Yoshida, H. Shima, T. Matsui, H. Hirobe, T. Kanamaru, K. Naka, T. Tsujikawa, T. Ishikawa, and K. Ishikawa

**AIR POLUTION IN YOKKAICHI (I).** (Yokkaichi no taiki osen (1)). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 6(1):197, 1971. (Presented at the National Council Meeting of Air Pollution Studies, 12th, Nagoya, Japan, Oct. 27-29, 1971.)

The particulate pollutant concentrations were measured at five locations in Yokkaichi City in 1970. Samples were collected using a high-volume air sampler two to three times a month, and determined by spectrophotometry and the atomic absorption method. The average concentration at each of the five locations were in the following range (in micrograms/cu m): total particulate matter, 164-225; sulfate ion, 18.4-23.3; nitrate ion, 2.9-4.7; iron, 2.30-4.05; manganese, 0.11-0.19; lead, 0.18-0.33; copper, 0.05-0.08; vanadium, 0.06-0.11; titanium, 0.06-0.10; and nickel, 0.039-0.057. The maximum average values of each component are also given. An apparent correlation was observed between total particulate matter and SO4, and SO4 and vanadium.

37264

Laamanen, Arvo, Arvo Lofgren, and Timo J. Partanen

**SOME TRACE METALS IN PARTICULATES IN THE AIR OF HELSINKI AND TURKU, 1964-1969.** Work. Environ, Health, 8(2):63-69, 1971. 6 refs.

Minimal, median, and maximal values are given for trace metals in dust fall collected at 12 sites in Helsinki between Oct. 1964 and Sept 1965 and Oct. 1967 and Sept. 1968. Median values are given for trace metals in dust fall at two sites in Turku, 1966- 1969. In Helsinki, medians and maxima of all trace metals were higher in 1967-1968. The median increase was highest for copper and the maximum increase highest for nickel and chromium. With the exception of copper and tin, Turku medians also showed an annual increase. Relatively large variations were observed between collection sites. The study also verified correlations between some trace elements and general air impurity components in an industrial area of Helsinki. Dusts were measured in industrial, residential commercial, and traffic areas. Tested metals included titanium, vanadium, Cu, Sn, Ni, Cr, maganese, and lead.

37288

Nishi, Teizo

**STUDIES ON AIR POLLUTION IN KUMAMOTO CITY.** (Chiho chutoshi ni okeru taiki osen no eiseigakuteki kenkyu). Text in Japanese. Kumamoto Igakkai Zasshi (J. Kumamoto Med. Soc.), 45(9):895-931, Sept. 1971. 42 refs.

Air pollution in Kumamoto City was studied for seven years beginning with 1963. In order to determine the level of air pollution by means of white cloth hung outside houses, a preliminary test was performed; air contamination by sulfate ion was noticed. Average values of dust fall measured by the Conical Funnel method at seven sampling points was 7.79 t/sq km/month, indicating that the degree of pollution in Kumamoto City is about the same as that in Hiroshima and Kyoto. The amount of soluble substances was great compared with insoluble substances and significantly high in June and July. The components of dust fall, silicon dioxide, zinc, copper, lead, manganese, and titanium were analyzed. Zinc, copper, and Si02 which showed a relatively high ratio may be derived from Aso volcanic ash. Average value of sulfur dioxide was 0.017 ppm/year. The amount of suspended particulate matter in busy intersections was 175 - 576 micrograms/ cu m; the concentration of lead at the same points was 0.020 - 0.325 micrograms/cu m. The concentration of carbon monoxide was 11 - 18 ppm and showed two peaks after sunrise and sunset, as did suspended particulate matter and sulfur dioxide. During one year, traffic volume increased 10%; the concentration of carbon monoxide increased 30%. The pH value of rainfall has been gradually decreasing and it showed 5.8 in 1970. This phenomenon indicates that the level of air pollution in Kumamoto becomes more serious by the complicated reaction of various pollutants.

37320

Hamamura, N., T. Fukuda, H. Inoue, K. Toyoshima, K. Ishida, B. Tomita, Y. Shimizu, K. Nakamura, M. Hayakawa, and M. Noma

**ON THE AIR POLLUTION OF ELECTRIC FURNACE.** (Denkiro ni yoru taiki osen ni tsuite). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 6(1):245, 1971. (Presented at the National Council Meeting of Air Pollution Studies, 12th, Nagoya, Japan, Oct. 27-29, 1971.)

The chemical analysis of the particulate matter emitted from electric furnaces revealed a high concentration of iron and heavy metals such as zinc, lead, and manganese. Samples were collected using a high-volume air sampler by 24-hour sampling in the surrounding area of three steel foundries. In the highly polluted area, the total amount of particulate matter per day was as high as 1.0 micrograms/cu m, and the chemical composition was very similar to that of the dust in the electric furnace dust collector. The concentration range of pollutants in the polluted area were Fe, 162-14.8 micrograms/cu m; Zn, 212-7.6 micrograms/cu m; Pb, 34-0.96 micrograms/cu m; Mn, 23-1.07 micrograms/cu m; and copper, 1.9-0.11 micrograms/cu m. The concentration of cadmium was 0.42-0.03 micrograms/cu m.

37366

Wada, Akio, Hiroo Mizutani, Masaru Kitase, Morihiko Hayakawa, and Eiichi Ito

**MAIN STREET AIR POLLUTION FROM VEHICLE EXHAUST IN NAGOYA.** (Nagoyashi kotsu yochi ni okeru jidosha haiki gasu osen). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 6(1):231, 1971. (Presented at the National Council Meeting of Air Pollution Studies, 12th, Nagoya, Japan, Oct. 27-29, 1971.)

Carbon monoxide, nitrogen oxides, and lead compounds from auto exhaust were analyzed in relation to the traffic volume and wind speed. Samples collected at two intersections in Nagoya City by 48 hour continuous samplings were analyzed by infrared spectroscopy (CO), Saltzman s method (NOx), and atomic absorption method (Pb). The average CO concentration was 4.6 ppm at Fushimi and 6.1 ppm at Ichiba, and the correlation values of CO to traffic volume were 0.70 and 0.73, respectively. The CO concentration was greatly dependent on the wind speed. The average Pb concentration was 1.55 gamma/cum at Fushimi and 1.73 gamma/cu m at Ichiba, and their correlation values with traffic volume were 0.57 and 0.27, respectively. The correlation value of CO and Pb concentration was 0.87. The Pb concentration at 100 m above ground was three quarters of that of the ground level. The concentrations of particulate matter was 0.272 mg/cu m at Fushimi and 0.283 mg/cu m at Ichiba.

37369

Yamaguchi Prefecture (Japan), Research Inst. of Health and Yamaguchi Prefecture, Bureau of Public Nuisance (Japan)

**ABOUT THE SURVEY RESULT ON ENVIRONMENTAL POLLUTION DUE TO LEAD IN SHINNANYO CITY.** (Shinnanyo-shi ni okeru kankyoosen chosa kekka ni tsuite). Text in Japanese. Yamaguchi-ken Eisei Kenkyusho Nenpo (Ann. Rept. Yamaguchi Prefect. Res. Inst. Health), no. 13:73-75, 1971.

A factory to manufacture 4-alkyl-lead (an anti-knock agent for gasoline) was expected to begin operations in March, 1971 in Shinnanyo City. It had been closed since January 1971. Survey results of lead contained in the air, sea, and rivers around this factory before starting operations are indicated. The survey on lead contained in the air was made by collecting suspended particulate matter with high-volume air samplers at three spots each for two days in May, July, and September 1970; the survey on lead contained in the sea and rivers was made one day each on three spots by atomic absorption spectrometry. Lead in air was 027 micrograms/cu m for a three-month average; the monthly average was 0.28 micrograms/cu m in May; 0.14 micrograms/cu m in July; and 0.34 micrograms/cu m in September. On two spots leeward to a group of factories, the concentration increased when the wind blew a little towards the south; when it leaned toward the north, the concentration tended to decrease. In one spot close to a highway, the tendency to increase during the day when traffic was busy was evident. The average figure of lead in sea water in two spots was 0.021 ppm; the average figure for a river in one spot was 0.005 ppm.

37394

Wada, Akio

**AIR POLLUTION BY AUTOMOBILE EXHAUST GASES AT MAIN PLACES IN NAGOYA CITY.** (Nagoya-shi kotsu yochi ni okeru jidosha haiki gasu osen). Text in Japanese. Nagoya-shi Eisei Kenkyusho (Ann. Rept. Nagoya City Health Res. Inst.), no. 17:83-87, 1970. 6 refs.

Sampling was carried out six times at two points on national highway with heavy traffic and at other 18 points. Each measurement was done every hour started from nine o oclock in the morning and lasted for 48 hr. Carbon monoxide, nitrogen oxides, suspended particulate substances, lead, wind direction, wind velocity, and traffic volume were measured. As a result, significant pollution was not seen in Nagoya City except in certain districts and at certain times. But when traffic was more than 8000 cars/hr, it was observed that carbon monoxide and lead were over the standard concentration although for a short period. In this case, the amount of suspended particulate substances was also locally high.

37518

Oikawa, K., Y. Okubo, and J. Kimura

**ANALYSIS OF INORGANIC PARTICULATE MATTER NO. 2. METAL CONCENTRATION OF EACH SIZE.** (Taikichu muki seibun ni kansuru kenkyu. Dainiho. Ryudobetsu kinzoku sosei ni tsuite). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 6(1):94, 1971. (Presented at the National Council Meeting of Air pollution Studies, 12th, Nagoya, Japan, Oct. 27-29, 1971.)

Collection of air-borne dust by size group and metal content in each size group were carried out as preparation for an investigation of the effect of fine particles on the human body. Samples were collected at 4 points in Tokyo at a velocity of 1 cu ft/min for 3 to 4 days by means of a 6-stage Andersen Sampler with an additional and final stage made of an 0.8 micron membrane filter. Collected samples underwent a series of acid treatments to produce sample solution, which was analyzed by means of atomic absorption spectroscopy for cadmium, lead, zinc, manganese, iron, chromium, and nickel. There were two relative maximums for air-borne dust at the diameter of 3 to 6 micron and at smaller than 0.8 micron. More smaller particles exist for lead, and larger particles for iron; manganese has a fairly constant distribution.

38110

Hiroshima Prefecture (Japan)

**WHITE PAPER OF ENVIRONMENTAL POLLUTIONS IN HIROSHIMA PREFECTURE, 1970.** (Hiroshima-ken kogai hakusho showa 46 nendo ban). Text in Japanese. 212p., July 1971.

Actual status and control measures of environmental pollution in Hiroshima Prefecture were discussed. Environmental hazards occurred chiefly at the littoral industrial district of the Inland Sea, such as the Otake district (petroleum complexes), Kure district (iron and steel, shipbuilding, machine, and pulp industries), Fukuyama district (iron and steel industries and electric power industries) and the center of Hiroshima City. Air pollutants were sulfur oxides, suspended particulate matter, and automobile exhaust gases. The average value of sulfur oxides for three years from 1968 decreased in the Otake district but increased in Kure and Fukuyama districts. The average amount of dust fall in Kure City was 12.39 t/sq m and 10t/k sq m in other districts and suspended dust was 375.08 micrograms/cu m in Hiroshima City. Environmental pollution by lead had spread as pollution by automobile exhaust gases. The average value obtained at all the measuring points was 2.030 micrograms/cu m. Carbon monoxide, nitrogen oxides, and hydrocarbons tended to increase, but photochemical smog has not yet occurred. Water pollution spread mainly at the Inland Sea of Japan. Fish perished at the Bay of Hiroshima. Nosie, vibration, and offensive odor also caused troubles, mainly at industrial districts. As a countermeasure, pollution control regulations were issued from April 1970. A telemeter system was newly provided and continuous monitoring has been carried out by the Department of Public Health of cities, the Laboratory for Environmental Pollution of the Hygienic Institute, and the Head Office and Council for Pollution Control.

38133

Kubo, Kiyoshi, Eiichi Ito, and Kimiko Hirata

**CHEMICAL COMPONENTS IN AIR-BORNE DUST IN THE SOUTHERN INDUSTRIAL AREA OF NAGOYA CITY.** (Nagoya-shi nanbu kogyochiiki ni okeru taikichu fuyufunjinchu no kagakutekiseibun ni tsuite). Text in Japanese. Nagoya-shi Eisei Kenkyushoho (Ann. Rept. Nagoya City Health Res. Inst.), no. 17:79-82, 1970. 4 refs.

To study relationship between the gross amount of air-borne dust and the amount of chemical components in it, samples of air-borne dust obtained at the rooftop of the Nagoya City Health Research Institute during Oct. 1970 through Jan. 1971 and at six sampling spots in the southern industrial area of Nagoya City were analyzed giving consideration to emission sources and environmental factors. The mean value for the month of chemical components in air-borne dust samples on the rooftop was 0.170 mg/cu m; tar component, 11.3 micrograms/cu m; lead, 1.42 micrograms/cu m; iron, 1.46 micrograms/ cu m; sulfuric acid ion, 11.0 micrograms/cu m; and sulfur dioxide gas in the air, 0.041 ppm. The correlation coefficient between the gross amounts of dust and tar components was 0.93. The amounts of iron, sulfuric acid ion, and sulfur dioxide were well related to the gross amount of dust. At all sampling spots, the highest value was 0.315 mg/cu m, and the lowest value was 0.089 mg/cu m. The iron component showed about 1.2 - 1.3% of the amount of dust. Lead showed higher values at sampling spots with heavy traffic volume. This means that the lead amount in air-borne dust is affected by automobile exhaust gases. The nearer the sampling spots were to the emission sources, the higher the amount of dust.

39081

Suginami Ward Office, Tokyo (Japan), Construction Div.

**INTERIM REPORT OF ENVIRONMENT SURVEY, APRIL 1971-SEPT. 1971.** (Kankyo chosa no chukan hokoku, 46nen 4gatsu-46nen 9gatsu). Text in Japanese. 107p., Oct. 1971.

An automotive exhaust gas survey, a night environmental noise survey, photochemical smog, and statistics of grievances on public nuisance are discussed, and the related statistics for FY 1969 and 1970 are given. For the automotive exhaust gas survey, concentrations of carbon monoxide and lead and traffic were measured at seven selected locations in Suginami Ward once a month during 5 mo. An infrared analyzer for carbon monoxide and the atomic absorption photometric analyzer for lead were used. The 5-month averages at the roadside in front of the Suginami Ward Office were 7.6 ppm for CO along the road, 3.1 ppm for CO behind the road, 1.4 micrograms/cu m for lead and 4017 cars/hr traffic. The high-concentration zone appears even at the same measuring spot, depending on wind direction, wind velocity, and availability of sidewalk and buildings around. The CO concentration alongside the road is 2 or 3 times that behind the road and CO tends to increase with traffic increase, giving a higher CO value in July. The night noise survey was made at eight selected locations for 4 mo, May and June through Sept. 1971. The measured values are shown in a number of tables and charts. From the data, one location was exceeding the legally stipulated allowable noise level. In the photochemical smog section, the alarm level of air pollution or oxidant concentration and measures and procedures to be taken in such a case or in case of actual photochemical smog emergency were shown extracted from Air Pollution Control Law and Tokyo Metropolitan Ordinances. The statistics show that the photochemical smog alarm was issued in Tokyo for 13 times in 1971; once in May, seven times in June, and five times in July. The grievances received were 28 in April, 31 in May, 53 in June, 51 in July, 39 in August, and 37 in September.

39405

Jutzi, W.

**LEAD CONTENT OF THE STREET DUST AND OF THE STREET ATMOSPHERE IN THE CITY OF ZURICH IN THE SPRING OF 1970.** (Bleigehalt des Strassenstaubs und der Strassenluft in der Stadt Zurich im Fruehjahr 1970). Text in German. Bull. Eidgenoess. Gesundheitsamtes, Beilage B, no. 3:77-83, March 1971. 2 refs.

Sedimentary dust was collected in the city of Zurich in 1970 with a dry brush. The dust sample was dried at 105 C, sifted, and particles of a diameter smaller than 0.15 mm were tested for their lead content by emission spectrography. A measured volume of air (40 cu m/h) was filtered through a tarred paper filter, and the amount of suspended dust was determined by weighing. The filter was then mineralized and lead was determined by atomic absorption spectrometry. Sampling was performed during the midday and evening rush hour. A comparison of results obtained in 1970 with those from 1963 revealed that while the lead content in the atmosphere increased at all points in the city where measurements were performed, the lead content in the sedimentary dust decreased everywhere. While the first observation is in accord with the increased traffic and concomitant emission of lead, the second observation is not easily explainable. One explanation could be the protracted rainy period preceding the sampling of the dust and the observation that in the spring atmospheric lead levels are generally lower. The median sedimentary dust lead content from 19 sampling sites was 0.52 pro mille in July 1948, 0.85 in Sept. 1948, 0.84 in March 1949, 1.03 in June 1949, 1.13 in Aug. 1950, 0.88 in March 1951, 2.06 in June 1955, and 1.06 in May 1970. The lead content in dust suspended in the atmosphere rose from 100% in 1963 to from 100-175% in 1970 in nine sampling sites. The median Pb contents in suspended dust were from 1.4 to 21 micrograms/cu m.

39535

Moore, Carl E.

**SOME PHYSICAL AND BIOLIGICAL ASPECTS OF AIR POLLUTANTS.** IEEE Trans. Nucl. Sci., NS-18(1):13-18, Feb. 1971.

Data are presented on lead concentrations (1969) in the Chicago Metropolitan Area and on monthly (1964-1969) concentrations of atmospheric particulates and lead in suspended particulates over Morton Grove, a Chicago suburb. Atmospheric lead concentrations in Morton Grove are slowly rising due to increased urbanization and heavier automobile traffic. Over the entire metropolitan area, lead levels are higher along major expressways than in less travelled districts Results are also given for neutron activation analysis of Chicago air samples. The analysis identified some elements of known biologic interest, for example, zinc, cobalt, and selenium. In view of the exponential character of the growth curve associated with human activities, it is imperative that the effects of trace metals on biological systems be determined.

39914

Harrison, Paul Roger

**AREA-WIDE DISTRIBUTION OF LEAD, COPPER, CADMIUM, AND BISMUTH IN ATMOSPHERIC PARTICLES IN CHICAGO AND NORTHWEST INDIANA: A MULTI-SAMPLE APPLICATION OF ANODIC STRIPPING VOLTAMMETRY.** Michigan Univ., Ann Arbor, Environmental Science Dept., Thesis (Ph.D.), Ann Arbor, Mich., Univ. Microfilms, Inc., 1970. 427p. 52 refs.

The elemental composition of aerosols was determined on an area-wide, simultaneous basis in the southern Lake Michigan region in order to exhibit the feasibility and usefulness of such studies. Lead, copper, cadmium, and bismuth were analyzed from standard glass fiber filters obtained from the local high volume sampling networks in Chicago and Northwest Indiana. During the analysis of these samples the highly sensitive techniques of anodic stripping voltammetry were documented, and the physical characteristics of the cell design and hardware were further improved for routine use with multiple analysis. When comparisons with estimations of source strengths and distributions were tried the results suggested that lead aerosols were emanating almost completely from automobiles; whereas most of the cadmium and nonanomalous copper aerosols can be explained by fuel-burning sources. (Author abstract modified)

39988

Shimizu Municipal Office (Japan)

**SURVEY REPORT ON ENVIRONMENTAL CONDITIONS (CONCERNING PUBLIC NUISANCE CAUSED BY TRAFFIC).** (Kankyo joken chosa hokoku (kotsu kogai kankei). Text in Japanese. Rept. 4-(3), 20p., March 1972.

A comprehensive survey on pollution and other public nuisances caused by traffic was conducted at the Omagari five-forked road intersection at 10 am through 10 pm, Sept. 2, 1971. Wind direction, wind velocity, atmospheric pressure, temperature, and humidity were all measured each hour. The day s weather was cloudy, rainy later, NE wind with the average velocity of 2.8 m/sec, 21.9 C average temperature. The automobile traffic was counted for the first 15 min of each hour, separately by the type, diesel engines, and gasoline engines. The highest traffic was recorded during 1700-1800 hours and the lowest during 1200-1400 hours. The gasoline cars chiefly emitted carbon monoxide and lead, while the diesel cars emitted soot and have something to do with vibrations and noise. The CO was continuously measured by the automatic recorder. Its average concentration was 5.1 ppm, a value greater than the legal criterion. Correlativity was recognized between CO concentration and the number of gasoline cars. Sampled by a High-volume Air Sampler, the dust was 112.0 micrograms/cu m out of 858 cu m/12 hr of air at one spot and 162.6 micrograms/cu m out of 972 cu m/12 hr at another where only lead was detected, 1.22 micrograms/cu m. This concentration of dust is higher than the legal limit value. The average noise was 72-75 phons, higher by 8-10 phons than the standard. The highest vibration value recorded during 1500-1800 hours was 3.0 micron/sec or three times the legal standard, 0.9 micron/sec. The highest value of oxidant was 0.026 ppm recorded during 1400-1500 hours. This very favorably compares with the highest allowable limit of the legal standard value, 0.15 ppm. Similar roadside studies made at three other spots are also briefly discussed.

40118

**SUMMARY OF THE RESULT OF INVESTIGATION ON ENVIRONMENTAL POLLUTION BY AUTOMOBILE EXHAUST GASES AND NOISE OF CARS.** (Jidosha haishutsu gasu kankyoosen narabini jidosha souon chosakekka no gaiyo). Text in Japanese. 10p., 1971.

Measurement was carried out at 24 places on a highway in Amagasaki City and other 17 cities or towns during July 12 and September 21, 1971. The maximum average value of carbon monoxide/hr for 24 hr was 7.6 ppm at the Kuisegi-cho intersection of Amagasaki City. The maximum value of nitric oxide was 0.220 ppm at Cukuchi intersection of Amagasaki City, and nitrogen dioxide was 0.46 ppm at Fudabe intersection of Nishimoniya City. The maximum concentration of lead during 8 hr in the daytime was 2.560 micrograms/cu m and was higher at places with heavy traffic volumes. Automobile exhaust gases thus affected lead pollution. The maximum level of suspended particulate matter was 0.069 mg/cu m at the Shitamachi intersection of Ono City. The maximum amount of total airborne dust was 2.19 mg/cu m at the Midorigaoka intersection of Itami City. The maximum concentration of sulfur oxides was 0.043 ppm at Kobe City, Hanshin highway, and Uosaki- Shinbori lump. Since all the places with high concentration of SOx were closed to industrial districts, emission gases from the factories affected the pollution. These measured values were lower than the environmental standard for each pollutant. All the values except the concentration of lead and SOx increased compared with the results of measurements in the previous year.

40363

Tokai Metropolitan Government (Japan)

**TRENDS IN MEASUREMENTS OF SULFUR DIOXIDE AND DUSTS IN TOKAI CITY.** Text in Japanese. 4p., March 1972.

Monthly fluctuations of sulfur oxides (sulfur dioxide and trioxide) measured by automatic measurement equipment and by the lead oxide method, and fluctuations of settling particles are presented in table forms. Comparisons of sulfur oxides measurements and environmental standards are presented by graphs. Automatic measurements were taken at five locations in Tokai for 1970 and 1971. Individual monthly measurements ranged from 0.021 ppm in May and June at one location to 0.089 ppm in February at another location. The highest single measurement of sulfur trioxide by the lead dioxide method was 4.99 mg/100 sq cm/day, and the lowest was 0.48 mg/100 sq cm/day. Of the 18 locations where SO3 measurements were taken, the highest daily average was 3.99 mg and the lowest was 0.87 mg throughout 1970 and 1971. Winter months from November through February showed higher sulfur oxides con-

centrations in general. Comparisons of measurements and environmental standards revealed an overwhelmingly heavy SOx concentration for 1970 at all five locations where automatic measurements were taken; all five, but in particular two or three locations, showed a notable improvement in 1971. The amount of settling particles measured at five locations varied from 5.78 tons/sq km/mo in August at one location from 23.72 tons/sq km/mo in March at another location for single measurement. No particular patterns were found for settling particles.

40574

**SWAIN S REPORT ON SMOKE IN SALT LAKE VALLEY.** Chem. Met. Eng., 24(11):463-465, March 16, 1921. 2 refs.

During Feb. 1920, a smoke suit was decided against the American smelting and Refining Co. and the United States Smelting, Refining and Mining Co., allowing their smelters at Murray and Midvale respectively to continue operations under certain conditions and under observation of a staff headed by Prof. R. E. Swain of Stanford University. A summary is presented of a year s research by eight assistants and Prof. Swain, indicating that there was no damage whatever by sulfur dioxide even to the extent of questionable foliar markings on the most sensitive plants in the Murray district. During the growing season, 4386 determinations of SO2 were made on the air of this district at locations which were as nearly as possible in the line of movement of the roaster stack gases. The average human adult, who is already acquainted with the odor of SO2, will first be able to detect it at a concentration of 3-3.5 ppm, while the average person not well acquainted with the smell could detect the gas at a concentration of from 4-5 ppm. A survey of the entire record of atmospheric tests in the Murray district, amounting to 5923 single determinations, shows that only 19 of these represent a concentration of 3 parts or more per million, and only one a concentration of 6 ppm. Both plants employ the Dwight-Lloyd and the Wedge type of roasting furnaces, and the amount of leakage from these furnaces is small, owing to their construction and to the good draft maintained. There were no indications that the lead and arsenic losses were objectionable at the Murray plant. Soot fall experiments are also indicated. The Midvale plant, on the other nand, at times during the past season was an agent of injury to the vegetation of the neighboring district. Remedial steps are recommended, as well as guarantees and restrictions.

40584

Wells, A. E.

**INVESTIGATIONS TO DETERMINE THE EXTENT OF THE CONTAMINATIONS OF THE ATMOSPHERE IN THE SELBY SMOKE ZONE BY THE SMELTER EMANATIONS. Bull. Bureau Mines, no. 98: 82-212,503-520, 1915. 86 refs.**

A portable laboratory was used to determine sulfur dioxide concentrations and total sulfur in urban and agricultural areas inside and outside the Selby smoke zone. Additional SO2 determinations in the zone were made under various wind conditions, under the most unfavorable wind and smoke conditions, at different time periods, and at times when Selby smoke was smelled or supposed to have been smelled. Analyses were also made for lead and arsenic on soil and grasses in the smoke zone. Of the 4862 instaneous air samples taken in the smoke zone during Sept., Oct., and Nov. 1913 and March, April, and May 1914, 75.5% contained less than 0.2 ppm SO2, 86.26% less than 0.4 ppm, and 97.46% less than 1.0 ppm. Only 21 samples, or 0.43%, contained more than two parts SO2 and no sample analyzed contained more than 7.1 ppm SO2. Concentrations were highest when west winds blew smelter smoke over the smoke zone. Daily peaks were observed at noon or in the early afternoon. Under moderate or brisk wind conditions, a maximum of 1.25 ppm SO2 was found when the smelter emitted 70 tons SO2/day. Even under the worst wind conditions and with plant output of 90 tons SO2/day, the maximum concentration in Benicia was only 2.40 ppm. Thus Selby smoke does not constitute a menace to the successful growing of crops in the smoke zone.

40716

Tatsumi, Syuzo and Hiroshi Ishihara

**THE POLLUTED MATERIALS IN THE STREET TREE LEAVES.** (Gairo juyobu ni fuchaku suru osen busshitsu ni tsuite). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 6(1):156, 1971. (Presented at the National Council Meeting of Air Pollution Studies, 12th, Nagoya, Japan, Oct. 27-29, 1971.)

The amount of particulates falling on the main street of Takamatsu city was measured at five locations close to the camphor trees area with 1-meter dust collectors. The particulates were separated as tar substances, combustible substances, and ash, and lead content in tar and ash was investigated. The amount of particulates was dependent on season and maximum traffic at intersection. The maximum total particulates was 140 tons/sq km/mo; tar substance was 1-6 tons; and lead content was 2-40 grams. Particulates sticking on leaves of the trees were also collected and analyzed. Lead content in tar substance of particulates on the tree leaves was studied by comparing with commercial gasoline using gas chromatography. A 2-meter column packed with 40% nujol/chromosorb was used for the analysis. A substance corresponding to tetraethyl lead was found in the tar substances.

40997

Ishikawa Prefectural Government (Japan), Dept of Environment

**ISHIKAWA PREFECTURE WHITE PAPER ON PUBLIC NUISANCE.** (Ishikawa-ken kogai hakusho showa 46-nendo). Text in Japanese. 113p., 1971.

In 1970, 370,700 kl of heavy oil were consumed in Ishikawa Prefecture. The particulate concentration in Kanazawa city was 10 to 33 tons/sq km/mo in 1966, but gradually decreased every year. However, the sulfur trioxide concentration, measured by the lead dioxide method, increased from 0.17 mg/sq km/mo to 0.37 mg/sq km/mo in 1969. Due to significant increases of automobiles, the automotive exhaust gases were becoming a major pollution problem in Kanazawa city. The carbon monoxide concentration at certain intersections was as high as 13.5 ppm, and the lead concentration at other intersections was 4.2 micrograms/cum/day. The lead dioxide method and a deposit cage were used for the measurement of sulfur oxides and particulates prior to 1970. In order to achieve high efficiencies, automatic detectors for SO3 were used at five detecting stations, and automatic detectors for CO, hydrocarbons, and nitrogen oxides were also used.

41033

Repetto, M. and M. Menendez

**ATMOSPHERIC POLLUTION IN SEVILLE, 1970-1971.** (La polucion atmosferica en Sevilla, 1970-71). Text in Spanish. Rev. San. Hig. Pub., 45(10):921-954, 1971.

A study carried out in Seville between May 1970 and May 1971 deals with the atmospheric pollution rates. Urban pollution from ammonia, lead, zinc and smoke is important. Ammonia sources are fertilizer plants located in the main part of

the town, motor vehicles and domestic heating. In studying pollution rates, reduction of motorized traffic in the center of the town is considered because traffic had been forbidden since the previous winter. It accounts for diminution of carbon monoxide rates. Sedimentable matter contains a high percentage of lead and zinc. The lead source seems to be tetraethyl lead from cars. Lead and zinc values correlated. Maximum rates of lead/sq m were 1.5 mg at Republica Argentina Avenue and 2.00 mg at Velazquez Street.

41520

Morlin, Zoltan and Magdolna Kertesz Saringer

**DETERMINATION OF SMALL AMOUNTS OF LEAD IN CITY AIR AND IN DUST SEDIMENTS.** (Vizsgalatok Kismennyisegu olomszennyezesek meghatarozasara a varosi szabad levegoben es szedimentalt porban). Text in Hungarian. Egeszsegtudomany, 15(4):389-395, 1971. 10 refs.

The lead content in atmospheric air and settled particulates was determined by quartz emission spectrography. Samples taken at nine locations in Budapest showed 0.2 to 5.0 micrograms of Pb/cu m in the atmosphere, and 1-10 milligrams of Pb/g in settled dust from roadway samples. The daily standard is 0.7 micrograms/cu m in the air. Only the samples taken in traffic free areas of Budapest are under this standard.

41664

Laveskog, Anders

**ORGANIC LEAD COMPOUNDS IN AUTOMOTIVE EXHAUSTS AND IN STREET AIR.** (Organiska blyforeningar i bilavgaser ock gatuluft). Text in Swedish. Stockholm Univ., Inst. of Analytical Chemistry, TPM-BIL- 64, 84p., Jan. 1971. 20 refs.

The organic lead compounds analyzed were tetraalkyl lead compounds: among them tetramethyl lead, TML, and tetraethyl lead, TEL, have occurred most frequently and are often the only ones present. The method of analysis that has been developed is based upon enrichment of gas samples, separation in a gas chromatograph, and detection with a mass spectrometer. The time required for sampling is short, 10-15 min for street air and between 5 sec and 1 min for automobile exhaust gases. The TML and TEL are analyzed separated from each other and from other organic lead compounds, and the sensitivity of the method is high, 10 ng/cu m of air. Analyses of automobile exhaust gases have shown that the amount of TML and TEL varies between 5 and 5000 micrograms/cu m of exhaust gas and that this difference seems to depend on the working temperature of the motor, with higher quantities found at lower temperatures. Analyses of street air has shown that the quantity of TML and TEL varies between 0.02 and 2 micrograms/cu m of air. The 24-hour average values of about 0.25 micrograms/cu m have been measured in major streets in Stockholm in Nov. and Dec. 1969. Very weak correlation between the occurrence of tetraalkyl lead and other pollutants in street air has been found, but the density of traffic gives better correlation to tetraalkyl lead. (Author abstract)

41887

Environmental Protection Agency, Research Triangle Park, N. C., Office of Air Programs

**SUMMARY.** In: Helena Valley, Montana, Area Environmental Pollution Study, Pub-AP-91, p. 1-23, Jan. 1972. NTIS: PB 207126

The history, topography, climatology, population statistics, industry, and agricultural activity of Helena Valley, Montana, are reviewed. Air, water, and soil were examined for contamination by arsenic, cadmium, lead, and zinc. In addition, airborne sulfur dioxide was measured. Pollutant effects on vegetation and accumulation of heavy metals in hair, organs, and edible animal tissue were studied. The exposure of area residents to heavy metals was reflected by elevated concentrations of arsenic, cadmium, and lead in the hair of fourth-grade school boys. Pollution sources from lead smelting, slag processing, and paint pigment production were surveyed. Meteorology and source-receptor relationships were examined, including atmospheric stability and temperature inversions, and diffusion estimates of short-term SO2, long-term SO2, and particulate matter. Ozone and nitrogen dioxide levels were also studied.

41888

Huey, Norman A.

**SURVEY OF AIRBORNE POLLUTANTS.** In: Helena Valley, Montana, Area Environmental Pollution Study. Environmental Protection Agency, Research Triangle Park, N. C., Office of Air Programs, Pub-AP-91, p. 25-60, Jan. 1972. 3 refs. NTIS: PB 207126

The Helena Valley, Montana, area was surveyed for pollution by sulfur dioxide, airborne particulates, arsenic, cadmium, lead, and zinc. All measurements were made between June and November 1969 except for sulfation measurements, which were continued until June 1970. Sulfur dioxide was measured with continuous monitors at five locations and with sulfation plates at approximately 200 locations. Measurements related to SO2 pollution, that is, sulfate and total acidity, were also made on suspended particulates. Total suspended and total settleable particulates (dustfall) were measured at five locations; windblown particulates and soiling index were measured at 40 and 4 locations, respectively. Arsenic, cadmium, lead, and zinc were determined in suspended and settleable particules. Ozone and nitrogen oxides were measured by continuous monitors for brief periods of time at one or two locations. The spatial distributions of SO2 during different intervals of the study period are mapped. A small area in the center of the city of East Helena was polluted to a level greater than 0.04 ppm SO2 annual average. A 10-square mile area lying adjacent to and southeast of East Helena was polluted to a level greater than 0.02 ppm SO2.

41975

Nagata, Tomoko, Tomio Kono, Kunihiko Akino, Kinji Nakano, Toshio Ohira, and Hiroshi Yamazaki

**AIR POLLUTION IN TOKYO BY METALS.** (Tokyotonai no jikinzokuosen ni tsuite). Text in Japanese. Tokyo to Kogai Kenkyusho Nenpo (Annu. Rept. Tokyo Met. Res. Inst. Environ. Prot.), 3(3):3-10, 1972. 9 refs.

Continuous sampling for 24 hours by a high volume air sampler was carried out every 10 days during Aug. 1968 to March 1970 and every 12 days during May 1970 and March 1971. Differences between the observed values by year and area were compared and ratio of the concentration of each metal to the total amount of dust and soot were calculated. Metal content in suspended particulate matter was affected by pollution sources of industries. Concentration of iron, manganese, lead, cadmium, and chromium were related to the total amount of dust and soot. Pollution by these metals will be reduced by the control of dust and soot. However, control of pollution by such metal as copper, concentrations of which varied by place, will be more difficult.

41979

Ibaragi Prefecture (Japan), Environmental Pollution Research Center

**ANNUAL REPORT OF THE ENVIRONMENTAL POLLUTION RESEARCH CENTER OF IBARAKI-KEN NO. 3.** (Ibaraki-ken kogai gijutsu senta nenpo). Text in Japanese. 162p., Aug. 1970.

Air pollution, noise and water quality in Ibaragi are discussed. Falling dust, sulfur oxides, and meteorological observation in Hitachi and Kashima areas are given. Waste gas of factories in 16 areas of Ibaragi Prefecture and odor in Kashima area are mentioned. Automobile exhaust gases in five cities whose street traffic is comparatively heavy was measured. Dust fall near a cement factory was heavy and the concentration of sulfur dioxide in the basin of the River Miyata was as high as in the preceding year. There was a large amount of dust fall in the Kashima area. This was caused by the sand dune zone around the area and the effect of various construction works in Kashima. The amount of smoke from some factories where several complaints were reported was over the emission standard of environmental pollution control regulations in Ibaragi Prefecture. Hydrogen sulfide, ammonia, SO2, methyl mercaptan, and hydrogen fluoride were the cause of odor. The concentration of carbon monoxide and the amount of lead in automobile exhaust was low in every area, compared with the degree of pollution in the main cities. Water quality of different rivers and drainage of factory sewage were surveyed and reported.

42120

Takaishi Municipal Office (Japan), Section of Public Nuisance

**PRESENT STATE AND COUNTERMEASURES OF POLLUTION IN TAKAISHI CITY.** (Takaishi-shi no kogai no genkyo to taisaku. Showa 46-nen 10-gatsu). Text in Japanese. 57p., Oct. 1971.

The investigation of environmental pollution in Takaishi City, which is located in southern part of Osaka Prefecture, was carried out continuously from 1966 through 1970. As a result of the investigation of air pollution, it was found that although the annual value of each kind of measurements showed little change, the concentration of carbon monoxide, nitrogen oxides, and lead amount showed high values in the districts influenced by heavy traffic or development of the neighboring industrial areas. A questionnaire to inhabitants showed that the number of complaints from respiratory diseases caused by air pollution was increasing. Three rivers running through the city and water along Osaka Bay were polluted. The noise was higher than the environmental standard of 40 dB (A) in many measuring spots, especially facing roadways. Furthermore, the responses made by 26 environmental pollution monitors in the city indicated that stream pollution and offensive odors were becoming acute. The sewage drain system should be completed and drainage from factories should be always inspected. Countermeasures against noise in factories was also needed. In addition, it was recognized that establishment of facilities and systems for analysis and inspection was in need.

42122

Ministry of Health and Welfare (Japan); Fukuoka Prefectural Office (Japan); and Kumamoto Prefectural Office (Japan)

**RESULTS OF INVESTIGATION ON ENVIRONMENTAL AIR IN FUKUOKA PREFECTURE, KUMAMOTO PREFECTURE, OMUTA CITY, AND ARAO CITY.** March 1970. (Fukuoka-ken, Kumamoto-ken Omuta- Arao-chiku kankyo taiki chosa kekka). Text in Japanese. 106p., 1970.

Measurements of air pollution (levels of sulfur dioxide, suspended particulate matter, and component analyses) and meteorological observations (wind direction and velocity, temperature, and humidity) were made at five spots during Nov. 17-25 in 1969. Results of measurements were recorded and summarized. The results of density measurements of sulfur oxides (at 20 spots) by means of colorimetry and electric conductivity were indicated by day and hour. The suspended particulate matter was collected by a hi-vol air sampler (at 10 spots). The component analyses were made concerning organic substances (amounts extracted by benzene), water-soluble substances (pH, sulfate, and nitrate) and metals (beryllium, copper, vanadium, chromium, manganese, iron, cobalt, nickel, zinc, lead, cadmium, and titanium by atomic absorption fluorospectrometry. The results of density measurements are given by day and hour and those of component analyses are given by day. Meteorological observations including general weather condition and wind direction and velocity measured by day and hour at each spot were indicated. Factories producing soot and smoke and conditions of fuel use during the observation periods were given from Nov. 18-24. Further, conditions of air pollution (dust, SO2) at the main observation spots and conditions of occurrence of accidents during 1966 to 1968 were shown. These observations were made in various cities in Fukuoka and Kumamoto Prefectures including Arao and Omuta.

42247

Bogen, D. C.

**DAILY VARIATION IN LEAD AIR CONCENTRATION.** In: Health and Safety Laboratory Fallout Program. Quarterly Summary Report. Atomic Energy Commission, New York, Health and Safety Lab., Rept. HASL 249, p. I-46 - I-61, April 1, 1972. 4 refs. NTIS: HASL-249

Daily variation in lead air concentration was measured over a one-year period to establish any trends in the lead concentration with time, weather conditions (wind and rain), and seasonal effects. The air sampling system, on the roof of a building, about 120 ft above the street, automatically collected seven 24-hour samples on polystyrene filters. The concentrations were higher on week days than weekends, probably due to vehicular activity. There was no significant correlation between lead air concentrations and meteorological conditions such as wind and rain. The average monthly values were lowest during the winter months.

42367

Fujiwara, Masahiro

**THE STATE OF AIR POLLUTION BY HEAVY METALS AND ITS REGULATION.** (Jukinzoku ni yoru taiki osen no jittai to sono kisei). Text in Japanese. Kogai to Taisaku (J. Pollution Control), 8(6):510-522, June 1972. 24 refs.

The highest, average, and lowest daily concentrations of metal pollutants in the air, measured in 1970 twice a month at 11 major cities in Japan, are tabulated. The average concentrations of cadmium ranges from 0.002 to 0.030 micrograms/cu m, lead 0.06 to 1.46 micrograms/cu m, zinc 0.3 to 2.0 micrograns/cu m, cobalt 0.00 to 0.00 micrograms/cu m, copper 0.04 to 0.51 micrograms/cu m, iron 0.7 to 15.5 micrograms/cu m, manganese 0.02 to 0.43 micrograms/cu m, nickel 0.019 to 0.149 micrograms/cu m, tin 0.0 to 0.1 micrograms/cu m. and vanadium 0.014 to 0.269 micrograms/cu m. The measurement results at many special areas of several major cities are also shown. In the air pollution control regulations, metals, such as cadmium and lead, are listed as harmful substances. The national standard for cadmium and cadmium compound concen-

trations is 1.0 mg/N cu m from all kinds of furnaces and facilities. That for lead and lead compound concentrations ranges from 10 mg/N cu m to 30 mg/N cu m depending on the sources.

42742

Volchok, H. L. and B. Krajewski

**RADIONUCLIDES AND LEAD IN SURFACE AIR.** In: Health and Safety Laboratory Fallout Program. Quarterly Summary Report. Appendix. Atomic Energy Commission, New York, Health and Safety Lab., C-1 to C-9, C-97 to C-102, April 1, 1972. 4 refs. NTIS: HASL-249

A surface air sampling program was initiated in January 1963 to study the spatial and temporal distribution of nuclear weapons debris and lead in the surface air. Initially, sites had been grouped roughly along the 80th meridian (west); subsequently, a number of other sites were added to investigate the possible effects of longitude, elevation, and proximity to coast lines. From late 1965 through March 1969, samplers were placed on four Atlantic Ocean weather ships to extend the surface air study over the marine environment. The present network extends from about 81 deg north to 90 deg south. For the routine program approximately 1400 cu m/day ambient air are drawn through a 20 cm diameter Microsorban filter for the land stations. At the ocean stations, about 2200 cu m/day of air are filtered by 20 by 25 cm Microsorban filters. Each sample is split into equal aliquots, one for gamma counting and spectrometry and the other for radiochemistry. The gamma activity of half of the monthly composites are obtained with an 8-inch by 4-inch sodium iodide crystal. Gamma spectra of the monthly composites are obtained using a lithium-drifted germanium diode system. Since there were no major weapon test series from the end of 1962 until May 1966, only the longer-lived artificially produced radionuclides were present in the filters collected during this period. In samples collected after French or Chinese atmospheric weapons tests additional short-lived nuclides were analyzed. In response to the growing concern over air pollution and in particular to the known hazard linked to stable lead, analysis for this element was added to the program. Activity concentrations for the radionuclide, gross gamma, and stable lead analyses are reported in tabular form.

42921

**THE CONCENTRATIONS OF ATMOSPHERIC PARTICULATE MATTER IN SELECTED URBAN AND NONURBAN LOCATIONS.** In: Air Pollution Manual. Part I Evaluation. Detroit, American Industrial Hygiene Assoc., 1960, Chapt. 3, p. 17-30. 10 refs.

Data on levels of particulate matter, benzene soluble organic matter, beta-radioactivity, nitrates, sulfates, iron, and lead from a large number of urban National Air Sampling Network stations are presented for 1967 and 1958, as well as similar data from a smaller number of nonurban stations for 1958. In each table the following information is listed on a yearly basis: number of samples collected; minimum, maximum, and arithmetic mean concentrations; and geometric mean concentrations and standard geometric deviations. Using the geometric mean and standard geometric deviation, a straight line can be plotted on log probability paper which reconstructs the distribution of sample data, and from which can be made approximations of concentrations which can be expected to occur with a specific probability. The primary objective of the Network is to determine trends in pollution levels in a given community rather than to determine differences between communities.

43316

Japan Environmental Agency, Tokyo, Bureau of Air Quality

**RESULT OF MEASUREMENTS BY NATIONAL AIR POLLUTION SAMPLING NETWORK, FISCAL YEAR 1970.** (Showa 45 nendo. Kokusetsu Taikiosen sokutei- (NASN) Sokutei kekka). Text in Japanese. 197p., Jan. 1972.

Air pollution measurements are given for the National Air Pollution Monitoring Station in 1970. The amounts of sulfur oxides, nitrogen oxides, oxidants, carbon monoxide, and hydrocarbons were measured by continuous measurement. The amounts of cadmium, cobalt, copper, iron, manganese, nickel, lead, tin, vanadium, and zinc in dust were measured by atomic absorption spectrometry and luminous spectrometry.

43388

Volchok, H. L. and B. Krajewski

**RADIONUCLIDES AND LEAD IN SURFACE AIR.** In: Appendix to Health and Safety Laboratory Fallout Program. Quarterly Summary Report. March 1, 1972 through June 1, 1972. Atomic Energy Commission, New York, Health and Safety Lab., p. C-1 to C-9, C-102 to C-107, 1972. 4 refs.

A program to study the spatial and temporal distribution of nuclear weapons debris and lead in the surface air is reviewed. Sampling sites along with their coordinates and elevations are listed. Gamma analysis was made of one-half of the monthly composites using a lithium-drifted germanium diode (GeLi) system. Concentrations of the nuclides were determined by computer resolution of the spectra. Radiochemical analysis was made of the second-half of the monthly composites. Only the longer-lived artificially produced radionuclides were collected in the filters and emphasis was given to the determination of manganese(-54), iron(-55), strontium(-89), strontium(-90), cadmium(-109), cesium(-134), cerium(-141), cerium (-144), plutonium(-238), plutonium(-239), and zirconium(-95). Stable lead analysis is reviewed. Quality control and sampling procedures are described. Data from all three analyses are given.

43468

Pierson, William R., Wanda Brachaczek, and Joseph T. Kummer

**SEARCH FOR AIRBORNE PARTICULATE DEBRIS FROM RUBBER TIRES.** Am. Chem. Soc., Div. Fuel Chem., Preprints, 11(2):236-244, 1971. 13 refs.

Air from the intake and exhaust areas of two motor vehicle tunnels was drawn through 47 mm cellulose triacetate filters weighing 50 mg and having 0.2 micron mean pore diameter. Samples were collected over intervals ranging from a few hr to a few days. These samples, weighing several mg, were analyzed for styrene- butadiene rubber, zinc, bromine, and lead. Analysis for SBR was performed by infrared absorption spectroscopy. The samples were refluxed in benzene, centrifuged, and the solution in- corporated into a potassium bromide pellet for standard infrared analysis. Zinc was determined by neutron activation, atomic absorption, and anodic stripping voltammetry. Bromine was determined by neutron activation; and lead was determined by atomic absorption and anodic stripping voltammetry. Intake samples were too small to obtain their infrared spectra. At most, there are less than 40% as much particulates from tire wear as from exhaust. Lead ranges from 2 to 10% of the particulate matter added to the air during passage through the tunnel. Tire wear conditions at the two tunnel sites are probably rather mild and more work will be necessary to justify dismissing tire particulates as a significant matter for concern.

43558

Volchok, H. L. and M. T. Kleinman

**RADIONUCLIDES AND LEAD IN SURFACE AIR.** Atomic Energy Commission, New York, Health and Safety Lab. HASL Fallout Program Quarterly Summary Report, Sept. 1, 1971-Dec. 1, 1971, Appendix C, p. C1-C10, C97, C102, 1972. 4 refs.

In 1963, a surface-air sampling program was initiated to study the spatial and temporal distribution of nuclear weapons debris and lead in surface air. Monthly composites collected at stations extending from about 81 deg North to 90 deg South are analyzed for gamma spectra, radionuclides, and stable lead. The activity concentrations for gamma analyses conducted in 1963 and for stable lead analyses from 1966 through 1971 are given. Radionuclides detectable between 1962 and 1966 are discussed.

43693

Heros, Rene

**OPERATION LEAD AND BENZO-3,4-PYRENE.** (Operation Plomb et benzo-3,4 pyrene). Text in French. In: Etudes de Pollution Atmospherique a Paris et les Departements Peripheriques en 1970. Prefecture de Police, Paris (France), Lab. Central, p. VI-3 to VI-4, April 1971.

Results of lead and benzo-3,4-pyrene concentration measurements, performed in Paris in the period from April 14 through Nov. 20, 1970, are presented. The dust sampling was made by means of a High Volume Air Sampler placed at a distance of 6 m from a highway. The lead concentrations varied from 0.5 to 8.4 micrograms/cu m. The benzo-3,4-pyrene content in the dust samples was in a range of 0.3-16.8 nanograms/cu m. No correlation between lead or benzo-3,4- pyrene concentrations and traffic density could be secured due to the influence of meteorological factors.

43962

Ohshino, Akira, Toru Fujii, Kenji Oka, Fujihiko Go, Kaori Inoue, Keisuke Taguchi, Ken-ichiro Yoshimura, Yoshinari Kurosaka, Toshihiro Okuno, and Nobuko Akashi

**INVESTIGATION OF ATMOSPHERIC POLLUTION IN THE TUNNEL UNDER YAO AIRPORT.** (Jidosha haiki ni yoru taiki osen ni kansuru kenkyu (1) Chikado ni okeru kuki osen chosa). Text in Japanese. Osaka-fu Kogai Kanshi Senta Chosa-Shitsu Kenkyu Hokoku (Proc. Res. Sect. Osaka Environ. Pollution Control Center), no. 2:55-58, 1971. 6 refs.

The Yao tunnel, 251 m long and 33.4 sq m in cross-sectional area was investigated for pollution. Carbon monoxide, nitrogen oxides, dust, lead, the number of automobiles, and weather conditions were measured in Nov., 1970 for three days. The CO was measured by infrared analysis, NOx was collected with a hand sampler (impinger method) and measured by the Saltzman method. Dust and Pb were collected by a high volume air sampler and measured by polarography. Results of the three days are presented in the tables and graphs. The results indicate that the weather conditions do not affect the pollution in the tunnel. Wind does not clear up the automobile exhausts in the tunnel. The CO concentration was about 15-35 ppm from 8 am to 4 pm. Automobiles passed at a rate of 600 to 1000/hr. The NO concentration is very high and it is about 10 to 15 times higher than the NOx concentration on busy highways. The dust concentration is 4.48 mg/cu m both in the morning and afternoon. The lead concentration was 5.47 micrograms/cu m in the morning and 5.73 micrograms/cu m in the afternoon. It is clear that a ventilation rate of 1200 cu m/min is not enough for this tunnel.

44059

Osaka Prefectural Government (Japan), Environmental Pollution Control Center

**THE YEAR 1968: INVESTIGATION OF EFFECTS BY SMOKE AND DUST: REPORT ON THE RESULTS OF ENVIRONMENTAL DETERMINATION.** (Showa 43 nendo Baien-to Eikyo Chosa Kankyo Sokutei Kekka Hokoku-sho). Text in Japanese. Preprint, 33p., 1968.

The Fuku primary school, Nishiyodogawa ward office and Kawakita primary school in Osaka City were selected as polluted areas and the Ikeda primary school, Ikeda Health Center of Osaka Prefecture, Ikeda works of the Daihatsu Industry, and Ikeda Municipal Hospital were chosen as the control area. At each measuring spot, suspended smoke and dust was determined by the British standard method, sulfur dioxide by the lead dioxide method and automatic measuring equipment, and floating dust by an automatic high volume air sampler. Also, quantitative analysis of 3,4-benzopyrene, vanadium, iron, copper, manganese, and lead in dust were made by means of fluorescence spectrophotometry, polarography, and atomic absorption methods. The ratio of suspended dust was the same as that of the previous year, except for soluble components. In the determination of SO2 by the Pb02 method, the ratio of the mean values in both areas was slightly decreased from 5.7 last year to 4.9 this year, however, it is increased from 2.7 the year before last. The amount of suspended dust in the polluted area was 4.3 times as much as that of control area; while 3,4-benzopyrene was 6.3 times the amount. During the period of medical inspection in the Fuku primary school, meteorological conditions were continuously recorded. Both atmospheric temperature and wind velocity were within ordinary range; and the concentration of air pollution determined during this period was not unusual.

44063

Tomoto, Nagata, Tetsuhito Komeji, and Kinji Nakano

**LEAD AND CO CONCENTRATIONS AT 11 INTERSECTIONS IN TOKYO.** (Tonai 11 kosaten ni okeru namari-nodo to issankatanso-nodo). Text in Japanese. Tokyo to Kagai Kenkyusho Nenpo (Annu. Rept. Tokyo Met. Res. Inst. Environ. Prot.), no. 2:44-61, 1971.

Concentrations of lead and carbon monoxide were measured during May to Sept. 1970. Measuring stations were at intersections in Tokyo, and measuring points at each intersection were the four corners of intersection, the roadside 100 m from the intersection, and a point 50 m or 100 m away from the road. The mean concentration of lead at each intersection was between the levels of 1.4 micrograms/cu m and 4.73 micrograms/cu m. At the roadside 100 m from the intersection it was between 0.3 micrograms/cu m and 4.16 micrograms/cu m. The main pollution source was lead from automobile exhaust gases. The relationship between the concentrations of lead and CO at the road was different from that behind the road. The relationship between the concentrations of lead and CO was different depending on each measurement station.

44170

**SURVEILLANCE NETWORK RECORDS AIR POLLUTION.** Mod. Power Eng., 66(6):42-43, June 1972.

Under the Clean Air Act, a coordinated national air pollution surveillance network is being established in Canada. The purpose of the program is to monitor and assess the quality of the ambient air in the populated regions of Canada on a continuous basis. Data is now being collected in 37 major cities across Canada, and the aim is to provide continuous monitoring in 48 urban areas by 1974. Information from 237 sampling instru-

ments is being gathered by cooperating agencies and forwarded to the Environment Department for compilation. Measurements new being taken include soiling index, suspended particulates and lead, dustfall and sulfation rate, and sulfur dioxide. Measurement equipment and procedures are described.

44234

Severs, Richard K. and Leslie A. Chambers

**DIFFERENCES IN METAL AREAL DISTRIBUTION DISPLAYED BY TREND-SURFACE ANALYSIS.** Arch Environ. Health, 25(2):139-145, Aug. 1972. 8 ref

Trend-surface computer maps were prepared to estimate the areal concentration isopleths of cadmium, copper, magnesium, manganese, lead, and zinc, suspended particulates, and the associated benzene- soluble concentrations which occurred on April 13, 1970. The samples were collected from a 17-station ambient air surveillance network in Houston and then analyzed. A comparison of maps indicates important areal differences in the distribution of all pollutants. Suggestions are made as to how these maps could be used for further studies based on areal data. (Author abstract modified)

44330

Tokyo Metropolitan Government (Japan), Minato Ward Office

**THE PRESENT CONDITION OF PUBLIC NUISANCE BY AUTOMOBILES.** (Jidosha kogai no jittai). 72p., 1972.

The conditions of air pollution and noise caused by automobiles were investigated in one particular area of Minato Ward in Tokyo, on Sept. 17 and 18, 1970, within an area of 300 m radius. Carbon monoxide was measured at 13 points of the intersection using pumps and mylar bags, and analyzed by nondispersion infrared spectrometry. Nitric oxide and nitrogen dioxide were measured at eight points by gas samplers and the improved Jacobs method. Hydrocarbons were sampled at the same 13 locations where CO was measured, and analyzed by flame ionization detectors. Suspended particulates and lead were measured from the samples captured by hi-volume samplers; lead was analyzed by atomic absorption spectrophotometry. Odor was measured by sensitivity tests at three points. Noise and traffic amount were also measured. Questionnaires were sent to the area s inhabitants in order to investigate their health conditions. The lead content in the inhabitant s blood samples were taken. The maximum measurements of CO ranged from 5 to 11 ppm at various locations which averaged out to be 2 to 7 ppm. Hydrocarbon measurements ranged from 0.3 ppm to 3.5 ppm. The NO measurements averaged at 0.038 ppm, and NO2 ranged from 0.009 to 0.034 ppm. The dust concentration ranged from 83 micrograms/cu m to 811 micrograms/cu m, and the lead concentration ranged from 0.6 micrograms/cu m to 4.5 micrograms/cu m. The maximum figures of dusts and lead were detected at the same location.

44580

Severs, Richard Keith

**SUSPENDED PARTICULATE HAZARDS TO HUMAN HEALTH IN HOUSTON, TEXAS.** Texas Univ., Houston School of Public Health, Thesis (Ph.D.), Ann Arbor, Mich., Univ. Microfilms, Inc., 1971, 159p. 65 refs.

The suspended particulate hazards to human health in Houston, Texas were assessed after a study of data related to the following aspects of suspended particulates: a time series, probability of occurrence at hazardous concentrations, metals constituent, and reported hazardous conditions. Metal urban concentrations of copper, zinc, lead, manganese, magnesium, cadmium, chromium, aluminum, cobalt, nickel, vanadium, potassium, calcium, and sodium were measured. Maps were utilized to display the geographic distribution of factors of interest. A time-series study of data gathered by the National Air Surveillance Network was conducted, and trend lines were calculated by four methods. A five year running mean, semi-average, linear regression, and polynomial regression methods all revealed a decline in suspended particulate concentration during 1953-1968. Criteria were developed for comparison of the geographic distribution of suspended particulates in different years. The comparative studies employed probability statistics based on a logarithmical normal transformation of the data. The study of geographic distributions of the several metallic components of suspended particulates was based on several hundred analytical determinations of the metals by means of atomic absorption spectroscopy. Suspended particulates, sulfur oxides, and cadmium were found in some areas of Houston in concentrations which have been associated with morbidity and mortality in other cities. (Author abstract modified)

44996

Zhigalovskaya, T. N., V. V. Yegorov, S. G. Malakhov, A. I. Shilina, and Yu. P. Krasnopevtsev

**CONTENT OF HEAVY METALS IN THE AIR OF CERTAIN REGIONS OF THE USSR.** In: American Institute of Crop Ecology Survey of USSR Air Pollution Literature. Technical Papers from the Leningrad International Symposium on the Meteorological Aspects of Atmospheric Pollution. Part III. M. Y. Nuttonson (ed.), Vol. 14, Silver Spring, Md., American Institute of Crop Ecology, 1972, p. 69-77. 10 refs. Translated from Russian. (Also: Meteorologisheskie Aspekty Zagryazneniya Atmosfery, Glavnoe Upravlenie Gidrometeorologicheskoy Sluzhby Pri Sovete Ministrov SSSR, p. 320-329, 1971.) NTIS: PB-209945 Data on the content of lead, chromium, vanadium, manganese, cadmium, nickel, tin, molybdenum, copper, and zinc, which are emitted into the atmosphere as a result of human activity, are presented. These microelements were determined in samples of atmospheric dust collected in different regions of the Soviet Union in 1965-67. The sampling was carried out at a filter- ventilation installation of a Petryanov filter with an area of 0.5 sq m. The filters used during each month were burned down, and the ash residue was analyzed by means of a spectroscopic method. The method has a sensitivity of 10 to the minus 8th, to 10 to the minus 10th g. The relative mean-square error of the method amounts to 20% of the evaluated content. The values of total microelement content in the air are presented for some regions of the USSR during the course of a year. The marked influence of meteorological factors, especially wind direction and precipitation, on concentration was noted. The microelement content in the air closely correlates with the annual course of the monthly precipitation amount, which indicates a significant washing-out action of precipitation. Lead content in the atmosphere is considered separately. The highest lead concentrations, on the order of 0.16 micrograms/cu m, were discovered near industrial towns such as Kuibyshev, Semipalatinsk, and Novosibirsk, in the spring and in the neighborhood of Magadan in the autumn. Lead content amounts to less than 0.05 micrograms/ cu m in the atmosphere of seaside regions and to 0.05-0.08 micrograms/cu m in highland regions. The values of dust content and absolute microelement concentrations in the air for continental and seaside regions of the USSR and data on the aerosol content over the ocean at a latitude of 0 degrees and a longitude of 180

degrees in 1966 are compared with data on the microelement content in the air of industrial cities and country regions of the U.S.A. and Bulgaria. (Author abstract modified)

45218

Marenco, Alain and Jacques Fontan

**SOURCES OF POLONIUM-210 WITHIN THE TROPOSPHERE.** Tellus (Uppsala), 24(1):38-46, 1972. 38 refs.

Contemporary technical literature has given consideration to complementary sources of polonium(210) (fossil, terrestrial, stratospheric, and artificial). The importance of these various sources, based on short-time measurements of Po(210), of Pb(210), of longlived nuclides, and of products representative of pollution, carried out in southwest France is discussed. Tropospheric Po-210 is of natural origin and derived essentially from the decay of the Pb(210) in the atmosphere. (Author abstract modified)

# E. ATMOSPHERIC INTERACTION

00834

C.S. Benson

**ICE FOG: LOW TEMPERATURE AIR POLLUTION (DEFINED WITH FAIRBANKS, ALASKA AS TYPE LOCALITY).** Alaska Univ., College, Geophysical Inst. Nov. 1965. 196 pp. CFSTI, DDC: AD 631553

Ice fog crystals are an order of magnitude smaller than diamond dust, or cirrus cloud crystals, which in turn are an order of magnitude smaller than common snow crystals (0901, 0.1 and 1 to 5 mm respectively). The differences in size are shown to result from differences in cooling rates over 5 orders of magnitude. Most of the ice fog crystals have settling rates which are slower than the upward velocity of air over the city center. The upward air movement is caused by convection cells driven by the 6 C 'heat island' over Fairbanks. This causes a reduced precipitation rate which permits the density of ice fog in the city center to be three times greater than that in the outlying areas. The inversions which occur during cold spells over Fairbanks begin at ground level and are among the strongest and most persistent in the world. They are three times stronger than those in the inversion layer over Los Angeles. Thus, the low-lying air over Fairbanks stagnates and becomes effectively decoupled from the atmosphere above, permitting high concentrations of all pollutants. The combustion of fuel oil, gasoline, and coal provides daily inputs of: 4.1 x 10 to the sixth power kg $CO_2$; 8.6 x 10 to the third power kg $SO_2$; and 60, 46 and 20 kg of Pb, Br and Cl respectively, into a lens-like layer of air resting on the surface with a total volume less than 3 x 10 to the ninth power cubic meter. The air pollution over Fairbanks during cold spells couldn't be worse, because the mechanisms for cleaning the air are virtually eliminated while all activities which pollute the air are increased. (Author abstract modified)

01821

K.G. Blemel

**ATMOSPHERIC LEAD CONCENTRATIONS AS A FUNCTION OF METEOROLOGY.** Arch. Environ. Health 14, (4) 594-603, Apr. 1967. (Presented at the 58th Annual Meeting, Air Pollution Control Association, Toronto, Canada, June 20-24, 1965.)

A 1-year study provided data on atmospheric lead concentrations at ground level in Philadelphia. The relationship of meteorology to atmospheric lead concentration is analyzed to give the effect of wind speed and direction, precipitation, and other parameters on the dispersion of air pollutants emitted at surface level from an area source. (Author abstract)

03841

D. H. Peirson, R. S. Cambray, and G. S. Spicer

**LEAD-210 AND POLONIUM-210 IN THE ATMOSPHERE.** Tellus (Uppsala) 18, (2-3) 427-33, 1966.

The concentration of Pb-210 has been measured at several altitudes in the atmosphere over the United Kingdom during 1958. The gradient into the lower stratosphere was less steep than observed by Burton & Stewart (1960) and conformed to the diffusion models of Jacobi & Andre (1963) for the case of short washout times, and Machta (1960). The concentrations of Pb-210 and Po-210 in surface air and Pb-210 in rainwater have been measured continuously since 1961. The ratio of Po-210/Pb-210 exhibits a seasonal variation during 1962 and 1963: this might be attributed to artificial production of Pb-210 during the weapon tests of 1961-2. An estimate has been obtained of the global deposition of Pb-210. (Author summary)

05713

Hosler, C. R.

**METEOROLOGICAL EFFECTS ON ATMOSPHERIC CONCENTRATIONS OF RADON (RN 222), RAB (PB214), AND RAC(BI214) NEAR THE GROUND.** Monthly Weather Rev., 94(2):89-99, Feb. 1966.

Atmospheric concentrations of radon were calculated from filtered radon daughter beta activity, obtained from 1-m and 15-m. elevations at a rural site, and from 1-m. and 91-m. elevations at a semi-rural site near Washington, D.C. Measurements were obtained from the sucdessive filtration of air over 20-min. periods for durations of several hours during various meteorological conditions. The extent of secular equilibrium between radon and its daughter products in the atmosphere near the ground (less than or equal to 15 m.) was determined from a calculation of the RaC/RaB atom ratio (rho) in air, derived from the measured rate of decay of the filtered beta activity. Estimates of an effective residence time (tau) in the atmosphere of the radon conglomerate, based on either a continuous or single emission of radon into the air, are presented. The relationship between rho and tau for various weather conditions is discussed, as well as possible effects of wind, thermal stability, atmospheric scavenging, and precipitation on measured levels of natural radioactivity. Radon concentrations measured during an 'air pollution potential' episode and during fumigation conditions are presented. In general, the response of measured beta activity in the air to changes in the turbulent state of the atmosphere near the ground gives evidence of the feasibility of using naturally occurring radon and radon daughter products as tracers for determining atmospheric diffusivity. (Author's abstract, modified)

06841

B. J. Steigerwald and D. A. Lynn

**AIR IONS AS AN INDEX OF AIR POLLUTION.** Preprint. (1962).

This report details the results of an 18 month investigation of the effect of air contaminants on atmospheric ions. The relationships between air contaminants and atmospheric ions were studied both by the use of field sampling activities and through controlled laboratory investigations. Results indicate that urban air contains high concentrations of intermediate and large ions and low concentrations of small ions compared to rural atmospheres. The positive large ion concentration was used to study quantitatively the relationship between air contaminants and atmospheric ions. The data were analyzed statistically using correlation and regression methods. Tem-

perature, humidity, CO2 and SO2 at ambient concentrations had no effect on large ions. Large ion concentration correlated only silghtly with particulate stain concentration, but correlated very strongly with automobile exhausts. It appears that in complex urban atmospheres the concentration of automobile exhaust is the dominant factor in the alteration of natural atmospheric ion levels. (Authors' abstract)

10215

Drozdova, V. M. and P. F. Svistov

**THE CONTENTS OF SOME MICROELEMENTS IN ATMOSPHERIC PRECIPITATIONS.** ((O soderzhanii nekotorykh mikroelementov v atmosfernykh osadkakh.)) Text in Russian. Tr. Gl. Geofiz. Observ. (Leningrad), No. 207:92-98, 1968. 12 refs.

Atmospheric precipitations collected in Voeikovo, Vyazovye, Mudyug, Kashira, Dal'nie, Zelentsy, Sobakino and Kudymkar during 1964-1965 were analyzed for microelement contents. The samples were processed by extraction with sodium diethyldithiocarbamate or kupferon in chloroform. The extracts containing the microelements were then analyzed spectrographically. Other samples were treated with an ion exchange resin and the concentrates analyzed spectrographically. All samples contained Si, Cu, and Mn. In many samples iron was detected. Cadmium was not found; either it was not present or the methods used were not sensitive enough. Be, Pb, Al, Ba, and Ti were also determined in some samples.

12777

McKee, Arthur G. and Co., San Francisco, Calif., Western Knapp Engineering Div.

**SYSTEMS STUDY FOR CONTROL OF EMISSIONS. PRIMARY NONFERROUS SMELTING INDUSTRY. (FINAL REPORT). VOLUME III: APPENDICES C THROUGH G.** Contract PH 86-65-85, Rept. 993, 114p., June 1969. 130 refs. CFSTI: PB 184 886

A systems study of the primary copper, lead, and zinc smelting industries is presented to make clear the technological and economic factors that bear on the problem of control of sulfur oxide emissions. Various sulfur oxides control methods, including scrubbing, absorption, and reduction, are matched with smelter models to determine optimum control and production combinations. A precise analysis of the pollution potential of an individual smelter requires meteorological data for the specific smelter site. The variables that can be considered in such a topographical analysis include inversion frequencies, monthly mean maximum mixing depths, surface winds, and general airflow conditions. An analysis of the U. S. markets for zinc, lead, and copper is presented, as well as markets for sulfur byproducts. A literature review of control methods for sulfur oxide emissions from primary copper, lead, and zinc smelters is included.

19058

Schaefer, Vincent J.

**THE INADVERTENT MODIFICATION OF THE ATMOSPHERE BY AIR POLLUTION.** Bull. Am. Meteorol. Soc., 50(4):199-206, April 1969. 16 refs.

There has been a noticeable increase in air pollution over and downwind of the several large metropolitan areas of the United States. The worst accumulation of particulates occurs at the top of an inversion which intensifies at night, 1000 to 4000 feet above the ground. These particulates may modify the weather conditions of the affected area by entraining cloud droplet nuclei, so that rain does not develop. Over the past several years, rain and snow storms in some areas have consisted of small precipitation particles. When collected on plastic sheets, the precipitation consisted of badly polluted water. Auto exhaust may account for the high concentration of ice crystals observed downwind of the large cities. When iodine reacts with the lead in exhaust gases, a nucleating zone for ice crystal formation is formed. If pollution sources lead to increased dustiness from ill-used land, more cloud nuclei from burnish trash, and more ice nuclei from the lead permeated exhaust of internal combustion engines, not only will the advantage of extracting additional water from the sky be lost, but there may be a drastic change in U. S. climatological patterns.

21182

Assaf, G.

**EMANATED PRODUCTS AS A PROBE OF ATMOSPHERIC TRANSPORT.** Tellus (Uppsala), 820-828, 1969. 16 refs.

Atmospheric transport of radon, thoron, and their decay products is analyzed in the light of the Richardson diffusion theory, replacing the length scale by a time scale. The mean operation involved in the usual procedure of parameterization eddy diffusion must be related to the isotopic mean life, and its relation, to spectra of atmospheric turbulence. There are cases where the conventional parameterization of eddy diffusion is inconsistent and contradictory; for example, thoron distribution generally must be treated by Richardson formalism. The conventional methods are reasonalbe for interpretation of radon (222) and Pb (212) Profiles, provided this is done carefully. The vertical transport due to the mean wind cannot be neglected, as sometimes it is a dominant factor. A criterion for estimating the relative importance of advection and eddy diffusion is derived. Application of this criterion established that, in the free atmosphere, radon transport is generally dominated by advection. This result is demonstrated by semi-uniform numerical model. (Author abstract modified)

21796

Francis, Chester W., Gordon Chesters, and Larry A. Haskin

**DETERMINATION OF PB(210) MEAN RESIDENCE TIME IN THE ATMOSPHERE.** Environ. Sci. Technol., 4(7):586-589, July 1970. 9 refs.

Rainwater was filtered through an 0.22-micron Millipore filter and the resultant dust and filtrate fractions analyzed for polinium-210 by alpha-particle counting with a semiconductor detector. Growth curves for Po-210 and Pb-210 were obtained by counting several filtered rain samples at different times. Approximately one-half of the Pb-210 in freshly fallen rain was in the dust fractions. In contrast, only 2-3% of the Pb-210 in freshly fallen rain was in dust fractions, suggesting that the mechanism for its transfer from rain to dust is more complicated than simple adsorption. The Po-210 and Pb-210 in dust fractions were already in radioactive equilibrium at the time of the rainfall, indicating that the Pb-210 was not recently scavenged from the troposphere. The lack of radioactive equilibrium between Po-210 and Pb-210 in the filtrate fractions suggested that both components originated in, and were somehow scavenged from, the atmosphere. Thus only filtrate fractions should be used for estimating the mean residence time of Pb-210 in the atmosphere. From the filtrate ratios of the two components, the mean residence time of Pb-210 was estimated to be 9.6 days, plus or minus 20%.

22754

Dingle, A. Nelson

**RAIN SCAVENGING STUDIES.** Michigan Univ., Ann Arbor, Dept of Meteorology and Oceanography, AEC Contract AT(11-1)-1407, Office of Research Administration Proj. 06867, Progress Rept. 6, 97p., Dec. 1969. 13 refs. CFSTI: C 001407-33

The construction and instrument installation of a rain sampling station in Illinois is described. The measurement data obtained are sparse, and opportunity for good tracer experiments (using indium flares) did not develop, because of a severely dry season. Those data that were obtained are presented in terms of tables, graphs, and weather maps. Analyses were made for radioactivity, pollen, lead, oxygen-18, deuterium, and trace metals. Objectives of the program are not specified. Laboratory work has progressed in the improvement of the neutron activation analysis procedure, including measurement of beta-radiation. Measurements of the particle size distribution of the flare-generated indium tracer yield a bimodal curve which is not clearly understood and calls for further experiments. Calibration of the drop-size spectrometer is described; improved means of producing uniform small drops are needed. (Author abstract modified)

22959

Ter Haar, G. L., R. B. Holtzman, and H. F. Lucus, Jr.

**LEAD AND LEAD-210 IN RAINWATER.** Nature, vol. 216:353-355, Oct. 28, 1967. 16 refs.

Knowing the mean residence time of the lead aerosol in the atmosphere is important, because for any given set of meteorological conditions and fixed rate of injection, the atmospheric concentration will be an inverse function of the residence time. Lead-210 has a half-life of 21.4 yr and would be an ideal tracer for stable lead if lead and lead-210 were acted on by the same forces. To evaluate their relationship in the atmosphere, samples of rainwater were collected, filtered, and analyzed by a spectrophotometric dithizone method. The rainwater was collected in a semi-rural area 25 miles west of Chicago and in an area of farms 125 miles north-east of the Argonne site. Lead- 210 was determined from the beta count rate of its bismuth-210 daughter. Concentrations of the stable lead and lead-210 and the amount and type of rainfall in the various samples of rainwater from the two sites are presented tabularly. A shower had lower concentrations than a slow, even rainfall; thundershowers usually had lower concentrations, but they could also be very high. One rainfall with high values was preceded by a thermal inversion for the 7 days prior to precipitation, that the preceding weather may affect lead concentrations. A brief study near Argonne showed that the soil contained about 20 micrograms of lead and 1.5% of lead-210 per g of dry material. From these data and from the correlation between lead and lead-210 established in this study, a mean residence time for stable lead of about 1 month is indicated. It appears that the radioactive isotope is an adequate tracer for estimate of the residence time of stable lead only in rainwater or perhaps in air from higher altitudes, not above the ground.

23743

Atkins, Patrick R.

**LEAD PARTICULATE MATTER IN THE ENVIRONMENT.** Preprint, Air Pollution Control Association, New York City, 20p., 1969. 15 refs. (Presented at the Air Pollution Control Association Annual Meeting, 62nd, New York, June 22-26, 1969, Paper 69-61.)

The American Industrial Hygiene Association recently recommended a tentative Air Quality Value for lead of 10 micrograms/cu m of air averaged over thirty days. The increasing volume of high speed, high-density traffic in urban and suburban expressways produces large quantities of lead particulate matter in populated areas; but certain atmospheric cleansing processes appear to be capable of reducing the airborne lead concentrations below the recommended limits in most cases. The effectiveness of dispersion, sedimentation, and raindrop scavenging was observed by determining the lead content of air, dry fallout, and rainfall samples at three sites in a suburban community served by one major expressway. The results suggest that sedimentation and raindrop scavenging may remove large quantities of lead particulate matter. Dry fallout levels of one milligram of lead per square foot per week were common near the expressway, and lead concentrations in excess of 0.2 mg/l were observed in rainfall. These values were considerably reduced at the sites located several miles from the heavy traffic. Since the lead pollutants re believed to be exhausted from automobiles in the form of submicronic inorganic particles too small to be affected by sedimentation and scavenging, some growth process must occur. Nucleation and droplet growth may occur on the lead particles in the exhaust stream, producing aerosol particles which may coalesce rapidly or impact on the larger dust and combustion product particles present in areas of heavy traffic. (Author abstract modified)

24109

Benson, Carl S.

**ICE FOG. LOW TEMPERATURE AIR POLLUTION.** Army Cold Regions Researc and Engineering Lab., Hanover, N. H., Grants DA-ENG-11-190-61-G3, DA-ENG-27-021-62-G5, and DA-AMC-27-021-64-G8, RR 121, 118p., June 1970. 196 refs. NTIS, DDC: AD 708544

Stable pressure systems over interior Alaska sometimes produce prolonged, extreme (below -40 C) cold spells at the surface. The rate of radiative cooling of the air is enhanced by suspended ice crystals which are themselves a result of the initial cooling. Radiation fogs formed during the onset of cold spells are generally of short duration. The polluted air over Fairbanks allows droplets to begin freezing at the relatively high temperature of -35 C. Between -35 and -40 C the amount of water vapor condensed by freezing of super-cooled water droplets is 3 to 5 times greater than the amount condensed by 1 C of cooling at these temperatures. This results in rapid and widespread formation of ice fog which persists in the Fairbanks area as long as the cold spell lasts. The persistence of Fairbanks ice fog depends on a continual source of moisture from human activities within the fog. Most of the ice fog crystals have settling rates which are slower than the upward velocity of air over the city center. The upward air movement is caused by convection cells driven by the 6 C 'heat island' over Fairbanks. This causes a reduced precipitation rate which permits the density of ice fog in the city center to be three times greater than that in the outlying areas. The inversions which occur during cold spells over Fairbanks begin at ground level and are among the strongest and most persistent in the world. Thus, the low-lying air over Fairbanks stagnates and becomes effectively decoupled from the atmosphere above, permitting high concentrations of all pollutants. The combustion of fuel oil, gasoline, and coal provides daily inputs of carbon dioxide, sulfur dioxide, lead, bromine, and chlorine into a lens-like layer of air resting on the surface. The air pollution over Fairbanks during cold spells is further worsened, because the mechanisms for cleaning the air are virtually eliminated while all activities which pollute the air are increased. (Author abstract modified)

24166

Bakulin, V. N., E. E. Senko, B. G. Starikov, and V. A. Trufakin

**INVESTIGATION OF TURBULENT EXCHANGE AND WASH-OUT BY MEASUREMENT OF NATURAL RADIOACTIVITY IN SURFACE AIR.** J. Geophys. Res., 75(18):3669-3674, June 20, 1970. 10 refs.

Based on a comparison of methods of measuring the degree of disequilibrium between the short-lived decay products of radon Ra(222), an improved and simplified method is proposed for general use. In accordance with theoretical considerations, the existence of a linear dependence between Po218 (RaA)/Pb214 (RaB) and RaB/Bi21 (RaC) concentration ratios in the atmosphere is established, permitting determination of the atmospheric concentrations of Rn, RA, RaB, and RaC from two points on the radioactivity decay curve for aerosol samples collected on a filter. As a rule, two maximums in the diurnal variation of disequilibrium between radon and its daughter products have been observed. From the differences in this variation at altitudes of 1, 11, and 20 m, an attempt is made to explain the mechanism of convective and dynamic components of turbulent exchange near the ground. From the diurnal variations of radon and thoron concentrations at 1 and 5 m and their short-lived decay products at 1, 11, and 20 m, the diurnal change in the turbulent diffusion coefficient in the surface layer is computed and compared with that from meteorologica parameters. The velocity of washout of the troposphere is estimated from Ra/Pb210(RaD) concentration ratio variations averaged for one-day intervals. (Author abstract modified)

24549

Vette, J. I.

**LOW-ENERGY GAMMA RAYS PRODUCED IN AIR AND IN LEAD BY COSMIC RAYS.** J. Geophys. Res., 67(5):1731-1739, May 1962. 22 refs.

Measurements were made of gamma rays produced in lead and in air within the energy range 25-1060 at 40.5 deg N geomagnetic latitude up to altitudes of 5.4 g/sq cm by means of balloon-borne scintillation counters. Gamma rays of atmospheric origin exhibit a transition curve that peaks at 70 g/sq cm and is similar to transition curves measured with other omnidirectional detectors. A flux of 17.3 photons/sq cm/sec is obtained at the peak of the transition curve; extrapolation to the top of the atmosphere gives an albedo of 5.7 photons/sq cm/sec. The spectra of the photons produced in lead and in air are very similar, and the production per gram of lead is about 2.7 times that per gram of air. The power contained in gamma rays up to 1 Mev is estimated to be 7% of the incoming power from primary cosmic rays. Because of this large intensity, the origin of the photons is difficult to explain in terms of the nucleonic component but is compatible with an explanation based on an electromagnetic origin. (Author abstract)

24570

Bryson, Reid A.

**INADVERTENT CLIMATIC MODIFICATION.** Preprint, Wisconsin Univ., Madison, Dept. of Meteorology, 16p., Sept. 27, 1966. 15 refs. (Also: IS MAN CHANGING THE CLIMATE OF THE EARTH. Saturday Rev., April 1, 1967.)

In creating an urban environment, man has created an urban climate which is distinctly different than the climate in rural areas. As much as 50-60% of city area may be waterproofed, and any dust which gets on the surface may be stirred up. In heavily industrialized uncontrolled areas, there may be 10,000 times as many dust particles in the air. This dust load provides condensation nuclei for the formation of fog, and contains such compounds as sulfur dioxide, sulfuric acid, ozone, ozonated hydrocarbons, and lead. It also contains 10 times as many microorganisms as the open countryside. In a city there is up to 30% less sunlight than in the open countryside and 90% less ultraviolet light. Rain is more frequent and nights are warmer in cities. Over every square mile of northwestern India, there are about 5 1/2 tons of finely divided dust suspended in the air. This dust changes the radiative colling and sinking of the air, explaining the desert-like situation of the area.

27116

Besner, David and Patrick R. Atkins

***THE DISPERSION OF LEAD AND CARBON MONOXIDE FROM A HEAVILY-TRAVELLED EXPRESSWAY.*** Preprint, Air Pollution Control Assoc., Pittsburgh, Pa., 21p., 1970. 7 refs. (Presented at the Air Pollution Control Association, Annual Meeting, 63rd, St. Louis, Mo., June 14-18, 1970 Paper 70-12.)

If the atmospheric concentrations of one exhaust constituent could be estimated by use of the dispersion models available, then the concentrations of the other exhaust pollutants might be traced by correlation after taking into account their atmospheric interaction such as chemical reaction, rainout, and sedimentation. High-volume air samplers were used in conjunction with Whatman No. 41 filter paper to collect the atmospheric lead particulates, while a Beckman non-dispersive infrared analyzer was employed to obtain a series of carbon monoxide concentrations simultaneously with the lead data. Wind direction and velocity were also determined. The samplers were placed at various heights from the ground extending westwardly from a highway. Carbon monoxide and lead particulate concentration were found to be highly correlated, although the correlation was strongly dependent on sampling location with respect to traffic. The ratio of CO concentration to lead increased with increasing distance from traffic. Although the dispersion models commonly in use could be used to estimate ground level pollutant concentration for short distances downwind of a highway, a significant removal process for atmospheric lead near the highway was indicated. Lead samples taken at heights of thirty and sixty feet above ground level indicate that traffic-induced turbulence creates a pollutant cloud of significant vertical dimensions at the highway. The result is that most models presently in use would underestimate the concentrations of exhaust pollutants found at elevated receptors a short distance downwind of the source. Since there is no known or suspected 'sink' for CO over the short distances considered, it would be more practical to use CO as a tracer rather than lead. (Author abstract modified)

28586

Winchester, John W. and Robert A. Duce

**THE GLOBAL DISTRIBUTION OF IODINE, BROMINE, AND CHLORINE IN MARINE AEROSOLS.** Naturwissenschaften (Berlin), 54(5):110-113, March 1967. 7 refs.

Atmospheric samples were analyzed for iodine, bromine, and chlorine by neutron activation analysis. Aerosols of marine origin, derived from sea spray, contained halogens in relative proportions different from sea water. Data from Hawaii and northern Alaska indicated fractionation of the elements both during transfer across the sea-air interface and by chemical reactions in the atmosphere. The ratio Br/Cl is usually several-fold greater in aerosols over land than in sea water; over open sea water, it is less. The ratio I/Br exhibits a greater degree of constancy than does I/Cl or Br/Cl, suggesting a long residence

time and a coherence of I and Br in their movement as particulate material in the atmosphere. However, a singularly effective sea-air transfer mechanism for iodine is indicated by its generaly high atmospheric concentration compared to sea water. Bromine of pollution origin and associated with lead was observed in aerosols from Cambridge, Massachusetts. Chlorine and iodine concentrations in Cambridge are similar to the Hawaii values and provide a basis for resolving excess pollution bromine from the natural marine component. The ratio (excess Br)/Pb in aerosols appears to be correlated directly with the haziness of the air. (Author summary modified)

28799

Machta, L., R. J. List, M. E. Smith, Jr., and H. Oeschger

**USE OF NATURAL RADIOACTIVITIES TO ESTIMATE LARGE-SCALE PRECIPITATION SCAVENGING.** Battelle Memorial Inst., Richland., Wash., Pacific Northwest Lab. and Atomic Energy Commission, Washington, D. C., Fallout Studies Branch, Precipitation Scavenging Proc. Symp, Richland, Wash., 1970, p. 465-474. 22 refs. (June 2-4.)

Beryllium-7 and argon-37 are naturally occurring cosmogenic radionuclides with similar half-lives. Relative productions as a function of altitude and latitude are identical. Beryllium-7 is subject to precipitation scavenging; argon-37, a noble gas, is not. A one-dimensional vertical diffusion model produces surface-air concentrations to fit the few surface-air Ar(37) measurements. Scavenging is added to the diffusion model to compare predictions with the observed Be(7) vertical profile. The diffusion-scavenging model can also be tested against the distribution of lead (210) resulting from the decay of radon gas emitted from the earth's surface. The technique promises to provide useful information on large-scale precipitation scavenging.

29445

Roberts, Walter Orr

**INADVERTENT WEATHER MODIFICATION.** In: A Century of Weather Progress. American Meteorological Society, 1970, p. 165-170. 25 refs.

Natural climate changes have occurred on all geographic scales and at all time intervals. But man may cause the greatest intervention and inadvertent weather modification might become a hugh problem. The development of megalopolises will alter the Earth s albedo, the surface roughness, add heat to the atmosphere, and add dust and other particulates. Although there is little data on such effects, the data which has been obtained is quite striking. For example, an increase of 57% turbidity was found over Washington, D. C. between 1905 and 1964, and an 88% increase was found in Davos, Switzerland between 1920 and 1958. Urban effects include an increase in heat near cities, changes in inversion stability, and fog formation over a wide region. Energy production leads to heat dumping which by 2000 A.D. will reach 0.2% of the solar radiation absorbed by the Earth. Carbon dioxide has also increased by 0.2% per year; it may increase world temperatures through an increased greenhouse effect which results from its infrared opacity Mathematical models are being developed to study this effect. Particulate contamination may decrease precipitation. The city of La Porte, Indiana was found to be effected by upwind industrial pollution. A rainfall increase of 30% has occurred along with a 200% increase in hailstorms. And other studies show a relationship between freezing nuclei and weather changes. Lead compounds produced by the combustion of leaded gasoline, smoke from wood burning, and other pollutants can cause ice nuclei. Also, subsonic jet aircraft can cause suddenly-forming cirrus clouds. A Global Atmospheric Research Program has been established to assess the prospects for large-scale weather modification.

29688

Fuquay, J. J.

**SCAVENGING IN PERSPECTIVE.** Battelle Memorial Inst., Richland, Wash., Pacific Northwest Lab. and Atomic Energy Commission, Washington, D. C., Fallout Studies Branch, Precipitation Scavenging Proc. Symp., Richland, Wash., 1970, p. 1-5. 15 refs. (June 2-4.)

Studies of precipitation scavenging are briefly reviewed in terms of three major divisions: delivery or transport of the material to the scavenging site; in-cloud scavenging by the cloud elements and precipitation, usually called rainout and snowout; and below-cloud scavenging by the precipitation, usually called washout. These earlier investigations included calculations of washout coefficients for various rainfall rates and cloud droplet sizes; the role of snow was an effective scavenger for at least large particulates; depending on crystal type, shape, fall speed, and electrical charge; and predictions of the scavenging of gases on the basis of molecular diffusion to the drop or droplet in accordance with the vapor pressures and solubilities of the free and collected gases. Scavenging of material from the air by hydrometeors of all types is of particular interest because this represents perhaps the most significant natural mechanism for cleansing the air. However, cleansing of the air results in deposition of the pollutants on or in people, animals, vegetation, land, water, and structures. The impact of deposition processes on the biosphere poses a host of new formidable problems. The biological activity of several metals such as lead are causing increasing concern over the allowable concentration limits in drinking water.

29699

Selezneva, Ye. S., B. I. Styro, V. G. Khorguani, and A. Kh. Khrgian

**INTERNATIONAL CONFERENCE ON CONDENSATION NUCLEI AND ICE-FORMING NUCLEI.** Izv. Akad. Nauk. SSSR, Ser. Fiz. Atmosfery i Okeana, 6(3):183-185, March 1970.

The 7th International Conference on Condensation Nuclei and Ice-forming Nuclei was held on the 18th-24th of September in Prague and Vienna. Several papers were devoted to the physical problem of the creation of nuclei, including their photochemical formation under the influence of ultraviolet radiation. A direct correlation was established between the amount of sulfur dioxide in the air and the concentration of nuclei. One paper was presented on the photochemical formation of crystallization nuclei from the lead oxide of automobile exhausts. The oxides of nitrogen were responsible for the oxidation of lead in the atmosphere. Others examined the thermodynamic conditions of vapor condensation on a mixed condensation nucleus in which its insoluble part was not completely wetted by the electrolyte incorporated in the nucleus. The hypothesis was developed that the cooling of nuclei to low temperatures at a humidity less than saturation humidity made them subsequently more active. A paper was presented on heat-mass transfer in the formation of a cloud and on the role of boundary conditions. Additional results from other studies are mentioned.

29910

Konovalov, G. S. and T. Kh. Kolesnikova

**TRACE ELEMENTS IN ATMOSPHERIC PRECIPITATION AROUND THE OTKAZNOE RESERVOIR.** (Mikroelementy v

atmosfernykh osakdakh rayona Otkaznenskogo vodokhranilishcha). Text in Russian. Gidrokhim. Materialy, vol. 49:74-79, 1969. 15 refs.

The amounts of 17 trace elements introduced into Otkaznoe water reservoir with atmospheric precipitation were analyzed in a one year study. Boron, fluorine, bromine, and iodine in atmospheric precipitation were determined by chemical analysis; those of vanadium, manganese, cobalt, nickel, copper, molybdenum, silver, tin, lead, iron, aluminum, bismuth, and titanium were determined spectroscopically. The elements Co, Mo, Ag, Sn, Pb, and Bi were not found in atmospheric precipitation. The content of other elements was higher in comparison with other areas. This is explained as depending on the character of climatic conditions of the area, i.e., dry and windy climate and poor coverage by plants, which cause increased dustiness of the atmosphere.

29946

Marty, A.-M., M.-L. Huertas, J. Fontan, and J. C. Couturaud

**THE STUDY OF THE EVOLUTION OF ATOMIC SIZED PARTICLES IN THE AIR.** (Etude de l evolution dans l air de particules de dimensions atomiques). Text in French. J. Rech. Atmospheriques, 4(4):205- 210, Oct.-Dec. 1970. 8 refs. (Presented at the Congres de l Association Francaise pour l Avancement des Sciences, 89th, Brest, France, July 6-11, 1970.)

The evolution of neutral metallic ultra-fine particles in air was studied by measuring their diffusion coefficients. The actinium boron(211 lead 82) neutral particles seemed to reach a limited size in air as ions; their evolution was slower than that of ionized particles. Ultraviolet irradiation increased the particles size.

30073

Kobayashi, Yoshitaka, Masahiro Hiro, and Fujikawa Takeshi

**ON PLUMBIC POLLUTION OF MUNICIPAL ATMOSPHERE--BEHAVIORS OF PLUMBIC COMPOUND AS AEROSOL.** (Toshitaiki no namari osen ni tsuit --earozol to shiteno namari kagobutsu no kyodo). Text in Japanese. *Preprint, Safety Engineering Research Group (Japan)*, 6p., 1970. (Presented at the Safety Engineering Society, 3rd Research Presentation Meeting, Tokyo, Japan, Dec. 9-10, 1970, Paper 19.)

A study was made to clarify the behavior of lead particulates discharged into the atmosphere from automobile engines, particularly their diffusion and precipitation. The measurements were made at several spots along, and some distance away, from a main street with automobile traffic of 40,000 cars per day. The lead density at a spot along the side of the street (one m above ground level) was highly correlated with the magnitude of the automobile traffic, as were the densities of carbon monoxide and suspended dust. Measured for two-hour durations, the lead density was two to five microgram/cu m (daily average, 2.9 microgram/cu m on a day of comparatively low diffusion and 0.9-3 microgram/cu m (daily average, two microgram/cu m) on a day of higher diffusion. The horizontal distribution of the lead density indicated that the density decreased by one half at a point 5-10 m away from the side of the street, then remained practically constant over increasing distance. The density showed a vertical decrease right above the street while it was practically the same value in a vertical direction at a spot 100 m away from the street. The grain size distribution for the latter spot also indicated that lead particulates of smaller sizes were prevalent. This indicated that comparatively larger particulates precipitate mostly within a radius of some tens of meters from the source, as they travel with wind and density diffusion. Once diffused, the lead particulate forms a comparatively stable aerosol. This is made clear by the fact that while density measured at a spot 20 m from the ground and 100 m away from the street was 0.1%, in the suspended dust above the same spot it was 0.5%. The average density at the 100 m distance on a windy day (average wind velocity 5 m/sec or higher) was 0.50 microgram/cu m or two-thirds of the value obtained on non-windy days, which differed from the low CO density on windy days. A portion of the lead particulate first rises in the atmosphere and then gradually precipitates by gravity, thus keeping the density near the ground surface somewhat constant. Another measurement of the density indicates that rainfall is not as effective in reducing lead density in the atmosphere as it is for water-soluble sulfur dioxide.

30676

Patterson, Clair C.

**LEAD IN THE ENVIRONMENT.** Conn. Med., 35(6):347-352, June 1971. 9 refs. 30863 Robinson, Elmer EFFECT ON THE PHYSICAL PROPERTIES OF THE ATMOSPHERE. In: Air Pollution. Arthur C. Stern (ed.), Vol. 1, 2nd ed., New York, Academic Press, 1968, Chapt. 11, p. 349-400. 47 refs.

The presence of air pollutants can affect the observed properties of the atmosphere in a number of different ways, but the deterioration of visibility is probably the first indication of air pollution of which a citizen becomes aware. Urban air pollutants also significantly alter the concentrations of condensation nuclei, as shown by the pattern of atmospheric electricity measurements over wide areas far removed from urban centers. The effects of air pollution on visibility are considered, including observational problems and meteorological factors, and inversion height, wind speed, hygroscopic particles, humidity, and air quality standards are noted. Mathematical concepts of visibility are cited. Rayleigh scattering, Mie scattering, absorption factors, and color effects due to atmospheric nitrogen dioxide concentrations are included. Visibility can be calculated from the extinction coefficient. If the assumption is made that the particulate material in the atmosphere is of uniform size and that scattering alone accounts for the extinction, then the concentration of particulate material coinciding with a given visibility can be determined. To calculate the opacity of a typical metallurgical fume from light scattering data, it is necessary to calculate the number of particles in each size interval per unit of gas volume. Plume opacity calculations for open burning, calculation of plume opacity control limits, and smoke plume absorption measurements using laser techniques are also described. Effects of air pollution on fog, clouds, precipitation, and urban radiation conditions are reviewed. Urban turbidity applications and visibility observations for urban air pollution studies are considered. Possible changes in atmospheric concentrations of carbon dioxide, lead aerosols, fine particle concentrations, and trace gas concentrations of sulfur dioxide and carbon monoxide are also discussed.

31852

Nathans, Marcel W. and Gordon J. Stopps

**GLOBAL EFFECTS OF LEAD CONTAINING POLLUTANTS.** Preprint, Air Pollution Control Assoc., Pittsburgh, Pa., 31p., 1971. 20 refs. (Presented at the Air Pollution Control Association, Annual Meeting, 64th, Atlantic City, N. J., June 27-July 2, 1971, Paper 71-116.)

The magnitude of the lead contamination of the earth s surface caused by lead-containing particulates introduced into the at-

mosphere was estimated. The tops and bottoms of a number of 3sft long soil cores from Norway, India, and Peru were analyzed by mass spectrometry for total lead and lead isotopic composition. With the exception of, the cores from Norway, the surface layers had the same or a lower lead concentration than the deep layers, indicating that the global effects of lead pollution were not measurable in soils within the composition variability of the lead concentration in the soil and that caused by experimental error. This conclusion was confirmed by the isotopic composition data; the isotopic composition of the lead in the soils appears to be more consistent with that of trace lead in rocks than with that of lead in ores. Estimates of the amount of lead emitted by pollution sources and deposited globally are included. These figures indicate that, as yet, insignificant amounts of lead are added to the surface of the earth at large distances from the sources. (Author abstract modified)

31895

Colacino, M., A. Guerrini, and F. M. Vivona

**AIR POLLUTION AND CLIMATE.** (Inquinamento atmosferico e clima). Text in Italian. Geofis Meteorol., 19(5-6):139-142, Sept.-Dec. 1970. 10 refs.

According to a review of the literature, air pollutants modify not only the chemical composition of the atmosphere, but also its thermodynamic equilibrium. High levels of solid particulate matter in the air result in an increase of local temperature, appearance of artificial condensation nuclei, and subsequent changes in the degree and nature of precipitation. The present trend towards increased solid particulate levels in the urban air is best illustrated by the increased urban levels of aerosols (originated by the combustion of gasoline in automobiles) over those above the sea or in the mountains. Furthermore, as compared to 1967, the level of lead in the air of some American cities has increased by 50%. Carbon dioxide levels also affect climate. It has been estimated that if the levels of carbon dioxide continue to increase at the present rate, the average daily temperature of the earth in the year 2000 should increase by 0.8 C with respect to the year 1900. Recent observations have shown that, as compared to rural areas, the urban environment shows higher temperatures, cloudiness, precipitation, and lower relative humidity and sunlight. The high density of buildings and population, pavement, and heating plants also affect the climate of urban areas.

32155

Corn, Morton

**NONVIABLE PARTICLES IN THE AIR.** In: Air Pollution. Arthur C. Stern (ed.), vol. 1, 2nd ed., New York, Academic Press, 1968, Chapt. 3, p. 47-94. 141 refs.

Dispersion of aerosols such as mists, dusts, and smoke are described with regard to size, properties, types of gas cleaning equipment, typical particles, methods for particle size analysis, terminal gravitational settling, and particle diffusion coefficient. Common atmospheric dispersoids are smog, clouds, fog, mist, rain, and haze. A frequency distribution curve can be obtained mathematically for determination of the light scattering properties of particles. Mathematical models are used to describe particle size and shape. Particle motion in the atmosphere is also discussed including sedimentation, brownian motion, diffusion, and coagulation. Particles have a size distribution from .00006 micron to 20 micron. Air also contains ions formed from solar and cosmic radiation and from radioactive materials present in the atmosphere and ground. They can be measured by an electrometer. Ion concentration varies with the seasons and weather. A strong correlation exists between atmospheric lead concentration (indicative of automobile exhaust) and large ion concentration. Particles smaller than 0.1 micron are called Aitken nuclei and can facilitate the condensation of vapor. Larger molecules can also facilitate cloud formation. The complete size distribution of particles can be obtained by combining Aitken Nuclei counts (obtained with a recording condensation nuclei detector) and larger particle counts (obtained with an impactor sampler), by sedimentation, by membrane filters, by electron microscopes, or by other methods. Particles can be composed of sulfates, sulfuric acid, lead, or many other substances. Particle size distributions and concentrations have been measured in many areas. Also, area surveys have been set up such as the British National Survey of Air Pollution and the American National Air Sampling Network. Dust fall, suspended particulate matter and the staining or soiling index are discussed in detail with data for various cities. Smoke, organic compounds, collection techniques, and many other aspects are also mentioned.

32158

Atkins, Patrick R. and Paul Kruger

**THE NATURAL REMOVAL OF LEAD POLLUTANTS FROM A SUBURBAN ATMOSPHERE.** Stanford Univ., Calif., Dept. of Civil Engineering, Federal Water Pollution Control Administration Training Grant WP-009, Research Fellowship 5F1-WP-33,496, TR-98, 220p., Aug. 1968. 75 refs.

The removal of lead from the atmosphere by natural cleansing processes after being injected into the atmosphere was studied. A field sampling program was conducted in Palo Alto, Calif. to determine the effectiveness of sedimentation, impaction, rainout, and washout in removing lead contaminants from the atmosphere. A laboratory study was also conducted simultaneously to determine how well specific lead compound aerosol particles act as nuclei for droplet formation. A modified thermal-gradient diffusion chamber was used to produce slightly supersaturated conditions similar to a growing cloud. The field sampling data indicate that sedimentation is responsible for a major portion of the lead removal which occurs in the Palo Alto area. More than 90% of the lead pollutants reaching the surface during the one year sampling period were collected in dry fallout. Approximately one percent of the total dry fallout collected near a major expressway was lead. A correlation was found between the lead particulate matter and total dust fall in the dry fallout samples. The limited rainfall accounted for five to 10% of the lead removal at the sampling sites. Lead concentrations in excess of one mg/l were found in some rainfall samples, and average concentrations of 0.18 and 0.04 mg/l were observed near the freeway and at the outskirts of the city, respectively. Sedimentation and rainfall scavenging are relatively inefficient processed for the removal of submicronic particles. A growth process must occur to make the lead particles susceptible to these cleansing processes. The field data suggest that the formation of water droplets around the lead particles may account for the rapid removal of lead pollutants. The nucleation studies show that lead compound particles may act as nuclei for droplet formation. The results indicate that the thermodynamic approach using accepted values of solubility, wettability, and heat and vapor diffusion, fails to adequately describe the nucleation process.

33225

Langford, J. C.

**PARTICULATE PB, PB (210) and PO (210) IN THE ENVIRONMENT.** In: Pacific Northwest Laboratory Annual Report for 1970 to the USAEC Division of Biology and

Medicine. Volume II: Physical Sciences. Part 2. Radiological Sciences. Battelle Memorial Inst., Richland, Wash., Environmental and Life Sciences Div., p. 49, March 1971. NTIS: BNWL-1551, Part 2

Particulate lead, lead (210), and polonium (210) were measured in a Pacific Ocean depth profile 350 miles west of Newport, Oregon, and in Atlantic Ocean surface samples collected between the Bahama Islands and Sierra Leone, Africa. Lead (210) and Polonium (210) concentrations in the Pacific Ocean depth profile decreased with depth to 656 m. Stable lead concentrations decreased with depth to 1639 m and approached 0.02 microgram/l. The particulate stable lead concentration in the Atlantic Ocean decreased ninefold over 1440 miles, then slowly decreased by approximately 20% near the African coast. Polonium (210) and lead (210) concentrations in the Atlantic Ocean surface water averaged 0.016 and 0.2 dpm/l, respectively. Since the Bahama Islands and the Gulf Stream are physical barriers to the eastward flow of mainland rivers from the Florida coast, the source of particulate lead in the ocean is presumably air pollution.

33873

Langer, Gerhard

**PHOTOCHEMICAL GENERATION OF LEAD OXIDE ICE NUCLEI FROM AUTOMOBILE EXHAUST.** International Union of Geodesy and Geophysics, International Commission of Cloud Physics, Intern. Conf. Condensation Ice Nuclei, 7th, Prague, Czechoslovakia - Vienna, Austria, 1969, p. 215-219. 13 refs. (Sept. 18-24.)

Measurement of ice nuclei under varying conditions in the Denver-Boulder atmosphere are described which indicate that lead oxide, rather than lead iodide, is the active nucleating agent. Atmospheric ice nuclei were counted with the National Center for Atmospheric Research Ice Nucleus Counter, the Bigg-Warner expansion chamber, and the membrane technique; condensation nuclei were measured with NCAR Condensation Nucleus Counter. Measurements were taken at an elevation of 5400 ft, 6150 ft, and in the high mountain valley of Fraser, 50 mi west of Boulder. Counts were also made with airborne instruments. High counts correlated with light southerly winds, warm dry days, and a yellow-brown haze bank extending from Denver toward Boulder along the front range of the mountains. Active particles formed only in the upper part of haze or smog layer, explaining the lack of counts of lower elevations in Boulder. A heavy haze layer with a sharp dark brownish edge was indicative of high counts. On a number of occasions high counts were encountered with no iodine present to activate lead particles in the air. Free lead may react in some manner to form lead oxide, possibly with the aid of nitrogen oxides.

35207

Gillette, Dale Alan

**A STUDY OF AGING OF LEAD AEROSOLS.** Michigan Univ., Ann Arbor, Thesis (Ph.D.), Ann Arbor, Mich., Univ. Microfilms, Inc., 1970, 195p. 61 refs.

The aging of lead aerosols was studied by determining size distributions of collected lead aerosols and by performing a numerical simulation experiment. To investigate differences of lead aerosol size distributions in different source regions (areas of high automobile traffic), lead aerosols were collection in one urban area (Chicago) and in cities of 100,000-200,000 population (Ann Arbor, Michigan and Lincoln, Nebraska). to investigate the response of the lead size distribution to different weather conditions, a series of samples was collected in Ann Arbor for 24-hr sampling periods and the weather data were recorded. To obtain aged lead aerosols, samples were taken over Lake Michigan, where no sources of lead aerosol exist. The ages of the aerosols were assumed to equal the travel time over the lake before collection. The samples were collected with cascade impactors and analyzed by anodic stripping voltametry. A mathematical model was constructed as a simulation experiment to separate aerosol aging effects and to determine aging effects not due to weather variation. The simulation experiment showed rapid lead coagulation removal for particles with a radius less than 0.04 micron and gravitational sedimentation removal for particles with a radius greater than five micron. As determined by both observational and simulation studies, little change of the lead spectrum occurred within a 10-hr period.

35264

Ter Haar, Gary L. and Ruth E. Stephens

**THE EFFECTS OF AUTOMOBILE EXHAUST PARTICULATES ON VISIBILITY.** Preprint, California Air Resources Board, Sacramento, and California State Dept. of Public Health, 9p., 1971. 13 refs. (Presented at the Conference on Methods in Air Pollution an Industrial Hygiene Studies, 12th, Los Angeles, Calif., April 6-8, 1971.)

The effect of automobile exhaust particulates on visibility was determined using an integrating nephelometer to measure visibility degradation from light scattering. Exhaust was sampled from leaded and unleaded fuels, on cold and hot cycle runs, and from automobiles fitted with exhaust emission control equipment. The effect of time on light scattering was also determined. The particulates had a mass median diameter of about 0.2 micron at zero time, increasing to about 0.4 micron in two and a half hours; maximum light scattering occurred at about two hours. Individual light scattering due to carbon, lead, and other exhausted particulates was determined by regression data analysis. Carbonaceous particulates produced more than twice the light scatter of lead particulates. (Author abstract modified)

36038

Sano, Isamu

**PRODUCTION OF AEROSOLS.** (Enmutai no seisei). Text in Japanese. Kuki Seijo (Clean Air-J. Japan Air Cleaning Assoc., Tokyo), 9(5):2-11, Dec. 1971. 23 refs.

Following the classification of aerosols into smokes or mists, the fundamentals of their production are presented. Dispersion and the use of homogeneous aerosols in basic studies are reviewed. The production of lead, iron oxide, sodium sulfate, and sulfuric acid aerosols is discussed. Their particle size and distribution, density, toxicity, and chemical reactivity are considered. Aerosol generators are described, with particular reference to those which have come into recent use for producing monodisperse aerosols.

36487

Nakazawa, M., S. Wakamatsu, Y. Saiki, S. Kanno, T. Kashimizu, K. Takamatsu, and Y. Sekiguchi

**VERTICAL DISTRIBUTION OF HEAVY METALS CARBON MONOXIDE ETC. IN THE URBAN AIR.** (Taikichu jukinzoku no kodobetsu nodo bunpu ni tsuite Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 6(1):218, 1971. (Presented at the National Council Meeting of Air Pollution Studies, 12th, Nagoya, Japan, Oct. 27-29, 1971.)

The vertical distribution of lead, cadmium, nickel, manganese, carbon monoxide, and sulfur dioxide in the polluted and non-

polluted areas in Kanagawa Prefecture were surveyed. Samples collected at different altitudes by high-volume air samplers were analyzed by the atomic absorption method. In the polluted area, the amounts of particulate matter were 76, 51, and 50 micrograms/cu m at altitudes 350, 500, and 700 m, respectively. As for heavy metals, the concentrations of Pb were 0.17, 0.14, and 0.17 micrograms/cu m at 350, 500, and 700 m, respectively. The sulfur dioxide concentration was in the range of 0.003 - 0.006 ppm, and decreased with the attitude. In the polluted area, the amounts of particulates were 163, 138, 144, and 107 micrograms/cu m 1.0, 31, 58, and 90 m, respectively. The heavy metal concentration was the highest on the ground level and decreased with altitude. The Pb concentration was 0.79 micrograms/cu m at 1.0 m, which decreased to 0.37 micrograms/cu m at 90 m.

36714

Schaefer, Vincent J.

**THE INADVERTENT MODIFICATION OF THE ATMOSPHERE BY AIR POLLUTION.** American Assoc. for the Advancement of Science, Washington, D. C., Global Eff. Environ. Pollut., Symp., Dallas, Tex., 1968, p. 158- 174. 16 refs.

Effects of inadvertent cloud seeding from man-caused particulate pollution are discussed, including increased rain, increased cloud opacity, misty rain and dust-like snow, and particularly the formation of dense concentrations of ice crystals both from urban pollution and from dust raised by agricultural activities. Laboratory and field data implicating lead particulates from auto exhaust as a potential source of the ice nuclei above urban areas, based on the reaction of lead compounds with iodine to form lead iodide, are reported. Project Air Sample, a series of eight transcontinental flights made in 1966-68 to collect data on this question, revealed that in practically every instance where polluted air was present, values in potential ice nuclei (using the iodine reaction) were high (except in certain areas where auto exhausts could contribute very little if anything to the sampled air). The possible effects on weather system dynamics of the presence of high concentrations of tiny ice crystals in air colder than zero deg C over thousands of cubic miles are considered.

37953

Jaskulla, N., W. Prietsch, and H. Torge

**DISTRIBUTION LAWS OF AUTOMOBILE EXHAUST GASES IN THE FREE ATMOSPHERE AND IN RESIDENTIAL AREAS.** (Gesetzmaessigkeiten der Verteilung von Kraftfahrzeugabgasen in der freien Atmosphaere und in umbauten Raeumen). Text in German. Technik (Berlin), 27(1):41-47, Jan. 1972. 21 refs.

A general mathematical analysis reveals that the pollutant concentration in the ambient air after the mixing process is influenced by the parameters of pollutant emission, total volume, air exchange, and time. With the help of measurement results concerning the carbon monoxide distribution in the free atmosphere, the expected emissions caused by the exhaust gases of automobiles for residential areas can be theoretically determined. It has been assumed that the distribution of all pollutants follows linearly the CO distribution. The influence of the wind velocity and the emission changes with the height above the ground were taken into consideration. According to the theoretical considerations, the relationship between emission and traffic density is directly proportional. Practical measurements of CO, nitrogen dioxide, and hydrocarbons confirmed this finding. By including the wind velocity (multiple regression), a linear correlation between the atmospheric CO concentration and the traffic density was found. By comparison with measured data taken from the literature, the linear relationship between the CO distribution and the distribution of other pollutants (hydrocarbons and lead), assumed for the theoretical considerations, were confirmed.

38118

Fujii, J., T. Hasegawa, and A. Sugimae

**TREACE METAL IN SUSPENDED PARTICULATES (VIII).** (Fuyu funjinchu no kinzoku seibun (Daihachiho)). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 6(1):216, 1971. (Presented at the National Council Meeting of Air Pollution Studies, 12th, Nagoya, Japan, Oct. 27-29, 1971.)

Diurnal and hourly variations in the atmospheric lead concentration attributed to auto exhaust were measured in Osaka. Particulate matter was collected on glass fiber filters using a high-volume air sampler and determined by emission spectroscopy. The results of one month continuous sampling indicated that the diurnal variation at two different locations, one with heavy traffic and ther other with less traffic, were similar. This indicates the effect of meteorological conditions such as wind speed. The plotting of wind speed versus lead concentration clearly indicates the marked effect of wind speed, and the gradient of the regression curve is larger when traffic is heavier. The hourly variations in lead concentration and wind speed showed similar patterns, which also corresponded to the traffic pattern. The vertical distribution of lead concentration and particle-size distribution are also reported.

38666

Chamberlain, A. C. and S. A. Penkett

**ATMOSPHERIC POLLUTION--PRESENT TRENDS AND FUTURE PROBLEMS.** Contemp. Phys., 13(2):179-198, March 1972. 19 refs.

The amount of smoke and sulfur dioxide in the atmosphere is considered in relation to the source of these pollutants and the processes of dispersion or deposition. The amount of SO2 in the air is much less, in relation to the output from stacks, than the amount of smoke and this is considered primarily due to the rapid absorption of SO2 at the ground surface. Measurements of the particle size and chemical form of the atmospheric aerosol, both at Harwell and at Tees-side in Great Britain, are discussed. Ammonium sulfate constitutes a high proportion of the soluble fraction. Pollution from motor vehicles is assuming more importance, and the influence of pollutants such as lead, oxides of nitrogen, and hydrocarbons is discussed. Recent laboratory work at Harwell has shown that photochemical oxidation of SO2 may be more important than has been previously supposed. The effects of atmospheric pollution on visibility, vegetation, and human health are briefly considered. The human effects of air pollution are overshadowed by the much greater effect of smoking. An urban factor in bronchitis and similar diseases has been observed, but it has not been possible to associate this with any particular constituent of pollution. (Author summary modified)

40157

Stalevich, D. D. and T. S. Uchevatkina

**ICE FORMING REAGENT EXPENDITURE CRITERIA IN GENERATING ARTIFICIAL PRECIPITATION FROM CONVECTIVE CLOUDS.** (Normy raskhodov ldoobrazuyushchikh reagentov pri iskusstvennom vyzyvanii osadkov iz konvektivnykh oblakov). Text in Russian. Tr. Gl. Geofiz. Observ. (Moscow), no. 262:43-53, 1971. 7 refs.

Theoretical determinations of optimum ice forming reagent expenditures are described and compared with actual expenditures as applied in experiments. The amount of the precipitation is primarily determined by the reagent expenditure; cloud size and water content are factors of secondary importance. The optimum expenditures for three different ice forming reagents (silver iodide, lead iodide, and copper sulfide) as a function of cloud size, water content, and temperature were determined by conversion from data obtained for a theoretical reagent with an ice forming activity of 1 trillion particles/g. Clouds below 2.0 km, above 4.0 km and those overcooled were not considered. The optimum AgI expenditure was about 1 g for rather super cooled, and about 10 kg for clouds with temperatures close to the specific threshold. The optimum expenditure for PbI2 lay within a range of 40-100 g, while the optimum for copper sulfide for -4 C and temperatures below 8 C were 1 kg and a maximum of 100 g, respectively. The results of the theoretical calculations were in good accordance with experimental data. No precipitation was obtained in experiments where the ratio of the actual to the optimum expenditure was under 0.25, and expenditures far above the optimum level caused only a slight increase in the amount of the precipitation. The above results suggest the good applicability of theoretical optimum values in experiments.

40164

Benini, Franco, Vincenzo Colamussi, Gianpietro Sivieri, and Giovanna Cervi

**ENVIRONMENTAL CONCENTRATIONS AND ATMOSPHERIC DISPERSION OF ALKYL LEAD DURING THE GASOLINE ETHYLATION AND METHYLATION PROCEDURES.** (Concentrazione ambientale e dispersione atmosferica del piombo alchile, durante i procedimenti di etilazione e metilazione delle benzine). Text in Italian. Arcisp. S. Anna di Ferrara, 23(4/5):385-400, 1970. 42 refs.

The concentration and dispersion of alkyl lead in petrol ethylation plants above and around the wagon which discharges ethyl fluid and in the atmosphere both close to and far from this plant were examined. A considerable part of organic lead vapors was absorbed and conveyed by the cooling wares. In the petrol ethylation process itself, there was little leakage, and none at all in petrol blends. Vapors with a high concentration were emitted during the intake of the contents of the wagons, none above and around them. Tetraethyl lead concentrations of up to 14 cu m were formed in the external atmosphere when there was heavy humidity, and organic lead compounds were determined even as far away as 70 m from the source. On dry sunny days there was no dispersion in the atmosphere, since the poison quickly disappears; triethyl lead probably turns into crystalline compounds. (Author summary modified) ½

42720

Thomas, Robert W. L.

**ON THE RELATIONSHIP BETWEEN AEROSOL CONTENT AND ERRORS IN TELEPHOTOMETER EXPERIMENTS.** Preprint, American Chemical Society, Washington, D. C.; American Institute of Aeronautics and Astronautics, New York; Environmental Protection Agency, Washington, D. C.; Institute of Electrical and Electronic Engineers, New York; Instrument Society of American, New york; National Aeronautics and Space Administration, Washington, D. C.; National Oceanographic and Atmospheric Administration, Washington, D. C., 7p., 1971. 8 refs. (Presented at the Joint Conference on Sensing of Environmental Pollutants, Palo Alto, Calif., Nov. 8-10, 1971, Paper 71-1062.)

An invariant imbedding theory of multiple scattering phenomena contributing to errors in telephotometer experiments is presented. The theory indicates that there is a simple relationship between the magnitudes of the errors introduced by successive orders of scattering and it is shown that for all optical thicknesses each order can be represented by a coefficient which depends on the field of view of the telescope and the properties of the scattering medium. The verification of the theory and the derivation of the coefficients has been accomplished by a Monte Carlo program. Both monodisperse and polydisperse systems of Mie scatterers have been treated. The results demonstrate that for a given optical thickness the coefficients increase strongly with the mean particle size particularly for the smaller fields of view. (Author abstract modified)

44813

General Electric Co., Philadelphia, Pa.

**STUDY OF AIR POLLTUION ASPECTS OF ROADWAY CONFIGURATIONS. (FINAL REPORT).** New York City Dept. of Air Resources Contract 209624, APTD-1146, 196p., Sept. 1, 1971. NTIS: PB 211235

The air quality in the immediate vicinity of various urban roadway configurations in New York City was measured to determine how the roadway configurations aid or hinder the diffusion of pollutants emitted by urban traffic and to develop mathematical relationships between traffic, traffic speed, pollutant concentration, meteorological parameters, and roadway configuration. Ten urban roadway configurations were evaluated for traffic flow rate; horizontal and vertical carbon monoxide concentrations; hydrocarbon concentrations; particulate concentrations; trace metal concentrations of lead, nickel, copper, iron, cadmium, manganese, chromium, and zinc, soiling index; and ventilation characteristics with respect to winds and general atmospheric movements. Complete test data and results of measurements, site descriptions, measurement techniques, instrumentation, study methodology, and model developments are examined.

44999

Gavasheli, Sh. G.

**STUDY OF AIR POLLUTION AND ATMOSPHERIC PRECIPITATION RESULTING FROM ARTIFICIAL MODIFICATION OF CLOUDS.** *In: American Institute of Cr Ecology* Survey of USSR Air Pollution Literature. Technical Papers from the Leningrad International Symposium on the Meteorological Aspects of Atmospheric Pollution. Part III. M. Y. Nuttonson (ed.), Vol. 14, Silver Spring, Md., American Institute of Crop Ecology, 1972, p. 96-99. Translated from Russian. (Also: Meteorologisheskie Aspekty Zagryazneniya Atmosfery, Glavnoe Upravlenie Gidrometeorologicheskoy Sluzhby Pri Sovete Ministrov SSSR, p. 345-348, 1971.) NTIS: PB-209945

The extent to which air and precipitation are polluted after the introduction of lead iodide into clouds was investigated. Air and precipitation samples were taken during expeditions in Georgia, USSR, while conducting artificial modification of clouds. On the whole, 210 samples of precipitation and 20 air samples were analyzed for 1964-67. Data analysis shows that the lead amount in precipitation increases at modification, but still remains less than the maximum permissible concentration. The largest mean lead concentration in precipitation was observed in Chotory on June 12, 1966. It amounts to 0.02 mg/l. As to the air, the lead amount considerably increases at modifications, sometimes surpassing the maximum permissible concentration by 30-35 times. On June 13, 1966 in Chotory, the

measured lead concentration in the air was equal to 0.024 mg/cu m, and exceeded the maximum permissible concentration by about 34 times.

45050

Vandenabeele, Willy Joseph

**DISTRIBUTION AND RETENTION IN SOILS OF LEAD AEROSOLS ALONG A LINE SOURCE.** Utah State Univ., Logan, Dept. of Environmental Sciences, Thesis (Ph.D.), Ann Arbor, Mich., Univ. Microfilms, Inc., 1971, 108p. 105 refs.

The soils used for the lead adsorption studies were collected along a highway in Utah, and only the fraction that passed the U. S. Standard Sieve Number 60 was retained for the study. Atmospheric lead was investigated immediately after leaving the tail pipe and at a short distance from the road. An atomic adsorption spectrophotometer was used for the lead analysis. The major effect of traffic is limited to a narrow zone along the highway. Lead in unusually high amounts was found in an alluvial soil at 10 cm depth. Lead in the soil is submitted to a dual type of reaction, one involving precipitation and another involving adsorption. Due to two reference materials, calcium carbonate and bentonite, the two reactions could clearly be differentiated and identified. While only precipitation can occur in the presence of CaCo3, adsorption is the only way for bentonite to remove lead from a solution. The adsorption process is the most important of the two, though both processes take place in most soils. Low temperature and the presence of sodium chloride diminish the retention potential of soil for lead. The mass median diameter of the lead particles settling along the highway increased slightly with the age of the car, while a more important increase resulted from the use of the car under load. Applying the atmospheric diffusion formula, a close relationship could be found between the experimental data and a theoretical model for neutral conditions, a windspeed of 1 m/sec and a wind direction fluctuating around 15 deg with the road orientation. Since three variables determine the shape of the diffusion curve, an infinite number of models can be built to represent the sedimentation pattern. The above one, though, is the one that best obeys the prevalent atmospheric conditions in Cache Valley.

# F. BASIC SCIENCE AND TECHNOLOGY

00058

R.S. Tipson

**REVIEW OF OXIDATION OF POLYCYCLIC, AROMATIC HYDROCARBONS.** National Bureau of Standards, Washington, D.C., Division of Physical Chemistry.(NBS Rept. 8363.) (NBS with PHS support.) May 27, 1964. 89pp.

A survey has been made of the literature on the oxidation of polycyclic, aromatic hydrocarbons. Information has been assembled on (1) the oxidants effective in the oxidation of such hydrocar- bons, (2) the relative reactivity of the hydrocarbons, (3) the conditions under which oxidation proceeds, (4) the chemical mechanisms involved when such oxidations occur, and (5) the products formed. (Author)

00841

M. Murozumi, T.J. Chow, C. Patterson

**CONCENTRATIONS OF COMMON LEAD IN GREENLAND SNOWS.** Rhode Island Univ., Kingston, Graduate School of Oceanography (From the Symposium on Marine Geochemistry, Rhode Island Univ., Publication No. 3-1965). Dec. 7, 1965. pp. 213-5. CFSTI, DDC: AD 625447

Material balance calculations indicate that the rate of increase of lead alkyl decomposition aerosols in the atmosphere of the northern hemisphere should exceed the concentration of lead in fossil precipitation, or preserved snow. An experiment has been carried out to test this possibility by collecting snow at ten-year intervals in Greenland. Lead analyses were performed for two samples using the isotopic dilution technique, and siliva concentrations were determined by emission spectrography of sodium chloride.

03525

V. G. Matsak

**VAPOR PRESSURE AND EVAPORATION OF SUBSTANCES IN MOVABLE AIR.** Gigiena i Sanit. 22, (8) 35-41, 1957. DDC: AD 425608

A description is given of a nomogram for the determination of saturated vapor pressure and a method of calculating the rate of evaporation of various chemically pure substances in moving air. The potential danger of toxic substances may be evaluated and industrial ventilation requirements may be calculated using this nomogram.

03799

S. Sourirajan, M. A. Accomazzo, and K. Nobe

**CATALYSIS STUDIES FOR AIR POLLUTION CONTROL (PART I: CATALYTIC OXIDATION OF N-HEXANE PRESENT IN LOW CONCENTRATIONS).** California Univ., Los Angeles, Dept. of Engineering. (Rept. No. 60-13.) Feb. 1960. 44 pp.

The catalytic oxidation of hydrocarbons present in low concentrations is a possible method of air pollution control. Results obtained on the catalytic oxidation of n-hexane present in concentrations of 400-4000 ppm using catalysts containing V2O5 or CuO in the temperature range 200-560 C are reported. In all experiments, the oxygen concentration was 3.5-4 times the stoichiomc ric amount required for complete oxidation. Alumina was found to be superior to kieselguhr as the catalyst carrier. n-Hexane present in concentrations of about 1200 ppm in diluent N2 was oxidized at temperatures above 200 C in the presence of the V2O5 (10-50%)-alumina catalysts which exhibited their highest effectiveness above 400 C when 65-75% of the hydrocarbon was oxidized in terms of the total combustibles measured. The CuO (10-50%)-alumina catalysts proved more effective for the reaction. At temperatures above 380 C, the CuO-Al2O3(50:50) catalyst oxidized more than 90% of n-hexane completely at all concentrations up to 4000 ppm, and gas space velocities up to 16,000/hr measured at 25 C. The experimental data on the catalytic oxidation of n-hexane obtained in these studies were found to fit an empirical half-order reaction rate equation with respect to n-hexane concentration, and the apparent activation energies obtained in the presence of different catalysts varied in the range 10-21 kcal/mol. Experiments with the exhaust gases from a two-cylinder engine using leaded gasoline fuel showed that more than 90% of the combustibles (present in concentration levels of 400-4000 ppm n-hexane equivalents) in the exhaust gases were oxidized to carbon dioxide and water in the presence of the CuO-Al2O3 (50:50) catalyst at all temperatures above 380 C and at gas space velocities up to about 15,000/hr at 25 C; no deterioration of the effectiveness of the catalyst was found even after 100 hrs of actual service with the engine exhaust gases at temperatures in the range 300-800 C. (Author abstract)

05440

R. Gelius and W. Franke

**AN INVESTIGATION OF THE COMBUSTION PRODUCTS OF ALKYL-LEAD COMPOUNDS.** NNZur Kenntnis der Verbrennungsprodukte von Alkylbleiverbindungen.)) Brennstoff-Chem. Essen 47(9) 280-5, Sept. 1966. Ger.

Tetramethyl-, tetraethyl-, and tetra-n-propyl lead were burned in air in the presence of n-n-heptane, isooctane, or benzene. The combustion products were collected on the surface of a cooled glass tube, in a glass wool filter, and in an electrofilter. In order to eliminate the formation of nitrites, the nitrogen in the air could be replaced by argon. The combustion of the alkyl lead compounds takes place as follows: the compounds thermolyze when the combustible mixture approaches the hot regions of the flame. The result is a smoke of fine PbO particles. The combustion residues are then almost identical to those from the alkyl lead mixture. In the third zone, behind the flame, PbCO3(52-86%), Pb0(13-45%), Pb02 (as Pb304, etc. 0.1-3%), and Pb(N02)2 is formed. In internal combustion engines the effectiveness of PbO as an antiknock agent lasts about 1 millisecond. These experiments suggest that the surfaces of the PbO particles may convert to Pb(NO2)2, thereby rendering the antiknock additive ineffective.

05849

N. A. Renzetti and G. J. Doyle

**THE CHEMICAL NATURE OF THE PARTICULATE IN IRRADIATED AUTOMOBILE EXHAUST.** J. Air Pollution Control Assoc. 8 (4), 293-6 (Feb. 1959).

The Los Angeles smog is characterized by its several manifestations namely, eye irritation, crop damage, reduced visibility, and high ozone concentrations. Since automobile exhaust is the major contributor to the pollution of the Los Angeles atmosphere, its relation to all aspects of smog formation is of prime importance. There have been three studies of the chemical nature of the particulate in non-irradiated auto exhaust. This is believed to be the first report on the nature of photochemically generated aerosol in auto exhaust. All of the aerosol collected for the chemical analyses was generated under similar conditions. The irradiated chamber was first flushed with pure air and then auto exhaust at 5000 or 7200 ppm by volume was allowed to enter the chamber after passing through the inlet filter. As soon as steady state concentrations were reached, the chamber irradiation lamps were turned on. The experiments were dynamic in nature with 1-hr residence time for the mixture in the chamber during which period the irradiation took place. The aerosol under study was that generated essentially in a stirred flow reactor. The runs lasted up to 9 hr in order to collect samples of sufficient size for the standard microanalytical techniques to be used in the analyses. Microcombustion technique, microanalytical chemical techniques and infrared absorption spectrum measurements are reported. Irradiated auto exhaust appears to be the principal source of nitrate, sulfate, lead, and organic compounds in the particulate matter of Los Angeles smog. Further, these findings explain the higher values of nitrate and sulfate found in Los Angeles and other similar West Coast cities in comparison with other cities. Assuming six million gallons of gasoline are consumed in auto engines per day in Los Angeles, about one ton per day of non-irradiated particulate and at least 10 tons per day of photochemically generated particulate are present in a typical smog.

06648

Matsak, V. G.

**VAPOR TENSION AND VAPORIZATION OF SUBSTANCES IN MOVING AIR.** Gigiena i Sanit., (8) 35-41, 1958. In: U.S.S.R. Literature on Air Pollution and Related Occupational Diseases, Translated from Russian by B. S. Levine, Vol. 8, 1-9, 1962 CFSTI: 62-11103

The purpose was to place at the disposal of engineers and hygienists working in the field of sanitary technology basic data regarding vapor tension and rate of vaporization of different inorganic and organic substances in moving air. Particular emphasis was placed on substances, and especially toxic substances, most commonly used in industrial technology. Such information should allow hygienists to evaluate the potential danger associated with vaporization of toxic substances in relation to their physico-chemical and toxicological properties, and sanitary engineers to apply it in their computation of air ventilation in general and of quantative determination of the degree of air charged with vapor of high-molecular substances, and in correctly distributing incoming and exhaust air, and in computing other means required for the sanitary improvement of labor conditions. It is suggested that sanitary engineers use the nomograms presented especially where a 5% error is permissible. More than 85 chemically pure substances are represented in three nomograms and two tables.

07451

Scharf, P. B., B. B. Goshgarian, H. M. Nelson, and G. L. Hody

**THE MEASUREMENT OF THE EXHAUST COMPOSITION OF SELECTED HELICOPTER ARMAMENT.** Air Force Rocket Propulsion Lab., Edwards AFB, Calif. and Army Aeromed. Res. Unit, Fort Rucker, Ala., Proj. No. 3A0 2560 1A 819, Task No. 051, Rept. No. AFRPL-TR-67-203 and USAARU-67-10, 46p., June 1967. 4 refs.

A study of the exhaust composition of rapid fire machine guns and rockets has been conducted. Methods of analysis were evaluated and exhaust compositions for the 50 cal and 7.62mm machine gun and the 2.75' rocket were determined. A rapid scan infrared spectrophotometer was used for immediate examination of effluent gases in order to detect reactive species. The exhaust gases were analyzed at concentrations as high as 1000 times those present in helicopters to minimize the chance of missing any significant toxic product. A qualitative and quantitative analysis of gas phase and aerosol components is given. It may well be that the proportion of carbon monoxide in the exhaust is so high that permissible exposure times can be selected on the basis of its concentration alone while still limiting exposures to all other toxic materials to safe leevls. However, significant amounts of nitrogen dioxide, ammonia, carbonyl sulfide, hydrogen cyanide, lead and copper were found.

08207

Sourirajan, S. and Mauro A. Accomazzo

**THE APPLICATION OF THE COPPER OXIDE-ALUMINA CATALYST FOR AIR POLLUTION CONTROL.** Can. J. Chem. Eng. (Ottawa), 39(2):83-93, Apri 1961. 8 refs.

The catalytic combustion of 1-hexene present in diluent nitrogen in the concentrations of 1170 ppm and 3000 ppm by excess oxygen, has been studied in the presence of CuO-A1203 (1:1) catalyst in the temperature range 242 deg. to 424 deg. C. and gas space velocity in the range 4000-16,000 hr.-1. The experimental data on the kinetics of the reaction were found to fit an empirical half-order law with respect to the 1-hexene concentration. The presence of water vapor in the reactants was found to have no effect on the efficiency of the catalyst at temperatures higher than 400 deg. C. The above results were similar to those obtained for the catalytic oxidation of n-hexene studied earlier. The possible use of the above copper oxide-alumina catalyst for the simultaneous removal of hydrocarbons and carbon monoxide present in the auto exhaust gases has been tested, making use of a 1955 six-cylinder automobile engine run on leaded gasoline fuel. The hydrocarbon and carbon monoxide concentrations encountered in these studies varied in the range 170 16,000 ppm and 1-7 percent respectively. It was found that the minimum initial temperature of the catalyst bed required for the complete removal of both hydrocarbons and carbon monoxide, simultaneously, was 226 deg. C. under no load condition, 342 deg. C. under an engine load of 2.5 hp, 400 deg. C. under an engine load of 5.1 hp or higher, and 236 deg. C. under deceleration conditions. The catalyst showed no deterioration in performance even after 100 hours of continuous service in conjunction with the above auto exhaust gases. Authors abstract

09578

Salooja, K. C.

**MECHANISM OF ACTION OF LEAD MONOXIDE ON COMBUSTION: INTERACTION BETWEEN LEAD MONOXIDE AND OXYGEN DERIVATIVES OF HYDROCARBONS.** Combust. Flame, 11(6):511-514, Dec. 1967. 3 refs.

A better understanding of the mechanism of catalytic action of lead monoxides on combusion is provided by studies showing that the lead oxides react with carbonyl and hydroxyl derivatives of hydrocarbons (whose combustion they promote), but not with ethers and hydrocarbons (whose combustion they inhibit). The principal products of reaction of lead monoxides with acetone, acetaldehyde, methanol, methyl acetate, acetic acid and acetic anhydride were analysed. The effect of metallic lead on these organic compounds was also studied.

09745

Mieville, Rodney L. and Garbis H. Mequerian

**MECHANISM OF SULFUR-ALKYLLEAD ANTAGONISM.** Ind. Eng. Chem., Prod. Res. Develop., 6(4):253-257, Dec. 1967. 16 refs. 6(4):253-257, Dec. 1967. 16 refs.

Sulfur compounds reduce the antiknock effectiveness of alkylleads by a dual mechanism involving the induced decomposition of alkylleads by thiyl radicals and the deactivation of active PbO by SO2. With a fuel containing either tetraethyllead or tetramethyllead, octane losses in an engine and reductions in autoignition temperatures in a tubular reactor were determined for thiophene, thiophenol, butyl mercaptan, ethyl sulfide, ethyl disulfide, and di-tert-butyl polysulfide. The two effects correlate directly with each other. Autoignition experiments with an unleaded fuel in a tubular reactor coated with lead oxide showed that reduction in autoignition temperature was caused by SO2 produced by the oxidation of sulfur compounds. However, rates of SO2 production correlate with octane losses only for thiophene, ethyl sulfide, and disulfide. Octane losses caused by mercaptans and the polysulfide are high relative to their ability to induce decomposition of alkylleads at lower temperatures. The initiation of the decomposition is postulated to occur through thiyl radicals in the liquid phase. Engine results with several fuels containing different sulfur compounds are consistent with the proposed dual mechanism. (Authors' abstract)

10599

Smith, B. M., R. L. Walker, and L. E. Stettler

**INTERACTION OF AIRBORNE VAPORS WITH PARTICULATES.** In: Health Physics Division Annual Progress Report for Period Ending July 31, 1967, Oak Ridge National Lab., Tenn., Contract W-7405-eng-26, p. 299-301, Oct. 1967. ((6)) refs. CFSTI: ONRL-4168

An experiment was conducted to study the adsorption of gases onto metal aerosols in the 0.01 to 0.10 micron size range. The aerosol and test gas were mixed in a chamber and allowed to interact. Samples of the particles were then taken using filters, and the gas absorbed on the aerosol was determined quantitatively. The gases used were I2 and SO2. Another test method was to trap aerosol particles between two pieces of filter paper and then draw the gas through them. Adsorption capacities for SO2 are presented for the following metals in decreasing capacity: lead, palladium, magnesium, cadmium, nickel, idium, silver, gold, tantalum, aluminum, zirconium, copper, tin, iron, molybdenum, platinum, and tungsten.

11570

Kosmider, S.

**RELATIONSHIP BETWEEN HEAVY METAL POISONING, ATHEROMATOSIS, AND HEART AND CIRCULATORY DISORDERS.** ((Zusammenhange zwischen Schwermetallvergiftungen und Atheromatose bsw. Herz-und Kreislaufstorungen.)) Text in German. Z. Ges. Hyg. 14(5):355-360, May 1968. 12 refs.

Experimental lead poisoning in dogs induced electrocardiographic disorders (changes in repolarization) and histopathological alterations of the heart muscle. The clinical study of 108 patients with chronic lead toxicity (no details as to occupation) revealed that vagotonia prevailed mainly in younger subjects (22 of 60 patients between 18 and 45 years old) while older individuals (14 of 48 between 46 and 65 years old) had alterations of the heart muscle. Phonocardiography revealed that heart murmurs not connected to anemia but to the injury of the heart muscle. Experimental mercury poisoning in dogs was responsible for high levels of cholesterol and beta-lipoproteins in the serum, as well as for increased mucopolysaccharides in the aortic wall.

11582

Selander, Stig, Kim Cramer, Birgitta Borjesson, and Gunilla Mandorf

**DETERMINATION OF LEAD IN BLOOD BY ATOMIC ABSORPTION SPECTROPHOTOMETRY.** Brit. J. Ind. Med. 25(3):209-213, July 1968. 9 refs.

Lead in blood was determined by atomic absorption spectrophotometry, using a wet ashing procedure and a procedure in which the proteins were precipitated with trichloroacetic acid. In both methods the lead was extracted into isobutylmethylketone before measurement, using ammonium pyrrolidine dithiocarbamate as chelator. The simpler precipitation procedure was shown to give results identical with those obtained with the ashing technique. In addition, blood specimens were examined by the precipitation method and by spectral analysis, which method includes wet ashing of the samples, with good agreement. All analyses were done on blood samples from 'normal' persons or from lead-exposed workers, and no additions of inorganic lead were made. The relatively simple protein precipitation technique gave accurate results and is suitable for the large-scale control of lead-exposed workers.

13451

Booker, D. V., A. C. Chamberlain, and A. N. B. Scott

**UPTAKE OF RADIOACTIVE LEAD FOLLOWING INHALATION AND INJECTION.** Brit. J. Radiol., 42(498):457-466, June 1969. 14 refs.

Experiments have been made with human volunteers to determine the fate of Pb212 after inhalation. Two subjects inhaled Pb212 as a submicron aerosol and one also inhaled it as a vapor. The two subjects also received injections of Pb212 in saline solution so that the levels in blood following the two routes of entry could be compared. Measurements of the activity in excreta were made by gamma ray spectrometry. The activity removed from the lung had a half-life of about 10 hours. At 24 hours after inhalation about 3/4 of the particulate intially retained in the lung was found in the blood. Removal from the blood to permanent sites of deposition and by excretion was comparatively slow. When a vapor of Pb212 was inhaled, however, there was substantial fecal excretion. This is attributed to Pb212 deposited on the ciliated epithelium of the upper respiratory tract and subsequently brought up and swallowed. (Authors' abstract modified)

13461

Tikhonova, Z. I. and V. A. Zore

**SPECTROSCOPIC DETERMINATION OF MANGANESE, COPPER, ALUMINUM, LEAD AND TIN IN CERTAIN VEGETABLES AND BERRIES.** (Spektral'noe opredelenie margantsa, medi, alyuminiya, svintsa i olova v nekotorykh ovoshchakh i yagodakh.) Hyg. Sanit. (English translation of: Gigiena i Sanit.), 33(3):62-64, 1968. (8) refs.

A method for the simultaneous quantitative spectroscopic determination of manganese, copper, aluminum, lead, and tin in vegetables and berries is described. The product was brought to a constant weight, ashed, and placed in the crater of a carbon electrode. The sample was compacted and ignited in an a.c. arc, and its spectrum photographed. The error of the method was within 6% for copper, lead, and tin, and 10% for manganese and aluminum. Among the products tested, the highest manganese concentrations were found in cranberry, dill, and dog rose. The highest concentrations of copper occurred in black currants, dill and dog rose, and those of aluminum in dill, black currants and "blackberry" mountain ash. Further qualitative spectroscopic determinations were made of the elements Mn, Pb, Sn, Si, Fe, Al, Tl, Mo, Cu, Co, Zn, Ni, Cr, Ag, Mg, V, K, Ca, Na, P, and Sr. Every product contained all or nearly all these elements. The findings may be of help in the estimation of the content of trace elements in food.

13534

Mackiw, V. N.

**CURRENT TRENDS IN CHEMICAL METALLURGY.** Can. J. Chem. Eng., 46(1): 3-15, Feb. 1968. 52 refs.

Recent developments in hydrometallurgy and pyrometallurgy are reviewed. Some processes presently in commercial operation and some in the developmental stage are presented from the standpoint of extraction of metals and from their fabrication into useful materials. The chemical reactions of various commerical processes are shown both graphically and chemically. New processes are presented for the treatment of Zn Cu, and Pb concentrates, complex Pb-Zn, Cu, FeS2 bulk concentrates, and Zn plant residues. A combination of roasting and hydrometallurgy for the recovery of molybdenum from molybdenite is displayed diagramatically. Laterite treatment and other investigations and reactions are reviewed. It is concluded that new products from new processes will evolve economically through a new technology.

13635

Danilova, Y. I. and G. S. Freits

**REACTION OF METALS WITH SULFUR DIOXIDE.** (V-zaimodeystviye metallov s sernistym gazom.) Text in Russian. Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk, 11:25-33, 1955. 6 refs.

Reaction of metallic zinc, cadmium, lead, and copper with sulfur dioxide was studied at the Institute of Metallurgy as an important intermediate reaction in the oxidation of metal sulfides. Over the range 227-927 deg, tabulated values of free reaction energy reveals the relative reactivity sequence: zinc, cadmium, lead, copper. The same sequence is reflected in a plot of relative reaction rate at 800 deg. Copper was non-reactive over the range 20-1290 deg. Most complete reaction was found to occur at 600 deg for lead and 800 deg for zinc. The ratio of sulfide to sulfate in the reaction product increases with reaction temperature.

13705

Dawson, J. B. and D J. Ellis

**PULSED CURRENT OPERATION OF HOLLOW CATHODE LAMPS TO INCREASE THE INTENSITY OF RESONANCE LINES FOR ATOMIC ABSORPTION SPECTROSCOPY.** Spectrochim. Acta, vol. 23A:565-569, 1967. 4 refs.

Pulses of high intensity resonance radiation were obtained by passing large currents of short duration repetitively through conventional hollow cathode discharge lamps. In addition to high intensity, the emitted radiation appears to be practically free from self absorption and, as the mean power dissipated in the lamp is low, the working life of the lamp is extended. The shelf life also appears to be increased. This mode of lamp operation may be applied to the determination of a wide variety of elements, including Ca, Co, Cu, Mg, Mn, Pb, and Sr by atomic absorption spectroscopy. Other applications of the operation could include atomic fluorescence spectroscopy and new forms of multichannel atomic absorption instruments.

13839

Sachdev, Sham L. and Philip W. West

**CONCENTRATION AND DETERMINATION OF TRACES OF METAL IONS.** Anal. Chim. Acta, 44:301-307, 1969. 9 refs.

A procedure is presented for the preconcentration and simultaneous determination of Ag(I), Cd(II), Co(II), Cu(II), Ni(II), Pb(II), and Zn(II). The conditions for the extraction of these metal ions with diphenylthiocarbazone (dithizone) in ethyl propionate, along with atomic absorption spectrophotometry procedures, are described. The metal dithizonates are very stable in ethyl propionate, and the chelate-solvent system enhances the sensitivity for the atomic absorption method used for the determination. For the determination of the metals in question, an oxidizing flame provides better conditions than a reducing flame. The desirable aspiration rate of 3 ml/min is easily achieved by attaching a polyethylene capillary tube of 0.0015 in. inner diameter and 2.5 in. length to the capillary of the burner. With 10:1 aqueous-organic solvent ratios, the sensitivities for 1% absorption of the signal range from 0.001 micrograms for Cd(II) and Zn(II) to 0.004 micrograms for Pb(II). Among 38 diverse ions and compounds whose interference effects were studied, only silicate, tellurite, tin (IV), and antimony (III) are incompatible with this extraction system. (Author summary modified)

13879

Schenck, Rudolf and Agnes Albers

**CHEMICAL EQUILIBRIA BETWEEN LEAD SULFIDE AND ITS ROASTING PRODUCTS. I.** (Ueber die chemischeu Gleichgewichte zwischen Bleisulfid und seinen Roestprodukten. I). Text in German. Z. Anorg. Allgem. Chem., vol. 105:145-166, 1918. 20 refs.

Measurements of reaction tensions associated with the reaction of lead sulfide with its oxidation products were repeated using calcium phosphate heating tubes to avoid errors occurring when silica vessels are used. At all measurable equilibria, lead sulfide is present in the condensed constituent. The nine possible tension curves were found and their mutual positions were determined. The most stable curves are those in which the metal phase, the sulfide, and an oxygen phase form the condensed constituent. Univariant equilibria, in which the metal phase coexists with two oxygen solid phases and a gaseous phase, could not be observed and they appear to be very labile. Reinders' explanations of the lead roasting reaction are incomplete and mostly incorrect. The gas atmosphere always contains, in addition to sulfur dioxide, lead sulfide vapor in measurable amounts, which must be taken into account. The set of the univariant equilibria of the system Pb-S-O can therefore be represented on by a three-dimensional diagram with the coordinates: temperature, gas pressure, and composition of the gas atmosphere, expressed in mole percent of lead- sulfide vapor. The mutual positions of the equilibrium tension curves in the case when, in addition to lead sulfide and one oxygenous solid phase, the condensed constituent includes a liquid lead oxide- lead sulfate melt, were considered in considerable detail. It was concluded that there exists a definite

sequence of tension curves in the systems in which lead sulfide and two oxygenous phases form the condensed constituent. In this manner, a further means of identification of the observed reaction tension curves was obtained. Vapor pressures of lead sulfide, which can be rapidly distilled in vacuum at 900 C, were measured in the temperature interval between 850 and 1000 C.

13911

Manning, D. L., M. Blander, and J. Braunstein

**ASSOCIATION CONSTANTS OF LEAD AND BROMIDE IONS IN MOLTEN SODIUM NITRATE-POTASSIUM NITRATE MIXTURES AND THEIR COMPARISON WITH THE QUASI-LATTICE THEORY.** Inorg. Chem., 2(2):345-347, April 1963. 11 refs.

The association constants K1 and K2 for the formation of PbBr(plus) and PbBr2 were evaluated from electromotive force measurements in molten mixtures of NaNO3 and KNO3. The constants K1 and K2 in mole fraction units were respectively, 250 and 125 at 240 deg, 190 and 85 at 280 deg, and 170 and 70 at 300 deg when the solvent was equimolar NaNO3 and KNO3. A variation in the composition of the solvent changed the value of the association constants so as to give stronger binding as the proportion of KNO3 increased. The temperature dependence of the association constants, within the experimental error was predictable from calculations based on the quasi-lattice model. (Author abstract modified)

13943

Paduchev, V. V., V. V. Toporova, and N. P. Diyev

**INVESTIGATION OF THE REACTION OF LEAD SULFIDE WITH SULFUR DIOXIDE.** (Issledovaniye vzaimodeystviya sul'fida svintsa s sernistym angidridom). Text in Russian. Zh. Prikl. Khim., vol. 34: 676-679, Jan.-April 1961. 6 refs.

Sulfur 35 isotope was used to study the reaction of lead sulfide with sulfur dioxide at 650 and 700 C. Data obtained contradict the so-called 'sulfate theory' of sulfide oxidation which proposes that under conditions of sulfating calcination, first the sulfur of the sulfides themselves is oxidized to anions SO3(2-) and SO4(2-) and that the metal oxides formed during calcination are only products of subsequent dissociation of the initially obtained sulfates. It now seems more likely that the sulfates formed do not retain sulfur of the original sulfides but acquire it later from the gas phase, i.e., the metal oxides appear ahead of the sulfates: 4MeS* plus 2SO2 yields 4MeO plus 2S*2 plus S2; 4MeO plus 4SO2 yields 4MeSO3; 4MeSO3 yields 3MeSO4 plus MeS.

14008

Thalmayer, C. E., S. Bruckenstein, and D. M. Gruen

**CHRONOPOTENTIOMETRIC DETERMINATION OF INTERDIFFUSION COEFFICIENTS AND HEATS OF INTERDIFFUSION IN MOLTEN SALTS.** J. Inorg. Nucl. Chem., 26(2):347-357, Feb. 1964. 19 refs.

The interdiffusion coefficients of Ag(I), Cd(II), Pb(II), Bi(III), and U(IV) in lithium chloride-potassium chloride eutectic and of Ag(I) in molten sodium nitrate and molten cesium nitrate were determined by chronopotentiometry and calculated from the Sand equation. The heat of activation for interdiffusion of each ion was determined by the method of least squares. The following diffusion coefficients in sq cm/sec x 1,000,000 at 400 C and heats of activation in kcal/mole were obtained for the ionic species in the LiCl-KCl melt: Ag(I), 24 and 5.8; Cd(II), 12.1 and 6.5; Pb(II), 8.9 and 7.9; Bi(III), 6.3 and 9.8; U(IV), 4.9 and 7.7. The temperature range studied was approximately 365 to 750 C. The diffusion coefficient and heat of activation for diffusion for Ag(I) in sodium nitrate are 32.5 and 4.52, respectively. In cesium nitrate they are 24.8 and 5.06. These data indicate that interdiffusion proceeds by a mechanism quite different than that for viscous flow. Since each solute ion interacts with the melt to an unknown extent, e.g., by complex ion formation with unknown coordination number, the different diffusion coefficients and activation energy values are explained by the 'effective radius' of the solute ion in the melt. Significant transport via a paired vacancy mechanisum is not supported for interdiffusion in these melts. (Author abstract modified)

14039

Thalmayer, C. E., S. Bruckenstein, and D. M. Gruen

**CHRONOPOTENTIOMETRIC DETERMINATION OF INTERDIFFUSION COEFFICIENTS AND HEATS OF INTERDIFFUSION IN MOLTEN SALTS.** J. Inorg. Nucl. Chem., vol. 26:347-357, 1964. 19 refs.

The interdiffusion coefficients of various ions in several molten salts were determined over a sufficiently large temperature range to calculate the heats of activation for interdiffusion. The chronopotentiometric method was used and the interdiffusion coefficients and heats of activation were calculated for Ag(I), Cd(II), Pb(II), Bi(III), and U(IV) in LiCl-KCl eutectic solution and for Ag(I) in molten NaNO3 and in molten CsNO3. The temperature range was approximately 365-750 C. The standard deviations within each run were quite small, but the differences between runs of the same system were quite large. This seemed to indicate that the largest experimental error is in a quantity which is constant within each run, probably the analytical concentration. The other principal source of error is the measurement of the transition time. This was difficult to eliminate because prior reduction of the ion enhances the transition times for all trace impurities which were subsequently reduced. The chronopotentiometric results indicated that interdiffusion does not obey the Stokes-Einstein relation in LiCl-KCl eutectic solution, molten NaNO3, or molten CsNO3. In addition, while there was strong evidence that paired-vacancy diffusion was a significant transport process in the self- diffusion of the solvent cation and anion in some alkali metal halides and NaNO3, such as mechanism for interdiffusion seemed unlikely in the solvents studied.

14138

Heric, E. L.

**A PHASE RULE EXPERIMENT: THE SYSTEM LEAD NITRATE-SODIUM NITRATE- WATER.** J. Chem. Educ., 35(10):510-513, Jan.-Dec. 1958. 7 refs.

A phase rule experiment involving a solid-liquid system is described and suggested to be of greater value to physical chemistry students than the experiments on ternary systems given in current textbooks, involving systems containing only liquid phases. In the experiment described, the analytical procedure was reduced to a minimum, the determination of total anhydrous solids. This was accomplished by extension of the wet residue method of Schreinemakers and the method of algebraic extrapolation so that a knowledge of the composition of two synthetic samples on the same tie line is used to fix the latter. While the principles involved are presented in terms of the system lead nitrate-sodium nitrate-water, the method is not specific and might be applied to many ternary systems in which one of the components is easily separable from the others. Evidence indicates that with several refinements the method may also be a suitable tool for research, especially for some of those systems where the usual methods of analysis

are not satisfactory. The apparatus, materials, and calculations of the experiment are fully described.

14510

Van Artsdalen, Ervin R.

**COMPLEX IONS IN MOLTEN SALTS. IONIC ASSOCIATION AND COMMON ION EFFECT.** J. Phys. Chem., vol. 60:172-177, Feb. 1956. 12 refs.

The concepts of complex ion and ideality were considered in the case of molten salt solutions. Freezing point depression measurements in molten sodium nitrate as solvent were used to determine the nature and number of ions into which several solutes dissociate. It was demonstrated that a number of salts of relatively simple oxy-acids, as well as many other simple salts, are stable and remarkably ideal in solution in molten sodium nitrate. Partial dissociation and complex ion formation were shown to exist at high dilution in the case of lead(II) chloride, copper(II) chloride, cadmium chloride, zinc chloride, and cadmium bromide. The important species in the solutions appear to be those with zero, two, and four chlorines per (II) metal ion. The occurrence of the common ion effect is amply substantiated with these compounds and chloro anions containing the (II) metal exist even at low concentrations. Reactions were proposed which account for the results, and equilibrium constants were calculated for these reactions. (Author abstract modified)

14743

Cunningham, J. C. J.

**THE SYSTEM: LEAD OXIDE-COPPER OXIDE. PRELIMINARY RESULTS.** (Das System: Bleioxyd-Kupferoxyd. Vorlaeufige Mitteilung). Text in German. Z. Anorg. Chem., 89(1):48-52, 1914. 7 refs.

The possible existence of chemical bonds between lead oxide and copper oxide was investigated. First, the melting point of the lead oxide was determined by heating in a platinum container to be 875 C. Next, the melting points of mixtures of lead oxides with copper oxides were determined. The platinum vessel and contents were heated to 980 C, at which temperature the entire composition was liquid. The lead oxide was determined in the form of lead sulfate, and the copper oxide was determined electrolytically as copper. The melting point of the lead oxide dropped upon addition of copper oxide. It was found that no compounds formed from the molten mixture of lead oxide and copper oxide, at least not as PbO.CuO or 2PbO.CuO. A eutectic mixture formed which melted at 698 C.

14868

Duke, F. R. and M. L. Iverson

**COMPLEX IONS IN FUSED SALTS.** J. Phys. Chem., 62(4):417-419, April 1958. 12 refs.

The complex ion formation constants for a series of bivalent metal halides were determined using fused KNO3-NaNO3 eutectic mixtures as a solvent. The method involved measuring the increase in solubility of the slightly soluble metal chromate as halide ion was added. The solubility of lead chromate increases with increasing sodium chloride content up to the limiting solubility of sodium chloride. A similar increase in solubility is shown with the addition of sodium bromide. The solubility of cadmium chromate also increases with the addition of chloride or bromide and forms a more stable complex with halide ions than lead. The solubilities of the chromium salts of magnesium, calcium, and barium are not affected significantly by the addition of halides. The increase in solubility of a salt was interpreted on the basis of complex ion formation. It was evident that the trend is toward a decrease in stability of the complex with an increase in temperature in the case of lead. An interpretation of the data on the basis of stable complex ions does not indicate whether the complex is of ionic or chemical, since the role of the solvent is not known.

14995

Barusch, M. R. and J. H. MacPherson

**ENGINE FUEL ADDITIVES.** In: Advan. Petrol. Chem. Refining. John J. McKetta, Jr. (ed.), vol. 10, New York, Interscience, 1965, Chapt. 10, p. 457-546. 215 refs.

A detailed discussion of antiknock agents is given, emphasizing data on such new antidetonants as methylcyclopentadienylmanganese tricarbonyl, tetraethyllead (TEL), and mixtures of methylethyllead alkyls. With one exception, only additives used in commercial fuels are discussed. The exception is the class of compounds known as lead extenders, i.e., compounds which enhance the effectiveness of lead alkyls by the formation of carboxylic acids in the combustion chamber of an engine. Their performance characteristics provide considerable insight into the mechanism by which antiknock agents operate. Other subjects covered include scavengers for lead, surface ignition suppressants, antioxidants, metal deactivators, rust-preventing additives, gasoline detergents, additives to prevent carburetor icing, diesel fuel detergents and dispersants, biocides, and additives to prevent the buildup of static electricity during fuel handling. In considering antiknock agents, the influence of fuel composition on TEL effectiveness and the antagonism of sulfur to TEL are discussed. A brief note on antiknock additives for aviation gasoline is included. (Author introduction modified)

15413

Schenck, Rudolf and W. Rassbach

**CHEMICAL EQUILIBRIA IN THE REACTION BETWEEN LEAD SULFIDE AND ITS OXIDATION PRODUCTS. III.** (Ueber die chemischen Gleichgewichte bei der Reaktion zwischen Bleisulfid und seinen Oxydationsprodukten. III). Text in German. Chem. Ber., 41(13):2917-2925, Aug. 10, 1908. 2 refs.

In earlier studies of the system PbS + 2PbO equals 3Pb + SO2, an equilibrium shift was observed when the basic substances were subjected to temperatures above 800 C. To obtain more information on the cause of this shift, solidification phenomena of a mixture of lead oxide and lead sulfate were studied. The cooling curves of 25 different mixtures of the two components were studied as well as the solidifaication, and conversion products were determined. A mixture was heated to about 1020 C and a Le Chatelier thermocouple dipped into the melt operated an automatically recording galvanometer. No melting of the pure lead sulfate up to temperatures of more than 1000 C could be observed. The same was true for very sulfate rich mixtures. The melting point of the sulfate seems to be above 1100 C. But even if such a temperature could be achieved, it will be difficult to determine the melting point of the pure substance since SO3 is formed in the process of heating. Pure lead sulfate experiences a change in solid state which becomes apparent both at heating and cooling at 850 C. The melting point of pure lead oxide was found to be 879 C. The solidification curve shows a whole series of branches within which two maxima were observed: one at 966 C and 40% lead oxide and another at 951 C and 61.5% oxide. The compounds PbSO4-PbO (42.4 lead oxide), PbSO4-2PbO (59.5% of lead oxide), and PbSO4-3PbO (68.8% oxide) are precipated. At room temperature, the oxide rich melts decompose to a coarse powder in which lead oxide flakes can be seen. The SO2 tension curves of the three alkaline sulfates were determined.

15493

Zhdanov, A. K. and V. V. Yakovlev

**SOLUBILITY OF LEAD SULFATE IN ELECTROLYTE SOLUTIONS AT 25 C.** (Rastvorimost' sul'fata svintsa v rastvorakh elektrolitov pri 25 ts). Text in Russian. Uzbeksk. Khim. Zh., no. 2:5-10, 1958. 3 refs.

Solubilities of lead sulfate at 25 C were determined for the following ternary systems: PbSO4-NaNO3-H2O; PbSO4-NaCl-H2O; PbSO4-NaBr-H2O; and PbSO4-NaC2H3O2-H2O. The sodium salt concentrations were varied from 0.001 to 3 moles/liter. Solubility of the sulfate increased with the concentration of additional salt in every case. Relative nitrate solubility with these salts increases in the following order: NaNO3, NaCl, NaBr, NaC2H3O2. Experimental data were used to calculate the products of lead sulfate activities in first and second approximation according to the Debye-Huckel equation.

15618

Kettner, Helmut

**THE REAGENT BLANK VALUE IN THE DETERMINATION OF SMALL LEAD CONCENTRATIONS IN ATMOSPHERIC AIR.** (Ueber den Reagenzienblindwer bei der Bestimmung von kleinen Bleimengen in der atmosphaerischen Luft). Text in German. Schriftenreihe Ver. Wasser Boden Lufthyg., (29):51-54, 1969. 1 ref.

During closely successive lead analysis, the extinction decreased stepwise but returned to its inital value after several days. This lead to the assumption that the blank value stems from lead liberated from the glass material. To confirm this, the blank value was determined with lead free glass vessels and polyethylene flasks. The results of this study showed that in the majority of cases, the extinction was below 0.010, even with the addition of fourfold the required reagent, i.e., in a range where the analyzer begins to measure inaccurately. The lead amount introduced by the reagents was negligibly low. The reagent blank value resulted primarily from the lead of the glass vessels.

16595

Flengas, S. N. and T. R. Ingraham

**ELECTROMOTIVE FORCE SERIES OF METALS IN FUSED SALTS AND ACTIVITIES OF METAL CHLORIDES IN 1:1 MOLAR KCl-NACl SOLUTIONS.** J. Electrochem. Soc., 106(8):714-721, Aug. 1959. 18 refs. (Presented at the Electrochemical Society, Ottawa, Canada, Sept. 28-Oct. 2, 1958.)

The potentials of a series of metal-metal chloride systems in an equimolar mixture of molten potassium and sodium chlorides were measured against a silver-silver chloride reference electrode. An electromotive force series of metals at different temperatures was established for the 1:1 KCl-NaCl solvent. Experiments with a chlorine electrode showed that the solutions of silver chloride in the KCl-NaCl solvent were ideal, and hence, the deviations from ideality of the other chlorides in the solvent could be attributed directly to the formation of complexes in the melts. Three types of behavior was observed for the Mn-MnCl2, Zn-ZnCl2, Cr-CrCl2, Tl-TlCl, Cd-CdCl2, Fe-FeCl2, Pb-PbCl2, Sn-SnCl2, Co-CoCl2, Ni-NiCl2, and Cu-CuCl systems. Ideality, and positive and negative deviations from ideality, were observed. Activity coefficients were calculated. For metal chloride solution such as MnCl2, ZnCl2, and all the others for which the activity coefficents are less than unity, the formation of complexes can be postulated. Although the presence of finite complexes in melts was demonstrated by the measurements, it was reasonable that in ionic metals, there exists several intermediate states of aggregation between the so-called non-complexed ionic state and the type of finite complexes found in aqueous solutions. The values of the activity coefficients, and of other thermodynamic functions which characterize these complexes in solution, will depend entirely upon the definition of a non-complexed state. It is possible to obtain solutions with positive, negative, or zero deviation from ideality by regulating the composition of the solvent and temperature. It was concluded that what is thermodynamically an ideal state is not necessarily a non-complexed state.

16659

Shams El Din, A. M. and A. A. El Hosary

**POTENTIOMETRIC ACID-BASE TITRATIONS IN MOLTEN SALTS. THE ACID CHARACTER OF LI(+), NA(+), K(+), CA(2+), SR(2+), BA(2+) AND PB(2+) AS INFERRED FROM THE REACTION OF THEIR CARBONATES WITH K2CR2O7 IN MOLTEN KNO3.** J. Electroanal. Chem., vol. 16:551-562, 1968. 10 refs.

The acid K2Cr2O7 was titrated potentiometrically with the carbonates of Li, Na, K, Ca, Sr, Ba, and Pb in fused KNO3 at 350 deg; both 'forward' neutralization experiments (in which the oxide-ion donors were added to the acid in fused KNO3) and 'backward' experiments (in which the procedure was reversed) were carried out. An oxygen electrode was used as indicator electrode and its potential was measured relative to an Ag/Ag(I), melt/glass reference half-cell. Both 'forward' and 'backward' neutralization curves (except for the case of Pb) consist of a single step corresponding usually to formation of CrO4(2-). 'Cyclic' neutralization curves with NaOH and KOH suggest that Na(+) is acid with respect to K(+). The acidity of Ca(2+), Sr(2+) and Ba(2+) decreases in the order given. CaCrO4 and SrCrO4 add an extra molecule of Na2CO3 to give CaCrO4.Na2CO3 (SrCrO4.Na2CO3); BaCrO4 does not. Pb(2+) is the most acid cation studied. PbCrO4 adds another molecule of PbCO3 and gives a second inflexion in the titration curves, corresponding to the formation of PbCrO4.PbCO3. PbCO3 decomposes thermally in fused KNO3 to give white lead, 2PbCO3.PbO. The reaction is zero-order with respect to PbCO3 and has an activation energy of 38.2 kcal mole(-1). The decreasing order of acidity established in these experiments is the same as that determined in a previous study on the basis of the reaction of the same carbonates with NaPO3. (Author summary modified)

17161

Voronin, G. F. and A. M. Evseev

**THERMODYNAMIC PROPERTIES OF LIQUID LEAD-TIN ALLOYS.** Russ. J. Phys. Chem. (English translation from Russian of: Zh. Fiz. Khim.), 33(10):373-375, Oct. 1959. 8 refs.

A thermodynamic study of the lead-tin system in the range 730-790 C, accomplished by measuring the vapor pressure of the lead, is described. A simple continuous weighing method was developed for determining the activities of metals in liquid alloys; the method is a variation of Knudsen's method for vapor pressure determinations. An effusion chamber, consisting of a 0.3 quartz ampoule with a 2.37 mm diameter opening was used, the shape of the ampoule ensuring a constant rate of evaporation. Temperature was controlled to 2 deg and measured using a platinum-rhodium thermocouple in the quartz tube and a poteniometer. The evaporation rate was measured by following the rate of contraction of the quartz spring, using a cathometer, with an accuracy of 0.005 mm. The thermodynamic functions for a number of lead alloys were calculated. It was found that liquid lead-tin alloys exhibit molecular non-uniformity.

17585

Harmelin, Mireille and Clement Duval

**A STUDY OF REACTIONS IN THE SOLID STATE BETWEEN THE TREE OF SATURN AND SALTS CONTAINING THE GROUP XO3: 1. QUALITATIVE STUDY OF THE REACTION BETWEEN LEAD AND THE NO3(-)ION.** (Etude de reactions a l'etat solide entre l'arbre de Saturne et des sels contenant le groupement XO3: 1. Etude qualitative de la reaction entre le plomb et l'ion NO3(-)). Text in French. Microchim. Acta, vol. 2-4:211-215, 1964. 5 refs.

In analogy to Hampe's reaction formerly employed in industry to prepare NaNO2 in which Pb flakes were gradually added to molten NaNO3 at about 310 C, nitrites of other metals could be obtained by reaction of Pb with the corresponding nitrates. To investigate this possibility, Pb was prepared in the form of a fine and shiny powder by the technique of growing a 'lead free' from an agueous 1.5% solution of Pb acetate with the addition of 1% of pure acetic acid. This Pb powder was mixed at room temperature with nitrates of Li, Na, K, Cs, Cu, Ag, Mg, Ca, Sr, Ba, Zn, Th, Pb, Co, and Ni in the appropriate stoichiometric ratio; the resulting products were analyzed chemically, thermogravimetrically, by differential thermal analysis, infrared absorption spectrography, as well as microscopically. In every case, immediately after the admixture of Pb powder, the presence of the corresponding nitrite could be established with the aid of the alpha-naphthylamine reaction, which is completely insensitive to NO3(-)ions. Among the mixtures submitted to differential thermal analysis, only that prepared with Tl nitrate showed a very strong exothermic peak characteristic of the oxidation of Pb at 170 C. In the others, the oxidation of Pb took place gradually as exemplified by the mixture of Pb with Na nitrate. In the case of K nitrate, the reaction was particularly slow; in the Cu and Ag nitrates, it was extremely rapid and seemed to go beyond the nitrite formation. In all other cases, the reaction was slow and, though the presence of nitrite was chemically ascertained the amount formed was insufficient to show up in the infrared absorption spectra.

17689

Takahashi, Tadao and Fumio Jotani

**METAL OXIDE CATALYTIC COMBUSTION CATALYSTS.** (Kinsoku-sankabutsu- kei sesshoku nensho shokubai). Text in Japanese. Nenryo Kyokaishi (J. Fuel Soc. Japan, Tokyo), 46(487):828-837, Nov. 1967. 10 refs.

Three factors of metal oxide catalysts important for the complete combustion of automobile exhaust gas are the activity, thermal stability, and chemical tolerance against lead compounds. The harmful components of automobile exhaust gas used in this study were carbon monoxide, methane, and lead compounds. The metal oxide catalysts used were Fe203, CuO, Mn203, Al203, Cr203, or 1:3 mixtures of these compounds; the particle sizes varied from 10 to 30 mesh. A 1.1 cm long quartz cylinder was used to examine the activity of the catalysts using 2.0 ccm of catalysts, a gas speed of 12 liter per hour and reaction time of 15 minutes. The gas used was later analyzed by gas chromatography. The chemical tolerance test was performed by the use of 0.3 to 0.5 grams PbBr2 and 12 liter/hr of exhaust gas for 2 hours under the temperature of 500 C in the similar quartz cylinder. High activities of two-component iron oxide catalysts (Fe203-Mn203, Fe203-Cr203, Fe203-Co304, and Fe203-CuO) were lowered by the high temperature. The CuO-Al203 was the most active and thermostable catalyst among co-precipitated CuO, Mn203, and Cr203. Cupric aluminate which was derived from CuO and Al203 in high temperatures also showed high catalytic activity and thermostability. This catalyst (CuO-Al203) increased oxidation of CO by adding MgO(CuO-MgO-Al203) and that of methane by adding ZnO (CuO-ZnO-Al203).

17882

Sinistri, Cesare

**STUDY OF COMPLEX IONS IN MOLTEN EQUIMOLAR NANO3-KNO3. PART 1. THE COMPLEXES CDCL, PBCL, TLCL AND AGSO4.** (Studio di ioni complessi nella miscela equimolecolare fusa NaNO3-KNO3 Nota 1: Complessi CdCl, PbCl, TlCl e AgSO4). Text in Italian. Ric. Sci. Rend. A, 2(6):638-643, 1962. 8 refs.

The study of complex-forming phenomena was studied by recording the solubility of an 'indicator' substance (silver chloride) as appropriate complex-forming agents were gradually added. The indicator substance furnishes the chloride anion, which acts as a binder for the 3 cations: thallium, lead, and cadmium. It also furnishes the silver cation, which acts as a binder for the sulfate anion. Measurements were made at temperatures of 275, 300, and 325 C. Of the three nitrates tested for their effect on the solubility of silver chloride in molten equimolar NaNO3-KNO3, the thallium salt had little effect, the lead salt had a noticeable effect, and the cadmium salt had a strong effect. The data thus obtained was used to calculate the first formation constants for thallium chloride, lead chloride, cadmium chloride, and silver sulfate, in moles/kg of the solvent. The results are tabulated, discussed mathematically, and compared with the values obtained by other authors.

17949

Cola, Mario and Carla Castellani Bisi

**THERMAL DECOMPOSITION OF CERTAIN METALLIC SULFITES.** (Decomposizione termica di alcuni solfiti metallici). Text in Italian. Gaz. Chim. Ital., vol. 91:173-186, Jan.-July 1961. 10 refs.

Experiments are presented of heating sulfites of silver, tantalum (valence 1), strontium, barium, and lead in a stream of nitrogen in order to demonstrate the role of the dismutation reaction in the formation of sulfides and sulfates. This was the principal reaction in the case of tantalum, strontium, and barium sulfites. With lead sulfite, it ran paralled with the dissociation to an oxide and sulfur dioxide; with silver sulfite, it seemed to be completely absent.

19823

Sano, Isamu, Tomoyuki, Tokida, and Yasuo Ueno

**FORMATION OF LEAD AEROSOLS IN NITROGEN AND THEIR CHEMICAL REACTIVITY.** (Chissochu ni okeru namari emmutai no seisei to sono hannosei ni kansuru ichijikken). Text in Japanese. Funtai Kogaku Kenkyu Daishi (J. Res. Assoc. Powder Technol., Japan), 7(2):91-97, April 1970. 7 refs.

With nitrogen gas as the medium, lead aerosols were generated in order to investigate the conditions under which monodisperse aerosols can be formed. The weight concentration and the particle size vary with the temperatures at which lead vapors arise (950-1150 C) and with the flow rate of nitrogen gas (1.0-4.5 liter/min). At constant temperature, the concentration and the particle size pass through a maximum with the increase in flow rate whereas the particle concentration passes through a minimum. At constant flow rate of nitrogen, there is a linear relationship between the logarithm of the particle size and the inverse of the temperature. Aerosols of high monodispersity can be obtained by setting the flow rate at around 1.5 liters/min in the range of 1000-1100 C. In the

preliminary experiment concerning the reaction between iodine vapor and lead aerosols toward the formation of lead iodide, the reactivity was higher for coarser particles and affected by temperature to the extent of about 2% and 16% per 15 mins at 30 and 50 C, respectively. The heat of activation was calculated to be about 21 kcal/mol.

27348

Fedorchenko, I. M. and O. S. Nichiporenko

**FACTORS DETERMINING THE FORMATION OF POWDER PARTICLES DURING ATOMIZATION WITH A GAS FLOW.** (Faktory, opredelyayuschchiye formirovaniye chastits poroshka v protssesse raspyleniya gazovym potokom). Text in Russian. Dokl. Akad. Nauk SSSR, Fiz., 179(3): 578-580, March 1968. 5 refs.

Process rates were calculated for the spheroidization and cooling of copper and lead particles during atomization at temperatures ranging from 1100 to 1300 C for copper, and 350 to 1000 C for lead. Calculated cooling and spheroidization times are plotted as functions of particle size for diameters of 50 to 500 microns for various temperatures within these ranges. It is noted that spheroidization time is 2 to 3 orders of magnitude smaller than the cooling time regardless of the surface tension. It is not surface tension but rather the formation of a stiff surface film, often due to the oxidation of alloying substances, a critical factor in achieving spherical particles. This was confirmed experimentally with the vaporization, with air and with helium, of bronze containing 0.1% Al and 0.06% Mg.

27752

Holtzman, R. B. and F. H. Ilcewicz

**TEN PB AND 210 PO IN WOOD AND THE CIRCULATION OF LEAD IN TREES. (SIC.).** In: Radiological Physics Division Annual Report, Argonn National Lab., Ill., Radiological Physics Div., Rept. ANL-7615, p. 38-43, 1969. 12 refs.

Measurements of lead (210) and polonium (210) concentrations in tree rings from four 100-year-old trees were made in order to estimate the rates of radial translocation. Decrease of the concentration of the lead (210) with a 21.4-year half-life showed that there is little circulation of lead in hickory heartwood more than 20 years old. In oak there appears to be little circulation in wood less than 5 years old, but this conclusion is less reliable because of the low concentration of the lead (210) and the presence of radium (226). The concentrations of the polonium (210) correlated fairly well with those of the lead (210). Preliminary measurements of the stable lead concentrations did not show increased uptake in recent times. However, more detailed studies on the lead (210) and stable lead concentrations are needed to determine the value of the heart-wood of trees as a temporal record of lead contamination of the environment. (Author abstract)

28908

Rocchi, Bernardo

**MOTOR KNOCK AND ANTI-KNOCK MIXTURES.** (La detonacion y mezclas antidetonantes). Text in Spanish. Rev. Aeronaut. (Madrid), vol. 3:364-365, May 1942.

The 'knock' that occurs in an internal combustion motor is comparable in many ways to a true explosion, creating a pressure of 80 atmospheres with a speed of propagation of 300 meters per second. The history and present state of knowledge on the subject are reviewed. Four basic principles are involved: (1) proximity of the source of ignition (spark plug) to the firing chamber, (2) amount and nature of the turbulence existing in the firing chamber at the moment of ignition, (3) temperature and pressure of the fuel mixture at ignition, and (4) temperature of the walls of the firing chamber at ignition. Two approaches to the problem of motor knock are discussed: the addition of sizeable quantities of benzene, alcohol, or isooctane; and the addition of small quantities of a catalyst such as tetraethyl lead. Various formulas are presented and discussed, and the problems of using leaded gasoline are considered from the standpoint of motor efficiency and wear.

29400

Inouye Toshiyuki and Yasuo Ito

**GENERATION AND QUANTITATIVE ANALYSIS OF MIXED AEROSOL OF TWO COMPONENTS.** (2-seibunkei kongo eazoru no hassei narabini teiryo) Text in Japanese. Preprint, Japan Chemical Society, Tokyo, 1p., 1971. (Presented at the Japan Chem. Soc. Annual Meet., 24th, Tokyo, March 1971., Paper 3404.)

An evaporation method was adopted to generate aerosols, and the relationship between the heating temperature and the aerosol concentration was studied. A mixed aerosol of two components was also generated, and the proportion of components and conditions for varying the degree of concentration investigated. Chlorides such as lead and cadmium, which melt at comparatively low temperatures were used as samples. The sample was placed in a porcelain tube 5 mm inner diameter, which was then hung in the center of a vertical tube furnace whose temperature was kept constant. Air was sent in continuously from the bottom in order to melt and evaporate the sample. The generated aerosol was passed to a tank. The two-component aerosol was prepared by placing lead chloride and cadmium chloride, generated separately, into the mixing tank. The aerosol concentration in the atmosphere was impinged, at 3 l/min an measured by light absorption using diphenylthiocarbazone. When the solids are melted and evaporated and the aerosol is generated by natural cooling, one of the conditions for obtaining a uniform concentration is to maintain the evaporation rate. A deep vessel, with a small evaporation surface, is suitable and can supply a certain required concentration of aerosol for a long period of time The uniformity of the aerosol concentration is also influenced by temperature; therefore, it is necessary to maintain a constant temperature. When the temperature is higher than the melting point of that sample, the aerosol concentration increases with temperature. For lead chloride and cadmium chloride, there is an inverse correlation between the aerosol concentration and temperature (I/T). When the aerosols of lead chloride and cadmium chloride are mixed at 10%-90%, it was shown that a mixed aerosol of two components can be continuously generated, regardless of the mixing ratio, over a long time period.

34297

Singh Dev, Rajinder K. Kautz, and H. Kirsch

**CRYSTAL STRUCTURAL PROCESSES AT THE REACTION OF SO3 AND SO2 WITH FLY ASH PARTICLES AND ADDITIVES.** (Kristallstrukturelle Vorgaenge bei der Reaktion von SO3 and SO2 mit Flugaschepartikeln und Additiven). Text in German. Mitt. Ver. Grosskesselbetr., 51(4):338-341, Aug. 1971. 4 refs.

Sulfate formation through the reaction of carbonates and oxides of calcium, magnesium, iron, manganese, lead, and zinc with the sulfur dioxide and sulfur trioxide in flue gas was studied. Natural carbonate crystals were split and heated 10-15 C above their dissociation temperature. The sulfatization experiments were carried out with the crystal oxide aggregates obtained through calcination. Temperatures were between 500 and 600 C. Carbonates reacted faster and more efficiently with

SO3 than the respective oxides. The oxide structure is thought to require more regrouping, while the SO3 group most likely replaces the carbon dioxide group in the carbonate structure. Oxides become more reactive as temperatures increase. Calcium carbonate and calcium monoxide most likely bind not only the SO3, but also the SO2, while magnesium carbonate and magnesium monoxide probably only bind SO3.

34607

Aleksandrov, Yu. A., B. I. Tarunin, and V. A. Shushunov.

**KINETICS OF REACTIONS BETWEEN OZONE AND COMPLETE ETHYL COMPOUNDS OF SILICIUM, GERMANIUM, TIN, AND LEAD.** (Kinetika reaktsii ozona s polnymi etilnymi soyedineniyami kremniya, germaniya, olova i svintsa). Text in Russian. Kinetika i Kataliz, 12(4):898-902, 1971. 5 refs.

The kinetics of the ozonolytic process of silicon, germanium, tin, or lead tetraethyl derivatives between zero and 25 C were investigated. A known amount of the tetraethyl compound was introduced into a certain volume of ozone saturated carbon tetrachloride under conditions of continuous bubbling of an ozone-oxygen mixture. The rate of the reaction was measured by spectrophotometric ozone determinations before and after ozonolysis. Rate constants for the bimolecular mechanisms of the reactions are computed. The practical meaning of the equation describing the reaction rate constant consists in its variation according to the affinity of the tetraethyl derivative towards ozone. Specific kinetic curves were obtained for ozonolysis of the less active tetraethyl derivatives of germanium and silicon, such curves presented a different trend in the case of lead or tin tetraethyl derivatives. Ozonolysis of tetraethyl lead or tetraethyl tin appeared to be a first order reaction with respect to both ozone and the initial tetraethyl compound when the effect of its initial concentration on the reaction rate was studied. The temperature dependence of the rate constant for all studied tetraethyl derivatives satisfied the Arrhenius equation. A parallelism between the variation of the rate constant and the nucleophilicity of the heteroatom contained by the tetraethyl compound was established.

34948

**NEW DIRECTIONS IN ION-SELECTIVE ELECTRODES.** Chem. Eng. News, 48(27):40-41, June 29, 1970.

Ion-selective membrane electrodes measure the activities of unassociated ions in solution with a sensitivity often less than one part/billion. The selectivity of the electrodes is such that they can be used in electrolyte solutions containing other species either present naturally or added to control the ionic strength and pH of the solution. There are now more than 20 electrodes available for more than 20 ions, including alkali and alkaline earth ions, heavy metal ions, and a wide variety of anions such as fluoride, nitrate, sulfide, and perchlorate. In recent work, ion-selective electrodes were used to measure formation constant in adenosine triphosphate complexes, complex formation of calcium, magnesium, and beryllium ions with biologically important ligands, and lead in urine samples.

35378

Carpenter, Kathleen E.

**THE LEAD MINE AS AN ACTIVE AGENT IN RIVER POLLUTION.** Ann. Appl. Biol. (London), 13(3):395-401, 1926. 6 refs.

Investigation of the effects of a lead mining and dressing operation on a neighboring stream showed slight but definite deterioration of the river after 12 months of partial activity, despite sedimentation practices. The pollution while the mine was active was of the same type as the effects which persisted after closure. The responsible agents were traces of metallic solutions (lead, zinc, copper, and iron) derived from direct action of the water upon the solid mine waste; the solid waste in itself was harmless.

35379

Carpenter, Kathleen E.

**ON THE BIOLOGICAL FACTORS INVOLVED IN THE DESTRUCTION OF RIVER-FISHERIES BY POLLUTION DUE TO LEAD-MINING.** Ann. Appl. Biol (London), 12(1):1-13, Feb. 1925. 4 refs.

The biological factors involved in the destruction of river fisheries by pollution due to lead mining were investigated. The chemical alteration of the water at flood times after heavy precipitation was an agent in the destruction of fish. The index to the fatal character of the flood water was the presence of soluble lead. Death of the fish was ultimately referable to a chemical interaction between a secretion of the skin and the lead dissolved in the surrounding medium, producing a colloidal substance which, when present in sufficient quantity, inhibited respiration.

36067

Nix, J. and Tom Goodwin

**THE SIMULTANEOUS EXTRACTION OF IRON, MANGANESE, COPPER, COBALT, NICKEL, CHROMIUM, LEAD, AND ZINC FROM NATURAL WATER FOR DETERMINATION BY ATOMIC ABSORPTION SPECTROSCOPY.** At. Absorption Newslett., 9(6):119-122, Nov.-Dec. 1970. 8 refs.

A method for the determination of eight heavy metals (iron, manganese, copper, cobalt, nickel, chromium, lead, and zinc) in natural water in the concentration range of a few ppb is presented. The method utilizes a diethyldithiocarbamic acid chelation followed by a methyl isobutyl ketone extraction to preconcentrate all eight of the metals in a single extract. This extract can be used for the determination of the metals by atomic absorption spectroscopy. Using proper field filtration, the method can be adapted for the determination of both the filtered and particulate fraction of these metals in natural water. (Author abstract)

36076

McCabe, L. J.

**METAL LEVELS FOUND IN DISTRIBUTION SAMPLES.** Preprint,American Water Works Assoc., New York, 9p., 1970. (Presented at the American Water Works Association Seminar on Corrosion by Soft Water Washington. D. C., June 21, 1970.)

Some trace metals are included in the Drinking Water Standard because they are toxic and the limit is set to protect the public health: cadmium, chromium, lead, and silver, for example. Others are toxic at high levels but the limits are set to keep the water potable, e.g., copper and zinc. Other metal limits are based on aesthetics, as with iron and manganese. However, analysis of distribution samples from public water supply systems, carried out as part of the Public Health Service Community Water Supply Study, indicates that some families are receiving too much lead as well as some other compounds in their drinking water. Water with relatively lower pH showed the most samples exceeding the standards, while the metal problem was greater with the least mineralized water.

36524

Domrachev, G. A., K. G. Shalnova, and V. A. Varyukhin

**CATALYTIC REDUCTION OF TERTRAPHENYL LEAD WITH BIS-ALLYL PALLADIUM CHLORIDE.** (Kataliticheskoye vosstanovleniye tetrafenilsvintsa v reaktsii s bis-allilpalladiykhloridom). Text in Russian. Zh. Obshch. Khim., 41(9):1924-1925. 1971. 2 refs.

The reaction of tetraphenyl lead with bis-allyl palladium chloride was studied. It is a substitution reaction, which is catalyzed by Lewis-type acids (allyl palladium chloride in this case). The mechanism of the reaction is discussed. Most probably, the reaction of tetraphenyl lead with bis-allyl palladium chloride takes place in a complex and results in the dealkylation of tetraphenyl lead and the catalytic reduction of Pb(IV) to Pb(II). In the analysis of the reaction products, the following substances were found: benzene, diphenyl, allyl benzene, tetraphenyl lead, diallyl, and lead(II) chloride.

37213

Matsuura, Akira and Sadao Oomichi

**VARIATION OF CONCENTRATION BETWEEN SULFUR DIOXIDE AND PARTICLES.** (Nisanka io nodo no biryushi ni yoru henka). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 6(1):58, 1971. (Presented at the National Council Meeting of Air Pollution Studies, 12th, Nagoya, Japan, Oct. 27-29, 1971.)

For the purpose of investigating the effect of other pollutants in the atmosphere such as particulate metals on sulfur dioxide behavior, the effect of lead particles on SO2 concentration was measured. The experimental apparatus is described with a schematic diagram. The SO2 from a permeation tube and Pb particles from an electric furnace were led into a test chamber were both components were throughly mixed. The SO2 concentration was then determined by the West-Gaeke method. By the presence of various amount of Pb particles, the SO2 concentration was reduced to 66-48% of the original concentration.

39522

Konovalov, G. S., A. A. Ivanova, and T. Kh. Kolesnikova

**RARE AND DISPERSED ELEMENTS (MICROELEMENTS) IN THE WATER AND IN THE SUSPENDED SUBSTANCES IN RIVERS OF THE EUROPEAN TERRITORY OF USSR. (Redkiye i rasseyannyye elementy (microelementy) v vode i vo vzveshennykh veshchestvakh rek yevropeyskoy territorii SSSR). Gidrokhim. Materialy, vol. 42:94-111, 1966. 14 refs. Translated from Russian. 29p.**

Vanadium, manganese, cobalt, nickel, copper, zinc, molybdenum, silver, tin, lead, and bismuth concentrations were determined in river waters of the USSR, both in dissolved and suspended states. Water samples were filtered under vacuum in the laboratory. Suspended substances collected on the filter were dried, ground, and chemically prepared for spectral determination. Bismuth was not discovered in either dissolved or suspended form. Lead, tin, silver, and cobalt were found only in suspended substances, but not in all rivers. Other elements were distributed in the following increasing order of occurrence in dissolved form: V, Mn, Ni, Zn, and Cu.

39901

Hoare, D. E., A. D. Walsh, and Ting-Man Li

**THE OXIDATION OF TETRAMETHYL LEAD AND RELATED REACTIONS.** Combustion Inst., Pittsburgh, Pa., Symp. (Int.) Combust. (Proc.), 13th, Salt Lake City, Utah, 1970, p. 461-469. 19 refs. (Aug. 23-29.)

The reaction of pure tetramethyl lead (TML) with oxygen and reactions of lead monoxide with formaldehyde, methanol, carbon monoxide, and di-tert-butyl peroxide were studied at 330 C in a static system. The major products in the early stages of TML oxidation were carbon dioxide and hydrogen; methanol was a less important product, and methane a minor product. The overall reaction was nonchain; therefore it did not involve CH2Pb(CH3)3 radicals. It seems likely that the main reaction occurred via methyl radicals which were oxidized to methyl peroxy radicals at a rate consistent with that published by Barnard and Cohen. It appeared that hydrogen was adsorbed on the surface of lead monoxide, and it is postulated that reduction of peroxy and oxy radicals may have occurred. Nonchain propagation reactions for the formation of methanol and formaldehyde are therefore postulated. Formaldehyde was oxidized very rapidly on a lead monoxide surface to give the same products of carbon dioxide, and initially, smaller amounts of hydrogen, so it well may be an intermediate in the oxidation of TML. Carbon monoxide and methanol oxidized too slowly to be intermediates, and di-tert-butyl peroxide was unaffected in its decomposition by a surface of lead monoxide. Presumably methyl radicals do not react with the surface. The results show that lead monoxide, which is said to be an effective inhibitor of combustion by removal of peroxides, also may be effective by removal of formaldehyde, where formaldehyde is a degenerate branching intermediate, e.g., in high-temperature combustion. (Author abstract modified)

40387

Pollitzer, E. L.

**PLATINUM CATALYSTS IN LEAD-FREE GASOLINE PRODUCTION.** Platinum Metals Rev., 16(2):42-47, April 1972.

Processes applicable the manufacture of lead-free clear gasoline and the role of platinum catalysts in such a conversion are discussed. Since the octane number of the U. S. gasoline pool is about 89.5 Research Octane Number on a lead-free basis, it is obvious that a boost in octane will be required if there is a general conversion to lead-free gasoline. Catalytic reforming has been used to produce high octane blending components and, in a new approach to the problems of catalyst stability at high severities, a continuous Platformer has been designed and built. Catalyst is continuously withdrawn from the lowest reactor in the stacked configuration, continuously regenerated in an external system, and continuously returned to the lead reactor. However, the most publicized advance in the area of catalytic reforming concerns the development of a family of new reforming catalysts which contain a modifier in addition to platinum. The main characteristic of such catalysts is greatly improved temperature stability and, particularly, yield stability. The new reforming catalysts and catalytic reforming are discussed, as well as the proposal to upgrade some of the lower octane gasoline components instead of trying to overwhelm them by the addition of high octane Platformate. This approach will probably involve a number of different processes but it is more than likely that the first step will involve isomerization of pentanes and hexanes. Increased production of alkylate is considered.

41787

Shigeta, Tameyoshi and Tadato Yamamoto

**SENSITIVITY OF GASOLINE.** (Gasorin no sensitivity ni tsuite). Text in Japanese. Preprint, Ministry of International Trade and Industry (Japan), Public Nuisance Resources Research Inst., p. 24- 30, June 1972. (Presented at the Public Nuisance Resources Research Seminar, Tokyo, Japan, 1971.)

Japanese regulations require no-lead gasoline by 1974. The octane number must be 88 for regular gasoline and 95 for premium. No-lead gasoline causes problems such as valve recession, increased photochemical reactions, increased knocking, and increased olefin and aromatic hydrocarbons. The sensitivity of gasoline was measured as a function of iso-octane, n-heptane, and tetraethyl lead. As lead increases, sensitivity decreases. Sensitivity was measured as a function of n-heptane and toluene. As the toluene increases, the sensitivity increases. The sensitivity was measured as a function of the increase of lead; as lead increases the sensitivity decreases. The sensitivity of gasolines for 1969-1971 were measured and found to be increasing.

42772

Fujita, Minoru and Toshio Yamauchi

**DIRECT DETERMINATION OF LEAD IN GEAR OILS BY AN X-RAY FLUORESCENCE METHOD.** (Keiko xsen bunsekiho ni yoru giyayu-chu no namari no chokusetsu teiryo). Text in Japanese. Junkatsu (J. Japan Soc. Lubrication Engrs.), 17(6):29-33, June 1972. 12 refs.

By X-ray fluorescence analysis, the lead content in gear oils was directly determined by calibration curves. Concentration ranges of calibration curves were 0.5-2.0 wt % for industrial gear oil and 0.5-0.3 wt % for automobile gear oil. The accuracy of this analytical method was within 3%, expressed as standard deviation. The analytical results of the lead content in various gear oils by chemical analysis and the X-ray fluorescence method were nearly identical. No problems were encountered in applying the X-ray fluorescence method to industrial analysis; it could be replaced by the chemical analysis in the laboratory. The total time required to complete the analysis if it was necessary to remove the contaminated materials was two hours; without removal it was 10 min, so that a quick and automatic analysis was made satisfactorily. (Author abstract modified)

43245

Fong, Clifford W. and William Kitching

**SULFUR DIOXIDE INSERTION INTO CARBON-LEAD BONDS.** J. Organometal. Chem., 21(2):365-375, Feb. 1970. 20 refs.

The insertion of sulfur dioxide into a variety of carbon-lead systems was studied to establish rigorously the O- or S-sulfinato nature of the insertion product and the coordination about lead; provide data on relative rates and sites of insertion with various organic groups attached to lead; and demonstrate rearrangements accompanying the insertion. Spectroscopic and molecular weight data strongly suggested the presence of bridging (SO2) and essentially planar R-3Pb moieties. Relative rates of insertion into a number of differing R-Pb bonds were completely in line with an electrophilic cleavage description of the insertion process. Differences from and similarities with the behavior of analogous organotin systems were rationalized. (Author summary modified)

43436

Swaine, D. J. and R. L. Mitchell

**TRACE-ELEMENT DISTRIBUTION IN SOIL PROFILES.** J. Soil Sci., 11(2):347-368, 1960. 32 refs.

The contents of total and extractable trace elements present in Scottish soil profiles are primarily related to the geological parent material from which the soils were derived. Little or no effect within the profile attributable to pedeological factors has been observed in the total contents. The most marked effect on the contents of extractable trace elements, notably cobalt, nickel, copper, manganese, molybdenum, zinc, and lead, is their increased mobilization in conditions of restricted drainage. Very high extractable amounts occur in gleyed horizons of very poorly drained soils. No marked accumulation of trace elements has been observed in the iron pan or illuvial horizons of podzolized profiles. Higher contents of acetic-acid-extractable aluminum occur in soil with unrestricted drainage, the amounts present being of the same order as the exchangeable-calcium contents. Several tables are included showing the distribution of trace elements in Scottish soil profiles. (Author summary modified)

44032

Rao, V. Kuppu and C. R. Prasad

**KNOCK SUPPRESSION IN PETROL ENGINES.** Combustion Flame, 18(2): 167-172, April 1972. 25 refs.

Some experiments are described which establish beyond doubt that lead monoxide particles in the solid phase can suppress knock in gasoline engines by a heterogeneous reaction mechanism. The effectiveness of tetraethyl lead can be completely accounted for if some of the tetraethyl lead that decomposes forms lead monoxide particles before the reactions leading to knock occur in the end gas. This is indicated by a comparison of the total surface area furnished by the lead monoxide particles thus formed, with the total surface area of lead monoxide powder directly supplied for achieving similar knock suppression. Many other lead compounds exerted antiknock effects in the solid phase to varying degrees. The antiknock effects of different compounds followed the same trend as their inhibitive effects on hydrocarbon oxidation reactions in low pressure reaction vessels. The total surface area of the inhibiting compound is the chief criterion that decides its effectiveness rather than the weight of lead it contains. (Author abstract modified)

44164

Finelli, Vincent N., Edward E. Menden, and Harol G. Petering

**ISOLATION OF METAL-BINDING FRACTIONS FROM TOBACCO SMOKE CONDENSATE.** Environ. Sci. Technol., 6(8):740-742, Aug. 1972. 13 refs.

Tobacco smoke condensate (TSC) from nonfilter research cigarettes was fractionated on a weak cation exchange column (carboxymethyl cellulose in the Cu(II) form), yielding three fractions: noncomplexing substances, protonated copper-binding ligands, and nonprotonated copper-binding ligands. Analysis for copper was done by atomic absorption spectrometry and showed the amount of complexed copper in the protonated ligand fraction to be 271 + or - 42 micrograms/cigarette and in the nonprotonated ligand fraction to be 720 + or - 59 micrograms/cigarette. Several known protonated and nonprotonated ligands were also fractionated on the cation exchanger, and their behavior was compared to that of the TSC fractions. The cation exchanger was also used in the zinc, cadmium, iron(III), and lead forms to determine the binding activity of whole TSC solutions toward these metals. Results, expressed in micromoles of metal/cigarette, were copper, 14.6; zinc, 12.8; cadmium, 8.3; iron, 0.5; and lead, 0.5. (Author abstract modified)

44332

Seeley, J. L., D. Dick, J. H. Arvik, R. L. Zimdahl, and R. K. Skogerboe

**DETERMINATION OF LEAD IN SOIL.** Appl. Spectry., 26(4):456-460, July/Aug. 1972. 12 refs.

The analytical determination of lead in soil is discussed with particular reference to emission spectrographic and atomic absorption spectrophotometric methods. The problems associated with the two techniques are discussed, and accuracy and precision data are presented. Data indicating that the titanium-to-lead concentration ratio can be used to differentiate between lead- contaminated and noncontaminated soils are presented. To check the possible use of titanium as a contamination reference, the emission spectrometric photo plates accumulated in the analysis of soil samples were used to determine the intensity ratio I-lead(2633)/ I-titanium(2942), and this was correlated with the lead concentration determined for each sample. Samples from three different locations were collected. The correlation coefficient calculated for the data obtained is 0.97. If the titanium concentration is constant over the sampling domain at a particular location, the lead-to-titanium intensity ratio should be a constant for those samples which are not contaminated with lead from non-natural sources, i.e., an analysis correlating the intensity ratio with the lead concentration of noncontaminated samples should show no correlation. There is no correlation, and the titanium ratio can be used to determine which samples represent the natural lead concentration in the soil. Since it was proved that the titanium ratio method produces the same result as the previous statistical analysis, it is appropriate to consider the potential universality of this approach. Application of the indicator element approach to other types of systems will require that other criteria dependent on the system in question be satisfied to validate the technique.

45295

Bratzel, M. P., Jr. and C. L. Chakrabarti

**DETERMINATION OF LEAD IN PETROLEUM AND PETROLEUM PRODUCTS BY ATOMIC ABSORPTION SPECTROMETRY WITH A CARBON ROD ATOMIZER.** Anal. Chim. Acta, 61(1):25-26, Aug. 1972. 22 refs.

The atomic absorption spectrometer and the carbon rod unit were used to measure lead in petroleum and petroleum products. Radiation was detected with a R-106 response phototube, and the slit width was 0.100 mm, corresponding to a spectral bandpass of 0.33 nm. Lead was extracted into a known volume of 40% of nitric acid. Then the effects of the hydrogen diffusion flame, the solvent type, the chemical nature of the lead compound on the sensitivity of the lead signal, and a comparison of the sensitivity of the two lead lines at 217.00 nm and at 283.31 nm were studied. The hydrogen diffusion flame, the solvent type, and the chemical nature of the lead compounds used, had no effect on the sensitivity at either wavelength. However, the use of the hydrogen diffusion flame is recommended because it prolongs the life of the carbon rods by preventing atmospheric oxygen from burning the rods. Any standard lead compounds and solvents xylene, methyl isobutyl ketone, and 40% nitic acid can be used for the construction of analytical working curves. Although the 217.00-nm line exhibits greater sensitivity than the 283.31-nm line, the greater noise at the former wavelength precludes its use with very low concentrations of lead. The noise at 283.31 nm was about nine times less than at 217.00 nm; the greater noise was mainly the result of the increased photomultiplier voltage required to detect the signal at the lower wavelength. The detection limit for lead at 283.31 nm with the carbon rod atomizer was 2 times 10 to the -12th power g (absolute).

# G. EFFECTS-HUMAN HEALTH

00020

J. R. Goldsmith and L. H. Rogers

**HEALTH HAZARDS OF AUTOMOBILE EXHAUST.** Public Health Rept., 74(6):551-558, June 1959.

Of the substances which occur in automobile exhaust and their reaction products, hygienic standards have been established for industrial exposure to carbon monoxide, nitrogen dioxide, lead, and ozone. Establishing a full set of levels for community exposures to these substances is very difficult because of the sensitivity of frail or ill individuals, the indeterminate period of exposure, the effect of agents in combination, and the cumulative effect of exposure from other sources, such as cigarette smoking. The hazard of automobile exhaust to the population of a large community will depend, among other things, on the extent and way that vehicles are used, and the meteorology of the area. In the absence of effective control for air pollution from automobile exhaust, the public health hazard should be evaluated. (Author)

00076

**SURVEY OF LEAD IN THE ATMOSPHERE OF THREE URBAN COMMUNITIES.** Public Health Service, Cincinnati, Ohio, Division of Air Pollution. (999-AP-12.) Jan. 1965. 97pp. HEW: 999-AP-12

A study of the concentrations of lead in the atmospheres of Cincinnati, Los Angeles, and Philadelphia was conducted jointly by industrial, State, Federal, and university groups during the period June 1961 through May 1962. In each city, from four to eight sampling stations, representing four geographical and land- use classifications (rural, residential, commercial, and industrial) were operated continuously with membrane filter samplers. In addition, at one station of each classification in each city, diurnal variations were investigated by use of sequential tape samplers. In each city samples of blood and urine were obtained from selected groups of residents and examined for concentrations of lead. All samples were analyzed by the dithizone method. Approximately 3,400 samples of particulate lead from the atmosphere were obtained, and the concentrations of lead in blood of approximately 2,300 individuals and of lead in urine of 1,700 males were determined. Details of the study and the results obtained are reported. (Author)

00148

R. F. Lutmer, K. A. Busch, and R. G. Miller

**LEAD FROM AUTO EXHAUST: EFFECT ON MOUSE BONE LEAD CONCENTRATION.** Atmospheric Environ. 1, 585-9 (1967).

Mice exposed for 15 months to low levels of nonirradiated auto exhaust in a cyclic diurnal pattern contained more lead in their bones than corresponding groups exposed to equal or slightly lower concentrations of irradiated auto exhaust even though the daily average-atmospheric-lead concentrations were about the same in both atmospheres. Bone-lead concentrations in mice exposed to irradiated auto exhaust were not significantly higher than those in control-air animals until the 24-hr. average-atmospheric-lead concentrations exceeded 9.6 microgram Pb/cubic meter, but mice exposed to as little as 2.6 microgram Pb/cubic meter of nonirradiated exhaust had bone-lead concentrations higher than the control mice. (Author)

00177

H. Buchberg, M. H. Jones, K. G. Lindh, and K. W. Wilson

**AIR POLLUTION STUDIES WITH SIMULATED ATMOSPHERES.** California Univ., Los Angeles, Dept. of Engineering. (Rept. No. 61-44.) July 1961. 185 pp.

Part I of this report deals with the statistical relations among interacting atmospheric variables. Also contained in this report are the results of several auxiliary or supporting studies as follows: Air Purification Studies; Development of an Eye Mask for the Measurement of the Threshold of Eye Irritation; Development of an Omnidirectional Solar Radiometer for a Limited Spectral Region Centered about 0.36 microns; A Comparison of Concentration and Duration as Measures of Threshold for Eye Irritation; A Comparison of Threshold to Eye Irritation Resulting from Reacted Air Mixtures Sampled at Different Points in the Exposure System; A Comparison of Odor Threshold and Eye Irritation Threshold for Formaldehyde, Acrolein, and Ozone. (Author)

00375

R. A. Prindle

**AIR POLLUTION AND COMMUNITY HEALTH (CHAPTER EIGHTEEN).** Medical Climatology 505-18, 1964.

In this chapter author reviews major pollution episodes which have occurred since 1930 in various parts of the world. These episodes have demonstrated the danger and the lethality that may result when certain meteorologic phenomena occur in geographical areas where potentially high concentrations of air pollutants may form. Certain pollutants that might be tolerated in low concentrations in some inhabited areas might become dangerous when mixed with pollutants from other sources that could exert an accentuating or synergistic action. SO2, particulates, CO, beryllium, lead, fluoride, photochemical, and allergenic pollutants and their effect on man and animals are discussed. The most important animal experiments as well as other research are reviewed.

00473

F.G. Hueter, G.L. Contner, K.A. Busch, R.G. Hinners

**BIOLOGICAL EFFECTS OF ATMOSPHERES CONTAMINATED BY AUTO EXHAUST.** Arch. Environ. Health 12, 553-60, May 1966. (Presented at the 58th Annual Meeting, Air Pollution Control Association, Toronto, Canada, June 20-24, 1965.)

This report represents a status summary of the biological results obtained from the chronic exposures of experimental animals to various concentrations of irradiated and nonirradiated auto exhaust for periods of 6 weeks to 23 months. The chronic exposure of experimental animals to various concentrations of irradiated and nonirradiated auto exhaust-air mixtures resulted in significant biological effects indicating the

following: irradiated auto exhaust (1) increases the susceptibility to pulmonary infection and chronic disease during the latter half of the animal's lifetime, and (2) markedly decreases mouse fertility and decreases the survival rate of infant mice; both raw and irradiated auto exhaust cause a stress and adaptation response in mice as measured via spontaneous activity, increase bone lead concentrations, and increase the amount of nonfunctional or abnormal lung tissue. No experimental atmospheric effects were observed concerning: mortality; histopathology; growth- bodyweight; immunology; hematology restricted to erythrocyte count, erythrocyte cell size distribution, hematocrit or hemoglobin concentration; blood O2 and CO2 values; oxygen consumption; or pulmonary function in relation to permanent impairment. Further studies are indicated to elucidate more fully the affected biologic parameters.

00597

E.J. Catcott, R.G. Keenan, C. Xintaras, and D. H. Hofreuter

**THE PUBLIC HEALTH SIGNIFICANCE OF ATMOSPHERIC LEAD.** Arch. Environ. Health 3, 82-8, Nov. 1961.

Approximately 1,000 human blood samples and 250 urine specimens were collected and analyzed for lead content during the past year. The samples were obtained in 6 major cities and 1 rural area in the United States. The analyses for lead were done at one U.S. Public Health Service laboratory employing the U.S.P.H.S. Method for Lead. Data from the subjects were grouped to provide comparison of the lead levels on the basis of geographic location, sex, occupational exposure to lead, age, and smoking habits. Highly significant differences were observed when blood lead concentrations were compared for urban and rural groups and for smokers and non-smokers. Higher blood and urine lead levels also were detected consistently among workmen exposed to unusual quantities of vehicular exhaust in their customary working environment. Finally, these surveys demonstrated the existence of significantly higher blood levels among men than among women, none of whom were occupationally exposed to lead. Although significant differences were found between various classifications, the mean values for each group were within the recognized normal range of lead concentrations. Not a single value exceeded the accepted high normal limit of 0.07 mg. per 100 gm. of whole blood. The data reported are offered as an approximation of the blood and urine lead levels associated with current urban and rural living in the United States. The results of these surveys tend to support previous reports concerning the human body's lead concentrations. It is hoped that the information collected will provide a useful basis for comparison when studies are undertaken in the future. (Authors' abstract)

00642

C. C. Patterson

**CONTAMINATED AND NATURAL LEAD ENVIRONMENTS OF MAN.** Arch. Environ. Health Vol 11:344-360, Sept. 1965.

There are definite indications that residents of the United States today are undergoing severe chronic lead insult. The average American ingests some 400 micrograms of lead per day in food, air and water, a process which has been viewed with complacency for decades. Geochemical relationships and material balance considerations show that this ingestion of about 20 tons of lead per year on a national basis is grossly excessive compared to natural conditions. It probably originates from the 1 million tons of lead dispersed yearly in such forms as lead alkyls, lead arsenates, and food can solder, and from the many millions of tons of lead accumulated throughout past decades and stored as paints, alloys, piping, glazes, and spent ammunition. Existing rates of lead absorption are about 30 times higher than inferred natural rates, yielding body burdens of about 200 mg Pb/70 kg body, and blood concentrations of 0.25 ppm Pb, which values are about 100 times above inferred natural levels of 2 mg Pb/70 kg body and 0.0025 ppm Pb in blood. Existing blood lead concentrations have for decades been regarded as natural, although it is well known that the average value lies only slightly below threshold levels for classical lead poisoning which are 0.5 to 0.8 ppm Pb. It appears that the following activities deserve serious consideration and support: defining natural and toxic lead levels with greater care than in the past; investigating deleterious effects of severe chronic lead insult; investigating the dispersion of industrial lead into food chains; elimination of some of the most serious sources of lead pollution, such as lead alkyls, insecticides, food can solder, water service pipes, kitchenware glazes, and paints; and a reevaluation by persons in positions of responsibility in the field of public health of their role in this matter. (Author summary)

00662

R. E. Nusbaum, E.M. Butt, T.C. Gilmour, S.L. DiDio

**RELATION OF AIR POLLUTANTS TO TRACE METALS IN BONE.** Arch. Environ. Health Vol. 10(2):227-232, b8feb. 1965. (Presented at the Seventh Annual Air Pollution Medical Research Conference, Los Angeles, Calif., Feb. 10-11, 1964.)

Calvarium and rib samples from each of 175 autopsy cases from Los Angeles County Hospital were analyzed for 14 elements; mean values were determined. Relatively complete histories were obtained for 65 of the cases and results of analyses of these have been studied in some detail. For the latter group there was no correlation between lead concentration and length of time lived in Los Angeles area. Also, there was little or no correlation between lead concentration and age. Lead concentrations for males were higher than those for females; the difference between the means was significant at the 99% level. Males who smoked had more lead in the rib and lung than female smokers and men who did not smoke. Histories are given for five patients who showed extreme lead levels. (Author summary)

00705

**LEAD ABSORPTION AND LEAD POISONING.** Lancet 1(7450):1307-8, June 11, 1966

There is a strong need for a clear distinction between the diagnosis of lead poisoning and the measurement of lead absorption. Further study of patients with poisoning should lead to improved diagnosis. An improved measurement of lead absorption should be expected from a study of the biological indices in exposed groups where the level of absorption is known with some accuracy.

00708

**DETECTION OF INDUSTRIAL LEAD POISONING.** Lancet, 1(7430):191- 192, Jan 22, 1966.

A range of tests to establish a diagnosis of lead poisoning in the absence of classical symptoms and signs is described. More refined screening methods than those now used are required for proper medical care of men exposed to a risk of lead absorption. Due to general atmospheric contamination with lead, the average concentration of lead in blood (for a resident of the U.S.) is 0.25 ppm, compared with a threshold limit of 0.8 ppm. Chemical tests of individuals not industrially exposed, as well as environmental measurement of lead, are recommended.

00736

S. Miano

**THE PROBLEM OF LEAD POISONING IN CHILDREN.** J. Environ. Health, 27(6):913-916, June 1965.

Causes and symptoms of lead poisoning in children are discussed. The experience of the City of Philadelphia, where a legal requirement for reporting lead poisoning has been in effect since 1950, is described. There is a high ratio of cases in the lower socio-economic group. The preventive role of the sanitarian, legislation, an educational program, and research are all needed to cope with the problem.

00740

G.W. Schucker, E. H. Vail, E.B. Kelley, E. Kaplan

**PREVENTION OF LEAD PAINT POISONING AMONG BALTIMORE CHILDREN.** Public Health Rept. (U.S.), 80(11):969-983, Nov. 1965.

An intensive 'hard sell' program was conducted in Baltimore during 1952 through 1964 to prevent lead paint poisoning in three census tracts of the city. The primary emphasis was on home visits by a sanitarian and personal communication with the person caring for the child. It was impossible to demonstrate statistically that the program reversed the trends either of clinically diagnosed plumbism or abnormal absorption of lead in children under 4 years of age. During the 3-year program, the average annual rate of diagnosed lead poisoning and elevated blood-lead levels among children under 4 years of age was 4.5 per 1,000 in the study area and 5.4 in the control area. During the preceding 3-year period, the average annual rate had been 7.4 in the study area and 10.4 in the control area. The limited success of the hardsell program apparently would not justify its citywide expansion with relatively costly professional personnel on a full-time basis for home instruction. (Authors' summary)

00808

H.A. Waldron

**THE ANAEMIA OF LEAD POISONING: A REVIEW.** Brit. J. Ind. Med. (London) 23, (2) 83-97, Apr. 1966.

There is no single factor responsible for the production of the anaemia of lead poisoning. Much of the evidence which has been put forward to show that the anaemia is haemolytic in character is equivocal, although there can be no doubt that high concentrations of lead can produce morphological changes in mature circulating red cells both in vitro and in vivo. On the other hand, threre seems no doubt that lead has a profound effect on red cell precursors in the bone marrow, producing morphological changes and also causing defective haemoglobinization by inhibiting haem synthesis, and any changes induced in the peripheral red cells may be the results of this primary action on erythroblastic cells in the marrow. The precise cause of the anaemia of lead poisoning is still not known, but, in the author's opinion, the answer is likely to be found in the effect of lead on a complex of enzymes, both those responsible for haem synthesis and those concerned with glycolysis. (Author's abstract)

00810

M.K. Williams

**BLOOD LEAD AND HAEMOGLOBIN IN LEAD ABSORPTION.** Brit. J. Ind. Med. (London) 23, (2) 105-11, Apr. 1966.

In an analysis of blood lead and haemoglobin estimations from 655 lead workers, there was no indication of any change in the haemoglobin until the blood lead exceeded 110 micrograms/100 ml.; the slight fall at higher levels of blood lead was not significant at the 5% level of confidence. Sixty-seven men who had blood leads greater than 90 micrograms/100 ml. were examined clinically. One had a low haemoglobin but none had symptoms or signs that were likely to be due to lead absorption. A further 18 men had haemoglobins of 89% (13 g./100 ml.) or less. None was thought to be low due to lead absorption. The absence of symptoms, signs, and low haemoglobins in association with relatively high blood leads is unlikely to be due to errors in blood lead or haemoglobin estimation. Alternative possibilities are that there were no susceptible workers among those studied; or that the stable conditions of exposure in this population allowed the development of relatively high blood leads without other evidence of high lead absorption. It is concluded that in a population where sophisticated lead control is practiced no purpose is served by estimating haemoglobins in all lead workers every three months, but only in those whose blood lead is likely to be in excess of 110 micrograms/100 ml. (Author summary)

00821

K. Cramer S. Selander

**STUDIES IN LEAD POISONING.** Brit. J. Ind. Med. (London) 22, (4) 311-4, Oct. 1965.

The urinary output of sigma-aminolaevulic acid (ALA), coproporphyrins, and lead in 15 lead-intoxicated workers was determined and correlated with the amount of lead excreted after treatment with a total dosage of 9 g. penicillamine. Weak correlations were found between therapeutically excreted lead and initial values for lead and coproporphyrin in urine. In contrast the intitial values for ALA correlate very closely. It is concluded that determinations of the output of ALA are to be preferred in the evaluation of lead intoxication and that they point directly to the amount of metabolically active lead in the organism. (Author summary)

00873

E.S. Ferri E.J. Baratta

**POLONIUM 210 IN TOBACCO, CIGARETTE SMOKE, AND SELECTED HUMAN ORGANS.** Public Health Rept. (U.S.) 81(2):121-127, Feb. 1966.

The polonium 210 in tobacco may be implicated in the origin of lung cancer. Speculation on this possibility promoted a study at the Northeastern Radiological Health Laboratory, Public Health Service, to determine the levels of polonium 210 in several brands of cigarettes. The levels of lead 210 and radium 226 were also measured to determine whether the polonium 210 was in equilibrium with these precursors or was present independently. Samples of human organs were also analyzed for polonium 210 content to determine whether a difference could be detected in the concentration of this radionuclide between smokers and nonsmokers. Polonium 210 and associated radionuclides lead 210 and bismuth 210 were found to be present in tobacco. Considerably smaller quantities of radium 226 were also found. Tests indicated that lead 210 is deposited in the tobacco independently of radium 226 and its daughter bismuth 210. For the various brands tested, the activities of polonium 210 in the total cigarette were of about the same level with one exception: the cellulose plus charcoal brand was 30% higher than the average of all brands. Because polonium 210 is volatile at the temperature of burning tobacco and subsequently is inhaled in the smoke, a smoking machine was devised for determining amounts inhaled from various brands. To determine the feasibility of studying the distribution of polonium 210 in selected tissues and organs of the human body, random specimens of lung, liver, kidney, heart, and psoas muscle were obtained from smokers and non-

smokers. Tests indicated higher levels of polonium 210 in the organs of smokers. (Author summary)

00902

S. Mehani

**LEAD RETENTION BY THE LUNGS OF LEAD-EXPOSED WORKERS.** Ann. Occupational Hyg. (London), Vol. 9:165-171, July 1966.

A study has been made of the retention of lead dust and fumes by the lungs of 51 lead workers, 22 shipburners, and 25 control subjects. It was found that 39-47 wt-% of the inspired lead is retained in the lungs of lead-exposed workers, and in this group, the average ventilation under various working conditions is approximately 10 cu m per 8 hr shift. It is concluded that at an atmospheric concentration of lead of 2 mg per 10 cu m of air, the working conditions are within safe limits, as the amount of lead retained per shift is less than one half the amount which can be tolerated by man without producing evidence of ill-health. It was also found that the degree of lead retention was not associated with the depth of breathing. The present findings, and those of previous authors, and the various factors which affect dust retention are discussed. (Author summary)

00993

A.J. DeKrester H.A. Waldron

**FURTHER OBSERVATIONS ON THE MECHANICAL FRAGILITY OF THE RED CELL IN LEAD POISONING.** Brit. J. Ind. Med., Vol. 22:315-316, 1965.

Further experiments on the effects of lead on the mechanical fragility of the red cell confirm previous findings, that lead does not increase the mechanical fragility index of the red cell at the blood lead levels found in clinical plumbism (i.e. lead poisoning). Above these levels lead does increase the mechanical fragility index, reaching its maximum effect at about 50 micrograms of lead/ml. blood. (Author abstract)

01341

J. E. Cremer

**TOXICOLOGY AND BIOCHEMISTRY OF ALKYL LEAD COMPOUNDS.** Occupational Health Rev. (Ottawa), 17(3):14-19, 1965.

The two organo-lead compounds used on a large commercial scale are tetraethyl lead and tetramethyl lead. Each is used as an antiknock additive to motor fuels. Although the conditions of working and the precautions taken by men handling these two compounds are normally sufficient to exclude dangers of intoxication, cases of poisoning by tetraethyl lead have been reported in the literature. The author describes the symptomatology, experimental poisoning in laboratory animals and biochemical studies on the mechanism of action of the two tetraalkyl lead compounds together with similar studies on trimethyl and triethyl lead. The toxicity of the tetraalkyl leads is almost certainly due to their conversion in the body to the corresponding trialkyl lead derivatives which have a dominant action on the central nervous system. (Author abstract)

01500

N. Castellino, P. Lamanna, and B. Grieco

**BILIARY EXCRETION OF LEAD IN THE RAT.** Brit. J. Ind. Med. (London), 23(3):237-239, July 1966.

Studies have been made in the rat of the elimination of 210 Pb, in the bile after the intravenous injection of 100 micrograms of lead. Four groups of rats were used, in 2 the bile was drained by cannulation of the bile duct, and in the other 2 the bile flow to the duodenum was interrupted by ligation or division of the bile duct. The radioactivity of the bile, of the intestinal walls, and of the intestinal contents and feces was determined. The results showed that lead is eliminated from the liver mainly by the bile, thus excluding passage through the intestinal walls into the feces as important under these conditions. (Author abstract)

01512

H. Oyanguren and E. Perez

**POISONING OF INDUSTRIAL ORIGIN IN A COMMUNITY.** Arch. Environ. Health, Vol. 13:185-189, Aug. 1966.

Various types of poisoning of industrial origin which have occurred in the neighborhood of industrial plants, smelters, or factories are discussed. This paper presents certain Chilean experiences in the last decade in connection with 2 types of poisoning, arsenic and lead. Serious cases of lead poisoning in children are described.

01731

H. A. Schroeder, W. H. Vinton, Jr., and J. J. Balassa

**EFFECT OF CHROMIUM, CADMIUM AND OTHER TRACE METALS ON THE GROWTH AND SURVIVAL OF MICE.** J. Nutr. 80, (1) 39-47, May 1963.

Seven hundred weanling white mice were fed a diet of rye, corn oil and dried skim milk containing no detectable cadmium and only small amounts of chromium, titanium, lead and nickel. They were housed in quarters from which most contaminating metals were excluded. Groups of 100 or more animals were given 5 ppm of these metals in drinking water as soluble salts. Trivalent chromium increased the growth of both sexes and lessened the mortality of male animals up to 17 months of age. Tetravalent titanium increased growth, but did not significantly affect mortality. Divalent lead, nickel and cadmium had no marked effect on growth, mature weights nor mortalities up to 18 months of age, but after that, cadmium and lead significantly increased death rates in males when tissue levels were less than or equal to those of adult human beings. Mice 'cadmium-free' by microanalytical methods (less than 0.02 micro/g, wet tissue) grew normally and did not differ in any obvious way from those given the metal, except for prolonged survival of males. Chromium appears to act as an accessory trace metal for growth and survival while cadmium is not essential in these terms, having an innate 'toxicity' similar lead. (Author abstract)

01754

J. Greengard

**LEAD POISONING IN CHILDHOOD: SIGNS, SYMPTOMS, CURRENT THERAPY, CLINICAL EXPRESSIONS.** Clin. Pedriatr. (Philadelphia) 5, (5) 269-76, May 1966.

This paper is a review specifically of 182 cases of lead encephalopathy treated at Chicago's Cook County Hospital; it also includes a general discussion based on 25 references of various phases of the problem of lead poisoning. Etiology (usually from ingested plaster and paint in slum housing), diagnosis, treatment, and complications are reviewed. Emphasis is placed on treatment of the more severe cases which result in lead encephalopathy. Prevention by removal of lead sources was considered as obviously the best treatment, but difficult to put in practice because of the slum housing areas prevalent in the urban neighborhood.

01755

H. Jacobziner

**LEAD POISONING IN CHILDHOOD: EPIDEMIOLOGY MANIFESTATIONS, AND PREVENTION.** Clin. Pediatr. (Philadelphia) 5, (5) 277-86, May 1966.

The epidemiology of lead poisoning in New York City is reviewed. Most cases seem to occur as a result of ingestion of old lead containing paint in sub-standard housing, particularly in children under 7 with a history of pica. Death occurs in 15-20% of cases and neurologic symptoms in 25% of survivors. The most useful diagnostic indication is a lead concentration of 0.06 mg/ml whole blood. Although ingestion of lead paint is the most frequent source of poisoning, inhalation of lead also occurs. The increased incidence of lead encephalopathy in the summer time is tentatively ascribed to increased absorption through the mediation of ultra violet radiation. The program of the New 0ork City Department of Health in isolating, treating and preventing lead poisoning is described.

01756

E. Berman

**THE BIOCHEMISTRY OF LEAD: REVIEW OF THE BODY DISTRIBUTION AND METHODS OF LEAD DETERMINATION.** Clin. Pediatr. (Philadelphia) 5, (5) 287-91, May 1966.

Routes of lead absorption, tissue distribution, blood lead levels and methods of lead analysis are discussed. Although lead is ingested orally in most cases of childhood lead poisoning, inhalation of lead is the route of absorption in most industrial and a few children's poisonings. Absorption from the respiratory tract is more rapid and complete than from the gastro-intestinal tract. Lead passes from early concentration in liver and kidney to deposition in the bone. Blood lead levels are of diagnostic value only in acute cases, since the blood is rapidly cleared of lead; urine levels should also be determined. The author used atomic absorption spectrometry in the detection of lead in blood and urine samples; the method required only 1-1/2 hours, and could detect less than 0.2 ppm in an aqueous solution. Analyses made during BAL-versenate therapy showed an increase in lead excretion, then a gradual decrease as the bound lead was excreted.

01757

M. A. Perlstein and R. Attala

**NEUROLOGIC SEQUELAE OF PLUMBISM IN CHILDREN.** Clin. Pediatr. (Philadelphia) 5, (5) 292-8, May 1966.

Cases of lead poisoning in 425 children are reviewed, with emphasis placed on permanent nerve damage. Although most cases resulted from ingestion of old painted plaster, the burning of battery casings was responsible for poisoning by inhalation in 17 cases. In 61% of the cases, recovery was complete. The main sequelae were mental retardation, (occurring in 22% of the total series) recurrent seizures, (20%), cerebral palsy (2%) and optic atrophy (1%). The most severe cases, those with encephalopathic onset of symptoms, were also those in which sequelae were most frequent. In the largest group of patients, presenting with gastro-intestinal symptoms, sequelae were relatively infrequent. Three case histories are given in detail.

01797

F.W. Sunderman, Jr.

**STUDIES OF NICKEL CARCINOGENESIS: ALTERATIONS OF RIBONUCLEIC ACID FOLLOWING INHALATION OF NICKEL CARBONYL.** Am. J. Clin. Pathol. 39, (6) 549-61, June 1963. (Presented at the American Society of Clinical Pathologists Meeting, Chicago Ill., Sept. 5, 1962.)

Measurements were undertaken of nickel and other trace metals in ribounucleic acid (RNA) from tissues of normal rats and of rats exposed to nickel carbonyl. An ultraviolet spectrophotometric method was devised for the determination of nickel in samples of RNA containing as little as 0.4 microgram of nickel. Measurements of chromium, manganese, lead, tin, and zinc in RNA were made by means of emission spectrography. Rat lung RNA was found to be rich in trace metals and to contain nickel, chromium, manganese, lead, tin, and zinc in quantities that exceed those present in RNA from rat liver, kidney, and skeletal muscle. Acute exposure of rats to nickel carbonyl resulted in an incrase in the concentration of nickel in NaCl-precipitable lung RNA and a decrease in the concentration of nickel in NaCl-soluble lung RNA. The concentration of nickelin NaCl-precipitable liver RNA increased following exposure of rats to nickel carbonyl, whereas that in NaCl-soluble liver RNA was not significantly altered. Following inhalation of nickel carbonyl, changes that were consistent with an increase in metal-bonding were observed in the phase-transition curves of NaCl-precipitable RNA from liver and lung. The change that was observed in the phase- transition curbe of NaCl-soluble lung RNA was consistent with disruption of hydrogen bonds. (Author summary)

01812

M.P. Westerman, E. Pfitzer, L.D. Ellis, W.N. Jensen

**CONCENTRATIONS OF LEAD IN BONE IN PLUMBISM.** New Engl. J. Med. 273, (23) 1246-50, Dec. 2, 1965.

The relation between lead concentrations in bone marrow, blood and urine and provocative chelation testing is evaluated in a group of workers exposed to lead. One patient with severe clinical plumbism was observed for three years. The observations suggested that determinations of lead in the bone marrow may be a useful aid in the evaluation and management of patients with plumbism or exposure to lead. (Author summary)

01923

H.A. Schroeder, J.J. Balassa, W.H. Vinton, Jr.

**CHROMIUM, CADMIUM AND LEAD IN RATS: EFFECTS ON LIFE SPAN, TUMORS AND TISSUE LEVELS.** J. Nutr. 86, (1) 51-66, May 1965.

Groups of 50 or more Long Evans rats in a low metal environment and fed a diet devoid of cadmium and low in many trace metals were given 5 ppm chromium (III), cadmium or lead in drinking water from weaning until death. Life span was shortened in those fed lead and cadmium; tissue concentrations were within human ranges. Longevity of the last 10% was increased in those fed chromium; tissue concentrations wre within ranges of young human beings, and females resisted an epidemic of pneumonia. Rats fed lead had fewer tumors than control or other groups. Arteriolar sclerosis in kidneys and ventricular hypertrophy occurred largely in cadmium-fed animals; cirrhosis of the liver in all groups. Organs of control were cadmium-free; the metal occurred in animals from another laboratory. Cadmium did not accumulate in kidneys at older ages. Older rats fed lead showed less in organs than younger ones. Chromium did not accumulate in tissues. Extension of life span by restriction of food was reproduced by restriction of lead and cadmium and feeding of chromium. Results indicate that lead and cadmium at human tissue concentrations are toxic to rats in terms of life span and longevity, whereas chromium (III) is not. (Author abstract)

02191

R. W. Ellis

**URINARY SCREENING TESTS TO DETECT EXCESSIVE LEAD ABSORPTION.** Rrit. J. Ind. Med. (London), 23, (4) 263-81, Oct. 1966.

The biological variation encountered in spot urine samples was assessed by collecting 6 sets of serial urine specimens from 5 men. The lead, coproporphyrin, and creatinine contents of each specimen were determined and the specific gravity was measured. By measuring the group av. lead and coproporphyrin excretions at regular intervals the lead hazard can be monitored with a reasonable degree of accuracy. It is valid to compare the daily excretion levels of men working under different conditions. Unless they are considered collectively, the results of single spot specimens are too variable to indicate the excretion levels of the metabolites. The urinary concentrations of lead and coproporphyrin, of people in comparable environmental conditions, reflect the lead absorption.

02202

S. Selander, K. Cramer, L. Hallberg

**STUDIES IN LEAD POISONING.** Oral Therapy with Penicillamine. Relationship between Lead in Blood and other Laboratory Tests. Brit. J. Ind. Med. (London) 23, (4) 282-91, Oct. 1966.

Fifteen workers with lead poisoning of varying degrees were treated with penicillamine given by mouth. The effect on symptoms and pathological laboratory values was satisfactory, side effects were generally mild and the drug is considered to be good alternative to Ca-EDTA, which must be given intravenously. Previous studies on the reliability of different laboratory tests in evaluating the degree of lead poisoning and the effect of the theraphy were extended with special respect to the lead levels in blood. The correlations between lead in blood and lead in urine, coproporphyrins in urine and lead excreted during treatment were of the same order as those found between delta-aminolavulic acid (ALA) in urine and the same parameters. As could be expected, the correlation between the initial values of lead in blood and ALA in urine was very strong (P-0.001). It also persisted during treatment. It is concluded that penicillamine is efficient and useful in the treatment of lead poisoning. Determinations of lead in blood and ALA in urine are equivalent as expressions of lead poisoning, provided that the lead level in blood is not temporarily raised because of an acute exposure. (Author abstract)

03086

P. Stocks

**ON THE RELATIONS BETWEEN ATMOSPHERIC POLLUTION IN URBAN AND RURAL LOCALITIES AND MORTALITY FROM CANCER, BRONCHITIS AND PNEUMONIA, WITH PARTICULAR REFERENCE TO 3:4 BENZOPYRENE, BERYLLIUM, MOLYBDENUM, VANADIUM AND ARSENIC.** Brit. J. Cancer (London) 14, 397-418, 1960

of polycyclic hydrocarbons and a statistical process of Lung cancer mortality is strongly correlated with smoke density in the atmosphere in Northern England and Wales. In 26 localities the smoke samples were analysed in respect successive elimination was applied to discover which hydrocarbon was responsible for the smoke correlation with mortality rates. For lung cancer and bronchitis 3:4 benzopyrene emerges clearly as the substance of prime importance, with 1:12 benzoperylene contributing weakly for lung cancer, but for pneumonia 3:4 benzopyrene is apparently not important. The composite group of other cancers in males is correlated with several hydrocarbons, but cancers of the breast and other sites in females show no relations with any of them. In 23 localities spectrographic analyses for 13 trace elements were made and a similar process of successive elimination was applied to those which showed appreciable correlations with mortality rates. For lung cancer beryllium and molybdenum emerge as the elements of most consequence, with arsenic, zinc and vanadium showing weaker associations. For bronchitis molybdenum appears to be the important element in both sexes whilst males beryllium, arsenic, vanadium and zinc may also be concerned as for lung cancer. For pneumonia beryllium emerges as the important element in both sexes, with vanadium also concerned in males. With other cancer in males beryllium, molybdenum and vanadium show associations, but breast and other cancers in females show no realtions with any element. (Author summary modified)

03281

H. E. Stokinger.

**RECENT HISTORY OF LEAD EXPOSURE IN U.S. INDUSTRY, 1935-1965.** Public Health Service, Cincinnati, Ohio, Div. of Occupational Health. (Presented at the Symposium on Environmental Lead Contamination, Public Health Service, Washington, D.C., Dec. 13-15, 1965.) Mar. 1966. pp. 29-6.

This review was made of unpublished data on lead exposure as measured by concentrations in air and in urine in 7 of 8 work categories, representing the major uses of lead: auto body, collision and manufacture; foundries, printing; storage battery manufacture and rebuilding; secondary smelters. The concentration of lead in air and in urine can be used as measures of exposure to inorganic forms of lead. There is a decrease in concentrations of air-borne lead, dust and fume in all industrial categories since 1934. This decrease has continued, but at a slower rate since 1945, at which time the average exposure in most work categories was below the acceptable limits owing to the introduction of safe work standards for lead in air and in urine. Only one garage mechanic showed evidence of exposure (elevated urinary lead values) slightly in excess of normal, in a ninth work-exposure category, involving exposure to gasoline additives. Tables illustrating the lead levels in the work categories are given.

03282

J. F. Tomashefski and R. I. Mitchell.

**UNDER WHAT CIRCUMSTANCES IS INHALATION OF LEAD DANGEROUS? Battelle Memorial Inst., Columbus, Ohio. (Presented at the Symposium on Environmental Lead Contamination, Public Health Service, Washington, D.C., Dec. 13-15, 1965.) Mar. 1966. PP. 39-49. GPO 0-210-345; HEW 1440**

It appears that the majority of inhaled lead is removed or cleansed from the tracheobronchial tree by the natural cleaning mechanism and swallowed or expectorated. Whether lead is taken up by the lungs depends upon solubility factors and particle mechanics. Highly soluble lead in proper particle size such as fumes or mists can rapidly be absorbed and approximate an intravenous injection. A possible unproven relationship exists between pulmonary disease--bronchitis and emphysema--with particle deposition, cleansing, and accumulation of lead. There is no known direct effect of lead on the brochopulmonary system. There is need for further determination of the concentration and particle size of lead in the atmosphere. Studies on particle retention and deposition of lead in the lungs are lacking. The synergistic effect of lead with other pollutants such as carbon monoxide and sulfur dioxide is not known. This is especially true in the patient with chronic

obstructive pulmonary disease. It would seem that patients would be more susceptible to lead inhaled because of greater retention and increased deposition. Studies are needed to determine the concentrates of lead in the tissues and fluids of the lungs. Whether lead is immobilized from body stores in diseased states such as respiratory acidosis remains to be proven. (Author summary)

03283

R. A. Kehoe.

**UNDER WHAT CIRCUMSTANCES IS INGESTION OF LEAD DANGEROUS? Cincinnati Univ., Ohio, Coll. of Medicine. (Presented at the Symposium on Environmental Lead Contamination, Public Health Service, Washington, D.C., Dec. 13-15, 1965.) Mar. 1966. PP. 51-8. GPO 0-210-345; HEW 1440**

Following topics are discussed in this paper: The total magnitude of the current exposure of the general population to lead, the significance of the current exposure of the general population to lead, from the aspect of hazard; the margin between the current levels of the concentration of lead in the general population and those associated with the occurrence of lead poisoning, and lead poisoning from the ingestion of lead.

03284

TEPPER, L. B.

**UNDER WHAT CIRCUMSTANCES IS DIRECT CONTACT WITH LEAD DANGEROUS? Cincinnati Univ., Ohio, Coll. of Medicine. (Presented at the Symposium on Environmental Lead Contamination, Public Health Service, Washington, D.C., Dec. 13-15, 1965.) Mar. 1966. PP. 59-62. GPO 0-210-345; HEW 1440**

Absorption of inorganic lead compounds through the skin by direct contact is discussed. The process of weighting silk and its possible toxic effects are discussed, as well as experiments with leaded lubricants being massaged into the skin of human volunteers. A rise in blood lead by a factor of two after ten minutes and by a factor of three at one hour have been reported, but not confirmed. Experiments with tetraethyl lead are also briefly discussed.

03285

R. G. Smith.

**HOW SENSITIVE AND HOW APPROPRIATE ARE OUR CURRENT STANDARDS OF 'NORMAL' AND 'SAFE' BODY CONTENT OF LEAD.** Wayne State Univ., Detroit, Mich., School of Medicine. (Presented at the Symposium on Environmental Lead Contamination, Public Health Service, Washington, D.C., Dec. 13-15, 1965.) Mar. 1966. PP. 65-72. GPO 0-210-345; HEW 1440

Lead is but one of many metals present in the atmosphere and diet of man. Further it is only a minor component in the tremendous mixture of chemical and biological matter which permeates the environment. There are many substances present in this mixture which man never encountered at all until relatively recent times, while in the case of many other substances, the quantities which man breathes or ingests have increased sharply since he existed in a 'so-called natural' state. It seems unwise to assume that one of these substances can bring about the far-reaching consequences of which lead is accused, without due regard for possible interactions of many substances as well as the ability of the biological system to accomodate itself to a changing environment. This attitude certainly does not rule out the need for continuing research, but it does make it imperative that insofar as possible, the impact of the stress imposed by the total environment be considered.

03286

H. L. Hardy.

**LEAD.** Massachusetts Inst. of Tech., Cambridge. (Presented at the Symposium on Environmental Lead Contamination, Public Health Service, Washington, D.C., Dec. 13-15, 1965.) Mar. 1966. pp. 73-83. GPO 0-210-345; HEW 1440

Author summarizes this extensive review with the following: Well-designed prospective studies of special populations should help establish how long and at what low levels can those in such identified groups tolerate the extra burden of lead in air, water soil and food. The effect of multiple factors acting with tetraethyl lead on an organ or system should be investigated. Extension of studies relating mental retardation and psychic disturbances in children with measurable excess lead stores both with and without overt tetraethyl lead poisoning are also advocated.

03287

M. W. First.

**POSSIBILITIES OF REMOVAL OF SOURCES OF LEAD CONTAMINATION IN THE ENVIRONMENT.** Harvard School of Public Health, Boston, Mass. (Presented at the Symposium on Environmental Lead Contamination, Public Health Service, Washington, D.C., Dec. 13-15, 1965.) Mar. 1966. pp. 87-94. GPO 0-210-345; HEW 1440

Emissions of lead to the environment from mining, smelting, refining, processing, and fabricating lead and lead-containing substances and objects may be greatly reduced, both in-plant and out, by the application of well-known control measures. The remaining principal sources of lead in the environment (lead insecticides, lead-containing surface finishes, lead anti-knock compounds, lead and brass water and waste-water pipes may be eliminated entirely by prohibiting their further use. Suitable substitutes are available, although they may be more costly and less convenient to use. Additional controls on the introduction of lead into the environment must, in my opinion, be based on a clearly perceived threat to the public health to justify the wide-spread dislocations and economic hardships that would be certain to follow. (Author summary modified)

03635

D. Tanaka

**(AN ELECTROPHORETIC STUDY ON LEAD WORKERS' SERUM.) Japan J. Ind. Health (Tokyo), 1(2):35-42, Apr. 1959. Text in Japanese.**

Lead workers with slight anemia by lead absorption show a higher level of Y-globulin percentage of serum protein than those without any sumptoms of anemia, including healthy controls. The decrease of the albumin and globulin ratio (A/G) measured by the Kunkel Method in lead workers' sera is established, as is that seen in experimental lead poisoning in animals. In comparing the symptoms and protein fraction changes due to lead absorption, an electrophoretic study on the sera of lead workers in a storage battery factory was done using Tiselius apparatus. The determination of the fraction bound by lead was made by Zone electrophoresis. It was found that the lead in the serum was mainly in the fraction which corresponds to that of albumin and there seemed to be no relation between the cause of Y-globulin percentage increase and the lead-binding capacity of the protein fraction of the serum. (Author summary modified)

03654

J. Steel

**TOXIC HAZARDS IN THE MANUFACTURE AND USE OF SURFACE COATINGS.** Paint Technol. (London) 30(11):26-28, 30-4, Nov. 1966.

The recognition of the hazards inherent in the handling of more than 2000 raw materials in a prerequisite for any program to promote healthy working conditions among the 50,000 workers involved in the manufacture of paints, varnishes, lacquers, and printing inks. The maximum allowable concentrations assigned by the British Ministry of Labour are given for a large number of materials used in the manufacture of paint. Although there has been a steady decline in the incidence of lead poisoning over the last few decades, one sixth of the 407 cases in the 1960-1964 period were caused by the manufacture and industrial use of lead paints, enamels, and pigments. The problems of the newer hazards such as tolylene diisocyanate which because of its potential for sensitizing action has required an extremely low M.A.C. of 0.02 ppm are discussed. The hazards from the degradation of surface coatings during burning or cutting operations are discussed. The application of research to the development of safer paints is advocated. Any toxic hazard involved in the manufacture or use of surface coatings can be controlled.

03892

C. Albahary and J. Guillaume

**LEAD POISONING AND PENICILLAMINE.** Saturnisme et Penicillamine. Presse Med. (Paris) 74, (43) 2193-6, Oct. 1966. Text in Fr.

The literature and the author's own work with penicillamine in the treatment of lead poisoning are reviewed. Penicillamine is less efficient than either Ca EDTA Na2 or Ca DTPA Na2 and it is thus of less value in the treatment of a subacute lead poisoning or as a diagnostic test than the other chelates. Under certain conditions, however, it is desirable to take advantage of the fact that penicillamine may be administered orally. This is of great advantage in the treatment of incipient cases or in maintaining cures especially in those who continue to work in atmospheres contaminated with lead dust. The chief cause of concern is the occurrence of proteinuria which should be looked for periodically.

03893

K. Tsuchiya, D. Tanaka, M. Nishimaru, K. Sho, and N. Sato

**LEAD CONTENTS IN ORAL CAVITY OF LEAD WORKERS AND LEAD INTAKE INTO THE BODIES.** Japan J. Ind. Health (Tokyo) 1,(2) 65-8, Apr. 1959. Text in Jap.

The lead content of the mouth of lead workers in a storage battery and a lead refining plant was estimated and was compared with the blood lead contents, whole blood gravity, and coproporphyrinuria. The oral lead was estimated in samples of the tooth calculus or coating, and also in samples of 30cc of 0.5% acetic acid solution, used as a mouth wash for the workers. It was found that the lead contents of tooth calculus and coating was approximately 3 to 120 micrograms per 100 mg. Little lead was recovered from saliva from the parotid gland. The lead content of tooth calculus and coating showed no correlation with that of blood lead. Therefore, it is logically assumed that the oral lead of the lead workers is of environmental origin and not from the lead absorbed in the body. The lead content of the used mouth wash solution of the workers indicated a high correlation (r= -3.71) with the whole blood gravity, which is one of the best indicators of the chronic lead intake. The lead content of the mouth wash solution must be directly influenced by the lead concentration of the environmental air. (Author summary modified)

03897

K. Sho

**SUSCEPTIBILITY TO LEAD POISONING AND ITS RELATION TO PARATHYROID FUNCTION.** Japan J. Ind. Health (Tokyo) 1, (2) 49-60, Apr. 1959. Text in Jap.

According to the previous investigators, K. Tsuchiya and M. Nishimura, it has beeen demonstrated that parathyroidectomized rats showed fewer serious symptoms of lead poisoning than the control rats. They concluded that this phenomenon might be due to the decrease of precipitation of the serum calcium that was accompanied by an increase in the lead precipitation in the bones. The fact that growing animals are more susceptible to the lead administration than are fully grown ones remains to be determined. This author compared the calcium and lead metabolism in growing animals with experimental lead poisoning with that of fully grown animals receiving parathyroid hormones subcutaneously, simultaneously with lead. The principal conclusions were 1) that the growing rats yielded more serious lead poisoning symptoms regarding anemia and body weight than the grown ones did. The lead poisoning was advanced by the infections of the parathyroid hormone. 2) The lead contents of the bones and blood of the growing rats were found to be greater than those of the grown. The animals receiving parathyroid hormone had more lead in their blood and less in their bones than the control animals did. 3) The hypersusceptibility of the growing rats to lead might be attributed to the higher activity of the hormone in them, although the growing rats were not necessarily analogous to the grown with injections of parathyroid hormone, in the comparisons of calcium and lead metabolism. (Author summary modified)

04196

C. De Pedrini, A. Bonzanino, and L. Gatti

**TECHNICAL AND BIOLOGICAL PREVENTION OF LEAD POISONING.** Minerva Med. 57, (54) 2457-60, July 7, 1966. It.

The prevention of lead poisoning varies according to occupation, but the following basic concepts should be followed: 1) The use of lead should be reduced to a minimum. Ideally, its use should be discontinued and non-poisonous metals be substituted. For example, in the car industry, a lead-tin alloy is used. It should be possible to use a much higher tin-to-lead ratio. 2) It is necessary to detect and neutralize any lead present in the work environment. Rooms should be well ventilated, dust removed by vacuum, and workers protected with masks. Rooms where lead is used should be isolated so that other rooms will not be contaminated. The biological aspect of lead poisoning prevention should consist of a 'routine' examination for every person exposed to lead, as well as a complete clinical examination with emphasis on the gastro-intestinal and cardiovascular systems. The author found that treatments of subjects exposed to lead poisoning with calcium versenate given intravenously is beneficial, since this chelating agent has no bad side effects and helps the excretion of lead. For this reason, the administration of versenate is of diagnostic and prophylactic as well as therapeutic value.

04251

N. V. Petrova and T. S. Lisunova

**LEAD CONTENTS IN THE AIR OF IRON MINES EMPLOYING SHORT-DELAY ELECTRIC BLASTING CAPS (DETONATORS).** (Soderzhanie svintsa v vosdushnoi srede

zhelezorudnykh shakht pri primenenii elektrodetonatorov korotkozamedlennogo deistviya.) Hyg. Sanit. 31, (8) 326-7, Aug. 1966. Russ. (Tr.) CFSTI: T 66-51160/7-9

In the mines of the Krivoi Rog iron-ore basin, the blasting is mainly done with short-delay electric blasting caps. They contain lead compounds which may pollute the air in the mine. In 63-68% of the air samples taken in mine workings, the lead contents were above the maximum permissible concentration, varying from 0.02 to 0.057 mg/cu m, an average of 0.13 mg/cu m. Such high concentrations were due to unsatisfactory ventilation. An improvement in the ventilation of dead-end faces may lead to a reduction in the lead content in the air down to maximum permissible concentration and even lower. This is shown by the fact that lead was not discovered or else did not exceed the maximum permissible concentration in 33-37% of the samples. According to the investigations, in the case when the ventilation was improved so as to satisfy the standard requirements, the lead concentration was reduced to the maximum permissible level (0.01 mg/cu m). Periodic medical examinations of miners must include tests for lead poisoning.

04877

K. Nozaki

**METHOD FOR STUDIES ON INHALED PARTICLES IN HUMAN RESPIRATORY SYSTEM AND RETENTION OF LEAD FUME.** Ind. Health (Kawasaki, Japan) 4, (3) 118-28, Oct. 1966.

Method for the determination of retention of inhaled particles in the human respiratory tract was studied. Aerosol concentration was determined by light scattering, respiratory air flow by pneumotachograph, and carbon dioxide content by infrared analyzer These were recorded simultaneously and continuously during breathing aerosol. Detector or parts of these measuring apparatus were inserted into the mouthpiece of which inner space was 9.5 ml. This extreme reduction of the dead space of mouthpiece enabled the measuring apparatus to work with quick response. By this method, the retention of lead fume in the respiratory tract was studied. Lead fumes with various sizes from 0.05 micron to 1 micron were prepared by high frequency induction furnace. Total retention rate of lead fumes decreased with particle size, for instance, it was 63.2% for 1 micron particle but 42.5% for 0.5 micron at 10 respirations per minute. And the increase of respiratory rate resulted in the drop of retention. Retention rates in the upper and lower respiratory tracts were also determined.

05002

California State Dept. of Public Health, Berkeley, Bureau of Air Sanitation and Air and Industrial Hygiene Labs. Mar. 1967. 84 pp.

**LEAD IN THE ENVIRONMENT AND ITS EFFECTS ON HUMANS.** California

Industrial consumption of lead in California was approximately 109,000 tons in 1964, and about 20% of this amount was used in gasoline anti-knock additives. Almost all of the lead in the atmosphere of California communities comes from motor vehicle exhausts. In 1965, motor vehicles emitted about 6,000 tons of lead in Los Angeles County and about 16,000 tons in the state. With a continuation of current rates of increase of gasoline usage and with no changes in the concentration of lead in gasoline, these figures will be doubled in 1977. There are no regulations which limit the amount of lead antiknock compounds in motor fuel. There are 4.0 cubic centimeters of tetraethyl lead per gallon. Over 90% of the lead in the atmosphere is contained in particles of sizes which can be retained in the lung. The concentration of blood lead in the population is 1/4 to 1/2 of that recognized as hazardous to workers in industries using lead. Mean ambient air concentrations of inorganic lead are 1/80 to 1/8 of the Threshold Limit Value used as a guide in industrial exposure. The average concentration at eight stationary sampling sites in Los Angeles during 1961-62 was 2.5 micrograms/cm and the highest single sample concentration was 11.4 micrograms/cm. Concentrations of lead over freeways in Los Angeles during daylight hours averaged 25 micrograms/cm and in downtown traffic about 15 micrograms/cm. Tables and figures are given. Appendix contains information on known effects of exposure to inorganic and organic lead compounds.

05025

L. W. Saunders

**TETRAETHYLLEAD INTOXICATION.** Arch. Environ. Health 8, 280-8, Feb. 1964. (Presented at the Symposium on Lead, Cincinnati, Ohio, Feb. 25-27, 1963.)

It is the purpose of this paper to describe the disease, as well as the symptoms, signs, and factors which lead to its diagnosis. The first symptoms noticed by the patient or his family or associates are those of nervous irritability. There is no lowering of the hemoglobin, no diminution in the numbers of erythrocytes, and no increase in the number of stippled cells. During the early phase of a syndrome of this general type, determinations of the lead content of the blood and urine are highly advantageous for correct diagnosis and appropriate therapy. An important point to be considered is the striking difference between tetraethyllead poisoning and that by the inorganic compounds of lead. In the latter, the lead content of the blood is the most precise and reliable indication of the general extent and significance of the absorption of lead, while, in the former, the concentration of lead in the blood will be only slightly elevated or, more likely, within the normal range. The urine, in both types of lead intoxication, may be abnormally and significantly high in its concentration of lead; but, in tetraethyllead intoxication, it is likely to be appreciably higher. The nervous symptoms may vary greatly in severity. In instances of mild intoxication they may subside completely in two or three days. On the other hand, they may be only the prodromal symptoms of severe intoxication. It is in this form or stage of the illness, when errors, both positive and negative, are very likely to be made.

05280

J. B. Little; and E. P. Radfor, Jr.

**POLONIUM-210 IN BRONCHIAL EPITHELIUM OF CIGARETTE SMOKERS.** Science 155, (3762) 606-7, Feb. 3, 1967.

The biologic significance of radioactive polonium in tobacco smoke has been widely debated since the original report by Radford and Hunt, 1964. Holtzman and Ilcewicz, 1966, have mentioned some seemingly conflicting evidence concerning radiation doses from this source to bronchial epithelium. The latter's paper for the first time indicates that, in addition to 210Po, tobacco smoke contains some of that isotope's grandparent, long-lived lead-210; and that, in rib bones and lung parenchyma, 210Pb was higher in smokers than in nonsmokers of about the same age. It is agreed by the authors that this means of exposure to environmental 210Pb is important, and results of a few studies roughly confirm this. Indeed 210Pb in smoke may be more significant than their data imply. As far as radiobiological implications are concerned, however, it is the amount of 210Pb present in the bronchial epithelium of smokers that is of greatest interest; no evidence is yet availa-

ble. The presence of 210Po in 'hot spots' reported at bifurcations of segmental bronchi may depend on the presence of 210Pb, environmental sources of which may account for the 210Po found in epithelia of nonsmokers. Another problem in any analysis of bronchial epithelium is the rapidity of postmortem changes in this tissue. Histologic sections obtained within even a few hours of death often show loss of considerable areas of epithelium.

05475

H. Watanabe, H. Murayama, S. Yamaoka

**SOME CLINICAL FINDINGS ON VANADIUM WORKERS.** Japan J. Ind. Health (Tohyo ) 8, (7) 23-7, July 1966. Jap.

Observation was made of workers in the production of white lead to vanadium pentoxide. In workers handling vanadium only, the symptoms of lead poisoning such as anemia, basophilic stippled cells and coproporphyrinurea were present but improved gradually indicating that the handling of vanadium was not causing the health impairment. The most prevalent symptoms in both vanadium and lead handlers were irritation of the respiratory tract or the eye and abnormal pigmentation of the tongue. Mean concentrations of serum cholesterol and concentrations of vanadium in the urine were not significant. It was, however, suggested that excessive absorption of vanadium in the body caused adisorder of the oxidation-reduction system of ascorbic acid metabolism. (Authors' summary, modified)

05478

Gilfillan, S. C.

**LEAD POISONING AND THE FALL OF ROME.** J. Occupational Med. 7, (2) 53-60, Feb. 1965.

A theory is presented for the underlying cause of the decline of ancient Rome. It is postulated that the Roman aristocracy was decimated by the ingestion of lead. Archeological evidence is cited of lead found in human bones of the classical period, and of lead in their cooking and drinking utensils. Further corroboration is provided by citations from classical authors on ancient culinary and dietary customs and illness. The wealthy, by use of leaden cooking ware and by virtue of their eating and drinking habits were gradually poisoned by lead, thereby diminishing their fertility, hastening their death, and mentally damaging their surviving children. The different eating and drinking patterns of the poor and their use of earthenware utensils enable them to survive. Thus, the most productive and intelligent members of the Roman empire were gradually displaced by the inferior members leading to cultural stagnation.

05483

R. A. Kehoe

**THE FATE OF INHALED PARTICULATE LEAD COMPOUNDS.** Preprint. 1966.

Experiments are described in which two human subjects were exposed to lead. Two identical respiratory chambers were used into which air containing 150 micrograms of lead per cubic meter, dispersed in particles ranging up to 0.18 microns in diameter and having a mean diameter of 0.05 microns, was introduced and evenly distributed, During a 16 week period the subjects were exposed for periods ranging from 10.5 hrs; to 42 hrs per week. During each successive period of 16 weeks, the concentration of lead in the urine and blood of the subjects rose up to a certain point and then continued at essentially constant levels. A line connecting the points representing the final levels of lead in the blood reached in the successive periods of 16 weeks became a straight line of uniform slope. The result of the extension of this line to a point that corresponded to continuous exposure is illustrated, as well as other analytical data of the experiment. The greatest practical importance of these results lies in the indication of the feasibility of this method for determining the maximum concentration of lead in the ambient amosphere compttible with human health. Other experiments are described, in progress or projected, deal- ing with exposure to minimal amounts of lead, extension of the period of exposure.

05541

**LEAD POISONING.** Consumer Bull. 50, (2) 37-40, Feb. 1967.

The controversy aroused by a specific scientific report of the increase in the blood levels of lead in the average American is described. The resistance of Government and industry officials is cited. Facts are extracted from the controversial paper regarding the exposure of the average individual to lead through a variety of sources. It is concluded that the author of the report was unfairly criticized and attacked.

05671

Castellino, N. and S. Aloj

**EFFECTS OF CALCIUM SODIUM ETHYLENEDIAMINETETRA-ACETATE ON THE KINETICS OF DISTRIBUTION AND EXCRETION OF LEAD IN THE RAT.** Brit. J. Ind. Med. (London), vol. 22:172-180, 1965.

The effects of calcium sodium ethylenediaminetetra-acetate (CaNa2EDTA) on the kinetice of distribution and excretion of lead (210Pb) have been studied in rats. When the chelant was given intravenously, at 50 mg/rat daily after a single intravenous injection of 100 micrograms lead/rat, it greatly increased the urinary excretion of lead but reduced the faecal excretion. The greatest effects occurred in the rats treated with chelant shortly after the lead injection. When the chelant was given seven or more days after the lead the increase in lead excretion was negligible. CaNa2EDTA mobilized lead from every tissue, but the kinetics analysis of the disappearance of 210Pb showed the presence of two elimination phases. Lead ions weakly bound to the cells were rapidly removed by EDTA, whereas the lead fixed to endocellular constituents was only slowly removed. The chelant did not mobilize lead from bone. Probably CaNa2EDTA entered the extravascular space but not the cells. Hence it only accelerated the passage of lead from the cells by lowering the concentration of lead outside them. Pb210 was also given orally in doses of 500 micrograms lead/rat. About 18% of the dose was absorbed through the intestine to be distributed in all tissues. Rats treated orally with CaNa2EDTA showed an increase in urinary lead excretion and a reduction in lead fixed in the body.

05697

D. G. Fowler

**FACTS ABOUT LEAD AND INDUSTRIAL HYGIENE.** J. Occupational Med. 7 (7) , 324-9 (July 1965).

Lead is a normal constituent of human tissue from birth through life. Human exposure experiments have shown that there is constant in-take and elimination and that the body does achieve and maintain a balance, or dynamic equilibrium, between intake and elimination. The amount of lead in the body is a function of this balance, and so blood and urine lead determinations are used to provide a picture of this balance for each individual and to measure absorption, transport and excretion. The two-pronged attack used today to control lead

expcsure: 1. Measuring and controlling the amount of lead in the plant environment, with airborne lead determinations and the providing of engineering controls, and (2) Measuring the physiological lead balance in the employee, through blood lead or urine lead determinations. These two approaches give effective means of determining the potential exposure within a plant and the actual exposure of an individual. Action can then be taken to reduce any excessive exposures. Continuing studies in industry, correlated with controlled exposure research with human subjects, provide the basis for the widely accepted permissible levels in industry toady. The present standard for industrial exposure to lead in air is 0.2 mg. of lead per cubic meter of air measured over an eight-hour day. This standard states that, when the air of workrooms contains regularly not more than 0.2 mg. of inorganic lead per cubic meter of air, as measured by prescribed methods, cases of lead intoxication will not occur. It is only in combination with determination of blood and/or urine lead levels in exposed persons that the environmental determinations are meaningful. Two methods of establishing the approximate level of absorption of lead into the body are found most useful: 1. Measurements of concentration of lead in the whole blood and, 2. Determination of the concentration of lead in the urine. Control of exposure to toxic materials in industry is primarily an engineering and administrative problem. It involves dust control, ventilation, plant layout, good housekeeping, the education of personnel in hygienic procedures and a sound medical program.

05780

Tsuchiya, K. and Harashima, S.

**LEAD EXPOSURE AND THE DERIVATION OF MAXIMUM ALLOWABLE CONCENTRATIONS AND THRESHOLD LIMIT VALUES.** Brit. J. Ind. Med. (London) 22, 181-6, 1965.

An investigation of lead workers is reported, and recommendations are made based on the data obtained. The survey was carried out in printing works and storage battery factories; the order of development of abnormal biochemical findings was reconfirmed. The threshold limit value (T.L.V.) was determined for each stage of lead absorption by a graphic method. T.L.V.s for an eight to 10- hour working day were determined as 0.10 mg/cu m to produce a urinary lead of 0.15 mg/l, 0.12 mg/cu m for coproporphyrinuria of about 50 microgram/l, 0.14 mg/cu m for basophilic stippling at the 0.3 per thousand level, and most likely 0.14 to 0.15 mg/cu m for lead anaemia. The biochemical function chosen was an increased excretion of coproporphyrin, and to keep this below 50 micrograms/l it is suggested that the T.L.V. should be about 0.12 mg/cu m or a little more in the case of a 40-hour week. It is also recommended that the ceiling for lead in the air should be about 0.19 mg/cu m. (Author abstract modified)

06028

J. D. Williams, D. A. Leigh, and G. A. Matthews

**DIAGNOSIS OF EXCESSIVE LEAD ABSORPTION BY USE OF ORAL CALCIUM DISODIUM VERSENATE.** Ann. Occupational Hyg. (London) 9(1):1-5, Jan. 1966.

In order to assess the degree of lead absorption by lead workers lg of Versenate was given orally and lead concentration determined in early morning specimens of urine collected before and after the dose. In non-exposed workers only small increases of lead concentration (up to 80 micrograms/l were found after Versenate. Increasing concentrations of urine lead were found after Versenate in men in whom standard tests for lead absorption showed increasing degrees of absorption. Levels of urine lead up to 1500 microgram/l were found in men who were judged by other criteria as fit to continue working whereas when the standard tests showed excessive absorption the lead excretion post Versenate exceeded 1760 microgram/1. The results of this test (the Versenate provocation test) were reproducible when it was carried out on twelve men at weekly intervals. It is suggested that this test may prove useful in detecting excessive lead absorption both in lead workers and non-industrially exposed persons.

06059

Haley, T. J.

**CHRONIC LEAD INTOXICATION FROM ENVIRONMENTAL CONTAMINATION: MYTH OR FACT? Arch. Environ. Health 12(6):881-885, June 1966. 19 refs. Also translated into German. Erdoel Kohle (Hamburg), 21(2):90-93, Feb. 1968.**

The population of the United States is in lead balance and the old causes of acute and chronic lead intoxication have been reduced to very low levels by changes in technology. Lead body burdens of the population have been maintained at the same level for the past 30 years regardless of the fact that there has been a 2.5-fold increase in the use of leaded gasoline. The bulk of the body burden of lead has been obtained via the food chain and not by inhalation from the environment. Although lead is present in the ambient air, only a small percentage of the inhaled lead is in the correct particle size for pulmonary retention and even that fraction contributes only an extremely small amount to the body lead burden. Body defense mechanisms make it highly unlikely that environmental lead could induce chronic lead insult in the population. Greatly increased exposure to lead slowly increases the body burden but only at levels well above those encountered in the environment. The supposed chronic lead intoxication from environmental contamination is a myth, not a fact.

06151

Clark, R.L., Jones, J.H., and Jones, J.F.

**SCREENING LEAD WORKERS FOR THE PRESENCE OF STIPPLED ERYTHROCYTES.** J. Clin. Pathol. 20, (2) 166-9, 1967.

The possibility of false low results from the technique of counting the number of red cells showing basophilic stippling to detect lead intoxication is investigated. The number of the stippled erythrocytes in the blood of lead workers showed a marked fall when the blood is taken into an anticoagulant. The affected erythrocytes probably became altered in some way as the result of contact with anticoagulants so that their stippling was lost or was no longer demonstrable. While urinary coproporphyrin estimations have been suggested as a more sensitive index of excessive lead absorption, enumeration of the stippled cells is still widely used for screeing lead workers. Although the nature of the reaction of lead in the erythrocytes is by no means clear, it is generally accepted that stippled cells are reticulocytes in which the basophlic material has been modified in some way. It has been shown that more stippled cells are found in the marrow than in the peripheral blood which suggests that lead has its main effect on the red cell precursors than on the circulating erythrocytes.

06174

Lane, R. E.

**THE CLINICAL ASPECTS OF POISONING BY INORGANIC LEAD COMPOUNDS.** Ann. Occupational Hyg. (London) 8 (1), 31-4 (Mar. 1965). (Presented at the 16th Conference, British Occupational Hygiene Society, Apr. 7- 8, 1964.)

The doctor faced with the supervision of lead workers should have a sound knowledge of the clinical manifestations of ex-

cessive lead absorption. It is particularly important that he should be able to identify those workers who have passed into the zone of excessive absorption while still remaining capable of work. It is suggested that years of such exposure may lead to renal damage. An investigation is reported which shows there is not excess of deaths from malignant disease among lead workers but in those who have been heavily exposed for many years a significant excess of deaths from cerebro-vascular catastrophe occurs. (Author abstract)

06177

Malcom. D.

**INDUSTRIAL CONTROL OF PERSONNEL.** Ann. Occupational Hyg. (London) 8, (1) 35-42 (Mar. 1965). (Presented at the 16th Conference, British Occupational Hygiene Society, Apr. 7-8, 1964.)

The diagnosis of lead poisoning is a clinical diagnosis. The task of the doctor in industry is not only to prevent episodes of classical lead poisoning, but to prevent any damage to the health of the individual due to excessive absorption of lead over a lifetime of work in lead industry, for instance: anemia due to lead exposure, an excessive incidence of kidney disease, or cerebrovascular accidents. In addition to routine inspections required by law, a number of biological tests are useful signals that lead absorption may be excessive. Haemoglobin level, punctate basophil counts, lead in urine and blood measurements and urinary coproporphyrin levels are discussed. None of these tests is in itself diagnostic of lead poisoning. Problems of interpretation are discussed. The doctor in charge of the health of lead workers should have up-to-date information on lead in air levels in working areas, and should co-operate closely with engineers and factory management in the control of these levels. (Author abstract)

06704

Berg, B. A. and C. Zenz

**ENVIRONMENTAL AND CLINICAL CONTROL OF LEAD EXPOSURE IN A NON-FERROUS FOUNDRY.** Am. Ind. Hyg. Assoc. J., 28(2):175-178, March-April 1967. 3 refs. (Presented at the 15th International Congress on Occupational Health, Vienna, Austria, Sept. 24, 1966.)

In a non-ferrous foundry employing 75 workers, monitoring of the lead concentrations in the workroom atmosphere and in the urine of workers began in 1943. A rise in concentrations was noted over the years and found to be due to increased lead in the alloys and to development of some poor work habits. Installation of modern exhaust ventilation and a clinical surveillance program have prevented any cases of clinical lead poisoning. The urinary coproporphyrin screening technique has proven to be valuable in this program. (Authors' abstract)

06814

W. Bolanowska, J. Piotrowski, and H. Garczynski

**TRIETHYLLEAD IN THE BIOLOGICAL MATERIAL IN CASES OF ACUTE TETRAETHYLLEAD POISONING.** Arch. Toxikol. (Berlin) 22 (4), 278-82 (Mar. 1967).

Triethyllead and the total lead were determined in the tissues in three acute fatal cases of tetraethyllead poisoning. In each case high concentrations of triethyllead were found (2.0 - 22.0 micro g/g) being of the same range as the total lead content. The triethyllead content of the tissues showed a slightly decreasing trend with the length of the surviving period. High levels of the total lead were also found in blood (3.3 - 4.0 micro g/ml), and urine (0.4 - 8.0 micro g/ml), the highest values being observed after EDTA treatment. The triethyllead content in blood and urine was much lower. (Author summary)

06985

J. Hasan, V. Vihko, S. Hernberg

**DEFICIENT RED CELL MEMBRANE NA+/K+/ ATPASE IN LEAD POISONING.** Arch. Environ. Health, 14(2):313-318, Feb. 1967. 27 refs.

The activity of the sodium and potassium activated (and strophanthininhibited) enzyme catalyzing the hydrolysis of adenosine triphosphate was studied in fragmented erythrocyte membranes prepared from blood samples of 10 men hospitalized because of poisoning with inorganic lead, and of 14 ostensibly healthy men never knowingly exposed to heavy metals. Several hematological and biochemical parameters were also determined in the former in order to define the intensity of toxic exposure for each worker. The mean activity (plus or minus S D) of the erythrocyte membrane/Na+/K+/-ATPase in the group of patients was 4.42 plus or minus 1.23 X 10 to the minus 13th power micromol Pi sq micron/hr and in the nonexposed controls, 6.34 plus or minus 1.29 X 10 to the minus 13th power micromol Pi sq micron/hr; the difference was statistically significant (t equal 3.80, P less than 0.01). There was no significant relationship between the degree of inhibition in this enzymatic activity and the magnitudes of any of the following parameters: the concentration of hemoglobin, the erythrocyte count, the relative number of reticulocytes and stippled erythrocytes in blood; the concentration of lead in blood and urine; and the daily excretion of coproporphyrin in urine. The possible relevance of these findings to previous ovserbations of accelerated potassium loss in vitro from erythrocytes of people exposed to lead is discussed. The data obtained so far do not indicate how much of the action of lead ions on the erythrocyte in vivo is mediated by the erythropoietic tissue and to which extent it is a direct effect on the circulating erythrocyte. AS

07162

B. G. Ferris, Jr. and N. R. Frank

**AIR POLLUTION AND DISEASE.** Anesthesiology 25(4):470-478 Aug. 1964.

Atmospheric pollution can be classified under three headings: general, occupational and personal. The components are complex and variable so that it is difficult to extrapolate the prevalence of disease in one area to that of another unless the two have similar chemical compositions. Significant exposures can occur at work and may produce impairment of respiratory function. It is emphasized that tobacco smoking, and particularly cigarette smoking, is a most important factor in the causation of chronic nonspecific respiratory disease. Much research has been done to elucidate the mechanism whereby such changes are induced but specific answers concerning the mechanisms have not been forthcoming. Tables are included showing types of atmospheric pollution; comparison of Los Angeles and London types of pollution; categories of airborne materials with selected examples that may occur in industry and that may cause disease; age standardized rates of respiratory diseases by tobacco usage and sex; age standardized rates (%) of respiratory disease by current cigarette smoking habits and sex.

07169

E. Marsden

**INCIDENCE AND POSSIBLE SIGNIFICANCE OF INHALED OR INGESTED POLONIUM.** Nature (London) Vol. 203:230-233, July 18, 1964.

Experimental evidence is given of polonium and its possible effects in cancer initiation at various sites, including the lung and also in relation to certain possible induced genetic

changes. Polonium can enter the body either through the water consumed, or as a contaminant of the air inspired, or as a trace constituent of foodstuffs via radioactive soil or from natural fall-out as the result of disintegration of radon which has escaped into the atmosphere from soil. In the case of drinking-water, the amount does not appear to be relatively important except for certain artesian waters generally also highly charged with radon. Normal air is said to contain lead-210 to an average extent of 0.003 pc./kg with upwards of 0.09 of this quantity of polonium-210, according to season. This figure would correspond to some 0.007 pc. inhaled by an average person per day. Two widespread probable sources of inspired polonium are (1) inhaled tobacco smoke, when certain tobaccos are used in the cigarette blend and in the absence of a suitable filter; (2) the exhaust of motor-car petrol engines when lead compounds are used for enhancement of octane rating. These two sources could assume varying relative importance in different conditions and regions, though too little is known regarding the magnitude of the latter. The average retention period in the lung of such inspired polonium is of the order of 70 days but will probably vary with particle size, the nuclide presumably being more readily removed before disintegration when not associated with certain types of particulate matter, for example, smoke condensate or car exhaust material under certain conditions or urban pollution. (Author's introduction modified)

07396

S. Saito, A. Sanshi

**RELATION BETWEEN LEAD POISONING AND ELECTROENCEPHALOGRAPHY.** Text in Japanese. Japan J. Ind. Health (Tokyo), 7 (6):20-27, June 1965. 16 refs.

Ine chronically lead-poisoned patients ranging in age from 18 to 30 years and seven normal clerical employees of lead smelting works ranging in age from 23 to 29 years were examined as follows: blood specific gravity, hemoglobin, microhematocrit, basophilic stippled cells, lead in the whole blood, 24 hours' excretion of urine, coproporphyrin, lead in the urine, bluish line along the gums, subjective symptoms and EEG and their frequency analysis. The results of the examinations were statistically significant between the lead poisoned group and the control group. As to the results of EEG and their frequency analysis of the lead poisoned group, increases of 4 to about 6 c/s and decreases of 8 to about 12 c/s and 12 to about 16 c/s were recognized. The amplitude of EEG of the lead poisoned hroup was lower than that of the control group. The relation between these examinations and the distribution of EEG frequencies is described in detail. These changes of EEG were statistically significant, and from the relation between those results of examinations and the distribution of EEG frequencies, chronic diffuse changes of the central nervous system in the chronically lead-poisoned group are briefly discussed. (Authors' summary, modified)

07423

Heimann, H.

**STATUS OF AIR POLLUTION HEALTH RESEARCH, 1966.** Arch. Environ. Health, 14(3):488-503, Mar. 1967. 178 red Health, 14(3):488-503, Mar. 1967. 178 refs. (Presented in part before the American Industrial Hygiene Conference, Pittsburgh, Pa., May 16-20, 1966.)

Consideration is limited to man-made air pollutants, omitting naturally occurring adventitious airborne materials. Radioactive materials were not discussed. Acute episodes of air pollution; systemic effects of air pollution caused by arsenical compounds, mercury, beryllium, lead, carbon monoxide, economic poisons, manganese, and asbestos; air pollutants as irritants; medical conditions such as acute nonspecific upper respiratory disease, chronic obstructive ventilatory diseases, chronic bronchitis, pulmonary emphysema, bronchial asthma, and lung cancer, are reviewed.

07551

Lambie, John A.

**LEAD POISONING IN MISSILE-SILO WORKERS.** J. Am. Med. Assoc., 200(9):137-138, May 29, 1967. 9 refs.

Two cases of 'Minuteman Disease', lead poisoning among missile-silo workers are reported in which the men had been grinding lead paint off the metal walls of a Minuteman missile silo. One man had been doing this work from July 1965 to March 1966 and the other from December 1965 to March 1966. During the winter there was poor ventilation in the 100-ft-deep silos which were covered to protect the workers from the cold. Two other missile-silo workers were hospitalized elsewhere and treated for lead poisoning as indicated by cramping abdominal pains. The diagnosis of lead poisoning was suggested by a history of exposure to red lead paint dust, the symptomatology, and the various laboratory findings.

07740

Hansan, J., S. Hernberg, P. Metsala, and V. Vihko

**ENHANCED POTASSIUM LOSS IN BLOOD CELLS FROM MEN EXPOSED TO LEAD.** Arch. Environ. Health, 14(2):309-312, Feb. 1967. 24 refs.

The possibility that lead ions in vivo would interfere with the erythrocyte membrane functions suggested a study of some properties of the RBC of men exposed occupationally to inorganic lead. Blood samples were collected from seven shipyard workers exposed to lead oxide paint and from seven nonexposed control subjects. No signs or symptoms of lead poisoning could be detected in the exposed men, and the concentration of lead in their blood did not exceed 0.07 mg/100 ml. During incubation in a heparinized glass tube at 37 C for two hours, the concentration of potassium in the plasma of blood samples from the control group consistently decreased by 0.19 to 0.62 mEq/liter; it decreased in the blood sample of one exposed worker by 0.17 mEq/liter. In the blood samples of seven of the exposed workers, the concentration of potassium, under identical conditions, increased by 0.34 to 1.38 mEq/liter. No differences could be demonstrated between the mean potassium concentrations in the red cell samples from the two groups. Essentially similar results were obtained in samples from seven control subjects and seven of the same eight exposed workers after an interval of four months. No systematic differences were observed between the changes in sodium concentration in the blood samples from exposed and nonexposed workers. The results are interpreted as reflecting a deficiency in the functional capacity of erythrocytes of men exposed to inorganic lead, revealed by the load imposed on the cells by the incubation in vitro.

07892

Hernberg, Sven, Veikko Vihko, and Jeddi Hasan

**RED CELL MEMBRANE ATPASES IN WORKERS EXPOSED TO INORGANIC LEAD.** Arch. Environ. Health, 14(2):319-324, Feb. 1967. 9 refs. (Presented in part at the 15th International Congress on Occupational Health, Vienna, Sept. 1966.)

The activivites of of NA+/K+ ATPase and total ATPase were measured in preparations of membrane fragments from erythrocytes of 40 workers exposed to inorganic lead and of 24 ostensibly healthy persons never knowingly exposed to

heavy metals. The intensity of exposure was estimated by analyses of air samples and by determining the magnitudes of a variety of conventionally employed hematological and biochemical parameters, viz, the concentration of hemoglobin and lead in blood, the erythrocyte count, the relative number of reticulocytes and stippled erythrocytes, and the excretion of coproporphyrin in the urine. The measured activity of Na+/K+-ATPase in membrane fragments of cells from exposed workers (1.21 plus or minus 0.34 (SD) x 10 to the -12th power micro mole Pi/sq. micron/hr) was lower than in those cells from the unexposed controls (1.62 plus or minus 0.39 x 10 to the -12th power micro mole Pi/sq. micron/hr). The difference of the means was statistically highly significant (t equals 4.20, P less than 0.001). In the cells of half of the exposed group, this enzyme activity was more than 1 standard deviation below the mean of the control group; and in one third of the former, it was more than 2 standard deviations below the mean of the latter. No significant correlation could be established between the magnitudes or relative rankings of the conventional hematological and biochemical parameters studied and the degree of inhibition in the enzyme activities. There was no difference in the total ATPase activity between the cell membranes from exposed workers (3.78 plus or minus 0.79 x 10 to the -12th power micro mole Pi/sq. micron/hr) and those from the controls (3.80 plus or minus 0.70 x 10 to the -12th power micro mole Pi/sq. micron/hr). Activity was thus higher in the cell membranes from the former groups, in absolute units (2.57 plus or minus 0.77 x 10 to the -12th power compared to 2.18 plus or minus 0.54 x 10 to the -12th power micro mole Pi/sq. micron/hr) as well as in its relation to the total ATPase activity (mean = 66.9%, compared to 58.3%, t = 3.02 for the difference; P less than 0.01.) AS

08326

Thomas, Heriberto V., Benno K. Milmore, Gerald A. Heidbreder, and Benjamin A. Kogan

**BLOOD LEAD OF PERSONS LIVING NEAR FREEWAYS.** Arch. Environ. Health, Vol. 15, p. 695-702, Dec. 1967. 11 refs.

Fifty adults who had resided for at least three years within 250 feet of a freeway were compared with 50 who had resided for a like period near the ocean or at least 1 mile from a freeway. Average blood lead levels were substantially higher in the population sample living near the freeway. However, these blood lead levels were similar to other Los Angeles populations and lower than those reported for some other urban populations. The atmospheric lead concentration is lower near the ocean than in central Los Angeles. It is higher in heavy freeway traffic streams than in downtown areas. However, available evidence suggests that, at a distance of 150 feet from freeway traffic lanes, the concentration of lead in the atmosphere is about the same as at monitoring stations in the central metropolitan area. It is concluded that the observed difference between the two population samples is consistent with the existence of coastal-inland atmospheric lead and blood lead gradients within the Los Angeles basin. A specific effect of residential proximity (25 to 250 feet) to a freeway has not been demonstrated. (Authors' summary)

08381

I. Prerovska, S. Drdkova

**THE EFFECT OF THE CHRONIC ACTION OF INDUSTRAIL NOXIOUS SUBSTANCES ON EXPOSED WORKERS WITH RESPECT TO THE DEVELOPMENT OF ARTERIOSCLEROSIS.** ((Vliv chronickeho pusobeni prumyslovych skodlivin na exponovane pracovniky Vzhledem k rozvoji arterosklerozy.)) Text in Czech. Casopis Lekaru Cexkych (Prague), 106(28-29):754-759, 1967. 31 refs.

Groups of 50 male workers in the age group of 20-40 years were subjected to clinical testing. A group exposed to carbon disulfide (CS2) had been working for 1-12 years in an atmosphere containing an average of 200 gamma/liter CS2, which exceeds four times the concentration permissible by Czechoslovak standards. A group exposed to lead had been working for 2-16 years in an atmosphere containing lead in concentrations which sometimes exceeded the standard by 1-3 orders of magnitude. A third group, exposed to carbon monoxide, worked for 3-20 years in an atmosphere containing carbon monoxide sometimes exceeding the permissible concentration by 1-2 orders of magnitude. The control group was composed of office workers. The total cholesterol, phospholipids, lipoproteins, and total lipids were determined and the average concentrations, the statistically significant deviations from the average, and the concentration vs. age were tabulated and plotted. None of the exposed groups showed any clinical signs of arteriosclerosis. The results indicate that long time exposure to carbon monoxide or lead does not change the lipid spectrum of the exposed workers. Workers exposed to CS2, however, exhibited a higher level of total cholesterol and beta-lipoproteins and the concentrations of these substances increased more rapidly with increasing age than in the other groups, and the concentrations were directly proportional to the exposure time. The findings are in agreement with previous animal tests which also indicated that none of the poisons alone (including CS2) causes sclerotic lesions of the blood vessels. It is concluded that exposure to CO or Pb does not cause premature development of arteriosclerosis while exposure to CS2 may be one of the etiological factors.

08411

Goldsmith, John R. and Alfred C. Hexter

**RESPIRATORY EXPOSURE TO LEAD: EPIDEMIOLOGICAL AND EXPERIMENTAL DOSE-RESPONSE RELATIONSHIPS.** Science, 158(10):132-134, Oct. 6, 1967. 12 refs.

The relative importance of respiratory exposures to lead is discussed. Epidemiologic studies of blood lead levels in general and occupational groups show a logarithmic regression on estimated atmospheric exposure. Experimental results at the same and higher levels show a dose-response relationship which fits the same regression. The data imply that long-term increases in atmospheric lead will result in predictably higher blood lead levels in the exposed populations.

08566

Komura, S.

**PREVENTION OF LEAD POISONING IN THE PATENTING SHOP Mass Prod. (London), 43(12):49-52, Dec. 1967. Also: Wire Wire Prod., 42(6):982-984, June 1967.**

The lead content of the blood of all the workers in a patenting shop in Japan was found to be above 0.06 mg/dl. The following control methods were instituted: (1) improvement of sand tank construction to avoid dust formation, and the construction of an air duct to exhaust the air containing a large amount of the lead; (2) sweeping the floor in the patenting shop by the wet method to avoid flying dust; (3) strict enforcement of the use of masks during work and an oral rinse with 0.1 percent aqueous solution of magnesium sulfate after work; (4) construction of shower room for the workers; (5) provision of milk free of charge by the company; and, (6) administration of calcium salt injections. Institution of these measures was followed by 18 months of improvement in red blood cell counts and in the levels of coproporphyrin in the urine and protoporphyrin in the blood. Improvement increased steadily, until after 42 months all the workers had recovered from symptoms of acute and chronic lead poisoning.

08683

Knockaert, O. E., G. L. Maes, and M. H. Faes

**A POLAROGRAPHIC METHOD FOR THE SIMULTANEOUS DETERMINATION OF LEAD AND CADMIUM IN URINE.** Am. Ind. Hyg. Assoc. J., 28(6):595-598, Nov Dec. 1967. 8 refs.

A polarographic method for the routine determination of both lead and cadmium in urine is described. Ashing of the sample is done with a mixture of HNO3 and HC104. After neutralization, lead and cadmium are precipitated in alcohol medium as sulfates. The whole manipulation is carried out in the same container; this includes ashing, chemical separation, centrifugation and polarographic recordings. (Authors abstract)

08949

Grigor'ev, Z. E.

**THE CONSEQUENCES OF CHRONIC LEAD POISONING.** (0 posledestviyakh Kdhronicheskoi svintsovoi intoksikatsii.) Text in Russian. Vrachebnoe Delo, No. 11, p. 117-118, Nov. 1967.

Workers in various professions exposed to lead vapors or dust in concentrations exceeding 0.01 mg/cubic meter were examined and working capability was evaluated on the basis of clinical symptoms and general condition. In earlier stages of poisoning, temporary transfer to working places without exposure to lead is recommended. Where the symptoms do not disappear, then permanent retirement must be recommended. The average exposure time before retirenent due to chronic poisoning was 11.6 years for men and 12 years for women. Retirement of women is less frequent than for men, which is attributed to the less hazardous conditions for women.

08999

Schlaepfer, William W.

**ULTRASTRUCTURAL AND HISTOCHEMICAL STUDIES OF A PRIMARY SENSORY NEUROPATHY IN RATS PRODUCED BY CHRONIC LEAD INTOXICATION.** J. Neuropathol. Exp. Neurol., 27(1):111-112, Jan. 1968.

The pathology of the rat peripheral nervous system in chronic lead intoxication appears to differ from the selective motor involvement and prominent segmental demyelinization observed in other species. Following prolonged ingestion of a 1 percent lead acetate solution by adult albino rats for periods ranging up to 18 months, no signs of paralysis were observed. However, an investigation of the ultrastructural morphology and acid phosphatase activity in the peripheral nervous system of these animals showed significant alterations that were prominently located in the dorsal root ganglia and in the distal segments of peripheral nerves. Examination of aldehyde-fixed, unstained ganglia revealed compact aggregates of fine, electron-dense particles compatible with lead within lysosomes of the capsular cells. Although not containing similarly demonstrable lead particles, the ganglion cells showed an increase in lysosomal acid phosphatase activity. Focal concentrations of this enzymatic activity were also noted in the perimodal asoplasm of peripheral nerve fibers. These changes were accompanied by a focal 'Wallerian degeneration' which could best be appreciated in the distal segments of peripheral nerve using whole-mount, myelin- stained, teased perparations of nerve. Ultrastructural examination of peripheral nerve confirmed the presence of degenerative changes in myelinated and unmyelinated axons. (Author abstract)

09019

Lehnert, G., K. H. Schaller, A. Kuehner, and D. Szadkowski

**EFFECTS OF CIGARETTE SMOKING ON THE BLOOD LEAD LEVEL.** Intern. Arch. Gewerbepathol. Gewerbehyg. (Heidelberg), Vol. 23, p. 358-363, 1967. 6 refs. Translated from German. Joint Publications Research Service, Washington, D. C., R-9067-D, 7p., Jan. 30, 1968.

In the cigarette smoking investigations described, the smoke as well as the tobacco remains of eight of the most popular cigarette brands was analyzed with an atomic absorption spectrophotometric procedure for its lead concentration. An average of 0.8 micrograms of Pb (II) was inhaled per cigarette, and of this amount some 0.3 micrograms was absorbed by the body. One hundred and sixteen subjects (71 smokers and 45 nonsmokers) were investigated under ecologically uniform conditions, but no statistically valid effects of cigarette smoking on the blood lead level could be determined. (Authors' summary)

09253

Djordjevic, Sr. M. Stankovic

**AIR POLLUTION AND COMMUNAL SATURNISM IN MALO RUDARE VILLAGE.** ((Aerozagadenje i komunalni saturnizam u selu Malo Rudare.)) Higijena (Belgrade), 12(1):35-44, 1960. 13 refs.

A study as conducted of the occurrence of respiratory and eye ailments among 107 inhabitants of the villate of Malo Rudare in Yugoslavia. The village is located in close proximity to a lead and zinc foundry. Pharyngitis was the predominant illness, occurring in 86 percent of the study population. Percentage values are given for several other illnesses. Symptoms of chronic lead poisoning were found in the course of the study, which lead to an analysis of the lead content of the blood and urine of the subjects. Measurements were also made of lead in the air, soil, water, and food products of the region. Findings of an autopsy performed on a lamb indicated that lead might be producing a harmful effect upon grazing animals. On the basis of these studies it was concluded that the lead and zinc foundry was producing changes in the environment that were hazardous to the population.

09261

Gossmann, H. H. and S. Heilenz

**LEAD CONTENT IN THE HUMAN BONEY TISSUE.** ((Zum Bleigehalt menschlichen Knochengewebes.)) Text in German. Deut. Med. Wochschr., 92(49):2267-2269, 2293, Dec. 1967. 13 refs.

Lead content was determined in bones ash from 5 persons (aged 35-60 yrs.) with chronic lead poisoning. Spectrophotometry showed lead content of 12.5-200 gamma in 1 gm. bone ash. One female patient with chronic lead poisoning incurred through glass working had a bone ash lead content of 200 gamma, which fell after 6 months to 160 gamma, and after 8 months to 111 gamma. In 4 subjects not exposed to lead, concentrations of 4.0-12.4 gamma were found. For quantitative evaluations of lead poisoning, determination of bone ash lead content is recommended. The technique is described.

09408

Mirando, E. H. and Manel Gomez

**LEAD POISONING IN CHILDHOOD IN CEYLON.** Arch. Disease Childhood 42(226):579-582, Dec. 1967. 3 refs.

A series of 12 cases is presented where lead intoxication was traced to inhalation of fumes and dermal absorption. The chil-

dren, agen 7 months to 9 yrs., generally presented with convulsions. The source of Pb in 6 of the cases was traced to a gold recovery process used in jewelry manufacture. In Ceylon, such recovery is practiced by small, caste communities scattered throughout the crowded slums; the recovery process is primitive, in which jewelry scraps are fused with smelted Pb in a shallow bricked-up hearth. Clouds of smoke laden with lead fumes and finely dispersed lead oxide dust are emitted during this process. A second source of exposure was a battery repair and reconditioning establishment, where lead was released into the atmosphere during the destruction of lead oxide battery plates and the smelting of scrap thus obtained. Other sources of exposure were a smithy and a lead-type foundry. Anemia was presented in 6 of the cases; urinary lead levels were as high as 9.85 mg./l.

09484

Sokolov, V. V., N. A. Chufina, and N. K. Byalko

**ON THE PATHOGENESIS OF ERYTHROCYTOPENIA IN CHRONIC LEAD POISONING.** Gigiena Truda i Prof. Zabolevaniya (Moscow), 10(8):31-36, 1966. 36 refs. Translated from Russian. Joint Publications Research Service, Washington, D. C., p. 53-61, Dec. 2, 1966. CFSTI: TT 66-35351

A study was made of causes provoking erythrocytopenia in lead poisoning. In 65 males the amount of hemoglobin, erythrocyte count, their diameter, volume, thickness, spherical index, osmotic, saponin and acid resistance were analyzed. Estimation was made of free hemoglobin and bilirubin. Myelograms of the bone marrow, its proliferative and macrophage activity were studied. The authors found more than normal destruction of erythrocytes by the macrophage elements of the connective tissue. The intravascular hemolysis in the examined patients was of no material importance. In response to hyperhemolysis the bone marrow becomes the seat of a developing erythroid series hyperplasia. The circulating blood receives an increased number of young cells, some of which differ from the normal ones both morphologically and functionally. There are grounds to believe that lead acts upon the erythroid series of the bone marrow, this results in the production of inferior erythrocyes and leads to their quicker destruction. (Authors' summary, modified)

09486

B. F. Murashov

**FUNCTIONAL STATE OF THE ADRENAL CORTEX IN CHRONIC INTOXICATION WITH TETRAETHYL LEAD.** Gigiena Truda i Prof. Zabolevaniya (Moscow), 10(8):46-47, 1966. 8 refs. Translated from Russian. Joint Publications Research Service, Washington, D. C., p. 79-82, Dec. 2, 1966. CFSTI: TT 66-35351

An attempt to elucidate the functional state of the adrenal cortex in persons exposed to a chronic action of tetraethyl lead was made. Its function was estimated from the content of 17-oxycorticoster- oids (17-OCS) in the blood plasma and from the content of 18- OCS and 17-ketosteroids in diurnal urine. The reserve possi- bilities of the adrenal cortex were ascertained by means of a func- tional -- through a study of the level of 17-OCS in the blood plams before and two hours after intramuscular administration of 25 units of ACTH (adrenocortiocotrophic hormone). Examina- tion was made of 25 subjects (drivers and automobile mechanics) with chronic intoxication with TEL (23 males and two females) aged from 36 to 56. Their exposure to TEL lasted 10--30 years. The clinical picture of intoxication was characterized by pro- nounced asthenovegetative distrubances expressed in the majority of patients by general weakness, as well as by functional and organic affections of gastrointestinal tract (nine subjects); besides, five patients complained of 'softening' of teeth and sensation of the presence of a 'hair' in the mouth. Among disturbances of cardio- vascular system there were noted bradycardia (in 18 patients), hypotension or a tendency towards it (in 12), and an increase of arterial pressure (in one). All the investigated persons were treated several times (from three to six) in various therapeutic institutions due to their asthenic condition caused by a chronic intoxication with TEL. The control group was represented by 125 healtyy persons. Analysis of the results showed a significant de- crease of 17-OCS level in the blood plasma and urine, as well as a decrease of diurnal excretion of neutral 17-KS. 17-OCS level in the blood plasma following the introduction of ACTH increased by 150%.

09493

P. A. Chayka

**ON THE PROTECTIVE EFFECT OF PECTINS AGAINST THE POISONING OF ANIMALS WITH AN AEROSOL OF LEAD.** Gigiena Gruda i Prof. Zabolevaniya (Moscow), 10(3):47-49 1966. 19 refs. Translated from Russian. Joint Publications Research Service, Washing- ton, D. C., p. 67-72, June 9, 1966. CFSTI: TT 32361

Poisoning rats with an aerosol of lead in a concentration of 0.004 mg/l for 6 hrs/day for 120 days evoked in them a pronounced clincial picture of lead poisoning. Apple pectin, added to the ordinary ration in the amount of 400 mg/l kg of animal weight, considerably reduces the toxic effect of lead, not only when this substance is introduced enterically, but also when it enters the organism through the respiratory organs in the form of an aerosol. On the basis of data in the literature and this research it is recommended that workers in lead enterprises be given apple pectin in the form of marmalade, fruit jelly or tablets with an addition of sugar and natural syrups as a supplementary element in a diet intended to have a prophylactic affect. The protective dose of pectin must be measured by taking into account the degree of the hazard of lead poisoning, within the limits of 0.2-0.5 g per 1 kg of the worker's weight.

09535

Teisinger, J.

**RELATIONSHIP BETWEEN LEAD LEVEL IN BLOOD AND IN URINE IN PERSONS NOT EXPOSED TO LEAD.** ((Vztah mezi hladinou olova v krvi a v moci u lidi olovu neexponovaných.)) Text in Czech. Casopsis Lekaru Ceskych (Prague 105(30):810-812, July 5, 1966. 5refs.

Lead levels are tabulated for 789 urine and blood samples obtained from persons in 16 countries and major cities who had not been occupationally or otherwise exposed to lead. Lead levels in blood and urine ranged from 7-26microgram% in blood and 22-46 microgram/1 in urine. Analysis of the data showed that the lead concentration in the blood is directly proportional to that in urine. An in- crease in the blood level of 1 microgram % is accompanied by an increase in the urine level of 1.4 microgram/1. A plot of lead concentration in the blood vs. that in the urine gives a straight line which intersects the urine concentration ordinate at a value of about 12 microgram/1. Since this is impossible it appears that the correlation line must be curved in the lower concentra- tion range. The proportionality between the lead concentration in the urine and in the blood is considered as indirect evidence that lead at normal blood levels is excreted by glomerular filtra- tion only.

10434

J. Kubota, V. A. Lazar, F. Losee

**COPPER, ZINC, CADMIUM, AND LEAD IN HUMAN BLOOD FROM 19 locations IN THE UNITED STATES.** Arch, Environ. Health, 16(6):788-793 June 1968. 20 refs.

Copper (Cu), zinc (Zn), cadmium (Cd), and lead (Pb) were determined in 243 blood samples of male residents of 19 cities in the continental United States. The mean Cu and Zn concentrations of all samples agreed closely with values reported by other investigators. The means among the 19 locations, however, differed by threefold in Cu and fivefold in Zn. The levels of Cu and Zn in blood in 17 locations were normally distributed about their means except in two locations. Unlike Cu and Zn, the concentrations of Cd and Pb varied widely among samples from a given location. (Authors' abstract)

10793T

Castellino, N. and V. Perla

**CARBON MONOXIDE CONCENTRATION IN THE BLOOD.** (Contributo allo studio della carbossiemia.) Translated from Italian. Folia Med. (Naples), 42(3):209-222, March 1959. 20 refs.

COHb levels were measured in 302 patients: 46 with diabetes, 66 with gastrointestinal and hepatic disorders, 38 with anemia, 30 with cardiac conditions, 74 with respiratory ailments, and several with occupational diseases (24 with caisson disease and 14 with lead poisoning). Readings were compared with those from 100 normal subjects, with breakdown by smoking habit. In only a very few patients with uncompensated cardio-circulatory disturbances or respiratory diseases was any increase in COHb level noted. The high levels in these particular morbid conditions are attributed to incomplete CO elimination through the lungs, with a consequent build-up in the blood, rather than, as others have proposed, to oxygen insufficiency, with consequent failure to oxidize carbon to carbohydrate. Thus, the presence of CO in the human bloodstream is considered to be of foreign origin, no endogenous. The wide variations observed simply reflect heavier absorption or lowered elimination as a result of individual or environmental differences.

10856T

Stofen, D.

**EFFECT OF LEADED GASOLINE ON HEALTH.** ((Gesundheitliche Folgen der Benzinverbleiung.)) Translated from German. Preprint, 6p., 1965. 17 refs.

Work dealing with the dangers of leaded gasoline are reviewed. Much of the research, conducted by Kettering Laboratories, points out that the lead level in the blood of the average American is not essentially increased by the use of leaded gasoline. Swiss workers report that blood lead levels are deceptive and unreliable. Furthermore, tetraethyl lead can be directly inhaled by passengers in an air-conditioned car if the engine and carburetor are not correctly adjusted. Genetic effects of lead on the fetus have been noted. Effects of lead poisoning on human beings, especially upon intelligence, are reviewed, and a few precautions listed.

11462T

Bousser, Jaques

**FROM SATURNISM.....TO THALASSEMIA.** ((Du saturnisme.....a la thalassemie.)) Translated from French. Cahiers du College Medicine Hopitaux de Paris, Vol. 6, p. 253-254, March 1965.

The observations of a patient who had worked in a plant for 6 months handling toxic products of the 'White Spirit' type are given. He showed signs of chronic lead poisoning; however he did not touch any toxic products that might have contained lead. After extensive examination, it was found that the patient had minimal thalassemia, a hereditary blood anomaly which was not of great consequence to his health and which could not prevent him from working in any way.

11468T

Scheel-Thomsen, A.

**LEAD POISONING OF ANIMALS BY THE EXHAUST FROM MOTOR VEHICLES.** ((Dyr blyforgiftede af Ubdlaesning Fra Motorkoretojer.)) Translated from Danish. Dansk Dyrlaegeforening Medlemsblad (Copenhagen), Vol. 39, p. 596-598, 1956.

Three cases of lead poisoning in dogs are reported. One dog spend considerable time in a large engine shed for motor trains, another spent most of the day in an auto dealer's garage, and the third involved a dog which traveled daily with its owner in an automobile, always lying on the floor of the automobile. The investigation revealed a local stomatitis, in two of the dogs. All three displayed tremor in the hindquarters, loss of weight, sluggishness, and albumin in the urine. All three patients reacted promptly to Antoxol treatment.

11552

Ambrosi, L., F. Vimercati, and C. di Nunno

**LARGE LYMPHOCYTES IN THE BLOOD OF PATIENTS WITH CHRONIC LEAD POISONING.** ((Sui grandi linfociti del sangue dei saturnini.)) Text in Italian. Med. Lavoro 59(2):125-135, Feb. 1968. 16 refs.

High percentages (19-59%) of large lymphocytes were found in the peripheral blood of 20 patients with saturnism employed in the manufacturing of storage batteries. These cells, stained by the method of Unna-Pappenheim, showed intense cytoplasmic basophilia. In the peripheral blood of 20 subjects not exposed to lead, the percentage of large lymphocytes was within normal limits (2-19%). The results are discussed on the basis of bibliographic data on the significance of the large lymphocytes and of changes of Coombs' test in saturnism. The usefulness of the determination of large lymphocytes in saturnism is emphasized.

11580

Lilis, R., N. Gavrilescu, B. Nestorescu, C. Dumitriu, and Ama Roventa

**NEPHROPATHY IN CHRONIC LEAD POISONING.** Brit. J. Ind. Med., 25(3):196-202, July 1968. 33 refs.

A study of renal function in 102 patients with lead poisoning is presented. Every possible cause of renal damage, other than lead, was excluded by a careful differential diagnosis. Significant decreases of the clearance values (less than 50 ml./min. urea clearance and less than 80 ml./min. creatinine clearance), persistent high blood urea (more than 50 mg./100 ml.), and high blood creatinine (more than 1.2 mg./100 ml.) were found in a significant number of cases. Signs of impaired renal function and high blood pressure were more frequent in the group of patients with chronic lead poisoning who had had several episodes of colic and an occupational exposure of more than 10 years. The duration of occupational lead exposure, the high absorption in the past, and the long period of observation of these patients, most of whom were repeatedly hospitalized, may explain the relatively high incidence (17 cases) of nephropathy with chronic renal failure in the present group.

Impairment of urea clearance seems to be the earliest sign, at a time when the creatinine clearance is still normal. As the duration of exposure lengthens and the patient is subjected to active episodes of poisoning, creatinine clearance also deteriorates. Persistent urea retention and high creatininaemia may follow in time, accompanied rather frequently by arterial hypertension. Functional and temporary alterations of renal function are probably caused by impairment of renal circulation, resulting from marked vasoconstriction caused by lead poisoning. Prolonged exposure and frequently recurring episodes of acute poisoning may lead to progressive impairment of renal function and to the development of organic lesions.

11630

Antal, Andrei, Jeanette Timaru, Elena Muncaci, Ecaterina Ardevan, Ala Ionescu, and Lia Sandulache

**VARIATIONS OF THE ORGANISM REACTIVITY AND THE STATE OF HEALTH OF CHILDREN IN REGARD TO TOWN AIR POLLUTION.** (Les variations de la reactivite de l'organisme et de l'etat de sante des enfants en rapport avec la pollution de l'air communal). Atmos. Environ., 2(4):382-392, 1968. 33 refs. Franklin Inst. Research Labs., Philadelphia, Pa., Science Info. Services, 20p.

Organism reaction and state of health of the child population in a metallurgical center where atmospheric lead concentrations exceeded prevailing sanitary standards was studied in various investigations (clinical, somatometric, capillaroscopic, nerve reactivity, adaption disturbance, psychometric, etc.) In a parallel manner, children in a control city where the air was relatively pure were examined. The observations were made on varying numbers of children, according to the kind and character of the tests. Antropometric tests were applied to 2310 children, dynamometric to 1702, capillaroscopic to 1658, and tests of neuropsychic activity to 258-948 children. The data obtained indicate a decreased resistance of the respiratory apparatus to pathogenic agents on the part of the children in the polluted city. In particular, upper respiratory tract infections, pneumonia and bronchopneumonia, anemia, anitaminosis, rachitis, disorders of the digestive tract, and dental decay were more frequent by 9 to 31%. In addition, the children exhibited poorer psychical and physical development, more frequent adjustment problems, reduced scholastic performance, and greater frequency of aberrant capillaries. The degree of air pollution reaction differences was found to be related not on the extent of pollution, but also to the degree of development, sex, age, biological condition of the subjects, and duration of exposure. Sensitivity was greater in girls and preschool children, and proportional to the length of exposure to pollutants.

11808

Sellent, Robert, Harriet Sun, and Hannes Callisen

**DETERMINATION OF CERTAIN SUBTOXIC EFFECTS OF LEAD IN RABBITS AS A FUNCTION OF BLOOD LEAD BURDEN.** In: Air Pollution Project: An Educational Experiment in Self-Directed Research, Summer 1968. Associated Students of the California Inst. of Tech., Pasadena, p. 65-72, 1968. 4 refs.

Studies of the toxic effects of different levels of lead in the body require an environment in which laboratory animals can be raised with minimum exposure to lead. For this purpose, special chambers were constructed of lucite and wood. Compressed air is supplied to the chambers through a filtration system calculated to remove approximately 95% of atmospheric lead. Lead samples are obtained for atomic absorption spectrophotometry analysis by adding in turn NaOH, ammonium pyrrolidine dithiocarbamate, and methyl isobutyl ketone to centrifuged mixtures of trichloroacetic acid and whole blood. Preliminary tests indicate that animals kept in the chambers for two months experienced a 25% reduction in lead concentrations.

12038

**HEALTH AND AIR POLLUTION SUBJECT OF NEW STUDIES.** Environ. Sci. Technol., 2(4):246-249, Apr. 1968.

For the next seven years, Hazleton Laboratories Inc. will be studying the effects of air pollutants on laboratory animals, including guinea pigs and monkeys. One study financed by Edison Electric Institute and National Coal Association is intended to provide data useful in setting criteria for the three most conspicuous pollutants emitted from stacks of coal-burning plants: SO2, H2SO4 mist, and flyash. Test animals exposed to the pollutants are being checked regularly to determine whether their respiration is being affected and if so, how much. The second study, financed by the American Petroleum Institute will emphasize the possible role of synergism in air pollution. This study will cover various concentrations of five air pollutants: CO, NO2, SO2, lead chlorobromide, and CaSO4.

12070

Einbrodt, Hans Joachim, Heinrich Reploh, and Hildegard Kortemme

**LEAD DEPOSITION IN NORMAL HUMAN LUNGS.** Staub (English translation), 28(8):22-25, Aug. 1968. 23 refs. CFSTI TT 68-5044818

Lungs from dead bodies of females persons, who lived in large industrial towns, were dissolved by means of formamide. The lead content of dust present in the lungs and of the formamide residue was determined. It was found that the lungs of younger women retained a considerably larger amount of organic lead than those of older women. This fact is associated with increasing pollution of air with lead occurring in large towns. The amounts of lead found corresponded to the values for lead content of human lungs determined in Los Angeles. (Authors' summary)

12075

Schroeder, H. A., and Isabel H. Tipton

**THE HUMAN BODY BURDEN OF LEAD.** Arch. Environ. Health, 17(6):965-978, Dec. 1968. 40 refs.

Concentrations of lead in human tissues from 33 cities of the United States and foreign countries were determined. Differences from place to place were observed, median values generally being higher in US subjects than in those from Africa, the Middle East, and in a few tissues, the Far East. Mean values of Pb increased with age in US aortas, kidneys, bones, livers, lungs, spleens, and pancreases; in foreign tissues only aortic lead increased with age. Smooth, striated, and heart muscles and brain had little lead. Bone lead was higher in US subjects than in Far Easterners. Bone contained 91% of the total body lead. It is likely that atmospheric lead from motor vehicle exhausts largely accounts for increased exposures, and that inspired Pb may make up a sizable portion of the total amount absorbed by the body. In human soft tissues, mean concentrations of lead were found to displace any of the essential trace elements of low concentration: chromium, manganese, cobalt, copper, or molybdenum. In view of the steadily increasing annual pollution of air and soils with Pb from motor vehicle exhausts, innate toxicity in exposed human beings may appear. (Author's Summary Modified)

12646

**BEHAVIORAL TOXICOLOGY LOOKS AT AIR POLLUTANTS.** Environ. Sci. Technol., 2(10):731-733, Oct. 1968.

Behavioral toxicology research attempts to relate subtle chemical and physiological changes induced in the brain to changes in behavior. A research group under Dr. Charles Xintaras, head of the National Air Pollution Control Administration's behavioral toxicology unit, is studying the effect of various air pollutants on the neurochemistry, neurophysiology, and behavior of rats and monkeys. The Cincinnati group has concentrated its studies on three commonly occurring pollutants: Carbon monoxide which appears to interfere with the subject's awareness of his environment; ozone which may impair vision and depress body temperature; and lead which appears to interfere with brain function. The preliminary studies are discussed and a brief review of the work to be undertaken is presented.

12984

Einbrodt, H. J., H. Kinny, and H. Kortemme

**QUANTITATIVE STUDIES ON LEAD TRANSPORT BY LYMPHATIC GLANDS IN THE HUMAN LUNG.** (Quantitative Untersuchungen uber den Lymphtransport von Blei aus der menschlichen Lunge). Text in German. Arch. Hyg., 153(2):105-108, April 1969. 12 refs.

Dusts from the lymphatic glands of 17 female residents of the Ruhr area and 14 miners afflicted with silicosis were examined for their lead content. For this purpose the dusts were isolated by the formamide method. The dust from the female lymphatic glands contained an average of 53 micrograms of lead (absolute) and 5.5 mg Pb per 100 g dry tissue. As a measure of the lymphatic transport, the quotient: lead in the lymphatic gland dust/% lead in the lung dust was used. Thus, a quotient of 2 for the lymphatic transport was obtained in this case. The dusts in the lymph glands of the miners contained on the average 62 micrograms of lead (absolute) and 1.339 mg Pb per 100 g dry tissue. The quotient for the lymphatic transport of lead was 1.22. This quotient is almost as high as that of quartz, and the quotient for women is even higher. But strikingly enough, a still higher quotient was found in the control group. This can be explained by the fact that lymphatic transport ceases in persons afflicted with silicosis since the glands are filled, whereas in persons not exposed to dust, lymphatic transport is maintained. The studies also showed that lead has a cytotoxic effect which is similar to that of quartz.

13059

Chovin, P. and L. Truffert

**DISTRIBUTION AND SIGNIFICANCE OF CARBON MONOXIDE AS AN ATMOSPHERIC POLLUTANT. IMPORTANCE OF OTHER POLLUTANTS EMITTED IN AUTOMOBILE EXHAUST. (Distribution et signification de l'oxyde de carbone en tant que polluant atmospherique. Importance des autres polluants emis par les gaz d'echappement des vehicules automobiles).** Text in French. Pollut. Atmos. (Paris), no. 39: 148-155, July-Sept. 1968. 66 refs.

The distribution of carbon monoxide is discussed, particularly that arising from automobile exhaust gases, and an empirical formula is given for calculating the carbon monoxide content at any height, given a background concentration, the number of vehicles per hour, and a constant which in turn is a function of the width of the road and the height of the exhaust. The hemoglobin-CO reaction in the blood is reviewed, and studies made on police officers in Paris are cited in which levels of blood carbon monoxide were determined. In non-smokers, there was a definite rise in concentration. Levels fixed in California for carbon monoxide in ambient air are cited as 30 ppm for 8 hours or 120 ppm for 1 hour for serious exposure; exposure of 240 ppm for 1 hour can cause acute illness, since 10% of the hemoglobin is bound as carboxyhemoglobin. Effects of carbon monoxide in man other than combination with hemoglobin are cited, i.e., effects on the blood-forming apparatus, circulatory system, and the eye. Other pollutants arising from automobile exhaust are mentioned, including lead, oxides of nitrogen, compounds produced by photochemical reactions with ozone, and aldehydes. In conclusion, the many differences in allowable levels of carbon monoxide in Russia and western countries are pointed out, and the differences in carbon monoxide ingestion between smokers and non-smokers. A common sense approach to setting standards for air quality is advocated.

13154

Tada, Osamu

**ON THE METHODS OF EVALUATING THE EXPOSURE TO TOXIC SUBSTANCES BY ANALYZING THE METABOLITES IN THE BODY.** (Tainai taisha sanbutsu n yoru yugaibutsu bakuro hyokaho). Text in Japanese. Rodo Kagaku (J. Sci. Labour, Tokyo), 45(4):171-183, 1969. 177 refs.

Under certain conditions, the amount of toxic substance absorbed by workers exposed to toxic air contaminants cannot be predicted from air analysis data. If the concentration of metabolites in tissue or excreta is proportional to that of the toxic substance in the air, the degree of adverse exposure may be evaluated by analyzing samples of expired air, blood, urine, or hair, with reference to atmospheric threshold limit values. Tests for assessing the level of exposure to carbon monoxide, mercuric vapor, inorganic lead, and chlorinated hydrocarbons are discussed. Of the various methods developed for determining the carboxyhemoglobin level in the blood of workers exposed to carbon monoxide, the 20-second breath holding method is the most practical and convenient. If the determination is carefully made, the urinary excretion of mercury can be used as an indicator of exposure to mercuric vapor. The absorption of lead varies according to whether it is absorbed as fume or dust. Therefore, the degree of exposure should be evaluated by analyses of lead in urine or blood during repeated exposure. The storage of lead in the body can be determined by the increase in urinary excretion of lead following the administration of calcium ethylenediaminetetraacetate. The determination of urinary excretion of alkaline-pyridine reactants is tentatively suggested as an indicator of exposure to chlorinated hydrocarbons. (Author abstract modified)

13159

Ferrando, R. and G. Milhaud

**THE BIOLOGICAL EFFECTS OF AIR POLLUTION OF ANIMALS.** (Effets biologiques de la pollution atmospherique sur les animaux). Text in French. Rev. Hyg. Med. Soc., 17(3):295-306, 1969. 2 refs.

Air pollution has many effects on animal organisms. Fluorine by-products, lead, and molybdenum are the major offending constituents in industrial air pollution. Cement dust and sulfur dioxide cause less of a problem. Pollution of agricultural origin is essentially linked to the more or less controlled use of pesticides. A temporary imbalance of natural fauna is most often indicated when domestic animals are victims of atmospheric pollution. The damage caused to livestock by this pollution will remain localized and its economic consequence will be relatively unimportant. The social consequences of this pollution are more severe, and it is as important to preserve the social climate as the health of the animals. The solution to these

problems has long been in the hands of lawyers. Though indirect, the risk to the food cycle is serious. It will be necessary to institute strict tests for determining the amount of residual pollutants able to exist in food destined for men and to regulate the use of products absorbing these pollutants.

13625

Lindberg, Walter

**AIR POLLUTION IN NORWAY. II. PUBLIC HEALTH ASPECTS OF AIR POLLUTION - A LITERATURE STUDY.** (Den Alminnelige Luftforurensning i Norge. Luftforurensning som Helseproblem, - en Litteraturstudie.) Translated from Norwegian. Oslo Univ. (Norway), p. 66-77, 1968.

This presentation discusses functional and anatomical changes arising from diseases caused by air pollution. The discussion includes air pollution episodes, pollutants known to cause specific effects (arsenic compounds, mercury, beryllium compounds, manganese compounds, and lead). Lead and carbon monoxide are discussed in greater detail. Emphasis is also placed on respiratory irritations caused by SO2, nonspecific upper respiratory diseases, the effect of air pollution on the occurrence of colds, smoking, chronic bronchitis emphysema, bronchial asthma, lung cancer, and heart disease.

14156

Spies, H. W.

**ENVIRONMENTAL RESEARCH IN LEAD AND SULFUR.** Proc. Am. Petrol. Inst., Sect. III, vol. 49:550-563, 1969. (Presented at the Session on Air and Water Conservation, 34th Midyear Meeting, Div. of Refining, Am. Petrol. Inst., May 13, 1969.)

Several research projects in lead and sulfur effects sponsored by the American Petroleum Institute are reviewed. A study of the effects of SO2 and dust exposure on rats was completed. With increasing times of SO2 exposure, there was a marginal effect with some diminution of ciliary activity after four weeks and some recovery of ciliary function after 8-12 weeks of exposure. The effects of air pollution on individuals with chronic respiratory disease was the subject of another study. Sulfur dioxide and particulates were monitored, and a correlation was found between high levels of pollutants and conditions of atmospheric inversion phenomena as demonstrated by a higher incidence of respiratory symptoms in individuals over 55 with chronic pulmonary disease. A study on the standards for lead in ambient air showed that the only effect on a subject exposed to lead was a slight increase in the amount of lead excreted during the latter part of the exposure. Another study on lead in air, plants, and soil as influenced by proximity to highways showed that there is a rapid decrease in concentrations of lead in the air and in the first 100 ft from the highway and that concentrations are highest in September and January. It was also reported that there would be a continuation and expansion of a study of urban lead levels. Blood and urine specimens will be taken from individuals and analyzed for lead content. In another study not yet completed, volunteers will be exposed to 10 micrograms of lead/cu m of air for 22 hours a day, seven days a week, for a period of 16 weeks. Biological specimens will be taken from them and analyzed. (Author abstract modified)

14492

Yamaga, S., K. Ohmori, M. Tanaka, and H. Nakamura

**EFFECTS OF INHALATION OF LEADED GASOLINE.** (Kaen gasoline kyunyu no eikyo ni tsuite). Text in Japanese. Nippon Eiseigaku Zasshi (Japan J. Hyg.), 24(1):144, April 1969.

Since leaded gasolines have been increasingly used as automobiles multiply, the examination of their effects on human health has become necessary. Examination of lead content of the urine of 16 gas station attendants and nine automobile drivers did not show the influence of lead inhalation. The lead content of blood, urine, and organs was studied in six rabbits who inhaled 500 ppm leaded gasoline for 3 hrs/day, five days a week, for 92 to 220 days. Lead in the blood increased gradually, but lead in the urine did not vary much. General quality of blood was normal, except that some samples were anemic. Accumulation of lead in the liver and kidneys was observed in all cases.

15703T

Delwaide, P., C. Heusghem, and A. Noirfalise

**CHRONIC LEAD POISONING: BIOCHEMICAL LESIONS AND BIOCHEMICAL SYMPTOMATOLOGY.** (Le saturnisme: Lesions biochimiques et semeiologie biologique.) Translated from French. Ann. Biol. Clin. (Paris), 26(7-9):987-1001, 1968. 44 refs.

This paper reviews what is known about lead metabolism, and discusses biochemical toxicology, the biosynthesis of porphyrins, iron metabolism, the effect of lead on mature erythrocytes, and other metabolic disturbances. The complexity of lead metabolism precludes any diagnostic value of isolated lead level determinations in blood or urine. To demonstrate the state of impregnation of the organism with this toxin, the test of provoked urinary lead excretion should be performed in the chronic stage. Furthermore, a battery of assays including the levels of delta-ALA, PBG, CP and free PP in erythrocytes are required to reveal the biochemical disturbances at the target level where individual variations may play a role.

15731

ERMAKOV, E. V. and B. F. Murashov

**ON THE MECHANISM OF TETRAETHYL LEAD ACTION.** (K voprosu o mekhanizme deystviya tetraetilsvintsa). Text in Russian. Gigiena Truda i Prof. Zabolevaniya, no. 7:53-54, 1969.

Studies were conducted at the Kirov Military-Medical Academy to evaluate the effects of tetraethyl lead (TEL) on the neuroendocrine system. Four hundred patients were examined. Electroencephalograms were conducted on 103 patients; 78 showed EEG deviation. Focal Affectation of the brain was not detected. However, 31 patients showed a decrease in or total loss reaction to light; 32 patients showed a decrease in or total loss of reaction to sound; and 6 patients showed inverted reaction to light and sound.

16810

Goldsmith, John R.

**EPIDEMIOLOGICAL BASES FOR POSSIBLE AIR QUALITY CRITERIA FOR LEAD.** J. Air Pollution Control Assoc., 19(9):714-719, Sept. 1969. 23 refs.

In at least some urban areas, population exposure to elevated atmospheric lead levels is associated with increased blood lead. No reasonable alternative explanation exists other than that the increased levels of lead pollution are causing increased lead storage in the body. The study of lead body burdens in U. S. populations indicates an increasing concentration with age in liver, spleen, pancreas, kidney, and lung. No such increase is found in samples of residents from foreign countries. The effect of increased storage of lead on porphyrin metabolism is in urgent need of investigation. Higher levels of lead exposure may interfere with hemoglobin synthesis. Using

W. H. O. categories for air quality guides (criteria), a level I criterion for two micrograms of lead per cubic meter of air for a long-term average can be proposed. It would apply to pollution largely derived from motor vehicular sources. (A discussion by Gordon J. Stopps follows the main text.) (Author's Abstract)

16820

Pitts, James N., Jr.

**ENVIRONMENTAL APPRAISAL: OXIDANTS, HYDROCARBONS, AND OXIDES OF NITROGEN.** J. Air Pollution Control Assoc., 19(9):658-669, Sept. 1969. 55 refs.

The relationship between criteria, standards, and control of air pollutants involve complex multidisciplinary interactions. Their overall impact on the public health and welfare is directly related to the confidence level held by members of government, industry, and universities in the validity of the data upon which these criteria are based. The Environmental Appraisal section of the preliminary draft of the Air Quality Criteria Document 'Photochemical Oxidant' prepared by the State of California, Department of Public Health, is reviewed. In general, it is a thoughtful and extensive effort to present the current status of information concerning the physical and chemical aspects of photochemical oxidant. Suggestions as to how it might be extended, revised or updated are presented along with a brief discussion of two new research areas of possible interest, singlet molecular oxygen as a possible environmental oxidant and the photochemistry of mixed lead halides in the atmosphere. This article is followed with a discussion by Richard D. Cadle. (Author's Abstract)

17214

Harley, John H.

**DISCUSSION. SOURCES OF LEAD IN PERENNIAL RYEGRASS AND RADISHES.** Environ. Sci. Technol., 4(3):225, March 1970.

Human intake of lead was described. The highest concentration of lead was found in New York City. Using 2 micrograms/cu m as the average concentration and a breathing rate of 20 cu m/day, the total annual intake of lead by man would be only 15 mg. The usual values for drinking water were 10 micrograms Pb/liter. The standard consumption of 400-500 liters/year would contribute 4-5 mg Pb/year. The amount of lead found in various diet components was also given. The majority of man's exposure to lead comes from dietary sources. The previously reported suggestion that prehistoric man ingested a smaller amount of lead than modern man by avoiding plant foods was considered unlikely. In actuality, the meat portion of the diet contributes about one-third of the lead and only 10% of the mass of the diet. If prehistoric man avoided plant foods, his dietary intake would most likely be higher than if he was a vegetarian. It was also found that cattle living under conditions described (air concentration 1 microgram/cu m, fodder concentration 5 micrograms/g dry weight) would be taking in about 30 g Pb a year from the diet and about 50 mg from the air. Thus, the animals' fraction of intake from the diet is higher than man.

17244

Suzuki, Takeo

**STATUS OF AIR POLLUTION BY AUTOMOBILE EXHAUST IN JAPAN -- IN VIEW OF PUBLIC HEALTH.** (Jidosha haikigasu niyoru kankyoosen no taiyo Koshu eiseigaku no tachiba kara). Text in Japanese. Kogai to Taisaku (J. Pollution Control), 4(11): 702-712, Nov. 15, 1968. 17 refs.

In the past, research on the effect of motor vehicle exhaust gas on humans was limited to laboratory experiments. When the effect of emissions on public health becomes more visible, a comparative study was undertaken in the United States of carbon monoxide density inside a house and outdoors. No significant difference was observed, indicating that buildings do not work to exclude atmospheric pollutants. Of motor vehicle exhaust components, those that matter from hygienic viewpoint are, in order of their importance carbon monoxide, nitric oxide, and lead. Carbon monoxide density is commonly referred to in determining the effect of auto exhaust has on the human body because of its strong chemical affinity with hemoglobin; and a medical survey has disclosed a relationship between the amount of blood and CO density in environmental atmosphere. People living in areas of heavy traffic have an average CO hemoglobin of 3.75%, which is nearly equivalent to that found in cigarette smokers. Of the nitrogen oxides, NO alone may not have a specific effect on the human body, but even low concentrations of NO2 effect the respiratory organ even with low density because of its water- resistant nature and the ease with which it pentrates the lung cells. Unlike the other gaseous components, lead accumulates also in water, vegetation, and foods.

17470

Shirakaw, Kenichi

**SYMPTOMS OF NERVE TROUBLE DUE TO PUBLIC NUISANCE. HEAVY METALS AND ORGANIC SOLVENTS.** (Kogai niyoru shinkeishojo. Jukinzoku to yukiyozai). Text in Japanese. Nippon Rinsho (Japan Clin.), 28(3):551-555, March 10, 1970. 10 refs.

Characteristic symptoms of heavy metal and organic solvent poisoning are discussed, with emphasis on representative neural symptoms. Motor symptoms identified with inorganic lead poisoning are paralysis of the arms, mononeuritis, and polyneuritis, the latter characterized by sharp contractions of the legs and arms. Early symptoms of alkyl lead poisoning are chronic fatigue, headache, and vertigo. These are followed by muscular ache, low fever, perspiration, low blood pressure, feeble pulse, and declining mental faculties, which are defined as nerve debility at the serious stage. Arsenic poisoning manifests itself in catarrh of the digestive and respiratory organs and in neuritis and skin disease. In arsenic poisoning, perceptive nerve troubles appear after one or two weeks' exposure, followed by mental derangement and, in some cases, pain, resulting in the loss of sensation of movement. Barium poisoning is considered a cause of alopecia and polyneuritis. Acute cases exhibit fever, skin disease, alimentary and mental disorders, in addition to respiratory diseases. The latter can result in death. Chronic inorganic mercury poisoning is accompanied by vertigo, insomnia, and heart acceleration. Organic mercury poisoning exhibits diverse symptoms, including concentric constriction of the visual field. Immediately following ingestion, manganese produces hallucination and mental disorders. Chronic manganese poisoning manifests in symptoms resembling those of Parkinson and Wilson's disease. Tin poisoning does not appear to remarkably influence neural organs, though alimentary disorders can result from prolonged exposure. Symptoms of cadmium poisoning, in addition to those of organic solvents, are briefly reviewed.

18046

Hursh, J. B., A. Schraub, E. L. Sattler, and H. P. Hofmann

**FATE OF 212Pb INHALED BY HUMAN SUBJECTS.** Health Phys., 16(3): 257-267, March 1969. 18 refs.

Ten human subjects inhaled 212Pb carried on natural aerosols. Deposition in the lung varied from 14 to 45% of the amount inhaled. Clearance from the lung to the systemic tissues occurred with an estimated half-time of 6.5 hr. The average 24-hr urinary excretion of 212Pb was 2.8 plus or minus 0.15% of the body content. The total loss by fecal excretion adjusted to zero time averaged 3% body content. The 212Pb absorbed from the lungs into the blood is in part fixed by the circulating red cells and in part distributed to other tissues. The red cell 212Pb burden grows to a steady state level which averages 50% of the total body burden. The results are interpreted to indicate that the clearance of radon daughters from the lung parenchyma by absorption into the blood has little dosimetric significance, whereas, in the case of thoron daughters, the average lung dose is reduced to less than half. (Author's Abstract)

18417

Bingham, Eula, Emil A. Pfitzer, William Barkley, and Edward P. Radford

**ALVEOLAR MACROPHAGES: REDUCED NUMBER IN RATS AFTER PROLONGED INHALATION OF LEAD SESQUIOXIDE.** Science, vol. 162:1297-1299, Dec. 13, 1968. 10 refs.

The technique of harvesting alveolar macrophages from excised mammalian lungs was used to obtain a quantitative estimate of the number of these cells. A decreased number was found in washings from lungs of rats inhaling small particles of lead sesquioxide for three to 12 months, compared with control animals exposed to filtered air. This result contrasts with that reported by others for animals given massive exposures to various dusts for short periods of time. Because the concentrations of lead were comparable to those observed in some industrial (150 microgram/ cu m) or urban (10 microgram/cu m) environmental conditions, the results may be significant in terms of human lung clearance processes after such exposure. (Author abstract modified)

18494

Bullock, John D., Robert J. Wey, John A. Zaia, Irwin Zarembok, and Henry A. Schroeder

**EFFECT OF TETRAETHYLLEAD ON LEARNING AND MEMORY IN THE RAT.** Arch. Environ. Health, vol. 13:21-22, July 1966. 4 refs.

Tetraethyl lead injected into rats in doses sufficient to cause overt neurotoxicity did not significantly depress ability to learn a simple task, escape from a water T-maze, nor to remember the task. The mean escape times of 20 controls and 20 rats previously injected with 15 mg/kg TEL body weight, tested 15 times, were significantly different during the first four trials but not thereafter. The rate of learning, that is, the progressive decrease in swimming times from about eight seconds to about three seconds, was similar in the two groups. Mean escape times of trained rats on each day before and during which they received 5 mg TEL/kg body weight on days four through seven and on days six through nine were similar to those of controls.

18501

Cholak, Jacob

**THE QUANTITATIVE SPECTROGRAPHIC DETERMINATION OF LEAD IN URINE.** J. Am. Chem. Soc., vol. 57:104-107, Jan. 1935. 11 refs.

A quantitative spectrographic method is described by which concentrations of lead in urine as low as 1 pphm can easily be detected. Concentrations that can be measured accurately by the technique described lie between 0.01 and 0.20 mg per liter. For amounts of lead up to 0.10 mg per liter the accuracy of the method is 0.01 mg per liter; for amounts above 0.10 and up to 0.20 mg per liter the error is somewhat greater. (Author summary modified)

18502

Catizone, Olga and Peter Gray

**EXPERIMENTS ON CHEMICAL INTERFERENCE WITH THE EARLY MORPHOGENESIS OF THE CHICK. II. THE EFFECTS OF LEAD ON THE CENTRAL NERVOUS SYSTEM.** J. Exp. Zool., vol. 87:71-83, June 5, 1941. 12 refs.

The analysis of results of 348 sub-germinal injections of lead chloride in saline, controlled by 109 injections of saline, shows that lead produces abnormalities of the central nervous system which are not found in the saline controls. These abnormalities are of three kinds of which two--open central nervous system and sinuous central nervous system--are probably due to the same effect. The former, which is most frequently produced by injection of lead after 18 hours incubation, is due to a failure in concrescence of the central nervous system. In sinuous central nervous system, the somites are so crowded together that they are occasionally found lying on top of each other. The third abnormality of the central nervous system-anterior end destroyed--supports the view that the action of lead is on the central nervous system rather than the ectodermal tissues in general, since there is no corresponding destruction of the amnion in this region. It is possible specifically to affect the morphogenesis of a localized organ system, and the nature of the effect on the organ is dependent on the reagent employed. (Author summary modified).

18503

Barltrop, Donald

**TRANSFER OF LEAD TO THE HUMAN FOETUS.** Min. Metab. Paediat. Proc. Glaxo Symp., Greenford, England, 1968, p. 135-151. 25 refs.

The transfer of lead across the placenta was demonstrated at different gastational ages by analysis of human fetal tissues. Differences in the affinity of lead for various tissues are noted and discussed. Results of serial blood lead analyses made on a group of women throughout pregnancy related to the cord blood lead concentrations. A maternal-fetal blood lead equilibrium may exist. (Author summary modified)

18508

Cheatham, James S. and Edwin F. Chobot, Jr.

**THE CLINICAL DIAGNOSIS AND TREATMENT OF LEAD ENCEPHALOPATHY.** Southern Med. J., vol. 61:529-531, May 1968. 3 refs. (Presented at the Southern Medical Association, Annual Meeting, 61st, Miami Beach, Fla., Nov. 13-16, 1967.)

The relationship between lead intoxiciation with encephalopathy and the drinking of illicitly manufactured alcohol in the southeastern region of the United States is discussed. Chattanooga, Tennessee, is a focal point in the manufacture, distribution, and consumption of illicit alcohol, most of which is consumed by members of the lower socioeconomic classes. The signs and symptoms of lead intoxication with encephalopathy include confusion, clouding of the sensorium, disorientation, impairment of memory, and possible auditory and visual hallucinations. Among the various clinical and laboratory guidelines found useful in the identification of lead intoxication are hypochromic anemia, basophilic stippling of the red blood cells, and an increased excretion of porphyrins

in the urine. All patients admitted to the psychiatric unit of a Chattanooga hospital who appeared to be suffering from an acute brain syndrome associated with chronic alcoholism or recent excessive intake of alcohol were checked systematically for lead intoxication; to date eight cases of lead intoxication with encephalopathy have been identified as a reasonable possibility.

18515

Galle, P. and L. Morel-Maroger

**THE RENAL LESIONS OF CLINICAL AND EXPERIMENTAL LEAD POISONING.** (Les lesions renales du saturnisme humain et experimental). Text in French. Nephron (Basel), vol. 2:273-286, 1965. 20 refs.

Renal lesions produced by lead poisoning in man and experimental animals were studied by light and electron microscopy. The study material comprised renal biopsy specimens from 10 patients with lead poisoning, usually of occupational origin, and from 25 rats in which the poisoning had been induced by oral administration of basic lead acetate. The renal lesions of lead poisoning selectively affect the proximal tubular cells, in which appear, in addition to the classic intranuclear inclusions, intracytoplasmic inclusions containing iron and significant mitochondrial lesions. The ultrastructure of the intranuclear inclusions seen most frequently in lead poisoning in man differ from those seen in experimental lead poisoning owing to the difference in the duration of poisoning. The ultrastructural appearance of the intranuclear inclusions seems to be specific for lead poisoning, and these characteristic inclusions tend to persist long after cessation of lead poisoning.

18518

Barltrop, D. and N. J. P. Killala

**FAECAL EXCRETION OF LEAD BY CHILDREN.** Lancet, vol. 2, 1017-1019, Nov. 11, 1967. 10 refs.

Results of preliminary animal work confirming that fecal lead is a sensitive index of the ingestion of lead compounds compared with blood and urine measurements were applied to healthy and lead-poisoned children. The mean fecal lead of single stool specimens from nineteen healthy children was 124 micrograms per stool with an upper limit of normal of 183 micrograms. Values for six hospital inpatients fell within these limits. Three lead-poisoned children had fecal lead levels which exceeded those of normal children by an amount that made statistical comparison unnecessary.

18549

Goldsmith, John R. and Alfred C. Hexter

**RESPIRATORY EXPOSURE TO LEAD: EPIDEMIOLOGICAL AND EXPERIMENTAL DOSE-RESPONSE RELATIONSHIPS.** Science, vol. 158:132-134, Oct. 6, 1967. 12 refs.

Epidemiologic studies of blood lead levels in general and occupational groups show a logarithmic regression on estimated atmospheric exposure. Experimental results at the same and higher levels show a dose-response relationship which fits the same regression. The data indicate that for many urban residents the total quantity of lead absorbed from the respiratory tract is of the same order of magnitude as that absorbed from the gastrointestinal tract; that increased respiratory exposure within the range observed in community air pollution is capable of producing materially increased storage of lead in the body, as reflected in the blood lead level; and that further increases in atmospheric lead will result in high blood lead levels in the population in a predictable relationship.

19159

Kehoe, Robert A., Jacob Cholak, and Robert V. Story

**A SPECTROCHEMICAL STUDY OF THE NORMAL RANGES OF CONCENTRATION OF CERTAIN TRACE METALS IN BIOLOGICAL MATERIALS.** J. Nutr., 19(6):579-592, June 10, 1940. 7 refs. (Presented at the Meeting of the American Chemical Society, 98th, Boston, Mass., Sept. 11-15, 1939.)

A quantitative spectrographic method of high sensitivity and precision was employed for the simultaneous determination of lead, manganese, tin, aluminum, copper, and silver in normal biological material. Lead, manganese, copper, and aluminum were present in all materials examined; tin was present in about 80% and silver in 10-20% of the samples. The mean concentrations of these metals in a liter of normal urine was below 0.01 mg for manganese and 0.078, 0.034, 0.027, 0.011, and 0.00 mg respectively for aluminum, copper, lead, tin, and silver. The mean concentration of the metals in 100 gm of normal whole blood was 0.114, 0.025, 0.015, 0.013, 0.012, and 0.00 plus mg respectively for copper, lead, manganese, aluminum, tin, and silver. Practically all the manganese, lead, and tin were contained in the formed elements of the blood; aluminum was found almost entirely in the plasma, while copper was divided almost evenly between the two, the formed elements usually containing a slightly higher concentration. The concentrations of these metals in consecutive daily or weekly samples of urine and blood from the same individuals were not constant, but varied from sample to sample. The daily output of this group of metals in the feces was practically the equivalent of their daily intake in the diet. The wide distribution of lead was indicated by data obtained on a large number of natural materials. (Author summary modified)

19304

**COUNTERMEASURE FOR LEAD NUISANCE BY AUTOMOTIVE GASOLINE.** (Jidosha gasorin niyoru engai no boshitaisaku nitsuite). Text in Japanese. Sangyo Kogai (Ind. Public Nuisance), 6(6):383-387, June 25, 1970.

Based on an investigation of lead pollution at Ushigome Yanagicho in Tokyo, the Ministry of International Trade and Industry has announced several temporary countermeasures. The lead content of high-octane gasoline should be reduced to half by July 1, 1970, while blending with more than 1.1 ml lead/gallon, which is an average for regular gasoline, is prohibited. By these measures the total lead content of automotive gasoline will be reduced to 25%. The octane value of the high-octane gasoline will be 97, and that of the regular gasoline 90. An extensive countermeasure for automotive exhaust is under consideration. Statistics are included on the permissible concentration of lead for labor hygiene, lead content of gasoline, lead consumption in Japan, lead density in atmospheric particulates, results of physical check-ups at Ushigome Yanagicho, measurements of lead concentration in Tokyo and Osaka, lead consumption in the U. S., concentrations in the atmosphere at Cincinnati, Los Angeles, and Philadelphia, lead content in the urine of workers in battery factories, and the range of hazardous lead content for workers breathing high amounts of lead. The Ministry is working in close cooperation with the Ministry of Health and Welfare, the Ministry of Transportation, and the Police Agency.

19881

Kauranen, P., T. Jaakkola, and J. K. Miettinen

**STABLE LEAD AND RADIOLEAD (210PB) IN THE 'ARCTIC' FOOD CHAIN.** In: Radioactive Foodchains in the Sub-

arctic Environment. (Annual Report). Helsinki Univ. (Finland), Dept. of Radiochemistry, AEC Grant AT (30-1) 3446, Paper 24, 6p., Aug. 1969. 10 refs. CFSTI: NYO-3446-13

The concentrations of stable and radioactive lead in the arctic food chain were determined. Lead was measured by an atomic absorption spectrophotometer. In lichen samples from Lapland, the radiolead concentration was slightly higher, and the stable lead concentration significantly lower than in samples from southern Finland. The specific activity of lead in lichen from Lapland is very high, over 1000 pCi/mg; in southern Finland, the specific activity is 300 pCi/mg. In reindeer samples, specific lead activities between 700 and 1000 pCi/mg were found. Results from human samples indicate that the average stable lead concentration of blood is about the same in Lapps and in southern Finns; the radiolead concentration in the Lapps is 2.5 times higher. This is a consequence of the higher specific activity of lead in the arctic food chain, lichen-reindeer-man. The average specific activity of lead in human blood was 47 pCi/mg in Lapps and 20 pCi/mg in southern Finns. It seems that lichen is the source of the high specific activity lead in the arctic food chain, and that the lead gradually become diluted with less active lead from other sources.

19940

Nishii, S.

**ON THE INFLUENCE OF EXHAUST OF AUTOMOBILE ON HUMAN BODY.** (Jidosha haiki-gasu niyoru osen kuki no jintai ni oyobosu eikyo no tsuite). Text in Japanese. Naika, 21(5):813-819, May 1968. 13 refs.

Chemical substances within the automobile exhaust gas are carbon monoxide, carbon dioxide, methane or other carbon hydrates (including 3,4-benzpyrene and olefins), sulfur oxides, nitrogen oxides, etc. The concentration or amount of these chemical substances differs according to the kind, size, age, or driving condition of the engine. The air to fuel ratio also changes the composition of these substances. Carbon monoxide, carbon hydrates, and dust have higher concentrations under incomplete combustion due to the inadequate air to fuel ratio. Concentrations of CO2, nitrogen oxides, sulfur oxides, and lead are increased with an increase of fuel consumption or an increase of engine rotation. Exhaust gas from a diesel engine has very low CO concentration (0.02 to 0.09%) and a high concentration of dust (0.3 mg/N cu m). The concentrations of CO and dust are the reverse of this in the exhaust gas from a gasoline or LPG engine. Nitrogen oxides show high concentration during acceleration or cruise with a high speed, and low concentration during idling. LPG engines emit higher concentrations of nitrogen oxides, The concentration of Pb (lead oxides or haloid lead) within the automobile exhaust gas is usually 2000 to 5000 micrograms/cu m. Automobile exhaust gas emitted to the ambient air is dispersed immediately after its emission. Dispersion and concentration of the emitted gas differs according to meteorological conditions, surrounding buildings, amount or density of traffic, and so on. The meteorological conditions play the most important role. Among chemical substances which have harmful effects on human bodies, CO is the most important, causing headache, thirst, drowsiness, or slight amnesia; the localized air pollution by CO is seriously observed in Japan (Tokyo and Osaka). In Los Angeles, photo-chemical products are most important, causing mainly irritation to mucous membranes (eyes, respiratory tract) or plants on the road. The radical procedures against air pollution due to automobile exhaust gas are (1) control and removal of harmful chemical components from the exhaust gas; and (2) improvement of the fuel.

20087

Tansy, M. F. and R. P. Roth

**PIGEONS: A NEW ROLE IN AIR POLLUTION.** J. Air Pollution Control Assoc., 20(5):307-309, May 1970. 15 refs.

A study was conducted to ascertian the tissue lead content of randomly procured Philadelphia city pigeons versus rural pigeons, in which the lead content of both groups was assayed by means of atomic absorption spectrophotometry. Tissues were weighed, then vacuum dried at 25 in. pressure to constant weight in 19 hours, and organic matter was removed by wet chemical digestion with a mixture of perchloric and nitric acids. After decomposition of organic matter was complete, the mixture was heated to drive off the volatile constituents, and the lead determinations were made. With one exception, lead concentrations were greater in feathers, nails, beak, femur, liver, and kidney of birds collected from the downtown Philadelphia area then in the feathers and corresponding hard and soft tissues of the country pigeons, while there was no appreciable difference between the lead levels in the blood, tongue, skeletal muscle, brain, trachea, crop, heart, lung, pancreas, spleen, peripheral nerve, and gastrointestinal tract. Possible sources of lead intake were examined and references to past literature were cited, indicating that the most significant general source of biological lead is probably atmospheric.

20198

Smith, Ralph G., Joanne Szajnar, and Lawrence Hecker

**STUDY OF LEAD LEVELS IN EXPERIMENTAL ANIMALS.** Environ. Sci. Technol., 4(4):333-338, April 1970. 10 refs. (Presented at the Division of Industrial and Engineering Chemistry, Symposium on Air Conservation and Lead Division of Water, Air, and Waste Chemistry, 157th National Meeting, Minneapolis, Minn., April 14-15, 1969.)

A large number of rodents was maintained in chambers and exposed to air from an intersection in central Detroit. A comparable group of animals was maintained in identical fashion, but supplied with filtered air that was presumed to contain no lead content. Although lead levels tended to be higher in the exposed group, the difference was significant only in the case of bone levels. Both rabbits and guinea pigs displayed significantly increased bone lead levels. The increases are attributed to the inhalation of approximately 2.5 micrograms/cu m of lead for a period of nearly four years. Estimates indicate that although the lead intake by ingestion was considerably greater than that by inhalation, lead is more efficiently absorbed by inhalation. (Author abstract modified)

20287

Jerardino, M. and C. Barrios

**ATOMIC ABSORPTION SPECTROPHOTOMETRIC DETERMINATION OF REGIONAL-TYPE PLUMBEMIAS.** (Determinacion por espectrofotometria de absorcion atomica de una plumbemia de tipo regional). Text in Spanish. Anales Real Acad. Farm. (Madrid), 35(4):421-435, 1969. 27 refs.

Blood and urine samples were taken from 100 normal human subjects (50 urban, 50 rural) and from 40 subjects from environments in which they were known to be exposed to quantities of lead; samples were examined for lead content, using a Perkin-Elmer atomic absorption spectrophotometer. From the data, a standard 'urban' value and a standard 'rural' value for the lead content of the blood was established. No significant difference was found between urban and rural values in the case of the lead content of urine, and serum proteins did not differ significantly except in the case of the gamma globulins. Employees of Acero del Pacifico, of gasoline companies, and of a printing plant gave blood samples with a significantly

higher lead content. The lead content of blood in normal individuals was dependent on age.

20687

Linch, Adrian L., Emil G. Wiest, and Morris D. Carter

**EVALUATION OF TETRAALKYL LEAD EXPOSURE BY PERSONNEL MONITOR SURVEYS.** Am. Ind. Hyg. Assoc. J., 31(2):170-179, March-April 1970. 9 refs.

Coincident with a review of the Threshold Limit Values (TLV's) for tetraalkyl lead and the incorporation of TLV's into state regulations, an evaluation of the lead exposure control program was made. Fixed station atmospheric sampling in the tetraethyl lead (TEL) and tetramethyl lead (TML) manufacturing areas did not correlate well with urinary excretion rates or routine medical examinations of personnel. Personnel monitoring with individually worn mobile samplers was studied as a means of obtaining valid evaluation of the highly variable ambient work atmosphere. The results did not correlate with fixed-station sampling, but did give significantly higher concentrations. An approximately linear relationship was found between breathing zone concentrations and urinary excretion of lead when the sum of weekly average organic and inorganic TLV coefficients was compared with the corresponding average urinary excretion. The 1967 TLV's for TEL and TML were exceeded by factors of two and four, respectively, before urinary lead excretion exceeded 0.1 mg/l. (Author abstract modified)

20704

Orton, W. T.

**LEAD POISONING AMONG CHILDREN IN HARINGEY.** Medical Officer, 123(12):147-152, March 20, 1970. 10 refs.

Four case reports of lead poisoning among five children are discussed. The ages of the children ranged from 22 months to 13 years. All suffered from pica. The clinical histories and the investigations conducted to determine the origin of the lead are described. The results showed the diversity of causes of lead poisoning in children. Modern paints with low lead content gave only apparent protection if applied over old paints containing high quantities of lead. There was evidence suggesting that wall plaster could be a cause of poisoning. The very high concentrations of lead found over a wide area demonstrate a potentially dangerous source of lead to any child who eats soil. It is believed that the contamination came from a number of sources: dust from a battery factory; automobile exhausts; and old split paint in builders' rubble. There is added danger, with respect to vegetables grown in the soil. Automobile exhaust fumes, particularly where the traffic is most dense raise the lead content of the dust and earth nearby; they can also affect rainwater. Contamination from all these sources can build up and ultimately reach toxic levels.

20990

Hursh, J. B and T. T. Mercer

**MEASUREMENT OF PB212 LOSS RATE FROM HUMAN LUNGS.** J. Appl. Physiol., 28(3):268-274, March 1970. 17 refs.

Experiments were performed in which four human subjects were administered Pb(212) by mouth inhalation and by intravenous injection. Blood, urine, and fecal samples were collected. Pb(212) inhaled on natural aerosols showed lung depositions of 27-62% the amount depending on well-characterized aerosol size differences. The loss rate from the lung measured by in vivo gamma counting, as corrected for extralung activity in the lung survey field, had a half-time of from 10.5 to 11.5 hours. Twenty-four hour urinary lead excretion after intravenous injection was from 2.6 to 6.6% of the dose. Fecal collections (34 - 48 hr) yielded 0.2 - 2.7% of the dose. (Author abstract)

21037

Secchi, G. C. and L. Alessio

**STUDIES ON THE MECHANISM OF THE INHIBITION BY LEAD OF ERYTHROCYTE Na(+)/K(+) -ATPASE.** (Ricerche sul meccanismo d'inibizione della Na(+)/K(+) -ATPasi eritrocitaria ad opera del piombo). Text in Italian. Med. Lavoro (Milan), 60(11):670-673, 1969. 6 refs. (Presented at the International Congress of Clinical Chemistry, 7th, Geneva, Sept. 8-13, 1969.)

A study of the mechanism of the inhibition by lead of sodium(+)/ potassium(+) -adenosine triphosphatase demonstrated that lead can partially inhibit this enzyme of the red blood cell membranes both in vivo and in vitro at 1 mM concentration. The inhibition of such enzyme activity could be completely removed by adding cysteine at 25 mM concentration. (Author abstract modified)

21070

Becker, Robert O., Joseph A. Spadaro, and Edward W. Berg

**THE TRACE ELEMENTS OF HUMAN BONE.** J. Bone Joint Surg., 50-A(2):326-334, March 1968. 28 refs.

Trace elements in human bones of recent origin from Syracuse, N. Y. were analyzed in comparison with specimens of ancient human bones from burial sites in Peru and Pennsylvania, in an effort to distinguish those elements consistently associated with and possibly essential to the matrix from those resulting from dietary and environmental variations. The Pennsylvania sample was about 500 years old, while the Peruvian samples were about 500-600 years old. The tibia or femur was used. After drying-ashing procedures, semiquantitative spectrographic analysis with sensitive direct current arc excitation was employed. The detected elements fell into three groups. The first (copper, zinc, strontium, iron, silicon, vanadium, and aluminum) were detected rather consistently in all specimens, despite such factors as specimen age and soil leaching; some of the these may be functionally important in the matrix. The second group consists of elements sporadically detected, such as manganese, silver, tin, and rubidium; these probably are not essential to bone, but may occur because of local environmental or occupational factors. The third group contains two elements, lead and vanadium, detected in all but one sample but invariably present in very small concentrations (less than 5 ppm) in ancient bone and in much higher concentrations (Pb, 50 ppm; V, 11 ppm) in modern bone. Contemporary air pollution is strongly implicated as the primary cause of this increase.

21259

Wolkonsky, Peter Malia

**PULMONARY EFFECTS OF AIR POLLUTION.** Arch. Environ. Health, vol. 19:586-592, Oct. 1969. 35 refs. (Presented at the American Academy of Occupational Medicine, 21st Annual Meeting, Boston, Mass., Feb. 5, 1969.)

The pulmonary effects of a variety of air pollutants are reviewed. Interest in most particulates is due to their role as carriers of other pollutants, while known pathogenic particulates (such as the benzo(a)pyrenes or the products of tetraethyl lead combustion) are of primary interest as chemicals rather than particles. Carbon monoxide apparently has no significant direct effects on the lungs, but the question has been raised as to whether there may also be subacute or

chronic effects. In experimental animals exposed to sulfur dioxide at concentrations higher than those typically observed in ambient air, SO2 acts as a primary irritant, and leads to bronchoconstriction and increased airway resistance. Alveolar and bronchiolar lesions typify exposure to nitrogen oxides. Profound and permanent changes possibly occur in lungs exposed to nitrogen dioxide, as in the acute pulmonary edema associated with silo-filler's disease. Nitrogen dioxide has been found to cause emphysematous lungs in rats. Exposure to NO2 is also believed to permit better bacterial colonization in the lungs by inhibition of bacterial clearance. Ozone may decrease the percentage of alveolar macrophages and their ability to engulf streptococci. The severity of symptoms in a group of Chicago patients with chronic bronchitis or emphysema showed seasonal fluctuations related to mean monthly temperature, with briefer exacerbations, closely correlated to low temperature and high SO2 level. The pathological and synergistic effects of air pollution are also discussed.

21266

Reichel, G., F. Wobith, and W. T. Ulmer

**ACUTE AND CHRONIC EFFECTS OF AIR POLLUTION PRODUCED BY TRAFFIC AT A BUSY CROSSING ON LUNG FUNCTION IN HUMANS. DETERMINATION OF CO, HB, PB, IN BLOOD.** (Akute and chronische Wirkung von Strassenluft an verkehrsreicher Kreuzung auf die Lungenfunktion des Menschen, Den CO-, Hb-, und Bleigehalt des Blutes). Text in German. Arbeitsmedizin, 26(1):84-97, 1970. 73 refs.

To determine the effects of exposure to street traffic on lung function restrictions, 44 persons were subjected to a blood-gas analysis and whole-body plethysmographic examination before and after an exposure of three hours at a busy crossing. The carbon monoxide and lead levels were also determined. No insufficiencies or functional restrictions of the lungs were verified as a result of acute exposure. These findings were also confirmed when examining 10 policemen permanently exposed to the air pollution of a large city. A suspicious saturation of the blood with CO could not be verified. In smokers, a decrease in the CO-level during the testing period, when no smoking was allowed, was observed. The increase of the blood-lead-level needs further investigation. Even if the lead level after exposure does not exceed the toxic limit value, the problem of gasoline lead additives needs further attention.

21423

Stoefen, Detlev

**PROPHYLACTIC MEASURES AGAINST POISONING BY LEADED GASOLINE- CRITERIA AND CONSEQUENCES.** (Die Prophylaxe der mit der Benzinverbleiung verbundenen Gefahren - Kriterien und Konsequenzen). Text in German. Staedtehygiene(Uelzen/Hamburg), 21(4):94-97, April 1970. 23 refs.

Seventy percent of the lead in gasoline is emitted with the exhausts. The dangers of lead poisoning (genetic defects, brain strokes, etc.) have been pointed out repeatedly, but no maximum allowable concentrations have yet been worked out with the exception of the Soviet Union, where the limit was determined to be 0.0007 mg/cu m. Measurements near stop signs in Hamburg revealed a lead concentration of about 0.002 mg/cu m; in a tunnel, 0.004 mg/cu m; and in the large cities of the Rhine Valley, the lead concentration fluctuated between 0.5 and 12 mircrograms cu m. As indicated by delta-amino levulin acid discharge tests, latent lead poisoning is widely spread in motorized countries. Examination of 48 policemen in Basel indicated that they discharge 3 to 7.5 mg delta-amino levulin acid/day. The limit concentration was 6 to 9 mg/day.

21766

Holtzman, R. B., H. F. Lucas, Jr., and F. H. Ilcewicz

**THE CONCENTRATION OF LEAD IN HUMAN BONES.** In: Radiological Physics Division Annual Report July 1968 through June 1969. Argonne National Lab., Ill., Radiological Physics Div., p. 43-49, 1969. 22 refs. CFSTI: ANL-7615

Lead concentration in bone from humans whose ages ranged from newborn to 85 years increased with age at a rate of 0.6 micrograms/(g ash)/yr and to be 8.7 micrograms/(g ash) at birth. These results corroborate previous reports of increases up to age 30, and they show a continuing and similar increase in the group over 35 years of age. This rate represents an increase in skeletal content of about 4 micrograms/day, which is about 1% of the daily intake. The biological half-life of lead implied from the data from this study ranges from 70 to 90 years and is longer than previously reported. Lead concentrations in the group over 30 apparently consisted of two normally-distributed populations, which may reflect differences in the cigarette smoking habits of the subjects. Further studies are required to more accurately evaluate the effects of smoking and to determine whether the accumulation of lead in adults simply reflects a long biological half-life or is caused by changing levels of lead intake. Lead concentration was determined by a spectrophotometric method in which the bone is ashed 8 hr at 600 C and dissolved in 9 M HCL at a concentration of up to 0.2 g ash/ml. After extraction with triisooctylamine to remove interfering elements, mainly iron, the lead is determined from the absorbance at a wavelength of 271 millimicrons. Bone samples were obtained during normal surgical or autopsy procedures, and lead concentration was also determined in teeth from 29 other subjects from Chicago and neighboring regions of Illinois. (Author abstract modified)

22222

Stoefen, D.

**THE DEVELOPMENT OF LEAD POISONING.** (Die larvierte Bleivergiftung). Text in German. Arch. Hyg. Bakteriol. (Munich), 152(5):551-558, June 1968. 65 refs.

The sanitation of the biosphere in the sense of microtoxicology would involve considerable expenses. Byrne of the American Union Oil Company estimates that investments of $5,680,000,000 would become necessary if the USA prohibited the addition of lead to gas. The German Federal Republic is far removed from a disclosure of Soviet technology. It can only hope that the results of Soviet research reach it by way of the USA, whose Public Health Service deals with these results in a comprehensive research program. Sweden has already prohibited the addition of lead to fuel on the basis of these results. The American research program requires approximately four years, the conversion of the petroleum industry another four years. It is questionable whether the system can bear this load for another eight years. At present, even the symptoms are not recorded. There is good reason to assume that at least 50% of the functional diseases are due to lead and that at least 25% can be healed by specific medical treatment. The blocking of numerous enzymatic and biosynthetic processes summarized by Bersin in 1966 should be taken into consideration. (Author abstract)

22637

Hernberg, Sven, Jorma Nikkanen, Guy Mellin, and Helena Lilius

**DELTA-AMINOLEVULINIC ACID DEHYDRASE AS A MEASURE OF LEAD EXPOSURE.** Arch. Environ. Health, 21(2):140-145, Aug. 1970. 21 refs.

The concentration of lead in the blood is the most valid indicator of exposure to possible lead poisoning environments. Close negative correlation between the concentration of lead in blood (Pb-B) and the logarithm of erythrocyte delta-aminolevulinic acid dehydrase (ALA-D) was found for 159 persons with Pb-B levels ranging from 5 micrograms to 95 micrograms per 100 ml. A statistically significant correlation between Pb-B and delta-aminolevulinic acid (ALA) in urine was obtained only for Pb-B values over 50 microgram per 100 ml. These results indicate that erythrocyte ALAD is more accurate and more sensitive than ALA in urine as an indicator of the amount of circulating lead. ALAD assays can be used as a screening procedure to exclude a lead absorption over a given level. Fairly accurate estimates of the mean Pb-B of groups of people can also be made from their mean ALAD activity. (Author abstract modified)

23167

Gilluly, Richard H.

**THE HAZARDS OF TRACE ELEMENTS.** Sci. News, 97(23):560-561, June 6, 1970.

When researchers at a metal-free laboratory at Brattleboro, Vt., exposed rats and mice orally over their lifetimes to environmental amounts of all the elements found in the National Air Sampling Stations, three elements appeared of concern in the amounts found in the environment: lead, nickel, and cadmium. In doses comparabl to amounts that might accumulate in humans living near dense traffic, lead shortened life spans of the experimental animals and caused nervous system deterioration. Nickel carbonyl results from a reaction between nickel and hot carbon monoxide which probably takes place in incinerators and in internal combustion engines. It is absorbed by the lungs and is probably carcinogenic. Inhaled, cadmium can cause emphysema and bronchitis. Taken into the body, through the lungs or otherwise, it is associated with cardiovascular death rates, hypertension, and kidney disease. Vanadium alone is nontoxic in laboratory animals in amounts far larger than found in the environment, but it may facilitate creation of enough sulfur trioxide to cause problems. However, adequate chromium in the diets of experimental rats will prevent the toxic effects of lead. An approach that has been suggested to deal with trace elements in water supplies is to create dual water-supply systems, one system for industrial uses and residentia uses and the second for drinking water.

23582

Bonsignore, D.

**THE ERYTHROCYTE ALA-DEHYDRASE ACTIVITY AS A DIAGNOSTIC TEST IN OCCUPATIONAL LEAD POISONING.** (L'attivita ala-deidratasica eritrocitaria quale test diagnoltico ned saturnisma professionale). Med. Lavoro (Milan), vol. 57:647-654, 1966. 13 refs. Translated from Italian. Belov and Associates, Denver, Colo., 9p., July 16, 1970.

The effect of lead poisoning on amino-levulinic-dehydrase activity was studied by colorimetrically determining the porphobilinogen, which is formed by ALA-dehydrase activity, present in the erythrocyctes of 50 subjects with chronic or acute lead poisoning. In 19 patients, no enzyme activity could be identified; in the others, it was distinctly lowered. The results demonstrate that diagnosis of ALA-dehydrase acitivity is a valid test of lead poisoning.

23715

Engel, Ronald E. and Jerry F. Stara

**THE ROLE OF THE VETERINARIAN IN AIR POLLUTION RESEARCH.** Preprint, National Air Pollution Control Administration, Raleigh, N. C., llp., 1970. 7 refs.

Meaningful environmental research requires input from the integration of three scientific approaches: (1) laboratory animal toxicological studies; (2) laboratory clinical investigations of human subjects; and (3) epidemiological studies under naturally occuring conditions. Animal toxicology is needed to identify prime effects of pollutants by conducting controlled experimental exposures that block out the environmental variables normally existing under field conditions. Veterinary toxicologists, primarily those interested in all animals, are playing an important part in air pollution research and in interpreting animal experiments that are essential to establish the margin of safety for air quality standards. In the National Air Pollution Control Administration alone, veterinarians design and execute studies, the results of which are used for air quality criteria documents. One such study is an investigation of the chronic effects on beagles exposed to irradiated automobile exhaust. Other studies of environmental toxicity performed by government veterinarians includ the effects of nitrogen dioxide on minimum responses; carcinogenicity of hydrocarbons; effects of ozone on the respirator tract; effects of long-term exposure to cadmium, lead, and arsenic; and determinations of effects from inhalation of less common pollutants.

23768

Goldsmith, John R.

**EPIDEMIOLOGICAL BASES FOR POSSIBLE AIR QUALITY CRITERIA FOR LEAD.** Preprint, Air Pollution Control Association, New York City, 26p., 1969. 23 refs. (Presented at the Air Pollution Control Association Symposium on Toxicological and Epidemiological Bases for Air Quality Criteria, June 24-25, 1969, Paper 69-146B.)

For most individuals, the diet is the major source of lead exposure. However, amounts of lead absorbed by the body via the oral and the respiratory routes may be similar in magnitude, even though the total amount ingested with food and water is usually several times the total inspired with air. Inorganic lead in sufficient amounts is implicated as a causative agent in decreased hemoglobin synthesis, liver and kidney damage, mental retardation in children, and abnormalities of fertility and pregnancy. There is evidence that exposure to moderately low lead levels may produce abnormalities in the synthesis of porphyrines, particularly by the inhibition of delta-aminolevulinic acid (d-ALA) dehydrase. This inhibition leads to increased blood and urine levels of d-ALA, and air quality criteria should include a criterion based on d-ALA excretion, if it can be shown to be related to community air pollution exposure. Recent epidemiologic data show that there is not a balance between lead absorption and excretion in Americans, lead concentrations increase in liver, spleen, pancreas, kidney, and lung up to the fifth decade and in the bone up to the fourth decade. Other studies imply that the total lead burden of the body is, in part, a function of respiratory exposure in areas of high motor pollution. It is recommended that air quality criteria proposed by the World Health Organization be amended to refer to concentrations and exposure times which result in significantly increased storage in the body of potentially toxic materials, significant alteration of an essential metabolic process (such as porphyrin metabolism), and significant alteration in hematopoesis.

23801

Hunt, William F., Jr., Cecil Pinkerton, Owen McNulty, and John Creason

**A STUDY IN TRACE ELEMENT POLLUTION OF AIR IN 77 MIDWESTERN CITIES.** Preprint, Missouri Univ., Columbia, 21p., 1970. 14 refs. (Presented at the Conference on Trace Substances in Environmental Health, 4th Annual, Columbia, Mo., June 23-24, 1970.)

A study is reported to examine a possible relationship between cadmium, lead, and zinc air pollution and cardiovascular disease by examining the metal fallout in the residential, commercial, and industrial areas of each of 77 midwestern U. S. cities chosen from standard metropolitan statistical areas. Monthly rainfall and maximum and minimum temperatures were obtained from the weather station nearest each dust fall sampling site. The dried residues o dust fall samples were analyzed for the three metals by atomic absorption spectrophotometry. Annual death rates for white males from cardiovascular diseases were calculated, and milk samples were analyzed for cadmium and lead. Statistical analysis did not reveal any significant relationship between cadmium fallout and cardiovascular death rates in the cities studied, despite earlier work suggesting such a relationship, nor was any association found when cadmium in milk was used as an indicator of cadmium fallout on croplands or in rural areas. A significant association was found between cardiovascular death rates and lead fallout in residential areas and with dust fall, and maximum and minimum temperatures. The association was found only for minimum temperature in the commercial and industrial areas. Evidence suggests that the relationship may reflect some factor or urbanization not examined and deserving of further study, despite the absence of any clinical or physiological evidence.

23876

Blumer, W.

**DOES AUTOMOBILE EXHAUST CAUSE HEADACHES? (Kopfschmerzen durch auto-abgase?). Z. Praeventivmed., vol. 14:303-304, Sept.-Oct. 1969. 4 refs. Translated from German. Belov and Associates, Denver, Colo., 4p., Sept. 3, 1970.**

Adult inhabitants of a residential area without through traffic were compared with all people living right next to the heavily frequented main street of the same place. The cases concerned include all patients complaining about constant headaches during th past ten years, when no organic cause could be detected by means of general practice. In the houses immediately adjacent to the main street, percentage wise three times as many patients with headaches lived there than in the outside area. Observing these patients for many years, a short change of residence made the headache disappear. One hundred and twelve patients received twice weekly for four to five weeks an intravenous injection of a mixture of calcium-dinitrate-EDTA (20 mg per kilogram body weight), vitamin C (200 mg), and vitamin B1 (200 mg). This small dosage immediately cured 71% of the patients, distinctly improved 19%, and was unsuccessful with only 10%. In order to prove that this treatment actually causes an increased secretion of lead, a lead analysis of the urine was made for five patients. All cases showed an increase of lead secretion with the exception of one female patient. The people living close to traffic inhale at least four more kinds of exhaust gases (carbon monoxide, hydrocarbon, nitric oxides, tetraethyl lead), which cause headaches as an early symptom themselves and which simultaneously reinforce the toxicity of lead.

23887

Neubert, Heinz

**ON INDUSTRIAL LEAD POISONING-A STATISTICAL SURVEY.** (Zur Bleierkrankung in der gewerblichen Wirtschaft - ein statistischer Ueberblick). Text in German. Staub, Reinhaltung Luft, 30(8): 322-323, Aug. 1970.

The number of reported cases of lead poisoning in industry decreased by 48.2% in 1968 as compared with the cases reported in 1950. During the same period, the number of cases in which compensations were granted for the first time was reduced from 93 to 16. These compensations in the reported cases decreased from 9.5% (1950) to 3.1% (1968). From 1965 to 1968, the conditions varied every year for different branches of industry.

23926

Goyer, Robert A., Daniel L. Leonard, John F. Moore, Bonnie Rhyne, and Martin R. Krigman

**LEAD DOSAGE AND THE ROLE OF THE INTRANUCLEAR INCLUSION BODY. AN EXPERIMENTAL STUDY.** Arch. Environ. Health, 20(6):705-711, June 1970. 21 refs.

Biological parameters known to be affected in lead poisoning were measured in rats following ingestion of graded dosages of lead. Six groups of rats were given tap water containing the following quantities of lead in the form of lead acetate: 0.08, 0.20, 0.40 1.20, 2.00, and 10.0 mg of lead per milliliter. The animals were weighed weekly and 24-hour urine collections were made prior to killing at 10 weeks of age. Both kidneys were quickly excised and analyzed. Another group of rats received pulverized 1% lead as lead acetate mixed with powdered laboratory food for about four months. Intranuclear inclusion bodies were formed in renal tubular lining cells with smaller doses of lead than produced other changes. Decreased body weight was the next most sensitive abnormality. This was followed by increased delta-aminolevulinic acid excretion, reticulocytosis, renal edema, and aminoaciduria. Anemia only occurred at the highest lead dosage. Over a wide range of lead ingestion, urinary lead excretio remained constant, although renal lead content increased. Quantitative analysis of cell organelles showed that lead is concentrated within the inclusion bodies. Relatively small amounts of lead were present in the cytoplasm and mitochondria. It is suggested that soft-tissue lead accumulates in the intranuclear inclusion body, thereby sparing toxic injury to cytoplasmic organelles. (Author abstract modified)

24081

Tada, Osamu

**LEAD IN ENVIRONMENTS.** (Kankyochu no namari). Text in Japanese. Rodo Kagaku (J. Sci. Labour, Tokyo), 46(10):577-583, Oct. 10, 1970. 50 refs.

The effect of absorbed lead on human health depends on the quantity and the duration of lead absorption from the atmosphere. The amount of lead absorbed into the body through food and beverage should also be taken into account. For lead in the living environment, physiological data on lead in blood and urine were studied. For lead in the atmosphere, actual investigations conducted in the United States concerning air pollution by automobiles were studied. For lead in the occupational environment, problems due to dusts, fumes, and vapors in the working areas in Japan were investigated. Evaluating the relationship between the environmental lead and lead in the body together with the ways of diagnosing the initial physical changes due to poisoning is the main task for the future.

24192

Prerovska, I. and D. Chladkova

**FOLLOW-UP WORKERS FROM ENVIRONMENT OF LEAD HAZARDS AIMED AT EARLY DEVELOPMENT OF ATHEROSCLEROSIS.** (Untersuchung vom Bleirisiko bedrohter Arbeiter in Hinsicht auf vorzeitige Entwicklung von Atherosklerose). Text in German. Intern. Arch. Gewerbepathol. Gewerbehyg. (Heidelberg), 26(3):205-215, 1970. 13 refs.

Fifty workers, aged 20-40 years, were first examined in 1963 for th effect of occupational exposure to lead. Neither clinical examinations nor levels of serum lipids in the group showed any deviations suggesting early development of atherosclerosis. The woekers were re-examined in 1969, by which time they had been exposed to lead hazards for an average of 13 years. Although lead concentrations in the working environment were several times higher than those permitted by standards, only half the subjects showed lead concentrations exceeding normal limits and then only for transitory periods. No atherogenic effects of lead could be proved. Internal examinations supplemented by blood pressure, ECG, and urine tests, together with examinations of the fundus of the eye, showed that pathologic changes indicative of atherosclerosis were neither more frequent nor more critical in the exposed group than in a control group of similar age span. The values determined for serum lipids were within physiological limits

24288

Xintaras, Charles

**MEASUREMENT AND INTERPRETATION OF SPONTANEOUS AND EVOKED BRAIN POTENTIALS IN RATS.** Aerospace Medical Research Lab., Wright- Patterson AFB., Ohio, Proc. Conf. Atmos. Contamination Confined Spaces, 3rd Annu., Wright-Patterson AFB, Ohio, 1967, p. 358-380. 6 refs. (May 9-11.) CFSTI: AD 835008

Studies were undertaken to determine whether spontaneous brain wave activity and the sensory evoked response are sensitive and reliable measures of the effect of exposure to air pollutants. Subcortical and cortical electrodes were implanted stereotaxically in anesthetized male albino rats. The primary exposure and testing chamber was a modified Skinner box designed to permit the simultaneous measurement of behavioral and electrophysiological responses and, in addition, to serve as a dynamic inhalation chamber. Water containing lead acetate was available in the secondary chambers. Observations were made regarding the rat's behavior via a closed-circuit TV system in order to relate changes in the electrophysiological records with changes in the rat's behavior Brain potentials evoked in response to light flashes were graphed or recorded. Pentobarbital was used as a standard for comparing the depressant effects of carbon monoxide. In the transition from wakefulness to sleep, specific components of the evoked response were attenuated whereas others were markedly augmented. Carbon monoxide and pentobarbital induced changes in the response that appeared similar to the changes recorded during the subjects' normal transition from wakefulness to spontaneous sleep. Consistent relationships were noted between the spontaneous EEG and the magnitude of the visual evoked response. Lead acetate induced changes in the duration and stability of the periods of rapid eye movement (REM); excessive spindle-slow-wave complexes appeared during periods of REM sleep. Alterations in the REM phase in lead treated animals may be directly or indirectly associated with an impaired neural control system, and in particular with the mechanism responsible for controlling changes in levels of consciousness. Alterations in the evoked response during light spontaneous or induced sleep may be associated with a general lowering of the level of vigilance and may be related to the integrative functions necessary to awareness.

24314

Hendricks, N. V.

**TOXIC GASES IN INDUSTRY.** Southern Power Ind., vol. 65:66-69, 86, April 1947.

The physiological effects of carbon monoxide, hydrogen cyanide, sulfur dioxide, chlorine, ammonia, nitrogen oxides, hydrogen sulfide, tetraethyl lead, nickel and iron carbonyl, arsine, and hydrogen phosphide are discussed. In the presence of carbon monoxide, the carrying power for oxygen through the bloodstream is rapidly reduced so that within a short time a condition of asphyxiation results. Hydrogen cyanide also produces asphyxiation by interfering with the transfer of oxygen from the blood to the tissues. Repeated exposures to low concentrations of sulfur dioxide may cause such symptoms as catarrh, disturbance of taste and smell, fatigue. The least amount of chlorine causes coughing, while ammonia is strongly irritating to the eyes, nose, throat, and lungs. Chronic exposures to oxides of nitrogen may result in headache, coughing, and weakness. The toxicity of hydrogen sulfide in nearly equal to that of hydrogen cyanide. The metallic carbonyl when inhaled causes strong lung irritation and it toxicity is extremely high. Symptoms of arsine poisoning may include vomiting, weakness, jaundice, and lung edema. Convulsions may result from hydrogen phosphide, followed by death. Industrial sources of these compounds are also mentioned.

24428

Noweir, Madbuli H. and Emil A. Pfitzer

**EVALUATION OF COPROPORPHYRIN IN URINE FROM WORKERS EXPOSED TO LEAD. Am. Ind. Hyg. Assoc. J., 31(4):492-500, July-Aug. 1970. 51 refs. (Presented at the American Industrial Hygiene Association Conference, Denver, Colo., May 11-16, 1969.)**

Studies were undertaken to evaluate the urinary coproporphyrin test as an economical routine method for identifying individual workers absorbing excessive quantities of lead and to evaluate the relationship between the concentration of coproporphyrin in urine and the concentration of lead in air. Lead was determined in particulate matter removed from 200 to 300 liters of air at a lead oxide plant, a lead soldering operation in a canning plant, two lead battery plants, and two lead smelters. Twenty-four hour samples of urine were collected from all the exposed 171 workers, and from a control group of 77 workers employed in an iron foundry and in a plastics molding plant. The average concentration of coproporphyrin in the urine of groups of workers increased with the average concentration of lead to which they were exposed. However, the correlation between atmospheric lead and coproporphyrin levels in urine did not appear to follow any simple curvilinear relationship, particularly for workers exposed to excessively high concentration of urinary coproporphyrin and periods of exposure. Only when the measurement of lead in blood cannot be obtained, the use of the relatively simple determination of coproporphyrin in urine and lead in air, together, but not separately, may provide the basis for reasonable hygienic control in the lead trades, if accompanied by the appropriate medical supervision. (Author abstract modified)

24573

Ohm, H. J.

**THE LOCALIZATION OF LEAD DEPOSITED IN HUMAN TEETH.** (Die Lokalisation des in meschliehen Zaehen abgelagerten Belis). Deut. Zahnaerzrtl., 24(3):202-209, March 1969. 42 refs. Translated from German. Belov and Associates, Denver, Colo. 16p., Sept. 8, 1970.

Healthy and decayed human teeth were fixed immediately after extraction in alcohol containing hydrogen sulfide and were then decalcified with hydrogen sulfide saturated with formic acid. After subsequent deacidification and desalination, the teeth were frozen in crystals and mounted on glass covers. Physical development was carried out with a mixture of gum arabic solution and silver nitrate. With this method deposits of lead were demonstrated and their location determined. In tissue sections, deposited lead sulfides appear as find brown to black granules afte physical development. Lead appears to have a preference for the small canals in the dentine, layers of secondary dentine, and interglobular spaces as well as for cement. The distribution of th lead sulfide particles in the individual dentine regions also shows a direct dependence on metabolism. Similarly, it is possible to recognize a change in the distribution of lead sulfide granules in the region of decalcification due to caries.

24603

Greenburg, Leonard and Morris B. Jacobs

**AIR POLLUTION CONTROL: HEALTH ASPECTS AND MICROTECHNIQUES.** Trans. N. Y. Acad. Sci., Ser. 2, 18(4):289-297, Feb. 1956. 28 refs.

The greatest source of air pollution in New York City is burning fuels. The relationship of air pollution to health is dramatically indicated by the episodes in the Meuse Valley, in Donora, Pa., in Poza Rica, Mexico, and in London, England. The principal category of microanalysis in air pollution studies is the determination of very small amounts of a substance in a large volume of air. The principle of deposition is used for sootfall or dustfall sampling. Absorption methods for air sampling are of two types: impingers an absorbers. Filtration methods include the high-volume sampler, the automatic paper tape samplers, and millipore filters. Condensation and adsorption are also employed in collecting work. The peroxide method is preferred over the alkaline iodide or colorimetric method in analyzing sulfur dioxide. Sulfur trioxide can be measure by direct titration and gravimetrically. Infrared spectrometry is the method of choice for determining carbon monoxide; however, the CO tube colorimetry method has been adopted by some investigators. The method commonly used for nitrogen oxides involves estimating by the phenodisulfonic acid method. Ammonia and ammonia compounds are trapped in a bubbler containing sulfuric acid and are estimating by nesslerization. Methods of analysis are described for aldehydes, cyanides, fluorides, ozone, hydrogen sulfide, lead, hydrocarbons, and other components.

24716

Hammer, D. I., J. F. Finklea, R. H. Hendricks, C. M. Shy, and R. J. M. Horton

**HAIR TRACE METAL LEVELS AND ENVIRONMENTAL EXPOSURE.** Preprint, National Air Pollution Control Administration, Durham, N. C., Div. of Health Effects Research and Western Area Occupational Health Lab., Salt Lake City, Utah, 20p., 1970 (?). 33 refs.

Hair may be a practical dosimeter for metallic pollutants. Hair levels of arsenic and lead have been useful in the diagnosis of clinical poisoning. Hair trace metal levels were related to environmental exposure in a study of 4th grade boys in cities representing exposure dose gradients for arsenic, cadmium and lead, copper, and zinc. Hair samples were carefully and stringently washed before analysis for As by spectrophotometry and for Cd, Cu, Pb and Zn by atomic absorption. Hair trace metal distributions for As, Cd, Cu and Pb were positively skewed while those for Zn were symmetrical. Means were in accord with exposure rankings for As, Cd, and Pb but not for Cu and Zn. When grouped across a ranking gradient, differences among the means for As, Cd and Pb were statistically significant while those of Cu and Zn were not. The present study minimized possible effects of age, sex, hair color, varying hair length and chemical treatments. Despite residual problems of exogenous deposition, endogenous absorption routes, and relationships of hair metal to body burden, mean hair metals levels for As, Cd, and Pb accurately reflected community exposures. (Author abstract modified)

24784

Bonsignore, D., C. Cartasegna, C. Vergnano, and V. Ardoino

**STUDIES ON HUMAN AND EXPERIMENTAL LEAD POISONING. THE INHIBITORY MECHANISM OF RED BLOOD CELL ALA-DEHYDRATASE.** (Studi sulla intossicazione umana e sperimentale da piombo. Sul meccanismo inibitorio dell' ala-deidratasi eritrocitaria). Text in Italian. Med. Lavoro (Milan), 59(6-7):419-424, June-July 1968. 7 refs.

The red blood cell delta-aminolevulinico (ALA)-dehydratase, which is highly reduced in saturnism, can be brought to normal values by heating the haemolysate for 5 min at 60 C. In vitro lead-inhibited enzyme can not be reactivated by heat. Such results point out a great difference between the inhibition of the enzyme in vitro and that found in saturnism. The results are discussed with the aim of interpreting the mechanism of the inhibition of the ALA- dehydratase in lead poisoned patients.

24877

Ethyl Corp., New York

**LEAD AND AIR POLLUTION: AN ANALYSIS OF THE MORSE REPORT.** Special Report, 12p., 1967 (?). 5 refs.

Citing the possible adverse effects of gasoline lead additives on human health, modification of atmospheric processes, and deactivation of catalysts in devices for controlling engine exhaust emissions, the Morse Report to the Commerce Department recommended immediate restrictions on leaded gasoline. According to the Ethyl Corporation, this recommendation is directly contrary to the overwhelming weight of scientific evidence. Lead compounds do not contribute to photochemical smog (the most widespread air pollution problem). Only half or less of lead in gasoline is exhausted in particles significantly small to be suspended in air. A portion is retained in the engine and exhaust systems, and of the lead exhausted, the larger and heavier particles fall to the ground and do not become airborne. A number of catalytic exhaust devices, including one developed by Ethyl, have worked well with leaded gasoline and have met previous California standards. No evidence has been obtained in clinical studies suggesting that significant, subtle, or unrecognizable changes are occurring in the general population as the result of exposure to environmental lead, levels of which (according to the World Health Organization) are no greater than they were 20 years ago. Before any action is taken to restrict lead usage, research should be carried to the point where there is adequate data on which to base a decision.

24961

Regan, C. J.

**MOTOR FUMES AND ATMOSPHERIC POLLUTION.** Chem. Ind. (London), 51(29):605-607, July 15, 1932. 23 refs.

The most important constituent of exhaust gas as regards atmospheri pollution is carbon monoxide, which varies from 1 to 12% and averages about 5%. Six hours inhalation 'at rest' to air containin 20 parts CO per 100,000 can lead to 15-20% of CO-hemoglobin (i.e., 60-70% of the maximum possible value for this concentration). Exercise would reduce the period required to produce this state to four hours or less. However, air in towns and congested areas rarely contains more than 20 parts CO per 100,000 so there is no chance of acute CO poisoning of ordinary street users. There is some danger in the case of persons controlling congested traffic intersections for long periods: traffic policemen have shown values up to 30% CO saturation of hemoglobin at the end of turns of duty. An attitude of caution is also advisable with regard to the amount of lead emitted by automobiles. The amount inhaled may not reach the maximum (2 mg per day) required for chronic lead poisoning, but lead is a cumulative poison and the possibility exists that smaller amounts may be a danger to the human system.

25068

Hueter, F. G., D. S. Barth, and Gottberg

**GERMAN-UNITED STATES COMPARATIVE STUDIES.** Preprint, International Union of Air Pollution Prevention Associations, 8p., 1970. (Presented at the International Clean Air Congress, 2nd, Washington, D. C., Dec. 6-11, 1970, Paper AD-42C.)

A collaborative research program designed to provide information for the development or revision of air criteria documents has been agreed on by the Ministry of Interior of West Germany and the Department of Health, Education and Welfare. The criteria documents will form the basis of separate air quality standards in each country. Research areas of mutual interest are considered to be the health effects of automotive exhaust on humans; health an environmental effects of lead; studies of the effects of airborne carcinogens; and the health effects of asbestos, including the development of monitoring methods. The program will be implemented through cooperation in the design of the respective experiments, internal quality control on all aspects of research, and the exchange of information during the course of experiments. It is hoped that the program will enable both nations to proceed more rapidly in solving their air pollution problems.

25328

Stopps, Gordon J., Mary E. Maxfield, Martha McLaughlin, and Sidney Pell

**LEAD RESEARCH: CURRENT MEDICAL DEVELOPMENTS.** In: Air Pollution-1970, Part 2. 91st Congress (Senate), Second Session on S.3229, S.3466, S.3546, p. 551-592, 1970. 64 refs. (Hearings before the Subcommittee on Air and Water Pollution of the Committee on Public Works, March 19, 20, 23, 1970.) (Presented at the Industrial Hygiene Foundation, 31st Annual Meeting, Pittsburgh, Pa., Oct. 18-19, 1966.)

Of 772 workers who had been exposed to tetraethyl lead for six months or longer, mean urinary excretions were 0.064 plus or minus 0.033 mgPb/l as compared to a mean level of 0.03 plus or minus 0.017 mgPb/l for a nonexposed group of workers. However, no adverse health effects could be attributed to the increased lead levels. Only in the case of a few workers with urine lead values of 0.08 mgPb/l was there any correlation between lead concentrations and hemoglobin values. The prevalance of the most common chronic diseases--hypertension, coronary heart disease, and peptic ulcer--was lower among prior TEL workers and significantly lower among current TEL workers than among controls. With regard to leaded gasoline, new process technology and the development of reforming catalysts with a high degree of stability may help achieve the goal of removing lead from automobile fuel. This would have the primary benefit of eliminating the 500 million pounds of lead currently emitted by motor vehicles and the secondary benefit of making the use of catalytic devices for internal combustion engines completely feasible.

25705

Bylinsky, Gene

**METALLIC MENACE IN THE ENVIRONMENT.** Fortune, 83(1):110-113, 125, Jan. 1971.

The flow of metallic pollutants to the environment has accelerated in recent decades to such an extent that the public at large may be threatened with what used to be considered 'occupational' health hazards mines or factories. The serious difficulty with these pollutants is their persistence; unlike organic substances, no metal is degradable by natural processes. The first efforts to combat metallic pollution are represented by criteria to be issued this year by the Federal government for permissible lead concentrations in ambient air. Guidelines for beryllium will follow next year. Later, other metals will come under control. Because of the economic implications of control, it is essential that 'safe' levels for metallic pollutants be based on sound data. The search for data on lead is reviewed; future lead levels may be determined by recent investigations indicating the effects of low-lead levels on ALA-dehydrase activity.

26260

Horiuchi, Kazuya

**LEAD IN THE ENVIRONMENT AND ITS EFFECT ON MAN IN JAPAN.** Osaka City Med. J. (Japan), 16(1):1-28, 1970. 31 refs. (Presented at the International Conference on Chemical Pollution and Human Ecology, Prague, Czechoslovakia, Oct. 1970.)

The normal Japanese adult ingests about 230-320 micrograms of lead/ day with food and liquids and inhales about 80 micrograms. Approximately 90-95% of the lead ingested through the alimentary tract may be unabsorbed and discharged to the feces: the fecal lead amount is usually equivalent to the amount of lead ingested. Lead taken in through the respiratory tract remains in the body much longer than that taken in through the alimentary tract. The total body lead content of an adult Japanese may be over 100 milligrams, including the lead in whole blood. Lead in whole blood and urine appears to be related to motor exhaust, but additional studies are needed to clarify the relationship. Measurements made by the National Air Sampling Network indicate that the average lead content of particulate matter is 0.51 mcg/cu m, which is below values obtained in the United States.

26310

Tokyo Metropolitan Public Nuisance Research Inst. (Japan)

**AN INTERIM REPORT ON THE INVESTIGATION OF PUBLIC NUISANCE BY LEAD.** (Namari kogai chosa chukan hokoku). Text in Japanese. 62p., Sept. 1970.

Concentration of lead was measured for three to nine days, in and around seven crossroads of Tokyo during the period from May to August, 1970. Floating micro-particles in the air were collected i filters such as glass fibers, and the content of lead

was determined by atomic absorption spectrometry. When the mean concentration of lead was taken as 100 on the crossroads, it showed the value of 86 (in the range of 47-121) by the roadside which was 100 m from the crossroads. At the back points of the crossroad, 50-100 m from the road, it was as low as 38 (20-58), though there was no correlation between the concentrations on the crossroad and those in the other places. Concentration of carbon-monoxide was significantly correlated with that of lead. In 700 subjects of six districts, including six points of the above mentioned seven points contents of lead in the blood and the urine, coproporphyrin in the urine, and basophilic erythrocyte were measured. The content of lead was below 30 micrograms/100 ml blood in 99% of the subjects. Only two subjects showed above 80 micrograms/l (the value was 81 and 88 micrograms/l respectively) in urine analysis but other subjects showed below 30 micrograms/l. In the results of urinary coproporphyrin tests, there were 16 subjects who showed more than 120 mg/l of the substance. In the results of the test for basophilic erythrocyte, only one subject showed a value of more than 30/10000 erythrocytes; others showed below 5/10000 erythrocytes. In this case, other results were normal, so it was suggested that the high value of basophilic erythrocyte was not attributed to lead poisoning. In all cases, there was no clear difference in the blood and urinary tests among regional or residence groups, that is, whether the house stood by the road or not.

26356

Friberg, L., B. Holma, M. Piscator, and R. Rylander

**EFFECTS OF PROLONGED EXPOSURE TO LOW CONCENTRATIONS OF LEAD AND OZONE IN RABBITS AND GUINEAPIGS--WITH SPECIAL REFERENCE TO LUNG CLEARANCE AND ALVEOLAR MACROPHAGES.** Karolinska Inst., Stockholm (Sweden), Dept. of Hygiene; National Inst. of Public Health, Stockholm (Sweden), Dept. of Environmental Health; Copenhagen Univ. (Denmark), Inst. of Hygiene, PHS Grant AP 00212, Swedish Medical Research Council Proj. B69-14X-18, 26p., 1970. 8 refs.

Male rabbits and guinea pigs were exposed to lead sesquioxide for 16 hours a day in concentrations of 75 microgram/cu m and 150 microgram/cu m; in addition, a further group of rabbits and guinea pigs were exposed to 0.5 ppm of ozone. Lung clearance was studied in the rabbits by measuring the clearance rate of inhaled radioactive, monodisperse polystyrene and iron particles. With the guinea pigs, however, lung clearance was studied by taking x-ray films of animals exposed to radioactive E. coli. In rabbits, the number of free, alveolar macrophages was evaluated, and histopathological examinations were made. During the first experiment three rabbits died, two in the ozone and one in the control group. Pathological examinations showed pneumonia and rhinitis. Of the original 20 guinea pigs in the two lead exposure experiments, 3 died in the first experiment and 5 in the second; 4 animals out of 20 died in the ozone exposed group. Examination showed that they all suffered from extensive upper respiratory disease with severe pneumonitis. Concerning ozone exposure, no effect was observed on the mechanical clearance either in rabbits or guinea pigs, although there was a small decrease of bacterial clearance with the latter. Results were essentially negative concerning effects of lead sesquioxide on particle clearance. Further, there was no effect on the number of free alveolar macrophages or their phagocytic activity. That lead was absorbed was shown, however, by its accumulation in the liver and kidney.

26477

Stokinger, Herbert E.

**EFFECTS OF INHERITED METABOLIC PATTERNS ON AIR POLLUTANT SUSCEPTIBILITY.** In: Project Clean Air. Bureau of Occupational safety and Health, Cincinnati, Ohio, Lab. of Toxicology and Pathology, Vol. 2, App. L, 14p., Sept. 1, 1970. 32 refs.

With respect to heredity, physiologic response to environmental pollutants can be manifested by two mechanisms--direct alteration of genetic material and selection of various genes by an altered environment, or abnormal modification because of defects in metabolism from an altered genetic structure. The latter is discussed in relation to the potential effects of inherited metabolic patterns on air pollutant susceptibility under the following situations: allergic asthma from airborne organic dusts, familial pulmonary emphysema and serum antitrypsin deficiency, susceptibility to lead poisoning and red blood cell glucose-6-phosphate dehydrogenase deficiency, male susceptibility to chronic granulomatous disease and leucocytic glucose-6- phosphate dhydrogenase deficiency, atherosclerosis from carbon monoxide in persons with altered coronary artery patterns, and asthma and the diabetic.

26483

Teisinger, J.

**DISTRIBUTION AND BIOLOGICAL ACTIVITY OF LEAD IN ORGANISM.** Preprint 4p., 1970. (Presented at the International Conference on Chemical Pollution and Human Ecology, Prague, (Czechoslovakia), 1970.)

From experiments of lead poisoning in rabbits, changes of lead distribution in the body have been studied, as well as its excretion following termination of exposure. Lead is excreted rapidly from the liver and kidneys, with medium rapidity from the muscles, skin, and some other organs, with difficulty from the skeleton, and not at all from hair. Calcium-ethylenediaminetetraacetic acid may mobilize lead from the skeleton until avery long time after the exposure when lead is mainly bound in the mineral part of the bones. In 25 patients divided into two groups, the amount of lead excreted spontaneously as well as after several Ca-EDTA injections was compared with the period elapsed until normalization of coproporphyrin. Lead was found to decrease ALA-dehydrase activity in another series of tests.

26528

Tateishi, Ryuhei, Shoji Hattori, and Takanobu Hamaguchi

**AIR POLLUTION IN OSAKA. II. RELATIONSHIP BETWEEN HEAVY METAL CONTENTS AND ANTHRACOSIS IN HUMAN LUNGS.** Ann. Rept. Center Adult Diseases (Osaka), 8(2):46-52, 1968. 16 refs.

The relationship between heavy metal contents in the human lung and anthracosis is reviewed. Using the lungs of 213 autopsied cases who had lived for more than 10 years in Osaka and the air polluted environs and in Nara and other non-polluted areas, a qualitative and quantitative analyses of nickel, chrome, and lead is made, their relation to pulmonary anthracosis is studied, the effects of smoking and occupation are observed. The results are tabulated for the various metals as they appear in the lung. Nickel was not related to air pollution or smoking but appeared to be correlated with the development of lung cancer attributable to occupational factors. A correlation between chrome content, anthracosis, and smoking history was observed. Lead content in the lung showed no difference between people living in polluted or non-polluted areas, but it did correlate with anthracosis and smoking history.

26720

Pines, A. G.

**THE STATE OF CERTAIN INDICATORS OF GENERAL REACTIVITY DURING LEAD INTOXICATION.** Yrachebnoe Delo, vol. 3, 1965. Translated from Russian. Belov and Associates, Denver, Colo., 6p., Dec. 9, 1970.

Forty workers from 20 to 50 years of age were examined for the effect of prolonged exposure to lead (10 years or more) on general reactivity. The group included 19 men and 21 women. In the majority of those investigated, a dimunition in functional activity of the hypothalamial-hyophysealepinephral system was noted. In man cases, the dimunition manifested itself by an aberrant reaction to the administration of ephedrine, i.e., by a decrease in the quantit of secreted 17-ketosteroids instead of an increase; in more than half of the cases, dimunition was also evidenced by a negative or aberrant eosinopenia test. The well-known interdependency between the level of adreno-cortical hypofunction and the clinical apparentness of lead intoxication was observed. With regard to blood protein formula, a tendency was noted toward an increase in general protein, a decrease in albumins, and an increase in blood serum gamma globulin In the majority of cases, a lowering in functional activity of the connective tissue structure was observed via a dimunition in the magnitude of the skin test coefficient. With regard to peripheral blood, many workers exhibited a slowing of erythorocyte sedimentation and a weakening or aberration of the luekocyte reaction that indicated a change in the capacity of the blood system's regulator apparatus to adequately react to stress. (Author conclusions modified)

26775

Hattori, Shoji, Ryuhei Tateishi, and Takanobu Hamaguchi

**QUALITATIVE AND QUANTITATIVE STUDY OF HEAVY METALS IN THE HUMAN LUNGS, AND THE RELATION TO CARBON DUST DEPOSITS.** In: Histo-pathological Study on Contamination of Human Lungs Caused by Air Pollution. 1967. 40 refs. Translated from Japanese. Franklin Inst. Research Labs., Philadelphia, Pa., Science Info. Services, p. 29-40.

Results are given of the spectroscopic analysis of the nickel, lead, and chrome contents of 200 lung specimens, of a study of the relationship of the metal levels to residential locale, anthracosis (black powder pockets in the lungs), and smoking habits, and of the metal content in cancerous lungs. No correlation between nickel content was found with air pollution or smoking, but occupational exposure appeared to have some carcinogenic effect. Chrome content varied significantly with locality and appeared to be related to both air pollution and smoking although no separation of these factors was possible in this study. Lead content did not differ significantly between polluted and non-polluted areas but did show some relationship to anthracosis, enhanced by smoking. A brief review of other investigations of the levels and effects of the inhalation of heavy metals is included.

26883

Lehnert, G.

**CHROMOSOMAL ABERRATIONS DUE TO THE EFFECT OF LEAD.** Preprint, 11p., 1970. (Presented at the International Conference on Chemical Pollution and Human Ecology, Prague (Czechoslovakia), Oct. 1970.)

Studies were made of the morphology of chromosomes in leukocyte cultures obtained from workers exposed to lead oxide. None of the subjects showed clinical signs of lead poisoning, but the mean blood lead level of the group exceeded considerably the normal range. In the workers, there was an increased proportion of mitoses with secondary aberrations. The percentage of abnormal mitoses correlated very well with the high urinary ALA of the workers. The predominant chromosomal aberrations were of the gap and break type; nonspecific changes, such as spiralizing defects, chromosomal adhesions, and pulverization were also observed. The proportion of tetraploid mitoses and the mitoses index were slightly increased. In comparison to a control group, these findings were statistically significant. Serial controls with strict criteria of assessment are recommended for lead workers.

26886

Hernberg, Sven, Jorma Nikkanen, Sakari Tola, Sinikka Valkonen, and Ckaes-Hendrik Nordman

**ERYTHROCYTE ALA-DEHYDRATASE AS A TEST OF LEAD EXPOSURE.** Preprint, 15p., 1970. 10 refs. (Presented at the International Conference on Chemical Pollution and Human Ecology, Prague (Czechoslovakia), Oct. 1970.)

A study involving 159 persons with varying degrees of lead exposure, starting from 'normal' urban exposure (15 medical students), and ending with heavy industrial exposure (19 lead scrap smelters), showed a close negative correlation between erythrocyte delta-animolevulinic dehydratase (ALA-D) and the concentration of lead in blood (Pb-B). When the activity of ALA-D was plotted on a logarithmic scale, a straight regression line was obtained, indicating that there is no threshold for the inhibiting effect of lead on ALA-D. It is obvious that inhibition starts at lead concentrations far below the 70-80 micrograms per dl considered to be the 'safe' upper limit. The sensitivity of the ALA-D test makes it useful not only for the health control of occupationally exposed workers but also for studying the biochemical effects on the general population at exposures induced by environmental lead pollution.

26915

Smith, Ralph G.

**AIR QUALITY STANDARDS FOR LEAD.** American Petroleum Inst., New York, Div. of Environmental Affairs, No. 69-11, 15p., Feb. 1969. 51 refs.

Air quality standards for lead as determined by studies which are not immediately relevant to community health are discussed. Any review of the literature of the past several years dealing with lead as a community problem reveals a great number of expressed opinions concering the probable effects of present levels of lead in the atmosphere, but relatively little data to support the opinions. While occupational and pediatric lead poisoning have been well studied and characterized, much of what is known is not directly relevant to the problems of community exposures. In contrast to the difficulties of assessing the effects of lead on human health, it is relatively simple to measure with great sensitivity and accuracy the quantities of lead in all sorts of biological materials. Blood levels, urine levels, and bone and tissue samples are mentioned. Limited air sampling indicates that none of the cities approach the Threshold Limit Value of 200 micrograms/cu m.

26931

Einbrodt, Hans Joachim, Heinrich Reploh, and Hildegard Kortemme

**LEAD DEPOSITS IN NORMAL HUMAN LUNGS.** (Ueber Bleiablagerung in normalen menschlichen Lungen). Text in German. Staub, Reinhaltung Luft, 28(8):320-322, Aug. 1968. 13 refs.

Lungs from female cadavers who had lived in large industrial towns were dissolved by means of formamide. The lead content of dust present in the lungs and of the formamide residue was determined. The lungs of younger women retained a considerably larger amount of organic lead than those of older women. This fact is associated with increasing pollution of air with lead occurring in large towns. The amounts of lead found corresponded to the values for lead content of human lungs determined in Los Angeles.

27084

Haley, Thomas J.

**A REVIEW OF THE TOXICOLOGY OF LEAD.** American Petroleum Inst., New York, Div. of Environmental Affairs, Air Quality Monograph 69-7, 53p., 1969. 287 refs.

In reviewing the toxicology of pediatric, adult, and tetraethyllead plumbism, the following subjects are discussed: sources of environmental lead, lead sampling, body burden of lead, biochemical aspects, sources of lead overexposure, clinical aspects of lead poisoning, lead alkyl intoxication in occupational exposures, and air quality criteria. Environmental sources of lead, soil, water, and food, constitute the greatest source of lead intake, and lead in the ambient air contributes very little to the body burden of lead. The effects of lead on porphyrin metabolism are definitive, but as yet no standards for delta-aminolevulinic acid and coproporphyrin excretion in normal humans have been established. Any air quality criteria developed for ambient air lead concentration should be flexible until more definitive information on the effects of air lead on health have been elucidated. (Author summary modified)

27085

Jordi, A.

**INDUSTRIAL TOXICOLOGY AND SOCIAL MEDICINE.** (Gewerbliche Toxikologi und soziale Medizin). Text in German. Praxis (Bern), 57:785-793, June 4, 1968. 18 refs.

Toxicity of carbon monoxide increases as a result of various factor like fast smoking during the inhaling of air containing CO, reduction of partial oxygen pressure by other gases, or flying at altitudes of 3000 m. Since hypoxemia causes no sensation and gives no warning, the danger is especially great for automobile drivers and pilots. The gradual reduction of the leucocyte count has been known to physicians for 30 years. The count of 6000-8000 is no longer normal; today a count of 5000 is normal for urban populations. The causes, aside from exhaust gases, are various drugs like sulfonamides and antibiotics. Silicosis is still the most important occupational disease in Switzerland today in spite of intensive prophylaxis. The incidence of pulmonary asbestosis has increased somewhat since 1940 as has the incidence of lung cancer in contrast to silicosis. As a result of the processing of already purifiied cotton and good ventilation, byssinosis has rarely been observed in Switzerland in spite of the size of the textile industry. It seems to be more frequent in the jute and hemp industries. The incidence of chronic lead poisoning is in second place among recognized occupational diseases. The symptomatology is reviewed. Also reviewed are incidence, symptoms and social implications of poisonings by beryllium, by mercury and by organic solvents.

27107

**BEHAVIORAL REACTIONS TO CONTAMINANTS.** (Contamination Control), 1968:15-18, Dec. 1968. 528 refs.

The effects of some common pollutants on the behavior of animals ar discussed. Using the electroencephalograph to record brain-wave patterns and an on-line computer to put the patterns into a meaningful mathematical relationship, researchers have discovered that carbon monoxide, ozone, and lead affect the brain's electrical activity, an indicator of levels of consciousness. The effects of CO on rats resembled that of the depressant pentobarbitol. The experiments indicate that persons who have to make rapid, correct decisions may lose efficiency in performing their tasks if exposed to low levels of CO. The effects of lead on sleeping rats include a shortened and less stable sleep pattern. These changes in sleep may directly or indirectly indicate the impairment of a neural control system. The experiments suggest that ozone acts on a different site in the brain from CO. An index of articles that have appeared in Contamination Control during 1967 and 1968 on the subject of contaminants and their control is included.

27253

Mizuhara, Kan, Akira Miyagawa, Michiko Hashimoto, Shunji Kurono, Miyo Kishimoto, Tomiko Nakamura, Hiroshi Hashimoto, Yuriko Takeyama Hiroshi Muranaka, Setsuo Takaishi, Shizuko Ogawa, Sumie Matsuyama, Hiroyoshi Yoshida, Yoshio Watanabe, Tojiro Ito, Kazuko Nakanishi, Miyuki Iriyoshi, Teruko Takigawa, Kinuko Tomita, Toshio Kawaraya, Takahiro Haruki, Tadahiko Shimizu, Yoshizo Tsunetoshi, Nobuko Nakahashi, Seiko Okamoto, Chieko Hashimoto, Kazuo Kawai, Asao Yokoyama, Akiyuki Akiyama, Toshihisa Teraoka, and Harue Morita

**HUMAN EFFECT SURVEY ON AUTOMOBILE EXHAUST GASES ALONG THE OSAKA HIGHWAY 26. PART II. HEALTH SURVEY AND ITS RESULT.** (Osaka koku 26 go sen endo ni okeru jidosha haishutsu gasu jintai eikyo chosa. Sono 2. Kenko chosa to kenshin seiseki). Text in Japanese. Seikatsu Eisei (J. Urban Living Health Assoc.), 14(5):132-140, Oct. 1970. 13 refs. (Presented at the Japanese Society of Public Health, Annual Meeting, 9th, the Japan Society of Air Pollution, Annual Meeting 11th, and the Japanese Society of Public Health, Annual Meeting, 25th.)

A survey on effects of automobile exhaust gases on human bodies was conducted; consciousness and health examinations were made in September and October of 1969. Subjects were men and women above 20 years of age who lived in Naniwa, Nishinari, and Sumiyoshi wards The number of the subjects was 594 in the exposed area along the highway, and 212 in the non-exposed area separated about 100 meters from the highway. Consciousness examination was carried out on 14 items in the basic survey and on 48 items for existence of conscious symptoms by oral examination. In two exposed areas, 30% - 50% of the subjects complained eight self-conscious symptoms like mental symptoms in men and mental symptoms and actual troubles in women. Health examination was carried out on such items as total blood specific gravity, amount of hemoglobin, blood cell volume, blood picture, carbon monoxide in expired air, carboxyhemoglobin, lead in blood, sputum examination, vital capacity, lung function, and blood pressure; in appearance frequency of total blood specific gravity, carbon monoxide in expired air, carboxyhemoglobin, lead in blood and sputum histocyte, each significant difference was recognized. It seemed that the difference in those complaints in both areas was depending on the influence of noise.

27291

Goldsmith, John R.

**THE NEW AIRBORNE DISEASE. COMMUNITY AIR POLLUTION.** Calif. Med., 113(5):13-20, Nov. 1970. 16 refs.

Photochemical air pollution of the California type involves newly defined atmospheric reactions, and it is due mostly to

motor vehicle exhaust, associated with both affluence and careless waste. It is oxidizing, and produces ozone, plant damage, impairment of visibility, and eye and respiratory symptoms. Aggravation of asthma, impairment of lung function among persons with chronic respiratory disease and a possible causal role, along with cigarette smoking, in emphysema and chronic bronchitis are some of the effects of photochemical pollution. More subtle effects of pollution include impairment of oxygen transport by the blood due to carbon monoxide and interference with porphyrin metabolism due to lead. Carbon monoxide exposures may affect survival of patients who are in hospitals because of myocardial infarction. The physician has two responsibilities in the field of air pollution. One is to his patients, through providing adequate specific protection for sensitive individuals against the specific effects of air pollution when it is elevated. The second role of the physician is to help shape public policy regarding pollution by applying knowledge of the respiratory and other health hazards that come from polluted air whether from occupational exposure, cigarette smoking, or community air pollution. (Author abstract modified)

27416

Tepper, L. B. and E. A. Pfitzer

**CLINCIAL AND BIOCHEMICAL APPROACHES TO THE STUDY OF LEAD AT LOW LEVELS. REPORT OF A SYMPOSIUM FEBRUARY 1970.** Cincinnati Univ., Ohio, Kettering Lab., NAPCA Contract CPA-70-14 and PHS Grant ES00159, 28p., 1970. NTIS: PB 196767

A summary of conference reports is given on the state of current knowledge of each of the following major subject areas as related to lead: environmental and human concentrations; subcellular physiology; kidney effects; effects on the hematopoietic system; and neurological manifestations. The presentations illustrate the increasingly sophisticated methodology being used to study the symptoms of excessive lead absorption. Of even greater importance, however, would be the development of sensitive and specific measures capable of establishing whether or not 'normal' people are being harmed by current concentrations of lead in the 'normal' environment. No new, practical measures are as yet available as screening procedures to detect very early adverse responses to lead but numerous approaches are being investigated, including aminoaciduria, inclusion bodies, sodium pump inhibition, biochemica functions, enzyme changes, essential trace metals, heme synthesis, and nerve conduction time. (Author summary modified)

27490

Ohmori, Kaoru, Haruko Saito, Akemi Tanizaki, Katsunori Omura, Masamichi Ichihara, and Kazuo Uryu

**EXPERIMENTAL STUDIES ON INHALATION OF LEADED GASOLINE VAPOR.** (Kaen gasorin kyunyu no eikyo ni kansuru jikkenteki kento). Text in Japanese. Yokohama Igaku (Yokohama Medical J.), 21(3): 387-391, Sept. 1970. 10 refs.

To determine the effect of alkyl lead compounds upon an organism, six male white rabbits were exposed to the vapors of commercial leaded gasoline (mineral lead; 0.56 g/l - 0.83 g/l) at a concentration of 500 ppm with continual exposure of 3 hours/day, and five days/week for 92-220 days. Every 15-20 days, blood and urine samples were obtained. The lead concentrations in blood and urine were measured by performing dithizone colorimetric analysis by means of the moist calcination method. The coproporphyrine concentrations in urine were measured by the Rimington - Sano method. Moreover, general dispositions of the blood were observed, by concentrating upon anemia and then, the concentrations of lead in the various tissues were observed by practicing dissection. The lead concentrations in blood increased gradually from 10 microgram/dl to the highest level of 70 microgram/dl with continuous exposure. The lead concentrations in urine increased slightly in general, but the amounts were, as a whole, in normal range, taking into account the peculiarity of the excretion process of alkyl lead, differences of excretion faculty according to the individual samples and the ranges of the amount of excretion in each individual sample. The excretion of coproporphyrine in urine was also normal. The lead concentrations in liver were 386.0 microgram/100 - 1170.6 microgram/100, and in kidney; 266.3 microgram/100 - 676.0 microgram/100 but remarkable accumulations were not recognized in the other tissues. From the above study, such positive symptoms as to support poisoning by the inhalation of alkyl lead were not established, but the symptoms of accumulations of lead in organism were apparently recognized.

27614

Ulmer, David D. and Bert L. Vallee

**EFFECTS OF LEAD ON BIOCHEMICAL SYSTEMS.** Missouri Univ., Columbia, Environmental Health Center and Missouri Univ., Columbia, Extension Div., Proc. Missouri Univ. Second Annu. Conf. Trace Substances Environ. Health, Columbia, No., 1968, p. 7-27. 27 refs. (July 16-18.)

Experiments of the biological effects of lead on systems of widely varying complexity, ranging from isolated enzymes to whole animals, were undertaken to provide a firmer basis for estimating potential hazards to health from this element in the ambient environment and to localize potential sites of its action in metabolism. Lead appears to act at a large number of biochemical sites and might contribute to metabolic alteractions through several different mechanisms. Lead markedly inhibited the enzymatic activity of pig heart lipoamide dehydrogenase: addition of 0.00000065 M lead to the assay caused a 50% inhibition of activity. The lead binds to the dithiol configuration at the active catalytic center. Protection was afforded by coenzymes and substrates and the inhibition was reversed by EDTA. The addition of 0.00001 M lead acetate to an incorporation of 14C- leucine into transfer ribunucleic acid (t-RNA) resulted in nearly 50% inhibition of enzymatic activity over the first few minutes of the reaction. The metal may affect protein synthesis by attacking the synthesizing enzymes and, perpahs, through binding and hydrolizing t-RNA. At the cellular level, lead inhibits the growth of the microorganisms Rhodopseudomonas spheroides, and appears to alter tetrapyrrole synthesis in this species through a complex metal-ion antagonism involving coproporphyrinogen oxidase (coprogenase), which action may well be the basis for the increased urinary coproporphyrin observed in plumbism. These and still other effects of lead are likely to be pertinent in evaluating the significance of exposure to this metal in higher forms of life. Chronic lead intoxidation was induced in a pony by oral administration of lead acetate over a four-month period. The animal was sacrificed and the organs and tissues were analyzed for their mental concentrations. Lead was localized primarily to liver, bone, kidney, spleen, lung, and hair, similar to the distribution observed in lower species. The distribution of lead and its binding to specific subcellular constituents, metallothionein and liver RNA, in the pony are reported as early efforts to delineate loci of interaction of the metal in intact animals. (Author summary modified)

27801

Davis, Wayne H.

**POLLUTION: WHENCE AND WHITHER.** Arch. Environ. Health, vol. 21: 3-4, July 1970. 4 refs.

Earth is the test tube and as numbers of people continue to rise, pollution and other toxic products of our civilization will destroy the entire ecosystem. Mercury, lead, carbon monoxide, oxides of sulfur and nitrogen, pesticides, herbicides, and radioactive wastes are some of the toxins which have already caused serious trouble. The most important factor concerning a toxin is concentration. Concentrations of DDT and its metabolites in the environment have nearly eliminated the brown pelican, Bermuda petrel, osprey, peregrine falcon, and the eastern bald eagle. A fundamental law of ecology is that the more species in a community the more stable it is. The starfish population explosion which is destroying the coral atols and threatening wave erosion loss of islands from Hawaii to Australia probably results from man's effects on the ecosystem, most likely his use of DDT. Concentrations of a few parts per billion of DDT inhibit photosynthesis in marine algae. Such algae not only are the base of the food chain upon which marine animals are dependent, but they also provide most of our oxygen. The food production advocates say that the underdeveloped nations must increase pesticide usage six-fold in order to feed themselves. Since these nations are the poorest and DDT the cheapest, that pesticide will be used. Rise in the human population means destruction to all.

27961

Osaka Prefecture (Japan) Dept. of Environmental Hygiene

**REPORT OF CONFERENCE OF SPECIAL COMMITTEE ON HEALTH SURVEY CONDUCTED OF POLLUTION IN OSAKA PREFECTURE.** (Osakafu kogai kenko chosa senmon iinkaigai). Text in Japanese. 45p., Jan. 27, 1971.

Results are reported for surveys of the health effects of emissions from an artificial leather company, a chemical company, a cotton cloth bleaching company, and a zinc plating plant. In addition, data are presented for a survey of the effects of lead in auto exhaust on housewives and for a survey of the effects of cadmium- contaminated crops. Based on interviews and blood and urine tests, the survey of housewifes indicated no adverse effects attributable to lead. Of 111 persons in Yao City who were examined for the effects of cadmium, 11 showed positive urine protein. These surveys were conducted in Osaka Prefecture.

28010

Hernberg, S. and J. Nikkanen

**ENZYME INHIBITION BY LEAD UNDER NORMAL URBAN CONDITIONS.** Lancet, 1(7637):63-64, Jan. 10, 1970. 15 refs.

A close negative correlation was found between the concentration of lead in blood and the activity of erythrocyte delta-aminolevulinic acid dehydrogenase in 26 healthy individuals, never exposed occupationally to lead. The concentration of lead in whole blood was measured after wet ashing using a dithizone method, while ALA dehydrogenase was measured from fresh heparinized whole blood according to Bonsignore's method. As a result of growing industrial use and the introduction of alkyl lead compounds as gasoline additives, exposure to lead is substantially above the background of absorption from food and drinking water. Present levels of environmental contamination with lead can produce a measurable biochemical alteration in man. (Author summary modified)

28011

Armstrong, David W.

**THE MEASUREMENT OF URINARY LEAD CONCENTRATION BY A SPECTROGRAPHIC METHOD.** Public Health Bulletin, no. 262:83-86, 1941.

The results of a quantitative spectrographic analysis of urinary lead are presented in the form of a graph of the distribution of urinary lead values in relation to atmospheric lead exposure and of a table of the urinary lead content of four exposure groups. The relations between urinary lead concentrations and lead exposure are further illustrated in a figure showing the extent of variations of concentration values above and below the mean for each of the four groups. The values obtained by spectrographic methods are in good agreement with the results of chemical analysis by the dithizone method.

28024

Bruin, A. De

**EFFECT OF LEAD EXPOSURE ON THE LEVEL OF DELTA-AMINOLEVULINIC- DEHYDRATASE ACTIVITY.** Med. Lavoro (Milan), 59(6-7):411-418, 1968. 13 refs.

The assay of aminolevulinic dehydratase activity in red blood cells was carried out in workers slightly exposed to inorganic lead, as well as in animals under the protracted influence of small amounts of the metal salt. In people working in a printing office, the enzyme activity was shown to be reduced on the average to 66% of a control group, despite the existence of urinary levels of coproporphyrine and delta-aminolevulinic acid not exceeding the upper normal limits. Rabbits subjected to repeated injections of lead acetate displayed a gradual decrease of ALA-dehydratase activity. Suppression of enzyme activity appeared to be dependent on the amounts of lead administered. In view of the early reduction of ALA-dehydratase activity, which largely precedes the increase of delta-aminolevulinic acid and coproporphyrine in the urine, estimation of the enzyme activity may be considered to provide a very sensitive test of increased lead absorption. It has been suggested that lead inhibits delta-aminolevulinic dehydratase activity by virtue of its affinity to the sulfhydryl-groups, indispensable for the enzyme activity. (Author summary modified)

28170

Tsuchiya, Kenzaburo

**ENVIRONMENTAL POLLUTION BY HEAVY METALS SUCH AS LEAD.** (Namarito jukinzoku miyaru kankyo osen). Text in Japanese. Rodo Kagaku (J. Sci. Labour, Tokyo), 25(10):4-10, Oct. 1970. 43 refs.

Although there has been a decrease in the incidence of occupational lead poisoning, the appearance of porphobilinogen, delta ALA, and similar diseases, is being observed with increasing frequency. This suggests the necessity of developing a method for the rapid diagnosis of the lead load being accumulated in the body as a result of increased atmospheric concentrations. This problem is not simple in the absence of proof that lead in urine indicates the degree of exposure to lead and that lead in blood indicates the lead accumulation in the body. Studies must be undertaken to determine the effects of small amounts of all lead compounds on a large population and also the interaction of lead with other metals. Only when all relevant data are scientifically sorted and utilized will it be possible to establish an environmental standard for lead.

28171

Akatsuka, Kyoji

**PROBLEMS OF HYGIENICS CONCERNING LEADED GASOLINE.** (Kaen gasorin nikansuru eiseigakuteki mondaiten). Text in Japanese. Rodo Kagaku (J. Sci. Labour, Tokyo), 25(10):20-31, Oct. 1970. 55 refs.

The toxicity of hydrocarbons is explained on the basis of clinical data and experimental data for men and/or animals. Symptoms of acute poisoning due to absorption of hydrocarbons include headaches, dizziness, insomnia, anxiety, and delirium; symptoms of acute poisoning due to skin irritation include conjunctivitis and coughing. Among the symptoms of chronic poisoning are inertia ennui, headaches, melancholy, and insomnia. The most marked effects are due to gasolines, particularly those that have undergon thermal cracking. Animals whose skins have been exposed to hydrocarbons have developed necrotic lesions and have not survived as long as animals absorbing gasoline. The pathological effects of hydrocarbons on animal organs are greatest in the case of leaded gaolines, which suggests that maximum allowable concentrations of lead should be determined. In addition, observation facilities and personnel should be increased.

28205

Gaultier, M., P. Gervais, P.-M. de Traverse, P.-E. Fournier, N.-L. Coquelet, A.-M. Loygue, and H. Housset

**GENETIC VARIATIONS IN THE HEMOBLOGIN CAUSED BY THE PROFESSIONAL ENVIRONMENT.** Arch. Maladies, Profess. Med. Trav., Security Sociale, 29(4-5):197-203, April-May 1968. 19 refs. Translated from French. Belov and Associates, Denver, Colo., 14p., Nov. 13, 1970.

Qualitative hemoglobinopathia and thalassemic syndromes have become very frequent in the Paris region due to immigration of workers of Mediterranean or African origin, working under conditions such as exposure to benzene, lead, or ionizing radiation The irregularities most frequently discovered are hemoglobins S and C on the one hand, thalassemia on the other hand. These red blood corpuscle irregularities sometimes pose diagnostic problems because of the presence of red blood corpuscles of basophilous granulations in lead poisoning and in thalassemic syndromes. The existence of a hemolytic process and aplasic attacks, in the course of different toxic hemopathia and in hemoglobinopathia, has lead numerous authors to eliminate the subjects carrying hemoglobin irregularities from any work which could possibly involve the danger of exposure to a hemotoxic substance. Comparative studies of toxic environment and hemotological functions of subjects carrying red blood corpuscle irregularities would be desirable in order to justify the professional classification of populations where red blood corpuscles variations are numerous. (Author summary modified)

28256

Cooper, Peter

**POISONS AND THE FOETUS.** Pharm. J., 204(5547):173-175, Feb. 21, 1970. 25 refs.

Examples are cited to show the correlation between lead in illicit moonshine and foetal abnormalties, the correlation between the cadmium content of cigarettes and chronic bronchitis and/or emphysema, and the close resemblance between signs and symptoms of chronic manganese poisoning and those of Parkinson's disease. In addition, the misuse of medicaments is discussed with reference to lithium carbonate, atropine, solanaceous alkaloids, and cough preparations. Also noted is the marked carcinogenic potential of benzidine and o-tolidine both used in testing for occult blood. Experiments with activated charcoal as an antidote to acute poisoning are reported.

28834

Schroeder, Henry A.

**SOME PROSPECTS FOR RESEARCH ON BIOLOGICALLY ACTIVE TRACE ELEMENTS.** Missouri Univ., Columbia, Conf. Trace Substances Environ. Health, 1st, Columbia, Mo., 1967, p. 20-28. 30 refs. (July 10-11.)

Only nine trace elements are recognized as essential to mammalian life or health, all probably important catalysts for differing biological functions, many of them unknown. These are chromium, manganese, iron, cobalt, copper, zinc, selenium, molybdenum, and iodine. Others which are suspected to have a biological function include vanadium, nickel, arsenate, and fluorine. Because of modern agricultural practices resulting from the increasing demand for food, and modern methods for the refining of food, human intakes of essential trace elements may become marginal or deficien in those necessary for man but less so for plants. Two specific examples of this are mentioned, and reference is made to chromium deficiency. An intake adequate for life is not necessarily one adequate for optimal health and function. Accumulation of essential elements, as caused by a wide variety of hereditary disorders and environmental exposures, is also discussed. Lead is mentioned as a consequence of automobile exhaust, while cadmium may promote hypertension.

29129

Yagyu, Hiroshi, Kiyoshi Morozumi, Masatake Kobayashi, Soji Yamazaki, Yasuhito Sato, and Shingo Ikeda

**ENVIRONMENTAL CONDITIONS AT A TOLL-GATE BOOTH AND THEIR INFLUENCE ON THE LABORS' HEALTH.** (Yuryodoro ryokinsho kankyo no ryokin shujuin ni oyobosu eikyo ni tsuite). Text in Japanese. Tokyo-Toritsu Eisei Kenkyusho Nenpo (Annu. Rept. Tokyo-to Lab. Med. Sci.), no. 21:129-146, 1969. 8 refs.

During three days in December 1969, a survey was made on the environmental conditions of toll-gate business and on health of workers at the booth of a toll-gate near Tokyo. The quantity of carbon monoxide and other substances in automobile exhaust was measured. Blood and urine was examined and fatigue was observed, in order to know whether exhaust gases effect the human body acutely or chronically. The effect of oxygen inhalation as countermeasure against the exhasut gas was also examined. The concentration of CO gas was 10 ppm when wind speed was 3-5 m/sec, but in the dead calm it indicated over 30-50 ppm. The concentration of nitric oxide gas was fairly high, indicating 1.20-1.37 ppm from 8:00 am to 12:00 and the maximum concentration of nitrogen dioxide gas was 0.22 ppm. The average weight of dust in the air was 0.74 mg/cu m (1.02 mg/cu m maximum and 0.45 mg/cu m minimum); that of lead was 12.7 mg/cu m average (17.2 mg/cu m maximum and 9.0 mg/cu m minimum); and that of silica dehydrate was 0.12 mg/cu m average (0.23 mg/cu m maximum and 0.03 mg/cu m minimum). All these were less than the permissible concentrations in the labor standards law. According to the survey results by C.M.I., there were a little more complaint about abnormalities in the circulatory system, but they had nothing to do with the length of employment. Examination of urine indicated comparatively more quasi-positive albuminuria in the people over 40 years old and working under 3 years. The amount of lead in blood and urine had nothing to do with the age and length of employment. Subjective fatigue and two-points touch-discrimination were investigated, showing some

effect with inhalation of oxygen, but no significant effect in the carboxyhemoglobin % in blood. Cigarette smoking had a greater influence in the investigation of fatigue. Under these circumstances, the environmental conditions of the workers at a toll-gate booth were considered beyond the permissible limits of the standards law.

29256

Saita, G., L. Moreo, and G. Levizzani

**THE BEHAVIOR OF DELTA-AMINOLEVULINIC ACID AND OF PROPHOBILINOGEN AFTER GLYCINE LOAD IN SATURNISM.** Med. Lavoro (Milan), 58(331):364-369, 1967. Translated from Italian.

Because other tests are not always conclusive indicators of minor lead intoxication, a study was made of the behavior of delta-aminolevulinic acid (ALA) and prophobinogen (PBG) in saturnism, before and after glycine load. Prior to glycine load, two of the 10 cases studied had ALA serum values above the maximum normal limit and nine had ALA urine values above maximal normal limits. After glycine load, a noteworthy increase of the serum and ALA values was observed in all cases. No changes in PBG were found. In 10 normal subjects, no pathological ALA and PBG increases occurred in either urine or serum. It is concluded that glycine load not only makes an already existing metabolic change increasingly evident, but also permits the documentation of the changes in those cases of saturnism for which preliminary analyses failed to demonstrate any ALA changes.

29286

Lob, Marc

**GASOLINE WITH LEAD CONTENT. I. THE PROBLEM OF REPLACING TETRAETHYL LEAD BY TETRAEMETHYL LEAD.** (A propos de la benzine au plomb. I. Probleme du remplacement du plomb tetraethyl par le plomb tetramethyle). Text in French. Z. Praeventivmed., 10(3):164-171, 1965.

The replacement of tetraethyl lead (TEL) with tetraemethyl lead (TML) as an antiknock agent in gasoline was studied. When injected into rats, TML produced toxic effects of less intensity than TEL. The effect of these agents on the health of employees of refineries and gasoline service stations is also important. TML is more volatile than TEL, and can cause a lead content in the air which is three times greater than TEL under comparable circumstances. However, the human being reacts less to the inhalation of TML than TEL. A set of urine tests from refinery personnel showed an average of 90 micrograms of lead per liter of urine when TEL was processed, as compared to 100 micrograms from TML, a difference of 10%. Lead content in the blood was again 10% higher from TML than from TEL. Test results from serivce station employees showed practically no difference in lead content in urine derived from persons who worked in stations selling TML compared with the findings obtained under comparable conditions from urine analyses derived from TEL gasoline station personnel. Safety precautions, wearing of gas masks, must be taken by operators in refineries who work in close contact with TML and where the atmosphere may contain as much as 200 micrograms of lead per cu m of air. For comparison, 5 to 10 micrograms per cu m were reported as average conditions in service stations in California.

29329

Tansy, M. F. and R. P. Roth

**PIGEONS: A NEW ROLE IN AIR POLLUTION.** J. Air Pollution Control Assoc., 20(5):307-309, May 1970. 15 refs.

A pilot study was conducted to determine the lead content of the various tissues and organs of two groups of wild pigeons. One group was obtained in the City of Philadelphia. The other group was captured in rural Jefferson County, Pennsylvania. Tissue and organ lead content of both groups was assayed by means of atomic absorption spectrophotometry. Each bird was carefully examined to determine the possible presence of imbedded or ingested lead. None was found. The mean lead content per unit weight of the hard tissues of the city pigeons was significantly higher than the corresponding values for the rural birds. The blood lead content of the two groups (a parameter which is often assayed in screenings of chronically exposed human populations) did not reflect a significant difference. Possible sources of lead intake are examined and references to past literature are cited which indicate that the most significant general source of biological lead is probably atmospheric. The routine examination of wild animals that may harbor disease- producing organisms or vectors is a commonly accepted procedure. The authors advance the proposition that the ubiquitous presence of certain animal pests, notably pigeons, may lend itself to a similar monitoring of the chronic uptake of atmospheric metallic pollutants. (Author abstract)

29493

Mills, A. L.

**LEAD IN THE ENVIRONMENT.** Chem. Brit., 7(4):160-162, April 1971. 18 refs.

Organic and inorganic lead have different modes of toxicological action and distribution in the tissues of the body, so it is important to distinguish between them in the environment. The amount of lead absorbed from a given air concentration varies according to the particle size. Of the lead from both air and dietary sources which is retained in the body, about 95% is found in bone. The most commonly used yardsticks of the total environmental exposure and the resulting body burden of lead are the concentrations in blood and urine. Sources of lead poisoning are indicated. Lead intoxication does not appear to occur at blood levels below 80 micrograms per 100 ml. The relationships between the blood concentration of lead and activity of the blood enzyme delta-aminolevulinic acid dehydratase and urinary coproporphyrin and delta-aminolevulinic acid require further study since such parameters appear to be directly related to the degree of exposure. Evidence on whether the lead concentration in air is going upwards or downwards is presented. Economic advantages of using lead have to be balanced against the degree of genuine hazard arising from possible environmental and health effects. The use of lead in gasoline is discussed in relation to automobile performance.

29588

Barnea, M., M. Zielinski, and M. Cucu.

**EXPERIMENTAL STUDIES ON THE EFFECT OF SMALL DOSES OF LEAD AND SULFUR DIOXIDE.** (Experimentelle Untersuchungen ueber die Wirkung geringer Mengen von Blei und Schwefeldioxid). Text in German. Wiss. Z. Humboldt Univ. Berlin Math. Naturw. Reihe, 19(5):461-462, 1970.

To evaluate the combined toxic effect of lead and sulfur dioxide, white Wistar rats were exposed to various concentrations and conditions of these pollutants in two test chambers. To simulate the condition of the air in residential areas, the SO2 was used in gaseous form, generated from a vessel containing the liquefied gas and equipped with a pressure reducer and control system for the air flow to the test chambers. The lead was used in the form of minute particles contained in vapors,

obtained from a metal container located in a hermetically sealed electric furnace equipped with temperature control. The vapor was drawn from the furnace by means of a nitrogen current. A system of control devices ensured a constant lead concentration in the two test chambers. One chamber obtained a controlled concentration of 0.4 mg/cu m SO2 and four micrograms per cu m Pb, the other chamber exactly half of these concentrations. The animals were exposed to the gases for six hours per day over a six-month period. A control group of rats was exposed to normal atmosphere. The test rats showed a smaller gain in weight than the controls. Oxygen consumption was greater with the test animals, indicating stimulation of the general catabolism due to the SO2 and Pb concentrations in the air. Other effects included reduced functioning of the central nervous system as proved by testing of reflexes to light and electrical impulses, reduced activity of liver enzymes, and reduced resistance of the test animals to experimental infection with pneumococci.

29663

Mishima, Masao, Tadashi Hoshiai, and Takeo Suzuki

**SEMI-AUTOMATIC DETERMINATION OF LEAD IN WIDE BLOOD.** (Oto anaraiza niyoru kecchu namari no bunseki). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 5(1):64, 1970. (Presented at the Japan Society of Air Pollution, Annual Meeting, 11th, Japan, 1970.)

Lead concentration in blood was tested using the automatic analyzer by Dithizon method to reduce individual errors. The blood samples were diluted with the buffer solution and dialyzed followed by addition of Dithizon-chloroform and determined by photometer. The results were checked by the atomic absorption photometric method.

29789

Murozumi, Masayo

**LEAD MEN HEADING TOWARD DESTRUCTION--SPREADING OMINOUS METAL POLLUTIONS.** (Metsubo e muko namari ningen--Bukimi ni hirogaru kinzoku osen). Text in Japanese. Kagaku Asahi (Sci. Asahi), 30(12):39-44, Dec. 1970.

Two articles on lead pollution were reviewed. If man is to eat 2 kg of food daily with an average intake of 0.2 ppm of lead, the micrograms 400 of lead are taken orally, of which 5% is absorbed into blood, and the remaining 380 micrograms are discharged. If 20 cu m air is necessary a day, and if lead concentration is 1.3 micrograms per 1 cu m, 26 micrograms enter the lungs of which 40% is absorbed into blood, totalling 30 micrograms. For smokers, there is another 10 micrograms premium. Although absorbed lead is partly discharged, the lead retained in human body gradually increases. In 1965, what was absorbed from food source was more than what was absorbed by lungs, but in 1970, the lead concentration in urban areas was 5 micrograms per 1 cu m. Accordingly, the lead contained in humans is nearly 100 times that of primitive man. Tetra- alkyl lead is especially dangerous, since it damages the brain and nervous system. An analysis of snow accumulated in the North Pole, Antarctic, and Greenland showed that lead was contained in the snow of Greenland 200 years ago, indicating that lead smelting was conducted in the northern hemisphere. The tendency corresponds to the increase in lead production, and especially in the recent 30 years, the increase in the consumption of tetra-alkyl lead was tremendous. The snow in the Antarctic contains less lead concentration than the snow of Greenland 200 years ago. Thus, even up to the extreme Polar area, the northern hemisphere is contaminated by lead in the atmosphere. While lead concentration in blood is still 20 micrograms/100 g, one-third of the safety standard, the amount of tetra-alkyl lead added to gasoline must be limited and electric cars must replace the present models.

29815

Horiuchi, Kazuya

**SOME PLANS FOR FUTURE STUDIES FOR LOW LEVEL OF LEAD ON THE HUMAN BEING.** Preprint, United States - Japan Cooperative Science Program. (Presented at the Conference of Effects of Environmental Trace Metals on Human Health, Honolulu, Hawaii, Feb. 1-5, 1971.) p. 20-27, 1971. 19 refs.

Since lead is normally present in small amounts in the human body, several studies were undertaken to establish the origin and amount present in blood, urine, feces, and organs of healthy persons. Based on the results, the maximum allowable concentration of lead oxide dust in working environments was established at 0.05 mg/cu m. Some experiments were performed on the amount of ambient lead in a large city in Japan. Studies now in progress pertain to oxygen consumption of reticulocytes and stippled cells, differences of absorption of lead compounds, and calculation of lead storage in the body. Plans for future studies include the velocity of electroconductivity of peripheral nerves of lead workers, resistance of peripheral red blood cells, reformation of discriminant function for the diagnosis of the lead body burden, and the effects of low levels of organic lead.

29816

Kobayashi, Yoshitaka and Kenzaburo Tsuchiya

**AIR POLLUTION BY TRACE METALS IN JAPAN.** Preprint, United States - Japan Cooperative Science Program, p. 28-48, 1971. 11 refs. (Presented at the Conference on Effects of Environmental Trace Metals on Human Health, Honolulu, Hawaii, Feb. 1-5, 1971.)

Environmental pollution by lead in Japan, mainly in cities, is thought to be caused chiefly by automobiles. Preliminary studies of urinary lead revealed no difference between school children from contaminated and non-contaminated areas. The horizontal and vertical distribution of lead in air is being investigated, as well as hourly and seasonal variations. Levels of ambient cadmium and its influence on the body are being studied. Problems requiring further study include standardization of sampling methods and methods of analysis, determination of normal values of lead in the human body, and collection of data from investigations undertaken in both Japan and the United States.

29825

Wada, Osamu

**FOUR-ALKYL LEAD AND ENVIRONMENTAL POLLUTION.** (4-arukirunamari to kankyoosen). Text in Japanese. Naika, 27(5):892-897, May 1971. 38 refs.

The history of tetraethyl lead as a gasoline additive was described including the history of its poisoning, properties, toxicity, factory environment, and toxic symptoms. The present problems of lead pollution in the general environment were also described. The effect of lead pollution on the human body could lessen human adaptation. The effect of lead on the human body can be determined by measurement of lead in blood and in urine; a better indication is the estimation of the activity of peripheral erythrocyte amino-levulinic acid dehydrase (ALA-dehydrase).

29958

Miura, H. and K. Taira

**EFFECTS OF ATMOSPHERIC LEAD ON TRAFFIC POLICEMEN IN A MEDIUM SIZED CITY.** (Chutoshi ni okeru taikichu namari no eikyo). Text in Japanese. Nippon Eiseigaku Zasshi (Japan J. Hyg.), 26(1):134, April 1971. (Presented at Japanese Society for Hygiene, Annual Meeting, 41st, Tokyo, Japan, April 3-4, 1971.)

The evaluate the effects of atmospheric lead on the human body, 50 policemen in Nagasaki Prefecture were selected according to their fields of activity. Porphyrin, its precursor, and lead were measured in the urine and blood. Atmospheric lead was trapped by a two-channel tape air sampler in a traffic congested area (I), a general area (II), and a residential area (III) within the city limits of Nagasaki. The air samples were analyzed with an atomic absorption photometer. Atmospheric lead decreased disproportionally with the traffic volume, the mean values for 24 hours being in area I, 2.03 microgram/cu m; II, 1.38 microgram/cu m; and III, 0.095 microgram/cu m. Coproporphyrin levels in urine were found in the following decreasing order; patrol car crew, outdoor workers, traffic controllers, police motorcyclists, and indoor workers. The difference between outdoor and indoor workers was large. Seven subjects had urine corproporphyrin content over 110 microgram/liter, seven had urine A.L.A. contents over 0.6 microgram/deciliter, and two had high levels in both coproporphyrin and amino levulenic acid. The results did not indicate a disturbance in the balance of lea metabolism in vivo or porphyrin excretion in vivo, in those exposed to concentration of atmospheric lead.

29963

**PROCEEDINGS OF THE 9TH CONFERENCE OF JAPAN ASSOCIATION OF INDUSTRIAL HEALTH.** (Dai 9 kai Nippon sangyoi kyogikai kiji). Text in Japanese. Sangyo Igaku (J. Ind. Health), 13(2):138-159, March 1971.

Brief summaries are given of conference reports on medical examinations of workers handling heavy metals, especially lead; case histories of lead poisoning in paint factories; health control at beryllium factories; and a case of an oxygen-deficient environment. Also summarized are reports on the effect of auto exhaust on patrols, results of medical check-ups on taxi drivers and toll collectors, and the hygienics of airborne lead particles.

30000

**ADDITION OF LEAD TO FUEL - HARMFUL OR DANGEROUS? (Bleizusaetze im Kraftstoff - harmlos oder gefaehrlich)? Text in German. VDI (Ver. Deut. Ingr.) Nachr. (Berlin), 25(9):6, 1971.**

In over 40 years of intense scientific research no proof has been found that lead additives in a gasoline cause damage to human health. Lead concentrations in urban atmospheres average less than 2 microgram/cu m in residential areas and 2 to 4 microgram/cu m in business districts. However, medical opinion rejects judgements by commercial firms which regard these values as low in comparison to maximum allowable work area concentrations of 200 micrograms/cu m because the lead measured in city streets is mainly found in fine dust below 5 microns diameter and the occupational standards are not geared to fine dust. The amount of lead ingested with food is greater than that inhaled; however, the considerably lower lead intake through inhalation is accompanied by a significantly higher retention in the lung. Even if only a small fraction of the lead is deposited in the bones, such lead accumulation may become important through long years of exposure.

30009

Lob, M. and P. Desbaumes

**STUDY OF THE LEAD CONTENT IN THE BLOOD AND IN THE URINE OF TWO GROUPS OF INMATES, ONE GROUP BEING DETAINED IN A PRISON IN RURAL SETTING, THE OTHER IN A PRISON LOCATED NEAR A HIGHWAY.** (Etude de la plombemie et de la plomburie chez deux groupes de detenus, les uns internes a la campagne, les autres a proximite immediate d une autoroute). Text in French. Schweiz. Med. Wochenschr. (Basel), 101(10):357-361, 1971. 15 refs.

The lead content in the blood and urine of two groups of prison inmates was compared. One group (A) was detained in a prison alongside a highway, the other (B) in a prison in the countryside. Group A, which was fed vegetables cultivated in a garden adjacent to the prison, was composed of 50% alcoholics and 50% delinquents and numbered 43 persons ranging in age from 19 to 79 (average age 44 years). Group B (mostly alcoholics) comprised 35 persons ranging in age from 35 to 76 years (average age 55 years). The average duration of the test was 16 months for group A, and 15 months for group B. The vegetables ingested by group A contained from 4 to 20 ppm lead in the desiccated residue. In this group, the arithmetic means of the amount of lead in the blood was 43.3 gamma percent (extreme valuue 28-70). In group B, the average was 40.5 gamma percent (extreme value 19-71). Statistically, there was no significant difference between the two sets of results. The average content of urinary lead was 35.5 gamma/liter (range 21-61) in group A, and 28.8 gamma/liter (range 10-55) in group B. The difference between these figures is highly significant and confirms that there is an increase of lead in the urine of a group of persons living in the immediate vicinity of a busy highway.

30156

**LEAD IN THE GASOLINE, DANGEROUS, HARMLESS: INDUSTRIAL ENTERPRISE INFORMS GOVERNMENT OFFICIALS -- MEDICAL DOCTORS COMMENT.** (Blei i Kraftstoff gefaehrlich harmlos. Industrieunternehmen informiert Parlamentarier - Mediziner kommentieren). Text in German. Umwelt (Duesseldorf), 1(2):31-33, 1971.

The company AK Chemie G.m.b.H. published a comment on the proposed law on reduction of the lead content in gasolines. The comment stated that lead is a natural component of the earth s crust. A reduction of the lead content will have no effect on lead metabolism in man. Lead compounds in gasoline also have no effect on human health. It is much more important to reduce the emission of unburned hydrocarbons, carbon monoxide, and nitrogen oxides. Contrary to this opinion, medical doctors have voiced concern about continued inhalation of lead compounds. Lead is readily resorbed in the lung. Chronic lead inhalation may lead to an accumulation in the bones, which is harmful. Any reduction of the lead content in the atmosphere should be welcome.

30181

Toyama Prefecture (Japan)

**REPORT ON HEALTH EXAMINATION OF OSHIMA AND DAIMON TOWN S INHABITANTS.** (Oshima, daimon cho jumin kenkochosa hokoku). Text in Japanese. 84p., Dec. 1970. 3 refs.

Health examinations of individual residents in the towns of Oshima and Daimon in Toyama Prefecture were reported. An industrial plant located in the area produces 44,600 tons of high carbon ferro- chromium and 3200 tons of low or medium carbon ferro-chromium annually. An environmental air pollution survey was conducted for three days from Oct. 20 to Oct.

22, 1970. It indicated that the average density of the suspended dust was 169.5 microgram/cu m for seven locations. Metals contained in the dust included iron, 3.94; manganese, 0.34; copper, 0.13; chromium, 0.26; nickel, 0.04; lead, 0.30; zinc, 1.55; cadmium, 0.01; calcium, 1.8; and magnesium, 1.36, all in micrograms/cu m. The purpose of the health examination was to find out how smoke and dust from the plant affects the health of the local inhabitants. A preliminary study was made with a questionnaire answered by the inhabitants which covered age, sex, place of employment, length of residence, smoking habit, and various symptoms of physical uneasiness including coughing, phlegm, asthma, throat pain, nose trouble, back ache, headache, breathing difficulties, and skin irritation. Those answering yes to four or more symptoms, or complaining of skin or eye diseases were given a second physical check consisting of an orgal diagnosis, X-rays, lung function examination, and urinalysis. Those requiring a further check were examined for hearing and given direct X-ray examinations, blood tests, and lung function tests. The results obtained from all the three health examinations were tabulated.

30198

Speizer, F. E., B. Ferris, Jr., and W. Burgess

**THE PREVALENCE OF RESPIRATORY FINDINGS IN A POPULATION WITH DEFINED CHRONIC EXPOSURE TO AMBIENT LEVELS OF AUTOMOBILE EXHAUST. Chest, 59(5):32-33, May 1971.**

The prevalence of chronic non-specific respiratory diseases was assessed using a modified version of the Medical Research Council s Respiratory Disease questionnaire in a population of 268 New England policemen exposed to a spectrum of levels of automobile exhaust as traffic officers, in-car officers, and inside clerical officers. Pulmonary function was assessed by spirometric tracing of FEV and FVC; peak expiratory flow was measured by the Wright peak flowmeter; and flow-volume curves were obtained on a Krogh spirometer modified and constructed for use in field studies. There were 99 men (36.9%) who fulfilled the criteria for the diagnosis of disease; two-thirds of these diagnoses were simple chronic bronchitis alone. Levels of cigarette smoking and history of years of exposure in traffic were included in the correlations. The lead content in scalp hair was also determined.

30328

Terzuolo, D.

**THE EFFECTS OF AIR POLLUTION DUE TO MOTOR VEHICLES ON MAN: A TOPICAL SOCIAL PROBLEM.** (Gli effetti dell inquinamento atmosferico causato da veicoli a motore sull organismo umano: un problema sociale di attualite). Text in Italian. Minerva Med., 61(87):4902-4906, 1970. 20 refs.

Detriments to human health are caused by a number of constituents of automotive emissions: lead compounds, polycyclic hydrocarbons, carbon monoxide, nitrogen compounds, and disagreeable odors, the last having mostly psychological effects. Control of automotive emissions, must include administrative measures to guarantee the reduction of such pollution without imposing too heavy a burden on the public, the development of appropriate procedures and mechanical devices, surveillance of the environment and public health, and aspects of urban planning related to maximum dispersion of the undesirable emissions. The American cities of Chicago and New York have conducted extensive studies of carbon monoxide and nitrogen oxide in the atmosphere. The State of California in 1961 and the United States in 1966 passed legislation aimed at the reduction of carbon monoxide, hydrocarbons, nitrogen oxides, and particulate emissions from motor vehicles, particularly those that burn gasoline. Beginning January 1, 1966, diesel motor operating in Belgium were inspected in terms of the opacity of their exhaust. Other countries that have adopted standards for air purity are West Germany, Rumania, Czechoslovakia, and the Soviet Union. In Great Britain, the Road traffic Act of 1930 and the Road Safety Act of 1967 sets standards for the manufacture of vehicles, stipulating that a vehicle is not to be used in a way that will cause it to emit fumes, vapors, or solid particles resulting from incomplete combustion. Japan has fixed the maximum carbon monoxide concentration of automotive emissions at three percent, as of September 1966. A bill recently introduced in West Germany calls for a 4.5% ceiling for carbon monoxide in motor exhaust.

30334

Sawinsky A., J. Durszt, and G. Pasztor

**LEUKOCYTE DAMAGE THROUGH EXPOSURE TO LEAD.** (Leukozytenschaedigung bei Bleiexposition). Text in German. Z. Ges. Hyg. Grenzg. (Berlin), 17(4):239-240, 1971. 10 refs.

Fifty workers, from three different lead processing plants were examined for specific changes and functional damage caused by lead exposure. The lead concentration of the air in the three plants was, on the average, 125, 210 and 625 mg/cu m. In the control group of 25 men, no specific changes were observed, whereas the porphyrin content in the urine of the exposed men was 100-1500 mg/l and the urine lead content 100 to 500 mg/l. The phagocytic activity of the leukocytes was considerably reduced compard to the control group. The osmotic resistence of the cells, primarily those of the meyloid forms, was below normal. The distribution of the neutrophile granuocytes changed and the activity of the younger cells increased. The segmentation of the neutrophile granulocytes rose and a shift to lymphoid cells was observed in the qualitative blood picture.

30355

Suzuki, Shosuke

**AUTO EXHAUST GAS--LEAD.** (Jidosha haikigasu--namari o chushin ni). Text in Japanese. Naika, 27(5):816-822, May 1971. 37 refs.

Automobile exhaust gas--its components, influence on air pollution, characteristics, and the effect of the components (especially lead and carbon monoxide) on the human body is discussed. The chief pollutants of exhaust gas are CO, nitrogen oxides, and hydrocarbons. The proporation of each pollutant in exhaust gas varies with automobile conditions and construction. With respect to the influence of exhaust gas on air pollution, volume of exhaust gas times concentration of a certain gas times time equals exhausted volume of certain gas is a question. The acute effect of CO is quite evident, but there is still divergence of opinion on chronic carbon monoxide poisoning. Considering the effect of 20 ppm CO in the general environment, it is necessary to make a physiological and behavioral study of the effect on age and the central nervous system, including new babies and infants, in connection with the proportion of carboxyhemoglobin. The indices to effects of lead are the amounts of lead, delta-amino- levulinic acid, and coproporphyrin in urine. However, the minimum effective dose of lead that effects these indices remains to be examined. There has been no report so far which indicates that these indices are effected by atmospheric lead of an average of a few micrograms/cu m. In future studies, a rigid distinction should be made between criteria which are academic statements and standards which are a problem of administration and control.

30395

Ueda, Kazuo and Tsutomu Eibihara

**RICKETS IN INFANTS IN THE JURISDICTION OF KOJIYA HEALTH CENTER. (SECOND REPORT).** (Kojiya hokensho kannai nyuji no kurubyo ni tsuite. (Dai II ho). Text in Japanese. Koshu Eisei Joho (Public Health Inform.), 1(1):24, April 1971.

The relationship between air pollution and rickets in infants was investigated in the jurisdiction of the Kojiya Health Center, a highly polluted district of Tokyo. The examination was performed four times from 1968 to 1969. The subjects were three- or four- month-old babies, numbering 2660 in 1968 and 2673 in 1969. The cup-shaped change seen in the distal edge of the ulna and the radius by x-ray examination of the carpal bones was defined as a rickets change. Air pollution in this district has been severe since 1965; in 1967, the amount of ultra-violet radiation decreased to two thirds of that in the suburbs. Large amounts of lead, manganese, and chromium were found in the dust fall of the area. The cup-shaped change in the distal edge of the ulna was seasonally independent in about seven percent of the infants who were born since 1966. It was not found at all among infants who were exposed to the sun for 30 min/day since one or two months after their birth. The infants with low birth weight or purely artificially fed infants showed a tendency for the cup-shaped change. Measured values of alkaline phosphatase and inorganic phosphorus in infants with rickets were within a normal range; those of calcium and phosphorus were also within normal limits.

30468

Grieco, B., R. Pennarola, and P. Lamanna

**HYSTO-AUTORADIOGRAPHIC STUDY OF THE DISTRIBUTION OF RADIOACTIVE LEAD (PB210) IN VARIOUS ORGANS OF RATS.** (Studio istoautoradiografico sulla distribuzione del piombo radioattivo (Pb210) in diversi organi del ratto). Folia Med. (Naples), vol. 49:937-947, 1966. 8 refs. Translated from Italian, 12p.

The organs of rats injected with a radioactive lead isotope were studied by hystoautoradiographic techniques to determine cellular localization of the lead. Organ sections prepared on demonstration slides were spread with photographic fluid using the stripping method. After 30-45 days in which the fluid was exposed to the radiation emitted from the hystologic cross sections, the slides were developed and colored, and later washed. Results confirmed the findings of other investigators that lead diffuses rapidly in several organs, principally, in order of preference, in the liver, lungs, kidneys, and spleen. In the first few hours after injection the deposits of the radioisotope are massive. Several of the hystoautoradiographs of the liver suggest a deposition of the metal both inside and outside the cell.

30671

Yokohama Municipal Univ. (Japan), Dept. of Hygiene and Yokohama Municipal Office (Japan), Center for Public Nuisance

**REPORT OF INVESTIGATING LEAD COMPOUNDS IN AUTOMOBILE EXHAUST GASES.** (Jidosha haikigasu chu no namari kagobutsu ni kansura kenkyu hokokusho). Text in Japanese. 80p., 1968 (?).

Rats, rabbits, and mice were exposed to automobile exhaust gases, which were diluted to a carbon monoxide concentration of 20-30 ppm, for three hours a day, six days a week. The experimental period was 80 to 500 days in length. The results did not show any chronic influences of exhaust gases on growth, volume of exercise, reproduction capacity, or growth of newborn animals. However, a positive impression was found in the pulse of rabbits and learning capacity of rats at the time of exposure. Rabbits were injected with hypodermic dilutions of an anti-knock agent; their reactions to the lead compounds contained in the agent were observed. The reaction to tetramethyl lead or mixed alkyl lead was greater than that to tetraethyl lead. The relationship between the quantity of lead in the environment and the traffic volume of Yokohama City was also studied. No relationship was seen between the quantity of lead in river and well water and traffic volume. However, the amount of lead in the air and on the leaves of trees expressed the traffic volume.

30672

Yokohama Municipal Univ. (Japan), Dept. of Hygiene

**RESEARCH ON INFLUENCES OF AUTOMOBILE EXHAUST GASES ON HUMAN BODIES.** (Jidosha haikigasu no Jintai ni oyobosu eikyo ni kansuru kenkyu). Text in Japanese. 30p., April 1969.

The influences of low-density lead on the human body were investigated from an aspect of lead accumulation in the organs. Exhaust gases, in which the carbon monoxide concentration was diluted to 75 ppm, were repeatedly exposed to light rays. The inhalation period was three hours a day, five days a week, and the experimental period was from 30 days to 240 days. Significant influences of exposure to exhaust gases were not found in the blood. The accumulation of lead in the blood and liver was clearly determined. In other organs, a significant accumulation of lead was not observed. Although precipitation of lead in the bones was seen in some cases, on the whole, the results did not indicate a correlation with exposure to exhaust gases. The quantity of lead in elementary school children s teeth was investigated in polluted areas, unpolluted areas, and intermediate areas of Kanagawa prefecture. A connection was found, to a certain degree, between the quantity of lead in the teeth and the degree of air pollution. The quantity of lead in the urine of persons handling lead-additive gasoline and the quantity of coproporphyrin in the urine were investigated. Repeated experiments of exposure to lead-additive gasoline were also made using rats. Possible influences of lead were found in the experimental animals, but for persons handling gasoline, no influences were seen. The problems which are caused by the lead of automobile exhaust gases were not found in the present environment. It was suggested however, that its influences should not be ignored, depending on the air pollution situation.

30686

Lepow, Martha

**DISCUSSION OF ADVERSE EFFECTS OF INORGANIC LEAD SALTS AS RELATED TO VARIOUS LEVELS OF ABSORPTION OF LEAD.** Conn. Med., 35(6): 353-355, June 1971. 7 refs.

The biology of lead poisoning is discussed. In man, excessive lead absorption particularly affects the biosynthesis of heme and certain functions of the kidney and brain. The metabolic effects of lead on heme synthesis are reversible when excessive exposure is eliminated, but this is not always the case when there is functional damage to the kidney and/or central nervous system. Acute lead poisoning usually does not occur until the blood lead level exceeds 80 micrograms. In young children, the most important syndrome of acute lead poisoning is acute encephalopathy. Clinical diagnosis depends on a high index of suspicion and laboratory tests, including blood lead concentration and demonstrating adverse metabolic effects in the form of increased output of delta-aminolevulinic acid and

coproporphyrin. Acute encephalopathy may be accompanied by urinary aminoaciduria, melituria, and hyperhposphaturia. Chronic encephalopathy may be related to long, continued, excessive absorption of lead. It may aalso occur as a result of recurrent bouts of the acute disease. The treatment consists of chelation therapy and removal of the source. It is estimated that children with encephalopathy have a level intake 250 times greater than normal. Asymptomatic children with increased lead absorption may take in 10 times the normal intake.

30831

Lutz, Garson, Arthur A. Levin, Sanford G. Bloom, Kaj L. Nielsen, Jack L. Cross, and David L. Morrison

**TECHNICAL, INTELLIGENCE, AND PROJECT INFORMATION SYSTEM FOR THE ENVIRONMENTAL HEALTH SERVICE (VOLUME III): LEAD MODEL CASE STUDY. (FINAL REPORT).** Battelle Memorial Inst., Columbus, Ohio, EHS Contract CPS-69-005, Rept. CPS-69-005-3, 140p., June 29, 1970. 613 refs. NTIS: PB 194 412

A lead model case study was undertaken to serve as a working example and to evaluate the technical, intelligence, and project system under consideration for the Environmental Health Service. Occurrence and use patterns for lead within the U. S. were examined. The major categories of uses in decreasing order were production of storage batteries and accessories, gasoline antiknock additives, pigments, ammunition, solder, cable covering, and caulking lead. Leaded fuels are the major source of environmental lead. Pediatric plumbism, the most significant acute health problem, arises from lead used as a pigment. The economic aspects of this problem were investigated. While lead is very slowly absorbed from environmental sources, its gradual accumulation in the body is the basis for progressive lead toxicity. Additional research is required to determine the chronic effects of lead in the environment on health, and better diagnostic and therapeutic techniques are needed in support of this research. A mathematical model was developed to represent the environmental transport of the stressor lead from several sources with subsequent intake of lead by man. This model can be used to assess the impact of contemplated actions of lead body burdens, to define research and development requirements, and to identify the needs and locations for monitoring and surveillance. A categorized bibliography for lead is included in this report. (Author abstract)

31040

Ilcewicz, F. H. and R. B. Holtzman

**BOAT SAMPLING METHODS FOR ANALYSIS OF LEAD AND TELLURIUM IN BIOLOGICAL MATERIALS.** In: Argonne National Lab. Ill., Radiological Physics Div., Annu. Rept. ANL-7760-Pt 2, p. 53-62, 1971 (?). 5 refs.

Two procedures using the atomic absorption boat sampling method were studied: one the direct mounting of a sample, the other a prior extraction of the sample with ammonium pyrrolidine dithiocarbamate (APDC). Modifications in the method improved the sensitivity, and a detection limit of 0.0004 microgram lead with about 6% was attained. Extraction of the sample with APDC extended this method to the analysis of tellurium in raw urine with a detection limit of about 0.003 microgram Te/ml urine, and to the analysis of lead in heavily salted solutions.

31228

Craig, Paul P. and Edward Berlin

**THE AIR OF POVERTY.** Environment, 13(5):2-9, June 1971. 41 refs.

The effects of lead on biological systems are discussed. Lead levels in the blood of average Americans exceed one-fourth of those considered diagnostic for classical lead poisoning. Lead can produce liver, kidney, and brain damage, and deterioration of the central nervous and reproductive systems. Children are especially susceptible to the effects of lead poisoning, including mental retardation and other signs of central nervous system involvement. Chronic exposure to lead at levels typical of urban environments is known to produce biochemical changes in healthy adults. In animals, injury has been observed at lead exposure levels typical of those experienced by urban dwellers. The chronic effects of sub-toxic body burdens of lead in city dwellers involve reduction in the activity of enzymes essential for hemoglobin synthesis. Lead can destroy existing red blood cells. It may cause physiological deficits in children and in people with inherited defects of red blood cell structure or function, or defective ability to manufacture hemoglobin. There is a critical need for intensive epidemiological studies of people in these categories. The increased concentrations of atmospheric lead in urban areas is mainly due to the use of lead in gasolines. Removal of this source would reduce the body lead levels in children and adults who may be particularly sensitive to this pollutant.

31280

**TRACE METALS: UNKNOWN, UNSEEN POLLUTION THREAT.** Chem. Eng. News, 49(29):29-30. 33, July 19, 1971.

Because no metal is degradable, toxic metals in the environment (such as cadmium, lead, nickel, tin, mercury, and arsenic) may be a more insidious problem than pollution by pesticides, sulfur dioxide, nitrogen oxides, carbon monoxide, and other gross contaminants. Public health experts are concerned that subtle physiological changes caused by trace metals may go completely undetected or, if detected, be attributed to other causes. The problem is how to detect harmful responses to very low doses of trace metals and how to differentiate adaptive responses from those representing the first stages of a disease. Also, synergistic and antagonistic relationships among trace metals must be defined. Until these questions and relationships are mor thoroughly explored, standards for trace metals in air, water, and food residue will be little more than guesses. Sources and health effects of some trace metals considered hazardous are summarized.

31303

Stoefen, D.

**DOES LEAD HAVE ANYTHING TO DO WITH THE PATHOGENESIS OF CARIES? (Spielt Blei eine Rolle in der Pathogenese der Karies)? Text in German. Protectio Vitae, 16(1):22, Feb. 1971. 9 refs. (Presented at the Internationalen Konvent fuer Zivilisationskrankheiten, Ernaehrung und Lebensbedingungen, 16th, Luxemburg und Trier, Belgium, Sept. 14-20, 1970.)**

The increasing occurrence of caries (tooth decay) may be due to increasing lead pollution. In 21 villages in New Guinea, where the lead content of Sago was high, a much higher caries rate was observed among the population than in neighboring villages. Lead inhibits protein synthesis. The protein containing forerunners of the dental enamel are not properly synthesized in the presence of lead. The developing enamel has no resistance to the strain of oral food intake.

31319

Schlipkoeter, H. W. and R. Dolgner

**HEALTH PERILS DUE TO AIR POLLUTION.** (Gesundheitsgefaehrdung durch Verunreinigung der Luft). Text in German. Atomwirtschaft, 16(6):288-293, June 1971. (Presented at the Reaktortagung Kerntechnischen Gesellschaft im Deutschen atomforum, Bonn, West Germany, March 30-April 2, 1971.)

Health risks through air pollution are discussed by means of specific examples. Emissions emanating from large industries are of limited importance only, since they effect merely the closer vicinity of the source of emission. Furthermore, the typical composition of pollutants is known for each of these industries, and their health risks can be evaluated and combatted individually. More reason for concern are emissions originating ubiquitously from all processes of incineration. Domestic heating, atuomobile engines, and a multiplicity of smaller industries produce a variety of air pollutants such as carbon monoxide, soot, polycyclic hydrocarbons, sulfur dioxide, lead compounds, and gaseous hydrochloric acid which arises in the incineration of polyvinyl compounds. Lead from automobile exhausts and fluorine compounds from aluminum works can be absorbed by food plants, and thus indirectly cause damage to the human organism. Sulfur dioxide and some hydrocarbons can attack the human respiratory tract and the lung. Dust in the air absorbs part of the ultraviolet radiation from the sun which is vital for some biological functions, for instance, the body development of children. Rickets, and affliction of the growing bone structure, and retardation in the growth of children can be ascribed to a lack of ultraviolet radiation. Carbon monoxide, when inhaled, combines with the hemoglobin of the blood to which it has a 200 time greater affinity than oxygen, and thus impedes the function of the blood in transporting oxygen.

31351

Iwata, Hiroshi, Makoto Kawai, Yoshihiro Katagiri, and Masatoshi Hirota

**EFFECTS OF LEAD IN AIR DURING WORK ON TRAFFIC CONTROLLERS.** (Shirobai jujisha no sokochu no kichunamari ni yoru eikyo). Text in Japanese. Gifu Daigaku Igakubu Kiyo (Papers Gifu Univ. School Med.), 18(5):479-485, Feb. 1971. 14 refs.

The amount of lead in the air and the medical examinations for lead poisoning in traffic controllers were tested on July 2, 1970 (fair weather). Levels of lead in air were determined with the personal dust sampler testing five traffic controllers during their work. The absolute levels of lead increased in relation to the increase of the absolute riding distance. This corresponded to a range from 3.3 microgram/cu m to 9.6 microgram/cu m. Medical examinations were carried out on 17 traffic controllers (group I) and 14 indoor policemen (group II). Subjective symptoms included headache and nettle rash, sore throat, nausea, constipation, lumbago, and dizziness. More complaints were found in group I. No difference was found between the two groups in terms of whole blood specific gravity, amount of blood pigment, and punctate fasophilic erythrocyte level. A coproporphyrin test in the urine of one subject in group I was positive. The average level of lead in urine ranged from 14.1-27.9 microgram/l in group I and 10.4-26.2 microgram/l in group II. The average level of lead in blood ranged from 12.3-24.5 microgram/dl in group I and 10.1-17.3 microgram/dl in group II, indicating slightly higher levels in group I but statistically no significant differences. Lead poisoning by the automobile exhaust gases in the traffic controllers in Gifu prefecture is not an urgent problem at the present stage, however, some high levels were recorded, suggesting that the traffic controllers exposure to lead cannot be wholely ignored.

31442

Tepper, Lloyd B.

**UNDER WHAT CIRCUMSTANCES IS DIRECT CONTACT WITH LEAD DANGEROUS? Public Health Service, Washington, D. C., Symp. Environ. Lead Contamination, 1965, p. 59-62. 4 refs. (Dec. 13-15.) (PHS Pub. 1440) NTIS: PB 198104**

External contact with inorganic lead, external contact with organic lead, and the toxicological aspects of particulate elemental lead deposits in the tissues are discussed. As for the absorption of inorganic lead compounds by direct contact, there is little evidence that this occurs, while there seems to be a great variability between reports concerning absorption through the skin of organic lead. Lead oleate seems to be absorbable through the skin of rats, but the evidence for absorption by humans is negligible. Lead naphthenate, added as an inhibitor to extreme pressure lubricants in concentrations of two to 10%, may have produced transcutaneous absorption of lead. Tetraethyl lead, applied to the skin of rabbits, can under some circumstances result in lethal absorption. Most of the reported cases of plumbism from retained lead projectiles would not satisfy present day requirements for the diagnosis of lead poisoning.

31452

Tomashefski, Joseph F. and Ralph I. Mitchell

**UNDER WHAT CIRCUMSTANCES IS INHALATION OF LEAD DANGEROUS? Public Health Service, Washington, D. C., Symp. Environ. Lead Contamination, 1965, p. 39-49. 9 refs. (Dec. 13-15.) (PHS Pub. 1440) NTIS: PB 198104**

The majority of inhaled lead is removed or cleansed from the tracheobronchial tree by the natural cleansing mechanisms and swallowed or expectorated. Whether lead is taken up by the lungs depends upon solubility factors and particle mechanics. Highly soluble lead in proper particle size such as fumes or mists can be readily absorbed and approximate an intravenous injection. A possible unproven relationship exists between pulmonary disease-- bronchitis and emphysema--with particle deposition, cleansing, and accumulation of lead. There is no known direct effect of lead on the bronchopulmonary system. The synergistic effect of lead with other pollutants such as carbon monoxide and sulfur dioxide is not known. Studies are needed to determine the concentrations of lead in the tissues and fluids of the lung. Whether lead is immobilized from body stores in diseased states such as respiratory acidosis, remains to be proven. (Author summary modified)

31491

**ON LEAD INTOXICATION OF LEADED FUELS. COMMENT OF THE INTERNATIONAL SOCIETY FOR RESEARCH ON CIVILISATION DISEASES AND VITAL SUBSTANCES.** Protectio Vitae, 16(1):23-24, Feb. 1971.

Lead concentrations in city air are between 1.5 to 40 micrograms of lead/cu m air. Even in the polar region, two to three micrograms of lead/cu m air were measured. The tolerance limit of lead in human blood is 50 micrograms/100 cc cu m blood serum. Concentrations of up to 35 micrograms/cu m air are considered normal. Any higher concentration may cause headache, insomnia, intestinal troubles, loss of appetite, rheumatic complaints, muscle weakness, and emotional disturbance. Lead inhibits the activity of following enzymes: ferrous enzymes, oxidative phosphorylic enzymes, pyruvate oxydase, carbonic acid anhydratase, alkaline phosphatases, aldolases, papain, cathepsin and amylases. Lead also inhibits the synthesis of acetylcholine, the biosynthesis of heme, the biosynthesis of hemoglobin, the biosynthesis of thymonucleic acid, the synthesis of actinomyosin, and the biosynthesis of

hormones. Random tests in various villages have shown that, at present, the official tolerance levels were exceeded in more than 50% of the persons examined.

31493

Goyer, Robert A.

**LEAD TOXICITY: A PROBLEM IN ENVIRONMENTAL PATHOLOGY.** Am. J. Pathol., 64(1):167-182, July 1971. 55 refs. (Presented at the Federation of American Societies for Experimental Biology, Annual Meeting, Symposium on Environmentally Induced Diseases, Atlantic City, N. J., April 15, 1970.)

The problems and unanswered questions about the health effects of lead are summarized, and a brief review of the experimental work currently in progress is presented. The most prominent signs and symptoms of overt lead intoxication are related to the central nervous system, the hematopoietic system, and the kidney. The environmental lead problem may be viewed at three levels. First, there is the problem of sporadic episodes of acute lead intoxication. Second is the problem of clinical and subclinical intoxication of large numbers of children in urban ghetto areas. The third aspect of the environmental problem concerns the question of the possible harmful effects of body stores of lead. An answer to this question can only be obtained through a better understanding of how lead is metabolized at the cellular level. Studies related to this problem have revealed that mitochondrial oxidation and phosphorylation are very sensitive to the presence of lead. Also, intranuclear inclusion bodies, characteristic of lead poisoning in man and in experimental animals, may function as a nondiffusible lead-protein complex. These inclusion bodies may have an important role in biologic adaptation to lead. Without the inclusion body protein, lead would be more toxic at lower doses than is presently evident. (Author summary modified)

31517

Heimann, Harry

**RISK OF EXPOSURE AND ABSORPTION OF LEAD.** Public Health Service, Washington, D. C., Symp. Environ. Lead Contamination, 1965, p. 143-153. (Dec. 13-15.) NTIS: PB 198104

Presentations given at the Symposium on Environmental Lead Pollution and relating to the risk of exposure and absorption of lead are reviewed. About 75% of particulate lead from automobile gasoline combustion was observed to be less than 0.90 micron in mean diameter, a size that easily reaches the alveoli. Experiments relating to the body burden of lead are cited.

31524

Nelson, Norton

**SUMMARY: TOXICOLOGY OF LEAD.** Public Health Service, Washington, D. C., Environ. Lead Contamination, 1965, p. 159-165. (Dec. 13-15.) NTIS: PB 198104

Articles pertaining to the toxicology of lead which were presented at the Symposium on Environmental Lead Contamination are reviewed. Some recommendations are given as to how society can reach a reasonable level of assurance that an additional increase or even present levels of lead are acceptable or non-acceptable from a health standpoint. The major need is to define the relevance for health of present typical lead levels and levels intermediate between these and frank lead poisoning. Also, the effective absorption of lead by inhalation from typical lead aerosols as found in the ambient air ought to be defined more accurately. Techniques should be developed for better assessment of body burden of lead and the biological mobility of lead in its several biological compartments. Studies on the relative contribution of the biosphere of lead from geological and technological sources should be continued and intensified.

31528

Engel, R. E., D. I. Hammer, R. J. M. Horton, N. M. Lane, and L. A. Plumlee

**ENVIRONMENTAL LEAD AND PUBLIC HEALTH.** Environmental Protection Agency, Research Triangle Park, N. C., Air Pollution Control Office, APCO Pub-AP-90; 34p., March 1971. 79 refs. NTIS: PB 199058

The major public health problems associated with lead in the environment and the respective roles of the Department of Health, Education, and Welfare and the Environmental Protection Agency are briefly summarized. A discussion of lead metabolism and toxicology in man includes absorption, intoxication, and a presentation of areas for further research. Lead in the diet and in consumer goods is traced to natural sources, such as fruits, vegetables, and fish; the drinking water, through water supplies and water pipes; and manufactured sources, i.e., ceramic glazes, moonshine, color additives and hair dyes, and cigarettes. Lead in the air is covered by discussions on the distribution of ambient lead particles; the relationship of particle size to deposition in the lungs; sources of atmospheric lead, such as primary and secondary lead smelters, other industries, combustion of coal and fuel oil, incineration, and automotive exhaust; measurement of atmospheric lead through sample collection and analysis; and atmospheric surveillance. Lead in occupational exposures, specifically small shops operations, and its reporting for diagnosis, and lead poisoning in children are examined. Proposed community control programs are presented.

31537

Bryce-Smith, Derek

**LEAD POLLUTION FROM PETROL.** Chem. Brit., 7(7):284-286, July 1971. 24 refs.

Lead is a cumulative poison in man, and no other toxic chemical pollutant appears to have accumulated in man to average levels so close to the threshold for potential clinical poisoning. Lead can harm the central nervous system, and is particularly liable to cause brain damage in children. Evidence indicates that exhaust fumes from motor vehicles may already be causing cases of toxic lead encephalosis (inflammation of the brain) among the urban population; the symptoms include depression, headaches, and undue fatigue. Treatment for lead poisoning with calcium-EDTA rapidly led to a cure or improvements in 85% of the cases. Adverse effects on mental efficiency from unidentified components of traffic fumes have been reported. Lead in city air, levels of lead in Greenland, and acceptable limits of lead are discussed.

31584

Kehoe, Robert A.

**UNDER WHAT CIRCUMSTANCES IS INGESTION OF LEAD DANGEROUS? Public Health Service, Washington, D. C., Symp. Environ. Lead Contamination, 1965, p. 51-58. 11 refs. (Dec. 13-15.) (PHS Pub. 1440) NTIS: PB 198104**

Lead poisoning may be induced in a short period of time by a high level of regular, daily, oral dosage, and in a longer period of time by a relatively low level of daily, oral dosage. The requirements are that the dose of lead be taken regularly, to maintain an essentially constant rate of absorption of lead

from the alimentary tract, and that enough lead is taken to lead to a progressive accumulation of lead of critical proportions within the lifetime of the individual. The presence of critical quantities of lead in the intact, living body -- the potentially hazardous body burden -- can be identified by finding a critical concentration of lead in the fluid tissue, the blood, and, with somewhat less precision, by the finding of a critical elevation of the rate of the excretion of lead in the urine. However, the actual onset of lead poisoning cannot be predicted, nor can this specific illness be identified, with certainty, on the basis of any analytical finding in the tissues, body fluids, or excreta. Only the danger of lead poisoning can be recognized by such means. When these principles were translated into quantitative terms, oral dosages of several hundred milligrams were capable of inducing acute, but not fatal illness, in the adult.

31899

Biener, K.

**LEAD POLLUTION BY AUTOMOBILE EXHAUSTS.** (Bleigefaehrdung durch Autoabgase). Text in German. Schweiz. Med. Wochenschr., 101(28):1038-1039, July 1971.

Seventy-nine refuse collectors and 79 street cleaners in Frankfurt/Main were examined for blood lead levels and delta-aminolevulinic acid elimination with urine. The subjects worked primarily in the center of the city, and most had been employed for five years. Blood samples were taken at 8:30 am about three hours after the beginning of work. Measured lead levels were significantly higher than those of the average level of a control group. The lead content of blood was higher among the street cleaners than among the garbage collectors. The same results were obtained for delta-aminolevulinic acid elimination. Even though clinical manifestations have not yet appeared, a biological lead contamination can be diagnosed among the workers.

31962

Stoefen, Detlev

**EFFECTS OF ENVIRONMENTAL LEAD ON PSYCHE.** (Die Auswirkungen des Umweltgifts Blei auf die Psyche). Text in German. Staedtehygiene (Uelzen/Hamburg), 22(8):172-176, Aug. 1971. 34 refs.

The average lead concentration in the population of the Federal Republic of Germany, as expressed by the content of delta-aminolevulinic acid in the urine, already exceeds the pathological threshold limit of a number of investigators. Lead is known to have effects on the nervous system. In London, mentally retarded children who had been given a chelating agent for lead decorporation showed considerable improvement. Metabolism difficulties receded and mental capacities were stimulated.

32041

Bolanowska, Wanda, Jerzy Piotrowski, and Barbara Trojanowska

**THE KINETICS OF DISTRIBUTION AND EXCRETION OF LEAD (PB-210) IN RATS. I. THE DISTRIBUTION OF A SINGLE INTRAVENOUS DOSIS.** (Kinetyka rozmieszczania i wydalania olowiu (Pb-210) u szczurow. I. Rozmieszczanie wewnatrzustrojowe jednorazowej dawki dozylnej). Text in Polish. Med. Pracy (Lodz), 18(1):29-41, 1967. 11 refs. (Presented at the International Congress on Occupational Health, 14th, Madrid, Spain, 1963 and the Krajowym Kongresie Biochemii, Lodz, Poland, 1963.)

A single dose of lead acetate (labeled Pb-210) was injected intravenously into adult albino male rats 200-250 g in weight. The animals were killed from 5 minutes to 98 days after injection. The organs were mineralized and the lead content was determined after one month, based on the Bi-210 beta irradiation, measured in an infinitely thick layer. Detailed data on the surviving periods, number of animals used, and on the distribution of lead (in percent of dosage) are included. The dynamics of lead distribution and characteristic periods of distribution are discussed. The data were analyzed with respect to the possible metabolic model and the rate of distribution processes. The different doses (1.0 and 0.1 mg/kg) compared for the surviving period of 30 days showed no significant differences in distribution.

32129

Selander, Stig, Kim Cramer, Birgitta Borjesson, and Gunilla Mandorf

**DETERMINATION OF LEAD IN BLOOD BY AUTOMIC ABSORPTION SPECTROPHOTOMETRY.** Brit. J. Ind. Med. (London), vol. 25:209-213, 1968. 9 refs.

Lead in blood was determined by atomic absorption spectrophotometry using a wet ashing procedure and a procedure in which the proteins were precipitated with trichloroacetic acid. In both methods, the lead was extracted into isobutylmethylketone before measurement, using ammonium pyrrolidine dithiocarbamate as the chelator. The simpler precipitation procedure was shown to give results identical with those obtained with the ashing technique. In addition, blood specimens were examined by the precipitation method and by spectral analysis, which includes wet ashing of the samples, with good agreement. All analyses were done on blood samples from normal persons or from lead-exposed workers, and no additions of inorganic lead were made. The relatively simple protein precipitation technique gave accurate results and is suitable for the large-scale control of lead-exposed workers. (Author abstract modified)

32216

Richet, G., C. Albahary, L. Morel-Maroger, P. Guillaume, and P. Galle

**RENAL CHANGES IN 23 CASES OF OCCUPATIONAL SATURNISM.** (Les alterations renales dans 23 cas de saturnisme professionnel). Text in French. Bull. Mem. Soc. Med. Hop. Paris, 117(5):441-466, 1966. 44 refs.

Renal clinical manifestations of lead poisoning including the urinary syndrome, cardiovascular involvement, the metabolism and excretion of uric acid, and electron microscopic results of renal biopsies of 23 cases of occupational saturnism acquired by up to 23 years of contact with lead are analyzed. The urinary syndrome was limited in four cases to an often intermittent mild proteinuria of less than one g/24 hours. A tendency to hypertension frequently existed, but malignant arterial hypertension was not observed. A definite tubular involvement existed, manifested by the presence of inclusions in certain nuclei. This anomaly was observable by an optical microscope as siderosomes in the cytoplasma, deformed mitochondria, and other modifications. These lesions are not accompanied by any manifestations of a proximal tubular syndrome during subclinical infant saturnism, except perhaps by hypophosphatemia with elevated phosphorus clearance. Renal insufficiency was found in only three cases of protracted lead poisoning. One case ended fatally at the age of 32.

32218

Jung, Fritz

**THE PATHOLOGY OF ERYTHROCYTES. PART II. THE EFFECTS OF SOME METAL SALTS.** (Zur Pathologie der roten Blutkoerperchen. II. Mitteilung. Wirkungen einiger Metallsalze). Text in German. Arch. Exp. Pathol. Pharmakol., vol. 204:139-156, 1947. 14 refs. Part I. Klin. Worchshr., p. 917, 1942.

The effects of zinc sulfate, and lead nitrate on isolated human erythrocytes was studied by means of an ultramicroscope and a potentiometer. High concentrations of mercury chloride caused fixation of erythrocytes and of erythrocytal stromata without significant optical structural changes. At lower HgCl2 concentrations, all degrees from the outside to the inward progressing fixation of cellular proteins were observed ultramicroscopically. Very low concentrations precipitated hemoglobin inside the cell with a simultaneous increase of osmotic resistance. Increasing concentrations brought about progressive hemolysis based on membranal denaturation. This was followed by a coagulation of the uppermost cellular layers coupled with a liberation of the central hemoglobin residue which can also form a circular coagulate within the fixated membrane. The minimal amount of sublimate per cell still causing hemolysis is about 1.2 times 0.00000001 molecules. In contrast in HgCl2, ZnSO4 and Pb(NO3)2 cause only increased rigidity of the membrane. Lead hydroxide and lead phosphate is adsorbed on erythrocytal membranes. The embedding of lead in the membrane can be observed ultramicroscopically.

32408

Cramer, Kim

**HEAVY METALS AND OUR ENVIRONMENT -- ALSO ON TV.** (Tunga metaller i var omgivning -- och i TV). Text in Swedish. Lakartidningen, 65(8):799-801, Feb. 1968. 2 refs.

Several professionals were interviewed during the preparation of a Swedish TV documentary entitled Is it Dangerous to Breathe Lead? Weaknesses in the telecast are discussed, the most serious of which was an exaggeration of the danger from lead poisoning to the inhabitant of a large city who is not directly engaged in an occupation involving exposure to lead. The show s approach to lead poisoning was influenced by experiences with the lead industry in England in the early 20th century, when little was being accomplished in the field of occupational medicine. Workers for a storage battery company in Manchester breathed air containing three to five mg of lead. Under such conditions, lead poisoning was not only severe, but the lead tended to accumulate in the worker s body. It is not necessarily valid to compare these conditions with the problems due to lead intake from the polluted air of a large city, which reaches a maximum of 0.003 mg/cu m, or about 1/60 of the lead concentration to which the lead industry workers were exposed.

32484

Nagel, S.

**ENVIRONMENTAL PROTECTION VS. ECONOMIC GROWTH.** (Umweltschutz kontra Wirtschaftswachstum). Text in German. Umwelt (Duesseldorf), 1(4):13-15, Aug. 1971.

Economic growth has increased the problem of air pollution and stimulated the need for environmental protection. More people died in 1961 during the smog condition in the Ruhr valley than had been statistically predicted. Air pollution increases the reaction of the lymphatic apparatus and causes a decrease in the red blood cells, thus retarding the physical development of children. Respiratory diseases are much more frequent in polluted areas than in nonpolluted areas. Carbon monoxide and organic compounds in the air, even in minute fractions, reduce the ability of a subject to concentrate. The inhalation of acidic aerosols, now common throughout most of Europe, causes the increased retention of dust. Lead penetrates into the lungs; as much as 90% of it can be stored in the bones, and during stress or fever it enters the bloodstream. Carcinogenic substances are also in the atmosphere. Maximum allowable emission standards have been set for some pollutants. The automobile industry, lacking initiative in the past, is working to control exhaust gas emissions. Automotive exhausts, which contribute CO, hydrocarbons, and 95% of the lead in the air, will reduce emissions over the next five years.

32487

Chisolm, J. Julian, Jr.

**LEAD POISONING.** Sci. Am., 224(2):15-23, Feb. 1971

In the young children of urban slums, lead poisoning is a major source of brain damage, mental deficiency, and serious behavior problems. Large-scale screening programs now in progress in Chicago and New York City indicate that between five and 10% of the children tested show evidence of asymptomatic increased lead absorption and that between one and two percent have unsuspected plumbism. At the level of cellular metabolism, the best-known adverse effect of lead is its inhibition of the activity of enzymes that are dependent on the presence of free sulfhydryl groups for their activity. The clearest manifestation of the inhibitory effect of lead on the activity of sulfhydryl-dependent enzymes is the disturbance it causes in the biosynthesis of heme. Lead is implicated specifically in the metabolism of delta-aminolevulinic acid and in the final formation of heme from iron and protoporphyrin. The decrease in heme synthesis leads at first to a decrease in the life-span of red cells and later to a decrease in the number of red cells and in the amount of hemoglobin per cell. The presence of stippled cells is the most characteristic finding in the blood of a patient with lead poisoning. In acute lead poisoning, there are visible changes in the kidney and kidney function is impaired. Much of the excess lead is concentrated in the form of dense inclusions in the nuclei of certain cells, including those lining the proximal renal tubules. Fanconi s syndrome is described. The best known chronic effect of lead poisoning is chronic nephritis, a disease characterized by a scarring and shrinking of kidney tissue. Peripheral nerve disease also can result from chronic overexposure to lead.

32608

Fairhall, Lawrence T.

**INORGANIC INDUSTRIAL HAZARDS.** Physiol. Rev., 25(1):182-202, Jan. 1945. 191 refs.

The effects of long continued exposure to relatively low concentrations of inorganic metal compounds are discussed in connection with industrial hygiene. The diagnosis of lead poisoning may be difficult. The usual symptoms are colic, basophilic stippling of the erythrocytes, urinary excretion of lead palsy, and anemia. However, any one or several of these may be absent, and thus make diagnosis doubtful. Poisoning by mercury, where it is not acute, is slow and insidious and leads to impairmen of tissue functions. The symptoms of cadmium poisoning are increased salivation, choking attacks, vomiting, abdominal pain, diarrhea, and tenesmus. Manganese poisoning is relatively rare in industry; it is a crippling disease with permanent disability, particularly of the legs. The increased use of beryllium has led to several cases of severe poisoning. The effects of molybdenum and tungsten com-

pounds are briefly discussed. Although antimony and arsenic are usually regarded as having comparable toxic qualities, the toxic effects of arsenic are believed to outweigh those of antimony. Antimonal poisoning does not appear to be an industrial disease of any consequence. Uranium and its salts are highly toxic. The absorption of small amounts over long periods of time causes a chronic nephritis. The effects of magnesium, zirconium, selenium, tellurium, vanadium, and chromates are also described.

32613

Sanders, Lester, W.

**LEAD EXCRETION AND HEALTH OF ANTIKNOCK BLENDERS.** Arch. Environ. Health, 10(6):886-892, June 1965. 16 refs.

The levels of urinary lead concentration (range and mean values) of 175 persons engaged in various jobs in gasoline refineries concerned with producing leaded (with tetraethyl lead) gasoline, and that of 29 gasoline loaders, was no greater than that of the general population, indicating that lead absorbed from occupational exposure of these persons is inconsequential in relation to that absorbed from other sources. Lead was excreted in the urine of these workmen within narrow limits of concentration; no relationship was found between rate of lead excretion and existence of possible or actual impairment of the physiologic functions examined. No evidence was obtained to suggest that the health of these workers was influenced adversely by their employment. (Author summary modified)

32624

Johns, David R.

**THE TREATMENT OF LEAD POISONING - PAST AND PRESENT.** Lead Industries Assoc., New York, Proc. Lead Hyg. Conf., Chicago, Ill., 1948, p. 25-40. (Nov. 15-16.)

The treatment of occupational lead poisoning is discussed. The treatment begins at the first signs of absorption as observed by the physician, such as constipation, a high stippled count, a moderately elevated lead urinary level, or lowered hemoglobin. It is recommended that a change in employment to a less hazardous location in the plant be made. A complete, yearly physical examination of all lead workers is strongly recommended. The diagnosis of lead poisoning implies that the patient has several symptoms, namely pallor, nausea, colic, generalized aching of body and joints, sleepiness, second / anemia, high stippled count, and moderate or high urin / levels. Active treatment should be instituted at once. The treatment suggested consists of immobilizing the lead in the blood by the metabolism of calcium. Calcium gluconate, fed intravenously, and a high calcium diet is prescribed when nausea subsides. Intestinal drainage by enema and salines are given as the nausea lessons. The pain of lead colic is controlled by morphine, atropine, and demerol. The secondary anemia is treated with hematinics and vitamins. In the discussion, other doctors state their treatments for lead poisoning as opposed to that of the author. All agreed that deleading of the patient is too dangerous a procedure to be used.

32625

Harrold, Gordon G. and Stuart F. Meek

**SOLUBILITY AND PARTICLE SIZE IN LEAD POISONING.** Lead Industries Assoc., New York, Proc. Lead Hyg. Conf., Chicago, Ill., 1948, p. 11-24. 18 refs. (Nov. 15-16.)

Solubility and particle size in lead poisoning are dicussed as they apply to lead chromate exposure. Lead oxide and lead carbonate are much more readily soluble in human lung fluid than lead chromate. Insoluble lead salts, which have solubilities of one mg or less in human lung fluid, will probably not cause lead poisoning. In the cases of over 100 men exposed to large quantities of lead chromate, the urinary lead excretory rate rose to 0.1 mg/l and remained above 0.06 mg/l for 18 months with no demonstrable damage. The particle sizes involved ranged from 0.1 micron or less to 1.0 micron for 98% of the particles. The lead urinary levels were very high, but the men had no complaints. High lead-in-urine levels may persist when the lead is soluble in the body and small in particle size. Thus, somewhat larger than usual lead-in-urine values may appear when workers are exposed to finely divided particles; the appearance of larger amounts of lead-in-urine in these situations may be indicative of actual or potential harmful atmospheric exposure. The limitations of this study are presented in the discussion.

3269

Spain, David M. and Donald A. Senhauser

**MINUTEMAN DISEASE: LEAD POISONING.** Arch. Environ. Health, 10(5):801-804, May 1965. 6 refs.

A case of lead poisoning in a 22-year-old white male laborer is presented, in which bizarre neurological symptoms and the absence of the usual laboratory evidence of plumbism obscured the diagnosis. Several months prior to hospital admission, the patient noticed the insidious onset of weakness and easy fatigability associated with transient episodes of blurred vision, occasional numbness and tingling of the extremities, and increased irritability. Two weeks prior to admission he developed a slight cough and generalized muscular aches and pains; one week prior to admission he noted the gradual onset of dull, cramping abdominal pain. Although lead intoxication had been suspected, the lack of stippling of the red cells and negative urinary coproporphyrins tended to rule out this diagnosis. X-ray examination of the thorax and abdomen, including barium studies, was unremarkable. Meanwhile a bone marrow aspiration was performed in the course of the work-up for anemia and revealed moderate erythroid hyperplasia and one to two plus basophilic stippling of the red cells, suggesting the possibility of lead intoxication. On careful questioning, it was revealed that the patient worked as a laborer at an ICBM (Minuteman) site, specifically, sandblasting the inner surfaces of the metal missile silos. The metal is coated with preservative red lead paint, which must be removed before a missile is placed in the silo. Blood samples were obtained, and an analysis for lead content showed 0.87 ppm with a control of 0.083 ppm. Urinary coproporphyrins were also markedly increased on repeat determinations.

32735

Mie Prefecture (Japan)

**REPORT ON THE INVESTIGATION INTO THE EFFECT BY SMOKE AND SO ON.** (Bien to eikyochosa hokokusho). Text in Japanese. 107p., 1968 (?).

Air pollution was investigated with respect to its effect on the health of school children. Pollutants were tested for traces of sulfur dioxide, sulfuric acid ion and mist, nitric acid ion, various metals (titanium, vanadium, manganese, iron, nickel, chromium, and lead), nitrogen oxides, hydrogen sulfide, aldehydes, aerosols, and particulates. Elementary school children in two polluted areas and two non-polluted areas were examined for respiratory function. Health investigation cards were distributed prior to the examinations. Chest X-ray and otorhinological examinations were given annually. Based on the medical histories, the rates of asthma and pneumonia in

the children in polluted school districts were 7.5 and 2.4 times higher than those in nonpolluted districts. The rates for conjunctivitis and trachoma were also high and differed significantly for the polluted and nonpolluted districts. Complaints about sickness, sputum, eye, ache, and pharyngeal ache were 3.7-6.7 times more frequent for the polluted districts; the rate of absenteeism due to respiratory diseases was also higher. The respiratory function of children in the polluted school districts decreased 87% (56.3% was significant); respiratory tract resistance increased 47% on the average and there was blocking damage. The tendency increased annually. The rate of specific inflammatory findings in the pharyngeal parts was high for the polluted districts and also increased yearly. Data on meteorology, environment, and other medical inquiries made simultaneously are included.

32737

Alpert, Joel J., Henri J. Breault, William K. Friend, Virginia G. Harris, Robert G. Scherz, Robert D. Semsch, Hugo D. Smith, Allan B. Coleman, and Julian J. Chisolm, Jr.

**PREVENTION, DIAGNOSIS, AND TREATMENT OF LEAD POISONING IN CHILDREN.** Pediatrics, 44(2):291-298, Aug. 1969. 19 refs.

Pediatricians have opportunities through health programs in urban areas to develop preventive techniques and to contribute significantly to the prevention of lead poisoning among children. Freedom from this disease can be procured when enlightened citizens are prepared to pay for the elimination or rehabilitation of defective housing in neglected areas of the cities. The interaction between child and mother is often the critical factor in the development of pica in children; maternal dependency is the pattern most often observed. Small amounts of lead are stored largely in bone over a period of time, and an excessive body burden of lead is only very slowly excreted. The biosynthesis of heme is exquisitively sensitive to the toxic effects of lead. Increased excretion of coproporphyrin and delta-aminolevulinic acid in the urine is virtually always found prior to the onset of clinical symptoms. Clinical manifestations and the diagnosis of plumbism in children are discussed. It is best to treat all symptomatic children as potential cases of acute encephalopathy and hence to begin treatment immediately before the results of the quantitative determination of lead in blood and urine are known. Initial therapy are considered, as well as the prevention of childhood lead intoxication.

32738

Selander, Stig and Kim Cramer

**INTERRELATIONSHIPS BETWEEN LEAD IN BLOOD, LEAD IN URINE, AND ALA IN URINE DURING LEAD WORK.** Brit. J. Ind. Med. (London), vol. 27:28-39, 1970. 15 refs.

One hundred and seventy-seven workers from a storage battery factory were examined for lead in blood and lead and delta-amino-levulinic acid (ALA) in urine. The workers were selected at random from those who had been employed for more than one month; most had been employed for several years at the same job. Thirty-six workers were from departments with no lead exposure. In three departments with high exposure, a rotating system with three weeks exposure and three weeks non-exposed work was applied. As the aim of the study was to establish the relationships between the three parameters during constant exposure, the values from these men were treated separately. The relationship between lead in blood and urinary ALA was best described by a curvilinear function; while the regression lines for ALA on lead in urine, and lead in urine on lead in blood were straight. Workers from the departments with the rotating system showed lower values for urinary lead and ALA, compared with non-rotating workers with the same level of lead in blood. All these workers were examined during their second or third week of lead work, i.e., with an accumulating lead body burden. This system may be beneficial, especially in departments where preventive measures are difficult to install, or for notoriously careless workers. Those who showed comparatively high ALA and urinary lead values in relation to their blood lead level were found to be workers with repeated incidents of metabolic lead influence, in whom the ALA values had seldom been normal. The mean values from different factory departments were of the same order as would be expected from previous studies in storage battery plants. The results are discussed in relation to present concepts of lead absorption and poisoning. (Author abstract)

32746

Sauer, R. M., B. C. Zook, and F. M. Garner

**DEMYELINATING ENCEPHALOMYELOPATHY ASSOCIATED WITH LEAD POISONING IN NONHUMAN PRIMATES.** Science, vol. 169:1091-1093, Sept. 11, 1970. 28 refs.

Lead poisoning was diagnosed in four primates by the finding of toxic amounts of lead in tissues. In the first three primates, the clinical signs of lead encephalomyelopathy were primarily amaurosis and epilepsy. The lesions of the central nervous system were characterized by proliferative and degenerative vascular changes, edema, laminar necrosis, and demyelination. These signs and lesions were strikingly similar to those that have been described for lead encephalopathy in children and idiopathic amaurotic epilepsy of nonhuman primates. The fourth case differs from the others in that sudden paraplegia was present rather than epilepsy; vascular lesions were minimal, and bilateral symmetrical demyelination was much more extensive. Scrapings of paint from bars of indoor and outdoor cages that housed the affected primates all contained lead.

32747

Catton, M. J., M. J. G. Harrison, Pamela M. Fullerton, and G. Kazantzis

**SUBCLINICAL NEUROPATHY IN LEAD WORKERS.** Brit. Med. J. (London), vol. 2:80-82, 1970. 18 refs.

Evidence is presented for a minimal defect of peripheral nerve function in a group of lead accumulator workers without clinical evidence of a neurological lesion. Of the 19 men examined, 13 had blood levels above 80 micrograms/100 ml and seven had hemoglobin levels below 12 grams/100 ml, showing that considerable exposure to lead was occurring. While maximal motor conduction velocity was normal in the group of workers exposed to lead, the ratio of the amplitude of the muscle action potential following stimulation of the lateral popiteal nerve at the knee and at the ankle was in some instances smaller than that in control subjects. (Author summary modified)

32749

Keppler, J. Fred, Mary E. Maxfield, William D. Moss, Gary Tietjen, and Adrian L. Linch

**INTERLABORATORY EVALUATION OF THE RELIABILITY OF BLOOD LEAD ANALYSES.** Am. Ind. Hyg. Assoc. J., vol. 31:412-429, July-Aug. 1970. 6 refs.

A survey was made to ascertain the reliability of analyses for lead in blood when performed by different laboratories. Specimens of blood containing natural lead in the range of 30

to 80 micrograms/100 g blood and spiked specimens were analyzed by more than 60 laboratories, each by their method of choice. Only the spectrophotometric and the atomic absorption techniques were used by enough laboratories to give realistic data on reliability. Statistical analysis of the data showed no significant differences by types of laboratories or by precedures used. Approximately half of the laboratories in each of two studies and 40% of those in both reported results of acceptable precision. A proposal for a reference sample service for the analysis of biological fluids for trace substances related to industrial exposures has been made. (Author abstract)

32787

Barry, P. S. I. and D. B. Mossman

**LEAD CONCENTRATIONS IN HUMAN TISSUES.** Brit. J. Ind. Med. (London), vol. 27:339-351, 1970. 25 refs.

Lead concentrations in human tissues were analyzed for 69 post-mortems (43 males and 26 females); the cases were classified within the urban group, and four male subjects had known histories of occupational exposure to lead. The soft tissues of infants and young children contained low lead concentrations, varying from 0.01 ppm in the muscle to 0.46 ppm in the liver. By the end of the second decade of life, the concentrations had increased to ranges between 0.06 ppm muscle and 1.35 ppm in liver; the lead concentrations did thereafter increase with age. The concentrations of lead in bone were considerably greater than in the soft tissues, varying between 1 ppm in infants and children and 40 ppm in persons over the age of 50 years. Adult male bones contained more lead than adult female bones. Total body burden varied for individuals. Lead content in bone was nearly 95% of the total. Hair and nails contained relatively high lead concentrations (approximately 20 ppm). The four male subjects with histories of occupational exposure to lead had greater concentrations of lead in the bone than other cases.

32834

Millar, J. A., V. Battistini, R. L. C. Cumming, F. Carswell, and A. Goldberg

**LEAD AND DELTA-AMINOLAEVULINIC ACID DEHYDRATASE LEVELS IN MENTALLY RETARDED CHILDREN AND IN LEAD-POISONED SUCKLING RATS.** Lancet, vol. 2:695-698, Oct. 3, 1970. 27 refs.

The sequelae of acute plumbism in children include recurrent seizures, cerebral palsy, and mental retardation. But it is not clear whether less severe lead poisoning, which gives rise to mild symptoms and only slightly elevated blood-lead levels, causes insidious mental retardation. Lead selectively inhibits enzymes which require participation of sulfhydryl groups, and is especially noted for its inhibitory action on the enzymes of heme biosynthesis. A negative correlation has been found between lead levels in blood and delta-aminolevulinic acid dehydratase activity in children. Significant decreases in enzyme activity occurred at lead levels considered to be in the upper range of normal (20-40 micrograms per 100 ml). When lead was fed to lactating rats there was a significant and commensurate reduction in both blood and brain A.L.A. -- dehydratase activity. Even modest elevations of blood-lead may be associated with biochemical abnormalities in childrens brains. (Author summary modified)

32905

Kanagawa Prefectural Police (Japan), Police Affairs Div. and Keio Univ. (Japan), Dept. of Hygiene

**REPORT ON THE RESULTS OF THE INVESTIGATION AMONG POLICEMEN OF KANAGAWA PREFECTURE CONCERNING PUBLIC NUISANCE DUE TO TRAFFIC.** (Kanagawaken keisatsu ni okeru kotsu kogai chosa no kekka hokokusho). Text in Japanese. 104p., 1971.

The effects of automotive exhausts upon policemen in Kanagawa Prefecture were investigated. The men were classified by district and duties performed. The concentrations of lead, dust, and carbon monoxide and meteorological conditions were determined for the respective districts and correlated with data on the health of the men, gathered from questionnaires, respiratory function tests, measurements of CO in expired air, and amounts of carboxyhemoglobin in the blood. Lead concentrations were high in areas with heavy traffic. Dust in some districts was over 300 micrograms/cu m, and the CO maximum standard was exceeded at half the measuring stations. Respiratory symptoms (continuous cough and sputum) were consistently high, especially in the Yokohama and Kawasaki districts, due to regional pollution. The amount of CO in expired air was generally higher for policemen when compared to the general population and increased in direct proportion to an increase in duration of service.

33052

Kraut, Heinrich, and Marta Weber

**ON THE LEAD CONTENT OF HAIR.** (Ueber den Bleigehalt der Haare). Text in German. Biochem. Z., vol. 317:133-148, 1944.

Hundred grams hair from 137 persons contained between 0.5 and 4.0 mg lead or an average of 1.7 mg. Women had an average of 1.5 mg, men 1.9 mg in 100 g hair. Thirty-one employees of an enterprise processing lead had 30 to 385 mg lead in their hair; a second analysis following a very thorough hair washing yielded a lead content of from 16 to 230 mg/100 g hair. The contention that the high lead content in the hair of workers employed in lead processing plants is not a symptom of lead poisoning but only an indicator of poor hygienic conditions is upheld. Guinea pigs hair contained considerably less lead than human hair, only between 0.04 and 0.64 mg/100 g hair. In the hair of 10 guinea-pigs fed a diet containing 8.0/mg lead/day over a four week period, the lead content rose only by three pro mille of the ingested lead quantity. The lead content of hair of five animals fed 16 mg lead/day increased by 0.20 mg lead/100 g hair, that of five animals fed 32 mg lead/day increased by 0.42 mg lead/100 g hair. Thus, lead is being stored in hair.

33165

Kawasaki City Office (Japan) Bureau of Hygiene

**REPORT OF A STUDY ON THE EFFECT OF AUTOMOBILE EXHAUST GAS ON HUMAN BODIES. (COMPARATIVE STUDY OF LEAD CONTENT IN TOOTH OF SCHOOL CHILDREN IN DIFFERENT REGIONS).** (Jidosha haikigasu no jintai eikyo ni kansuru chosa kenkyu hokokusho. Gakudo no shiga chu namari ryo no chikubetsu hikaku). Text in Japanese. 13p., March 1970.

The lead content in the teeth of school children in various districts in Kawasaki, Yokohama, Hatano, and Fujisawa cities was examined to determine the effect of lead emissions from automotive exhausts. The samples were prepared and analyzed for lead concentration by atomic absorption and colorimetry. The lead content, based on analysis results of the teeth of chil-

dren who had resided in the same district since birth, was highest in one area of Kawasaki, where pollution was highest. Pollution concentration and lead content did not correlate for the other districts, which resulted in a wide range of values, suggesting that the lead emissions from automobile exhaust gases had a limited effect and that other sources of lead emissions were involved.

33202

Smith, Ralph G.

**HOW SENSITIVE AND HOW APPROPRIATE ARE OUR CURRENT STANDARDS OF NORMAL AND SAFE BODY CONTENT OF LEAD.** Public Health Service, Washington, D. C., Symp. Environ. Lead Contamination, 1965, p. 65-72. 14 refs. (Dec. 13-15.) (PHS Pub. 1440) NTIS: PB 198104

Aside from semantic difficulties, our knowledge of normal values of lead in man is virtually unequalled for any other substance and must be considered sensitive and appropriate for virtually any purpose. Our knowledge of the sensitivity and appropriateness of safe body levels, based on blood and urinary lead levels, has been shown to be entirely adequate in the prevention of diagnosable lead poisoning in industry, and it is widely believed to be applicable to the population-at-large. However, the latter belief has been challenged. It is the primary responsibility of the challengers to make every effort to describe the alleged adverse effects, and to demonstrate them experimentally.

33234

Hardy, Harriet L.

**LEAD.** Public Health Service, Washington, D. C., Symp. Environ. Lead Contamination, 1965, p. 73-83. 31 refs. (Dec. 13-15.) (PHS Pub. 1440) NTIS: PB 198104

No harmful effect of lead is unique, except perhaps the motor palsy of the most-used muscle group, as in the wrist drop of a right-handed painter whose left wrist is unaffected. This nonspecificity of lead intoxication means that identification of low level damage requires a combination of epidemiological evidence, astute clinical observation to rule out other etiologies, together with old and new experimental evidence critically judged for consistency and repeatability. Another important consideration is that lead in the body, at levels considered from industrial experience to be harmless, can act with other factors to produce damage. The biological effects of lead include the destruction of red blood cells, its accumulation in various organs, and its damaging effect at certain levels on growth and enzyme activity. The harmful effect of lead on female reproduction is also discussed.

33372

Horiuchi, Kazuya and Shunichi Horiguchi

**A TRIAL TO ASSUME ABSORPTION AND EXCRETION OF LEAD IN THE HEALTHY JAPANESE POPULATION (REPORT 1).** (Ippan kenko nihonjin no enshush suitei no kokoromi (sono 1)). Text in Japanese. SangyoZggaku (Jap. J. Ind. Health), 13(5):64-65, Sept. 1971. 10 refs.

Based on previously reported data, tables of human lead intake from food and drink and lead content in human urine are presented; a graphic analysis of lead content in urine and lead absorption through the digestive tract, all classified according to various age groups is given. The amount of lead obtained by subtracting lead content via digestive system from the total lead content in urine may be assumed to be the amount which has been inhaled from the air without causing deposition of lead (lead surplus). Assuming that 50% of the lead quantity from the inhaled air was absorbed, a reverse calculation can be made in order to estimate the lead concentration in the air that does not cause deposition in the human body. Assuming the average air intake of the adult Japanese per day is 10 m3 and that of a child is 5 m3, cumulative air intake of each age group was used to divide the lead surplus and multiplied by two. According to this calculation, 1.5 to 4.4 micrograms/m3 is the amount of lead concentration in the air that does not cause lead deposition in the human body of adult Japanese between the ages of 40 and 50.

33374

Stopps, G. J.

**IS THERE A SAFE LEVEL OF LEAD EXPOSURE? J. Wash. Acad. Sci., 61(2):103-109, 1971.**

The history of lead exposure and human health is traced through three stages: learning about the biological effects of lead; recognition of the clinical picture without association with causative agent; and correlation of the effects with diseases and illnesses. Gases of plumbism among battery workers, deaths from cerebral hemorrhage, thrombosis, and arteriosclerosis according to grades of exposure, effects of exposure to lead arsenate used an an insecticide, and experiments conducted on dogs are reviewed. The effect of lead on enzymes, which could result in anemia when the level of lead in the blood reaches 110 micrograms/100 g of blood, is examined. Lead poisoning in children is discussed.

33497

Muniak, S. E.

**SURFACE ATMOSPHERIC LEAD AND WHAT DEPOSITS ON HUMAN ALVEOLI.** In: Radiological Physics Division Annual Report. Environmental Studies. Argonne National Lab., Ill., Radiological Physics Div., p. 156-162, 1970. 15 refs. NTIS: ANL-7760, Part III

Lead concentrations in surface atmospheric particulates at Argonne for 24 months were obtained and are reported in nanograms/cu m and microgram/100 mg particulates. Both measures show that the weighted mean for the season has shifted to higher values with time. The most recent weighed mean of the season (winter 1969-1970) is 860 ng/cu m of lead in the Argonne surface atmosphere. The lead came from motor vehicles. Thus, the net mean lead deposited in the alveoli was 2320 ng/day during the season. Breathing Argonne air contributes l0% of the total lead taken into circulation (21.3 mg/day).

33527

Lund, Charlotte

**THE EFFECT OF CHRONIC LEAD POISONING ON REPRODUCTIVE CAPACITY.** Nord. Hyg. Tidskr., vol. 18:12-20, 1936. 16 refs. Translated from Swedish. Mundus Systems, McGregor and Werner, Washington, D. C., 11p.

The effect of chronic lead poisoning on reproductive capacity was reviewed. Cases of infant mortalities and miscarriages were presented. In one example, two cases of miscarriages in the wives of house painters were reported. The women first gave birth to healthy children before the husband became a painter, and a second gave birth to healthy children when the husband ceased being a painter. Both had signs of lead poisoning. A case was reported in 1896 where a woman married to a painter gave birth to two healthy children in the first two years of his being a painter; simultaneously with his showing signs of lead poisoning, she started a series of 15 miscarriages. In 1901, a woman married to a painter had 22 pregnancies, six ending with miscarriages, six with premature birth, and five

children died in infancy. She had no history of lead poisoning. In 1906, the normal infant mortality rate in Lille was 8.2%, but among children of painters, 22.9%. It was apparent that the fathers working with lead may have a limited influence as compared with the mothers doing so. Individual animals tests performed in 1914 on rabbits and chickens showed that the progeny of a lead-poisoned male and a normal female were inferior to normal progeny. Of 13 married female lead workers in a printing shop in 1896, having 56 pregnancies, there were 26 miscarriages, nine premature births, one stillbirth, 21 living births at term, and 17 dead shortly after. Other studies showing similar results are reported.

33605

Klein, Michael, Rosalie Namer, Eleanor Harpur, and Richard Corbin

**EARTHENWARE CONTAINERS AS A SOURCE OF FATAL LEAD POISONING.** New England J. Med., 283(13):669-672, Sept. 24, 1970. 12 refs. (Includes comments by Michael Klein and Rosalie Namer, LEAD RELEASE FROM EARTHENWARE, Ibid., 238(23):1292, Dec. 3, 1970.)

Two young children suffered lead poisoning as a result of drinking juice stored in a modern handmade earthenware jug. One of the children died. Subsequent testing of 264 contemporary earthenware glaze surfaces revealed that 50% released sufficient lead to make them unsafe for culinary use. Between 10 and 25% of the pieces tested would have been capable of causing severe lead poisoning. Pottery samples had been washed with a dilute alkaline-detergent solution, rinsed with distilled water, filled to the top with four percent acetic acid solution, and the volume recorded. Samples were covered with a plastic film and allowed to stand at room temperature for 18 hours. Lead was determined by an atomic absorption technique. Compounding of safe earthenware is essential. (Author abstract modified)

33607

Rondia, D.

**TOXICITY OF ENGINE EXHAUST GASES.** (Toxicite des gaz d echappement de moteurs). Text in French. Ingenieursblad, 40(15-16):429-435, 1971. 12 refs.

Carbon monoxide, lead, and hydrocarbons are considered the most significant air pollutants. The main source of CO pollution is automobile exhaust, amounting to 60 million tons, or 60%; forest fires contribute 17%; industry cause 11%; incineration of refuse cause eight percent; and heating cause two percent. Inside of an automobile, the CO concentration can be as high as 100 ppm, or more if the occupant of the car smokes, since inhaled cigarette smoke contains about 500 ppm of CO. Carbon monoxide reacts with hemoglobin to form carboxyhemoglobin which deprives the blood of its oxygen carrier. A concentration of 30 ppm CO in the air will, after eight hours inhalation, transform five percent of the hemoglobin into carboxyhemoglobin. The most prominent source of air pollution by lead in recent years has been the use of tetraethyl lead as antiknock agent in gasoline. About 80% of this lead is released into the air with the exhaust gases in thy form of lead bromide, chloride, and oxide particles. Lead causes a partial inactivation of certain enzymes which are responsible for the synthesis of the blood hemoglobin, resulting, in the long run, in some degree of anemia. Of the hydrocarbons contained in automobile exhausts, the aliphatic group is gaseous, hardly toxic, and odorous. The polycyclic hydrocarbons, on the other hand, are emitted in the form of particles. Some of these, such as benzopyrene are carcinogens.

33778

Schlipkoeter, Hans-Werner

**MAN S BURDEN THROUGH AIR POLLUTION DUE TO MOTOR EXHAUST EMISSIONS.** (Die Belastung des Menschen durch Luftverunreinigungen von Kraftfahrzeugen). Text in German. Staedtehygiene (Uelzen/Hamburg), 22(10):227-231, Oct. 1971. 28 refs.

Air pollution from automobile exhaust emissions are due to incomplete combustion processes. The accumulation of dusts and aerosols in body tissues are primarily influenced by meteorological factors. Disturbances of vertical atmospheric exchange during low level inversions may lead to high accumulations of pollutants in the ambient air, resulting in acute illness. Persons subjected to vehicular emissions during traffic conditions may have blood levels of about two percent carboxyhemoglobin. Behavioral studies using test parameters of experimental psychology have demonstrated performance decrements even at low COHb-levels. Benzo(a)pyrene and lead compounds may be absorbed with a prolonged and intensified retention of particulate matter in the lung. The metablism and effects of aromatic polycyclic hydrocarbons and inhaled lead compounds are of primary importance in evaluating vehicular emissions. (Author abstract modified)

33779

Pott, F. and A. Brockhaus

**COMPARISONS OF ENTERAL AND PULMONARY ABSORPTION RATES OF LEAD COMPOUNDS.** (Vergeleich der enteralen und pulmonalen Resorptionsquote von Bleiverbindungen). Text in German. Zentralbl. Bakteriol., Parasitenk. Infektionskr. Hyg.: Abt. 1: Orig., Reihe B, vol. 155:1-17, 1971. 16 refs.

Rates of enteral and pulmonary absorption of lead by 235 rats were examined. Various dosages of two lead compounds of different solubility (lead bromide and lead oxide) were administered, orally or intratracheally, eight or 24 times. To obtain models of 100% absorption, corresponding groups of animals received lead intravenously. Lead content in bone tissue served as a measure of the amount absorbed. Examination of lead in the complete skeletons of 16 animals revealed that the content of the femora was fairly consistent, amounting to 6.8%. Therefore, femora lead was regarded as representative of the entire bone tissue and the lead assay was restricted to the femora. Amounts of lead in femoral bone tissue were the same after intratracheal and intraveneous injection. However, no more than five percent was demonstrable following oral administration. The findings suggest that atmospheric lead from leaded gasolines is of much greater biological importance than lead in foodstuff. (Author abstract modified)

33864

Kehoe, Robert A.

**SUMMARY: RISK OF EXPOSURE AND ABSORPTION OF LEAD.** Public Health Service, Washington, D. C., Symp. Environ. Lead Contamination, 1965, p. 154-157. (Dec. 13-15.) (PHS Pub. 1440.) NTIS: PB 198104

The steady rate of building up the body burden of lead, under conditions of steady continuous exposure, continues through the lifetime of an individual. The only presently acceptable criterion for safety from the regular ingestion of lead is the limitation of the average quantity ingested daily to a level which will not give evidence of an increase in the body burden of lead over a prolonged period of time. The threshold point in the regular ingestion of lead by the general population is regarded as being at or near 0.6 mg of lead per day, under conditions in which the opportunity for the inhalation of lead from

the ambient air is not significantly greater than at present. The ingestion of lead at the level of 1 mg of soluble lead daily, in addition to that in the daily diet (approximately 0.30 mg daily), will reach a dangerous level in about 8 years; that of 2 mg daily, under comparable conditions, in less than 4 years, while that of 3 mg daily requires only 8 to 12 months. Exposure to air containing lead sesquioxide in a dispersion of particles with a mean diameter of 0.05 micron at the concentration of 0.15 mg/cu m, on the intermittent schedule of 7.5 hrs/day on 5 days of each week, results in a prompt increase in the output of lead in in the urine and in the concentration of lead in the blood. These levels reach their maximum heights within 4 to 6 months. These peaks occurred at about 0.085 mg/l in the case of urine, and at about 0.042 mg/100 grams in the blood. The retention of lead in the respiratory tract during the inhalation of air containing particles of lead sesquioxide ranging from 0.18 micron in diameter amounted to 35 to 40% of that inhaled. Absorption from the lung was prompt and complete. Continuous exposure to air containing 0.15 mg of lead/cu m of air, dispersed in particles ranging up to 0.18 micron in diameter, would result in reaching a dangerous level of absorption in about two years.

33903

Lob, Marc

**ON LEADED GASOLINE II. COMPARATIVE STUDY ON THE LEVELS OF LEAD IN THE BLOOD, URINE, NA DPORPHYRINURIA IN VARIOUS POPULATION GROUPS OF LAUSANNE (OFFICE WORKERS, GARAGE WORKERS, POLICEMEN).** (A propos de la benzine au plomb. II. Etude comparative de la plombemie, de la plomburie et de la porphinurie chez divers groupes de la population lausannoise (employes de bureau, garagistes, agents de police). Text in French. Z. Praeventivmed., 10:172-179, May-June 1965. 20 refs.

The lead content in blood and the lead and porphyrin content in urine of office workers (40 individuals), and of garage workers (50 individuals) was compared with respective levels in identical worker groups ten years ago (1955/56). The median lead content in the blood of the two population groups was 29 gamma % and 37 gamma %, respectively. In ten especially exposed policemen, 38 gamma % lead was in the blood, however this group was not tested 10 years ago. The levels in office and garage workers exceeded respective levels found 10 years ago by approximately 15 gamma %. Porphyrinuria was not diagnosed in any of the tested individuals. Median lead urine levels found were 24.5 gamma/l in office workers, 37 gamma/l in policemen, and 36 gamma/l in garage workers. The maximal permissible level for urine is 80 gamma/l, 50 to 80 gamma/100 cu cm for blood.

33910

Richter, R. H. H., and Ch. Schlatter

**THE EFFECT OF LEAD FROM AUTOMOBILE EXHAUST GASES ON DOMESTIC ANIMALS.** (Zur Frage der Wirkung von Blei aus Motorfahrzeugabgase auf Nutztiere). Text in German. Bull. Eidgenoess. Gesundheitsamtes, Beilage B., no. 3:154-168, March 1971. 171 refs.

Whether inhalation of air polluted by lead causes changes in domestic animals is not known. The intake of contaminated feed leads to abnormal resorption and accumulation of lead in the organism, even though only one fifth to one tenth of the ingested lead is absorbed, compared with inhaled lead. The levels of lead found in organs and bones of milk cows fed contaminated fodder were up to 20 times higher than normal (pelvic bones were 24.99 ppm and 1.862 respectively). Numerous cases of lead poisoning of domestic and wild animals have been described where lead acted as a nerve, blood, capillary, metabolic, and cellular nuclear poison. The acutely lethal dose depends on the species, age, state of health, condition of the gastrointestinal tract, resorption and elimination rate, and previous exposure to low lead concentrations. Symptoms of chronic intoxication are anemia, reduced erythrocyte and thrombocyte count, loss of weight, loss of energy, cachexia, colic, spasms, and a variety of other abnormal manifestations. While the normal lead blood level is 0.25 ppm, animals with 1.52 ppm lead blood level need not yet show symptoms of intoxication.. Observations made on experimentally intoxicated cattle, calves, steers, sheep, dogs, guinea pigs, rabbits, mice, rats and aquatic birds are described. A daily intake of one to three g lead per cow (50-200 ppm in fodder), while tolerated by the animals without visible symptoms for years, can result in reduced milk production, abortion, and diseased calves.

34059

Bazell, Robert J.

**LEAD POISONING: COMBATING THE THREAT FROM THE AIR.** Science, 174(4009):574-576, Nov. 5, 1971.

Passed in August 1970 by the city council, New York s antilead ordinance requires a stepwise reduction to two grams of lead per gallon of premium gasoline and 1.5 per gallon of regular this month (Nov. 1971), and to no lead in any gasoline by January 1, 1974. The Environmental Protection Agency will publish some lead control regulations by the middle of December 1971, with 30 or more additional days allowed for comments. At the very least, the federal rules will require that lead-free or low-lead gasoline be available for 1975 model cars, which will be fitted with lead-sensitive catalytic mufflers to control polluting emissions. Lead poisoning, orginally an occupational disease, has also become a disease of urban slum children, who eat the paint crumbling off the walls of dilapidated housing. As measuring devices ary put closer to traffic, lead levels rise. The concentration of lead in the air is actually increasing in several locations.

34066

Stankovic, Milos K.

**BIOCHEMICAL TESTS FOR THE APPRAISAL OF EXPOSURE TO LEAD.** Arch. Environ. Health, vol. 23:265-269, Oct. 1971. 17 refs. (Presented at the Conference on Inorganic Lead, Amsterdam, Netherlands, Nov. 29, 1968.)

Increases in the rate of the excretion of delta-aminolevulinic acid and, to a slightly lesser extent, increase in the excretion of coproporphyrin, in the urine of persons subjected to occupational exposure to lead, parallel the increase in the excretion of lead in the urine (and the concentration of lead in the blood). Data derived from a study of groups of workmen subjected to varying degrees of exposure have been assembled to demonstrate the gradation of these several responses to graduated occupational exposure to lead, and to provide collective criteria for the establishment of threshold limits. (Author abstract)

34092

Golli, V., E. Stefanin, Brindusa Turnescu, and Rodica Stan

**RESEARCH ON THE ACTUAL PREVALENCE OF CHRONIC BRONCHITIS.** (Cercetari asupra prevlantei actuale a bronsitei cronice). Text in Rumanian. Rev. Med.-Chir., vol. 73:83-869, Oct.-Dec. 1969. 26 refs.

An epidemiological study of 2942 persons (1329 males and 1693 females) older than 15 years of age, in the city of Craiova

(Rumania), revealed that 7.95% (10.98% of males and 5.39% of (females) had chronic bronchitis. The frequency of the condition increased with age (2.29% among those younger than 30 compared to 15.43% in the over 50 years old group). Smokers had 5.5 times more bronchitis than did nonsmokers (24.6% and 4.44%, respectively); among smokers, the incidence of bronchitis increased with the duration of smoking and the number of cigarettes smoked daily. Unskilled workers had more bronchitis than did skilled workers (12.56% and 10.07%, respectively). Subjects exposed to temperature changes and various irritants (oil fumes, gasoline, diesel fuel, combustion gases, foundry fumes, lead, coal dust and fumes) had twice as much bronchitis than those living and working under good hygienic conditions. All other factors being equal, the frequency of bronchitis was significantly higher (five to six times) among smokers. The frequency of chronic bronchitis in workers engaged in dust free occupations was 5.47% as compared to 18.3% in those exposed to dust (flour mills, textile factories, foundries, coal and silica works); in this category also, smokers had a higher incidence of chronic bronchitis than did nonsmokers.

34095

Lin-Fu, Jane S.

**CHILDHOOD LEAD POISONING...AN ERADICABLE DISEASE.** Children, 17(1):2-9, Jan.-Feb. 1970. 6 refs.

Surveys have indicated that among children living in slum areas, from 10 to 25% of those between one and six years of age have absorbed potentially dangerous quantitites of lead, although clinical symptoms of lead poisoning have been present in only two to five percent of the children. Until the advent of chelating agents -- therapeutic agents that bind the lead ions and remove them from the body -- about two-thirds of the children with lead encephalopathy died. A follow-up study of 425 children in Chicago who were treated for lead poisoning revealed that 39% had some kind of neurological sequelae. Although clinical symptoms of lead poisoning often do not appear until the blood lead level is .06 mg/100 g of blood or higher, it is generally agreed that the normal blood lead level should not exceed .04 mg/100 g. Lack of awareness of the problem is discussed, as well as voluntary action. The ideal solution to childhood lead poisoning is slum clearance and urban renewal with the provision of adequate housing for families of low incomes. Public education and mass screening programs are also indicated. Urgently needed research is outlined.

34114

McAllister, Russell G., Andrew M. Michelakis, and Harold H. Sandstead

**PLASMA RENIN ACTIVITY IN CHRONIC PLUMBISM.** Arch. Internal Med., vol. 127:919-923, May 1971. 30 refs.

Plasma renin activity was found suppressed in two patients with chronic plumbism of different etiologies (moonshine ingestion and industrial poisoning). After long-term therapy with edetate disodium calcium administered intravenously to reduce the total body burden of lead, the plasma renin activity returned to normal. The evidence presented is compatible with the hypothesis that lead deposition in renal tissue impairs processes leading to renin production or release or both and that this abnormality may be corrected with edetate disodium calcium therapy. This is the first demonstration of an endocrinopathy apparently due to lead which can be reversed by chelation therapy. (Author abstract)

34175

Grabecki, J., T. Haduch, and H. Urbanowicz

**THE SIMPLE METHODS OF DETERMINING DELTA-AMINOLEVULINIC ACID (ALA) IN URINE.** (Die einfachen Bestimmungsmethoden der delta-Aminolaevulinsaeure im Harn). Text in German. Int. Archiv Gewerbepathol. Gewerbehyg., vol. 23:226-240, 1967. 18 refs.

Increased absorption of lead by the organism results in increased Delta-Aminolevulinic Acid (ALA) elimination in urine, the earliest and highly specific symptom of lead poisoning. The Mauzerall and Granick analytical method and two Shuster methods, all based on the formation of pyrrol compounds from ALA, were compared with other methods, based on the property of ALA to form a dye with picric acid in an alkaline medium, and the first method was found to be the best; however, it is time consuming and not suited for routine testing. A modification of this method is described which reduces its duration to 20 min. The modified method condenses ALA in urine with acetylacetone by heating. The resulting pyrrol compound forms with p-dimethylaminobenzaldehyde in acid solution a color complex which is determined spectrophotometrically. The accuracy of the method is 5.8%. Recovery tests yielded an average of 96.5%. Parallel analyses of urine from workers exposed to lead with the original and the modified Mauzerall-Granick method yielded identical results.

34246

Delves, H. T.

**A MICRO-SAMPLING METHOD FOR THE RAPID DETERMINATION OF LEAD IN BLOOD BY ATOMIC-ABSORPTION SPECTROPHOTOMETRY.** Analyst (London), vol. 95:431-438, May 1970. 10 refs.

The concentrations of lead in 10 microliter samples of whole blood are accurately determined in less than five minutes by atomic-absorption spectrophotometry. After partial oxidation with hydrogen peroxide in micro crucibles made from nickel foil, the samples are volatilized, using an air-acetylene flame, into a nickel absorption tube situated in the flame. The sensitivity of the method is one times 10 to the minus ninth power per one percent absorption at 283.3 nm. Thirty-nine blood samples with lead concentrations ranging from 19 to 245 micrograms per 100 ml were analyzed by the method described and by automated colorimetry involving the use of dithizone. The correlation coefficient between the results of both methods was 0.989. (Author abstract modified)

34406

Weaver, Neill K.

**TOXICOLOGIC IMPLICATIONS OF MOTOR GASOLINE AND AUTO EMISSIONS.** Proc. Am. Petrol. Inst., Div. Refining, vol. 51:951-967, 1971. (Presented at the Midyear Meeting, 36th, San Francisco, Calif., May 12-14, 1971.)

While gasoline mainly results in air pollution through the emission of exhaust components from the internal combustion engine, evaporative losses of hydrocarbons from the manufacture, transport, and storage may be of importance in certain situations. Of the pollutants found in urban air, gasoline and its combustion products contribute significantly to carbon monoxide, hydrocarbons, nitrogen oxides, and particulates, which are composed of lead and other trace elements and compounds. The initial contaminants may result in the development of other pollutants through reactions in the atmosphere, as in the case of photochemical smog. Since none of these comtaiminants, under ordinary circumstances, reaches levels in ambient air which are acutely toxic, concern rests

with their possible subacute or chronic effects at relatively low level, long-term exposures. For the various gasoline pollutants, the concentrations which are established to have chronically toxic effects are related to the levels actually achieved in urban air, the levels recommended by the American Petroleum Institute as a satisfactory standard, and the national promary standards proposed by the Air Pollution Control Office. The existence of uncertainties or discrepancies are noted for the Threshold Limit Values of the various gasoline and combustion products from the automobile. (Author abstract modified)

34436

Hardy, Harriet L., Richard I. Chamberlain, Clarence C. Maloof, George W. Boylen, Jr., and Mary C. Howell

**LEAD AS AN ENVIRONMENTAL POISON.** Clin. Pharmacol. Therap., 12(6):982-1002, Nov./Dec. 1971. 86 refs.

Sources of potential toxic body burden of lead were investigated and, to assess current body burden in and around a city (Boston), a number of assays were made of hair, urine, and postmortem samples. Additional studies were undertaken with chelating agents in an attempt to develop base-line data with which to assess low-level harmful lead effect. Finally, techniques used in evaluating occupational illness were employed in field trips to homes and neighborhoods of a few patients with proven lead poisoning. Soil samples in such neighborhoods contained lead in quantities sufficient to cause lead poisoning if eaten by children with pica. The lead concentration in soil was blamed in equal part on fallout from gasoline engine exhaust and on the washing of lead into the soil from exterior paint used on buildings. Two of 12 children with definite neurological disabilities had definetely elevated hair lead values (i.e., higher than the 25 ppm base line derived from analyses of hair samples from MIT students). Oral administration of pencillamine resulted in a marked increase in urinary lead excretion in children with lead poisoning without a corresponding decrease in fecal lead. Legislation banning the use of lead paint and leaded gasoline is urged and a screening program is proposed to identify those who have been poisoned by lead or risk poisoning. Six research needs of screening programs are enumerated. Acute and chronic poisoning are discussed.

34649

Gillette, Robert

**LEAD IN THE AIR: INDUSTRY WEIGHT ON ACADEMY PANEL CHALLENGED.** Science, 174(4011):800-802, Nov. 19, 1971.

A major report on the health effects of airborne lead, released by the National Academy of Sciences in September 1971, has become the focus of a controversy over the academy s use of industry employees on its advisory panels to the Environmental Protection Agency. Although the panel noted that some groups of workers and children in inner-city neighborhoods might potentially be at risk, it found that the amount of lead in the air of most major cities has not changed greatly in the past 15 years. Environmental Protection Agency officials, who had hoped that the report would furnish the scientific underpinnings for a national air quality standard to control lead (which would require evidence of a danger to health or welfare), showed considerably less exuberance than the lead industry and gasoline manufacturers. During their service on the panel, four of the eighteen authors of the report were employed either by the E. I. Dupont de Nemours Company or by the Ethyl Corporation, which together produce most of the approximately 260,000 tons of lead additives burned each year in the United States. Certain data which the panel cited was also released by an industry advisory group.

34701

Freeman, Ronald

**CHRONIC LEAD POISONING IN CHILDREN: A REVIEW OF 90 CHILDREN DIAGNOSED IN SYDNEY, 1948-1967.** Med. J. Australia (Sydney), vol. 1:640-647, March 28, 1970. 21 refs.

Based on a study of case histories, 90 children admitted to two Sydney hospitals between 1948 and 1967 had chronic lead poisoning. Forty of the children were treated in the three-year period 1963-1967. Most of the children were poisoned after ingesting lead-based paint peeling off the walls of their homes and most appeared to develop symptoms in the hot summer months. The incidence was highest in three of the older municipalities, but individual cases came from many other parts of Sydney, suggesting that the hazard is quite widespread. In a few cases, the only source of lead was toys. Legislation restricting the use of lead paint in New South Wales is urged.

34709

Williams, Michael

**LEAD POLLUTION ON TRIAL.** New Scientist Sci. J., 51(768):578-580, Sept. 9, 1971. 7 refs.

Because it has a long biological half-time in the body, lead is a cumulative agent. However, this renders lead less hazardous, for it allows time for measurement, assessment, and suitable action, if necessary. The central nervous system may certainly be involved in severe lead poisoning, but again there is no evidence that it is affected by lower levels of lead absorption, either in adults or in children. While rising lead contamination could be a factor in mental illness, which has also been indicated to be increasing particularly among the young, little actual evidence has been produced to indicate that either lead contamination or mental illness is increasing. It is misleading to imply that certain industrial areas have higher lead levels due to automobile emissions than non-urban areas when industries such as a single lead smelter could be equally at fault.

34738

Nye, L. J. J.

**AN INVESTIGATION OF THE EXTRAORDINARY INCIDENCE OF CHRONIC NEPHRITIS IN YOUNG PEOPLE IN QUEENSLAND.** Med. J. Australia, (Sydney) vol. 2:145-159, Aug. 3, 1929. 29 refs. (Presented at the British Medical Association, Queensland Branch, March 1, 1929.)

An extraordinary incidence of chronic nephritis in persons between the ages of ten and forty has been observed in Queensland, Australia. The type of nephritis is a chronic diffuse sclerosis of the kidney tissue and the name nephrosclerosis is submitted as a more appropriate term. In eighty consecutive case records of so-called interstitial nephritis it was found that in fourteen there was a history of the patient having received treatment for plumbism in childhood. Of twenty-two patients who were interviewed, twenty had spent their childhood in wooden houses with chalky paint on the walls and railings, while sixteen were nail biters or thumb suckers. The incidence of lead poisoning in Queensland is also remarkably high. Records have been made of the results of physical examination and renal function tests on twelve children who have suffered from previous lead poisoning, and on three who gave a history of frequently licking the rain drops from the veranda railings after a storm. All of these patients exhibited renal insufficiency. Nephrosclerosis is most prevalent where

the houses are built of wood and where children are confined to verandas. A close association has been observed between houses painted with lead paint, nail biters or thumb suckers, lead poisoning, and chronic nephritis.

34789

Witschi, Hanspeter

**DESORPTION OF SOME TOXIC HEAVY METALS FROM HUMAN ERYTHROCYTES IN VITRO.** Acta Haematol., vol. 34:101-115, 1965. 21 refs.

Human red cells were incubated in vitro with lead-210, mercury-203, and thallium-204 and thereafter washed repeatedly with different washing liquids; the desorption of these metals from the erythrocytes was determined. Lead was removed from the erythrocytes to a greater extent by repeated washings in their own plasma than in pure inorganic medium. In a heterogenous mixture of alpha- and beta-globulins including lipoproteins, even more lead was desorbed from the cells than in plasma, albumin or gamma-globulin solutions. It is supposed, therefore, that lead is bound at least partly to the deeper layers of the plasma protein film on the erythrocytic surface. On the other hand, mercury was observed to be rather fixed to lipoproteins, lipids, and/or smaller thiols of the outer surface. Thallium apparently shows no definite predilection to binding sites either in the plasma or in cells.

34791

Mao, Peter and John J. Molnar

**THE FINE STRUCTURE AND HISTOCHEMISTRY OF LEAD-INDUCED RENAL TUMORS IN RATS.** Am. J. Pathol., 50(4):571-603, April 1967. 27 refs.

The fine structure and histochemistry of lead-induced renal tumors in rats are described, and some data on the distribution of lead in the tumors themselves and in the tumor-bearing kidneys are presented. In 31 of 40 rats subjected to a long-term feeding of a diet containing one percent basic lead acetate, renal epithelial tumors were produced; the tumors displayed a varying histologic pattern and were composed of solid, papillary, or acinar-glandular structures. By electron microscopy, tumor cells showed varying degrees of differentiation. Well-differentiated cells resembled normal renal tunular epithelium, while poorly differentiated ones exhibited no features suggesting origin from renal tubules. Nuclear and nucleolar hypertrophy was frequent and probably signified enhanced cellular activity. The most prominent structural alterations appeared in the mitochondria of tumor cells; these served to correlate with the functional and enzymic abnormalities known to occur in neoplasms. Numerous lysosomes were present, and some of these probably contained lead and ferritin particles. Microbodies were numerous within the neoplastic cells. The absence of basal plasma membrane infolding and the relative lack of apical pits or vacuoles in tumor cells, coupled with a marked reduction in adenosine triphosphatase and alkaline phosphatase activity in the microvilli, suggest that the tumor cells play a negligible role in resorptive and transport activities. Chemical analysis showed lead in the tumors, but the adjacent renal parenchyma always contained a significantly greater amount. (Author summary modified)

34832

Fullerton, Pamela M.

**CHRONIC PERIPHERAL NEUROPATHY PRODUCED BY LEAD POISONING IN GUINEA-PIGS.** J. Neuropathol. Exp. Neurol., vol. 25:214-236, 1966. 38 refs.

Seventy-two guinea pigs were poisoned with repeated doses of intragastric lead acetate. During poisoning, growth was inhibited in young guinea pigs; in both young and adult animals, weight loss, anemia, and convulsions were seen. Only nine animals developed paralysis of the hind limbs, which was usually mild. Motor nerve conduction velocity was estimated in 40 animals, and was reduced in 17 of them. In some cases, maximal velocity fell from the normal range of 40 to 60 m/sec to less than 20 m/sec. In a few, single motor nerve fibers velocities as low as eight m/sec were recorded. The peripheral nerves were examined histologically in 52 animals and abnormalities were found in 31. The most common pathological change was a mixture of segmental demyelination and axonal degeneration. In eight animals, only segmental demyelination was found, and in five animals axonal degeneration was the sole finding. Markedly reduced conduction velocity was only seen in those animals in which segmental demyelination was present.

34836

Goyer, Robert A., Phillip May, Maxine M. Cates, and Martin R. Krigman

**LEAD AND PROTEIN CONTENT OF ISOLATED INTRANUCLEAR INCLUSION BODIES FROM KIDNEYS OF LEAD-POISONED RATS.** Lab. Invest., 22(3):245-251, March 1970. 26 refs.

In lead poisoning, nuclear inclusion bodies in renal tubular lining cells are shown to be composed of a lead-protein complex. The inclusions may be isolated for ultrastructural and biochemical study by the sonication of isolated nuclei and differential centrifugation. The morphologic integrity of the inclusions remains intact throughout the isolation procedure. The fine structure of the inclusions consists of a dense central core and an outer fibrillary zone. This ultrastructural appearance is altered by digestion with a proteolytic enzyme. Chemical analysis of the inclusions indicates a relatively constant lead-protein ratio, suggesting an orderly binding of lead by inclusion protein. The inclusion body may, therefore, function as a store or depot for intracellular lead. (Author abstract)

34837

Sandstead, Harold H., Edwin G. Stant, A. Bertram Brill, Luis I. Arias, and Robert T. Terry

**LEAD INTOXICATION AND THE THYROID.** Arch. Internal Med., vol. 123:632-635, June 1969. 26 refs.

Thyroid function was studied in 24 patients judged to have saturnism on the basis of their urinary excretion of lead following an infusion of edetate calcium disodium. Following administration of sodium iodide I-131, the mean 24-hour I-131 uptake for 23 patients was 10.0% plus or minus 3.7% standard deviation. A single patient had an uptake of 26.1%. All but three patients responded normally to treatment with thyroid stimulating hormone. Of two patients studied, one had a decreased secretion of thyroxine by the thyroid. Other measures of thyroid function were normal in the group. The findings are consistent with injury of the iodine concentrating mechanism of the thyroid. (Author abstract)

34841

Campbell, Kirby I., William M. Busey, Niell K. Weaver, James A. Taylor, and Alexis A. Krumm

**BIOLOGICAL EFFECTS IN ANIMALS CHRONICALLY EXPOSED TO LEAD CHLOROBROMIDE ATMOSPHERES.** Preprint, Hazleton Labs., Inc., Vienna, Va., Inhalation Toxicology Dept. and Environmental Protection Agency, Cincin-

nati, Ohio, Toxicology Program, Coordinating Research Council Contract CAPM-6-68, 20p., 1971. 20 refs.

Groups of nine cynomolgus monkeys were exposed virtually continuously for 104 weeks, in steel and glass inhalation chambers, to atmospheres characterized by respirable lead chlorobromide particulate alone and in simple combination with nitrogen dioxide, carbon monoxide, or sulfur dioxide. Nominal concentrations were: PbClBr at 0.6 mg/cu m, NO2 at 0.5 ppm, CO at 67.6 ppm, and SO2 at 10 ppm. A matching group, exposed only to filtered room air, served as controls. Various clinical and physiological determinations were performed prior to and throughout the exposure period, and histopathologic evaluations were conducted terminally at sacrifice. Compared to controls, all groups exposed to atmospheres containing PbClBr alone or in combination exhibited increased blood lead levels occurring early and sustaining throughout the exposure; corresponding elevations of urinary coproporphyrins and delta-aminolevulinic acid; reduced erythrocyte osmotic fragility; and nephropathy characterized by dilatation and epithelial cell degeneration in the proximal convoluted tubules, with cytoplasmic vacuolation, nuclear vesiculation, intranuclear inclusions, and disrupted borders. Elevated terminal blood levels and slightly increased renal pathology were also observed in corresponding groups of rats similarly exposed for 52 weeks in the same atmosphere. (Author summary)

34847

Morrow, J. J., G. Urta, and A. Goldberg

**THE EFFECT OF LEAD AND FERROUS AND FERRIC IRON ON DELTA-AMINOLAEVULIC ACID SYNTHETASE.** Clin. Sci., vol. 37:533-538, 1969. 11 refs.

Properties of delta-aminolaevulic acid synthetase were studied colorimetrically using particles of chicken cell haemolysate as the source of enzyme, glycine and alpha-ketoglutarate as substrates, and optimal concentrations of pyridoxal phosphate, coenzyme A, ethylenediaminetetraacetic acid, and magnesium chloride. There was a direct linear relationship between the amount of haemolysate added to the system and the delta-aminolaevulic acid formed. Optimal activity occurred with one-millimole EDTA. The effects of lead and ferrous or ferric iron were comparable in the presence and absence of EDTA. Ferrous iron in concentrations of 1,000,000 M increased enzyme activity by 12% and at 0.001 depressed activity by 56%. Ferric iron had no stimulating action but depressed activity by 12% at 0.001 M. Lead caused progressive depression of activity with increasing concentration. High concentrations of ferrous iron caused marked reduction in delta-aminolaevulic acid synthetase activity; this is in keeping with the observation that certain refractory anemias can be aggravated by excess iron.

34851

Oyasu, Ryoichi, Hector A. Battifora, Raymond A. Clasen, James H. McDonald, and George M. Hass

**INDUCTION OF CEREBRAL GLIOMAS IN RATS WITH DIETARY LEAD SUBACETATE AND 2-ACETYLAMINOFLUORENE.** Cancer Res., vol. 30:1248-1261, May 1970. 65 refs.

In a study of neoplasma induced by 2-acetylaminofluorene (2-AAF), 25 gliomas and three extracerebral intracranial tumors were found in 988 Wistar and caesarian-delivered (Sprague-Dawley) rats, of which 663 were used in experimental groups and 325 in control groups. The tumors usually developed after 52 weeks. Most tumors were classified as poorly deferentiated malignant gliomas. The highest incidence (8.6%) of gliomas was in animals ingesting lead subacetate; the difference compared with the incidence (0.3%) among controls was statistically significant. In animals given 2-AAF with or without olive oil, carbon tetrachloride, or ethionine, the incidence (2.5%) of gliomas was lower and their development was usually delayed until after 60 weeks of age; but the incidence (5.5%) among rats surviving 60 weeks or more was statistically significant when compared with that of 325 control rats in which only one glioma was found. Unsuccessful attempts were made to increase the incidence of gliomas by combining lead subacetate with 2-AAF management and by local freezing of the brain in the early stage of prolonged 2-AAF dietary treatment. (Author summary modified)

34895

Paulson, Glenn L., D. Max Snodderly, and William L. R. Cruce

**AIR POLLUTION IN THE QUEENS-MIDTOWN AND BROOKLYN-BATTERY TUNNELS.** Scientists Commmittee for Public Information, Inc., New York 13p., July 11, 1969. 20 refs.

Measured levels of carbon monoxide, nitrogen oxides, lead, suspended particulates, and aldehydes in two New York City vehicular tunnels, and the possible health effects of these levels are reviewed. Short-term exposure to CO has hemoglobin effects; long-term exposure may have cardiovascular implications. Potential synergistic effects are considered for sulfur dioxide and particulate matter, for nitrogen oxides, aldehydes, and SO2; and for CO and lead. Various studies indicate that the measured levels of CO are high enough to be causing short-term psychological effects in the men breathing them for a working day and that measured particulate levels, if sustained and coupled with New York SO2 levels, may be causing adverse health effects. Recommendations include improved tunnel ventilation, further studies on short-term and long-term health effects, improved air quality monitoring, definition of either occupational or ambient air quality standards within the tunnels, and rapid disclosure of publicly-funded studies.

34902

Williams, M. K., E. King, and Joan Walford

**AN INVESTIGATION OF LEAD ABSORPTION IN AN ELECTRIC ACCUMULATOR FACTORY WITH THE USE OF PERSONAL SAMPLERS.** Brit. J. Ind. Med. (London), vol. 26:202-216, 1969. 53 refs.

Thirty-nine lead workers and controls, in stable conditions of exposure, wore personal lead-in-air samplers daily for two weeks. During the second week, samples for blood lead, urinary lead, urinary coproporphyrin, urinary delta-aminolevulinic acid (ALA), the punctate basophil count, and hemoglobin were taken daily. Duplicate estimations were made on one day. The lead exposures of men doing almost identical jobs differed by ratios of up to four to one. This could be attributed only to personal differences in working habits. The correlation coefficients and regression equations of the biochemical tests with lead-in-air and with each other were determined. The mean values and 95% confidence limits of single determinations of some of the biochemical tests corresponding to the two commonly accepted threshold limit values of lead-in-air (0.20 and 0.15 mg/cu m) were calculated from the regression equations. For each biochemical test, the variation due to analytical error, the variation from day to day within subjects and the residual variation about the regression on lead-in-air were calculated. Previous estimates of the latter are not known. Excessive confidence may be placed in an index of exposure due to its low coefficient of variation within subjects unless the coef-

ficient of variation between subjects about regression is taken into account. The correction for specific gravity of estimations of lead and ALA in spot samples of urine reduced slightly the residual variation between subjects about the regression on lead-in-air and to increase the correlations with lead-in-air and with the other biochemical tests, but these changes were not statistically significant. The modified method used for estimating blood lead and urinary lead is described and validated. (Author abstract modified)

34914

Muro, Luis A. and Robert A. Goyer

**CHROMOSOME DAMAGE IN EXPERIMENTAL LEAD POISONING.** Arch. Pathol., vol. 87:660-663, June 1969. 18 refs.

Chromosomes from leukocyte cultures from mice fed a diet containing one percent lead acetate show an increased number of gap-break type aberrations. The observed chromosome abnormalities largely involve only single chromatids. This suggests the damage occurred after the deoxyribonucleic acid synthesis phase of the cell cycle. A possible relationship between increased DNA ase activity and the chromosome damage is discussed. These findings are of interest with respect to the known effect of lead on reduction of fertility and possible oncogenesis and teratogenesis. Chromosome analysis of persons suffering from lead intoxication is urged. (Author abstract)

34943

Rosenblum, William I. and Margaret G. Johnson

**NEUROPATHOLOGIC CHANGES PRODUCED IN SUCKLING MICE BY ADDING LEAD TO THE MATERNAL DIET.** Arch. Pathol., vol. 85:640-648, June 1968. 13 refs.

Suckling mice were intoxicated via maternal milk, by placing lead carbonate in the diet of the maternal animals immediately after they had given birth. Intoxicated neonates displayed faulty growth and development, and revealed hematologic evidence of lead intoxication. Neuropathologic findings included abnormally large numbers of fibrous, intercapillary strands in several cerebral loci, and astrocytosis in the hippocampus. The latter was recognized most easily in sections stained with phosphotungstic acid hematoxylin. In addition, metallic impregnations for astrocytes and microglia revealed consistent differences between experimental and control material suggesting a general alteration in the properties of glia and/or cerebral tissue of intoxicated mice. (Author abstract)

34947

Palmisano, Paul A., Raphael C. Sneed, and George Cassady

**UNTAXED WHISKEY AND FETAL LEAD EXPOSURE.** J. Pediat., 75(5):869-872, Nov. 1969. 9 refs.

A 10-week-old infant with evidence of neurological defects, intrauterine growth retardation, and postnatal failure to thrive was studied for abnormal lead accumulation because of a maternal history of long-term ingestion of untaxed whiskey. After challenge doses of calcium disodium edetate (CaEDTA), the following 24-hr urine lead concentration was 620 microgram/liter for the infant and 600 microgram/liter for the mother. Published normal values are 0-80 microgram/liter for adults. These data provide suggestive evidence of transmission of lead transplacentally. Because of the widespread ingestion of untaxed whiskey in the southeastern U. S., intrauterine lead exposure may be a cause of fetal and neonatal disease. (Author summary modified)

34951

Mehani, Shawkia

**LEAD RETENTION BY THE LUNGS OF LEAD-EXPOSED WORKERS.** Ann. Occupational Hyg., vol. 9:165-171, 1966. 12 refs.

The retention of lead dust and fumes in the lungs of 51 lead workers, 22 shipburners, and 25 control subjects was studied. Apparatus included a respirometer, air sampler, and filter. About 39-47% by weight of the inspired lead is retained in the lungs of lead-exposed workers, and in this group, the average ventilation under various working conditions is approximately 10 cu m/8.0 hr shift. At an atmospheric concentration of lead of two mg/10 cu m of air, the working conditions are within safe limits, as the amount of lead retained per shift was less than one half the amount which can be tolerated by man without producing evidence of ill-health. The degree of lead retention was not associated with the depth of breathing. The various factors which affect dust retention were discussed. (Author summary modified)

35021

Wada, Osamu

**AIR POLLUTION AND LEAD - RECENT PROGRESS IN STUDIES OF LEAD POISONING.** (Taikiosen to Namari - Namarichudoku kenkyu no saikin no shinpo). Text in Japanese. (Nippon Ishikai Zasshi (J. Japan Med. Assoc.), 66(7):729-736, Oct. 1971. 22 refs.

The environmental pollution due to lead is summarized. Lead in the environment and in the human body is discussed. The effect of lead on organisms, the effect of lead on heme synthesis in vitro, abnormality of prophyrin metabolism in persons exposed to lead, and lead metabolism of healthy people are discussed. Lead poisoning, intellectual retardation, and renal disorders are mentioned.

35041

Ministry of Health and Welfare (Japan) and Osaka Prefectural Government (Japan)

**REPORT ON THE EFFECT OF SMOKE AND DUST.** (Baien to eikyo chosa hokokusho. Showa 44 nendo ban). Text in Japanese. 85p., 1969.

Environmental monitoring and medical examinations have been carried out since 1965 to study the effect of air pollution on the health of school children. The Fuku elementary school, located in the district of the worst environmental condition in Osaka City, the Ikeda elementary school in a residential area, and the Nishiura elementary school in a rural area were examined. Annual fluctuation of dust fall in the polluted area was higher than that in the non-polluted area. From the determination of sulfur oxides by the lead dioxide method, a polluted area showed an average value of 3.29 sulfur trioxide mg/day/100 sq cm and a non-polluted area showed 0.71 SO3 mg/day/100 sq cm. The amount of floating dust in a polluted area was twice more and four times more than that in a non-polluted area, measured by digital dust counter and high volume air sampler respectively. Metallic content, such as lead, nickel, vanadium, copper, zinc, and cobalt, was remarkably high at a polluted area. Medical examinations were carried out three times a year. According to the questionnaire, subjective symptoms of sore throat, headache, and cough or sputum were frequently reported at the polluted school. Forced vital capacity and timed vital capacity were low at schools in the polluted area according to the pulmonary function test by vitalor.

35042

**TRACE METALS: UNKNOWN, UNSEEN POLLUTION THREAT.** Chem. Eng. News, 49(29):29, 30, 33, July 1971.

The toxicity of trace metals is well documented. Lead, cadmium, arsenic, antimony, and beryllium have all caused accidental deaths in industry. The most critical concern to public health experts today, however, is for subtle physiological changes caused by trace metals that may go completely undetected or, if detected, be attributed to other causes. Also, synergistic and antagonistic relationships among trace metals must be defined. Current confusion surrounding standards for trace metals is illustrated by the wide gap between U. S. and Soviet industrial standards for metals; often U. S. standards are a hundredfold higher than those in the USSR. Sources and health effects are listed tabularly for nickel, beryllium, boron, arsenic, mercury, cadmium, antimony, lead, and other compounds. Investigations have indicated that arsenic, as well as selenium and tellurium, may be acted on by bacteria in nature to produce highly poisonous compounds. The mechanism for the methylation of mercury is mentioned. Another factor which must be added to this tangled riddle is that of the still unknown health benefits of trace elements and combinations of these.

35055

Schroeder, Henry A.

**METALS IN THE AIR.** Environment, 13(8):18-24, 29-32, Oct. 1971. 43 refs.

Some metals sustain life, while others shorten it. Twenty-two metals have been found in polluted air in the United States, and three more are probably present. Lead, cadmium, nickel, and mercury represent potential or real public health hazards. The known consequences of breathing metallic compounds range from no ill effects to thyroid enlargement and lung cancer. Effects of lead include damage to the liver, kidney, brain, and central nervous and reproductive systems. Children are especially susceptible to lead poisoning. Cadmium contributes to high blood pressure and cardiovascular death rates. Nickel has caused cancer in animals and in man when inhaled as nickel carbonyl while skin inflammation occurs frequently in workers exposed to nickel in refineries and in electroplating plants. Alkyl mercury can cause irreversible brain damage and it is also toxic to the kidney. Berylliosis may develop in workers exposed to the highly toxic beryllium, and bismuth can cause kidney and liver damage in large doses. Antimony and tin were also found in several samples. Low-toxicity metals and trace metals are also listed, as well as the concentrations of the various metals found in both urban and non-urban areas.

35118

Zielhuis, R. L.

**MEDICAL-BIOLOGICAL EFFECTS OF TRAFFIC EXHAUST.** (Uitlaatgassen van gemotoriseerd verkeer. III. Medisch-biologische gezichtspunten). Text in Dutch. Tijdschr. Soc. Geneesk., 49(20):696-702, Oct. 8, 1971. 93 refs.

A review of the literature on the medical-biological consequences of exposure to traffic exhaust is presented, with emphasis on gasoline engines. Total emissions, carbon monoxide, lead and other metals, carcinogens, teratogens, mutagens, nitrogen oxides, oxidant smog, and aldehydes are discussed. Acceptable emission limits are proposed. Too little is known in the Netherlands about presen emission concentrations, and systematic monitoring of the environment is urgently needed. (Author summary modified)

35174

Acocella, G.

**CHEMOTHERAPY OF EXPERIMENTAL LEAD POISONING. NOTE II. EFFECTS OF NICOTINIC ACID ON COPROPORPHYRINURIA IN LEAD POISONED RATS.** (Studio sulla chemioterapia dell intossicazione sperimentale da piombo. Nota II. Effetti dell acido nicotinico sulla coproporfirinuria da intossicazione saturnina nel ratto). Text in Italian. Acta Vitaminol. (Milan), 20(5):195-202, 1966. 20 refs.

A survey of the literature on lead poisoning in the rabbit, rat, and man indicated that the biological change common to the three species is increased urinary coproporphyrin excretion. This index was used to evaluate the effectiveness of nicotinic acid in treating rats intoxicated with lead acetate. Different doses of lead acetate (300 and 100 mg/kg/day/os) were administered for different periods of time (21 and 45 days); treatment with nicotinic acid (50 mg/kg/day intramuscularly) began either simultaneously with the administration of lead acetate, or after 10 or 45 days. Though reported to reduce human and rabbit coprophoryinuria, nicotinic acid did not modify urinary coproporphyrin excretion in the lead-poisoned rats. The different behavior of the rats is attributed to a species difference; hence results obtained with one species should not be extended to another. (Author summary modified)

35211

Ball, Gene V. and Jean M. Morgan

**CHRONIC LEAD INGESTION AND GOUT.** Southern Med. J., vol. 61:21-24, Jan. 1968. 20 refs.

Thirty-four patients with gout were hospitalized in a Birmingham, Alabama, hospital in 1965. Thirteen of these patients had abnormally high urinary lead levels and 12 of the 13 were anemic. Only one of the 13 was not a moonshine drinker; however, he had burned batteries for two years. The mean serum urate level (8.1 plus or minus 1.24 mg for 100 ml) in the saturine gout patients was higher than in controls. Creatinine clearance values represented moderately severe impairment of kidney function. Both sets of values indicated renal retention of uric acid in the patients. It is likely that moonshine serves not only as a vehicle for lead and thereby a sustained rise in serum urate, but also leads to intermittent, even more marked elevations in the serum urate levels, perhaps provoking an acute gout attack at its apogee.

35217

Morgan, Jean M.

**A SIMPLIFIED SCREENING TEST FOR EXPOSURE TO LEAD.** Southern Med. J., vol. 60:435-438, April 1967. 20 refs.

The use of calcium disodium ethylenediaminetetraacetate to demonstrate excessive storage of lead in humans was discussed. Tests were attempted on all patients admitted to a 60 bed general hospital provided they were able to take oral medicine. Two grams of EDTA were administered orally and the overnight urine specimen (12 hr) was obtained for lead assay. Blood and urinary lead was determined by the dithizone method. Urinary delta-aminolevulinic acid was determined by the method of Mauzerall and Granick. One hundred and thirty-nine consecutive admissions over a period of six weeks were observed. Thirty-eight percent acknowledged or were known to have used illegal alcohol at some time. Ninety-eight patients (70%) received the oral EDTA. Of the 98 persons tested, 67 did not have evidence of excessive exposure to lead and 31 individuals had both history of exposure to illegal alcohol and had urinary excretion of lead greater than 0.5 mg/l. The EDTA test is simple, safe, and effective in detecting persons who were subjected to excessive storage of lead. A very significant

portion of men over 35 years of age in the South, particularly among Negroes, demonstrate excessive storage of lead as a result of previous regular use of illegally produced alcohol. Most of these persons do not have clinically recognized lead poisoning. Further studies are needed to elucidate the long-term consequences of this excess.

35219

Ferm, Virgil H. and Stanley J. Carpenter

**DEVELOPMENT MALFORMATIONS RESULTING FROM THE ADMINISTRATION OF LEAD SALTS.** Exp. Mol. Pathol., vol. 7:208-213, 1967. 11 refs.

Specific congenital-skeletal malformations were induced in hamster embryos by treatment of pregnant hamsters with various salts of lead. On either day seven, eight, or nine of pregnancy, lead nitrate, lead chloride, or lead acetate were injected intravenously into the mother via the lingual vein. The embryos were recovered between day 12 and day 15 of the normal 16-day gestation period. Malformations were primarily localized within the developing sacral and tail vertebrae and were characterized by varying degrees of tail malformations ranging from stunting to complete absence of the tail. Minor degrees of these malformations were compatible with life and the fertility of several affected newborns which were rared to adulthood did not appear to be affected.

35225

Barriero, Ofelia C.

**EFFECT OF CYSTEINE ON 5-AMINOLAEVULINATE HYDROLYASE FROM LIVER IN TWO CASES OF EXPERIMENTAL INTOXICATION.** Biochem. Pharmacol., vol. 18:2267-2271, 1969. 25 refs.

The effect of sulfhydryl groups of cysteine on the activity of 5-aminolaevulinate hydrolyase (delta-aminolevulinic acid, hydratase) extracted from the liver of animals receiving chemical compounds known to disturb the porphyrin metabolic pathway was described. The free -SH groups, delta ALA, and protein content in rat and rabbit liver were measured. Female rats were given subcutaneous injections of allylisopropylacetamide (AIA) (400 mg/kg) at 24 hr intervals. Twenty four hours prior to the first dose of AIA, food was withheld until sacrifice 18-24 hours after the last dose of AIA. Fasted control animals were given only two injections of saline solutions. Acute lead poisoning was induced in rabbits by the daily injection of a solution of lead acetate (20 mg Pb +2/ml, pH 5.5) with a dosage range of 20-40 mg Pb +2/kg of body weight per day during eight days and sacrificed four hours after the last injection. The activity of delta ALA dehydratase in vitro with no preincubation with Cy varied, giving smaller values for fasted normal rats than for fed normal rats. At the same time, livers from rats which received AIA gave lower results than those from normal fasted rats. Lower delta ALA hydratase activity values were observed in livers of animals treated with Pb +2. Delta ALA content were higher in treated than in normal rabbit livers. The same result was obtained for free -SH group contents.

35377

Barltrop, Donald

**THE EXCRETION OF DELTA-AMINOLAEVULINIC ACID BY CHILDREN.** Acta Paediat. Scand. (Stockholm), vol. 56:265-268, May 1967. 14 refs.

Twenty-four-hour urine specimens were collected from 339 children aged 0-12 years admitted to the hospital over an 11-month period. The mean excretion of delta-aminolevulinic acid per 24 hours was 1.61 mg with a range of 0.0-6.5 mg, 95% of the values falling between 0.08-4.39 mg/24 hours. The mean excretion of ALA was 0.08 mg/kg body weight 24 hours; this value did not vary with age. A seasonal variation in ALA excretion was observed, with maximum values in the winter months and minimum values in the summer. Since the excretion of ALA may be closely related to the non-skeletal or metabolically active lead status of the body, it is important to define the normal excretion of ALA. (Author summary modified)

35380

Chisolm, J. Julian, Jr.

**CHRONIC LEAD INTOXICATION IN CHILDREN.** Develop. Med. Child. Neurol. (London), 7(5):529-536, Oct. 1965. 40 refs.

The serious sequelae of lead intoxication during early childhood are mental retardation, behavior disturbances, convulsive disorders, and nephropathy. The protean symptoms of this chronic disease and the paucity of specific abnormal physical signs make a biological approach essential for accurate diagnosis. Fundamentally, the diagnosis requires the demonstration of an excessive body burden of lead together with some metabolic evidence of toxic effects in soft tissues. In children, serial determinations of lead concentration in whole blood provide the best means for following trends in total body lead burden and its distribution. When blood determinations give equivocal results, the edathamil calcium disodium (EDTA) mobilization test can be used to detect increased body lead. The cornerstone of therapy is prompt interruption of abnormal lead exposure. Even so, the excessive body burden may persist for months or years after excessive intake is halted. To reduce and maintain soft tissue lead concentrations at close to normal levels, more use should be made of chelating agents in long-term managements. (Author summary modified)

35387

Chisolm, J. Julian, Jr.

**THE USE OF CHELATING AGENTS IN THE TREATMENT OF ACUTE AND CHRONIC LEAD INTOXICATION IN CHILDHOOD.** J. Pediat., 73(1):1-38, July 1968. 92 refs.

The pharmacologic aspects of chelation are reviewed with particular reference to agents useful in lead intoxication, i.e., 2,3-dimercapto-1-propanol (BAL), edathamil (CaEDTA), and d-penicillamine. Toxicologic studies determined that prompt institution of chelation therapy with the combination of BAL and edathimil calcium disodium, together with appropriate supportive therapy can substantially reduce the mortality rate of acute encephalopathy in children with lead intoxication. Blood level concentrations were reduced to normal levels during a five day course of BAL-EDTA therapy, and initial urinary lead output was far greater with BAL-EDTA in patients with encephalopathy. The critical factors of treatment were prompt institution of chelation therapy, delayed for only the time needed to establish urine flow; witholding of all oral fluids and restriction of parenteral fluids; avoidance of hypertonic agents; avoidance of surgery; and suppression of seizures. Doses of d-penicillamine maintained blood lead concentrations within normal limits and suppressed urine delta-aminolevulinic acid output to normal during diuresis of lead. Daily doses of 20-40 mg/kg administered to children convalescing from plumbism were efficacious and without serious side effects.

35438

Byers, Randolph K. and Elizabeth E. Lord

**LATE EFFECTS OF LEAD POISONING ON MENTAL DEVELOPMENT.** Am. J. Dis. Child., 66(5):471-494, Nov. 1943. 16 refs.

A follow-up study was conducted of 20 school children who had been hospitalized in infancy or early childhood because of lead poisoning. The presence or absence of evidence of involvement of the nervous system bore no relation to the eventual intellectual development of the children; indeed, the only truly successful member of the group had the most severe encephalopathy encountered among the 20 children. With the one definite and a second possible exception, none of the children succeeded in school. Throughout the psychologic examination of the children with good intelligence levels and poor scholastic attainment, sensorimotor defects were found in most instances. Other evidences of interferference with the normal development of the nervous system were found.

35463

Freeman, Ronald

**REVERSIBLE MYOCARDITIS DUE TO CHRONIC LEAD POISONING IN CHILDHOOD.** Arch. Disease Childhood (London), vol. 40:389-393. 1965. 23 refs.

The case history of a three-year-old girl with myocarditis occurring in the presence of chronic lead poisoning and encephalopathy is described. The diagnosis of lead poisoning was made on a history of eating lead-containing paint and was confirmed by laboratory investigations and the response to sodium calcium edetate. Myocarditis was diagnosed by the presence of cardiac failure in association with T wave changes in the electrocardiogram. The rapid reversal of the clinical and electrocardiographic signs of myocarditis during treatment of the lead poisoning with sodium calciumedetate implied that lead was responsible for the cardiac changes. The absence of hypertension and of signs of nephropathy suggested that the myocardial impairment was due to the direct action of lead on the heart. Electrocardiographic studies for possible myocardial damage should be part of the management of a patient with chronic lead poisoning. Supportive measures may be life-saving in children with lead encephalopathy because undiagnosed myocarditis could cause death.

35559

Cassells, David A. K. and E. C. Dodds

**TETRA-ETHYL LEAD POISONING.** Brit. Med. J. (London), 1946:681-685, Nov. 9, 1946. 11 refs.

The properties of tetraethyl lead are briefly reviewed, and the opportunities to develop tetraethyl lead poisoning in Great Britain are described. Twenty-five cases of tetraethyl lead poisoning of varying degrees of severity occurred during tank-cleaning operations, and six of the cases are described in detail. The earliest symptoms of lead poisoning in these 25 cases were disturbance of sleep and symptoms in the alimentary tract. Other symptoms are indicated, as well as the diagnosis and treatment of lead poisoning. Urinary lead concentrations will give some idea of the degree of exposure. (Author summary modified)

35560

Chisolm, J. Julian, Jr.

**DETERMINATION OF DELTA-AMINOLEVULINIC ACID IN PLASMA.** Anal. Biochem., vol. 22:54-64, 1968. 6 refs.

A method for the determination of delta-aminolevulinic acid in plasma is reported. The procedure is adapted from the ion-exchange resin chromatography procedure of Mauzerall and Granick for the determination of ALA in urine. Normal fasting children and fasted patients with symptomatic lead intoxication for acute intermittent porphyria were studied. The mean normal value found in healthy subjects was 0.056 micrograms/ml. This method is best suited to the study of acutely ill patients in whom the concentration of ALA in plasma is increased four- to 40-fold. (Author summary)

35568

Hickman, J. R.

**LEAD POISONING: POTTERY GLAZES, AN OFTEN-IGNORED HAZARD.** Preprint, Canada Safety Council, Fredericton (New Brunswick), 13p., 1970. 18 refs. (Presented at the Canada Safety Council, Fredericton, New Brunswick, May 26, 1970.)

Lead poisoning due to the ingestion of foods stored and contaminated is glazed pottery is reviewed. Conditions favoring the dissolution of lead, the subsequent contamination of food, the constituents of pottery glazes, firing techniques to control lead dissolution, and alternatives are examined. Occupational exposure of potters inhaling lead-containing dusts is discussed with respect to preventive measures.

35587

Specter, Michael J. and Vincent F. Guinee

**EPIDEMIOLOGY OF LEAD POISONING IN NEW YORK CITY - 1970.** Preprint, American Public Health Assoc., New York, 10p., (Presented at the American Public Health Association Meeting, Houston, Tex., Oct. 26, 1970.)

In January 1970, in order to mount a more forceful and coordinated attack on the lead poisoning problem, the New York City Health Department created a new bureau, the Bureau of Lead Poisoning Control. The aims of the Bureau are to seek out children with significant lead exposure so that they can receive medical attention and theri home environment detoxified. the current definition of a case of lead poisoning is a child with a blood lead level equal to or greater than 60 micrograms. The prevalence of lead poisoning on New York city was first estimated by using data obtained from surveys of ghetto children in other cities. The incidence of lead poisoning and the percentage distrubution within New York City are indicated.

35714

**MOONSHINE: THE ROTGUT RACKET.** Licensed Beverage Industries, Inc., New York, 25p., 1971.

Illegal distilling activities in the United States are discussed. The information and statistics presented were obtained from various field investigations and from Federal, state, and local law enforcement agencies. Pertinent news accounts are also used to illustrate the health, economic, and social problems generated by moonshine. An overall sharp decrease is reported in the number of still seizures and in moonshine production. However, while production on the local level decreased from 531 gallons in 1968 to 478 gallons in 1969, production on the state level increased from 11.8 million gallons to 12.5 million gallons. Due to the poisonous lead salts found in the product, moonshine consumers are subject to sudden death, permanent blindness and paralysis, or chronic lead poisoning. In two southern cities, 90-91% of seized batches of illicit liquor contained lead salts. As noted by a Federal report, mothers who drink moonshine contaminated by the salts can give birth to babies with serious physical defects.

35792

ruin, A. de and R. L. Zielhuis

**TOXICOLOGICAL APPRAISAL OF LEAD AS PUBLIC HEALTH HAZARD.** Tijdschr. Soc. Geneesk, vol. 49:855-859, 1971. 31 refs.

The total daily absorbed amound of lead in the general population is 36 to 45 micrograms, depending on the extent of environmental pollution; only 12 to 19% is absorbed through the respiratory tract. Essential metabolic processes will not be significantly altered by these low exposure levels, but there is likely to be increased body storage in subjects living in urban areas. The potential toxic effects of progressive storage of minute amounts of lead cannot be discounted, especially in certain vulnerable groups. The groups include children, pregnant women, and subjects with impaired kidney function. The additional reasearch needed to verify the vital significance of low-level effects should be conducted with emphasis on these groups. Preventive measures should be directed not only at respiratory uptake but even more at oral uptake.

35811

Hall, Stephen K.

**POLLUTION AND POISONING.** Environ. Sci. Technol., 6(1):31-35, Jan. 1972. 5 refs.

Atmospheric levels resulting from the continued use of lead are far above those that would exist naturally and can have grave consequences on human health. Available data indicate that combustion of leaded gasoline is the major source of atmospheric lead in urban areas. Other sources are manufacturing, pesticides, incineration of refuse, and combustion of coal. In many communities, the atmospheric lead contribution to the body approaches or even surpasses the contribution made by dietary intake. The atmospheric level varies directly with volume of traffic and size of a community, and is correlated with the amount of lead in surface water supplies. In Los Angeles, with a population of more than 2.5 million, the mean atmospheric concentration is five microgram/cu m air. Other urban communties with a population greater than two million have values of about 2.5 microgram. Communities smaller than a million and communities of less than 100,000 have means of two microgram and 1.7 microgram, respectively. The mean is rising by as much as five percent a year. High body lead levels can affect the blood, kidneys, and nervous system. Repeated ingestion of lead paint by children can culminate in convulsions and coma and sometimes sudden death. Any further increase of lead in environment will result in further concentration in some food chains, leading ultimately to toxic doses for man and other important organisms.

36093

Duckering, G. Elmhirst

**THE CAUSE OF LEAD POISONING IN THE TINNING OF METALS.** J. Hyg., vol. 8:474-503, 1908. 2 refs.

Tinning of metals, the coating of metal articles with lead or tin, causes lead poisoning. The atmosphere of a tinning workshop contained of hydrochloric acid, chlorides of lead, zinc, iron, and copper in the state of vapor, and metallic tin and lead. In the neighborhood of the tinning baths and wiping stands, the quantity of lead chlroide ranges from approximately two parts to sixty parts/ten million parts by weight of air. The mechanical action of escaping vapor is not nearly as important a factor in causing air contamination as the chemical action of the materials (acid and flux) used in tinning on the tinning metal and subsequent vaporization of the products of this action. Workers cannot use a respirator because of the tendency of the chlorides to condense and block the filtering material. The distribution of deleterious substances in the atmosphere of a tinning workshop was also studied. Long continued absorption of small quantities of lead is of much more importance in causing lead poisoning than the amount of the dose.

36152

Chisolm, J. Julian

**TREATMENT OF LEAD POISONING.** Mod. Treat., 4(4):710-728, July 1967. 15 refs.

Plumbism results from the accumulation over a period of weeks, months, or years of an excessive body burden of lead. This burden is distrubuted between bone and soft tissues, with the major portion being stored in the bone. The cruical aspect of therapy in all age groups is prompt termination of lead exposure. Estimation of the duration of abnormal exposure provides an index of the period of time a patient will require medical supervision after exposure ends. As long as significant quantities of lead remain in the bone, any intercurrent illness that can cause demineralization can also cause mobilization of toxic quantities of lead into soft tissues and, hence, exacerbation of plumbism. Serial blood and urine lead determinations, together with coproporphyrin and delta-aminolevulinic acid measurements, provide the best index of soft tissue toxicity. Administration of chelating agents results in rapid reduction in soft tissue lead content, but not in removal of significant quantities of lead from bone. Chelating agents, therefore, do not accelerate the lead-excretion process. The most severe clinical manifestation of lead intoxication is acute encephalopathy, which is more frequent in children than in adults. Therapy must be instituted before the classic signs of increased intracranial pressure are apparent if central nervous system damage is to be prevented. Accurate lead analyses are essential for proper treatment. Laboratory tests required for diagnosis of lead intoxication in children and for monitoring occupational exposure are summarized, as are chelating agents for symptomatic and asymptomatic cases and for long-term follow-up care.

36207

Chisolm, J. Julian, Jr. and Eugene Kaplan

**LEAD POISONING IN CHILDHOOD - COMPREHENSIVE MANAGEMENT AND PREVENTION.** J. Pediat., 73(6):942-950, Dec. 1968. 20 refs.

Lead poisoning in the young child is a chronic disease. It results from the impact upon the urban slum child, in particular, of a variety of causative factors-pica and environmental exposure to lead, cultural and behavioral patterns of parents, and certain aspects of lead metabolism. Each of these factors and the natural course of the disease, neurological and renal sequelae, and a program for early recognition and mass screening are discussed. Balance studies indicate that atmospheric lead pollution in urban areas has not yet reached toxic levels for the general population. Hospitalization in a chronic disease facility which has a positive program of child and family rehabilitation is important in the total care of the affected child. The roles of health departments, pediatricians, medical social workers, and child guidance workers in a team approach, and the essential aspects of an effective community prevention program, are outlined.

36251

Castellino, N. and S. Aloj

**INTRACELLULAR DISTRIBUTION OF LEAD IN THE LIVER AND KIDNEY OF THE RAT.** Brit. J. Med. (London), vol. 26:139-143, 1969. 27 refs.

The distribution of lead in intracellular fractions of liver and kidney was studied in 46 rats for nine days after intravenous injection of 100 microgram PB(210) per rat. The radioactivity and the protein nitrogen were measured in homogenates and nuclei, mitochondria, microsomes, and cell sap. Lead was present in all fractions one hour after injection. During the first 72 hours, the relative amounts of lead in the different fractions varied, which ruled out the possibility that differences could be explained by redistribution after homogenization. The distribution of metal in the cell probably depends on differences in the nature and stability of bonding to intracellular structures. The binding of lead in the mitochondria was particularly stable, only 24.4% of the radioactivity being removed by washing with 0.25 M sucrose or 0.001 M ethylenediaminetetraacetic acid, or 0.001 M diethylenetriamino- penta-acetate in 0.25 M sucrose. The stability of binding of lead in the mitochondria is in agreement with the hypothesis of direct interference by lead with some steps in haem biosynthesis, probably due to an enzymatic block of delta- aminolevulinate dehydratase and haem synthetase. (Author abstract modified)

36283

Djuric, Dusan, Zarka Kerin, Ljubica Graovac-Leposavic, Ljiljana Novak, and Marija Kop

**ENVIRONMENTAL CONTAMINATION BY LEAD FROM A MINE AND SMELTER.** Arch. Environ. Health, 23(4):275-279, Oct. 1971. 1 ref. (Presented at the Conference on Inorganic Health, Amsterdam, Netherlands, Nov. 28, 1968.)

The comtamination of a large area in Yugoslavia by lead from a mine and smelter is illustrated in a preliminary report of fragmentary data obtained by the determination of lead in the surrounding air, in the water of a river draining in the area, in the soil, and in local vegetation. A screening test (determination of the urinary excretion of delta-aminolevulinic acid) applied to groups in the population suggests that the absorption of lead by members of the groups may be hazardous. (Author abstract)

36354

Buxbaum, J.

**LEAD IN THE AIR.** Preprint, Scientists Committee for Public Information, Inc., New York, 10p., Sept. 1, 1970. 20 refs.

It is probable that the bulk of lead found in the air comes from the combustion of leaded gasoline, that the level of lead is related to the volume and speed of traffic, and that in some, but not all, communities, lead levels are increasing. About 80% of the lead burned is emitted from the exhaust as aerosol particles small enough to penetrate the depths of the respiratory passages. Recent studies suggest that lead may interact with other pollutants to render them more toxic, and that there may be no threshold for the molecular effects of lead in biologic systems; however, further research is necessary. Blood lead levels in humans seem to be closely related to their exposure to automobile exhausts. Interactions of lead in the atmosphere, plant and animal effects, and the effects of removing lead from gasoline on levels of other pollutants are briefly discussed.

36534

Needleman, Herbert L., Orhan C. Tuncay, and Irving M. Shapiro

**LEAD LEVELS IN DECIDUOUS TEETH OF URBAN AND SUBURBAN AMERICAN CHILDREN.** Nature (London), 235(5333):111-112, Jan. 14, 1972. 3 refs.

Lead levels in deciduous teeth from children in a Philadelphia ghetto and in 49 teeth from children in suburban areas were determined by atomic absorption spectrophotometry. The mean tooth lead for suburban children was 11.1 plus or minus 14.8 ppm versus a mean of 51.1 plus or minus 109.0 ppm for ghetto children. Eleven children in the suburban group had tooth lead levels of 2 ppm or less, and four had levels too low to be detected. No urban children had lead levels below 2 ppm, and one child had a level of 110 ppm. These findings may be due to differences in atmospheric lead in the city and suburbs. In areas where lead eating by children is frequent, tooth lead levels are elevated.

36551

Belknap, Elston L.

**CLINICAL STUDIES ON LEAD ABSORPTION IN THE HUMAN. III. BLOOD PRESSURE OBSERVATIONS.** J. Ind. Hyg. Toxicol., 18(7):380-390, Sep 1936. 7 refs.

Eighty-one human cases of heavy lead absorption were clinically observed for from one to five years with bi-weekly or monthly serial blood pressure readings made during the last twelve months. All median blood pressure readings were within normal limits for each age group. They tended to drop slightly below the initial reading when a sampling of the initial and final readings was compared. There was no significant trend toward increase in systolic or diastolic blood pressure in these workers, 58% of whom had five years, and 17% had 10-20 years of heavy lead absorption. These observations point the way to the necessity of even a longer time serial study of blood pressure. (Author conclusions modified)

36740

Benkoe, A.

**THE COMBINED ACTION OF NICOTINAMIDE AND OF CORTIGEN ON PORPHYRINURIA IN LEAD POISONING.** (Die gemeinsame Wirkung des Nikotinsaeureamids und Cortigens auf die Porphyrinurie bei Bleivergiftung). Text in German. Deut. Med. Wochenschr., vol. 68:271-272, March 13, 1942. 14 refs.

Experiments were conducted designed to demonstrate to what extent vitamins can influence porphyrinuria induced by lead poisoning. Vitamins A, C, B1, and D had no effect on porphyrinuria induced in rabbits by daily administration of five cg lead acetate. Similarly one ampule of Cortigen administered intramuscularly to rabbits fed lead acetate did not manifest any change in urine porphyrin elimination. The combined administration of Cortigen and of nicotinamide injections in contrast did result in a marked drop of porphyrin elimination level in all experimental animals and reached normal levels in 12-16 days. Cortigen aids in the interaction between nicotinic and phosphoric acid and thus promotes cozymase formation through the synergistic action of a vitamin and a hormone. A similar observation was made in the case of lactoflavin. The experiments have shown that the curative effect of nicotinamide on porphyrinuria can be reinforced by Cortigen especially where nicotinamide must first be phosphorylated as in toxic porphyrinuria.

36747

Zawirska, B. and K. Medras

**TUMORS AND DEFECTS OF PORPHYRIN METABOLISM IN RATS WITH CHRONIC EXPERIMENTAL LEAD POISONING.** (Tumoren und Stoerungen des Porphyrinstoffwechsels bei Ratten mit chronischer experimenteller Bleiintoxikation). Text in German. Zentralbl. Allg. Pathol. Pathol. Anat., 111(1):1-12, 1968. 33 refs.

Rats were fed over a period of two months with three mg, afterwards with four mg lead acetate a day, and changes induced were diagnosed by palpation, microfluoroscopy, and histological examination. Aside from benign and malignant tumors of the kidneys and other organs, tumors of endocrine glands (testes, adrenal gland, thyroid gland, hypophysis, prostate) were diagnosed. Kidney, lung, and testicular tumors were transplated. Female rats manifested a greater incidence of tumors, especially those of the adrenal gland. In male rats, testes were particularly affected: hyperplasia interstitialis testis was found in 57.4% of the male rats. The occurrence of multiple tumors, not previously reported, is attributed to the high level of lead acetate ingested and to the long duration of feeding (up to 18 months). The possible connection between porphyria and the hormonal discorrelation caused by lead poisoning is as yet unresolved. No spontaneous tumors were found in control rats not fed with lead acetate. Results of these experiments indicate the possibility of a toxic effect of chronic subclinical poisoning on humans exposed to the effects of lead.

36765

Calvery, Herbert O.

**CHRONIC EFFECTS OF INGESTED LEAD AND ARSENIC.** J. Am. Med. Assoc., 111(19):1722-1729, Nov. 5, 1938. 34 refs. (Presented at the American Medical Association, 89th Annual Session, Section on Pharmacology and Therapeutics, San Francisco, Calif., June 17, 1938.)

A literature review and an investigation of the chronic effects of ingested lead and arsenic was presented. One of the most extensive studies made was the determination of storage and distribution of lead and arsenic in the organs and tissues of the animals when fed basic diets of known composition and the same diets to which known amounts of these elements were added. The concentrations of these diets ranged from a fraction of a mg to several hundred mg/kg. There was definite storage of lead in all organs and tissues examined. The storage of arsenic was also shown, even at the lowest levels fed. There are species differences in susceptibility to the toxicity of these deleterious substances. Variation of the calcium content from a low level approximating that of a large percentage of the human dietary to a higher level markedly influences the storage and toxicity of lead and arsenic. Calcium arsenate was more toxic and caused greater storage than did arsenic trioxide at the same level. There was no difference observed in the toxicities of lead acetate and lead arsenate when fed at the same relatively low levels, but at high levels arsenate was more toxic. Studies proved, by chemical analysis of large numbers of newborn animals, that both lead and arsenic are transferred from the mother s tissues to the fetus. Also, lead is transferred in the milk. In all animals fed diets containing added lead there was a striking effect on the size of the kidney. The kidney is one of the first organs to show signs of injury as a result of lead in the diet. (Author conclusions modified)

36932

Bruin, A. de and H. Hoolboom

**EARLY SIGNS OF LEAD-EXPOSURE. A COMPARATIVE STUDY OF LABORATORY TESTS.** Brit. J. Ind. Med. (London), 24:203-212, 1967. 29 refs.

Previous work has shown that urinary lead, coproporphyrin, and delta-aminolevulinic acid are closely related after exposure to lead. The relationship has been confirmed in 50 automobile workers with different exposures. Porphobilinogen levels have also been estimated. There was some evidence that a raised delta-aminolevulinic acid level gave an earlier sign of lead absorption than a raised coproporphyrin level. Delta-aminolevulinic acid-dehydratase activity was greatly reduced by exposure, on the average to 20% of normal. This reduction in activity was strongly correlated with the increases in urinary lead, coproporphyrin, and delta-aminolevulinic acid. In addition, the serum aspartate aminotransferase and serum alanine aminotranferase levels were estimated and were not affected by exposure to lead. Serum protein patterns and hemoglobin levels were also unaffected. (Author abstract modified)

36934

Zook, B. C., J. L. Carpenter, and E. B. Leeds

**LEAD POISONING IN DOGS.** J. Am. Vet. Med. Assoc., 155(8)1329-1342, Oct. 15, 1969. 40 refs.

Lead poisoning was diagnosed and studied in 60 dogs. Lead poisoning is a common disease of young dogs, especially in the summer and fall, and is related to their chewing and eating habits resulting in the ingestion of paint, linoleum, or other lead-containing materials. The signs were characterized by gastrointestinal dysfunction and nervous disorders. Blood findings consisted of numerous stippled and immature erythrocytes in the absence of severe anemia. Protein and casts were frequently found in the urine. Radiography sometimes revealed lead-containing particles in the gastrointestinal tract, and lead lines were occasionally detected in the metaphysis of long bones in immature dogs. Treatment with calcium ethylenediaminetetraacetic acid resulted in rapid and often dramatic recoveries in nearly all instances. (Author summary modified)

36935

Roe, F. J. C., E. Boyland, C. E. Dukes, and B. C. V. Mitchley

**FAILURE OF TESTOSTERONE OR XANTHOPTERIN TO INFLUENCE THE INDUCTION OF RENAL NEOPLASMS BY *LEAD IN* RATS.** *Brit. J. Cancer* (London), vol. 19:860-866, 1965. 13 refs.

An investigation was undertaken to determine whether the administration of testosterone or of xanthopterin to rats would influence renal carcinogenesis by lead. Three groups of 24 male CB Wistar rats were injected with lead phosphate repeatedly over a period of 34 weeks. The first group received a total dose of 450 mg per rat; the second group, 145 mg per rat; and the third, 29 mg per rat. More than half the rats in the first two groups which survived for more than 200 days developed benign or malignant kidney tumors. No renal tumors developed in the third group. Repeated injections of testosterone propionate or xanthopterin failed to influence the induction of renal tumors by lead. Primary neoplasms of sites other than the kidney arose in approximately equal frequency in all groups. (Author summary modified)

36957

Feldman, Felix, Herbert C. Lichtman, Stanley Oransky, Eladia Sta Ana, Lloyd Reiser, and Charles J. Malemud

**SERUM DELTA-AMINOLEVULINIC ACID IN PLUMBISM.** J. Pediat., 74(6):917-923, June 1969. 12 refs.

Blood lead and serum delta-aminolevulinic acid levels were determined in groups of children with increased lead absorption, lead intoxication, and lead encephalopathy. Although blood lead values tended to be higher in children with intoxication, they tended to overlap those of patients with increased absorption but without intoxication. Serum delta-aminolevulinic acid was consistently higher in patients with overt toxicity, with almost no overlapping of values. Blood lead and

serum delta-aminolevulinic acid levels were both markedly elevated in patients with encephalopathy. Lead and delta-aminolevulinic acid values failed to correlate well. Cerebrospinal fluid delta-aminolevulinic acid values were consistently lower than serum values. Thus, serum delta-aminolevulinic determinations are valuable in selecting infants who are intoxicated from those exposed to increased amounts of lead. (Author abstract) 0

36964

Pentschew, Angel

**MORPHOLOGY AND MORPHOGENESIS OF LEAD ENCEPHALOPATHY.** Acta Neuropathol., 5(2):133-160, 1965. 47 refs.

Twenty infantile cases of lead encephalopathy stimulated a reappraisal of its morphology and morphogenesis in the light of current better comprehension of the principles regulating the blood flow in the brain and the recent progress of the biochemistry of lead poisoning. The underlying cause of lead encephalopathy is most probably a toxic disorder of porphyrin synthesis. It brings about a deficit of an unknown factor participating the energy metabolism. In contrast to the other encephalopathies, the hemodynamics of the brain is impeded in addition to dysoria. The reason is that in lead poisoning the integrative homeostatic system which encompasses the autoregulation of the cerebral hemodynamics and the ability of shunting blood from less vital areas to the brain is also affected. The metabolic hypoxidosis of the brain in ssturnism is tolerated until additional stresses upset the labile balance between energy supply and energy demand. The acute exacerbation is brought about by increase in the lead content of the serum, further damaging the precarious porphyrin metabolism, or by disorders of the systemic circulation that might otherwise be insignificant but amount to the effect of a temporary cardiac failure on the brain already in a state of allobiosis. Inflammatory changes ranging from perivascular cuffings to granuloma formation give the lead encephalopathy its special physiognomy. The brunt of the damage in lead encephalopathy is borne by the cerebellar cortex, more specifically by its molecular layer. (Author summary modified)

37023

Barltrop, D.

**LEAD POISONING IN CHILDHOOD.** Postgrad. Med. J. (London), vol. 44:537-548, July 1968. 36 refs.

Childhood plumbism has features that distinguish it from the adult disorder in etiology, presentation, and prognosis. Since the sequelae include death and cerebral damage, it is important that children exposed to lead be identified and those with evidence of poisoning be treated. The metabolism and toxicology of lead in children are discussed, as well as predisposing factors. Pica, seasonal incidence, and clinical features are mentioned. Sources of lead are indicated. The determination of lead in the blood, feces, and urine is described. The presence of abnormal amounts of soft tissue lead may be inferred from the demonstration of characteristic abnormalities of porphyrin metabolism. Increased excretion of delta-aminolevulinic acid and increased free erythrocyte protoporphyrin are mentioned. Various red cell abnormalities are also present, and the reabsorptive mechanisms of the renal tubular cells are impaired. Radiologic aids and lumbar puncture are noted. The three major objectives in management of lead poisoning are the prevention of further absorption, the removal of lead from the soft tissues, and the prevention of recurrence.

37028

Makotchenko, V. M.

**ON THE FUNCTIONAL CONDITION OF CORTEX OF ADRENAL GLANDS ON CHRONIC INTOXICATION BY HEAVY METALS (LEAD, MERCURY).** (Funktsional noye sostoyanie kory nadpochechnikov pri chronicheskikh otravleniyakh tyazhelymi metallauri (svinets, rtut). Text in Russian. Tr. Ukr. Inst. Eksp. Endokrinol., vol. 20:162-170, 1965. 20 refs.

The steroid function of adrenal glands was studied on a group of people with chronic occupational intoxication by lead and mercury. Various clinical symptoms are discussed. Chronic intoxication by heavy metals is accompanied by decreased functioning of the cortex adrenal glands and by decrease of their functional reserves. During mercury intoxication, the functional reserves are markedly decreased; in lead intoxication, the decrease in function of the adrenal glands is directly proportional to the period of contact with lead and the intensity of intoxication.

37040

Smith, Ralph G.

**HEALTH ASPECTS OF ATMOSPHERIC EXPOSURE TO LEAD.** Society of Automotive Engineers, Inc., New York, Med. Aspects Air Pollut., Detroit, Mich., 1971, p. 53-66. 21 refs. (Jan. 14, Paper 710302.)

An extensive survey of lead levels conducted in 1962 in Cincinnati, Philadelphia, and Los Angeles showed an annual average concentration of lead in the atmosphere ranging from about 2 micrograms/cu m air in the downtown and industrial area of Cincinnati, to about 1 in the outlying areas of that city. The values in corresponding areas in Philadelphia ranged from 3 to 1, and in Los Angeles from 3 to 2. Air levels of lead are directly proportional to the amount of traffic in the area where measurements are made. Physical and chemical characteristics of lead aerosol are described. The importance of dietary lead intake is discussed, as well as the body burden of lead. One study indicated that the median body burden of lead for the so-called standard man was 121 mg, with a value range from 10-435 mg. Blood and urine levels of lead are discussed as indices of lead intake and in relation to occupational plumbism. Methods of analysis of biological samples for lead are presented. Lead interferes with the normal process of maturing red cells, and the presence of immature forms of red cells, in particular so-called stippled or basophilic cells, has been used in the past as a diagnostic aid. Lead also interferes with the formation of certain substances which are the precursors of the heme in hemoglobin. The action of lead results in excessive production of coproporphyrin III, while lead also inhibits the enzyme which converts delta-aminolevulinic acid to porphobilinogen.

37119

Sayers, R. R., A. C. Fieldner, W. P. Yant, and B. G. H. Thomas

**EXPERIMENTAL STUDIES ON THE EFFECT OF ETHYL GASOLINE AND ITS COMBUSTION PRODUCTS.** Bureau of Mines, Washington D. C., 447p., 1927. 65 refs.

The problem of making a marketable anti-knock material was not solved until the discovery was made that tetraethyl lead, a liquid soluble in gasoline, effectively suppressed detonation or knock, when present to the extent of one part in 1270 of gasoline -- which is less than 0.08%. The only apparent drawback to the general use of this new anti-knock compound was the possible hazard to public health from the lead in the

gasoline and its combustion products. Lead poisoning in general is discussed. An investigation was undertaken to determine the physiological effect of inhaling air contaminated with automobile exhaust gases. Monkeys, dogs, rabbits, guinea pigs, and pigeons were exposed to ethyl gasoline exhaust gases. Storage of lead in the tissues, pathology, weight, hematology, and symptoms were considered. Several tests were also made on men. An investigation was also undertaken to determine the effect of ethyl gasoline when applied to the skin. Certain quantities of 1.0, 0.5, 0.25, and 0.1 cc of ethyl gasoline, gasoline, benzol gasoline blend, benzol, and benezene were applied to monkeys, a dog, rabbits, guinea pigs, and rats. Pathological, hematological, and weight and growth observations were made. Symptoms were also indicated. Unburned gasoline vapors were also inhaled by the test animals. Exposure and test methods are discussed.

37180

Weaver, Neill K.

**TOXICOLOGIC IMPLICATIONS OF MOTOR GASOLINE AND AUTO EMISSIONS.** Ind. Med., 40(9):31-34, Dec. 1971. (Presented at the American Petroleum Institute, Division of Refining, Midyear Meeting, 36th San Francisco, Calif., May 11-14, 1971.)

Of the pollutants found in urban air, gasoline and its combustion products contribute significantly to concentrations of carbon monoxide, hydrocarbons, oxides of nitrogen, and particulates, which are composed of lead and other trace elements and compounds. Since none of these contaminants, under ordinary circumstances, reach levels in ambient air which are acutely toxic, concern rests with their possible subacute or chronic effects at relatively low level, long term exposures. The carbon monoxide standard recommended by the American Petroleum Institute is 30 ppm (8-hour maximum); exposure to 30 ppm of CO for 8 hr results in a carboxyhemoglobin level of 5%, a level which is regularly exceeded in cigarette smokers. The standard for nitrogen oxides recommended by API is 0.25 ppm (24- hour maximum), as compared to 0.13 ppm recommended by the Environmental Protection Agency. It is the belief of many experts in the petroleum industry that the need for ambient standards for hydrocarbons and lead compounds has not been demonstrated at the present time. Levels of acute, subacute, and chronic toxicity are also indicated for these compounds, as well as Threshold Limit Values. (Author abstract modified)

37229

Kettner H. and A. Hampel

**POLLUTANTS IN THE AIR AND THEIR EFFECT ON THE HUMAN ORGANISM.** (Schadstoffe in der Luft und ihre Einwirkungen auf den menschlichen Organismus). Text in German. Wasser Luft Betrieb, 15(12):441, Dec. 1971.

Exposure of the human organism to lead concentrations of 1 microgram/cu m air causes, in the long run, an increased discharge of coproporphyrin, i.e., in effect a disturbance of the metabolism. A similar effect is achieved by a carbon monoxide concentration of 2 mg/cu m. Concentrations of Pb and CO of the above magnitude are found in the atmosphere more than 50% of the time. The present methods of ventilation of homes and offices are ineffective, so such concentrations are also found indoors. The Institute of Climatology is presently conducting measurements, which are at the moment limited to sulfur dioxide, CO, Pb, aerosols, and aldehydes, for determination of the pollutant concentrations in the air which begin to affect the well being of man.

37297

Beritic, T.

**LEAD CONCENTRATION FOUND IN HUMAN BLOOD IN ASSOCIATION WITH LEAD COLIC.** Arch. Environ. Health, vol. 23:289-291, Oct. 1971. 1 ref (Presented at the Conference of Inorganic Lead, Amsterdam, Netherlands, Nov. 29, 1968.)

As determined by a modified dithizone method, blood lead levels in 13 of 64 patients with lead colic (abdominal) ranged from somewhat less than 40 micrograms/100 ml to just under 80 micrograms/100 ml of whole blood. In 51 of the 64 patients, lead concentrations in blood extended from 80 micrograms/100 ml to over 260 micrograms/100 ml. The fact that all concentrations were relatively low suggests that blood lead levels are not indicative of the existence of lead intoxication. Symptoms of intoxication may be presenin association with lead concentrations below any recognized threshold value, and may be absent when concentrations exceed those known to be potentially dangerous.

37420

Patterson, K.

**CONTAMINATION OF THE ENVIRONMENT WITH LEAD.** (Zagryaznenie vneshney sredy svintsom). Text in Russian. Gigiena i Sanit., 36(11):89-94, Nov. 1971. 16 refs.

Historic and recent problems of environmental contamination with industrial lead as well as criticism of the way related issues are handled in the U. S. are outlined. About 95% of the lead entering the organism with food is discharged with feces, and 40% of the lead inhaled can be detected in the blood. In highly industrialized countries, foodstuffs contain about 0.2 ppm of lead. Increasing contamination of the biosphere can be observe.' The world s lead production amounted to 3,500,000 tons in 1966, and a total of 430,000 tons are discharged into the seas yearly. The geochemical balance of several areas is disturbed by massive lead contaminations. Lead concentrations 100 times the normal value were measured over the Pacific, and levels 10,000 times the normal value were found in city air. Arctic snow contains lead 500 times the normal content. Increased lead content was revealed in soils, too. A total of 310,000 tons of lead was consumed by the chemical industry and as fuel additive in 1966. Americans incorporate, on a daily average, 350 and 20-50 micrograms of lead with food and water, and from air respectively. Their bodies contain about 200 mg of lead, with an average concentration of 0.25 ppm in the blood. Norms for lead contamination should be based on lead concentrations in blood. The natural lead level of the blood lies at 0.01 ppm, 0.8 ppm representing classic lead poisoning. After a long-lasting fight between health care and business interests, the medical aspects are becoming more important in the U.S.A.

37540

Milic, S., M. Stankovic, and Vera Delic

**EFFECT OF LOW LEAD EXPOSURE ON THE LEVEL OF DELTA-AMINOLEVULINIC ACID DEHYDRATASE ACTIVITY.** Arhiv Hig. Rada Toksikol (Yugoslavia) 21(3):241-246, 1970. 18 refs.

Urinary lead, coproporphyrin (CP), and delta-aminolevulinic acid (ALA) levels were measured in 99 typographers with slight exposure to lead. Parallel blood ALA-dehydratase (ALA-D) activity measurements were taken. A statistically significant difference (t equals 3.77; P less than 0.001) in ALA-D activity was obtained between the 99 exposed workers and 33 control subjects. The mean value of enzyme activity in the exposed group was 77% of that of the control group. About 60% of the lead workers had ALA-D activity below 80 units/ml of

RBC. In spite of the marked reduction of enzyme activity, mean urinary lead, ALA, and CP values for the exposed group were within normal limits. As a test for lead exposure, ALA-D activity determination may be too sensitive for use in industrial medicine, especially in control of workers with evident lead exposure.

37630

Barry, Patrick Stephen Ian

**LEAD IN THE AMBIENT ENVIRONMENT: A REVIEW OF HEALTH EFFECTS.** (Olovo u covjekovoj okolini. Pregled utjecaja na zdravlje). Text in Serbo Croatian. Nafta (Zagreb), 22(2):97-101, Feb. 1971. 50 refs. (Presented at the Znanstuenog savjeta za naftu pri JAZU, Panel Discussion, Zagreb, Yugoslavia, March 22, 1970.)

A literature review was undertaken to evaluate the effect of environmental lead on health and to determine the contribution of automobile exhausts to the total lead in the environment. Based on the many studies conducted in different parts of the world over the last 40 years, the presnet daily intake of lead in the general population has not increased, nor is lead from automobile exhausts significant with respect to health.

37685

Pott, F. and A. Brockhaus

**COMPARISON OF THE ENTERAL AND PULMONARY ABSORPTION RATES OF LEAD COMPOUNDS.** (Vergleich der enteralen und pulmonalen Resorptionsquote von bleiverbindungen). Text in German. Zentralbl. Bakteriol., Parasitenk. Infektionskr. Hyg.: Abt. 1: Orig., Reihe B, vol. 155:1-17, 1971. 16 refs.

The rates of enteral and pulmonary absorption of lead were examined in rats. Two lead compounds of different solubility (lead bromide and lead oxide) were administered orally or intratracheally at various dosages. Corresponding groups of animals received the lead intravenously to obtain models of a 100% rate of absorption. The content of lead in the femora, which was relatively constant at 6.8% was regarded as representative of the entire bone tissue. Following intratracheal injection of lead, the same amounts of lead were collected in the femoral bone tissue as following intravenous injection. Following oral administration, however, no more than 5% was determined. The content of lead in the air, therefore, is biologically more important than lead in food.

37722

Fukuda, Masao, Kazuyuki Akiyama, Hiroshi Seki, Hiroko Maeda, Hiroshi Yagyu, and Gen Oui

**PRESENT SITUATION OF LEAD POLLUTION EXHIBITED IN PIGEONS. PRELIMINARY EXPERIMENT).** (Hato ni arawaretaru namari osen no genkyo. (Yobi jikken). Text in Japanese. Tokyo-to Eisei-kyoku Gakkai-shi (Rept. Tokyo Public Health Studies) no. 48:22-23, Nov. 1971.

The degree of pollution in the center and suburban part of Tokyo was determined by measurement of lead in pigeons blood and the content of theta-aminolevulinic acid anhydrase (theta-ALAD) in organs. The estimation of the activity of ALA anhydrase was conducted within 20 hr after 1 ml of blood was taken from the pigeon. After taking out the thigh bones of both legs and kidneys and conducting a wet-type calcination, the estimation of lead in the organs was carried out by dithizone atomic absorption spectrometry. The activity of ALA anhydrase contained in pigeons blood tended to decrease as the lead content increased in each organ. When the situation in the urban area and the suburban part of Tokyo were compared, the difference in the lead content in organs was ten-fold on the average. In the amount of lead and of the activity of ALA anhydrase, fluctuations were evident. The pigeon can be a significant biological index of lead pollution.

37731

Dequidt, J., D. Vaast, and A. Lespagnol

**SATURNISM HAZARDS IN LEAD PROCESSING PLANT AREAS.** (Risques d impregnation saturnine au voisinage d usines de traitement du plomb). Text in French. Pollut. Atmos. (Paris), 13(52):289-292, Oct.-Dec. 1971. 7 refs.

Systematic urine tests were performed on 12-14-year-old childen living in a lead processing plant area. In a control group of 24 children living for at least 2 yrs in areas not affected by lead pollution, the average urine coproporphyrin and delta-aminolevulinic acid content were 79 micrograms/l (25-225 micrograms/l), and 1.786 mg/l (0.8-2.8 mg/l). For the children exposed to atmospheric lead pollution, the respective values were 11 times and 2.5 times higher. The relative frequencies for the amino-levulinic acid and coproporphyrin values can be regarded as significant. Though the values found were far below those characteristic of saturnism, severe poisonings are potentially due to the cumulative effect of lead poisoning.

37788

Blokker, P. C.

**A LITERATURE SURVEY ON SOME HEALTH ASPECTS OF LEAD EMISSIONS FROM GASOLINE ENGINES.** Atmos. Environ., 6(1):1-18, Jan. 1972. 64 ref

Literature on the health aspects of lead emissions from gasoline engines is surveyed. Data on the amount and concentrations of lead in the atmosphere, the influence of atmospheric lead on the lead content of food and drinking water, and the influence of lead alkyls on the hydrocarbon, carbon monoxide, and nitrogen oxide emissions from gasoline engines are reviewed. With regard to health aspects, absorption and excretion of lead, the lead content in the human body in toto, in blood, and in urine, studies on lead burdens in selected population groups, animal studies, and an assessment of general and specific health hazards are examined. Current fields of research in this area are discussed.

37933

Lehnert, G.

**LEAD CONTAMINATION BY AUTOMOBILE EXHAUSTS? (Bleivergiftung durch Autoabgase). Text in German. Deut. Med. Wochschr., 97(11):439- 440, March, 1972.**

Are lead additives to the fuel of automobiles dangerous to health at the present traffic density? According to a series of studies in Europe and the U. S., it must be assumed that at least during longer exposure at traffic intersections the intermediary metabolism is affected. The quantity of incorporated lead can be determined in the blood (not in the serum). The blood sample must be taken from the veins by a one-way plastic needle and mailed in a polyethylene container to an Institute concerned with occupational medicine. A measure for the lead contamination of the body can be obtained by examining the delta-aminolevulinic acid discharge in the urea. Long before clinical symptoms, appear the elimination rate of this substance is markedly higher.

37941

Tsuchiya, Kenzaburo

**EFFECT OF LEAD IN AIR ON HUMAN BODIES. (INTERIM REPORT).** (Taiki chu namari no jintai ni taisuru eikyo. (Chukan hokoku)). Text in Japanese. Kankyo Hoken Reporto (Environ. Health Rept.), no 5:45-46, Oct. 1971.

Since July 1970, lead content in urine and hair, delta aminolevulinic acid in urine, and coproporphyrin has been estimated in 60 children of an urban elementary school. The effect of lead (average 2-3 micrograms/cu m) in air appears as a fluctuation in the measured value. The delta aminolevulinic acid level in urine tends to become high in winter and coproporphyrin also becomes high during January through March. But a significant difference from control group was not found. The average value of coproporphyrin in the control group was higher, but a significant difference was not seen. Data of lead content in urine and hair is now being prepared for publication. As seen from the enzymatic disturbance of heme synthesis by lead, it is difficult to say that children in urban districts are affected by lead in air.

37942

Ministry of Health and Welfare (Japan), Dept. of Environmental Pollution Control

**REPORT ON THE RESULT OF EXAMINATION OF INFLUENCE OF AUTOMOBILE EXHAUST GAS ON HUMAN BODIES.** (Jidosha haiki gasu jintai eikyo chosa kekka hokoku). Text in Japanese. 93p., Feb. 1966.

The Ohara intersection that has heavy traffic was chosen as a polluted area and the vicinity of National Hygienic Research Institute was chosen as an unpolluted area. An examination of both the environment and the influence on human bodies was made. Carbon monoxide was detected only in the polluted area; the hourly average was 4.1 ppm and the value fluctuated between 0.5 - 22 ppm, according to the number of automobiles that went by. The momentary value at the center of the intersection averaged 55 ppm and its maximum value reached as high as 110 ppm. Nitrogen dioxide was detected only in the polluted area; the average value was 0.02 ppm and the maximum value was 0.06 ppm. Nitric oxide was detected in both areas; the average in the polluted area was 0.05 ppm, the maximum was 0.074 ppm, the average in the unpolluted area was 0.03 ppm, and the maximum was 0.30 ppm. Floating dust (222 g/cu m) and 4.8 g/cu m of lead were detected in the polluted area, on the hand, the amount of floating dust was 459 g/cu m in the unpolluted area. Sulfur dioxide averaged 0.005 ppm in the polluted area, and the average during the daytime was 0.14 ppm at the center of the intersection. The average of hydrocarbons was 0.66 ppm around the streets, and 0.16 ppm at some distance from the streets in the polluted area; it was 0.05 ppm in the unpolluted area. The subjects of the medical examination were only general inhabitants in the unpolluted area, not only general inhabitants, but also policemen and students were included in the subjects in the polluted area. And as a rule, people who had never smoked were chosen. As a result, during the respiratory function test, no definite trends were observed in either areas. During the blood test, no abnormality was observed in the amount of total hemoglobin in both areas; methemoglobin was not detected. About 4.27% of the carboxyhemoglobin was detected from the inhabitants of polluted area and 2.79% from those of the unpolluted area. The amount of carboxyhemoglobin detected from policemen and students averaged 2.62% before work and 3.75% half a day later. The amount of CO-hemoglobin rose more than 5% when CO concentration rose more than hourly average of 10 ppm. At the interview examination, unpleasant experiences, mental injuries, troubles of digestive organs, and eye irritation were very notable in the polluted area. More detailed data are shown in a separate volume.

37964

Haas, Th., A. G. Wieck, K. H. Schaller, K. Mache, and H. Valentin

**THE USUAL LEAD LOAD IN NEW-BORN INFANTS AND THEIR MOTHERS.** (Die usuelle Bleibelastung bei Neugeborenen und ihren Muettern). Text in German. Zentralbl. Bakteriol., Parasitenk. Infektionskr. Hyg.: Abt. 1: Orig., Reihe B, 155(4):341-349, 1972. 30 refs.

The primary source of lead in the atmosphere is automobile exhaust. The lead compounds in the exhaust gases not only contribute to pollution but also pollute vegetation; humans, therefore, both inhale and ingest lead. Lead intake by humans starts in prenatal life. The blood lead level and the excretion of delta-aminovulinic acid in the urine were determined in 294 new-born infants and their mothers. In all cases, lead was found in the blood of the infants, with the average level at 14.98 + or - 7.89 micrograms %. This was significantly below the average level determined in the blood of the mothers (16.89 + or - 8.57 micrograms %). Statistically, the lead concentration in the infants depended on the lead level in the blood of the mothers. The average delta-aminolevulinic acid excretion of infants was 1.9 + or - 1.4 mg/l or 4.6 + or - 4.9 mg/g creatinine. A dependence of the acid excretion on the blood lead level of infants could be proved statistically. The average delta-aminolevulinic acid excretion of the women under examination was 5.1 + or - 3.1 mg/l (4.3 + or - mg/g creatinine), or about double the amount excreted by adults of both sexes who are not occupationally exposed to lead. The most likely reason for this was an iron deficiency at the end of pregnancy.

38579

Barry, Patrick Stephen Ian

**LEAD IN THE AMBIENT ENVIRONMENT: A REVIEW OF HEALTH EFFECTS.** (Olovo u covjekovoj okolini. Pregled utjecaja na zdravlje). Text in Serbo-Croatian. Nafta (Zagreb), 22(2):97-101, Feb. 1971. 50 refs.

This is a compilation of information regarding the contribution of automobile exhaust gases to the lead concentration in the ambient air and lead s effects on health. Lead metabolism in man in health and disease, lead in city atmospheres, enzyme inhibition by lead under normal urban conditions, lead in food, plumbism in children and workers, and lead in human bones, blood, and urine are discussed. The adverse effects of lead present in the atmosphere on health claimed by some of the investigators have not been confirmed by any evidence. On the basis of many studies undertaken throughout the world during the past 40 yrs, the daily intake of lead from all sources by the entire population is not higher than it was in the past and lead emitted in automobile exhaust gases has an insignificant effect on man s health.

38580

Yoshikawa, Hiroshi

**METALS AND LIVING BODY.** (Kinzoku to seitai). Text in Japanese. Kogai Taisaku to Gyosei (Environ. Pollut. Countermeasure and Adm.), 3(7):4-26, July, 1971.

A review of the metal content in the normal human body and the environmental pollution by various metals are presented. Lead and cadmium are discussed as main sources of metal pollution, and other causes of occupational hazards such as

mercury, arsenic, nickel, chromium, manganese, beryllium, cobalt, tin, vanadium, and zinc are reviewed briefly. The toxic reactions and maximum permissible concentrations of various metal compounds are presented in a table. The atmosphere of Tokyo contains 1-5 micrograms of lead as compared to 1-2.5 micrograms in average American cities. The cadmium content in the air of Japanese cities runs from 0.01-1 micrograms/cu m, approximately the same as that of England. Cadmium is heavily contained in cigarettes. According to a published material, a normal person s daily intake of cadmium through the air is 0.24 micrograms, 12 micrograms/from 20 cigarettes, 80 micrograms through food, and 2 micrograms through water. But the absorption rates through the air and cigarettes are 30% respectively, whereas only 5% of intake through food and water are absorbed. According to this calculation, the total daily intake of cadmium by a normal person is 7.78 micrograms. A significant correlation exists between the cadmium concentration in the air and the hardening of arteries and all the heart diseases except for those caused by high blood pressure and rheumatism.

38616

Barnea, Matei and Pascu Ursu

**NOXIOUS EFFECTS OF AIR POLLUTION.** (Efectele Nocive ale impurificarii aerului). Text in Romanian. In: Protectia atmosferei impotriva impurificarii cu pulberi si gaze. Bucharest, Romania, Editura Technica, 1969, Chapt. 7-9, p. 130-183.

The mechanism of interaction between air pollutants and the respiratory tract is analyzed. Aerosols are categorized into toxic and nontoxic species and the indirect damaging of the latter as carriers for toxic substances is pointed out. The action of lead, fluorine, arsenic, beryllium, Manganese, and carcinogenic compounds is reviewed among the toxic aerosols. Included are discussions on the action of carbon monoxide, sulfur dioxide, nitrogen oxides, chlorine, hydrogen sulfide, and oxidant gases on the animal and plant organism. Reference is made to air pollution dwelling in metropolitan areas such as London, Los Angeles, or New York. Data illustrating morbidity and mortality due to chronic exposure to polluted environments are included. Discussions on economic damage from air pollution due to construction and other material deterioration are presented. The effect of air pollution on meteorology and solar radiation is also discussed.

38721

Corn, Morton

**DOSE TO THE RESPIRATORY TRACT FROM PERSONAL, OCCUPATIONAL AND COMMUNITY AIR POLLUTANTS.** Environ. Letters, 1(1):29-39, Jan. 1971. 8 refs. (Presented at the Pennsylvania Tuberculosis and Health Society, Annual Meeting, 78th, Pittsburgh, Pa., April 29, 1970.)

The doses (concentration-time) to the respiratory tract by urban, occupational and personal pollutants were calculated by assuming the pollutant concentrations in air equivalent to air quality standards, threshold limit values, and reported cigarette smoke concentrations, respectively. Urban pollution includes carbon monoxide, nitrogen oxides, lead, hydrocarbons, smoke, ash, sulfur dioxide, sulfuric acid, fluorine, beryllium, cadmium oxides, zinc oxides, pollens, allergens, and particulate matter from automotive, domestic, industrial, and natural sources; occupational pollution consists of dusts, fumes, gases, organic dusts, and radioactive particles within industries. The most severe challenge by a large margin was that posed to the pack-a-day cigarette smoker. Assumptions and results of calculations are presented. (Author abstract modified)

38867

Saito, Kazuo, Hiroko Inai, and Eimatsu Takakuwa

**STUDIES ON GASOLINE INTOXICATION. PART 1. ELECTROENCEPHALOGRAPHICAL CHANGES AND LEAD CONTENT IN ORGANS OF RATS ADMINISTERED LEAD-FREE AND LEAD CONTAINING BRANDS OF GASOLINE.** (Gasorin no dokusei ni kansuru kenkyu. Daiippo. Shihan muen oyobi kaen gasorin toyo ratto no nohagakuteki henka narabi ni zokichu enryo). Text in Japanese. Sangyo Igaku (Jap. J. Ind. Health), 14(1):9-20, Jan. 1972. 48 refs.

The effects of lead in gasolines in the central nervous systems in relation to the amount of lead in the organs were investigated in rats implanted with electrodes to record electroencephalographic changes. Three groups of rats were injected with 1 ml/100 g body weight of nonleaded gasoline, leaded regular gasoline, and leaded high-octane gasoline. Tetraethyl lead contents were 0.0, 0.15, and 1.41 ml/l, respectively, corresponding to the amount of tetraethyl lead in rats/kg body weight, i.e., 0.0, 2.5, and 23.3 mg. Lead content of the brain, heart, lung, liver, kidney, and blood was also determined. The increase in death rate was directly proportional to the amount of tetraethyl lead in the gasolines. Before gasoline injection, the EEG from the surface of the cortex was dominant in the theta wave and had a greater amplitude than that of other electrodes. In acute poisoning at the first to third day after injection of the leaded high-octane gasoline, the beta wave was dominant. The rats also exhibited symptoms of ataxia, drowsiness, dullness, nystagmus, convulsions of extremities, and lowering of body temperature. On the second day after injection, theta wave was less marked and beta wave was more dominant in the order of nonleaded gasoline, regular lead gasoline, and leaded high-octane gasoline. The amount of lead in the organs 10 days after injection did not differ with respect to distribution in the nonleaded gasoline group; values ranged within 0.35-0.54 gamma/g. In the groups injected with leaded gasolines, the content of lead was greatest in the liver, with values of 7.32 + or - 0.42 gamma/g in the leaded regular gasoline group and 7.44 + or - 1.86 gamma/g in the leaded high-octane gasoline group; respective lead content in the brain was 1.18 + or - 0.09 and 1.26 + or - 0.34 gamma/g. In general, the changes in EEG and average auditory evoked response were parallel with the level of poisoning.

38869

Antweiler, H. and F. Pott

**RESULTS OF ANIMAL EXPERIMENTS ON THE EFFECT OF AIR CONTAMINATION WITH PARTICLES AND GASES.** (Tierexperimentelle Ergebnisse ueber die Wirkung partikel- und gasfoermiger Luftverunreinigungen). Text in German. Zentralbl. Bakteriol., Parasitenk. Infektionskr. Hyg.: Abt. 1: Orig., Reihe B, 155(3):263-271, 1971. 30 refs. (Presented at the Anlass der Bad Godesberger Hygienetagung, 1971.)

Animal experiments with sulfur dioxide, polycyclic aromatic hydrocarbons, and lead are reviewed. Numerous experiments with guinea pigs, which are most sensitive to SO2, revealed that exposure to SO2 concentrations of less than 52 mg/cu m has no acute toxic effect. However, man is five to ten times more sensitive toward SO2 than guinea pigs. Long-term exposure (up to 12 mo) to concentrations of up to 15 mg/sq m caused no chronic or cumulative effect with respect to respiratory function and blood. Body weight, growth rate, and life span were not influenced. Other experiments with guinea pigs revealed that the toxicity of SO2 could be greatly enhanced by combination with soluble particulate matter, which by itself was harmless. Such substances include certain manganese, iron and vanadium salts which may catalyze the oxidation of SO2 to sulfuric acid. It is quite difficult to simulate air pollu-

tion conditions for the determination of the effect of carcinogenic pollutants on animals. The best test in this respect, namely the exposure of laboratory animals in city areas with high pollution, could not to be carried out because it is too expensive. The predominant tool for testing the carcinogenic effect of air pollutants is presently the inhalation chamber. Rats exposed in such a chamber to benzo(a)pyrene aerosol over a period of 2 yrs developed lung carcinoma at a rate of two out of 21. Animal experiments with lead have revealed that 100% of the lead retained in the lung is resorbed, while only 5% of the lead ingested with the food is resorbed. Experiments with mice in a chamber into which automobile exhaust gases were blown revealed that at an average lead concentration of 2.6 micrograms/cu m a clearly increased lead deposition in the bone took place. In sheep, the lead stored in bones could be mobilized by antibiotics which lead to a sudden increase of the lead table in the blood. The few examples of animal experiments stress the importance of such tests parallel to epidemiological studies.

39095

Hankin, Lester

**LEAD POISONING - A DISEASE OF OUR TIME.** J. Milk Food Technol., 35(2):86-97, Feb. 1972. 128 refs.

The lead poisoning problem among children is examined in detail with respect to the biochemical aspects, sources of lead contamination, body burden of lead, testing, and treatment. The outward signs of lead poisoning range listlessness and abdominal pain to vomiting to mental retardation. The sources of lead contamination include air pollution, i.e., lead emissions attributed primarily to automobile exhaust fumes; natural emissions of silicate dusts, volcanic halogen aerosols, forest fire smoke, aerosol sea salts, and meteoritic smoke; food contaminated by lead fallout on crops and pasture, accidental uptake by animals, and uptake by plants from soil and from effluents used in irrigation materials; growing crops contaminated by automotive exhausts; dust fallout from mining operations, and sewage sludge application to soils; water poisoned by natural contamination, fallout from auto and industrial pollution, and lead piping; containers containing lead in their makeup; soils; and paints containing lead and ingested by children. Some laboratory criteria for the diagnosis of lead poisoning are lead content in blood, x-rays of gastrointestinal tracts or bones, elevated urine level, basophilic stippling of red blood cells, and determination of delta-aminolevulinic acid in urine. Once diagnosed, the victims of lead poisoning may be treated by chelation therapy.

39161

Schuetze, Christian

**TWENTY-FOUR POINTS FOR ENVIRONMENT CONSCIOUS BEHAVIOR.** (24 Punkte fuer umweltbewusstes Verhalten. Text in German. Umwelt (Duesseldorf), 2(2):36-37, April 1972.

Some methods to control environmental damages are outlined. With respect to the effects of pollution on human health, harmful effects are caused by any kind of sprays, since the sprayed particles are so small that they penetrate through the filter of the human respiratory system. Plastic waste should not be burned because toxic gases form during combustion. When filling the tanks of cars, care must to taken to avoid benzene spills since tetraethyl lead vapors are dangerous and may cause skin damages. The carburetor of the car should be adjusted that the benzene percentage in the benzene-air mixture is smaller than the percentage of air in order to reduce the concentration of unburned hydrocarbons in the exhaust gas.

39179

Hammer, Douglas I., John F. Finklea, Russell H. Hendricks, Thomas A. Hinners, Wilson B. Riggan, and Carl M. Shy

**TRACE METALS IN HUMAN HAIR AS A SIMPLE EPIDEMIOLOGIC MONITOR OF ENVIRONMENTAL EXPOSURE.** Preprint, Missouri Univ., Columbia, 22p., 1972. 29 refs. (Presented at the Conference on Trace Substances in Environmental Health, Annual, 5th, Columbia, Mo., June 29-July 1, 1971.)

Scalp hair metal levels were previously shown to reflect environmental exposure gradients for arsenic (As), cadmium (Cd), and lead (Pb) in non-occupationally exposed schoolboys. Four problems were studied to explore further the epidemiologic utility of hair as a practical monitoring tool. First, a simple mathematical model was constructed to consider explicitly the multiple determinants of a measured hair trace metal level. Second, pre-analysis hair wash procedures suggested that detergent, alcohol, and distilled water, but not EDTA, wash rinses were sufficient. Third, hair trace metal levels of As, Cd, copper, Pb, and zinc were found to be temporarily consistent within individuals and over the exposure gradient. Fourth, hair and blood Pb levels correlated well (r equals 0.46), indicating that hair Pb reflects endogenous Pb absorption in addition to any exogenous deposition. Current human environmental Pb exposure is a function of fallout as well as airborne Pb. Increased Pb absorption most probably occurs by both respiratory and gastrointestinal routes. Future epidemiologic studies can no longer neglect dust fall metals when estimating environmental exposure. (Author abstract modified)

39193

Sayers, R. R., A. C. Fieldner, W. P. Yant, B. G. H. Thomas, and W. J. McConnell

**EXHAUST GASES FROM ENGINES USING ETHYL GASOLINE.** Bureau of Mines, Washington, D. C. and Bureau of Mines, Pittsburgh, Pa., Pittsburgh Experiment Station, Rept. 2661, 24p., Dec. 1924. 13 refs.

Various types of animals (rabbits, guinea pigs, pigeons, dogs, and monkeys) were exposed for 3-6 hr/day for up to 8 mo to definite concentrations of exhaust gas from an engine using ethyl gasoline. Blood and weight data are given for the exposed animals along with autopsy findings. No objective symptoms of plumbism were noted, and lead tissue accumulations, as determined in 25 autopsies, were insignificant. For all but two animals the value was on the order of 0.003 mg. With the exception of animals dying from causes ascertained to be other than due to lead, all remained normal as to activity, growth, appetite, and general health. Those that died had normal appetites and were active to within a couple of days before death, which is not in accordance with lead poisoning. The non-occurrence of lead poisoning was further substantiated by the small quantity of lead present in the exhaust gas-air mixture, together with observations on men that 75% of lead from exhaust is exhaled when inhaled.

39406

Lob, M. and P. Desbaumes

**STUDY OF PLUMBISM AND OF PLUMBURIA IN TWO GROUPS OF CONFINED INDIVIDUALS, ONE IN THE COUNTRY, THE OTHER IN THE IMMEDIATE VICINITY OF A HIGHWAY TRAVELED BY AUTOMOBILES.** (Etude de la plombemie et de la plomburie chez deux groupes de detenus, les uns internes a la campagne, les autres a proximite immediate d une autoroute). Text in French. Bull. Eidgenoess. Gesundheitsamtes, Beilage B, no. 3:84-85, March 1971. 10 refs.

The lead content in the blood and urine of adult individuals confined to institutions of open country and in the immediate vicinity of a highway was compared. The rural group consisted of 43 individuals aged 19-79, half of them alcoholics, the other half delinquents. The group near a highway consisted of 35 individuals, aged 35-76, mostly alcoholics. The duration of internment was 16 months for the first group, 15 months for the second. The rural group was on a diet including vegetables grown in the institutional garden containing between 4 and 20 ppm lead. While no significant differences were found in the blood lead content of the two groups, the urine of the rural group contained 35.5 micrograms Pb/l, the highway group had 28.8 micrograms/l. The difference between the two findings is highly significant.

39503

Pentschew, A. and H. Kassowitz

**COMPARATIVE INVESTIGATIONS ON THE EFFECTS OF VARIOUS METALLIC SALTS ON THE CENTRAL NERVOUS SYSTEM OF RABBITS.** (Vergleichende Untersuchungen ueber die Wirkung verschiedener Metallsalze auf das Zentralnervensystem von Kaninchen). Arch. Exp. Pathol Pharmakol., vol. 163:667-684, 1932. 16 refs. Translated from German. 31p.

A total of 29 water-soluble metallic salts were given by suboccipital injection to rabbits in order to compare the toxicity of these metals with the effect of lead on the central nervous system. Effects of the injections and the minimum lethal doses are indicated.

39621

Pecora, L., A. Silvestroni, and A. Brancaccio

**RELATIONS BETWEEN THE PORPHYRIN METABOLISM AND THE NICOTINIC ACID METABOLISM IN SATURNINE POISONING.** Panminerva Med., vol. 8:284-288, 1966. 6 refs.

Relations between porphyrin and nicotinic acid metabolism in lead poisoning were studied in experiments with three groups of six rabbits each. The first group was poisoned with 20 cg of lead acetate/day; the second group, poisoned as the first one, was treated from the first day onwards with 30 mg of nicotinic acid; the third group was dosed with nicotinic acid after the 15th day of poisoning. Urinary lead, erythrocyte free protoporphyrin, urinary coproporphyrin, aminolevulinic acid, and porphobilinogen in the urine, as well as nicotinic acid in the blood and urine, and xantheremic acid in the urine, were observed in all the animals. The inhibitory effect of lead on nicotinic acid formation was confirmed. Lead blocks the pathways from tryptophan to nicotinic acid and causes a considerable decrease in the nicotinic acid content in the blood as well as in the urinary elimination. Consequently the synthesis of pyridine coenzymes is inhibited. At the same time, the urinary elimination of xanthurenic acid increases considerably. This phenomenon is presumably due to a blockade of vitamin B6, which acts on the pathway from 3-oxykynurenine to 3-oxyanthranilic acid from where it arrives to the nicotinic acid through the quinolinic acid. The nicotinic acid is able not only to limit the urinary coproporphyrin elimination but also to inhibit the increase of erythrocyte free protoporphyrin, amino levulinic acid, and porphobilinogen. The fact that the nicotinic acid tends to normalize the disturbance of the porphyrinic metabolism, leads to the assumption that in saturnism it is, at least partially, a consequence of the action the lead has on the nicotinic acid, directly or indirectly through vitamin B6 inhibition, yielding a decrease of the pyridinic coenzyme synthesis. (Author conclusions modified)

39826

Sulzberger, Marion B.

**SKIN EFFECTS OF AIR POLLUTANTS.** Interdepartmental Committee on Air Pollution, Washington, D. C., Air Pollut., Proc. U. S. Tech. Conf., Washington, D. C., 1950, p. 462-467. 1 ref. (May 3-5, Louis C. McCabe, ed.)

Substances which can possibly produce systemic poisoning via skin penetration are listed, and include aromatic amines and nitro compounds, arsenic, lead (organic compounds), mercury, phenol, and vesicant war gases. In most instances, the concentrations and amounts of such substances suspended or dissolved in the air are of such relatively low magnitude that acute systemic poisoning from the air via the skin is not produced. However constant and repeated exposures to certain dusts and suspended particles can produce a variety of skin diseases, including blackheads, keratoses, precancers and cancers, urticarial eruptions from allergenic dusts, dermatitis, and infections.

39833

Dunning, James M.

**EFFECTS ON ORAL STRUCTURES FROM AIR POLLUTION.** Interdepartmental Committee on Air Pollution, Washington, D. C., Air Pollut., Proc. U. S. Tech. Conf., Washington, D. C., 1950, p. 503-506. (May 3-5, Louis C. McCabe, ed.)

Forty-two etiologic agents have been recorded as producing effects on oral structures, 18 of these agents are dusts and 12 are gases. Some of the agents cause physical damage such as staining or abrasion of the teeth, including copper, nickel, iron, chromium, coal dust, bone, celluloid, sawdust, flour, and tobacco. Chemical damage usually associated with some disease process may result from the heavy metals, fluorine, phosphorus, ionizing radiation, and sugar. Arsenic, chromium, phosphorus, and ionizing radiation produce syndromes characterized chiefly by soft tissue and alveolar necrosis. Bismuth, lead, and mercury greatly aggravate periodontal disease and usually produce gingival discoloration as well. Carbohydrate dust produces adherent plaques on the surfaces of teeth leading in time to dental caries. Most of these agents produce far greater effects upon already diseased oral structures than upon healthy ones.

39863

Jansen, Wallace N., Giuliana D. Moreno, and Marcel C. Bessis

**AN ELECTRON MICROSCOPIC DESCRIPTION OF BASOPHILIC STIPPLING IN RED CELLS.** Blood, 25(6):933-943, June 1965. 23 refs.

Blood or bone marrow cells from 20 rabbits, 20 guinea pigs, and 60 rats with lead intoxication were examined using a combination of supravital strains, light microscopy, and electron microscopy. There was marked variation in the time of appearance and in the number of stippled cells present. Stippling was always found in the bone marrow when it was present in peripheral blood, but was found only in the orthochromatophilic normoblasts which were relatively few in the animals with severe lead poisoning. Since the formation of stippling in cells depends on the dessication of the cells, they were not seen in plasma-suspended cells or in cells prepared in routine fastion for electron microscopy. The basic stippled material produced in blood cells by the action of supravital dye consisted exclusively of ribosomes. The spontaneous occurrence of the basophile stippling may be interpreted as evidence of ribosomal abnormality. However, the multiplicity of cellular

injuries induced by lead suggests that ribosomal aggregation results from alteration of nonribosomal organelles or other cellular consituents.

39867

Kopito, Louis, Ann M. Briley, and Harry Shwachman

**CHRONIC PLUMBISM IN CHILDREN.** J. Am. Med. Assoc., 209(2):243-248, July 14, 1969. 14 refs.

The cases of a family of four children and their neighboring cousin in whom the diagnosis on mild lead intoxication was initally suspected because these children had grossly elevated lead content in scalp hair are described. Ages ranged from 7 yrs, 4 mo. to 2 yrs, 1 mo. Lead concentrations in urine, blood, and hair were determined by atomic absorption spectroscopy. After determination of the lead concentration in a timed urine specimen, all the patients were given edetate calcium disodium in a single dose of 50 or 75 mg/kg body weight. All patients tolerated chelation therapy well. Elevated concentrations of lead in the blood were observed in four of the patients; the fifth had an elevated level of lead in the urine indicating active excretion of the metal. The determination of lead in scalp hair is a valuable diagnostic aid in chronic or mild lead intoxication particularly when the clinical or laboratory evidence is of questionable diagnostic quality. This continuously growing tissue accumulates and stores lead for long periods and may be used for estimating the time and duration of the exposure. Hair is easy to obtain, store, transport, and analyze and may provide a practical means for finding young children who may have been exposed to lead.

39883

Fullerton, Pamela M.

**TOXIC CHEMICALS AND PERIPHERAL NEUROPATHY: CLINICAL AND EPIDEMIOLOGICAL FEATURES.** Proc. Roy. Soc. Med., vol. 62:201-204, Feb. 1969. 29 refs. (Presented at the Royal Society of Medicine, Joint Meeting of Section of Occupational Medicine with Section of Neurology, May 9, 1968.)

Clinical and epidemiologic features of peripheral neuropathy caused by toxic substances encountered in industry are reviewed, classified by their main toxic effect. Peripheral neuropathy predominates with lead, acrylamide, organophosphates, and thallium, while central nervous system involvement predominates with carbon disulfide, methyl mercury, and methyl bromide. Effects appear only after gross overdose of arsenic, trichloroethylene, tetrachloroethane, 2,4-D (dichlorophenoxyacetic acid), pentachlorophenol, and DDT. Other systems are more affected by carbon tetrachloride and carbon monoxide. Criteria for establishing the metabolic toxicity of the substances are indicated as are criteria for implicating an immunologic mechanism in the production of neuropathy.

39989

Tsuchiya, Kensaburo

**EFFECT OF LEAD ON HUMAN BODY.** (Namari no jintai ni taisuru eikyo). Text in Japanese. Namari to Aen (Lead Zinc), 9(2):23-26, March 1972.

There has been no proven case of lead poisoning by airborne lead reported anywhere in the world. Cases of lead poisoning have been reported and known only as an occupational disease, especially in storage battery manufacturing firms. There is a definite relation between exposure to a poisonous chemical substance and human reaction. A man does not give abnormal symptoms until the exposure exceeds a certain degree. Once this limit is exceeded, rate of the poisoning is 100%. When plotted in a chart, this relation is indicated in S curve. Most of lead is taken in with food and through the digestive organs. The average Japanese takes in 0.3 mg/day lead from his diet. Lead is also taken in and absorbed through respiratory organs. Most of lead absorbed through the lungs goes directly into the circulation system, enters the liver, and is then deposited in the bones or discharged together with human waste. Lead carried by blood adheres to surfaces of globules. Part of the lead circulating with the blood enters the marrow where it disturbs the production of hemoglobin. Some of the lead reaches nerves and muscles where it ionizizes, causing breakdown of the ion equilibrium around the cells of smooth muscles and consequently paralysis of the muscles. Symptoms and diagnosis of lead poisoning are discussed at some length.

40014

Jefferies, D. J. and M. C. French

**LEAD CONCENTRATIONS IN SMALL MAMMALS TRAPPED ON ROADSIDE VERGES AND FIELD SITES.** Environ. Pollut., 3(2):147-156, April 1972. 11 ref

One hundred and one small mammals of three species of mice from sites in Huntingdonshire were analyzed to determine the lead concentration in the liver and whole body. The vegetation at the trap site was also analyzed. The range of sites covered roadside verges and fields. The mean lead concentration in the bodies of the mammals trapped increased from 4.19 dry weight ppm on woodland and arable sites, to 5.98 d/w ppm on verges of minor roads and 7.00 d/w ppm on the verges of a major highway 1.32, 1.92, and 2.26 wet weight ppm respectively). This differential of 1.7 times was much lower than that shown by the vegetation on the three types of sites (33.4, 42.5, and 306.7 d/w ppm respectively; 9.2 times differential). Microtus agrestis (field mice) contained significantly higher total body residues of lead on roadside verge sites (3.14 w/w ppm) than either Clethrionomys glareolus (bank voles) (1.89 w/w ppm) or Apodemus sylvaticus (field voles) (1.62 w/w ppm). This difference could be due to differing food and behavior. (Author abstract modified)

40021

Stankovic, M. and S. Milic

**THE VALIDITY OF LABORATORY TESTS IN THE EXAMINATION OF LEAD EXPOSED WORKERS.** (Vrednost laboratorijskih testova kod pregleda radnika izlozenih olovu). Text in Yugoslavian. Arhiv Hig. Rada Toksikol. (Yugoslavia), 21(3):233-239, 1970. 20 refs.

The validity of laboratory tests for the determination of lead levels was investigated on 317 workers occupationally exposed to lead. The increase in urinary elimation of lead, coproporphyrin and delta-amino levulinic acid (ALA) was evident. The determination of ALA proved to be the most sensitive test, suitable to define the quantity of metabolically active lead in the organism; ALA concentrations were highly correlative with urinary lead levels. The determination of ALA to creatinine ratio (ALA index) has no advantage over the simple expression of ALA in mg/l or in mg/100 ml urine.

40022

Haley, Thomas J.

**SATURNISM, PEDIATRIC AND ADULT LEAD POISONING.** Clin. Toxicol., 4(1):11-29, March 1971. 130 refs.

There are numerous differences between the two forms of active plumbism. Pica and lead fumes are the usual cause of pediatric variety, whereas poor industrial hygienic practices

produce adult plumbism. The pediatric disease involves hematological, gastrointestinal, and neurological symptoms, and the latter include drowsiness, coma, and grand mal seizures. Brain damage has implicated impedence of brain hemodynamics with changes in both white and gray matter. Adult plumbism requires more time for its development and presents a nonspecific symptom complex with low hemoglobin, gastrointestinal upsets, and increased delta aminolevulinic acid and coproporphyrin in the urine. There may be basophilic stippling and lead line on the gums, but these indications should not be used as sole diagnostic aids. With further development of the disease, the neuromuscular involvement becomes pronounced and in those instances where females are involved, sterility and abortion have been observed. The most valuable diagnostic aid is the determination of blood and urine lead levels, but only by a competent laboratory. The edetate lead mobilization test is also valuable. Therapy for pediatric plumbism includes intravenous edetate to remove blood lead and either urea or mannitol to reduce cerebral edema. Corticosteroids have also been used. In the adult form of the disease, edetate is also effected and in its absence, penicillamine can be used. Pentetate has been used in Europe, but its damaging effects on the islet cells of the pancreas may make its use questionable. (Author summary)

40057

Basecqz, J.-M., R. Lauwerys, and J.-P. Buchet

**COMPARATIVE STUDY OF VARIOUS BIOLOGICAL LEAD EXPOSURE TESTS.** (Etude comparative de divers tests biologiques d exposition au plomb). Text in French. Arch. Madadie Profess. Med. Trav. Securite Sociale (Paris), 32(6):453-463, June 1971. 36 refs.

On the basis of various known biological tests carried out to determine blood and urine lead levels in 2 groups of persons exposed to lead a control group, the validity of the determination of urinary delta-aminolevulinic acid for the determination of lead exposure was confirmed. Its 0correlation with urine-lead was definitely superior to that of coproporphyrinuria. Stippled cells research offers no interest. A significant inhibition of the globular enzyme delta-aminolevulinic dehydratase, however, can occur without increase in the urinary delta-aninolevulinic acid level. Therefore, the determination of the activity of this enzyme proves to be a very sensitive and very early test of lead exposure. Even in subjects nonoccupationally exposed to lead, the enzyme activity depends on the amount of circulating lead. (Author summary modified)

40068

Lachnit, V.

**CONTRIBUTION TO CHRONIC DAMAGES FROM ENVIRONMENTAL POLLUTANTS.** (Zur Problematik chronischer Schaedigungen durch Umweltverunreinigungen). Text in German. Wien. Med. Wochenschr., 122(4):43-49, Jan. 1972. 44 refs.

Pollutants, particularly trace elements which are present in the air in industrial plants and their environment and which may cause damage to health are reviewed. Few trace elements are concentrated enough to cause damage. Aluminum powder and aluminum oxide in high concentrations may cause diffuse interstitial fibrosis, while vanadium causes bronchitis. Beryllium, present in low concentrations, leads to beryllium pneumonia and berylliosis in high amounts. Cobalt affects the thyroid gland, and iron causes hemosiderosis. The mucous membranes are irritated by manganese and chromium, and the latter may have carcinogenic effect. Intensified studies on the effects of nickel and cadmium are required. The nickel intake from food and water is more important than from the air. Cadmium accumulates in the kidney and the liver, and may cause hypertonia. Lead has become one of the most important pollutants among the trace elements. The intake from air accounts for 30-50% of the total, while the daily intake in food lies at 0.3 mg. Some 10% of the total lead incorporated is resorbed. Lead concentrations of 80-115 ppm were found in plants near highways. Animals chronically exposed to lead showed reduced life expectancy. Decrease in delta-aminolevulinic acid dehydratase and reduced adenosintriphosphatase activity, constitute precursors of lead poisoning. The increased concentration of asbestos fibers, especially near building sites, represents a serious problem. Asbestos particles, showing the characteristic iron reaction, were revealed in the lung in 30-70% of the inhabitants in big cities. While the increased frequency of lung carcinoma and pleuromesothelioma may be associated with asbestos, a carcinogenic effect has not yet been ascertained.

40295

Lehnert, G., H. Mastall, D. Szadkowski, and K. H. Schaller

**VOCATIONAL LEAD CONTAMINATION BY AUTO EXHAUST GASES ON CITY STREETS.** (Berufliche Bleibelastung durch Autoabgase in Grossstadtsstrassen). Deut. Med. Wochschr., vol. 95:1097-1099, May 15, 1970. 21 refs. Translated from German. Leo Kanner Assoc., Redwood City, Calif., 11p., Dec. 1971.

A study on 158 employees of the vehicle pool of the city of Frankfurt/Main (79 garbage men and 79 street cleaners) was performed to investigate the possibility of lead poisoning due to air pollution originating from the use of leaded gasoline. Determination of the blood lead level and the delta-aminoevulinic acid deposit in the urine resulted in the following statistically warranted findings: Both occupational groups exhibited a larger lead accumulation than the general population. The mean blood lead level was higher for street cleaners than for garbage men. The degree of poisoning, based on the deposit of delta-aminolevulinic acid in the urine, must be regarded as no longer acceptable from the medical fitness-for-work standpoint for 16% of those examined. Tabular data consisting of mean values and deviations from standard of the delta-aminolevulinic acid (ALA) deposit in urine and variance analytical comparisons between the test group and a control group for blood lead level and ALA deposit in the urine are presented along with point correlation diagrams for the relationship between the ALA deposit in the urine and the blood lead level and for the relationship between the blood lead level and the length of employment.

40312

Sandstead, Harold H.

**EFFECT OF CHRONIC LEAD INTOXICATION ON IN VIVO I131 UPTAKE BY THE RAT THYROID.** Proc. Soc. Exp. Biol. Med. vol. 124: 18-20, 1967. 9 refs.

In vivo depression of iodine (131) uptake by rat thyroid and the conversion ratio has been produced by chronic lead intoxication. Lead apparently combines with sulfhydryl groups, thus inhibiting the enzymes. Lead may also displace iodine from a protein sulfenyl iodide carrier. This would effectively inhibit the uptake of iodine by the gland and inhibit the iodination of thyroylobin. Lead poisoning in recent years has become a problem affecting persons who consume moonshine whiskey. Impaired I(131) uptakes responsive to thyroid-stimulating hormones occurs in patients with plumbism and is caused by lead.

40316

Hasan, Jeddi and Sven Hernberg

**INTERACTIONS OF INORGANIC LEAD WITH HUMAN RED BLOOD CELLS.** Work Environ. Health, no. 2:26-44, 1966. 160 refs.

The simplicity of design of a mature human erythrocyte and its consequences, especially the absence of significant reproductive or regenerative capacity, renders the cell exceptionally vulnerable to deleterious physico-chemical influences, and makes it a sensitive indicator of their occurrence. Thus, interactions of red cells with even minute amounts of lead ions result in measureable alterations of function, particularly in the regulation of potassium and water exchange through the cell membrane. The effects appear also as changes in the osmotic resistance, the mechanical fragility, and in erythrocyte survival time in the circulation. (Author summary modified)

40317

Sobel, Raymond,

**THE PSYCHIATRIC IMPLICATIONS OF ACCIDENTAL POISONING IN CHILDHOOD.** Pediat. Clin. N. Amer., 17(3):653-685, Aug. 1970. 26 refs.

Childhood poisoning is a function primarily of parental psychopathology and family disturbance. Frequency of poisoning is unrelated to home safety, level of motor development, intelligence of the child, birth complications, and parental accident proneness. Childhood emotional disorder and accidental poisoning are related. Poisoning is one of the terminal links in a process which starts with a failure of mothering and leads to the frustration of a child s needs for dependency, autonomy and security. Poisoning is an act of defiance, a bid for attention, a coercive attempt to achieve dependency or an expression of anger deflected from the mother onto the self. Further attempts at education are likely to prove unavailing and more widespread use of safety devices is called for. The physician must treat accidental poisoning as a symptom of family disturbance. (Author summary modified)

40355

Grossklaus, Dieter

**FOREIGN MATTER AND RESIDUES IN POULTRY MEAT WHICH ARE HARMFUL TO HUMAN HEALTH.** (Fremde Stoffe und gesundheitlich bedenkliche Rueckstaende in Gefluegelfleisch). Text in German. Bundesgesundheitsblatt (Berlin), no. 3-4:42-50, Feb. 4, 1972.

Because of the lead bromium chloride contained in automotive exhaust gases, environmental lead concentrations, have increased considerably in recent years. Fodder crops near highways were found to contain up to 500 ppm lead. Poultry meat had an average lead concentration of 0.14 ppm in 1969. Continuous accumulation of lead residues in the body may lead to enzyme damage and to mutagenic and teratogenic effects.

40435

Kunitake, Eizaburo, Yasushi Kodama, and Noburu Ishinishi

**THE EFFECTS OF LEAD GENERATED FROM EXHAUST GASES. I. SPECIAL HEALTH EXAMINATION.** (Jidosha haikichu en no jinshin eikyo I. tokusho kenko shindan). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 6(1):165, 1971. (Presented at the National Council Meeting of Air Pollution Studies, 12th, Nagoya, Japan. Oct. 27-29, 1971.)

Fifty residents from a high traffic area of Fukuoka City and the same number of residents from a countryside residential area were studied for the effects of automotive exhaust gases on human health. Self-conscious symptoms were investigated based on questionnaires issued by the Welfare ministry. Special health examinations of lead poisoning were also carried out. The rate of resident with self-conscious symptoms, including headache, cough, nose, and eye symptoms was higher in the high traffic area, especially for female residents, who had a double rate. The investigation showed no differences for people in hazardous occupations and for heavy smokers from the two areas. Special health examinations of lead poisoning revealed no difference between the two groups of residents.

40485

**ANALYSIS OF THE BIOSPHERE POLLUTION WITH LEAD AND ITS BIOMEDICAL ASPECTS.** (Analyse de la situation de pollution de la biosphere par le plomb et aspects biomedicaux). Text in French. Protectio Vitae, no. 1:31-33, 1971.

Under present conditions, lead concentration in gasoline can vary from 0.2 to 1.1 g/l, with an average of 0.44 g/l. Total emission of lead from automobile exhausts in the Northern hemisphere amounts to several hundred thousands of tons per year. Concentrations of lead in the air in cities and near open roads with heavy traffic can reach as much as 40 micrograms/cu m. The World Health Organization considers a lead concentration of more than 2 micrograms/cu m in breathing air as objectionable, and suggests a permissible limit of 1 microgram/cu m. In rain water, as much as 300 micrograms lead/l have been found quite frequently, and accumulations of 1000 micrograms/sq m on the ground are not unusual. By means of radioactive isotopes of lead, information has been obtained on the mode of absorption, distribution, and retention of lead in the human body and its organs. Daily elimination removes a certain percentage of the quantities absorbed by digestion. The presence of lead can disturb the metabolic functions of the blood, central nervous system, liver, kidneys, and other organs. Tetraethyl lead, used as antiknock agent in gasoline, has particularly toxic properties. It penetrates preferentially into the central nervous system and can diffuse through intact skin. Symptoms of poisoning are troubled sleep, impaired vision, cramps, and drop of blood pressure. So far, the chemical and petrochemical industries have not found a product that can replace tetraethyl lead as an antiknock agent, despite the fact that some 200,000 chemical compounds have already been investigated.

40492

Beckert, J., G. Buehlmeyer, F. Unckell, and G. Tech

**INVESTIGATIONS CONCERNED WITH SUBJECTS EXPOSED TO LOW CONCENTRATIONS OF LEAD AT WORKPLACES.** (Untersuchungen bei Bleiexponierten mit primaer niedriger Bleikonzentration am Arbeitsplatz). Text in German. Zentr. Arbeitsmed. Arbeitsschutz, 21(7):207-213, July 1971. 29 refs.

The effect of low concentrations of lead on the urine content of delta-aminolevulinic acid (ALA), coproporphyrin (CP) and porphobilinogen (PBG) of 92 printing workers (machine setters exposed to an average lead concentration of 17 micrograms/cu m) was investigated. Despite the low lead concentrations, ALA excretion in 72 persons exceeded the normal values. Normal limits and maximum allowable concentration values are discussed. The average ALA excretion of the workers exposed to lead was statistically significantly higher than that of the controls.

40532

Dodo, Hidenori and Hitoshi Hasegawa

**THE STUDY ON THE EFFECT OF LEAD IN AIR IN KUSATSU, HIROSHIMA CITY.** (Hiroshima-shi Kusatsu chiku ni okeru taikichu-namari no eikyo ni tsuite). Text in Japanese. Hiroshima Igaku (J. Hiroshima Med. Assoc.), 25(4):495-497, April 1972. 3 refs.

The effects of lead in air on health were studied in the Kusatsu district of Hiroshima City, Hiroshima Prefecture. The measurements, including blood and urine levels of lead, hematocrit value, serum protein level, specific gravities of serum and blood, hemoglobin amount, coproporphyrinuria, and basophilic punctate erythocyte count were performed for housewives of Kusatsu district and those of Yamada district as controls. The blood level of lead was 16.5 micrograms/100 g on the average, ranging from 5 to 58 micrograms/100 g in Kusatsu district and the value was higher than in the Yamada district. The urine lead level was slightly higher in Yamada district, 27.6 micrograms/l on the average, and ranged from 9 to 15 micrograms/l. The blood examination revealed three patients with anemia in both districts, which was the result of nutrition or other causes. Among anemia patients, some basophilic punctate erythrocyte positive subjects were found, however, this count was within the normal limit. In Yamada district, three cases of coproporphyrinuria were seen. The average count of basophilic punctate erythrocyte was higher in the Kusatsu district. On the whole, there was no difference between two districts concerning mean values and rates of abnormalities of all items. No subjects had lead poisoning.

40634

Gualtierotti, R.

**GLOBAL POLLUTION OF THE ENVIRONMENT.** (L inquinamento globale dell ambiente). Text in Italian. Museoscienza, 12(1):23-34, Jan.-Feb. 1972.

Seventy percent of the oxygen of the biosphere is produced by marine phytoplankton which is being endangered by all types of environmental pollution. Only if the biosphere remains in the equilibrium which it attained five million years ago and which is now in acute danger can man survive. While each human consumes daily 14 kg of air, the combustion of each liter of gasoline uses up 16.5 kg air and the combustion of 1 kg of methane uses up 18 kg air. The current yearly emission of carbon dioxide, hydrocarbons, and nitrogen oxides into the atmosphere is estimated to amount to 142 million tons in the U.S.A. alone. When automobile emissions are exposed to sunlight smog formation results. Air pollution can have an acute or a chronic effect on living organisms. The former is manifested in humans by violent retrosternal pain, dyspnea, cough, vomiting, pulmonary edema, collapse, and death. The latter affects primarily the respiratory tract by inducing chronic bronchitis, spastic manifestations, pulmonary emphysema, and cor pulmonale. Hydrocarbons and benzopyrene, in particular, cause lung cancer, which is also indirectly caused by tetraethyl lead. Both these compounds and carbon monoxide have a deleterious effect on enzymes operative in respiration. Air pollution is estimated to be a contributory factor in the induction of tumors of the respiratory tract by 10%, in asthma by 10%, in congestive myocardial insufficiency by in acute infections of the upper respiratory tract by 10%, in acute bronchopneumopathies by 15%, in chronic bronchitis by 20%, in pylmonary abscesses by 10%, in pulmonary congestion and hypostasis by 5%, and in other diseases of the respiratory tract by 10%. The difference in mortality between 10.6 per mille in urban areas and 9.6 per mile in rural areas can be attributed to congestion as a factor of environmental pollution. Also, urban infant mortality is elevated. Mortality and morbidity attributable to air pollution involve mainly diseases of the respiratory tract and of the cardiocirculatory system. Of the 217 pollutants identified in the atmosphere by gas chromatography, tetraethyl lead has increased most, 70 times in the last 20 years.

40688

Isoard, P., F. Marcotte, G. Lemercier, and R. Fontanges

**STUDY ON THE EXPERIMENTAL ACTION OF ATMOSPHERIC POLLUTANTS ON THE LUNGS OF BALB/C MICE.** (Etude de l action experimentale de polluants atmospheriques sur le poumon de la souris Balb/c). Text in French. Pollut. Atmos. (Paris), 14-(53):43-55, Jan.-March 1972. 68 refs.

A study on the biological effects of fine particulate pollutants on new-born mice is described. The air samples, taken at a rate of 0.4 m/sec in an industrial area, were subjected to freeze-drying. The mineral content of the samples was 99% (silicon, magnesium, aluminum, calcium, iron, lead, copper, manganese, and zinc) and 17 polycyclic aromatic hydrocarbons (pyrene, chrysene, benzo(a)anthracene, benzo(a)pyrene, dibenz(a,h)anthracene and fluoroanthene, for example) were determined in the rest. The preparations were administered intranasally (2.5 mg/0.1 ml), subcutaneously (1, 1.5, 2, and 3 mg/0.1 ml), and in the form of aerosol (1.5 mg). The animals were killed after 9 months for the investigation. Injections of high doses, causing ecchymotic spots, killed the animals usually within 24 hours. The LD50 was determined to be 1.596 mg. The pathologic investigation of the lungs of the 11 groups revealed histiocytovascular hypertrophic reticular pneumonia (23.50-80%), atrophic reticular pneumonia (5.90-13.80%), lymphoid stimulation (3.80-38.20%), and adenomatosis (4-76.50%), while the percentage of the normal mice within the different groups ranged from 12 to 76.50%. The damages were due to irritations or acute of chronic toxic effects, the latter mainly within the grain size range of 1-5 micron. No statistically significant tumor proliferation was found.

40697

Borghetti, A., A. Cavatorta, A. Dal Canton, I. Franchini, T. M. Neri, and A. Novarini

**BIOLOGICAL INDICIES FOR THE EPIDEMIOLOGICAL STUDY OF LEAD POISONING.** (Elaborazione di indici biologici per rilievi epidemiologici nella esposizione saturnina). Text in Italian. G. Clin. Med. (Bologna), 52(3):234-246, 1971. 8 refs.

Urinary excretion studies in normal and lead-poisoned subjects show that the mg of certain urinary solutes/ml urine, divided by the urinary osmolarity, is correlated with the mg of those solutes/ml urine times the urinary minute volume. This was true for creatinine, gamma-aminolevulinic acid, coproporphyrin, and lead. These correlations may be useful in epidemiological studies of lead poisoning. (Author abstract modified)

40769

Silver, Walter and Ramon Rodriguez-Torres

**ELECTROCARDIOGRAPHIC STUDIES IN CHILDREN WITH LEAD POISONING.** Pediatrics, 41(6):1124-1127, June 1968. 16 refs.

Electrocardiographic studies before and after treatment were performed in 30 children with lead poisoning. Abnormal electrocardiograms were present in 70% of the patients on admission. Six cases had tachycardia which persisted after treatment

in only two. Atrial arrhythmias were found in five patients. Sinus rhythm was reestablished after treatment in all except the patient with left atrial rhythm. The P-R interval was shortened in four cases and prolonged in 2. After treatment, the patients (two) in whom the P-R interval was prolonged remained the same, while only one case of four with short P-R interval failed to return to normal. The QTc was prolonged in 15 patients on admission, and it became normal in all patients after treatment. Inverted T waves over the left precordium were found on admission in five patients. Only one failed to respond to treatment. An abnormally wide QRS-T angle was found in six patients on admission. The angle became normal in four patients but remained the same in two. The abnormalities described most likely represent myocardial damage.

41067

Yamada, Shin-ya

**THE USE OF METAL RESOURCES AND ENVIRONMENTAL POLLUTION--THE CONNECTION BETWEEN OCCUPATIONAL DISEASES AND POLLUTION.** (Kinzoku shigen no riyo to kankyo osen--shokugyobyo to kogai no tsunagari). Text in Japanese. Kagaku (Science), 41(10):530-544, Oct. 1971. 11 refs.

Topics discussed included the historical relationship between high pollution and occupational diseases starting from the 18th century, changes in labor conditions from a high- to a low-concentration exposure, the maximum permissible concentration of metal pollutants in the human body, monitoring by determining pollution sources, government anti-pollution policies, citizen awareness, an index for pollution monitoring, elimination of pollution by recovery in industrial areas, coordination of pollution monitoring within and outside of industrial areas, some pollution episodes, social attitudes toward occupational diseases, and the need for education of the public in order to eliminate occupational hazards by pollution. According to measurements made at a steel alloy factory, where lead is added to molten iron of 1500 C, 5-20 mg/cu m lead were found in the steam created immediately after the pouring of lead in the molten iron. This lasted for 5-10 min, and 0.001 to 0.01 mg/cu m concentration followed. Most of the lead is emitted to the atmosphere by suction, but the dust in the building contained 0.1-0.2% lead. An example of death by metal poisoning was the case of an old man who died of bronchial asthma after working at an iron foundry for 18 years. Autopsy showed a total lung silicosis and heavy carbon deposit in the lungs, and a long-term deterioration of lung and heart functions.

41097

Brondine, Virginia

**POINT OF DAMAGE.** Environment, 14(4):2-15, May 1972. 56 refs.

Health effects are represented in air quality standards only to the extent that a specific concentration of a single pollutant can be demonstrated to cause a harmful effect on health. A margin of safety is then added. These standards are not useless, but they are simplistic. Epidemiologic evidence has indicated the complexity of the interaction of pollutants and the variety of the human condition. Nitrogen dioxide lowers the resistance to bacterial and viral infection. Ozone, lead oxides, and particulates impair the ability of phagocytes to trap streptococci. Silicosis is caused by the inhalation of dust containing a high proportion of silica. Lung cancer has been induced in animals by the inhalation of benzypyrene, a hydrocarbon, and sulfur dioxide. When animals have been infected with influenza and exposed to ozonized gasoline, a synthetic smog, lung cancer has also been produced. Mutations have been produced by both SO2 and radiomimetic ozone. Low levels of toxic agents may result in a great variety of delayed pathological manifestations. Some populations suffer inherent risks due to special deficiencies, preexisting disease, or special exposure. The incidence of asthma has increased in urban areas. People who suffer from anemia are likely to be sensitive to CO and lead. Occupational exposure is reinforced by cigarette smoking, and the combined effect is greater than the sum of the two effects.

41124

Wada, Osamu

**ENVIRONMETNAL POLLUTION DISEASES.** (Kogaibyo). Text in Japanese. Shonika Rinsho (Japan. J. Pediat.), 25(4):35-42, April 1972. 11 refs.

The mutual relationship between an agent of disease, mankind, and various diseases is discussed by giving examples such as chronic bronchitis, pulmonary emphysema, bronchitis, and cancer of the lung which are generally called environmental pollution diseases caused by air pollution. Medical science in the future and the physician s role are discussed. The toxicity of lead, sulfur dioxide, nitrogen dioxide, and other pollutants are mentioned. The dose-response curve is described.

41368

Schlipkoeter

**DETERMINATION OF LEAD IN BONE MATERIAL BY ATOMIC ABSORPTION SPECTROPHOTOMETRY.** (Blei-Bestimmung in Knochenmaterial durch Atomabsorptionsspektrophotometrie). Preprint, Medizinisches Inst. fuer Lufthygiene und Silikoseforschung, Duesseldorf (West Germany), 1968 (). 2 refs. Translated from German. Leo Kanner Assoc., Redwood City, Calif., 8p., Dec. 1971.

Lead measurements for determination of lead in bone material were conducted with an atomic absorption spectrophotometer Perkin-Elmer model 303. The photometer is equipped with a lead hollow cathode lamp, a Bowling burner, an amplifier, and an absorption recorder. The measurements were conducted at a wave length of 283 nm. With an acetylene-air mixture, zero absorption is adjusted with methyl isobutyl ketone. Each solution is atomized for 15 sec. After each second sample solution, the calibration solution is measured with a suitable lead concentration as a reference value. After determination of the extinctions, the values of the sample calibration solutions are corrected on hand of the control extinctions; and, subsequently, the mean values of duplicate and multiple measurements are established. The concentration is read on a calibration curve and recalculated with the help of the sample volume to the quantity of lead per organ. Direct atomization and measuring of the aqueous solution of the samples is in most cases not possible due to the high salt content, since deposited salts clog up atomization nozzles and burner slots. In addition, scattering effects of the particles cause an erroneous absorption signal. The treatment of the material under investigation takes place through wet ashing with nitric acid, sulfuric acid, and perchloric acid. The salts present after ashing are soluble by boiling in a high-percentage ammonium citrate solution. By means of extraction, metals can be converted and concentrated from a large volume of aqueous solution into a small volume of organic solution. Such a concentration is required because of the low lead concentrations expected. Informaiton concerning reagents and solutions along with details on the laboratory procedure required are given at the end of the article.

41695

Pines, A. G.

**THE CONDITION OF SOME GENERAL INDICATORS IN LEAD POISONING.** (Sostoyanie nekotorykh pokazateley obshchey reaktivnosti pri svintsovykh intoksikatsiyakh). Text in Russian. Vrachebnoe Delo (Kiev), no. 3:93-96, 1962 ().

The variations of some parameters of the overall activity due to chronic lead poisoning were studied in 40 persons occupationally exposed to lead over more than 10 years. Reduced functional activity of the hypothalamus-hypophysis-adrenal gland system was observed in the majority of all cases. The urine lead content was 0.05 mg/l, maximum, and the basophilic granular erythrocyte count was 2-28/10,000. The percentage of reticulocytes was between 0.4 and 3.3. Spontaneous 17-ketosteroids excretion was decreased to 6.57 + or - 0.74 mg/day. The decrease in the 17-ketosteroid excretion after ephedrine administration, observed in 21 cases, indicated inadequate, distorted reaction. Eosinopenia was found in more than 50% of all cases. Correlation between the degree of the adrenocortical hypofunction and the clinical gravity of the poisoning was established. The total serum protein content showed a slightly rising tendency, while decreased albumins and increased gammaglobulins were determined. The decrease in the skin test coefficient revealed a reduced functional activity of the connective tissue system. Granulocytopenia, eosinopenia, retarded erythrocyte sedimentation reaction, as well as distorted or attenuated leukocyte reactions, observed in several cases in the peripheral blood, indicated the inability of the regulatory apparatus to react adequately upon the corresponding loads.

41717

Nikkanen, Jorma, Sven Hernberg, and Sakari Tola

**MODIFICATIONS OF THE DELTA-AMINOLEVULINIC ACID DEHYDRATES TEST AND THEIR SIGNIFICANCE FOR ASSESSING DIFFERENT INTENSITIES OF LEAD EXPOSURE.** Work Environ. Health (Helsinki), 9(1):46-52, 1972. 19 refs.

When the content of lead in blood (Pb--B) is normal, human erythrocyte delta-aminolevulinic acid dehydratase (ALA-D) activity has its pH optimum at 6.4. Another lower peak occurs at pH 6.8. When Pb-B is elevated, e.g., in occupational exposure, the pH optimum shifts to 5.8 and there is no other activity peak. Delta- aminolevulinic acid dehydratase activity increases in a linear manner as a function of time for periods between 15 and 90 minutes. Storage of whole blood at + 5 C results in some loss of activity. By using different pH values for the enzyme assay, the sensitivity of the ALA-D test can be altered. The test is most sensitive at pH 6.8, and considerably less sensitive at pH 5.8. The highest correlation coefficient between Pb-B and ALA-D (r equals minus 0.96) was obtained at pH 6.4, however. At this pH, the ALA-D test is accurate at Pb-B levels up to 100 micrograms/dl. For routine purposes, therefore, pH 6.4 is recommended. If very high Pb-B values are expected, pH 5.8 can be tried since the amount of porphobilinogen formed during incubation is measurable even when Pb-B is 150 micrograms/dl or more. The dependence of the pH optimum of Pb-B is compatible with an allosteric inhibition. The mechanism is apparently different when lead is added to the hemolysate in vitro, since the pH optimum remains the same as that for normal blood. (Author abstract modified)

41731

Djuric, Dusan, Ljubica Graovac-Leposavic, Svetislav Milic, and Ljuba Senicar

**LEAD CONTAMINATION OF MEZA VALLEY. LEAD MOBILIZATION WITH CA-NA2- EDTA FROM THE BODY OF INHABITANTS.** Pracovni Lekar. (Prague), 24(2-3):49-50, 1972. 8 refs.

In 108 persons living near a lead foundry in the Meza Valley, Yugoslavia, lead mobilization was carried out by intravenous injection of 1 g calcium-sodium-ethylene diamine tetraacetic acid. The urine was collected during 24 hr. Only 5.5% of persons excreted less than 0.35 mg Pb/l urine, 18.5% excreted between 0.35 and 0.5 mg/l, the remaining 81.5% excreted 0.5 to 4.2 mg/l. The spontaneously excreted lead represented in persons with normal value of mobilization 7.5 plus or minus 3% of the mobilizable amount, in high values of mobilization only 1.5 to 4%. The authors estimate lead deposition in persons with high values of mobilization to exceed 50 mg/person. (Author summary modified)

41737

Lange, Gerhard

**HEALTH HAZARDS DUE TO GASEOUS EMISSIONS FROM INDUSTRY, FIRINGS AND AUTOMOBILES.** (Gefaehrdung der Gesundheit durch Abgase von Industrie, Feuerungen und Kraftfahrzeugen). Text in German. Med. Monatsschr., 25(3):97-99, 1971. 13 refs.

The effects of different air pollutants from industrial sources, firings, and automobiles on man are reviewed. Sulfur dioxide, ozone, nitrogen oxides, carbon monoxide, hydrocarbons, and lead compounds are the pollutants that are most dangerous to human health in urban and industrial areas. Sulfur dioxide, in concentrations above one ppm, irritates the mucous membranes of the respiratory tract and the eye. Data on the correlation between disability, diseases of the respiratory tract, and mortality and SO2 concentrations above 0.2 ppm are available. Ozone concentrations above one ppm both irritate the mucous membranes, and may cause lung edema and headache. The maximum allowable concentrations for daily 8 hr-exposure is set at 0.1 ppm. Nitric oxide causes dyspnoea, nausea, and unconsciousness, while the more toxic nitrogen dioxide is responsible for irritations of the mucous membranes, cough, salivation, and dyspnoea as well as lung edema, after three to 24 hours latency. Carbon monoxide forms carboxyhemoglobin in the blood, inhibits brain functions, and may cause tissue damages due to chronic poisoning. The maximum allowable concentration is 50 ppm. Different hydrocarbons, present primarily in automobile exhaust, may cause irritation of the mucous membranes, cough, nausea, euphoria, narcosis, and some have a carcinogenic effect. The frequency of lung cancer was found to be higher in urban than in rural areas. Hydrocarbon emissions from automobiles can be reduced by improving combustion, and by applying afterburning. The tetraethyl lead added to gasoline is present in the exhaust in the form of lead oxide, chloride, or bromide. Lead incorporated in the organism may cause basophily of the erythrocytes, porphyrinuria, swollen liver, and encephalopathy. Correlation between lead concentrations in air and blood was established. Though the actual values lie far below the maximum allowable concentration of 200 micrograms/cu m, risks are present due to the contamination of plants near highways. The synergism of different air pollutants as well as air pollutants and drugs is a possibility.

41818

Sobel, Albert E., Irving B. Wexler, David D. Petrovsky, and Benjamin Kramer

**INFLUENCE OF DIETARY CALCIUM AND PHOSPHORUS UPON ACTION OF VITAMIN D IN EXPERIMENTAL LEAD POISONING.** Proc. Soc. Exp. Biol. Med., vol. 38:435-437, 1938. 6 refs.

Experiments were conducted on albino rats to study the effects of vitamin D on lead poisoning, as influenced by dietary calcium and phosphorus. One group of rats was fed a basal diet containing traces of calcium (0.03%) and a small amount of phosphorus (0.246%) to which lead carbonate was added. To this basal diet, 2.5% of calcium carbonate was added to produce a high calcium-low phosphorus diet for the second group. For the third group 2.75% of anhydrous sodium phosphate was added to produce a high phosphorus-low calcium diet. One half of each group was given 33 Steenbock units of vitamin D. After 23 to 25 days the animals were analyzed. The vitamin D groups contained a higher percentage of lead in both the dried bone and the bone ash. Parallel effects were noted in the blood lead concentration of groups A and B. In group C, which received the high phosphorus diet, the concentration of lead in the blood was too low to be accurately determined. The beneficial effects of the high phosphorus diet in experimental and clinical lead poisoning may be thus explained in terms of lowered blood concentration.

41847

Williams, Huntington, Wilmer H. Schulze, H. B. Rothchild, A. S. Brown, and Frank R. Smith

**LEAD POISONING FROM THE BURNING OF BATTERY CASING.** J. Am. Med. Assoc., 100(19):1485-1489, May 13, 1933. 17 refs.

A group of forty cases of acute lead poisoning have been discovered, due in all probability to inhalation, wherein discarded storage battery casing have been used in poor Negro families as a fuel. The majority of the patients had no serious subjective symptoms and experienced only slight discomfort. Among the group, however, were several patients with severe encephalopathies. Both children and adults were affected, and intensity rather than duration of exposure seems to have been chiefly responsible for the causation of poisoning. Two case studies are provided. Usage of this fuel seems to be fairly widespread, and effective control measures have been instituted in Baltimore. (Author summary modified)

41857

**SIR GEORGE BAKER (1722-1809) DISCOVERER OF THE PATHOGENESIS OF DEVONSHIRE COLIC.** J. Am. Med. Assoc., 204(6):221, May 6, 1968. 2 refs.

From documented historical aspects of the disease, Baker deduced that Devonshire colic was similar to clinical lead intoxication. The colic was indigenous to Devonshire and the recovery of significant quantities of lead from devonshire cider concluded the proof. He further traced the origin of the lead to the grinding troughs, presses, and conduits in which the cider was made. He concluded has scientific treatise on the matter with a plea for removal of the offending substance.

41872

Carpio, Guillermo del

**CHRONIC OCCUPATIONAL PLUMBISM IN OUR ENVIRONMENT. (CONCLUSION). CHAPTER III.** (Plumbismo cronico ocupacional en nuestro medio. (Conclusion). Capitulo III). Text in Spanish. Salud Ocup., 12(3-4):207-252, July-Dec 1967. 183 refs.

Occupational exposure to lead within the limits of maximum allowable concentrations produces no clinical symptoms but does cause biochemical alterations of enzyme activity, increased coproporphyrin excretion, and increased erythrocytic basophilia. Plumbism is a result of chronic lead poisoning and is characterized by symptoms which include paroxysneal abdominal pain, erythrocytic basophilia, anemia, anorexia and constipation, and arterial hypertension. Sometimes a central nervous system syndrome may occur including severe headache, mental disorders, convulsions, and coma. Laboratory analysis reveals high lead levels in the blood and urine and increased coproporphyrinuria. Treatment of saturnism is based on the administration of chelating agents such as EDTA and symptomatic treatment with atropine and calcium gluconate. Prophylaxis includes continuous environmental air monitoring for Pb concentration and periodical medical examination. A general bibliography on lead poisoning is included.

41894

Hammer, D. I., J. F. Finklea, R. H. Hendricks, C. M. Shy, and R. J. N. Norton

**TRACE-METAL CONCENTRATIONS IN HUMAN HAIR.** In: Helena Valley, Montana, Area Environmental Pollution Study. Environmental Protection Agency, Research Triangle Park, N. C., Office of Air Programs, Pub-AP-91, p. 125-134, Jan. 1972. 15 refs. NTIS: PB 207126

Human scalp hair was collected from 84 fourth-grade schoolboys living in East Helena, Helena, and Bozeman, Montana, to determine whether the content of lead, cadmium, and arsenic reflected environmental concentrations in the three cities. Lead, Cd, and As means were highest in East Helena, the most polluted community; were intermediate in Helena; and were lowest in Bozeman, the least polluted community. These differences for each pollutant were tested by a one-way analysis of variance on the original and on log-transformed data. The differences among the respective means of zinc and copper were not significant. The pre-analysis hair wash included detergent and ethylenediaminotetraacetic acid.

41895

Shibko, Samuel I.

**POSSIBLE HAZARDS ASSOCIATED WITH INGESTION OF GARDEN VEGETABLES CONTAMINATED BY TRACE METALS.** In: Helena Valley, Montana, Area Environmental Pollution Study. Environmental Protection Agency, Research Triangle Park, N. C., Office of Air Programs, Pub-AP-91, p. 135-144, Jan. 1972. 18 refs. NTIS: PB 207126

Calculation of the estimated daily dietary intake of arsenic, cadmium, lead, and zinc from Helena Valley, Montana, garden vegetables containing the maximum observed levels of the metals indicates that the suggested body burden of the metals will be exceeded for lead and cadmium. These calculations do not take into account the fact that the vegetables were not washed before analysis, or that garden vegetables may only provide a fraction of the total dietary intake of vegetables, or that the inhabitants of the area may have special dietary habits. Based on the calculations, the daily intake of lead from garden-grown vegetables would be 0.48 mg. The daily intake of lead from all food could be as high as 0.753 mg. The total daily intake of lead, including that from water and air, could be as high as 0.95 mg. Since this level poses a major hazard only in the case of continuous intake for many years, the problem in the Helena Valley area is one of chronic ingestion of lead. The significance of the increase cadmium intake, approximately 55% over the acceptable body burden, 30% of which comes from the diet, is not known. Additional data are required to determine whether a hazard exists from the consumption of

milk and meat derived from cattle in the area. Normal human zinc, cadmium, arsenic, and lead balance data, including rates of daily intake and output and routes of excretion, are summarized.

42022

Yoshikawa, Hiroshi

**INFLUENCE OF METALS ON HEALTH.** (Kinzoku no kenko e no eikyo). Text in Japanese. Kogai to Taisaku (J. Pollution Control), 8(6): 525-534, June 1972.

The existences of metals in humans and the effects on health are discussed. Large varieties of metals exist in the human body, from hair to bones. These metals either assist the metabolism or just remain as polluting substances. Metals such as cadmium, magnesium, lead, and arsenic accumulate in the human body and cause injuries; they mainly result from environmental pollutions. It is not necessary that metals required for the body would exhibit less toxicity. Experimental results show that mercury, followed by uranium, cadmium, indium, selenium, and copper, exhibit the strongest acute toxicity in mice, and chromium, manganese, and cobalt are less toxic. Toxic tolerances are given. The symptoms of occupational workers caused by various concentrations of certain metals are also tabulated.

42091

**ANALYSIS OF THE SITUATION REGARDING THE LEAD CONTAMINATION OF THE BIOSPHERE AND BIOMEDICAL ASPECTS.** Protectio Vitae, 1972:89-90, 1972.

In spite of extensive research, the chemical industry has not found an adequate substitute for lead additives in motor fuel. Motor engines will have to be structurally modified. The lead concentrations in gasoline vary from lower values of 0.2 g/l to 1.1 g/l. The rate of increase of lead emissions averages 3.5%/yr but in some areas has reached 5-15% and more. Lead concentrations at ground level near main roads and in cities varies from 10 micrograms/cu m to 40 micrograms/ cu m. The quality of the air cannot be guaranteed above 2 micrograms/cu m. Traces of lead compounds cause grave disturbances of metabolism. Even the smallest quantities of lead inhibit the activity of the delta- aminolevulinic acid dehydratase in erythrocytes. There are possible further effects of lead on mitochondria, cell division, gonads, biological oxidation, and the breathing chain. Tetraethyl lead has a remarkably high specific toxicity. It is easily soluble in fat, enriches itself in the central nervous system, and can permeate through unbroken skin. Claimed advantages of small reductions in lead emissions are quickly annulled by increased traffic.

42098

Tsuchiya, Kenzaburo

**INFLUENCE OF LEAD ON HEALTH.** (Namari no kenko e no eikyo). Text in Japanese. Kagaku (Science), 41(10):575-580, Oct. 1971. 13 refs

After the accumulation of lead in a human body, either through the respiratory system or the digestive system, reaches a certain point, the lead content in urine and blood increases extraordinarily, and delta aminolevulinic acid and/or copropolphiline in blood rise exceedingly. Anemia, which can be a barometer of the degree of lead exposure, is not actually serious. More serious symptoms are severe pain in the intestinal area, which is sometimes mistaken for gall bladder stones, appendicitis, or ileus. Several drops of monocalcium disodium ethylenediamine etra-acetic acid will cure the pain. Morphine must not be used. More serious symptoms include paralysis of arms. More serious and acute cases of lead poisoning can cause encepalopathia, cases of which have been seen in babies and children who have eaten old paint or cosmetic powder in the past. The maximum allowable concentration of lead in the air has been calculated to be somewhere in the neighborhood of 0.05 mg/cu m in the past, and more recently 0.10 to 0.12 mg/cu m. However, in an actual work environment both in Japan and the United States, 0.15 mg/cu m is designated as the maximum standard. Both lead and cadmium in human body increase with the age and reach maximum at about the age 50, decreasing slightly after that. The average amount of lead that goes into the human body is approximately 300 micrograms/day. The rate of absorption is about 10%. Therefore, daily accumulation of lead in a body is about 30 micrograms, and the daily discharge through urine is 30 to 40 micrograms. The lead accumulation from other sources than through food is about 10 micrograms. However, a long term accumulation can reach 80 to 120 micrograms in an average human body. The relationships among the accumulation quantity, discharge, absorption, half life, and time, are expressed by formulas. 0

42136

Vanhoorne, M., R. Dams, J. Bressers, and C. van Peteghem

**SMOKE OF THE TRIGGER PROCESS IN THE PRODUCTION OF NODULAR IRON AND ITS POSSIBLE EFFECTS ON MAN.** Int. Arch. Arbeitsmed., 29(2):102- 118, June 1972. 38 refs.

Following complaints of foundry workers about the smoke released by the triggering process in the production of nodular iron, the composition of this smoke and its possible effects on man were investigated. Nondestructive neutron activation analysis showed 34 elements, all in concentrations below threshold limit values. The possible acute effects of this smoke on man were investigated in 10 workers. Eight workers had subjective complaints, mainly respiratory discomfort. Determination of iron in serum and lead in blood of workers before and after exposure to the smoke showed no significant differences. Clinical laboratory investigations and body temperature readings indicate that metal fume fever did not occur. All subjects showed to a different extent a decrease of vital capacity shortly after exposure to the smoke. Forced expiratory volume in one second showed no consistent changes. Long term effects of repeated short exposures are unknown.

42463

Environmental Protection Agency, Rockville, Md., Office of Air Programs and Environmental Protection Agency, Research Triangle Park, N. C.

**HEALTH HAZARDS OF LEAD.** Preprint, 20p., April 27, 1972. 43 refs.

All relevant medical and scientific evidence available to the Environmental Protection Agency as of January 1, 1972 on the health hazards of airborne lead is summarized. Information is also provided on sources of airborne lead and lead levels in the environment. The available data indicate that, though the amounts of lead ingested in the diet generally are greater than the amounts inhaled, the body absorbs a greater percentage of inhaled lead (30% or more) than of ingested lead (about 10%). Human blood lead levels are the most frequently used index of human exposure to environmental lead; however, other tissues may provide a more accurate index of total body burden, particularly where exposure levels are relatively low. Human blood lead levels begin to rise appreciably with exposure to airborne lead concentrations in excess of 2 micrograms/cu m. Elevated lead intake for periods as short as 3 months is suffi-

cient to produce an increase in blood lead levels. Average blood lead levels tend to be higher among urban residents than among rural residents and among certain occupational groups more than others. Body burdens of lead, as measured by bone lead concentrations, increase with age at least until age 40 and probably thereafter. The activity of certain enzymes involved in heme syntheses is inhibited at blood lead levels significantly below those associated with clinical lead poisoning. Though ingestion of leaded paint clearly is the principal cause of lead poisoning among children, the high concentrations of lead in urban street dust are another potential source of lead intake. Precipitation samples from 32 locations in the U. S. showed a positive correlation between gasoline consumption and lead content of precipitation.

42661

Honma, Shuji

**A SIMPLIFIED METHOD FOR DETERMINATION OF LEAD IN THE BLOOD AND URINE BY ATOMIC ABSORPTION SPECTROPHOTOMETRY.** (Genshi kyuko bunsekiho ni yoru nyo chu oyobi ketchu no namari sokutei ho). Text in Japanese. Igaku to Seibutsugaku, 84(6):329-333, June 10, 1972. 6 refs.

The Pye-Unicam SP 90 type absorption spectrophotometric (made in Great Britain) combined with the Riken SPG-4 type recorder was used to determine lead in blood and urine. Using the standard lead liquid of 50 ng/dl reduced to APDC complex as the extraction solvent and lamp current set at 10 mA, sensitivity increased linearly with the slit width set at 0.1-0.2 mm but noise also increased, making the value reading impractical. The standard setting of the slit width was set at 0.2 mm. The effect of the addition of formamide on promoting ionization of organics was examined. Addition of formamide resulted in increased absorbancy, but the increase remained about the same with a 2-10 ml addition, so 2 ml was used. When 2 ml of 2% water solution of the chelate agent was used, APDC-MIBK gave the most stable chelate formation in a wider pH range. The extraction was made in the condition that pH of the test sample was on the acidic side. Recovery rate for lead in the blood was 97% and in the urine, 101.2%. The normal deviation factor was 2.76 for the blood and 3.78 for the urine. The effect of coexisting elements was reviewed; their effects should be negligible under normal conditions. Reproducibility was 99.4% w/normal deviation of 1.51.

42698

Mappes

**DIRECTIONS FOR LEAD DETERMINATION IN BLOOD AND URINE WITH DITHIZONE.** (Vorschrift zur Bleibestimmung in Blut and Urin mit Dithizon). Preprint, Staatliche Gewerbearzt fuer Westfalen (West Germany), 1968. Translated from German. Leo Kanner Assoc., Redwood City, Calif., 6p., Dec. 1971.

A detailed description of the determination of lead in blood and urine by the use of dithizone is given. The wet ashing is performed with sulfuric acid, nitric acid and perchloric acid. In the continued course of the analysis, precipitation through citrate is avoided and other dithizon metals are masked by potassium cyanide for tin, indium, bismuth, and thallium, which do not interfere for a variety of reasons. A detailed description of the determination of lead in dust which also contains soot and sulfate is given. Possibly present tetra-valent lead is reduced to bi-valent lead by heating the sample of dust with hydrochloric acid. The final sample solution may be diluted with addition of ammonium citrate according to the lead content.

42716

Sachs, Henrietta K., Lorry A. Blanksma, Edward F. Murray, and Morgan J. O Connell

**AMBULATORY TREATMENT OF LEAD POISONING: REPORT OF 1155 CASES.** Pediatrics, 46(3):389-996, Sept. 1970. 5 refs.

Subjects with lead concentrations greater than 50 micrograms/100 ml whole blood were referred to a Chicago municipal lead poisoning clinic for evaluation. Chelating agents were administered when two blood lead levels were more than 50 micrograms, or calcium disodium edetate (EDTA) provocative test yielded over 1000 micrograms/l of lead in the urine in the succeeding 8 hr. Therapy was on an ambulatory basis, but patients with moderate encephalopathy were hospitalized. Intramuscular EDTA, oral penicillamine, or the two drugs in sequence were given to 582 patients in 1967 and to 573 patients in 1968. Clinical evidence of lead intoxication was present in 103 or 8.9% of the 1155 patients. Several drug reactions to penicillamine were observed, but none to EDTA. Mortality dropped due to early detection and detoxification of subclinical cases of lead poisoning. (Author abstract modified)

42737

Calvery, Herbert O.

**CHRONIC EFFECTS OF INGESTED LEAD AND ARSENIC.** J. Am. Med. Assoc., 111(19):1722-1729, Nov. 5, 1938. 34 refs. (Presented at the American Medical Association, Annual Session, 89th, San Francisco, Calif., June 17, 1938.)

The minimum amounts of lead and arsenic were determined that, when ingested periodically, would cause effects which could be attributed directly to these elements. Rats and dogs were used as experimental animals. Since it was essential to know the effect of lead and arsenic separately as well as in combination, the salts selected for initial investigation were lead arsenate, calcium arsenate, lead acetate, and arsenic trioxide. The concentrations of these in the diets ranged from a fraction of a milligram to several hundred milligrams per kilogram. There was definite storage of lead in all organs and tissues examined at all levels fed. The storage of arsenic was also shown, even at the lowest levels fed. Variation of the calcium content from a low level approximating that of a large percentage of the human dietary to a higher level markedly influenced the storage and toxicity of lead, and a variation in the calcium to phosphorus ratio influenced the storage of arsenic. Calcium arsenate was more toxic and caused greater storage than did arsenic trioxide at the same level. There was no difference observed in the toxicities of lead acetate and lead arsenate when fed at the same relatively low levels, but at high levels the lead arsenate was the more toxic. Even at the lowest level of added lead, there was a significant effect on the growth rate of male rats and on both males and females at higher levels. In some cases there was also an influence on the intake of food. No significant differences were noted between the control and the experimental rats in either the P1 or the F1 generations on the fertility and fecundity. Both lead and arsenic are transferred from the mother s tissues to the fetus and lead is transferred in the milk. Even at the lowest levels of the intake of lead (0.61 ppm) the average concentration of lead of a large number of newborn animals was the same as that of the diet of the mother.

42757

Kehoe, Robert A., Frederick Thamann, and Jacob Cholak

**ON THE NORMAL ABSORPTION AND EXCRETION OF LEAD. I. LEAD ABSORPTION AND EXCRETION IN PRIMATIVE LIFE.** J. Ind. Hyg., 15(5):257-272, Sept. 1933. 22 refs.

Two isolated Mexican communities were studied in an attempt to measure the physological activity of lead in societies not influenced by the industrialized world. Urine and feces were taken from 95 subjects and analyzed for lead content. Lead content in feces was equivalent to the amounts of lead ingested daily. The presence of lead in human excreta is an inevitable consequence of life on a lead bearing planet. A basis has been provided for the appraisal of results obtained in a highly industrialized society. Lead in soil, water, pottery, food, blood, urine, and feces was measured.

42759

Moeschlin, Sven

**INORGANIC POISONS. METALS. LEAD (PB).** In: Poisoning. Diagnosis and Treatment. New York, Grune and Stratton, 1965, p. 45-71. 139 refs. Translated from German by Jenifer Bickel.

The toxic effects of lead in humans are reviewed. As with other metals, the toxic effect of the lead atom is most likely due to its integration into different cellular enzymes. The disturbance of normal porphyrin metabolism appears to play a significant part. An early sign of lead poisoning is the blockage of porphobilinogen synthesis through inhibition of the combination of two molecules of delta-aminolevulinic (ALA) acid. A high level of ALA in the urine is one of the best indicators of early lead hazard. The most common subjective symptoms of lead poisoning are weakness, anorexia, tiredness, nervousness, tremor, nausea, loss of body weight, headache, and gastric pain. Objective symptoms include constricted arterioles, loss of weight, increased delta-aminolevulinic aciduria, porphyinuria, constipation, blood and bone marrow changes, lead line along the margin of the gums, and weakness of extensor muscles. Lead encephalopathy is also considered. Specific and symptomatic treatments for chronic lead poisoning are described.

42881

Rondia, D.

**TOXICITY OF ENGINE EXHAUST GASES.** (Toxicite des gaz d echappement de moteurs). Text in French. Cent. Belge Etude Doc. Eaux, 25 (338):33-40, Jan. 1972. 12 refs.

The toxic effects of engine exhaust components (carbon monoxide, lead compounds, and hydrocarbons) and results of concentration measurements in cities are reviewed. Carbon monoxide concentrations in urban areas with high traffic density averaged 7 ppm. The concentrations over sidewalks ranged from 10-25 ppm, and those inside cars were about three times higher than outside, reaching 100 ppm in some cases. The CO concentrations measured in tunnels and congested traffic were 40-60 ppm. The toxic effect of CO is usually determined by hemoglobin CO content. The primary reactions between CO and hemoglobin are completely reversible. The quantity of CO incorporated in hemoglobin is a function of the atmospheric CO concentration, exposure time, and respirations rate. Some 20% of the CO inhaled is blocked in myoglobin. Visual acuity is impared by a COHb content of 2.5%, and 5% of COHb causes significant modification of the psychomotor response. Chronic poisoning tests on rats revealed inactivation of liver enzymes responsible for metabolizing organic poisons and morphological modifications in both cerebrum and myocardium. Some 80% of the lead added to gasoline is discharged in the form of fine particles (below 1 micron) of bromide, chloride, and lead oxide; 20-50% of the particles is resorbed by the lungs and 10% by the digestive tract. The blood lead content in urban inhabitants is 30 micrograms/100 ml, while the lead concentration in city air is 1-3 micrograms/cu m. Lead causes anemia by inhibiting hemoglobin- synthetizing enzymes. Lead accumulation in the organism increases with increased lead concentrations in air and food. While aliphatic hydrocarbons are of relatively low toxicity, certain particulate polycyclic hydrocarbons, formed especially at low engine speeds, are carcinogenic. Concentration measurements indicate the major role of automobiles as polycyclic hydrocarbon emission sources in comparison with domestic heating.

42884

Haeger-Aronsen, Birgitta, Mohammed Abdulla, and Bengt I. Fristedt

**EFFECT OF LEAD ON DELTA-AMINOLEVULINIC ACID DEHYDRASE ACTIVITY IN RED BLOOD CELLS.** Arch. Environ. Health, vol. 23:440-445, Dec. 1971. 34 refs.

The determination of delta-aminolevulinic acid dehydrase (ALAD) activity in erythrocytes as a suitable method for demographic studies of exposure to lead is examined. The variation of ALAD activity with the concentration of delta-aminolevulinic acid in the urine and the variation of ALAD activity with the concentration of lead in the blood were both exponential and the correlations inverse. Values were determined for hemoglobin level, lead concentration in the blood, aminolevulinic acid level in the urine, and ALAD activity in red blood cells in children, a control group of normal men and women, traffic personnel, and men with moderate or severe exposure to lead. ALAD activity in red blood cells varied significantly with sex. No significant difference was found in blood lead level or acid content in the urine between traffic personnel and normal men; the activity of ALAD in erythrocytes, however, was higher in the traffic personnel. The activity of ALAD in erythrocytes, however, was higher in the traffic personnel. The activity of ALAD in erythrocytes accurately reflects the blood lead level; the test is too sensitive, however, for routine followup of the degree of lead intoxication in occupationally exposed workers.

42957

Xintaras, C., M. F. Sobecki, and C. E. Ulrich

**SLEEP CHANGES IN RAPID-EYE-MOVEMENT PHASE IN CHRONIC LEAD ABSORPTION.** Toxicol. Appl. Pharmacol., vol. 10:384, 1967.

An abstract is given of research on the effect of chronic lead absorption on the electroencephalogram (EEG) record. Male rats were implanted with cortical reading electrodes and placed in electrically shielded chambers. Water containing lead acetate (1.5 mg/kg) was available ad libitum. To relate changes in the EEG record with behavioral changes, rat behavior, e.g., alert wakefulness and quiet sleep, was observed via a closed-circuit TV system. In the transition from wakefulness to sleep, the normal adult rat exhibited a typical succession of EEG changes similar to those found in man. The rapid-eye-movement (REM) sleep phase, a period of intense central nervous system activity, was entered by way of 15-cycle-per-second sleep spindles and was characterized by regular waves of 6 to 10 cycles per second. REM epochs were more abundant during the later part of the sleep record, i.e., late afternoon. Lead acetate induced changes in the duration and stability of the REM periods. Excessive spindle-slow-wave complexe appeared during periods of REM sleep. Treated animals showed more REM sleep during the early sleep periods compared to controls. These findings suggest that alterations in the REM phase in lead- treated animals may be directly or indirectly associated with an impaired neural control system. (Author abstract modified)

43196

Prerovska, I. and J. Teisinger

**EXCRETION OF LEAD AND ITS BIOLOGICAL ACTIVITY SEVERAL YEARS AFTER TERMINATION OF EXPOSURE.** Brit. J. Ind. Med. (London), vol. 27: 352-355, 1970. 12 refs.

A group of 27 persons who had been treated some years previously for chronic lead poisoning, and who had not come into occupational contact with lead since, was examined. Half of them had had no occupational exposure to lead for 3-5 yrs and the others for 8-17 yrs. In most of these persons there was still an increased lead excretion, originating from an increased deposit in the bones. The mobilization test after calcium versenate injection was greater than 0.350 mg/24 hr. The values found for hemoglobin, punctate basophilia, coproporphyrin and delta-aminolevulinic acid in urine were normal, but there was, in all cases, a decreased delta-aminolevulinic acid-dehydrase activity. The finding that lead is biologically active in very low concentrations raises a host of questions, such as what other enzymes or biological systems are affected by lead and perhaps by other metals. (Author abstract modified)

43277

Goldstein, Gerald

**BIOCHEMICAL INDICATORS OF ENVIRONMENTAL POLLUTION.** Preprint Oak Ridge National Lab., Tenn., Analytical Biochemistry Group, 39p., 1972. 176 refs.

Several studies related to the concept of biochemical indicators as monitors of environmental quality are reviewed Several kinds of tissues and organs are potentially useful as indicators including plant tissues, various animal tissues, and blood. One study done with plant tissues showed that exposure to Peroxyacetyl nitrate, ozone, and fluorides inhibits the biosynthesis of cellulose due to the inactivation of phosphoglucomutase and cellulose synthetase. By studying various enzymes in fish, it is possible to determine the effects of pesticides and toxic metals. A dietary level of 5 ppm of DDT reduced the activity of glucose-6-phosphate dehydrogenase in rats. Guinea pigs were exposed to 15 ppm of nitrogen dioxide continuously for 10 weeks, and lung, liver, spleen, and kidney tissues subsequently examined. Lactic dehydrogenase and aldolase levels were elevated in most tissues. This indicates that chronic inhalation of air pollutants can cause alterations in tissue enzyme activity levels which can be detected and used as sensitive indicators. The measurement of cholinesterase activity in human blood plasma and erythrocytes can be used as an indicator of exposure to organophosphorus and carbamate pesticides. A decrease in the gamma-aminolevulinic acid dehydrase level may indicate exposure to lead. Nitrogen dioxide has been tested against mouse liver and rabbit and rat lung cell cultures. In the first case, increased cell mortality was observed and in the latter, a reduced oxygen consumption reflecting reduced cellular metabolism. Sulfur dioxide inhibits the growth of mouse liver cells and damages human lymphocytes in culture. Ozone inhibits the growth of human strain L cells. Peroxyacetyl nitrate inactivates isocitric dehydrogenase, glucose-6-phosphate dehydrogenase, and malic dehydrogenase within a few minutes. Ozone inactivates papain and glyceraldehyde-3-phosphate dehydrogenase. Atmospheric SO2 and 03 inactivate acetylcholinesterase.

43337

Cernik, A. A. and M. H. P. Sayers

**DETERMINATION OF LEAD IN CAPILLARY BLOOD USING A PAPER PUNCHED DISC ATOMIC ABSORPTION TECHNIQUE. APPLICATION TO THE SUPERVISION OF LEAD WORKERS.** Brit. J. Ind. Med. (London), 28(4).392-398, 1971. 10 refs.

The presence of lead in blood is the most incontrovertible evidence of absorption. Previously, the need for venepuncture has limited lead determination in the supervision of industrial workers. Micro-methods, using atomic absorption spectrophotometry (AAS), have made possible the development of a sufficiently reliable test using a drop of blood, obtainable by ear prick, for use in the field for screening purposes. A micro-sampling method by AAS is compared with a routine polarographic procedure (POL) using venous blood. The pipetting of microliters of blood can be eliminated by spotting the blood onto filter paper, allowing it to dry in air, and then using a punched-out standard disc of dried blood for analysis. Correlation of this method (PD) with the micro-sampling technique (AAS) is good. The PD method using capillary blood also correlates acceptably with the micromethod using venous blood. A pilot field study using capillary blood estimated by the PD technique showed that, with this method, blood can be collected by ear prick in factories for monitoring workers in the lead industry. (Author abstract modified)

43531

Pentschew, A. and F. Garro

**LEAD ENCEPHALO-MYELOPATHY OF THE SUCKLING RAT AND ITS IMPLICATIONS ON THE PORPHYRINOPATHIC NERVOUS DISEASES. WITH SPECIAL REFERENCE TO THE PERMEABILITY DISORDERS OF THE NERVOUS SYSTEM S CAPILLARIES.** Acta Neuropathol., vol. 6:266-278, 1966. 23 refs.

Experimental lead encephalo-myelopathy of the suckling rat is the signpost on the road of uncovering prolonged metabolic dysoxidosis as the major pathogenetic principle in lead encephalopathy and in the other porphyrinopathic encephalopathies. This principle rests on the specific skill of the capillary endothelium of the nervous system to act as regulator of the blood-brain and blood-spinal cord barriers and on the extreme susceptability of this skill to chronic metabolic dysoxidosis. This same pathogenetic priniciple lies at the root of a group of neurological diseases for which the name system-bound dysoric encephalopathies is proposed. In contrast to lead encephelopathy of the suckling rat, human lead encephalopathy does not belong to this group because of added hemodynamic disorders. Such disorders prevent a pathoclitic distribution of the lesions. (Author summary modified)

43532

Waxman, Herbert S. and Marco Rabinovitz

**CONTROL OF RETICULOCYTE POLYRIBOSOME CONTENT AND HEMOGLOBIN SYNTHESIS BY HEME.** Biochim. Biophys. Acta (Amsterdam), vol. 129: 369-379, 1966. 39 refs.

Hemin was found to enhance polyribosome stabilization and formation as well as globin synthesis, thus duplicating the previously demonstrated effects of iron salts. Similar enhancing effects on polyribosome and globin production were seen with cobaltous ion, deuterohemin and zinc protoporphyrin. Nickel deuteroporphyrin was partially effective. Little or no effect was noted with other metal cations, metalloporphyrins or protoporphyrin IX. Lead ion, an inhibitor of both heme and globin synthesis in the reticulocyte, caused disaggregation of polyribosomes and marked suppression of protein synthesis. Hemin was more effective than iron in preventing the effect of lead on polyribosomes, but was less able to prevent the the inhibition of hemoglobin synthesis. Hemin, but not iron, was shown to protect polyribosomes against subsequent disruption by a high concentration of 2,2 prime-bipyridine and to reverse an established inhibition by lead. These results indicate that hemin is the intracellular mediator of polyribosome assembly;

the metalloporphyrin in some manner induces the aggregation of monomeric ribosomes and, presumably, messenger RNA into functional polyribosomes. (Author summary modified)

43559

Prendergast, W. Dowling

**THE CLASSIFICATION OF THE SYMPTOMS OF LEAD POISONING.** Brit. Med. J. (London), vol. 1:1164-1166, May 14, 1910.

Two main systems of classification of lead poisoning symptoms may be made. The first deals with the action of lead on the brain and nervous system, the sensory-motor apparatus, and the involuntory muscles. The second system, which is described in detail, is divided into two headings: Saturnina mitior and Saturnina gravior. The symptoms of Saturnina mitior include digestive disorders, cachexia, slight blue line on the gums, slight colic, anemia, pain in the trunk and limbs, loss of appetite and vomiting, polyurea, and slight albuminaria. If the individual continues to absorb lead, the symptoms of Saturnina gravior appear. These include marked cachexia and emaciation, acute prolonged colic, fetid breath, paralysis of the arms and legs, a well-marked blue line on the gums, acute pains in the head, disturbance in vision, tremors, suppression of urine, and convulsions.

43615

Esch, G. J. Van and R. Kroes

**THE INDUCTION OF RENAL TUMOURS BY FEEDING BASIC LEAD ACETATE TO MICE AND HAMSTERS.** Brit. J. Cancer (London), 23(4):765-771, 1969 10 refs.

Basic lead acetate was given to mice in a dose level of 0.1% and 1%/0.5% and to hamsters in a dose level of 0.1% and 0.5% in the diet. In the mice in the 0.1% group, seven renal tumors were found in 50 animals. In the 1.0%/0.5% group only one renal tumor was found. Most mice of the 1.0%/0.5% group and hamsters of the 0.5% group died early in the experiment, because of intoxication by the basic lead acetate. In hamsters no tumors of the kidneys could be found. Other specific alterations ascribable to the basic lead acetate were found in both animal species. In view of the fact that in rats and mice renal tumors were induced, it is suspected that basic lead acetate is also carcinogenic to hamsters. (Author summary modified)

43725

Scanlon, John

**FETAL EFFECTS OF LEAD EXPOSURE.** Pediatrics, 49(1):145-146, 1972.

It has been demonstrated that concentrations of lead found in the average child (20 to 40 micrograms/100 g whole blood) can inhibit delta-aminolevulinic acid (ALA) dehydratase activity. In suckling rats these usual lead levels inhibit ALA dehydratase activity in the blood and brain. Furthermore, the brain enzyme activity correlated with blood ALA dehydratase activity, suggesting that blood ALA dehydratase may be a useful measure of central nervous system enzyme activity. A small number of umbilical cord bloods from normal new-born infants revealed a mean lead level of 22 micrograms/100 g. It would be reasonable to expect that ALA dehydratase activity might have been diminished in utero at these lead levels. If these postulated intra-uterine enzyme effects do occur, they must be documented; this kind of knowledge will further understanding of the environment and of basic fetal physiology.

44053

Piscator, Magnus and Birger Lind

**CADMIUM, ZINC, COPPER, AND LEAD IN HUMAN RENAL CORTEX.** Arch. Environ. Health, 24(6):426-431, June, 1972. 12 refs.

Analysis of cadmium and zinc in the renal cortex of 67 Swedish subjects disclosed the same dependence on age as in United States subjects. In the 6-50 year age group, cadmium content and the cadmium-zinc ratio were correlated to age; thereafter, there was a decrease in cadmium and zinc and in the cadmium-zinc ratios. The increase in zinc paralleled the increase in cadmium. The difference between total zinc and the amount of zinc equivalent to the amount of cadmium provides a measure of the physiological zinc content of the cortex; this fraction, 160 ppm (based on dry weight of renal cortex), did not vary with age. In the age groups over 60, cadmium content was significantly lower in women than in men. That the levels of copper did not vary with age indicated that, when there is no excessive exposure to cadmium, copper metabolism in the kidney will not be disturbed. Lead showed an increase with age. However, the amounts were small in comparison with the cadmium levels, and normal exposure to lead can hardly be a contributory factor in kidney disease. The necessity of supplying adequate amounts of zinc to people exposed to cadmium is considered, as it is through that some forms of hypertension in man may result from a relative zinc deficiency through accumulation of cadmium. (Author abstract modified)

44087

Fujii, T., Y. Akashi, K. Kurosaka, K. Yoshimura, K. Inoue, K. Taguchi, F. Go, and K. Oka

**STUDIES ON THE LOCAL AIR POLLUTION. (1) AIR POLLUTION SURVEY NEAR NAKATESHIMA PRIMARY SCHOOL IN TOYONAKA CITY.** (Genkyokusei taiki osen ni kansuru kenkyu. (1) Osakafu Toyonaka-shi Nakateshima Shogakko fukin ni okeru taiki chosa). Text in Japanese. Osakafu Kogai Kanshi Senta Chosa-Shitsu Kenkyu Hokoku (Proc. Res. Sect. Osaka Environ. Pollution Control Center), no. 2:49-54, Dec. 1971.

On July 22 and 23, 1970, during the course of a swimming lesson, 60 children out of 240 children of the Primary School in Toyonaka City suddenly started to cough. Some animals in the same school died at the same time. Air pollution by photochemical reaction was the suspected cause. Nitrogen dioxide, hydrocarbons, carbon monoxide, dust, oxidants, sulfur oxides,and lead compounds were measured. On July 22, wind direction was west, and the velocity was 2 m/sec; the temperature was 35 C; and the humidity was 50%. There was no proof that oxidant significantly increased on this day. It is difficult to determine what was the real source of pollution. It was assumed that the source is west of the school. However, there is an incinerator near the school in which wood, paper, and plastic material were burned outside.

44176

Kaltstein, Andrej

**ENVIRONMENTAL PROTECTION AS A SOCIO-POLITICAL DEMAND OF THE 70 S.** (Umweltschutz als gesellschaftspolitische Forderung der 70er Jahre). Text in German. Oeffentl Gesundheits wesen (Stuttgart), 34(6):343-348, June 1972.

Of the total air pollution, 80% is attributed to traffic. The following harmful substances are emitted by automobiles: Hydrocarbons, nitrogen oxides, carbon monoxide, and lead. The nitrogen oxides are extremely toxic. They irritate the mucuous membranes which manifests itself by irritation of the

eyes, sore throat, and cough. In higher concentrations they may cause pneumonia. The maximum allowable emission concentration is 0.5 ppm. In Munich this value is exceeded at many points. The average CO concentration in the air above Munich is 30 ppm. Eight hour exposure to this concentration leads to reduced capacity and affects the heart contractions. The hydrocarbons contain carcinogenic substances such as benz-3,4-pyrene. A close relationship between the lung cancer rate and the increasing traffic density exists. In the center of Essen, where traffic is particularly dense, the lung cancer rate is 10 times higher than in rural areas. In German cities a lead concentration of 5 to 10 mg/cu m air is measured. In Moscow, where leaded gasolines are outlawed, the lead concentration in the air is only 0.7 mg/cu m. Lead is particularly well retained by the lung. It tends to be stored in the body. The causes for the ever increasing air pollution must be seen in the ever expanding economy and in the individual freedom of our society.

44251

Buckup, Heinrich

**LEAD FROM THE VIEW OF OCCUPATIONAL MEDICINE.** (Dad Blei aus arbeitsmedizinischer Sicht). Text in German. Z. Erzbergbau Metallhuettenwesen, 25(7):323-326, July 1972. 12 refs.

The atmospheric air we breath contains considerable lead concentrations which come mainly from the exhaust gases of automobiles operated with leaded gasolines. Extensive measurements of the atmospheric lead concentration were taken all over the industrialized world. Extremely high concentrations were measured in Japan (60 micrograms/cu m) and in the United States (120 micrograms/cu m). Recent measurements in Frankfurt yielded concentrations between 2.3 and 7.0 micrograms/cu m. The lead which is breathed by humans with the ambient air is usually in form of very fine-grained dust (weighing less than 1 microgram). Generally it is assumed that about 50% of the particles are retained and 100% of the retained lead is absorbed. In the Federal Republic of Germany the maximum allowable emission concentration is 2 micrograms/cu m air. The absorbed lead circulates in the blood and tends to deposit in the bones. Chromosome damage by lead compounds has been reported. Lead diseases by occupational exposure are on a downward trend. In the year 1965, 237 cases were reported of which actually 118 had the disease. Of them only 10% were incapacitated for more than 3 months.

44254

Roussel, Andre

**ACCOUNT OF THE BIOLOGICAL RESEARCH CONDUCTED AT THE AIR POLLUTION RESEARCH CENTER OF THE NATIONAL HEALTH AND MEDICAL RESEARCH INSTITUTE.** (Etude des recherches biologiques effectuees au centr de recherches sur la pollution atmospherique de l institut national de la sante et de la recherche medicale). Text in French. International Union of Air Pollution Prevention Associations, Proc. Int. Clean Air Congr., 2nd, Washington, D. C., 1970, p. 221-234. (Dec. 6-11, Paper MB 27A.)

The action of carbon monoxide and of engine exhaust on the hematological and biochemical parameters of rats and mice constituted some of the basic fields of the research carried out at the Air Pollution Research Center of the French National Health and Medical Research Inst. between 1968 and 1970. Sprague Dawley rats and CFL mice were exposed to 50 ppm CO in plexiglass-made 2.0 cu m chambers for two years or to engine exhaust (50 cu cm/cu m CO, 0.2 cu cm/cu m nitrogen oxides, and 0.1 cu cm/cu m aldehydes) in polyvinyl chloride chambers for five months. Blood sugar, total serum protein, total lipid, cholesterol, calcium, magnesium, and serum glutamate-oxaloacetate and glutamate pyruvate transaminase levels were found to be similar in the CO-treated and control rats. Hemoglobin, erythrocytes and leukocytes, and the electrocardiogram revealed no significant differences between the experimental groups. Exposure to engine exhaust produced considerable differences in the liver and spleen water content, in total serum lipids, and in the serum glutamate oxaloacetate transaminase levels. The significant increases in neutrophiles were attributed to the presence of lead in the engine fuel composition. Mice exposed to exhaust condensates for 11 months were lower in weight, compared to the controls, 6 months after the beginning of the experiment. No immunological alterations could be ascertained in the exhaust-treated groups. Studies on the relationship between tumor transplant susceptibility and leukemia incidence and CO and exhaust exposure on AKR mice are in progress. Development of staphylococcus aureus or pseudomonas aeruginosa was not affected by the high CO and CO2 concentrations occurring in a highway tunnel of the Paris region with an average 80,000 vehicle/day traffic. A five-year epidemiological study relating air pollution (sulfur dioxide, dust, and CO), meteorology, alcoholism, and lung cancer incidence in four cities in France is in progress.

44255

Ghelberg, N. W., Ileana Costin, Rodica Tomus, Susana Nagy, G. Torner, Elisabeta Major, and L. Baki

**COMMUNITY AIR CONTAMINATION WITH LEAD-RELATED BLOOD ALTERATIONS OCCURRING IN THE ADULT POPULATION.** (Modificari sanguine la populatia adulta in functie de poluarea atmosferei comunale cu concentratii variabile de plumb). Text in Rumanian. Clujul Med., 44(2):447-454, 1971. 25 refs.

Blood samples taken from two adult population groups, one dwelling in an industrial urban area with non-ferrous metallurgical plants and the other living in a non-polluted area, were analyzed to study the effects of lead on the community health condition. The average lead level of the polluted city air ranged between 20.8 and 22.2 micrograms/cu m. Reticulocytes, total hemoglobin, erythrocytes with Heinz bodies, glucose-6-phosphate dehydrogenase, erythrocytes with F hemoglobin, ceruloplasmin, serum sodium and potassium cations, and serum protein immunoelectrophoresis were investigated. Although all the values were within the normal limits in the blood samples of both the population groups, the number of reticulocytes, Hb F erythrocytes, blood G-6-PD serum ceruloplasmine, and sodium were significantly increased in the samples taken from the lead- polluted area. No differences in total hemoglobin levels were found. Decreased albumin precipitation bands and increased immunoglobulin G and beta 1c bands occurred in the serum of lead- polluted area dwellers. The above parameters should be applied as mass indicators in the follow-up of community health conditions as affected by long-term exposure to low lead concentrations occurring in the urban air.

44294

Schubert, Ralph H. W. and H. Sangl

**THE PROBLEM OF LEAD EXPOSURE CAUSED BY THE EXHAUST GASES OF MOTOR VEHICLES. A CONTRIBUTION TO THE APPLICABILITY OF THE DETERMINATION OF DELTA-AMINOLAEVULINIC ACID IN URINE AS A CRITERION FOR THE LEAD EXPOSURE CAUSED BY ENVIRONMENTAL FACTORS.** (Zur Frage der Bleibelastung durch Autoabgase. Ein Beitrag zur Verwendbarkeit der

Aminolaevulinsaeure-Bestimmung im Harn als Kriterium fuer die Umweltbedingte Bleibelastung). Text in German. Zentralbl. Bakteriol., Parasitenk. Infektionskr. Hyg: Abt. 1: Orig., Reihe B, 155(5-6):470-475, June 1972. 17 refs.

A comparative determination was made of the lead concentration in the blood and the delta-aminolevulinic acid excretion in the urine of 127 patrolling policemen, 59 policemen working in offices, and 38 street wardens in the city of Frankfurt am Mein. The average value of the lead concentration in blood in all three groups did not differ significantly. The values reflected the increased lead intake of the city population. The delta-aminolevulinic acid excretion in the urine never exceeded the limit of 10 mg delta-aminolevulinic acid/g creatinine relevant for diagnosis of lead intoxication in occupational medicine. A correlation between lead concentration in blood and delta-aminolevulinic acid excretion in urine cannot be stated in this field of environmental lead exposure. (Author abstract modified)

44364

Scanlon, John

**HUMAN FETAL HAZARDS FROM ENVIRONMENTAL POLLUTION WITH CERTAIN NON- ESSENTIAL TRACE ELEMENTS.** Clin. Pediatr., 11(3):135-141, March 1972. 41 refs.

Mercury, lead, cadmium, arsenic, titanium, nickel, vanadium, and niobium are some of the trace elements which might reach the fetus because of environmental pollution. It is postulated that the ability of living things to absorb trace metals from the environment is inversely related to the concentration of cadmium in the environment, and it appears that there are other rather complex interactions among the single elements. To evaluate the interuterine effects of any pollutant it is necessary to consider the genetic background of the fetus. Data on the alteration of fetal nutrition by the effects of the trace metals is extremely scarce, and in light of the adverse effects of these elements upon adults and other forms of life, and the ability of these materials to cross into the placenta, a need for information in this area is identified.

44381

Brooks, Robert E.

**ULTRASTRUCTURAL HISTOPATHOLOGY OF LUNGS OF LABORATORY RATS EXPOSED TO ENVIRONMENTAL AGENTS.** In: Annual Progress Report. June 1, 1971 to May 31, 1972. Oregon State Univ., Corvallis, Environmental Health Sciences Center, Center for Environmental Management Proj. 15, p. 83-84, 1972.

Lung tissues from rats exposed for up to 372 days to dietary dieldrin, dietary methyl mercuric chloride, dietary lead acetate, atmospheric carbon monoxide, atmospheric nitrogen dioxide, and dieldrin in combination with other agents are being processed for both routine histopathological study and detailed electron microscopic examination. Specimens are carefully examined for blood vessel damage, airway injury, edema, inflammation, and cell proliferation. At the electron microscopic level, tissues are examined for intracellular alteration and disturbances of cell-to-cell relationships. Preliminary gross and light microscopic examination of dieldrin-treated (5 ppm) rats indicated that most lung tissues are relatively normal. Some dieldrin-treated rats showed an increased incidence of lobular pneumonia as well as small focal pneumonic involvement--an emphysema-like condition--and an arteritis involving medium sized arteries. No morphological alterations was detected in rat lungs due to administration of dietary lead (3 ppm) or dietary methyl mercuric chloride (2 ppm). Similarly, no effect on lung tissue from inhaled carbon monoxide (100 ppm) was detected. Inhalation of NO2 (3 ppm) in air for up to 233 days resulted in relatively little peripheral lung damage, although mucus production in distal bronchioles was increased.

44385

Fink, G. B.

**PHARMACOLOGICAL EFFECTS OF PESTICIDES.** In: Annual Progress Report. June 1, 1971 to May 31, 1972. Oregon State Univ., Corvallis, Environmental Health Sciences Center, Environmental Toxicology of Pesticides Proj. B-8(1), p. 168-172, 1972.

The toxicity of organochlorine insecticides, lead, and carbon tetrachloride, the interactions among these agents, and neuropharmacologic parameters of seizures induced by the agents were studied in experimental animals. Median lethal doses for lead and for the organochlorine insecticides were determined. Female mice were more susceptible to the toxic effects of lead over a longer period of time than males. The organochlorine insecticides increased the susceptibility of mice to clonic seizures produced by electrical stimulation and by intravenous infusion of pentylenetetrazol. Although lead intoxication is reported to precipitate convulsions, little effect of lead on experimental seizure thresholds was noted. Lead also had little effect on rotating rod performance, whereas dieldrin exhibited definite impairment that was dose related. The effect of endrin on rat heart muscle was studied in vitro. Endrin did not alter the development of contractile force in the isolated trabecular muscle of the rat heart. Exposure of rats to low levels of DDT greatly potentiates the hepatotoxicity of CCl4 as demonstrated by increased serum transaminase levels, altered liver function tests, and histopathologic changes.

44395

Zielhuis, R. L.

**INDUSTRIAL MEDICINE AND ENVIRONMENTAL HEALTH.** (Bedrijfsgeneeskundig onderzoek geleid door het milieu-buiten-de-poort). Text in Dutch. Tijdschr. Soc. Geneesk., 50(2):34-40, 47, Jan. 1972. 21 refs.

The tasks priorities of the occupational physician are outlined with regard to environmental hygiene. By combining their observations of workers with the investigation of the ambient environment, occupational physicians will gain deeper insight into the public health effects of environmental factors with regard to the health of workers. Possibilities of such an approach, and basic fields on which investigations should focus, are described. Carbon monoxide, for which a maximum allowable hour concentration of 50 ppm, corresponding to a CO hemoglobin level of 8%, is required, may cause arteriosclerosis. Rabbits exposed to CO fo over 8 weeks (10-15% of COHb) developed aterial arteriosclerosis. Arteriosclerotic patients had higher COHb levels than healthy individuals. Inhaled asbestos is capable of producing pleural or peritoneal mesothelioma, particularly in aged persons. Lead, even in small amounts. reduces the delta-aminolevulinic acid dehydratase activity and the metabolism of tryptophan. Animals exposed chronically to lead had shorten lives as compared to the control group, and lead concentrations in their tissues were largely the same as in the population in the U. S.

44433

Kanagawa Prefecture (Japan)

**EFFECTS OF AIR POLLUTION.** In: Report No. 13 on Survey of Air Pollution in Kanagawa Prefecture. (Kanagawa-ken

taiki osen chosa kenkyu hokoku Dai-13-po). 1971. 35 refs. Translated from Japanese. Scientific translation Service Inc., Santa Barbara, Calif., 42p.

In the first of two studies reported, the lead content in roadside trees and in the dust adhering to the leaf surfaces was measured by atomic absorption photometry. The effects of hydrochloric, nitric, and sulfuric acids on the absorbance were investigated. Results showed that hydrochloric acid is suitable for dissolving incinerated plant samples. The amounts of lead contained in the leaves of roadside trees (gingko, platanus, sultan s parasol, and horse chestnut) were also investigated. The amounts were found to be 49 ppm in gingko, 25 ppm in platanus, and 50-60 ppm in sultan s parasol and horse chestnut. Large amounts of lead were contained in the gingko trees along the prefectural highway from Ogimachi to the Kawasaki station and in the horse chestnuts along the Isogo-Daikoku highway. There was a tendency for the amount of lead to increase seasonally in June and July. In a second study health survey questionnairies were distributed to 41,584 kindergarten children living in each of the five Yohohama areas selected for study. No relationship was found between a tendency to colds and sulfur trioxide concentration. There was a relationship between SO3 concentration and complaints of sore throats, eye trouble, incidence of asthma attacks, and proneness to eczema and urticaria. There was also an increase in complaints as SO3 concentration increased.

44463

Lourie, Reginald S., Emma M. Layman, and Frances K. Millican

**STUDIES OF PICA IN CHILDREN THROW LIGHT ON WHY CHILDREN EAT THINGS THAT ARE NOT FOOD.** Children, 10(4):143-146, July-Aug. 1963. 6 refs.

For the past eight years the Children s Hospital of the District of Columbia has been conducting studies of children with pica--a craving to eat bizarre substances not intended as food. The studies grew out of concern over an increasing number of lead poisoning cases in preschool children. Ninety-five of the children from the hospital pica clinic, 36 with lead poisoning, were studied intensively in the psychiatric phase of the research. The investigation included interviews with the parents, psychological testing of the child by a clinical psychologist, a playroom interview with the child by a psychiatrist, a Rorschah test of the mother, and follow-up studies of several of the children. In a random survey of 859 children, pica occurred chiefly among preschool children, the greatest incidence occurring in children between 18 months and two years. In lower socio- economic groups the incidence among children in this age group was between 50 and 60%; in higher income families, about 30%. Four emotional climates in which pica may develop are described. It may be an attempt by a young child to solve the problem of meeting his oral needs when the mother is unavailable. It may represent excessive oral gratification resulting from overstimulation by the mother. It may represent agression directed toward the mother as a continuation or displacement of early conflicts over feeding, especially around introduction of solid foods. Pica may also be accentuated or perpetuated by brain damage affecting perceptual and motor development. Nutritional factors do not appear to be a major etiological factor in pica. Incidence of pica was especially high among children whose mothers have pica themselves and those from communities where clay eating and starch eating are a part of the cultural pattern.

44508

Stoefen, Detlef

**HEALTH HAZARDS DUE TO LEAD IN GASOLINE - A WARNING FROM SWEDEN.** (Gesundheitsgefahren durch verbleites Benzin - eine warnende Stimme aus Schweden). Text in German. Staedtehygiene (Uelzen/Hamburg), no. 12:259-260, 1970.

Problems of lead poisoning due to automotive exhaust are reviewed with regard to measures taken in Sweden to reduce the gasoline lead content. The inorganic lead dust concentrations in exhaust gases vary from 330 to 3100 micrograms/cu m, and organic lead, more toxic than the former, is present in concentrations of 100-530 micrograms/cu m. A concentration of 4 micrograms/cu m in street air in Stockholm was measured during rush hours. The retention of lead by the lung is estimated at 50%. Exposures to lead in concentrations of 7.5-10.0 micrograms/cu m caused alterations in the blood picture. Daily intakes below 50-100 micrograms are assumed to induce biological troubles in the organism. Some 31.2% of the lead injected in an experiment was found in the organism after 98 days, and the rate of elimination decreased from 0.07 to 0.01 micrograms/day at the same time. A tolerable dose equaling one-tenth the ineffective dose has been adopted in Sweden.

44696

Carlberg, John R., John V. Crable, Leonard P. Limtiaca, Harold B. Norris, John L. Holtz, Patricia Mauer, and F. R. Wolowicz

**TOTAL DUST, COAL, FREE SILICA, AND TRACE METAL CONCENTRATIONS IN BITUMINOUS COAL MINERS LUNGS.** Am. Ind. Hyg. Assoc. J., 32(7): 432-440, July 1971. 15 refs.

Concentrations of free silica and coal, noncoal, and total dust found in the lung tissues from 65 deceased West Virginia bituminous coal miners were compared with the concentrations found in previously analyzed groups of West Vriginia bituminous coal miners. In addition, these concentrations were compared with the concentrations found by British and German investigators who have analyzed lung tissue of coal miners who have worked in other geographical areas. The section of the upper lobe of the left lung closest to the rib cage contained the greatest concentrations of nearly all constituents determined. Beryllium, magnesium, titanium, vanadium, chromium, manganese, iron, nickel, copper, zinc, and lead were the eleven trace elements determined. Coal miners hilar lymph nodes had greater concentrations of vanadium and free silica than did their lung tissue. Concentrations of nickel, however, were greater in the lung tissue. No significant concentration differences of any other constituents were found. The coal miners lung tissue had generally greater concentrations of trace elements than concentrations reported in the literature for nonminers lungs. (Author summary modified)

44746

Lehnert, G. and K. H. Schaller

**QUANTITATIVE LEAD DETERMINATION IN BLOOD AND URINE BY ATOMIC SPECTROPHOTOMETRY.** (Quantitative Bleibestimmung in Blut und Harn durch Atomabsorptionsspektrophometrie). Med. Welt, (Stuttgart), no. 18, May 6, 1967. 10 refs. Translated from German. Leo Kanner Assoc., Redwood City, Calif., 7p. (Also includes; Lehnert, G., K. H. Schaller, and D. Szadowski A RELIABLE AND RAPID METHOD FOR THE DETERMINATION OF LEAD IN SMALL QUANTITIES OF BLOOD. (Eine zuverlaessige Schnellmethode zur Bleibestimmung in kleinen Blutmengen).

Preprint, Erlangen Nuernberg Univ. (West Germany), Inst. fuer Arbeits und Sozialmedizin, 4p. 3 refs.) The fundamentals of emission flame photometry and atomic absorption spectrophotometry are discussed and compared. The lead content of blood and urine can be quantitatively determined in a quick and exact manner with the help of atomic absorption spectrophotometry. Details of the chemical preparation as well as reliability criteria and mean values are given. The retrieval rate averaged 98% for aqueous solutions, 90% for urine, and 97% for blood. The accuracy, as measured by the Pearson variability coefficient, is assumed to be plus or minus 2% for aqueous solutions, 5% for urine, and 2.5% for blood. As a lower limit for detectability, a lead concentration of about .02 microgram/ml organic solvent is specified. Applying this accuracy, concentrations of 1 microgram % in blood and 2 micrograms/l in urine are detectable. Additional advantages, as compared to the conventional techniques for lead determination, are speed and simplicity.

44867

Ruiz Salazar, Antonio and Alejandro Castanedo

**PATHOLOGICAL CONDITIONS CONNECTED WITH THE OIL INDUSTRY.** (Patologia de la industria del petrolio). Text in Spanish. Med. deporte trab., 18(128):560-581, 624-641, 674, 1953. 30 refs.

Petroleum processing plant-induced pathology is reviewed. Toxicology is analyzed in terms of effects produced by oil impurities (hydrogen sulfide), ingredients applied for the improvement of fuels (hydrofluoric acid and tetraethyl lead), and by the petroleum hydrocarbons themselves. Petroleum distillation generates air pollutants such as ethane, propane, and butane. But most of the petroleums are considered to be non-toxic. Gasoline cracking, however, produces toxic non-saturated compounds. Reference is made to an accident which occurred in 1922 under atmospheric inversion conditions in a settlement close to the A.G.W.I. processing plant. Fatalities were attributed to the action of carbon dioxide and/or H2S. Another air pollution accident which occurred in 1950, due to the deterioration of an emission control unit, is attributed to the large amounts of H2S in the air. The accident caused 22 deaths and more than 300 poisoning episodes. Autopsies revealed the lungs to be the most affected organ under the circumstances. Victims with tetraethyl lead poisoning were found with brain and lung congestion, and minor inflammation of the other internal organs. Chronic TEL poisoning is characterized by astenia, anemia, arterial hypotension, and loss of weight. Hydrofluoric acid is described in terms of acute effects due to its high respiratory tract irritation activity. Dermatoses are the most diffused diseases due to chronic exposure to petroleum. The petroleum industry has no causal connection with tuberculosis. The pathology of chronic exposure to the petroleum industry requires systematic studies in order to provide the appropriate control measures.

45005

Teisinger, J., I. Prerovska, V. Sedivec, J. Flek, and Z. Roth

**ATTEMPT ON DETERMINATION OF BIOLOGICALLY ACTIVE LEAD IN ORGANISM IN EXPERIMENTAL POISONING.** Int. Arch. Gewerbepath. Gewerbehyg. (Heidelberg), vol. 25:240-255, 1969. 15 refs.

In 23 rabbits, poisoned by lead peroally for two months, the excretion of lead from individual organs and urine up to 232 days after termination of exposure, was studied, The concept of active lead deposit in bones and soft organs was introduced, the biologic reaction of the organism depending on its size. The size of this deposit can be determined from the mobilization yield after CaEDTA injection. This yield averages 8.3% of the deposit and does not change during the period after termination of exposure. The daily amount of spontaneously excreted lead amounts in average to 1% of the active deposit. CaEDTA mobilizes lead not only from soft organs, but also from bones. In respect to the celocity of lead excretion from organs, it is possible to distinguish: easily exchangeable lead (liver, kidney), medium exchangeable lead (muscles, skin, other organs), lead hard to be exchanged (skeleton) and unchangeable lead (coat). Under easily exchangeable lead also belongs a considerable part of lead from the trabecular bones. (Author abstract modified)

45159

Bringmann, G. and R. Kuehn

**THE ACTION OF MINERAL OIL PRODUCTS, ESPECIALLY LEAD-CONTAINING SUPER GASOLINE, ON SULFATE-REDUCING, NITRATE-REDUCING AND DENITRIFYING SOIL BACTERIA.** (Einfluss von Mineraloelprodukten, speziell blei-haltigem Superbenzin, auf sulfatreduzierende, nitratreduzierende sowie denitrifizierende Bodenbakterien). Text in German. Gesundh. Ing., 93(3):81-86, March 1972. 7 refs.

The action of 1:100 infusions of crude oil, fuel oil, kerosene, lead-containing super gasoline, and regular gasoline on sulfate-reducing, nitrate-reducing, and dentrifying bacteria in diluvial sand samples with and without nutrient medium was studied. Crude oil, fuel oil and super gasoline had no influence on the proliferation of sulfate-reducing bacteria as induced by sodium thioglycolate, sodium, lactate, and sodium, magnesium, and iron sulfates during a 14-day anaerobic incubation at 27 C, although super gasoline induced small colonies in the Postgate agar subculture due to inhibition of the primary culture. Infusions of crude oil, fuel oil, and kerosene had no influence on the proliferation of nitrate-reducing bacteria incubated over 14 days in the presence or absence of nutrient medium, glutamic acid, sodium succinate, and potassium nitrate in anaerobic nitrogen atmosphere. Super gasoline had considerable bacteriostatic effect on nitrate-reducing bacteria, especially in the presence of nutrient medium, nitrogen and hydrogen donors, and hydrogen acceptors. The above bacteriostatic effect of super gasoline was, however, most powerful for denitrifying bacteria whose count remained largely the same after 14 days incubation. As the bacteriostatic effect of regular gasoline was much lower for nitrate-reducing bacteria, and was far from being total for denitrifying bacteria, the very powerful bacteriostatic effect of super gasoline is most probably due to its lead content.

45165

Schroeder, Henry A. and Dan K. Darrow

**RELATIONS OF TRACE METALS TO HUMAN HEALTH.** Environ. Affairs, 11(1):222-236, Spring 1972. 50 refs.

The effects of various trace elements on human health are reviewed in the light of annual industrial consumptions, natural abundances (on earth crust, in sea water, and in the contents of Reference Man), and changes in experimental animals fed low doses for life. Fourteen metals and two nonmetals are essential for life or health of mammals. All but two are mined in large amounts, are abundant on the earth s crust, and are found in human tissues in sizeable quantities. Most of these metals are nontoxic to mammals in ordinary concentrations. Five metals occur in low abundances, are consumed industrially in sizeable amounts, occur in the body of man, and are toxic of themselves. Of these, lead and cadmium are prevalent in man. Nine metals have low orders of toxicity and occur at

low crustal abundances. Eight have little or no toxicity, of which six are abundant. Metals in the environment of potential hazard to man are lead, by far the largest pollutant, cadmium, which may influence hypertension and emphysema, nickel as the carbonyl which is carcinogenic, antimony which is toxic, beryllium which can cause beryllosis, and methyl mercury which is highly toxic. At present levels of exposure, lead, cadmium, and possibly nickel are potentially hazardous to health. Only under special circumstances and in special circumstances and in special compounds are a few other elements hazardous. (Author summary modified)

45196

Wiethaup, Hans

**HEALTH-DAMAGING EFFECTS FROM NOISE, AIR AND WATER POLLUTION.** (Gesundheitsschaedliche Auswirkungen durch Laerm, Luft- und Wasserverunreinigung usw.). Text in German. In: Umweltschutzfibel - polizei und Umweltschutz. Vol. 5, Stuttgart, West Germany, Richard Boorberg Verlag, 1972, Chapt. II, p. 12-18. 14 refs.

Health effects of noise as well as air and water pollution are reviewed. Noise of 30-60 phon intensity causes nuisances due to its psychic effects; vegetative effects occur at 60-90 phon. Health impairment occurs at 90-120 phon due to psychic, vegetative, and otological effects. Maximum allowable noise levels for different types of environments during daytime and nighttime are given. A general definition of air pollution and examples of catastrophic pollution episodes are given. Health damage from air pollution is determined by toxic and synergetic effects. The incidence of heart, circulatory, and respiratory troubles, especially in higher age groups, is higher in areas with high pollution levels. Pollution-induced damages to plants, animals, and materials are also manifested. Lead concentration measurements near a highway revealed high concentrations well above ground level, which indicates possible health hazards in buildings near highways.

45273

Tsuchiya, Kenzaburo, Minoru Sugita, Ken Takahashi, and Yukio Seki

**LIVING BODY RELATIONS TO THE EXPOSURES TO LOW CONCENTRATION LEAD.** (Tei-nodo en bakuro to seitai hanno). Text in Japanese. Sangyo Igaku (Jap. J. Ind. Health), 14(4):141. July 1972.

Investigations were conducted on 58 workers of lead-covered cable manufacturers and 18 control persons on the total blood density, lead content in blood and urine, amount of coproporphyrin, hemoglobin, hemotropin, and urine protein, along with their ages and educational background. The atmospheric lead content was 1.0 to 125 micrograms/cu m and the average individual exposure concentration was 12.8 micrograms/cu m for 6 hours. Except for total blood density, Hb, Ht, and educational background, no difference was found between the test group and control group. The total blood density, Hb, and Ht were lower in the test group.

45288

Saito, Kazuo, Hiroko Inai, and Eisho Takakuwa

**STUDIES ON TOXICITY OF GASOLINE. (REPORT NO.2). ELECTROENCEPHALOGRAM AND LEAD IN THE INTESTINES OF RATS AFTER THE ADMINISTRATION OF NONLEAD AND LEAD WHITE GASOLINES.** (Gasorin no dokusei ni kansuru kenkyu (Dainiho) muen oyobi kaen howaito gasorin toyo ratto no noha narabi ni zokichu enryo (D)). Text in Japanese. Sangyo Igaku (Jap. J. Ind. Health), 14(4):147. July 1972.

One gram per 100 g body weight of nonlead white gasoline (WG), or lead white gasoline (LG) was injected intraperitoneally to 7-month-old Wistar rats. One ml of tetraethyl lead was added into 1 liter of WG to become LG. Therefore, the amount of tetraethyl lead administration per 100 g body weight was 1.65 mg. Electroencephalograms were recorded and lead content in the organs were measured. One day to 4 days after the injection, all rats became dull, crouching and unreactive to stimulation. On the fifth day, the WG group started to walk and recover nearly to their original conditions, whereas the LG group became emotional, anxious, and the symptoms reached a peak at the 7th and 8th days. The LG group had a higher loss of body weight. Higher lead content was detected in brains, livers, and kidneys of the LG group.

45293

Kumajo, Kazuo and Masana Ogata

**MICROPARTICLE DISTRIBUTION OF LEAD IN BODIES OF RATS.** (Enbiryushi ni yoru ratte tainai no namari no bunpu). Text in Japanese. Sangyo Igaku (Jap. J. Ind. Health), 14(4):405, July 1972.

Rats were subjected to lead fume inhalation at 53 + or - 12 mg/cu m for 1, 2, and 3 hours, and the lead distribution in the organs was studied. The diameters of the lead particles were 0.02 to 0.05 micron. The lead content in blood of the control group was 36 gamma/dl, and that in the 4-hour group was 303 gamma/dl, with 90% in the blood corpuscles. The lead content in lungs, livers, and kidneys of the control group and the 4-hour group was 71 gamma/100 g, 15 gamma/100 g, 19 gamma/100 g, and 1000 gamma/100 g, 85.7 gamma/100g, 383 gamma/100 g respectively. The amount of inhalation increased as time of inhalation increased.

# H. EFFECTS-PLANTS AND LIVESTOCK

01523

T. C. Tso, N. Harley, and L. T. Alexander

**SOURCE OF LEAD-210 AND POLONIUM-210 IN TOBACCO.** Science, Vol. 153, 880-882, Aug. 19, 1966.

Test plants were grown within a chamber enriched with radon-222 in the atmosphere, in tobacco fields with diffusion sources of phosphate-containing fertilizer, and in culture containing lead-210 in the nutrient solution. Harvested leaves were subjected to three curing conditions. The major portion of the lead-210 in the plant was probably absorbed through the roots. Airborne radon-222 and its daughters contributed much less to the plant's content of lead-210 and of polonium-210. The stage of leaf development and the methods used to cure the leaf affected the final amount of polonium-210 in tobacco leaf.

07742

Barrows, Harold L.

**THE AGRICULTURAL SIGNIFICANCE OF INORGANIC POLLUTANTS.** Preprint, Dept. of Agriculture, Beltsville, Md., Soils Lab., 12p. ((1967)). 22 refs. (Presented at a symposium on 'damage to Plants from Soil and Water Pollution', sponsored by the American Phytopa- thological Society, Washington, D. C., Aug. 21, 1967.)

The potential hazards of the accumulation of metals in plants and soil are reviewed. These toxic elements contaminate plant life through direct addition to the soil for enrichment, from spray residue, fertilizers, industrial sources, and automotive emissions. Although the threat from this type of pollution is not presently severe, localized conditions do exist in which the concentrations of these elements in the environment are detrimental to plants or to animals consuming the plants.

08884

Katz, M.

**EFFECTS OF CONTAMINANTS, OTHER THAN SULPHUR DIOXIDE, ON VEGETATION AND ANIMALS.** In: Pollution and Our Environment: Conference Background Papers. Vol. 1, Montreal, Canadian Council of Resource Ministers, Paper A4-2-2, p. 1-18, 1967. 23 refs. (Presented at the National Conference, Canadian Council of Resource Ministers, Montreal, Oct. 31-Nov. 4, 1966.) Available from the Canadian Council of Resource Ministers, 620 Dorchester Boulevard West, Montreal, Canada.

It is apparent that air pollution can cause harmful effects on agricultural crops, and other species of vegetation. Apart from paper, the principal pollutants of serious concern are fluorides, ozone, photochemical smog products, ethylene and various aerosols occurring as suspended particulate matter. Gases such as chloride, hydrogen sulphide, oxides of nitrogen, and ammonia may constitute a hazard or cause damage to vegetation on occasion in localized areas. Suspended particulate matters consisting of small particles of smoke, sulphuric acid mist, soot and various metallic dusts, may be transported by wind for considerable distances from strong sources such as urban and industrial areas. These pollutants accumulate on leaf surfaces and clog the stomata to produce direct damage or retardation in growth. Unfortunately, there is a great lack of information on the extent of the damage to the Canadian economy from the diverse effects of these pollutants on agriculture and forestry. Little, if any, coordinated research is being conducted in Canada on the biological effects of air pollutants on plants. Some studies have been conducted occasionally to meet the needs of a specific problem, such as the effects of ozone on tobacco. With regard to the harmful effects of air pollution on animal health, the evidence of major air pollution disasters points to adverse symptoms in animals of a character similar to those suffered by man. Animals in these episodes have suffered acute respiratory distress, bronchitis, emphysema and heart failure. Fluorides, arsenic and lead are highly toxic pollutants that may cause diseases in animals by accumulation in the forage and other crops that constitute the principal diet of cattle and other farm animals. There are many other pollutants derived from the incomplete products of combustion of fuels and from specific industrial processes that possess toxicological properties. However, animal research in this field is virtually non-existent in Canada. There is a great need for a broad, well-balanced research program to determine the biological effects of specific air pollutants and of simple and complex mixtures.

09448

Haar, G. L. Ter, R. R. Dedolph, R. B. Holtzman, and H. F. Lucas, Jr.

**AIR, WATER, AND SOIL AS SOURCES OF LEAD IN PLANTS.** In: Radiological Physics Division Annual Report. (July 1966 through June 1967.) Argonne National Lab., Ill. p. 147-149, 1967. 11 refs. CFSTI: ANL-7360

The relative contributions of soil, air, and water to the lead content of plants is investigated. Uptake and retention of lead by perennial rye grass and radishes were determined from the lead content of the plant parts, grown in specially constructed chambers located in a green house. The chamber was constructed from an epoxy-coated galvanized tub covered with a acrylic hemisphere. The alluvial black loam soil used was obtained 1-2 feet below the surface from a five-foot square area about 250 feet from a secondary roadway. Lead concentration data from 96 grass samples were subjected to variance analysis. The lead concentration in the air was the only significant variable. The lead concentrations in radishes, regardless of treatment, did not differ greatly. Half of the lead content in grass and all of that in radishes was obtained from the soil rather than from the air, with little or no significant absorption from simulated rainfall.

10318

C. Iosif

**ACUTE AND CHRONIC LEAD POISONING IN CATTLE.** ((L'intoxication augue et chronique par le plomb chez les bobins.)) Text in French. Rec. Med. Vet. Ecole Alfort (Par- is), 142(2):95-106, Feb. 1966. 23 refs.

Three cases of acute plumbism in cows are detailed: one of a six-year-old cow who accidentally ate about 100 gm of lead (in

1956); the second of a 12-year old cow who accidentally ate a packet containing about 100 gm of lead used in painting; and the third of a three-week-old heifer who licked a freshly painted bucket. Route of exposure to lead can be gastrointestinal following deposition of lead fumes (lead oxide, sulfide, and sulfate) on pasturage and in exposed drinking water, or respiratory following the inhalation of such fumes. The presence of CO2 in the respiratory tract is thought to provide a favorable situation for the dissolution of lead and the formation of soluble lead complexes. One author has calculated that 12% of respired lead is absorbed into the organism, while only 1-2% of ingested lead is absorbed. In an industrial Romanian village, where the air is loaded with 104-125 mg of lead (by sedimentation method), the geographic and climatic conditions combine to pool the fumes from a lead refinery. The zone of pollution extends 1 km N.E. and 2 km N.W. of the town. Snow sampling reveals 0.4-7.02 mg/sq m/month of lead. The particulate pollution is believed to be about 1,200,000 per sq m at ground level, and up to 200,000 particles per sq m at 40 m above the ground. Cows raised in this area are estimated to eat 26 mg of lead in 100 gm of herbage, but near the plant they may eat 0.07-0.16% lead by weight. Poisoning (in eight chronic cases) is exhibited as cachexia, decreased milk production, pale mucosa, and enteritis with alternating constipation and diarrhea. More severe cases (12) exhibit colic, muscular twitches, and nervous complaints. Illness in these latter cases appears in 2-4 days, while, in the former cases, it may take a week or several months. Blood samples in two severe cases show the red blood cell level is decreased by almost 50%, as are the thrombocyte and hemoglobin levels. Prognosis in the described cases is routinely unfavorable, and the animals are sacrificed. Treatment in the severe cases is with EDTA (92 mg/150 kg body weight) as well as vitamins C and B1. Such therapy, used since 1963, will lower the plumbemia to 28%, and permits an economic use of the affected animals. Attention is drawn to providing fodder which is low in lead and rich in calcium, phosphorus, and vitamins; cows should not be pastured near lead factories and should not be watered with contaminated lake or stream water.

11157

Agriculture Research Council, London (England)

**THE EFFECTS OF AIR POLLUTION ON PLANTS AND SOIL.** 53P., 1967. 202 refs.

An account of recent trends in the emissions and concentrations of smoke, deposited matter and sulphur dioxide in Britain and summa- rises the information available on the effects of these pollutants on plants and soil is given. The literature on the effects on plants and soil of fluorides and of photochemical, or oxidant, smog which some people think might be troublesome in this country in the future. A note on the contamination of plants near highways with lead from the exhaust fumes of motor vehicles is also included.

11452T

Cohrs, F.

**SICKENING OF DOMESTIC ANIMALS THROUGH SMOKE DAMAGE AND INDUSTRIAL WASTE WATER.** ((Erkrankungen der Haustiere durch Rauchschaeden und Abwaesser der Industrieanlagen.)) Translated from German. Monatsh. Veterinaermed., 11(2):662-669, 1956. 77 refs.

The effects of industrial smokes containing sulfur compounds, arsenic compounds, lead, copper, fluorine, molybdenum, zinc, and selenium on domestic animals are reviewed. The most frequent intoxications result from lead, arsenic, SO2, and fluorine. Fluorosis has gained considerable importance in the last 30 years and today represents the most important disease among the smoke injuries. Pneumoconiosis very seldom develops in animals as a results of flue ash. Clinical manifestations and pathological anatomy, the course of disease, the changing picture of the disease manifestations, and meteorological and topographic influences are discussed. Mechanical, chemical and physical effects of smoke are also considered.

11467T

Miessner, H.

**DAMAGE TO ANIMALS CAUSED BY INDUSTRY AND TECHNOLOGY.** ((Schadigung der Tierwelt durch Industrie und Technik.)) Translated from German. Deut. Tieraerztl. Wochschr., 39, p. 340-345, 1931. 26 refs.

Pollution of the air and damage to feed plants, and the resulting diseases of humans and animals, are extremely frequent in regions where ore-processing metallurgical plants are located. The fumes being produced during roasting and melting of the ore are usually bonded to sulfur and arsenic; consequently the smoke contains considerable quantities of SO2 and As2O3. This smoke most affects cattle. Acute arsenic intoxication becomes manifest in the form of vomiting and diarrhea, caustic injuries to the gastric mucosa, and fatty degeneration of the liver. In chronic cases, increasing cachexia, eczema and weakening resembling paralysis are observed. The metallic elements in the fly dust, moreover, can lead to harmful indigestion. During acute lead poisoning, stomach distress is observed, as well as spastic movements. Chronic lead intoxication leads to a general malaise combined with abortion, lead colic, muscular pain, epilepsy, and paralysis. The red blood corpuscles show a partial basophilic granulation. Hydrofluoric acid fumes from foundries and plants producing artificial fertilizers dissolve the calcium in the bones, and chronic calcium degradation and softening of the bones are the consequences. As a result of an air pollution episode in Luttich, damage by foundry smoke in fog caused hundreds of persons to fall ill and 63 to die, mostly within 1 to 2 days. Hardest hit were asthmatic and heart patients, and persons suffering from bronchitis. Copper intoxication was observed in sheep and cattle as a result of spraying orchards with lime and copper.

12536

*Liegeois, F., Derivaux, J., and Depelchin, A.*

**LEAD POISONING IN ANIMALS.** ((L'intoxication saturnine chez les animaux.)) Text in French. Ann. Med. Veterinaire, 105:57-81, 1961. 22 refs.

Lead poisoning of animals occurs on many occasions, since lead and its compounds are found in the fields where they feed and in the water they drink. Toxic doses depend on the product (nitrate, chloride, acetate, minium, white lead, sulfate, sulfide, phosphate, in decreasing order) and sensitivity (horses are ten times more resistant than cattle, sheep, pigs, and dogs; poultry is very sensitive). Absorption depends on the mode of intake. Rapid through the breathing appratus (which feeds the lead or lead compound vapors and dusts directly into the blood), it is slower through the digestive tract. Skin absorption is low. Localization: in cases of acute poisoning, lead is found in the digestive tract, vomited matter, the liver, spleen, kidneys. In chronic cases, lead appears in the bones, marrow, kidneys, blood, cephalo-rachidian liquid, milk, saliva, urine, stools. Elimination occurs through the milk, saliva, sweat, urine, and stools. Lesions include discoloration of the liver, kidneys, and muscles; infiltrations in the brain and rachis; neuritis and presence of basophiles. The action of lead on the cell is not fully known. Symptoms in acute cases include cramps,

convulsions sometimes leading to death (in cattle); depression, paresis (in horses); anorexia, vomiting convulsions (in dogs), muscular weakness, thirst and death (in poultry). Chronic cases, mostly in dogs and cats, cause low temperature, loss of weight, constipation, rheumatism, cerebral and circulatory disorders. Diagnosis is based on nervous disorders and laboratory tests on body liquids, tissues, and stools (data is tabulated and described). Preventive treatment consists in keeping the animals away from lead polluted environment. Curative treatment seeks to turn the lead into nontoxic forms, to neutralize the toxic action of absorbed products, and to eliminate these products from the body. Antidotes include albuminous water, milk, saline laxatives, ferric hydrate. Most effective are chelating agents (CaEDTA). Intramuscular or veinous injections often cause spectacular results.

12647

C. W. Francis, G. Chesters, W. H. Erhardt

**210 POLONIUM ENTRY INTO PLANTS.** Environ. Sci. Technol., 2(9):690-695, Sept. 1968.

The possibility that root uptake of 210Pb from soils is the principal mechanism of 210Po entry into plants was evaluated and proved to be invalid. If the 210Pb in the plant is not soil-derived, the second most likely source is natural radioactive fallout, of which the most important component is from rainfall. Material balances of the quantities of 210Pb in tobacco over time intervals of known rainfall indicate rains deposit approximately twice as much 210Pb as observed in tobacco leaves, verifying the hypothesis that deposition of 210Pb by rainfall is the principal mechanism of 210Po entry in plants. (Author's Abstract)

14489

Kobayashi, J., F. Morii, S. Muramoto, and S. Nakashima

**EFFECTS OF AIR AND WATER POLLUTION BY HEAVY METALS (CD PB AND ZN) ON AGRICULTURAL PRODUCTS CAUSED FROM A MINE REFINERY IN GUMMA PREFECTURE. (Gumma-ken ka no bo kozan seiren go no hai gas niyoru nosaku motsu nado no gukinzoku osen (Cd, Pb, Zn) ni tsuite). Text in Japanese. Nippon Eiseigaku Zasshi (Japan J. Hyg.), 24(1):67, April 1969.**

Pollution of plants growing on a hill by cadmium, zinc, and lead present in waste gases from a mine refinery was determined by atomic absorption spectrophotometric analysis of the elements following their extraction from dried and ashed plant samples. Plant distance from the refinery ranged from 400 to 2500 m, and plant content of metals varied with distance. Cadmium levels ranged from 17 to 3.3 ppm and zinc from 2590 to 360 ppm in mulberry leaves. The cadmium content of moss, greens, and eggplant leaves collected at 700 m from the refinery varied from 41 to 61 ppm and the zinc content from 2620 to 7010 ppm. Values were lower in corn, tomatoes, pumpkins, and persimmons. Taro, carrots, Welsh onions and burdochs showed medium values.

14786

Ter Haar, Gary L., Richard R. Dedolph, Richard B. Holtzman, and Henry F. Lucas, Jr.

**THE LEAD UPTAKE BY PERENNIAL RYEGRASS AND RADISHES FROM AIR, WATER AND SOIL.** Environ. Res., 2(4):267-271, 1969. 11 refs.

The lead content of food is the major source of an increase of lead in modern man. The lead content of fruits and vegetables as well as meats may be derived from soil, air, rainwater, and food processing. A study to investigate the relative contributions of soil, air, and water to the lead content of plants is described. Grass and radishes were grown in a specially constructed growth chamber with either normal or filtered air, while either distilled or lead-containing water was applied to the leaves or to the soil surface. A randomized complete block experimental design was employed with factorial arrangement of treatments; results were analyzed by the associated analysis of variance technique. The lead content of grass grown in filtered air was 2.5 micrograms/g while that grown in unfiltered air was 5.2 micrograms/g. These values are different at the 1% level of significance. The uptake of lead from the water applied either to the foliar parts or to the soil surface was not significant at the 5% level. The lead concentration of either radish leaves or edible parts did not differ greatly for any treatment at the 5% level, and was the same as for grass grown in filtered air. These measurements indicate that half of the lead content of grass and nearly all of that in radishes was obtained from the soil with little absorption from simulated rainfall. Although the study is judged too limited in scope to define the relative contribution of soil and airborne lead to the human body burden, it has indicated that a substantial fraction of the lead in man's food may be obtained from the soil. Variables other than those studied may be of importance, including soil type, pH value, and lead concentration, plant type, and seasonal effects.

16270

Cruz, J. A. Machado

**A FEW RESULTS OF HISTOCHEMICAL ANALYSIS IN THE STUDY OF HEAVY METAL ICHTYOPATHOLOGY.** (Sur quelques resultats de l'analyse histochemique dans l'etude de l'ichtyopathologie des metaux lourds). Bull. Office Int. Epizoot., 65(5-6):715-717, 1966. 5 refs. Translated from French. Franklin Inst. Research Labs., Philadelphia, Pa., Science Info. Services, 3p., Aug. 10, 1969.

The pathogenic action of heavy metals on fish was considered as only an external action, primarily affecting the gills. Histochemical studies of the pathogenic action of heavy metals on fish showed that this was not so. Experiments were conducted in which fish were placed in distilled water containing various quantities of iron and lead (from 5-100 mg of metal/l) during extremely varied periods from 5 min to 4 days. The techniques used in histochemically tracing the metals were Turnbull blue for iron, ammonium sulfate and sodium rhodizonate for lead. Metals were found in large quantities on the gills, in the digestive tract, either in the intestinal opening or in an intra-cellular state, and in the liver and kidney. It was concluded that histochemical examination of fish organs is important whenever metallic pollution is suspected and a precise diagnosis is sought.

16655

Keller, Th.

**THE CONTENT OF LEAD IN SPRUCE FASCICLES AS AN INDICATOR OF AIR CONTAMINATION DUE TO TRAFFIC.** (Obsah olova ve smrkovem - indikat znecisteni vzduchu pusobeneho dopravou). Scientific and Technical Society, Prague (Czechoslovakia), Agricultural and Forestry Section, Proc. Conf. Effect Ind. Emissions Forestry, Janske Lazne, Czechoslovakia, 1966, p. XVIII-1 to XVIII-14. 8 refs. (Oct. 11-14.) Translated from Czech. Franklin Inst. Research Labs., Philadelphia, Pa., Science Info. Services, April 24, 1969.

A chlorotic coloring of the fascicles of spruces and firs was observed in trees planted along the roads, especially in curves and on slopes. It was concluded that this damage was due to the toxic effects of exhaust gases. The lead content of the

fascicles was spectrographically determined. The assimilation parts of conifers located along turnpikes showed (in comparison to fascicles from remote regions) an increased content of lead which increases with increasing traffic. The lead content can therefore be considered as an indicator of air contamination due to traffic conditions. The lead content increases with the age of fascicles. The content of lead at the beginning increase with time of exposure, but probably a local equilibrium is established between the sediments and the scrubbing. The lead content shows a strong decrease with the increasing height from the road. The filtration effect of the forest was well demonstrated by fascicle analysis. The largest portion of the lead compounds are captured on the surface of the fascicles, so that poisoning of the vegetation rarely occurs. Measurement of the exchange gases showed the depression of CO2 assimilation even in normal, healthy looking fascicles with increasing lead content. This slowing down of assimilation must be explained in terms of contamination of the surface of the fascicles and by toxic effects of other components of waste gases.

17038

Koeppe, David E. and Raymond J. Miller

**LEAD EFFECTS ON CORN MITOCHONDRIAL RESPIRATION.** Science, 167(3923):1376-1378, March 1970. 7 refs.

Oxidation of exogenous nicotinamide adenine dinucleotide and succinate by corn mitochondria was measured as a function of lead chloride concentration. Concentrations of 50-60 micromoles/l stimulated oxidation of exogenous reduced nicotinamide adenine dinucleotide by 174-640%, depending on the reaction mediums; concentrations of 12.5 micromoles/l inhibited succinate oxidation by more than 80%. When inorganic phosphate was included in reaction mediums, the subsequent addition of lead was without effect due to the low solubility of lead phosphate. The addition of lead followed by the addition of phosphate released the inhibition of succinate oxidation by lead but did not decrease the stimulation of oxidation of reduced nicotinamide-adenine dinculeotide by lead. It is significant that the effects of lead seen in the study were observed at very low concentrations and that there was a sharp increase in the magnitude of its influence within a small range of concentrations. When effective concentrations of lead are reached in the atmosphere, there could be a dramatic reduction in plant growth under conditions of phosphate deficiency. (Author abstract modified)

17182

Schuck, E. A.

**LEAD IN SOILS AND PLANTS: ITS RELATIONSHIP TO TRAFFIC VOLUME AND PROXIMITY TO HIGHWAYS.** Environ. Sci. Technol., 4(3):238, March 1970.

The results of a study of the lead content in soils and plants and its relationship to traffic volume and proximity to highways are discussed. Crops grown downwind of heavily traveled highways exhibit contamination by the lead particulates present in automobile exhaust. However, it was not demonstrated whether this particulate lead contamination leads primarily to simple surface contamination or actual absorption by the plant. Absorption could lead to a concentrating mechanism which would pose more of a potential danger to the consumer. The effect of simple surface contamination would be limited in that the amount of lead which can cling to a surface is limited. Refinements in experimental techniques are needed to determine whether lead contamination is located on the surface or absorbed by the plant.

17215

Brandt, C. Stafford

**DISCUSSION. SOURCES OF LEAD IN PERENNIAL RYEGRASS AND RADISHES.** Environ. Sci. Technol., 4(3):224, March 1970.

Previously reported experiments on the sources of lead in ryegrass and radishes were discussed. Atmospheric lead contributes to the lead content of leaves, but other sources make a significant contribution. Actually, one-fourth of the filtered vs unfiltered air data indicated that atmospheric lead is not a contributor to vegetation lead. Intuition and limited data implicated the soil as the other source. The possibility of significant variation in lead content of vegetation caused by variation in the lead content of soil was not dismissed. Statistical treatment of the data was criticized. Combination of all the data was questioned. It was indicated that a foliar spray of water, containing considerable lead, did not increase the lead content of leaves. This raised an interesting question as to how atmospheric lead does increase the lead content of leaves. Although a soluble lead compound, sprayed on a plant, did not enter the leaf, a supposedly insoluble particulate readily entered the leaf.

17216

Lagerwerff, J. V.

**DISCUSSION. AIR AS A SOURCE OF LEAD IN EDIBLE CROPS.** Environ. Sci. Technol., 4(3):230, March 1970. 6 refs.

The conclusion from a previous experiment that under prevailing experimental conditions, most lead in plants is derived from soil and arterial Pb plays a very minor role was evaluated. The rate at which the plants respond to the Pb present in the environment under the general conditions established was discussed, particularly the question of whether the accumulation of Pb by plants was measured on a steep or on a flat part of the curve, characterizing the relationship between uptake rate and such experimental variables as Pb concentrations in soil and air or air movement in the greenhouse and distance from traffic observed in roadside studies. The net outcome may diminish differences in Pb content that otherwise would occur between plants exposed to the two aerial concentrations of Pb applied. With regard to completeness of data, no measurements were made of crop yield and, by implication, on total uptake of Pb by plants. Soil pH values also were not reported. Data interpretation was also questioned. In discussing the accumulation of Pb by sweet corn grown in the greenhouse, it was stated that the cob contained a higher concentration of Pb than the kernel, and that this distribution would be difficult to explain if the source of the lead were not the soil. This conclusion presumes the knowledge of the pathway followed by Pb taken up by the roots. In stressing the importance of soil-borne Pb relative to that of airborne Pb with regard to the composition of plants grown in roadside soils, the long-term, indirect effects were emphasized rather than the short-term, direct effects of aerial Pb. The broader ramifications included the significance of the effects of aerial Pb on the quality of our food.

17217

Dedolph, Richard, Gary Ter Haar, Richard Holtzman, and Henry Lucas, Jr.

**SOURCES OF LEAD IN PERENNIAL RYEGRASS AND RADISHES.** Environ. Sci. Technol., 4(3):217-223, March 1970. 9 refs. (Presented at the American Chemical Society National Meeting, 157th, Division of Water, Air and Waste Chemistry, Symposium on Air Conservation and Lead, Minneapolis, April 1969.)

Experiments were designed to study the role of air, water, and soil lead content as sources of lead in plants. Plants were grown in chambers, with half the samples receiving unfiltered air. The water applied was either lead free or contained 40 micrograms of Pb/liter as $PbCl_2$. Six successive harvests of ryegrass were made, followed by 3 harvests of radishes. Plants were also grown in a greenhouse. Plants were uniformly watered; half received unfiltered air. Radishes and ryegrass were also grown in a field adjacent to a highway in Detroit. Rows planted at right angles started at 20 feet east of the roadway and extended for 500 feet. Soil-lead contents were determined in samples at 20, 40, 70, 120, and 510 feet from the roadway along transects normal to the roadway. Results showed that only air and soil were significant sources of lead. Experiments affirmed that both grass and radish leaves derived 2-3 micrograms of lead/ gram dry weight from soil sources. Leaf-lead levels in excess of this were derived from, and quantitatively related to, atmospheric lead concentrations. Lead levels in radish roots were less than or equal to soil-derived-leaf-lead levels. The lead concentration in the edible portion of the radish plant was apparently unaffected by variations in lead concentrations in either soil or air. Collectively, data would not support a contention that the food of prehistoric man contained only a small fraction of the lead in the food of contemporary man, unless it is assumed that prehistoric man assiduously eschewed plants as a food source.

17218

Motto, Harry L., Robert H. Daines, Daniel M. Chilko, and Carlotta K. Motto

**LEAD IN SOILS AND PLANTS: ITS RELATIONSHIP TO TRAFFIC VOLUME AND PROXIMITY TO HIGHWAYS.** Environ. Sci. Technol., 4(3):231- 237, March 1970. 19 refs. (Presented at the American Chemical Society Annual Meeting, 157th, Division of Water, Air and Waste Chemistry, Symposium on Air Conservation and Lead, Mineapolis, April 1969.)

The lead content of grasses and soil samples along highways was determined. The results show that there is surface contamination of the plants and soils with lead. In addition, five crops - carrots, corn, lettuce, potatoes, and tomatoes - were grown at three distances from highways having various traffic densities. These same crops were grown in the greenhouse in soil from the surface six inches of field plots and in acid-washed sand to which soluble lead was added. Analysis of plants grown in the field revealed that the highest lead levels were associated with the leaves with lower levels in the roots. These same plants grown in the greenhouse exhibited lower levels in the leaves relative to the roots. The results indicate lead was absorbed through the root system in the greenhouse with some translocation to other parts of the plant. The overall results showed that the lead content of plants and soils increased with increasing traffic volume and decreased with increasing distance from highways. Most of the lead accumulation was within 100 feet of the highways. The edible portion of carrots, corn, potatoes, and tomatoes contained the lowest amounts of lead and showed the least effect of increased lead supply. The edible portion of lettuce contained a larger amount of lead. Similar relationships of lead in air, plants, and soils with traffic volume and distance from highways indicate a common source of lead, the gasoline consumed by motor vehicles. (Author summary modified)

17220

Ter Haar, Gary

**AIR AS A SOURCE OF LEAD IN EDIBLE CROPS.** Environ. Sci. Technol., 4(3):226-229, March 1970. 15 refs. (Presented at the American Chemical Society National Meeting, 157th, Div. Water, Air and Waste Chemistry, Symposium on Air Conservation and Lead, Minneapolis, April 1969.)

The source of lead in some plants that are important in the human diet was determined. Tomatoes, potatoes, wheat, carrots, leaf lettuce, cabbage, snap beans, and sweet corn were grown in filtered and unfiltered air. In all of these crops, except leaf lettuce, there was no measurable effect on the lead concentration of the edible portion due to lead in air. It seems probable that lead found in plants grown in filtered air was due to lead naturally present in the soil. Only in the case of leaf lettuce was there a measurable difference between the concentration of lead when the plants were grown in filtered and unfiltered air. This difference would add 0.5 to 1% to the daily intake of lead. When these same crops were grown at increasing distances from a heavily traveled highway, there was no measurable effect on lead concentration in the edible portion of tomatoes, potatoes, wheat, carrots, leaf lettuce, cabbage, oats, rice, and sweet corn. Snap beans had a higher lead concentration near the road, which could add about 0.75 to 1.5% to the daily intake of lead. The nonedible portions of the crops, such as corn husks, bean leaves, and the straw of grains, showed 2- to 3-fold increase in lead concentration due to lead in air. (Author conclusions modified)

17225

Lacasse, Norman L.

**DISCUSSION. LEAD IN SOILS AND PLANTS: ITS RELATIONSHIP TO TRAFFIC VOLUME AND PROXIMITY TO HIGHWAYS.** Environ. Sci. Technol. 4(3):237-238, March 1970. 5 refs.

Contamination of vegetation by lead is discussed in terms of variation of lead levels with time of year and of the effect of automotive exhausts on vegetation adjacent to highways. In a New Jersey study, the highest lead values were found in the fall months. This phenomenon may be related to greater atmospheric stability at that time of the year. It may also be related to factors such as precipitation, driving conditions, and engine performance. It is important to determine whether the difference is amplified or attenuated in localities which differ from New Jersey in their climatic and weather characteristics. While there is circumstantial and real evidence of the relationship between distance from the highway and lead contamination of vegetation, most sampling has been done at relatively large intervals. With another pollutant of a different nature but coming from the highway, as well as from salt used in ice and snow control, the main effects were limited to a distance of 30 ft. Extensive lead sampling needs to be done within 50 ft of highways.

17681

Ruhling, Ake and Germund Tyler

**AN ECOLOGICAL APPROACH TO THE LEAD PROBLEM.** Botan. Notiser, vol. 121:321-342, 1968. 7 refs.

In order to measure lead accumulation levels in Sweden, the concentration of lead in plants and soil was determined in transects across three large roads as well as at sites far from roads; uptake of lead by plant roots was also investigated in greenhouse experiments. Considerable accumulations were measured in plants and soil within a 50-100 m distance from the roads, although only a minor part of the lead emitted from cars settles and accumulates in the vicinity of the roads. To determine regional lead pollution, moss samples from distant roads in southern and central Scandinavia showed a distinct NE-SW gradient which decreased towards the NE. The lead

concentration increased with precipitation and with decreasing distance from large population centers; in one area, much of the rain precipitated lead originated outside of Sweden. Mosses appear to be useful indicator plants, since they naturally contain very little lead but accumulate it from the air to an unusual extent. A historical analysis of mosses collected in Skane from 1860 to 1968 showed marked increases in lead concentration in these samples, restricted to two distinct periods: the first occurred toward the end of the nineteenth century; and the second, during the last two decades. The first may be explained by the increased use of coal while the second coincides with the rapid increase in the combustion of leaded automotive fuels. Very low lead concentrations were measured in samples from northern Scandinavia.

17978

Kerin, Z.

**CONTAMINATION OF VEGETABLES BY THE EMISSIONS OF A LEAD REFINING PLANT.** (Verunreinigungen von Gemuese aus Emissionen einer Bleihuette). Text in German. Qualitas Plant. Mater. Vegetabiles, vol. 15:372-379, July 10, 1968. 3 refs.

Harvest-ripe samples of vegetables (cichorium endivia, cichorium intybus, brassica oleracea, Sauerkraut, phaseolus vulgaris, parsley leaves and roots, potatoes, red beets, and carrots) were collected in various distances from a lead-refining plant in the years 1965 and 1966. The vegetable samples were analyzed in washed and unwashed states. The samples were dried and pulverized and mixed with nitric acid. A spectrophotometer was used for the determination. Contaminated unwashed cichorium endivia contained 19 to 104 ppm Pb (average 57 ppm Pb) while the control plants contained only 1.30 ppm Pb. In the washed state, the lead content ranged from 5.0 to 55.0 ppm in contaminated plants. In washed control plants, the lead concentration was 0.50 ppm. Similar high lead concentrations were found in all other vegetables from the contaminated area. Although a large fraction of the lead can be washed off the plants, a considerable amount still remains on the plants. Tuberous plants had lead concentrations of 10 to 50 times higher than tuberous control plants. This fact is important, because it is a consequence of the high lead contamination of the soil which will last for decades, despite the planned installation of filters. Likewise, restrictions of the addition of tetraethyl lead to automobile fuels will not erase the lead contamination of the soil along highways.

18481

British Columbia Dept. of Agriculture (Victoria), Canada Food and Drug Directorate, Ottawa (Ontario), and Cominco Ltd., Trail (British Columbia)

**REPORT OF INTER-AGENCY COMMITTEE ON ENVIRONMENTAL STUDY ARISING OUT OF A DEBILITATING DISEASE IN YOUNG HORSES-TRAIL AREA, 1969.** 4p., 1970.

During 1968, six foals on three different premises in the area of Trail, British Columbia, were affected with a chronic debilitating disorder; an investigation revealed that the lead level in one of these foals was sufficiently high to permit a diagnosis of chronic lead poisoning. A committee was formed to carry out a comprehensive investigation in order to more accurately identify the underlying cause of the toxic disorder occurring in young horses, and to assess any potential harmful effects on human health. Controlled clinical studies of horses and cattle were conducted, as well as the chemical testing of air, water, vegetation and soil, local meat, milk, eggs and vegetables, and human urine and tissue specimens. While the committee is of the opinion that the presence of lead in the Trail area does not constitute a hazard to humans, foals have a high susceptibility to ingested lead and should therefore not be raised on locally grown forage in the area of a smelter.

18520

Ottoboni, Fred and Ephraim Kahn

**STUDY OF BENICIA AREA HORSE DEATHS. INTERIM REPORT.** California State Dept. of Public Health, Berkeley, Bureau of Occupational Health and Environmental Epidemiology, 12p., May 1, 1970.

Follow-up of a call for assistance when 12 out of approximately 30 horses pastured in a field directly across from an oil refinery were found dead reveaaled that approximately 25 more horses had died in the nearby area within a two-year period. Animal studies indicated lead as the etiologic agent and defined the area of contamination. Urinalysis of specimens from a selected population of adults and young children in the Vallejo-Benicia area show no lead intoxication in the human population. Possible lead sources in the area are being evaluated.

18521

Locke, L. N., G. E. Bagley, and L. T. Young

**THE INEFFECTIVENESS OF ACID-FAST INCLUSIONS IN DIAGNOSIS OF LEAD POISONING IN CANADA GEESE.** Bull. Wildlife Dis. Assoc., vol. 3:176, Oct. 1967. 3 refs.

Birds, particularly Canada geese, receiving a large exposure to lead may succumb without the formation of intranuclear acid-fast inclusions in the kidneys. In December 1966, a die-off of about 600 Canada geese occurred at Fox Lake, Wisconsin; 8 of these were autopsied. In all cases the inclusion bodies that were found were very small and took the acid-fast stain only faintly. Definite diagnosis must be based on chemical analysis of the tissues.

19604

Webster, C. C.

**THE EFFECTS OF AIR POLLUTION ON PLANTS AND SOIL.** London, Agricultural Reseach Council, 1967, 53p. 198 refs.

Recent trends in the emissions and concentrations of smoke, deposited matter, and sulfur dioxide in Britain and the effects of these pollutants on plants and soil are presented. Factors affecting the action of sulfur dioxide on plants are susceptibility of different species and varieties, stage of growth, time of day, environmental conditions, concentration of gas and time of exposure, intermittent exposure, and fluctuating concentration of gas. The effects on plants and soil of fluorides and photochemical or oxidant smog are considered. The contamination of plants near highways with lead from the exhaust fumes of motor vehicles is included. Plants as indicators of pollution are also discussed.

19620

Bashirova, F. N.

**CERTAIN CHARACTERISTICS OF INDUSTRIAL AND DOMESTIC CONTAMINATION OF SOIL IN CITIES OF THE KUSNTESK BASIN.** (Nekotoryye pokazateli promyshlennogo i bytovogo zagryazneniya pochv v Gorodakh Kuzbassa). Text in Russian. Okhrana Prirody na Urale, vol. 5:79-82, 1966.

Analysis of soil samples taken in and near cities of the Kusnetsk Basin, a coal and metal working center, has revealed significant changes caused by various waste products. Soils were found to contain harmful elements such as lead, and to

be poor in nutriment content. The natural composition of soil was found in gardens and parks where cultivation was maintained to a depth 60-130 cm. It is concluded that with proper agronomic measures, these soils can be made to support trees, shrubs, flowers, and grasses.

20062

Schuck, E. A. and J. K. Locke

**RELATIONSHIP OF AUTOMOTIVE LEAD PARTICULATES TO CERTAIN CONSUMER CROPS.** Environ. Sci. Technol., 4(4):324-330, April 1970. 8 refs (Presented at the Symposium on Air Conservation and Lead, Division of Water, Air, and Waste Chemistry, 157th National Meeting, American Chemical Society, Minneapolis, Minn., April 1969.)

The colorimetric dithizone technique was used to analyze cauliflower, tomatoes, cabbage, strawberries, and valencia oranges for their lead content. The soil, water, and air in contact with the crops were also analyzed for lead. The combined findings from the edible portion of four of the five crops strongly suggest that automotive lead particulates are not absorbed. They exist rather as a topical dust coating of which at least 50% can be removed by simple water washing. Neither did these crops show any inclination to absorb lead through their root systems. Similar conclusions relative to strawberries cannot be drawn, except by analogy to the other crops. In spite of growing near heavily traveled highways, i.e., up to 50,000 vehicles a day, the amount of lead associated with the five crops in an untreated state was never greater than one microgram of Pb per gram of fresh weight. The average Pb concentration of the entire crop areas studied was one or two orders of magnitude less than one microgram of Pb per gram of fresh weight. (Author abstract modified)

20237

Marten, G. C. and P. B. Hammond

**LEAD UPTAKE BY BROMEGRASS FROM CONTAMINATED SOILS.** Agron. J., 58(5):553-554, Sept.-Oct. 1966. 5 refs.

The possible absorption of concentrations of lead toxic to animals into the foliage of bromegrass growing in contaminated soils from specified sources was studied. Plants propagated from the same clone of bromegrass at an experimental farm were defoliated and transplanted to four soils in pots. The sandy-loam soils were from the surface, 25 mm from a farm adjoining a battery smelter (680 ppm lead); the surface, 25 mm from the bank of a well- traveled, 4-lane highway (59 ppm lead); from the normal greenhouse supply, (12 ppm lead); and a 25 mm layer at a 150 mm depth from a farm (95 ppm lead). Three crops were harvested from each pot. When the crops reached the heading stage (after 69 days) the first crop was harvested. The second crop was harvested after 73 days regrowth without heading. Chelates were added to the soils after the harvest of the second crop. The third crop was harvested at the heading stage after 37 days regrowth. Only the highly contaminated surface soil obtained from the smelter area (soil A) produced first-crop grass with significantly more lead than the control. No statistically significant differences appeared in the second crop, but there was a trend toward higher lead in soil A. The addition of chelates resulted in a distinct increase in lead concentration in grass growing in the two most contaminated soils. Trends toward greater lead uptake also appeared in the control and highway bank soils. Even the greatest lead grass concentration (34.5 ppm) was far below the level which would be toxic to animals consuming grass. At least 150 ppm lead in the total ration of dry matter is needed to approach levels to be toxic to cattle and horses.

21018

Maeno, M.

**EFFECTS OF AIR POLLUTION ON TREES. V. HEAVY METALS IN LEAF OF STREET TREES STUDIES ON DETERMINATION OF LEAD BY ATOMIC ABSORPTION SPECTROSCOPY AND RESULTS OF SOME MEASUREMENTS.** (Jumoku ni taisur taiki osen no eikyo: dai-goho. Gairojuyo no jukinzoku. Genshikyukoho ni yoru namari no sokuteiho no kento to sokuteirei). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution,) 4(1)136, 1969. (Proceedings of the 10th Annual Meeting of the Japan Society of Air Pollution, 1969.)

The effect of pollution on plants and trees from automobile exhausts was estimated by measuring the distribution of lead content of trees by means of atomic absorption spectroscopy. Attention was paid to the conditions of observation, the effects of coexisting elements, the methods of decomposing the samples, and the rate of data retrieval. Gingko, platanus, Chinese parasol, and horse chestnut trees were observed from ten locations in the Tokyo-Yokohama area. Gingko ranged from 17 to 116 ppm with an avaerage of 49 ppm in lead content, and platanus ranged from 17 to 34 ppm with an average of 25 ppm. The locational difference in the contents indicated that there is a close relationship between lead content and traffic volume; and in addition, the period of June to July was the time of increase of lead content. The dust (insoluble components) on the leaves had values ranging from 650 to 1318 ppm with an average of 932 ppm.

21794

Lagerwerff, J. V. and A. W. Specht

**CONTAMINATION OF ROADSIDE SOIL AND VEGETATION WITH CADMIUM, NICKEL, AND ZINC.** Environ. Sci. Technol., 4(7):583-586, July 1970. 37 refs.

Soil samples were collected as a function of depth in profile (0-5, 5-10, and 10-15 cm) and distance from traffic (8, 16, and 32 m) at four sampling sites adjacent to heavily travelled roads. As determined by atomic absorption spectrophotometric analyses of soil extracts and plant digests, concentrations of cadmium, nickel, lead, and zinc soil and vegetation decreased with distance from the road and with depth in soil profile. High concentration of one metal in the soils did not necessarily entail high concentrations of another one of the metals. Also, there was no consistent relationship between the metal concentrations of the 0-to 15-cm soil layer and that of the vegetation growing in the soil. An approximate linear relationship over the 32-m distance existed only for Pb. Nickel and lead in roadside soils appear to be related to gasolines and Zn and Cd to motor oils and automobile tires.

22926

Purves, D.

**TRACE-ELEMENT CONTAMINATION OF SOILS IN URBAN AREAS.** Trans. Int. Congr. Soil Sci., 9th, vol. 2:351-355, 1968. 14 refs.

The spectrochemical analysis of top-soils from urban areas in Scotland indicates that in such soils, levels of copper, boron, lead, and zinc are substantially higher by comparison than are arable top-soils from rural areas. Urban garden soils, as a group, contain on the average about five times as much EDTA- extractable copper, twice as much water-extractable boron, four times as much acetic acid-extractable lead, and twenty times as much acetic acid-extractable zinc as rural, arable soils in South- East Scotland. These differences are so great that they must be due to contamination resulting from various kinds of human activity in urban areas. Sources of

contamination and possible effects of the high levels on plants grown in urban areas are discussed. (Author abstract modified)

23258

Hultberg, Hans and Jan Stenson

**EFFECTS OF ACIDITY ON THE FISH FAUNA OF TWO SMALL LAKES IN BOHUSLAN, SOUTHWESTERN SWEDEN.** (Forsurningens effekter pa fiskfaunan i tva bohuslanksa smasjoar). Text in Swedish. Fauna Flora, no. 1:11-20, 1970. 10 refs.

Between 1962 and 1969, the pH of surface water in two oligotropic lakes decreased from about 5.8 to 4.6-4.8 due to the presence of sulfate ions in rainwater. A very high incidence of sulfate ions was observed in the lake water. When fish were collected for analysis by treating the lakes with rotenone, the pH values were lethal to eggs and fry, but not to fish in advanced stages of development. Adult pike appeared to be more resistant to low pH than adult perch. The effect of pH on eels is not clear; all collected eels were in good condition. The industrial dust that partly covered the lakes contained toxic lead, copper, and zinc.

23435

Ruhling, Ake

**HEAVY METALS WITHIN THE REGION OF VARGO-TROLLHATTAN.** (Tungmetallfororeningar inom Vargon-Trollhattanomradet). Text in Swedish. Lund Univ. (Sweden), Inst. of Ecological Botany, Rept. 14, 22p., April 1970.

Measurements of heavy metals were made within a region where heavy industry is situated. A common sort of moss, Hypnum cupressiforme, was analyzed at 127 sites for lead, iron, cadmium, cobalt, copper, chromium, manganese, molybdenum, nickel, vanadium, and zinc. The mosses were at least 100 m from any road to prevent the possibility of automotive contamination. In general, very high values of metals were observed in the mosses. For example, in the region of a ferroalloy plant, concentrations as high as 12,000 ppm of chromium and 30,000 ppm of manganese were found. The normal values for Sweden are 10 and 200 ppm respectively.

23581

Grouven, H.

**THE INFLUENCE OF COAL GAS ON TREES ON PARKWAYS AND STREETS.** (Einfluss des Leuchtgases auf die Promenadenund Strassenbaume). Z. Deut. Landwirthe, 1855: 151; Ibid., 1859: 360. 6 refs. Translated from German. Belov and Associates, Denver, Colo., 2p., July 10, 1970.

*Attention is called to the fact that trees on a number of European streets and boulevards have died when grown in soil contaminated by burned oily substances and sulfur and ammonia compounds from adjacent coal gas conduits. This has occurred even where cast iron pipes are used. Another source of vegetation damage is the arsenic and lead contained in dust emissions from foundries.*

24667

Genderen, H. Van

**SEVERAL TYPES OF SIDE-EFFECTS.** (Nevenwerkingen in soorten). Text in Dutch. TNO Nieuws, vol. 24:524-527, 1969.

A commission was appointed to study the side-effects of pesticides, with emphasis on environmental pollution due to the dispersal of some of these substances in air, water, soil, and food. The commission was subdivided into a number of study groups: birds and mammals, water, soil, chemical and biochemical transformations. In recent years there has been a high mortality of birds of prey in the Netherlands, which these studies have traced to the use of chlorohydrocarbon insecticides. Reference is made to the dangerous persistence of lead compounds released into the air by the use of tetraethyl lead in motor fuels.

24788

Kloke, A. and H. O. Leh

**POLLUTION OF CULTIVATED PLANTS WITH LEAD FROM AUTO EXHAUST.** (Verunreinigungen von Kulturpflanzen mit Blei aus Kraftfahrzeugabgasen). Air Pollution Proc. First European Congr. Influence Air Pollution Plants Animals, Wageningen, Netherlands, 1968, p. 259-268. Translated from German. Belov and Associates, Denver, Colo., 15p., Nov. 2, 1970.

Plant samples from areas adjacent to and remote from dense traffic were analyzed for lead. The lead content of the green parts of plants increased with increasing closeness to well-travelled highways and streets. Even in the vicinity of highways, no increase was noted in lead concentrations in below-ground and inner portions of plants. The lead content of feed plants growing along roads was far in excess of the suggested tolerable concentration of 10 ppm. For the protection of humans and cattle, cultivation of food and forage plants along roadways should be abandoned or the use of tetraethyl lead in fuel prohibited.

24947

Ter Haar, Gary

**AIR AS A SOURCE OF LEAD IN EDIBLE CROPS.** Environ. Sci. Technol., 4(3):226-230, March 1970. 19 refs. (Presented at the American Chemical Society National Meeting, 157th, Symposium on Air Conservation and Lead, Minneapolis, Minn., April 1969.)

The effect of airborne lead on the lead concentration of the edible and nonedible portions of several important types of food crops was studied by growing crops in greenhouses supplied with filtered and ambient air, and in plots planted in long rows perpendicular to a busy highway. Of the ten crops studied--wheat, potatoes, tomatoes, sweet corn, carrots, oats, cabbage, rice, leaf lettuce, and snap beans--eight were not affected by the concentration of lead in the air. Leaf lettuce was the only crop studied in the greenhouse whose edible portion had a statistically higher lead concentration when grown in unfiltered air than when grown in filtered air. The cob of sweet corn contained a higher concentration than the kernel. In contrast to the greenhouse plants, however, soybeans and snap b[illegible]s showed higher lead concentrations when grown near the r[illegible]. The pH of the soil may have been a factor. Inedible portions of the plants, such as corn husks, wheat, and oat chaff, soybean hulls and the broad, normally harvested, outer leaves of cabbage contained two to three times higher concentrations of lead when grown near the road, compared with further away. Lead occurring naturally in the soil was concluded to be the main source of lead in the edible portion of the crops studied, while airborne lead, based on the crops studied, contributes 0.5 to 1.5% of the lead content of the U. S. diet. To evaluate the significance of these conclusions, several questions were considered: how critical was the design of the experiment relative to the problem at hand; how complete were the data; and how meaningful were the conclusions arrived at when placed in a general context. (Author abstract modified)

25374

Page, A. L. and T. J. Ganhe

**ACCUMULATIONS OF LEAD IN SOILS FOR REGIONS OF HIGH AND LOW MOTOR VEHICLE TRAFFIC DENSITY.** Environ. Sci. Technol., 4(2):140-142, Feb. 1970. 13 refs.

Accumulation of lead in soils over a period of approximately 40 years was compared for areas of high and low motor vehicle traffic densities. Where motor vehicle traffic density was less than 80 motor vehicles/sq mi, no lead accumulation was observed, but where the motor vehicle traffic density was greater than 580 motor vehicles/sq mi, the concentration of lead in the surface 2.5 cm of soil increased by a factor of two to three times. Despite these percentage increases, the amount of lead found in the surface soil did not exceed 52 ppm, a level which is common to many soils from areas of low traffic density and not subjected to atmospheric or industrial lead contaminations. The amount is considerably below levels which may cause toxicities to economic plants. (Author abstract modified)

25878

Keller, Th.

**THE CURRENT LEAD CONTENT IN VEGETATION GROWING IN THE VICINITY OF SWISS HIGHWAYS.** (Der jetzige Bleigehalt der Vegetation in der Naehe schweizerischer Autostrassen). Text in German. Z. Praeventivmed., vol. 15:235-243, 1970. 12 refs.

The factors affecting the level of lead accumulated in cultures growing near highways travelled by automobiles are traffic density, season, the age of pine needles, the surface structure of the exposed plant organs, and the vertical and horizontal distance from the highway. In contrast, the lead content in the soil is hardly a factor, partly because only a small fraction of the lead compounds in the soil are absorbed by plant roots and partly because transport of lead within the plant is minimal. A large percentage of lead found in plants adheres to the surface, but this lead washes off only to a limited extent. The lead concentration of unwashed crops at a distance of 100 m from highways with heavy traffic was considerable; hay contained 2-8 ppm; leaf vegetables, 3-7 ppm; carrots, 2-3 ppm; fruit, 0.7 to 2.7 ppm; and cereals, 0.3-0.5 ppm. Conifers are an excellent air filter, and highways should be lined on both sides with a strip of evergreen trees and shrubs. Tetraethyl lead as an additive to gasoline should be replaced by safe substitutes, even though hitherto no actual harm has been caused to either plants, animals, or humans from lead emission from highway traffic.

25967

Cooper, R. C.

**OCCURRENCE OF AIRBORNE LEAD IN SAN FRANCISCO BAY AND ITS RELATION TO ANIMAL DISEASE.** In: Project Clean Air. California Univ., Berkeley, School of Public Health, California Univ. Res. Proj.

Fish and samples of bottom sediments were collected from San Francisco Bay and analyzed for lead by neutron activation analysis, proton activation analysis, and the dithizone 'wet chemical' method. Neutron activation analysis was a failure because of the high energy produced by sodium present in test samples. In addition, the dithizone method and proton activation yielded very real differences in values. Based on the dithizone results, lead levels in fish are relatively great: they range from 0.14 ppm in Sculpin to 6.37 ppm in shrimp. The amount of lead in Bay sediments ranged from 10.9 ppm near the shore to 7.80 ppm approximately 0.9 miles offshore. These values are not exceptionally high when compared to the 16 ppm average lead content in the earth's crust. No correlation between fish disease and lead content could be determined.

26055

Hanson, George P.

**MAN AND AIR -- THREATS TO PRAIRIE SURVIVAL.** Lasca Leaves, 20(4):78-81, 92, Dec. 1970. 6 refs. (Presented at the Prairie Conference, 2nd Midwest, Madison, Sept. 20, 1970.)

Most pollutants enter the leaf through tiny pores in the leaf surfaces and cause internal leaf damage. These tiny pores or stomates are the passages through which gas exchanges take place during photosynthesis and respiration. At a given pollutant level, other things being equal, a plant growing under conditions of high humidity will take in more pollutant and become more severely damaged than a plant growing under arid conditions. Once the pollutants have entered the leaf, each has its own characteristic type of interaction with the plant tissues. Small animals living along a busy highway could accumulate lead by consuming lead-containing herbage or breathing lead laden air. Fluoride air pollutants damaging to plants are hydrogen fluoride and silicon tetrafluoride. The characteristic symptom of fluoride damage is necrosis on leaf tips and margins where the fluoride has been concentrated. Ethylene causes a general reduction in growth, decreases apical dominance, and stimulates lateral development. Ozone enters through the stomates and attacks the palisade tissue, while sulfur dioxide enters the leaf through the stomates and reacts with water on the moist cell surfaces to form sulfite which is in turn slowly oxidized to sulfate. Peroxyacetyl nitrate enters the leaf through the stomates where it attacks the cells of the spongy mesophyll, and nitrogen dioxide causes growth reduction and defoliation at concentrations often present in polluted areas. Air pollution is having a detrimental economic effect on agriculture in the nation, while also altering the ecological relationships of plants and animals. Fortunately, most species have a great wealth of genetic variation in sensitivity to air pollution. The mechanism of plant tolerance to air pollutants is mentioned.

26092

Osterli, Victor P.

**EFFECTS OF AIR POLLUTION ON AGRICULTURE AND FORESTRY: ANIMALS.** In: Project Clean Air. California Univ., Berkeley, Task Force No. 5, Section 3, 3p., Sept. 1, 1970. 6 refs.

Serious economic losses have occurred when animals have been subjected to certain metallic compounds. Symptoms of fluorosis, which occurs when the diet contains more than 30 to 40 ppm of fluorides per day, include excessive wearing of the teeth, staining pitting of the enamel, and exposure of the dentine. In severe cases, joints may become enlarged and bone density increases significantly. Pasture grasses collected at the intersection of two U. S. highways near Denver contained 3000 ppm lead, while grasses collected next to a less travelled roadway contained 700 ppm lead. Suggested research needs with respect to lead pollution and its effects on animals would include the relative availability of lead to humans and animals from the different sources (air, water, and soil) and the transfer mechanism involved; the relative importance of surface contamination and absorption of lead; and whether the lead content of plants comes only from the air or also is taken up from the soil.

26276

Guss, Samuel B.

**CONTAMINATION OF DAIRY FEEDS BY AIR POLLUTION.** Milk Food. Technol., 33(12):553, 561, 567, Dec. 1970.

Where industry is encroaching upon land used for production of feed and forage crops, air pollution of forage for dairy cattle is already a serious problem. In Pennsylvania, lead poisoning and serious metabolic disease resulting from lime plant stack effluents have caused losses on dairy and beef cattle farms. Dairy cattle in the vicinity of lime plants have a very high incidence of milk fever, infertility, and bone abnormalities. Brood cows in a purebread beef cattle herd experienced ovarian cysts and osteopetrosis. Lime dust also affects the pH of the digestive tract to a great extent limiting digestion and absorption of some components of the diet. In two farms in Berks County, pastures close to lead smelters contained enough lead dust contamination on grass to kill cows. Effluents must be constantly monitored and the attitudes of the offenders must be changed by stiff penalties. Deposition of lead from gasoline exhaust may be an important factor influencing the health of animals living on farms along heavily traveled highways. Molybdenum and fluorine also have been involved in problems which have caused severe losses in a few cattle herds. (Author abstract modified)

27063

Eshleman, Alan and S. M. Siegel

**METALS IN THE ECOSYSTEM. LEADED GRASS AND OTHER ABOMINATIONS.** Preprint, Hawaii Univ., Honolulu, Dept. of Botany, 10p., 1970. 15 refs.

In Hawaii, the source of lead pollution is almost entirely the burning of leaded motor fuel, and since island soils in their natural state have a low lead content, it is possible to construct model bio-geochemical lead cycles using a pollution aerosol as a starting point. It is known with certaintly that these aerosols transfer at least some of their lead to soils from which plants tak it up, probably through the root system. Lead deposited from pollution aerosols seems to be confined to the upper few centimeter of soil surface, while the amount of organic matter in the soil apparently affects the quantity of lead taken up by plants. Laboratory results strongly suggest that lead may be concentrated through the decay process. The ingestion of lead is briefly discussed in relation to the fatal poisoning of animals pastured on leaded grass, intake through food in urban dwellers, possible transport of lead across the human placenta, and nesting failures of a marine bird species. The subtlety of the biological effects o environmental lead and the intrinsic toxicity of the element indicate that it is far more hazardous and merits far more attention than the more familiar classes of air pollutants.

27111

Weidensaul, T. Craig and Norman L. Lacasse

**RESULTS OF THE STATEWIDE SURVEY OF AIR POLLUTION DAMAGE TO VEGETATION.** Preprint, Air Pollution Control Assoc., Pittsburgh, Pa., 13p., 1970. 3 refs. (Presented at the Air Pollution Control Association, Annual Meeting, 63rd, St. Louis, Mo., June 14-18, 1970 Paper 70-108.)

Because of the lack of knowledge concerning damage to vegetation du to air pollution, a survey was implemented in the spring of 1969 to assess the economic effects of air pollution on vegetation in Pennsylvania and to place losses in food, fiber, and ornamental production in more realistic terms. Prior to the field session, a short training course was conducted to acquaint agricultural agents with symptoms of air pollution injury on plants, sources of pollutants, meteorological factors, diagnosis, and methods of assessing damage. Of the 92 field investigations which were made in 28 of 67 counties, 60 revealed damage directly attributable to air pollution. Vegetables, fruits, and agronomic crops were most seriously affected, accounting for more than 3.2 million dollars in direct losses. Damage to lawns, shrubs, and woody ornamentals resulted in more than 200 thousand dollars while timber losses exceeded 39 thousand dollars. Commercial flowers and foliag plants suffered over 56 thousand dollars in damages. The total amount of damage uncovered was estimated in excess of 3.5 million dollars, while total indirect losses were estimated at an additiona 8 million dollars. These losses include known grower profit losses reforestation costs of denuded land, grower relocation costs, and crop substitution losses. Some unassessed indirect losses were changes in vegetation type, decrease in water retention capacity of watersheds, erosion and stream silting, losses to related industries, and agricultural land forced out of production. The suspected major pollutants in decreasing order of importance are oxidants, sulfur oxides, lead, hydrogen chloride, particulates, herbicides, and ethylene.

27352

Djuric, Dusan and Zarka Kerin

**LEAD CONTAMINATION OF ENVIRONMENT IN MEZA VALLEY, YUGOSLAVIA: SOME CONSIDERATIONS ON LEAD CONTENT IN SOIL AND PLANTS.** Preprint, 10p., 1970. 2 refs. (Presented at the International Conference on Chemical Pollution and Human Ecology, Prague (Czechoslovakia), Oct. 1970.)

As part of a broad ecological study of lead contamination, soil samples and underground parts of some vegetables were analyzed for lead by the dithizone method. Vegetables fell into three groups: those with a relatively high Pb content (over 30 mg/kg); those with a medium Pb content (over 10 mg/kg); and those with a low Pb content (under 5 mg/kg). Variations in Pb content in the same kind of vegetables represented variations in soil Pb content and absorption. Variations between different kinds of vegetables were due to differences in plant physiology and capacity of absorption, shape and size of root, and depth of root in soil. Lead content was higher in vegetables grown in summer and fall than for the same vegetables grown in spring. Lead absorption coefficients were calculated for underground parts of vegetables according to the relation between the Pb content of the plant and total Pb content of soil and according to the relation between the Pb content of the plant and the AL-soluble Pb in soil (AL is the ammonium lactate acetic acid mixture). The latter method gave much less dispersed coefficients, indicating that AL-soluble Pb represents much more authoritative data for determining absorption coefficients than total soil Pb.

27386

Egan, D. A. and T. O'Cuill

**OPENCAST LEAD MINING AREAS--A TOXIC HAZARD TO GRAZING STOCK.** Vet. Rec., 84(9):230, March 4, 1969.

During 1966-1968, substantial losses of sheep and cattle were incurred in an area where opencast lead mining operations had recently started. Most of the animals showed signs of clinical lead poisoning and many had kidney cortex lead levels in excess of 25 ppm; however, two had values of 7.5 and 10 ppm, respectively. Both animals had access to forage heavily contaminated with lead carbonate and sulfide. It thus appears that kidney lead values of considerably less than 25 ppm may be indicative of lethal intake when clinical and environmental factors support the opinion. In th case of newly born animals

with no access to contaminated herbage, lethal amounts of lead were evidently supplied in utero and in milk

27391

MacLean, A. J., R. L. Halstead, and B. J. Finn

**EXTRACTABILITY OF ADDED LEAD IN SOILS AND ITS CONCENTRATION IN PLANTS.** Can. J. Soil Sci., 49(3):327-334, Oct. 1969. 11 refs.

Concentrations of lead in five species of plants were found to increase with proximity of the sampling sites to a well-travelled highway. The species were couchgrass, bromegrass, timothy, alfalfa and asparagus. In pot tests using four soils pretreated with lead chloride, the lead content of oats and alfalfa varied inversely with the organic matter content and pH of the soils. Amounts of lead taken up by the plants were reduced upon addition of phosphate or of lime to the acid soils. Furthermore, the beneficial effects of organic matter, phosphate and lime in reducing lead in the plants were usually in accord with corresponding reductions in extractable lead in the soils as measured in 1 N neutral ammonium acetate and 0.1 M calcium chloride. (Author abstract modified)

27489

Kobayashi, Jun, Fuji Morii, Shigeki Muramoto, and Susumu Nakashima

**EFFECT OF AIR AND WATER POLLUTION ON AGRICULTURAL PRODUCTS BY CD, PB, ZN ATTRIBUTED TO MINE REFINERY IN ANNAKA CITY, GUNMA PREFECTURE.** (Gunma-ken Annaka-shi no seirensho ni yoru nosakubutsu nado no junkinsoku (Cd, Pb, Zn) osen ni tsuite). Text in Japanese. Nippon Eiseigaku Zasshi (Jap. J. Hyg.), 25(4):364-75, Oct. 1970. 30 refs.

In an investigation of air and water pollution by zinc, lead and cadmium discharged from the zinc refinery in Annaka city, Gunma prefecture, agricultural products in the environs were sampled and the contents of the various metals were analyzed. The examinations were carried out twice: in October, 1968 and in June, 1969. The quantities were measured by the atomic absorption analysis method. The contents of the metals in mulberry leaves in the hilly regions 400-2500 m east of the refinery were: Cd 17 - 3.3 ppm, Zn 2590 - 360 ppm, Pb 160 - 41 ppm, and the contents of Cd and Zn showed a regression line, (Zn) equals 141(Cd) - 107, r equal 0.998, indicating a mutual relationship. For agricultural products, the results were: fruit vegetables Cd 8.6 - 0.3 ppm, Zn 150 - 29 ppm, Pb 11 less than 0.4 ppm, root vegetables, Cd 17 - 14 ppm, Zn 530 - 100 ppm, Pb 63 less than 0.02 ppm; leaf vegetables, Cd 61 - 3.2 ppm, Zn 7010 - 380 ppm, Pb 370 - 4.3 ppm. As to barley and wheat, the highest levels were recorded as follows: Cd 6.8 ppm, Zn 310 ppm, and Pb 14 ppm. Moreover, the contents of Pb in barley and wheat growing in the fields more than 1500 m below the refinery showed higher levels than those of Pb in barley and wheat growing in the hilly Yaden region, which is 800 - 1250 m south of the refinery; the fact indicates that the effect of water pollution cannot be ignored. The contents of Cd and Zn in wheat in Yaden and Iwai region showed a regression line, (Zn) equals 41 (Cd) + 50, r equals 0.95, indicating significant relationships. Also in Yaden region, higher levels of metals were found in leaf vegetables compared with root vegetables and fruit vegetables and in Annaka city, rice was not the only polluted agricultural product but leaf vegetables were especially highly polluted.

28105

Yokohama Center for Public Nuisance (Japan) and Yokohama Municipal Univ. (Japan), Dept. of Hygiene

**STUDY ON THE EFFECTS OF AUTOMOTIVE EXHAUST GAS: SECOND REPORT ON LEAD COMPOUNDS.** (Jidosha haikigasu no eikyo ni tsuite--Namari kagobutsu ni tsuite dainiho). Text in Japanese. Yokohama Public Nuisance Center Data 26, 24p., Sept. 1970.

Studies were conducted to determine the diffusion of lead contained in automotive exhaust and the accumulation of lead in the body. In the first study, trees growing along a side street with relatively light traffic were examined for their leaf lead content vs. that of the same species on the adjoining heavily travelled main thoroughfare. The results indicated that, in the absence of tall buildings and other obstructions, diffusion of lead reaches 50-70 m As shown by results obtained in May, June, and October, the relationship between exposure time and the accumulation of lead in leaves is quantitatively proportional. In the second study, cats were exposed to exhaust gas containing about 75 ppm carbon monoxide Blood density, hemocyte values, and hemachrome quantity increased in cats exposed to the gas for 30-100 days but decreased in those exposed for 150-202 days. This may be indicative of improved blood quality in the earlier stage of exposure and of subsequent deterioration with continued exposure. There was a marked increase of lead in blood and liver and a less pronounced increase in kidneys, lungs, spleen, and bones. The fact that the quantity of lead in lungs had no direct relationship with that in blood and other internal organs suggests that grain size and the solubility o lead particles are important factors in body lead accumulation.

28289

Ruhling, Ake and Germund Tyler

**AN ECOLOGICAL APPROACH TO THE LEAD PROBLEM.** Botaniska Notiser, vol. 121:321-342, 1968. 7 refs.

Field and greenhouse measurements of lead accumulation in plants and soil by atomic absorption spectrophotometry are reported. Experiments showed that plants collect airborne lead chiefly with their shoots, and that root uptake is minor. Measurements within 50-100 m from major roads indicated that only a minor part of the lead emitted by vehicles will settle and accumulate in the immediate vicinity of the roads. Mosses were found to accumulate lead to an exceptional extent, and samples of three common types were collected in central and southern Sweden no closer than 300 m to a road to measure regional lead pollution. A distinct NE-SW gradient was found with a decrease towards the NE. The lead concentrations of the mosses increased with precipitation and with decreasing distance to large population centers. In southwest Goetaland, much of the lead washed out by rainfall originates outside Sweden. Analysis of samples collected in Skane from 1860 to 1968 showed that lead concentrations more than doubled in 1875-1900 from their 1860-1875 levels of about 20 ppm. During the first half of the 20th century no measurable changes were observed, but after about 1950 there was a new strong increase to a present average of 80-90 ppm. Very low lead concentrations were measured in samples from northern Scandinavia, indicating that the 'natural' amounts of lead in mosses are very small and that the concentrations measured in this regional and historical study, principally reflect an influence of human activity. (Author abstract modified)

28379

Lagerwerff, J. V.

**UPTAKE OF CADMIUM, LEAD AND ZINC BY RADISH FROM SOIL AND AIR.** Soil Sci., 111(2):129-133, Feb. 1971. 11 refs.

Soil was sampled at 3 locations at both 7 meters and 200 meters from a heavily travelled road. The extractable metal contents, which were high and low, respectively, were determined by shaking 20 g of air-dry soil with 40 ml N hydrogen chloride for 1 hour, collecting a centrifugate, and analyzing by atomic absorption spectrophotometry. Nine-hudnred gram batches of soil were put in half-gallon cardboard containers lined with polyethylene; radish was sown and the seedlings were thinned to nine plants per container and grown to maturity. Large changes in the soil contents of cadmium, lead, and zinc caused only small changes in the only small changes in the contents of these metals in radish. Increasing the soil pH from 5.9 to 7.2 resulted in decreases in yield and metal contents of the plants. Grown at 200 meters from a busy highway, aerial contamination accounted for more than 40% of the Pb, Cd, and Zn of the radish tops. Only Zn was translocated to the roots to a significant extent. (Author summary modified)

28448

Tomson, N. M.

**CONTENT OF METALS IN ATMOSPHERIC DUST AND THEIR EFFECT ON LIVING ORGANISMS.** (Soderzhaniye metallov v atmosfernoy pyli i vliyaniye ikh na zhivyye organizmy). Text in Russian. Gigiena i Sanit., no. 10:11-13, 1948.

Analysis of test animal and plant tissue ash may serve as an index of atmospheric pollution by heavy elements, their normal concentration as trace elements in living organisms serving as a criterion for establishing maximum allowable concentrations. Test animals were exposed to a polluted environment for 5 months. Dust levels ranged from 0.02 to 0.05 mg/cu m and lead oxides constituted the major heavy-element pollutant. Lead content in exposed animals reached 95.5 mg/kg in bone (as compared to 12.2 mg in controls) and 23 mg in liver (compared to 3.7 mg). Exposed plant leaves contained 15 mg/kg of lead as compared to 90-300 mg/kg in leaves from unpolluted areas.

28471

Keller, Th.

**THE PROBLEM OF TRAFFIC-INDUCED RESIDUES OF LEAD IN VEGETATION.** (Zum Problem der verkehrsbedingten Bleirueckstaende in der Vegetation). Text in German. Strasse Verkehr., no. 1: 1970. 5 refs.

The examination of live and dried moss from Sweden disclosed that from 1860 to 1968 the lead content of moss even in localities far removed from traffic increased from 20 ppm to 80-90 ppm, with the highest increase registered since about 1950. This is because the size of three-quarters of the emitted lead particles is less than 5 microns and thus remains suspended in the atmosphere to be distributed eventually over wide areas. The increase of lead in plants has been proven to be due to the emissions in automobile exhaust gases. Lower lead contents were found in conifer needles 6 m above ground than in needles growing 2 m above ground. For the most part, the lead remains in the roots or needles, only a minimal share is transported by conifers. Another indication that the lead in vegetation comes from exhaust gases is the decrease in the lead content of vegetation with increasing distance from highways. Thus, hay harvested 10-49 m from a highway contained 5-19 ppm lead while hay harvested in a strip 50-100 m from the highway contained only 2-8 ppm lead. Swiss authorities contemplate setting 10 ppm lead as the maximal permissible level of lead in the dry fodder of domestic animals. The planting of hedgerows alongside highways is recommended as a protective measure against the contamination of vegetation with lead emissions.

28529

Yamaga, S., Kaoru Ohmori, Haruko Saito, and Akemi Tanizaki

**THE DIFFUSION OF LEAD IN AUTOMOBILE EXHAUST GAS.** (Jidosha haiki gasuchu namari no kakusan ni tsuite). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Polltuion), 5(1):256, 1970. (Proceedings of the Japan Society of Air Pollution, Annual Meeting, 10th, 1970.)

The pattern of diffusion of lead from automobile exhaust gas was investigated by studying the amount of lead adhering to or contained in leaves of ginkgo trees growing along less-travelled roads that cross a busy highway. Samples were dried at 100 C, then pulverized, and a definite portion wet-digested. After extraction by dithizone, lead was determined by atomic absorption spectrophotometry. The same routine was followed for surface soil at the root of the trees. Leaves at heights of 3 and 6 m were examined. At one of the two sampling sites, the lead content in surface soil tended to decrease with distance from the trunk highway. At both sites, the amount of lead in leaves tended to decrease with distance from the main highway. Lead was found in larger amounts in the leaves at the lower level. Also, those leaves collected in October contained more lead than those assembled earlier in the year.

30033

Cristea, I., R. Dulfu, P. Marian, and V. Dulfu

**RESEARCH ON THE LEAD INTOXICATION OF THE GALLINACEANS.** (Recherches sur l intoxication par le plomb chez les Gallinaces). Text in French. Rec. Med. Vet. Ecole Alfort (Paris), 146(8):783-790, Aug. 1970. 5 refs.

Gallinaceans, particularly the improved breeds and the young of all breeds, are sensitive to lead poisoning. The hens which are intoxicated by lead show apathy and a reduced appetite at the beginning of the disease. As the disease progresses, a state of nervous excitability and some visual problems are encountered. The production of eggs is small and the shell may be very fragile. Fertility and hatching are at a low level and the morbidity rate of young chicks is high. The quantitative determinations of lead showed an accumulation in the feathers, kidneys, and liver. Treatment with EDTA gave good results and ensured a rapid elimination of lead from the organism. (Author summary modified)

30225

Weiss, Siegfried

**AIR POLLUTION AND THE QUALITY OF WINE.** (Luftverunreinigung und Weinqualitaet). Text in German. Muench. Med. Wochenschr. (Munich), 113(23):901, 1971.

Emissions of sulfur dioxide and halogens such as hydrogen chloride, chlorine, fluorine, and hydrogen fluoride stemming from factories and refuse burning produce damage or retarded maturation in grape vines. The maturing fruit is injured by intake of the pollutants through assimilation and through the fine wax layer that coats the berries. The taste of the berries may be spoiled by smoke, mineral oil vapors, asphalt, and tar. Following use of freshly tarred wooden supports for the vine, the taste of tar was transferred through the roots. Dust and soot

deposits on the plants also slow the ripening process and impair the taste. Vines within 300 m of highways are polluted by lead. Fortunately, vineyards in Germany are rarely located near highways.

30424

Smith, William H.

**LEAD CONTAMINATION OF ROADSIDE WHITE PINE.** Forest Sci., 17(2): 195-198, 1971. 23 refs.

Lead contamination of eastern white pine was determined at various distances from an east-west section of Interstate 95 in southern Connecticut, which has a traffic density of 24,000 vehicles daily. Samples were collected on March 16, 1970, from a zone 1.2 to 1.8 m above the ground. Each consisted of twigs plus needles encompassing the entire growth (of the sampled branch) in the previous year. One sample was taken from the branch closest to the highway and another on the opposite side. The distance from the base of the tree to the closest paved surface of the highway was measured. Samples were prepared for lead analysis by drying at 80 C, grinding, and ashing at 500 C; lead content was determined by atomic absorption spectrophotometry. Lead contamination decreased regularly with increasing distance from the highway edge, was consistently higher on trees south of the roadway than on those to the north, and was generally greater on branches samples from the side of the tree closest to the highway as contrasted with branches analyzed farthest from the road on individual test trees. Samples up to 15 m distance from the highway often were contaminated with more than 100 ppm lead, much of which was presumably impacted on exterior surfaces. (Author abstract modified)

30921

Warren, H. V., R. E. Delavault, and K. W. Fletcher

**METAL POLLUTION--A GROWING PROBLEM IN INDUSTRIAL AND URBAN AREAS.** Can. Mining Met. Bull. (Montreal), 64(711):34-45, July 1971. 10 refs. (Presented at the CIM, General Meeting, Annual, 73rd, Quebec City, Quebec, April 1971.)

A preliminary study of soils, vegetables, variegated vegetal matter, and dusts demonstrates quite clearly that metal contamination is as severe in many cities as it is around some of the best-known metallurgical centers. Soils from both Sudbury and Noranda were found to be high in copper, while those from Riondel, Trail, and Noranda had higher than normal amounts of zinc, lead, and cadmium. Liverpool beets, lettuce, and cabbage were found to contain more zinc than those vegetables grown in the vicinity of Noranda. Lettuce grown in Vancouver was found to have more lead than lettuce harvested within the orbit of Trail s contamination. (Author conclusions modified)

30931

Bazell, Robert J.

**LEAD POISONING: ZOO ANIMALS MAY BE THE FIRST VICTIMS.** Science, 173(3992):130-131, July 9, 1971.

A large proportion of the animals at Staten Island Zoo suffer from lead poisoning. While some of the lead in the animals bodies may have come from paint in their cages, the major source appears to be atmospheric pollution. Lead poisoning was observed in all animals ranging from reptiles to primates. Hair clippings and blood and fecal samples from a variety of cats and primates showed lead concentrations often exceeding the level considered toxic in man. Grass, leaves, and soil collected on the zoo grounds contained lead in quantities as high as 3900 micrograms/mg dry weight. Significantly, the animals kept in outdoor cages, including those cages without paint, showed the highest levels of lead in their bodies. The wide range of species that were affected seems to indicate that man may well be in danger. This investigation will be continued to correlate the findings in the zoo animals with the surrounding human population.

31010

Garber, K.

**STATUS AND RESULTS OF RESEARCH IN AGRICULTURAL CHEMISTRY AND BIOLOGY. XVIII. AIR POLLUTION BY HEAVY METAL CONTAING DUST-- EFFECTS ON PLANTS.** Landwirtsch. Forsch., 21(1):59-68, 1968. 16 refs. Translated from German. Sanzare Assoc., Inc., Philadelphia, Pa., 19p.

Investigations were carried out in the vicinity of a lead factory, a zinc factory, a copper factory, and a brass factory, to determine the effect of dust emissions on the vegetation in the area. The soluble heavy metal content in the rainwater was first determined. Depending on the location and the distance from the source of emission, conifer needles contained 1280-2342 ppm Pb, about 4000 ppm Zn, and 500 ppm Cu; grass contained 350-1200 ppm Pb, 3000 ppm Zn, and 1500 ppm Cu. In areas having no industry, conifer needles were found to have 9-30 ppm Pb and 50-150 ppm Zn. In soils which had accumulated high concentrations of heavy metals, inhibition of plant growth was observed.

31185

Kerin, D. and Z. Kerin

**LEAD CONTAMINATION OF MILK AND HONEY THROUGH LEAD AEROSOLS BY THE INDUSTRY.** (Bleikontamination von Milch und Honig durch Bleiaresole der Industrie). Text in German. Protectio Vitae, 16(2):61-62, April 1971. 12 refs. (Presented at the Internationalen, Konvent fuer Zivilisationskrankheiten, Ernaelhrung und Lebensbedingungen, 16th, Luxemburg and Tier, Belgium, Sept. 14-20, 1970.)

The lead content was analyzed in hay, milk, honey, and in the blood of cows grazing in the vicinity of a roasting station for sulfidic lead ore. The waste gases from this process contain sulfur dioxide and heavy metal aerosols composed of primarily lead and lead oxide. Hay samples of non-industrial areas were found to contain 1.41 to 3.56 mg lead/kg dry substance. Grass between the two lanes of highways contains on the average of 105 mg lead/kg dry substance. Of twenty samples taken in the vicinity of this plant, 16 had more than 100 mg lead/kg dry substance. The lead concentration in the blood of the cows surpassed the normal value more than tenfold. The lead concentrations in the milk ranged from 0.16 to 0.29 mg/kg dry substance. The normal values are 0.01 to 0.04 mg lead/kg dry substance. Honey generally has a lead content of 0.18 to 0.46 mg/kg dry substance. In the area under examination it reached ten to twenty times this value.

31801

Purves, D. and E. Jean MacKenzie

**TRACE-ELEMENT CONTAMINATION OF PARKLANDS IN URBAN AREAS.** J. Soil Sci., 20(2):288-290, 1969. 14 refs.

Evidence is presented that soils in urban parklands are markedly contaminated with copper, boron, lead, and zinc. Zinc dibenzyl dithiocarbamate was used as the reagent for determining EDTA- extractable copper in soils, while copper in herbage was determined by a spectrographic plant-ash method. Porous-cup spark excitation using boron-free graphite elec-

trodes was used for the analysis of herbage and water extracts of soils with respect to B. Zinc in herbage and acetic acid extracts of soil was determined by atomic absorption spectrophotometry. Herbage from the same urban parklands contained significantly higher levels of Pb and Zn than herbage from permanent pastures in rural areas. (Author summary modified)

32224

Schucht, F., H. H. Baetge, and M. Dueker

**SOIL ANALYSES IN THE SMOKE DAMAGED AREA OF THE METALLURGICAL PLANT OKER IN UNTERHARZ.** (Ueber bodenkundliche Aufnahmen im Rauchschadengebiet der Unterharzer Huettenwerke Oker). Text in German. Landwirt. Jahrb., vol. 76:51-98, 1932. 39 refs.

The metallurgical plants in Oker primarily emit sulfur dioxide, nitrous acid, and carbon dioxide. The effect of these emissions on the soil was determined by taking soil samples, profile samples, and individual samples at 42 points. The area has primarily clay soil interspersed with sand and gravel. The soil was studied to determine the absorption, permeability, and coherence. Hydrochloric acid extracts were analyzed to determine if changes had occurred because of the pollutants. With prevailing west winds, an extensive area receives the emissions from the metallurgical plants. In all samples, an enrichment of the sulfates (in the form of calcium sulfate) was found. This cannot cause soil damage since the quantities are too small. With the influence of SO2 and CO2, the soil loses its alkalinity. However, the soil contained so much calcium the SO2 became bound. Iron sulfates, which form only without alkalinity, could not be determined. Within a belt of one to one and one half km wide, hardly anything grew. This belt was followed by a zone (2 km from the emission source) where the root crops were still heavily damaged. Between three and three and one half km from the emission source, the effect of the pollutants was weak. Also the metals copper, lead, zinc, and arsenic were found in the soil; they are mostly insoluble, and thus are harmless compounds.

32291

Stamatovic, S. and D. Milic

**PROBLEMS OF AIR POLLUTION IN YUGOSLAVIA.** Council of Europe, Committee of Experts on Air Pollution, Air Pollution Proc. First European Congr. Influence Air Pollution Plants Animals, Wageningen, Netherlands, 1968, p. 255-258. (April 22-27.)

The expansion of the nitrogen and phosphate fertilizer industries in Yugoslavia has caused an increase in fluor emissions, endangering plants and domestic animals. In affected areas, fluorosis has been observed in horses, cattle, sheep, and goats. Its occurrence is explained by the quantities of fluor measured in hay, straw, wheat, maize, and sunflower seeds. The intensity of the poisoning varies according to geographic location, climate, and animal species. Under normal conditions, damages are restricted to a distance of about 5 km from the factories. A lead foundry has created the problem of lead accumulation in soil, water, and animals, particularly in ruminants. Lead poisoning has been observed in lambs but so far not in sheep. Sheep milk in the affected area contains an average of 132 gamma/100 g lead. About the same concentration is found in milk from cows, though no lead poisoning has been observed in cattle.

32322

Warteresiewicz, Maria

**THE INFLUENCE OF AIR POLLUTION ON PLANTS IN THE VICINITY OF SOME ZINC WORKS.** (Einfluss der Luftverunreinigungen auf Pflanzen in der Naehe einiger Zinkhuetten). Text in German. Polska Akademia Nauk, Zaklad Badan Naukowych Gornoslaskiego Okregu Przemyslowego, Mater. Miedzynarodowej Konf., Wplyw Zanieczyszczen Powietrza na Lasy, 6th, Katowice, Poland, 1968, p. 185-195. 12 refs. (Sept. 9-14.)

Studies were made in 1965/66 in the vicinity of two zinc works in the Upper Silesian industrial district to determine decreases in the yield of crops, the influence of emissions on the chlorophyll content of plants, and effects on water content of plants. The gaseous emissions are sulfur dioxide and nitric oxide in substantial concentrations; dust emissions contains zinc, lead, cadmium and copper. The control points were located at varying distances between 0.4 and 2.5 km from the works, in different directions. Considerable damage to clover was found at times, with partly burned leaves which then dried and dropped off. During some periods crop yields decreased by 70% below normal in case of potatoes, 60% for clover, and 50% for beans. The chlorophyll content in damaged plants decreased. During the period of plant growth, tests were made to determine the loss of water in plants after they have been cut, by weighing the plant every hour after cutting for up to five hours. After five hours healthy bean leaves lost 43% of their weight, while damaged leaves lost 65%.

32335

Schoenbeck, Helfried

**THE APPLICATION OF THE TEST PLANT METHOD. A MODIFICATION OF SAURER S PLANT INDICATOR METHOD FOR THE DETECTION OF PLANT DAMAGING IMMISSIONS.** (Die Anwendung der Testpflanzenmethode. Ei Modifikation des Saurerschen Fangpflanzenverfahrens zum Nachweis von Pflanzenschaedigenden Immissionen). Text in German. Polska Akademia Nauk, Zaklad Badan Naukowych Gornoslaskiego Okregu Przemyslowego, Mater. Miedzynarodowej Konf., Wplyw Zanieczyszczen Powietrza na Lasy, 6th, Katowice, Poland, 1968, p. 313-325. 9 refs. (Sept. 9-14.)

Proof that damage to vegetation by emissions from a zinc smelter was obtained by cultivating identical plants at various distances downwind from the smelter and in an uncontaminated locality. To eliminate differences in soil and other environmental factors holes were made in the ground, lined with plastic to prevent interaction with the surrounding soil, and filled with loamy sand containing 20 mg Zn/100 g soil plus 11.4 mg Pb/100 g soil (contaminated soil) and 4.0 mg Zn/100 g soil plus 5 mg Pb/100 g soil (normal soil). Both soil types were used side by side in all experimental sites. Summer wheat, beans, oats, and sugar beet were used as experimental plants. Since damage to the control area plants was due only to the contaminated soil, any additional damage in a polluted atmosphere could be ascribed to the effect of atmospheric pollutants. Wheat grain yield at various distances from the smelter was 46-77% lower than the yield in the control area. Other cultures suffered comparably. Generally the damaging effect of air pollution on plant growth was smaller than that of the metal salt pollutants in the soil. The Zn, Pb, and S levels in plant tissues decreased with increasing distance from the zinc smelter.

32338

Paluch, Jan and Stanislaw Karweta

**ACCUMULATION OF ZINC AND OF LEAD IN THE SOIL AND IN PLANTS.** (Die Akkumulierung von Zink und Blei im Boden und in Pflanzen). Text in German. Polska Akademia Nauk, Zaklad Badan Naukowych Gornoslaskiego Okregu Przemyslowego, Mater. Miedzynarodowej Konf., Wplyw Zanieczyszczen Powietrza na Lasy, 6th, Katowice, Poland, 1968, p. 127-138. 4 refs. (Sept. 9-14.)

The accumulation of zinc and of lead in soil and plants was studied in a rural wooded area of Poland following the construction of a zinc, lead, and cadmium ore processing plant. Before establishment of the plant, the soil of the area contained between 15 and 1600 mg Zn/kg and between 40 and 3600 mg Pb/kg, indicating lead- and zinc-bearing outcroppings among the samples collected at 22 randomly selected points. Absorbable zinc and lead compounds fluctuated between trace quantities and 31.30 mg Pb/kg and 22.43 mg Zn/kg, depending on soil acidity. In alkaline soils these amounts were almost zero. Following operation of the plant for a year (and consequent dust emission) the Pb and Zn soil content increased noticeably, especially in soils with initially low Zn and Pb levels where the increase amounted to several hundred percent. Generally Pb and Zn content in conifers in the polluted area increased, with the Zn level increasing more than the Pb. A clear cut correlation was found between available soil Pb content and assimilation by plants; the correlation was less obvious for Zn. Both Zn and Pb levels in plants manifested great differences during the vegetation period. Zn content in pine needles increased steadily over a three-year observation period while no difference in the Pb content was found in two- and three- year old needles. Although no deleterious effects were noted in annual or in perennial plants, these are expected to occur eventually.

32423

Keller, Th.

**TRAFFIC-INDUCED LEAD RESIDUES IN CONIFERS.** (Ueber verkehrsbedingte Bleirueckstaende auf der forstlichen Vegetation). Text in German. Bull. Eidgenoess. Gesundheitsamtes, Beilage B, no. 3:186-198, March 1971. 16 refs.

The assimilation organs of conifers lining highways have, in comparison with needles from conifers situated at a distance from a highway, a higher lead content. The lead content in needles of these conifers increases with increasing traffic density and is thus a reliable indicator of environmental pollution. The normal lead content of year old pine needles is two to three ppm. The lead content in needles increases with increasing age of the needle only insofar as young needles contain less lead than one year old or older needles. The lead content increases the first year with the duration of exposure until a local dynamic equilibrium is reached. Lead content decreases sharply with height up to 10-12 m above ground level. Laterally, it decreases faster up to 50 m into the forest than in open country. More than 90% of the lead remains on th surface of the needles and can be removed by washing with an acid or a detergent solution. The residual lead content is so small that an intoxication of vegetation is unlikely. However, the CO2 assimilation of even healthy needles decreases with increasing lead content but this inhibition of photosynthesis is attributed to the coating of the needle surface and to the toxic effect of the other pollutants from exhaust gases.

32654

Keller, Th. and R. Zuber

**LEAD UPTAKE AND LEAD DISTRIBUTION IN YOUNG SPRUCE PLANTS.** (Ueber die Bleiaufnahme und die Bleiverteilung in jugen Fichten). Text in German. Forstwiss. Centralblatt, 89(1):20-26, 1970. 9 refs.

Spruce plants potted in sand were fed solutions containing up to 2000 ppm lead as lead nitrate. At the end of the growing season, plant parts were analyzed for lead by atomic absorption spectrophotometry. Measured concentrations were high in roots but low in shoots. Needles that transpired profusely did not differ significantly in Pb content from needles that transpired very little, suggesting the occurrence of only a minute PbO translocation with water transport. Photosynthesis was markedly depressed in plants fed 2000 ppm Pb, but this concentration is unlikely to occur in the field. The planting of spruce hedges along highways is, therefore, recommended. The hedges will protect agricultural crops against lead contamination by exhaust fumes. (Author summary modified)

32736

Schmitt, Nicholas, Gordon Brown, E. Larry Devlin, Anthony A. Larsen, E. Douglas McCausland, and J. Maxwell Saville

**LEAD POISONING IN HORSES.** Arch. Environ. Health, vol. 23:185-197, Sept. 1971. 13 refs.

Five elements (lead, zinc, fluorine, arsenic, and cadmium) were investigated in the vicinity of a smelter; excessive amounts of lead in ingested forage were considered to be the primary cause of a chronic debilitating disorder in six horses. The high lead levels in forage were related to the presence of lead in surface soil accumulated from emissions of a nearby smelter. Young horses were found to have a significantly higher susceptibility to the effects of lead than older horses and cattle. The role played by high concentrations of zinc in local grasses is not fully understood. The possibility of a synergistic effect of zinc and other trace elements on animal health deserves further study. While elevated fluoride content in some of the grasses tested was evident, fluorosis was ruled out as a cause of illness in the affected animals. Testing of local ambient air and drinking water for all five elements studied showed values to be well within acceptable limits. The same applied to the testing of most locally produced foods of animal and vegetable origin. A few species of leafy vegetables were the only human foodstuffs in which, occasionally, significantly elevated contents of lead and some of the other trace elements studied were found. However, the possibility of any health hazard related to their consumption was considered extremely remote. Human urine specimens and cattle were also studied.

33112

Rains, D. W.

**LEAD ACCUMULATION BY WILD OATS (AVENA FATUA) IN A CONTAMINATED AREA.** Nature (London), 233(5316):210-211, Sept. 17, 1971. 12 refs.

Wild oats growing in the Benicia-Vallejo area, exposed for 70 years to lead emissions from a smelter, were examined for lead accumulation. Initially, during the period of rapid growth (April-June), the lead concentrations decreased, but then increased substantially during ripening until autumn, when the plants were completely air-dry. The increase continued, accelerating after heavy rains in October and November, and reached a peak in December. Lead contamination in the new growth (1970-1971) was similar to that in the early samples of the 1970 season. To investigate the effect of rain, a series of

leaching experiments were conducted on dried straw. The results of the experiments are tabulated.

33201

Lewis, Keith H.

**THE DIET AS A SOURCE OF LEAD POLLUTION.** Public Health Service, Washington, D. C., Symp. Environ. Lead Contamination, 1965, p. 17-20. 10 refs. (Dec. 13-15.) (PHS Pub. 1440) NTIS: PB 198104

Exclusive of individuals accidently poisoned or occupationally exposed, it is generally agreed that the diet is the major source of lead exposure and contributes about 90% of the total intake. Techniques used to estimate dietary exposure include the direct determination of lead in whole diets and the calculation of lead intake from either the lead content of individual items that comprise a diet or the amount of lead excreted by the individual. The lead content of various foods is indicated, but of particular interest is the amount of lead in milk. Among the more important factors which may influence the concentration of lead in food are the concentration of lead in the growing environment of plants and food producing animals, contamination with lead pollutants through aerial fallout, use of lead compounds in agriculture, and direct contamination during processing, storage, and final preparation. The average daily lead intake from the diet is about 0.3 mg/day.

33362

Aronson, Arthur L.

**BIOLOGIC EFFECTS OF LEAD IN DOMESTIC ANIMALS.** J. Wash. Acad. Sci., 61(2):110-113, 1971. 21 refs.

Sources of lead and their effects on domestic animals are reviewed. A daily intake of six to seven mg/kg constitutes a minimum cumulative fatal dosage of lead for cattle, representing a concentration of approximately 300 ppm lead in the total diet. Horses grazing on pastures adjacent to a lead smelter were poisoned by eating hay containing 2.4 mg/kg/day of lead; the minimal toxic dose is 2 mg/kg/day. The horses, however, eat roots as well as forage, and the soil near the smelters contains more lead than the forage itself. Symptoms of lead poisoning include derangement of the central nervous system, gastrointestinal tract, muscular system, and hemopoietic system. The syndrome in cattle appears as depression, anorexia, colic, and maniacal excitement. Sheep exhibit depression, anorexia, abdominal pain, and diarrhea. Anemia is common during chronic ingestion. Horses knuckle at the fetlocks and have laryngeal paralysis. The effect of lead poisoning on the pregnant animal is discussed.

33364

Ter Haar, Gary L.

**THE EFFECT OF LEAD ANTIKNOCKS ON THE LEAD CONTENT OF CROPS.** J. Wash. Acad. Sci., 61(2):114-120, 1971. 25 refs.

The contribution of lead naturally in the soil, lead in the air, and lead content of the soil from lead deposited from the atmosphere or added artificially to the lead content of plants is examined. Plants grown in a filtered atmosphere were compared with those of a natural atmosphere. Most of the edible portions of the plant showed no effect from the increasing lead content in the air. Crops grown along a busy highway were analyzed. Edible portions of most compact crops, except soybeans and snap beans, showed no correlation between lead concentration and distance from road. The inedible parts contained two to three times higher lead concentrations when grown near the road. The leafy portions of plants near busy highways contained higher concentrations of lead. An increase of lead content in the soil did not change the concentration in the plant. Rain was not a significant source of lead. Seasonal variations and stresses on the plant were studied for correlation.

33922

Bovay, Ernest

**LEAD DEPOSITS ON VEGETATION ALONG HIGHWAYS. A STUDY OF FEEDING DAIRY FARM CATTLE HAY CONTAMINATED BY LEAD.** (Les depots de plomb sur la vegetation le long autoroutes. Essai d affouragement de vaches laitieres avec du foin souille par le plomb). Text in French. Bull. Eidgenoess Gesundheitsamtes, Beilage B, no. 3:169-186, March 1971. 36 refs.

Investigations conducted in Switzerland from 1967 through 1970 showed that relatively high quantities of lead are deposited along heavily frequented roads and highways. Plants growing in the immediate vicinity of the road contained in excess of 100 ppm lead. Although lead concentrations decreased rapidly with distance from the road, lead pollution was sometimes distinctly perceptible 100 m or more from the road. The rate and extent of diffusion of lead particles depended on the prevailing seasonal, orographic, and/or meteorological conditions. Lead retention was influenced to a large extent by the nature and composition of different plant organs: plants with large, hairy leaves accumulated much more lead than plants with straight, erect, and/or smooth leaves. A thorough washing removed from 35-65% of the lead deposits, indicating the superficial nature of the contamination. Nevertheless, roots of plants growing in lead-contaminated soils may absorb lead even when present in relatively insoluble forms. A limited translocation from roots to aerial organs may also occur. The vegetables showed no symptoms of intoxication or reduction in yield. Slightly elevated opaque screens or hedges of pine and fir trees could markedly reduce the dispersion of exhaust gases. Dairy cattle were feed hay harvested along a highway. A high proportion of lead ingested with the fodder was limited. However, large quantities of lead accumulated in bones, kidneys, and liver. Although ingestion of 1300 mg lead for 36 days produced no particular symptoms of intoxication in the animals, blood, urine, and milk contained excessive quantities of lead. (Author summary modified)

33985

Chadwick, R. C. and A. C. Chamberlain

**FIELD LOSS OF RADIONUCLIDES FROM GRASS.** Atmos. Environ., vol. 4:51-56, 1970. 8 refs.

Solutions of strontium(85), chromium(51), and lead(210) were sprayed onto grassland to measure the initial retention by the herbage and subsequent rate of field loss by weathering (precipitation and winds). The activity initially retained by the herbage was an average 40% of that applied in the spray. The subsequent field loss, corrected for radioactive decay, determined retention half lives of Sr(85) as chloride of about 19 days in the summer and 49 days in the winter. The rate of loss of Gr(51), as chromate, did not greatly differ from that of Sr(85); similar results were determined in the single experiment with tagged particles, but the rate of field loss of Pb(210) was somewhat less. (Author abstract modified)

34237

McCulloch, Ernest C. and J. L. St. John

**LEAD-ARSENATE POISONING OF SHEEP AND CATTLE.** J. Am. Vet. Med. Assoc., vol. 96:321-326, March 1940. 22 refs.

In order to establish more definitely the toxicity of known quantities of lead arsenate for sheep, healthy young sheep weighing between 36 and 45 kg were given weighed amounts of lead arsenate in gelatin capsules. The sheep generally died when fed sufficient lead arsenate to obtain two grams arsenic equivalent, expressed as As203. Analyses of the rumen contents of animals poisoned from eating lead arsenate-sprayed forage, however, indicated that much greater amounts of arsenic had been consumed. The possibility that the lead and arsenic were converted to some less toxic form is suggested. The lowered toxicity may be the result of decreased solubility within the digestive tract. The darkening of the bone marrow observed in some of the lead arsenate-fed sheep supports the suspicion that the feeding of arsenic-containing compounds may be responsible for the condition known as black cutters. (Author summary modified)

34830

Dawson, Alden B.

**THE HEMOPOIETIC RESPONSE IN THE CATFISH, AMEIURUS NEBULOSIS, TO CHRONIC LEAD POISONING.** Biol. Bull. 68(3):335-346, 1935. 12 refs.

With prolonged exposure to a solution of lead acetate, definite evidence of absorption of lead was obtained in the catfish. The surface mucus did not constitute an efficient barrier to the entrance of the metal. The degree of destruction of the erythrocytes was used as a measure of the rate of the absorption of lead. Following the early evidences of injury to blood cells, a mild regenerative response occurred, but eventually a pronounced secondary anemia was produced. Little phagocytosis of dead cells occurred in the peripheral circulation, but a progressive storage of the pigment derived from dead red blood cells was found in the interstitial tissues of the liver, spleen, and mesonephros. The hepatic cells also became crowded with pigment granules. No storage was observed in the heart. The pigment was accumulated chiefly in macrophages of local origin which, after ingesting erythrocytes, desquamated and migrated into the connective tissue. Monocytes and cosinophiles increased slightly in number in the blood stream, but the most striking change occurred in the numbers of atypical thrombocytes, and spindle cells which may belong to the thrombocytic series. The endothelium of the heart showed marked proliferative activity. In some regions there was localized differentiation of erythrocytes. In other regions the atypical elongated cells were formed in large radiating clusters on the surface of the ventricular trabeculae. No explanation of the latter response to lead poisoning can be given. (Author summary modified)

34831

Jones, J. R. Erichsen

**THE RELATIVE TOXICITY OF SALTS OF LEAD, ZINC AND COPPER TO THE STICKLEBACK (GASTEROSTEUS ACULEATUS L.) AND THE EFFECT OF CALCIUM ON THE TOXICITY OF LEAD AND ZINC SALTS.** J. Exp. Biol., vol. 15:394-407, 1938. 10 refs.

Lethal concentration limits were determined for lead, zinc, and copper for the three-spined stickleback. The addition of calcium salts to solutions of lead nitrate or zinc sulfate reduced the toxicity of these salts to the fish. Fifty mg/l of Ca was sufficient to annul the toxicity of a 0.000001 g/cu cm solution of lead or a 0.000002 g/cu cm solution of zinc. The reactions of the fish in the solution with and without calcium were compared and the respiratory symptoms were described with the aid of graphs illustrating the variation in respiratory rate during the survival time. A running supply of hard tap water containing approximately 50 mg/l of calcium as calcium bicarbonate was harmless to the minnow and the stickleback, when it also contains the maximum amount of lead that it can hold in solution seven times 10 to the minus seventh power g/cu cm). This concentration of lead in soft water is fatal to Gasterosteus in 38.5 hr. The same amount of calcium renders a 0.0000010 g/cu cm solution of lead harmless to the goldfish. Thus, in the presence of sufficient calcium, the interaction between the lead or zinc, and the mucus secreted by the fish does not take place. This conclusion was endorsed by experiments in vitro on the slime secreted by the eel. The application of these results to the pollution of natural water by effluents from lead and zinc workings was briefly discussed. (Author summary modified)

34901

Fairhill, Lawrence T. and John W. Miller

**A STUDY OF THE RELATIVE TOXICITY OF THE MOLECULAR COMPONENTS OF LEAD ARSENATE.** Public Health Rept., (U. S.), vol. 56:1610-1625, Aug. 8, 1941. 25 refs.

The ingestion of lead arsenate by rats was investigated over a period of two years to determine whether the lead or arsenic components of the molecule was responsible for the toxicity of the substance. Calcium arsenate, lead arsenate, or lead carbonate was fed daily in 10-gram rations to the rats. The order of toxicity was calcium arsenate, lead arsenate, and lead carbonate in order from highest to lowest. Pathologic studies showed significant changes in the kidney and spleen. The large hyperregenerative cells with large vesicular nuclei and cytoplasmic brown pigment granules in the renal convoluted tubules were most frequent in rats fed lead carbonate, less with lead arsenate, and least with calcium arsenate. The large oxyphil intranuclear inclusions appeared in the same order in the animals fed lead carbonate and lead arsenate but were absent in the calcium arsenate group. This seems to indicate that lead is the causative agent for these reactions. Splenic hemosiderosis occurred in greater amounts in the rats fed calcium arsenate and lead arsenate than in those fed lead carbonate. The distribution of lead and arsenic in the tissues of the one- and two-year groups indicated less storage of lead than of arsenic in the soft tissues of animals fed lead arsenate. The kidney content of arsenic in the calcium arsenate group was distinctly greater than that of the lead-arsenate group. With reference to the two lead compounds studied, there was a greater degree of lead deposition in the tissues of rats given lead carbonate than in those given lead arsenate. This was apparent in the case of bone-deposited lead, where pratically twice as much lead was deposited in the bones of the lead carbonate group as in the lead-arsenate group. Since bone-deposited lead is a safer index than lead deposition in soft tissues, it appeared that the arsenate radical either decreases the absorption or increases the excretion of lead. (Author conclusions modified)

35209

Aronson, A. L, P. B. Hammond, and A. C. Strafuss

**STUDIES WITH CALCIUM ETHYLENEDIAMINETETRAACETATE IN CALVES: TOXICITY AND USE IN BOVINE LEAD POISONING.** Toxicol. Appl. Pharmacol., vol. 12:337-349, 1968. 26 refs.

The most effective therapeutic regimen of calcium disodium ethylenediaminetetraacetate (CaEDTA) for the mobilization of lead in cattle was determined, and toxic effects associated with short-term administration of CaEDTA were evaluated. Optimal conditions of lead mobilization in calves are provided by concentrations in the order of 135 millimicron moles of EDTA/ml of plasma and above maintained for 10-12 hours. These

concentrations can be achieved by the constant intravenous infusion of CaEDTA at 110-220 mg/kg over 12 hours or approximated by two rapid intravenous injections six hours apart at 110 mg/kg each. Interperitoneal administration is not as effective as intravenous administration in mobilizing lead. Manifestations of CaEDTA toxicity in heart valves were similar to those observed in man and the dog, but were considerably more extensive than those reported for the rat. Daily 12-hour infusions of CaEDTA at 220 mg/kg were not toxic when maintained for three successive days and were mildly toxic when maintained for five successive days. Macroscopic and microscopic lesions and disturbances in intestines, kidneys, adrenal glands, and other tissues in calves receiving toxic doses are described. Urinary excretions of lead after administration of CaEDTA were determined. (Author abstract modified)

35234

Buck, William B.

**BEHAVIORAL AND NEUROLOGICAL EFFECTS OF LEAD.** Iowa State Univ. of Science and Technology, Ames, Veterinary Diagnostic Lab., Environmental Protection Agency Contract CPA 22-69-NEG-107, 51p., 1970. 6 refs.

Twelve pregnant sheep were exposed to sublethal doses of dietary lead throughout their gestation periods. They were fed varying concentrations of finely metallic lead mixed with a concentrate mixture containing 300 pounds of corn and 200 pounds of soybean meal at a rate of one-quarter pound/sheep/day. Most of the experimental sheep showed clinical signs of lead poisoning one week after beginning the experiment, including anorexia, loss of body weight, and cerebral depression; these symptoms were more marked during the second and third months of the experiment. Three of the experimental sheep aborted during the last trimester of pregnancy, and one of them had a mummified fetus. Five of the experimental sheep did not conceive. Chemical analyses of the tissues collected from euthanized experimental sheep revealed significant levels of lead, while aborted fetuses also revealed significant levels of lead in the liver. Blood lead analysis of two lamb born to the experimental sheep showed 0.14 to 0.17 ppm of lead in the blood for four weeks. The difference between the exposed and control groups for blood lead, urine lead, and urine aminolevulinic acid were highly significant. (Author summary modified)

35410

Kleinman, Abram

**INVESTIGATION OF LEAD RESIDUES ON GROWING FRUITS AND VEGETABLES.** Pesticides Monitoring J., 1(4):8-10, March 1968. 6 refs.

One hundred and thirty-two samples of a variety of mature fruit and vegetable crops grown near heavily traveled highways were collected and analyzed for lead. Samples, ranging from four to 15 lb, were examined without washing or peeling. The smaller samples were ground and mixed in entirety; the larger ones were reduced to about 1kg and then composited, ground, and mixed. Appropriate aliquots were analyzed by the official A.O.A.C. dithizone spectrophotometric procedure. Reported recoveries of added lead in recovery experiments ranged from 70 to 100%. Lead residues were compared with distance from the highway, traffic load, and the period of exposure to these conditions. The data suggest that a difference exists between crops growing adjacent to traffic and crops growing at further distances.

35827

Page, A. L., T. J. Ganje, and M. S. Joshi

**LEAD QUANTITIES IN PLANTS, SOIL, AND AIR NEAR SOME MAJOR HIGHWAYS IN SOUTHERN CALIFORNIA.** Hilgardia, 41(1):1-31, July 1971. 27 refs.

The lead content of 27 varieties of consumer crops and plants growing near some major southern California highways were colorimetrically ascertained. Amounts of Pb were also recorded for surface and subsurface soils and in suspended air particulates at or near the locations where the plant samples were obtained. Exposed tissues of plants grown very close to highways contained more Pb than similar tissues of plants grown some distance from the highways. This effect was most apparent at distances less than about 150 meters from the highway. Exposed tissues with smooth surfaces accumulated more lead than tissues with rough, hairy surfaces. The direction of the prevailing wind also significantly affected Pb concentratons in plants near highways: without exception, Pb in plants on the leeward side of the road exceeded that in plants on the windward side. A motor vehicle density of 35,000 vehicles/day also resulted in substantial Pb accumulations in plants. In soils and suspended particulates, lead concentrations were influenced by distance from highway and direction of prevailing winds. These results all demonstrate that the lead accumulations were caused primarily by aerial deposition and not -- at least to any great extent -- by absorption by the plant from Pb-contaminated soil.

35880

Kerin, D.

**DELIMITATION OF INDUSTRIAL EMISSIONS BY MEANS OF PLANT ANALYSIS.** Protectio Vitae, 16(5):201-202, Oct. 1971. 13 refs.

Vegetation damage in areas surrounded by metallurgical and industrial plants are mainly caused by sulfur dioxide and fluorine compounds. Plants are much more sensitive than humans or animals to SO2. Many plant varieties show signs of damage at a concentration of 0.3 ppm SO2. Fluorine and it compounds are particularly injurious to cherries, grapes, plums, various ornamental plants, and vegetables. The Ontario variety of apples is very susceptible. Visible damage to buildings is also caused by this group of pollutants. For determination of the effect of the above pollutants on vegetation, needle samples were taken in September and October in polluted areas and compared to needle samples from unpolluted regions. First and second year needles were separated. Average samples were taken from 100 grams dried needles. Sulfate, lead, zinc, iron, and manganese were determined. Plants taken from the immediate vicinity of a glass work were heavily contaminated with fluorine. Concentrations of 4.0 to 25 mg F/kg dried basis were measured. The sulfur concentration was between 0.50 to 1.5% (natural concentration is 0.20%). The lead concentration ranged from 24 to 1.136 mg Pb/kg (natural concentration is 3.0 mg Pb/kg dried needles). The zinc content ranged from 136 to 495 mg Zn/kg dried needles; in unpolluted areas it is 28 to 75 mg Zn/kg.

36196

Buck, William B.

**LEAD AND ORGANIC PESTICIDE POISONINGS IN CATTLE.** J. Am. Vet. Med. Assoc., 156(10):1468-1472, May 15, 1970. 5 refs.

During each of the past two years, approximately twenty-four episodes of lead poisoning in cattle were documented in the Veterinary Diagnostic Laboratory of the Iowa State Universi-

ty. The most frequent source of lead was used crankcase oil and machinery grease, both of which may contain high amounts of lead that is apparently readily absorbed via the gastrointestinal system. Other sources include old lead paint, storage batteries, and lead-containing insecticides. In nearly 50% of the episodes, the source of lead was not determined. Accidental incorporation of massive amounts of insecticides in animal feeds has been a primary source of pesticide problems in cattle. Such contamination results not only in the death of animals, but also in the contamination of resulting meat scraps and tankage products used for animal feeds and often accumulation of insecticide residues in the tissues of animals slaughtered for human consumption. Hazardous insecticides prepared in granular and powdered forms for agriculture purposes should be identified by the incorporation of a dye marker or some other readily identifiable material that would be immediately recognizable if it were incorporated in animal feeds. (Author summary modified)

36197

Mueller, Peter K. and Ronald L. Stanley

**ORIGIN OF LEAD IN SURFACE VEGETATION.** California State Dept. of Public Health, Berkeley, Air and Industrial Hygiene Lab., National Air Pollution Control Administration Contract 86-68-35, AIHL Rept. 87, 15p., July 1970. 20 refs.

A model is presented for determining the relationship of airborne lead and soil lead concentrations to lead concentrations in pasture grasses. The major portion of atmospheric lead is derived from combustion of leaded gasoline and from fumes and dusts of industries using lead. Soil may be contaminated with lead by aerial fallout, industrial wastes, pesticides, fertilizers, and agricultural minerals. Soil composition and its acidity are important factors in whether or not lead will be available for plant uptake. On the basis of several published studies, it is concluded that not more than 15 micrograms Pb/g dry weight in forage crops is due to the uptake of lead from soil even at soil lead contents up to about 700 micrograms/g and possibly 3000 micrograms/g. Amounts of lead in herbage substantially greater than 15 micrograms/g are therefore due to aerial fallout. The ratio of lead in herbage to the rate of lead fallout was reported previously as a constant of 50 sq m days/kg herbage. This model was applied to a typical situation in which grass lead content of pastures toxic to horses was greater than about 80 micrograms/g, top soil lead contents averaged about 300 micrograms/g, and the suspended particulate lead concentration averaged about 0.5 micrograms/cu m.

36265

Carpenter, Kathleen E.

**THE LETHAL ACTION OF SOLUBLE METALLIC SALTS ON FISHES.** Brit. J. Exp. Biol., 4(4):378-390, 1927. 9 refs.

The lethal action of soluble metallic salts on fishes was examined on the basis of mathematical analysis and physiological experiments. Investigation of the effects of lead salts on fishes determined a survival curve with no theoretical threshold of toxic concentration. The lethal efficacy of the solution varied in inverse proportion to the actual size of the fish and was directly dependent on the absolute quantity of lead salt. The role of the metallic ion in the lethal process was examined. The effective action of lead salts on fishes was purely external in character; the precipitation of an organic lead compound clogged the gills and inhibited their respiratory function, leading to death by suffocation. The effects of soluble salts of zinc, iron, copper, cadmium, and mercury were also studied. (Author summary modified)

36611

Leh, H.-O.

**CONTAMINATION OF CULTURED PLANTS BY LEAD FROM AUTOMOBILE EXHAUSTS.** (Verunreinigungen von Kulturpflanzen mit Blei von Kraftfahrzeugabgasen). Text in German. Gesunde Pflanz., 18(2):21-24, Feb. 1966.

Gasolines contain as antiknock additives of tetraethyl lead (0.02-0.06% by volume), equivalent to 200 to 600 milligrams of lead/l of gasoline, of which 50 to 70% are discharged into the air with the exhaust gases. Approximately 40 to 60 grams of lead km/hr would be emitted on an average highway. In 1964 the contamination of grass growing alongside of highways was tested. At a distance of one to two meters 53 to 95 micrograms of lead/g of dry substance (53-95 ppm) occurred; at five meters, 32-36 ppm occurred; at 100 m, 10 ppm was found. Potato leaves had an average lead content of 53 ppm at five meters and 37 ppm at 10 m distance. Beet leaves contained 29 ppm lead at five meters. These results were obtained with unwashed plants. The analysis of washed samples showed that most of the lead can be washed off, proving that the contamination takes place primarily on the surface. Generally the effect of the polluted air on the plants was noticeable at up to about 100 m distance from the highway. The lead content of the roots and plant components below the ground surface, such as potatoes, beets, and carrots was relatively low, even at high lead concentrations on the leaves. Tests conducted with grain growing at two meters from the highway revealed about five ppm lead content. A special commission of the European Common Market countries has recommended for fodder plants a maximum permissible lead content of 10 ppm in the dry substance.

36991

Anderson, William L. and Peggy L. Stewart

**RELATIONSHIPS BETWEEN INORGANIC IONS AND THE DISTRIBUTION OF PHEASANTS IN ILLINOIS.** J. Wildl. Manage., 33(2):254-270, April 1969. 25 refs.

The relationships between inorganic ions and the distribution of ring-necked pheasants in Illinois were investigated by comparing concentrations of 24 elements in soil, grit, corn, and tissues of pheasants collected from good (Sibley), fair (Humboldt), and poor (Neoga) pheasant range. Concentrations in soil and in grit indicated that calcium, iron, and nickel, and perhaps magnesium and potassium, were potentially less abundant in diets of Neoga pheasants than in those of Sibley birds. Conversely, lead, manganese, strontium, and zinc, and perhaps cadmium, chromium, copper, molybdenum, and vanadium, were potentially more abundant in diets at Neoga than at Sibley. Elemental concentrations in soil and in grit from Humboldt were, for the most part, intermediate between concentrations in these materials at Sibley and Neoga. Concentrations of major elements (Ca, Mg, K, phosphorus, and sodium) in internal organs were from 12-34% lower in Neoga pheasants, and from 4-20% lower in Humboldt pheasants, than in birds from Sibley. Three trace elements (barium, Mn, and titanium) were less than half as abundant, and five (Cr, Pb, Ni, V, and zirconium) at least twice as abundant, in blood, livers, or kidneys from Neoga pheasants as in these tissues from Sibley birds. Concentrations of cobalt and Mo in blood, livers, and kidneys of Neoga and Sibley pheasants exhibited conflicting area-to-area differences. Of the elements studied, suspicion is directed toward Ca, Mg, K, Cr, Co, and Mo as possibly influencing the distribution of pheasants in Illinois. (Author abstract modified)

37912

Chisnall, K. T. and J. Markland

**THE CONTAMINATION OF PASTURE LAND BY LEAD.** J. Ass. Pub. Anal., vol. 9:116-118, Dec. 1971. 3 refs. (Presented at the Association of Public Analysts, Annual Conference, Matlock, England, May 13-15, 1971.)

Following the death of several cattle and two ponies on a farm adjacent to waste heaps from old lead mine workings and near a lead smelter, grass samples from a number of fields were analyzed for lead. The amount of lead (80-520 ppm) in grass from 11 fields was high enough to support the diagnosis of lead poisoning. The presence of antimony in the grass in a high ratio relative to lead suggested that the contamination originated in the lead mine waste, and not in smelter fumes.

37926

Markland, J. and J. Vallance

**INVESTIGATION OF THE UPTAKE OF LEAD BY VEGETABLES FROM COMPOSTS CONTAINING LEAD.** J. Ass. Pub. Anal., vol. 9:119-121, Dec. 1971. 5 refs. (Presented at the Association of Public Analysts, Annual Conference, Matlock, England, May 13-15, 1971.)

Areas of Derbyshire near the sites of former lead mining operations have lead in the soil. The lead present in plants grown in the area could have been derived from air pollution or from the soil. An investigation was undertaken to determine the amount of lead in vegetables grown in soil with controlled lead content. John Innes No. 3 compost without calcium carbonate was used as an acid soil and the same compost with calcium carbonate as a neutral soil. The composts contained 50 parts of lead/million. Each compost was divided into four lots and the lots were dosed with lead carbonate to give added lead contents of 0, 250, 500, and 1000 ppm. Carrots, peas, French beans, lettuce, cabbage, and brussels were grown in these composts, out of doors. Samples were digested by the nitric acid/sulfuric acid process, followed by dithizone extraction, and colorimetric or polarographic estimation of lead. There was only a little evidence of lead uptake for peas and no evidence of lead content increasing with the lead content of the compost. The lead on the French beans increased with the lead content of the compost. Soil contamination by air pollution occurred with the carrots, lettuce, and the brassica samples.

37977

Purves, David

**CONSEQUENCES OF TRACE-ELEMENT CONTAMINATION OF SOILS.** (Environ. Pollut., 3(1):17-24, Jan. 1972. 14 refs.

The chemical composition of the bulk of food has been profoundly modified by the intensification of the means of food production and as a result of the general contamination of the environment. Contamination of the soil in urban and industrial areas with potentially toxic trace elements, e.g., copper, boron, lead, and zinc, is largely irreversible. Sources of soil contamination, the trace-element content of plants grown on contaminated soils, and the effects on plant growth are considered. Contrasts and comparisons are drawn for soils in urban and rural areas. The composition of materials commonly used in gardens, e.g., soot, coal ash, municipal compost, and sewage sludge, are likely sources of trace element contamination. The primary source of contamination in urban parklands is atmospheric pollution. The boron, copper, lead, molybdenum, nickel, and zinc contents of cabbages grown in urban and rural areas were measured; the differences in mean levels for each element were highly significant.

38332

Daessler H. -G. and S. Boertitz

**EFFECTS OF AIR POLLUTANTS ON AGRICULTURAL PRODUCTS.** (Zur Wirkungsweise von Luftverunreinigungen auf landwirtschaftliche Erzeugnisse). Text in German. Biol. Zentralbl., 90(5):611-619, Sept./Oct. 1971. 12 refs.

With the aid of simplified graphs, the specific effects of sulfur dioxide fluorides, and indifferent and toxic (lead, zinc, and arsenic containing) dusts on agricultural plants in the German Democratic Republic are shown. Continuous and long-term exposure to low S02 concentrations impair the photosynthesis (carbon dioxide assimilation), which in turn affects the quantity and quality of plant products. Most characteristic is the reduction of crop yield. Moreover, the S02 intake raises the sulfate level in plants. Relatively high S02 concentrations cause the death of cells, photosynthesis does not take place any more in necrotic tissue. Exposure to fluorine-containing emissions and to dusts leads to an accumulation of these pollutants in the plants to an extent which might be harmful to animals. Exposure of plants to non-toxic dusts such as fly ash and soot causes considerable changes of the plant metabolism. Toxic dusts inactivate ferments and retard root growth.

38743

Oelschlaeger, W. and E. Schwarz

**SOURCES OF ERROR AND THEIR ELIMINATION IN THE DETERMINATION OF LEAD IN BIOLOGICAL SUBSTANCES BY MEANS OF DITHIZONE.** (Fehlermoeglichkeiten und deren Eliminierung bei der Bestimmung von Blei mittels Dithizon in biologischen Substanzen). Text in German. Z. Anal. Chem., 258(3):203-207, 1972. 15 refs.

Dithizone forms with lead a carmin-red primary dithizonate both in weakly acid as well as in alkaline solution. The dithizonate can be easily extracted in chloroform. The extraction from citrate and cyanide containing solutions is complete only from a pH of 9 onward. Citrate is mostly added for prevention of a precipitation of phosphates, and cyanide is added for elimination of interferences of most of the heavy metals reacting with dithizone. The largest interference is caused by Bismuth (Bi). An examination of the average Bi and Pb concentrations of samples from areas with and without emissions revealed that Bi concentrations are generally higher in areas with air pollution than those from areas with none. A Bi separation is not necessary in such cases because the Pb concentration are also markedly higher, e.g., spruce needles from an air polluted area contained 0.19 ppm Bi and 18 ppm Pb, they contained 0.02 ppm Bi and 3 ppm Pb from an area without air pollution. A separation of Bi is required, however, in the case of samples taken from the vicinity of factories processing sulfur-containing ores. The best and quickest method of separation is that using diethylammonium-N, N-diethyldithiocarbamate. For the determination of lead, it should be taken into account that the reagents sodium, ammonium citrate, and hydrofluoric acid are contaminated with relatively high amounts of lead. Pure chloroform is used as a blank solution, since the extracted blank solution is not stable, even in darkness. Sources of error in ashing are also discussed; a method is described which can be carried out rapidly and is reproducible.

39204

Connor, J. J., J. D. Sims, and R. J. Ebens

**ROADSIDE EFFECTS ON TRACE ELEMENT CONTENT OF SOME ROCKS, SOILS. AND PLANTS OF MISSOURI.** Missouri Univ., Columbia, Proc. Missouri Univ. Fourth Annu. Conf. Trace Substances Environ. Health, Columbia, Mo., 1970, p. 26-34. 14 refs. (June 23-25.)

A study to estimate the effect of roadside location on trace element content of rocks, subsurface soils, and vegetation demonstrates that the major effect is that of lead accumulation in vegetation. Soils taken from a few inches depth both near pavement and away from pavement exhibit no significant differences in metal content, including Pb. Some higher trace element contents of bedrock in roadcuts were noted in this investigation, but these are believed to reflect specific geologic conditions rather than general roadside effects. The roadside effect on the Pb content of vegetation reflects mostly automotive exhaust from normal vehicular activity. (Author abstract)

39287

Warren, H. V., R. E. Delavault, K. Fletcher, and E. Wilks

**VARIATIONS IN THE COPPER, ZINC, LEAD, AND MOLYBDENUM CONTENT OF SOME BRITISH COLUMBIA VEGETABLES.** Missouri Univ., Columbia, Pro Missouri Univ. Fourth Annu. Conf. Trace Substances Environ. Health, Columbia, Mo., 1970, p. 94-103. 5 refs. (June 23-25.)

Samples of many British Columbian vegetables collected from 30 different gardens were analyzed for copper, zinc, lead, and molybdenum. Some vegetables actually had 500 times more Mo than others. Even Zn, which has the most restricted range of the four elements investigated, is 40 times more abundant in some vegetables than in others. Vegetal trace element concentrations that vary from what are becoming to be thought of as normal can usually be explained in terms of the pH, organic content, soil type, climate, topography, degree of pollution, and/or geological background of the related soil. However, some deviations from the normal cannot yet be readily explained. (Author abstract modified)

39328

Haut, Hans van

**ANALYSIS OF SEVERAL AIR POLLUTION COMPONENTS WITH KALE (BRASSICA OLERACEA ACEPHALA) AS INDICATOR PLANT.** (Nachweis mehrer Luftverunreinigungskomponenten mit Hilfe von Blaetterkohl (Brassica oleracea acephala als Indikatorpflanze)). Text in German. Staub, Reinhaltung Luft, 32(3):109-111, March 1972. 18 refs.

Kale (brassica oleracea acephalia) was used for identification of fluorine, chlorine, sulfur, and lead air pollutants. The plants were exposed to the atmosphere at various sites in the Ruhr valley. Plastic boxes with 60 l volume were used for growing the plants. The fluorine concentration was determined by the electrometric method developed by Reusmann and Westphalen, the chloride concentration by the familiar method of potentiometric titration, and the sulfur concentration by the microanalytic method by Stratmann. The lead concentration was determined by inverse-polarographically. For the determination of these components by the mentioned methods only 5 g dry substance are needed. The plants, five in a pot, were exposed over several successive years from the beginning of August to the middle of November. Control plants were exposed outside the Ruhr valley in an entirely emission-free area. The F-level in the plants was in all cases above (with one exception) that of the control plants. It ranged from 4.1 to 20.1 mg/100 g dry substance. In washed leaves, the F concentrations were lower by 15 to 30%. The chloride concentration in the plants from the polluted area was four times the concentration in the control plants, the lead concentration was ten times the concentration in the control plants. The highest sulfur dioxide was 1.83% versus 1.33% in the control plants. The results show that kale serves well as an indicator for the mentioned pollutants, as well as for a number of polycyclic hydrocarbons, including the carcinogenic benzo(a)pyrene.

39407

Richter, R. H. H. and Ch. Schlatter

**THE EFFECT OF LEAD FROM AUTOMOBILE EXHAUST GASES ON DOMESTIC ANIMALS.** (Zur Frage der Wirkung von Blei aus Motorfahrzeugabgasen auf nutztiere). Text in German. Bull. Eidgenoess. Gesundheitsamtes, Beilage B, no. 3:86-100, March 1971. 168 refs.

The effect of lead inhalation on animals is unknown. The intake of lead with fodder results in an accumulation of lead in the organism, but the quantity of lead absorbed is 5-10 times smaller than that absorbed from inhaled lead (from observation on humans). Cattle, sheep, goats, dogs, and chickens were accidentally poisoned by lead from sources other than automobile exhaust gases; the clinical picture varies from species to species and can sometimes be attributed to lead only with reservations. The lethal dose likewise varies with species, age, condition of gastrointestinal tract, rate of elimination, and the exposure. Cattle is especially sensitive. The lethal dose is 10-100 g compared with 500-750 g for horses, and 10-25 g for pigs. Calves are also especially sensitive. The symptoms of lead poisoning include anemia, reduced erythrocyte and thrombocyte count, loss of weight, loss of milk yield, sterility, cachexia, colic, and epileptic seizures. The principal biochemical change is hematoporphyrinuria. Lead ions interfere with the phosphate metabolism and complete with the calcium metabolism. Lead is stored in bones and can thence be mobilized by an unnatural metabolic situation which suddenly induces acute intoxication. The normal blood content of lead in ruminants is 0.05-0.25 ppm, which can increase to 1.52 ppm without toxic symptoms. All currently availble evidence leads to the conclusion that a daily intake of lead per cow exceeding 50-100 ppm (1-3 g lead) can affect milk production and reproduction and lead to undesirably high levels of lead in milk and meat.

39408

Bovay, Ernest

**LEAD DEPOSIT ON VEGETATION GROWING ALONG HIGHWAYS TRAVELED BY AUTOMOBILES. MILK COW FEEDING EXPERIMENTS WITH HAY CONTAMINATED WITH LEAD.** (Les depots de plomb sur la vegetation le long des autoroutes. Essai d affouragement de vaches laitieres avec du foin souille par le plomb). Text in French. Bull. Eidgenoess. Gesundheitsamtes, Beilage B, no. 3:101-117, March 1971. 36 refs.

Measurements conducted in Switzerland from 1967 through 1970 revealed that vegetation growing along highways contained lead in concentrations in excess of 100 ppm. Although the amounts of lead in vegetation rapidly decrease with distance from the highway, lead can be detected up to a distance of about 100 m. The rate and extent of dispersion of lead particles depended on seasonal orographic and/or meteorological conditions. Lead retention by different plant organs is governed by their nature and composition. Plants with large hairy leaves or leaves with a rough surface accumulate much more lead than plants with smooth leaves. From 35-65% of the plant tissue lead content can be removed by thorough washing, an indication that the contamination consists for the most part in a surface deposit. But plant roots growing in lead-contaminated soil absorb the element, even if present in a relatively insoluble form. In spite of these observations, no symptoms of plant disease or a decrease in crop yield has been noted. High tightly growing hedges of perennials (pine or fir) markedly reduce the dispersion of exhaust gases. Feeding trials with milk cows involving hay harvested along highways demonstrated that a high percentage of the lead ingested with the fodder was eliminated. Some organs like

bones, kidneys, and the liver accumulated large quantities of lead (up to 21-fold quantities). After four weeks on the contaminated hay, the lead content in milk quadrupled. The cows ingested 1300 mg lead daily with contamined fodder containing 99 ppm Pb. Toxic symptoms in cattle and horses do not appear until an ingestion level of about 2200 mg Pb/day is reached.

39409

Keller, Th.

**LEAD RESIDUES IN SYLVAN VEGETATION RESULTING FROM TRAFFIC.** (Ueber verkehrsbedingte Bleiruecksteande auf der forstlichen Vegetation). Text in German. Bull. Eidgenoess. Gesundheitsamtes, Beilage B, no. 3:118-130, March 1971. 16 refs.

The assimilation organs of conifers lining highways contain lead which increases in quantity with increasing traffic density. The lead content in needles of conifers can serve as an indicator of traffic-induced air pollution. The normal lead content of one-year-old pine needles is about 2-3 ppm. The lead content of needles increases with their age only to the extent that young needles contain less lead than one year-old or several-year-old needles. The lead content increases in the course of the first year of exposure until a local dynamic equilibrium was established. The lead content decreases with height above the highway surface, especially in the lower part of the tree crown up to a height of 10-12 m. Laterally, the lead content decreases in woods lining the highway within the first 50 m faster than in open country. Up to 90% of all lead remains on the surface of the needles and can be washed off with an acid and a detergent solution. The small residual lead content in needles indicates that exhaust gases are probably only seldom the cause of lead-induced damage to vegetation. While gas exchange measurements did disclose a depression of carbon dioxide assimilation with increasing lead content in needles, it seems that the inhibition of photosynthesis is due primarily to the soiling of the needle surface and to the toxic action of the other pollutants emitted by the exhaust gas.

39690

Ebaugh, W. Clarence

**GASES VS. SOLIDS: AN INVESTIGATION OF THE INJURIOUS INGREDIENTS OF SMELTER SMOKE.** J. Am. Chem. Soc., 29(7):951-970, July 1907. 4 refs.

The relative effects of sulfur dioxide and flue dusts in smelter smoke upon vegetation were investigated in the Salt Lake City area to assess the damages due to emission from lead and copper smelters. The concentrations of SO2 were monitored, and the effects of free SO2, sulfuric acid, SO2 in aqueous solutions, and dilute solutions of H2S04 were individually examined. Flue dust samples were analyzed for percent content of moisture, sulfur trioxide, iron, copper, insolubles (silicon dioxide), lead, arsenic, and zinc. Many repeated applications of SO2 in concentrations present in the air of a smelting district were needed to cause injury, the degree of which was dependent on humidity. Solutions of H2S04, if present to the extent of 1.38 g/l or stronger, caused marked corrosion. Solutions of flue dusts sprayed upon plants resulted in very severe corrosion. Soil mixtures containing 20% of the flue dust, when applied to plants, also caused very bad corrosion.

40024

Knuechel, F.

**REDUCTION OF THE VALUE OF DRINKING MILK THROUGH TETRAETHYL LEAD? (Wertminderung der Trinkmilch durch Bleitetraaethyl?). Text in German. Med. Welt (Stuttgart), 23(19):737, 1972.**

Tetraethyl lead Pb(C2H5)4 is a liquid which evaporates at about 200 C. Together with ethyl bromide, ethyl dichloride, it is added in concentrations of 0.01 to 0.1% to gasolines as an anti-knocking agent. Combustion produces mostly PbCl2 and PbBr2 which are found in the exhaust gas together with some unburned tetraethyl lead. Depending on the traffic density, the lead content of the air and street dust may rise considerably. In Basel, Switzerland concentrations of 5 to 7 micron/cu m were measured in 1956 vs. 2 to 4 micron in a rural village. A considerably higher lead intake of cattle grazing near highways or streets is feasible. Since lead is mainly discharged through urine and feces and only to a very minor extent through the milk, the human intake of toxic concentrations of lead through drinking milk is improbable.

40335

Hammett, Frederick S.

**STUDIES IN THE BIOLOGY OF METALS. III. THE LOCALIZATION OF LEAD WITHIN THE CELL OF THE GROWING ROOT.** Protoplasma, vol. 5:135- 141, 1928. 2 refs.

A variety of tests on root tips of onion sets, white beans, and field corn proved definitely that lead is concentrated within the nucleus and walls of these cells. Roots which had been gwown in distilled water containing 10 to the minus 4th power concentrations of lead nitrate were used as experimental material. Sulfuric acid and sodium bicarbonate were used to precipitate lead sulfate and lead carbonate in cell walls. Sodium sulfide was used to precipitate lead sulfide in the nucleus. The nucleolus of corn appeared to have a selective affinity for lead combination not found in the other roots.

40368

Zuber, Roberto

**NEW TASK FOR THE RESEARCH INSTITUTE: ENVIRONMENTAL HYGIENE.** (Neuer Aufgabenbereich der Forschungsanstalt: Umwelthygiene). Text in German. Chem. Rundschau (Solothurn), 25(16):450, April 1972.

A new department for environmental hygiene of the Swiss Research Institute for Agricultural Chemistry deals with health aspects of air pollutants on domestic animals with the effects of air pollutants on agricultural crops. The department tests the fodder, plants, fruits, as well as bones, and urine of animals from the vicinity of fluorine emitting industries as to the fluorine concentration. In all cases the method with the ion specific fluoride electrode was found most suitable for the analyses. Measurements of the lead concentration along street and highways by atomic anstorption spectrophotometry revealed that plants and grass carried lead concentrations of up to 170 ppm 1-3 m from the street curb. They decrease slowly to a distance of about 50 m. In some cases lead residues were still measured as far off as 100 to 200 m. The various types of plants accumulate the lead in different ways. Rain and tap water wash out the metal to half of the original concentration. The sulfur dioxide concentration of the air is presently being determined by the Ultragas unit. Measurements of other pollutants such as ammonia, chlorine, the oxides of nitrogen, dust, unburned hydrocarbons, oil, rubber, and asbestos shall be the target of future studies.

40540

**LEAD FROM THE EXHAUST GASES OF AUTOMOBILES IN GREEN CABBAGE.** (Blei aus Kraftfahrzeugabgasen in Gruenkohl). Text in German. Deut. Med. Wochenschr., 97(21):856, May 1972.

Examinations of a large number of green cabbage samples taken various distances from highways and roads revealed that the lead concentration was higher in plants that grew closer to the road. The fraction of the total lead content which could be washed off was small and ranged on the average around 10%. Boiled samples generally contained more lead than unboiled ones with the use of an enamelled pot for boiling. No increase of the lead content was observed when the samples were boiled in glass dishes.

40590

Shaw, Charles F. and E. E. Free

**AGRONOMIC AND SOIL CONDITIONS IN THE SELBY SMOKE ZONE.** Bull. Bureau Mines, no. 98:451-473, 503-520, 1915. 86 refs.

Maximum amounts of lead and arsenic found in soil samples from the Selby smoke zone were far too small to have any injurious effect on plants grown in the soils. Indeed, much larger amounts than those actually found would not affect the agriculture of the region. The poor agricultural conditions prevailing are amply accounted for by the naturally unfavorable soil and the extremely poor agricultural practices of the region.

40591

Haring, C. M. and K. F. Meyer

**INVESTIGATION OF LIVE-STOCK CONDITIONS AND LOSSES IN THE SELBY SMOKE ZONE.** Bull. Bureau Mines, no. 98:474-520, 1915. 86 refs.

During an investigation of livestock conditions at 32 ranches allegedly injured by smoke from the Selby smelter, 308 horses, 215 cattle, approximately 900 sheep, and about 500 swine were inspected. Post-mortem examinations were made on four horses, two heifers, and several hogs. No clinical evidence of injury from smelter smoke was found in cattle, hogs, or sheep. The effects of previous injury were evidenced by 30 cases of roaring in horses, of which 12 were carefully studied. The clinical symptoms of roaring were due to partial paralysis of larynx muscles supplied by the recurrent laryngeal nerves. In some cases, aspiration pneumonia had developed due to paralysis of the pneumogastric nerve. The laryngeal paralysis was probably due to ingestion of lead from soil contaminated by Selby emissions. However, the amount of lead in surface soils exposed to smelter smoke no longer constitutes a hazard and there is no evidence of injury since March 1914.

41143

Smith, William H.

**LEAD AND MERCURY BURDEN OF URBAN WOODY PLANTS.** Science, 176(4040):1237-1239, June 16, 1972. 30 refs.

Branch samples were collected from Sept.-Nov. 1970 throughout the city of New Haven, Connecticut. The species surveyed were pin oak, sugar maple, Norway maple, eastern hemlock, yew, and Norway spruce. Portions of the samples collected for lead analysis were subjected to various washing procedures. All samples were then dried and ashed. The lead content was determined by atomic absorption spectrophotometry. Mercury determinations were made with unwashed specimens by means of a flameless adaptation of atomic absorption spectrophotometry after wet digestion. The average values exceeded most lead concentrations reported for trees, and the maximum values, exceeded all previously reported lead concentrations, even for trees in areas with geologic lead deposits. The highest lead concentrations were associated with twigs in sugar maple, eastern hemlock, yew, and Norway spruce and with leaves in pin oak and Norway maple. The maximum lead concentration observed was 760 ppm in a washed hemlock twig. Washing procedures did not appear to affect the lead amounts. Also, ten unwashed samples of tree and shrub tissues collected in New Haven during the same period were analyzed for mercury. The mercury content of six of these samples slightly exceeded 0.5 ppm. Only one sample contained more than 1.0 ppm mercury. Woody plants may play an important role in heavy metal cycling in urban areas by acting as a short and long term repository

41461

Lewis, E. F., and J. C. Meikle

**NOTES ON THE USE OF CALCIUM DISODIUM VERSENATE IN HEAVY METAL POISONING OF LIVESTOCK.** Brit. Vet. J., vol. 114:69-71, 1958. 10 refs.

The phenomenon of chelation and its application to heavy metal poisoning of livestock are reviewed with respect to the pharmacology, clinical applications, and method of administration. Calcium disodium versenate (Ca-EDTA) shows chief value in the treatment of lead poisoning and acute copper poisoning. The chelate combines in the body with metals capable0ov displacing calcium while the nromal body content of the same metals is unaffected since the latter are already part of more stable complexes. Administration of Ca-EDTA should not produce anemia or derangement of B12 metabolism. A dose rate of 1 g for every 30 lb of body weight provides adequate chelation. Unabsorbed lead in alimentary system is rendered inert by oral doses. Normal administration is given intravenously at a final dilution of normal saline or glucosaline of 5%. Initial treatment should be followed by a second dose after several days interval.

41733

Darling, Frank Fraser

**PROBLEMS OF POLLUTION. III. LAND POLLUTION.** J. Roy. Soc. Arts (London), vol. 119:520-527, July 1971. 7 refs. (Presented at the Royal Society of Arts, London, England, March 29, 1971.)

Many soils are showing adverse effects as a result of pesticides and over cultivation. They are often greasy and are showing much more lateral run-off of water which carries some of the surplus mineral fertilizers into the river systems. The intricate buffer of humus is at a low ebb. The soil is no longer the sponge it was--a sponge which not only holds water for the crop, but also influences invertebrate soil fauna and their behavior in the presence of organochlorine pesticides. Fungicidal sprays and organo-mercurial seed dressings do not seem to concentrate in food chains; their use can, however, reach dangerous levels in such intensive culture as orchard row. It is too early to state definitely the effects of airborne mercury on soils because of the considerable natural mercurial content of most soils. Industrial soil pollution by copper, zinc, and lead has occurred often in the past, but is unlikely to become important in England in the future. Nevertheless, old polluted sites are persistent and in need of reclamation. Soil damage can result from an excess of nutrient organic matter in the form of farm-produced excreta and sewage sludge. Sometimes it is spread too heavily, and as pig manure is often in the form of slurry, there can be anaerobic sealing of the soil. The effects of radioactive pollutants and the dumping of solid wastes are discussed briefly.

41800

Maeno, M.

**EFFECT OF AIR POLLUTION ON TREES (VIII). HEAVY METALS IN LEAVES OF STREET TREES: LEAD, NICKEL, CHROME, AND CADMIUM.** (Jumoku ni taisuru taiki osen no eikyo (Dai hachi ho). Gairo juyo no jukinzoku nikkeru, nameri, kuromu, kadomiumu). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 6(1):159, 1971. (Presented at the National Council Meeting of Air Pollution Studies, 12th, Nagoya, Japan, Oct. 27-29, 1971.)

The nickel, lead, chromium and cadmium contents of leaves of plants grown in Tokyo area were measured. The nickel content ranged from 7-15 ppm, the lead content from 14-34 ppm, chromium from 4-16 ppm, and cadmium from 0.7-1.3 ppm. Fluctuations in metal contents were most pronounced for paulownia. High contents of nickel, lead, and chromium were found in highly polluted industrial areas of the three elements, the difference in lead content in industrial areas compared to that in residential and commercial areas was less significant. This was attributed to the contribution of lead in exhaust gases. Correlation coefficients between metal content and insoluble materials adhering to leaves were calculated for individual plants.

41891

Hindawi, Ibrahim J. and Grady E. Neely

**SOIL AND VEGETATION STUDY.** In: Helena Valley, Montana, Area Environmental Pollution Study. Environmental Protection Agency, Research Triangle Park, N. C., Office of Air Programs, Pub-AP-91, p. 81-94, Jan. 1972. NTIS: PB 207126

The investigation had three purposes: to determine how Helena Valley, Montana, vegetation was being contaminated by heavy metals, to determine the concentrations of heavy metals being accumulated in area vegetation, and to assess any sulfur dioxide damage that might be occurring in the Valley. The metal pollutants of interest were arsenic, cadmium, lead, and zinc. Alfalfa, pinto bean, carrot, beet, petunia, and tobacco plants were grown under controlled conditions at four locations in the study area for a period of 10 weeks. Some plants were supplied with ambient air, others with purified air. Comparative analyses of hydroponically grown vegetation and that grown in ambient air revealed that metals in the form of fine particles or in the gaseous state were not a major source of the heavy metals content of vegetation. The heavy metal concentrations in the experimentally grown vegetation varied directly with the metal concentration found in the soil. Soil concentration of each metal studied varied inversely with distance from the large smelting and refining stack in the area. Concentration of heavy metals in wheat kernels, barley kernels, oat kernels, pasture grass, alfalfa, and lettuce in the East Helena area did not indicate an inverse relationship with distance from the smelter. Sulfur dioxide and acid-mist injury developed on several plant varieties at two locations. Sulfur dioxide alone was the cause of leaf injury at the other locations. All locations where injury was found were within one mile of the stack of the smelting and refining facility. Relatively low concentrations of ozone and SO2, when mixed, caused vegetation damage.

41892

Gordon, C. C.

**EFFECTS OF AIR POLLUTION ON INDIGENOUS ANIMALS AND VEGETATION.** In: Helena Valley, Montana, Area Environmental Pollution Study. Environmental Protection Agency, Research Triangle Park, N. C., Office of Air Programs, Pub-AP-91, p. 95-112, Jan. 1972. 27 refs. NTIS: PB 207126

Accumulation of lead and cadmium in animals indigenous to the Helena Valley was determined by liver and kidney analyses of several species of area rodents. No definite correlation between lead or cadmium concentrations in animals and distance from East Helena smelter stacks was obvious. In conjunction with the rodent-trapping project, soil and grass were collected from each site where rodents were trapped. A comparison of the metal contents of washed and unwashed garden lettuce is presented. In another study, two groups of rabbits were fed lettuce thought to have high lead and cadmium concentrations. One group ate lettuce grown in East Helena gardens, and the other ate lettuce grown in Missoula on soil brought from East Helena. After six weeks, the animals were sacrificed, and bone, liver, and kidney analyses were performed. Only small differences in accumulation occurred between the groups, and total accumulation was insignificant. Collections of conifer foliage for histological studies were made at three locations in the vicinity of the smelter stack. The following phenomena were observed in photomicrographs: the mesophyll cell below the stomatal opening was almost invariably destroyed; this cell was either ruptured, collapsed, or completely disintegrated by the time the thin-walled cells of the vascular system were undergoing hypertrophy. The chloroplast and nuclei within the mesophyll cells were destroyed, giving the cells a granular appearance. The epithelial cells of the resin canals underwent hypertrophy and, if collapse did not occur, their enlarged cells became thick-walled and rigid. The inner walls of the endothermal cells, the parenchymatous cells of the transfusion tissue, and the albuminous parenchyma cells of the phloem tissue collapsed. All of these disease symptoms indicate sulfur dioxide damage.

41893

Lewis, Trent R.

**EFFECTS OF AIR POLLUTION ON LIVESTOCK AND ANIMAL PRODUCTS.** In: Helena Valley, Montana, Area Environmental Pollution Study. Environmental Protection Agency, Research Triangle Park, N. C., Office of Air Programs, Pub-AP-91, p. 113-124, Jan. 1972. NTIS: PB 207126

Arsenic, zinc, cadmium, and lead concentrations in the manes of 39 horses in the vicinity of the smelting and refining complex at East Helena, were determined. Proximity to the industrial area correlated well with increased levels or arsenic, lead, and cadmium in the manes of the horses. Furthermore, older animals, animals residing in Helena Valley for the longest duration, and chronically impaired animals had high concentrations of lead and cadmium in their manes. Fifty percent of the horses at sites investigated showed lead and cadmium levels two to five times greater than the values found in the control horses. A horse for which postmortem data are presented had highly toxic levels of cadmium and lead in the kidney and liver; these levels were not reflected in the mane. This disparity probably relates to an actue exposure to these metals rather than a long-term or chronic exposure. Metal contents of miscellaneous animal products, including chicken (muscle), rabbit (muscle), whole milk, beef tissue (liver and muscle), beef (knee bone), swine tissue (heart), and sausage were determined.

42207

Keaton, Clark M.

**THE INFLUENCE OF LEAD COMPOUNDS ON THE GROWTH OF BARLEY.** Soil Sci., 43(6):401-411, June 1937. 18 refs.

Evidence is shown by the results obtained in this study that because of the high fixing power of the soils used, large quantities of lead could be added without harmful effects. When

amounts at the rate of 7190 lbs lead carbonate/acre were used, no detrimental effects on the growth of barley were observed. The tendency was for the growth of barley to be stimulated by minute quantities of soluble lead in the soil. A relationship appears to exist between the growth stimulation and soluble lead content of the soil, with a tendency for maximum stimulation to occur when the concentration of soluble lead ranges between 0.1 to 0.4 ppm lead oxide. Lead was found in the plants in both tops and roots, the concentration in the latter being notably higher than in the tops. The tendency of the plants was to absorb greater quantities of lead with increasing concentrations of soluble lead in the soil. (Author summary modified)

42250

Costesque, L. M. and T. C. Hutchinson

**THE ECOLOGICAL CONSEQUENCES OF SOIL POLLUTION BY METALLIC DUST FROM THE SUDBURY SMELTERS.** Inst. of Environmental Sciences, Mt. Prospect, Ill., Proc. Inst. Environ. Sci., Annu. Tech. Meet., 18th, New York, 1972, p. 540-545. 16 refs. (May 1-4.)

The ecological consequences of heavy metal damage are probably being masked by the damage due to sulfur dioxide emitted by the metal smelters of Sudbury, Ontario in Canada. Soil and vegetation east and south of the source, plant leaves, and dust and rainfall were sampled for analysis of copper, nickel, cobalt, zinc, manganese, lead, and iron content. Elevated levels of nickel were detected up to 31 mi from the smelters and toxic water levels extended to 10 mi. The soil contamination has a pattern indicative of an airborne smelter source. A significant reduction of pH occurred in the soil within 1 1/2 mi of the smelter. A pH of 2.2 was recorded in one instance, suggesting the presence of free sulfuric acid. Nickel levels were 2835 ppm at 0.5 mi from the smelter, 1522 ppm at 4-5 mi, 306 ppm at 12 mi, and 83 ppm at 31 mi. Copper followed the same pattern from 1528 ppm to 31 ppm; cobalt decreased from 127 ppm to 19 ppm. Average soil levels should be 40 ppm for Ni, 20 ppm for Cu, and 8 ppm for Co. (Author summary modified)

42336

Maeno, Michio

**EFFECTS OF HEAVY METALS IN DUST ON TREES.** (Baijinchu no kinzoku seibun no jumoku e no eikyo). Text in Japanese. Kogai to Taisaku (J. Pollution Control), 8(6):535-542. June 1972.

Metal contents in trees were investigated at two major cities of Kanagawa Prefecture. Iron was found in the largest concentration, followed by zinc, manganese, lead, copper, nickel, chromium, and cadmium. All the metal contents were higher in trees in industrial areas than in those in commercial and residential areas. The average metal content of particulates on the leaves of seven kinds of trees in a industrial area in Kawasaki City were 86.7 mg/sq m leaf area for Fe, 1.33 mg/sq m for Mn, 1.07 mg/sq m for Zn, 0.34 mg/sq m for Pb, 0.11 mg/sq m for Cu, 0.11 mg/sq m for Ni, and 0.004 mg/sq m for Cd. The average components of particulates on the leaves of trees in an industrial area were 38.1% silicon dioxide, 14.1% aluminum oxide, 18.3% ferric oxide, 7.2% calcium oxide, 1.8% magnesium oxide, and 9.6% sulfur trioxide, and those in a non-industrial area were 45.3%, 16.6%, 8.8%, 6.2%, 2.0%, and 8.5%, respectively. Investigations on the growth of trees revealed that new leaves in industrial areas had smaller leave areas and poor growth conditions.

42607

Webber, M. D.

**A COMPARISON OF IGNITION TREATMENTS FOR PB MEASUREMENT IN PLANT TISSUES.** Can. J. Soil Sci., 52(2):282-284, June 1972. 4 refs.

Dry ignition at 460-500 C is frequently used to prepare plant tissue for lead analysis; however, it was observed that measurements for tissues following one dry ignition at 500 C were larger than after two ignitions. Consequently, a comparison of ignition treatments for analysis of lead in hay and pasture samples was carried out. Although the data for comparison of ignition treatments are incomplete, there was generally good agreement between the measurements after one dry ignition at 430 C; one dry ignition at 430 C followed by sodium carbonate fusion; and wet ignition with nitric acid, perchloric acid. Dry ignition at 450-500 C caused large reduction of Pb. Dry ignition at 300-430 C tested with one tissue and at 430 C tested with all tissues gave complete recovery of lead, but a large amount of unoxidized carbon remained. Wet ignition with HNO3 and HClO4 yielded complete recovery of Pb and rapid and complete oxidation of plant tissues.

42715

Shupe, James L., Wayne Binns, Lynn F. James, and Richard F. Keeler

**LUPINE, A CAUSE OF CROOKED CALF DISEASE.** J. Am. Vet. Med. Assoc., 151(2):198-203, July 15, 1967. 21 refs.

Lupine, lupine and lead, and lead alone were fed to cows to evaluate their teratogenic effects. Lupine proved to be a cause of crooked calf disease, which was characterized by either arthrogryposis or torticollis and scoliosis or both, and occasionally cleft palate. The principle time of insult for the front limbs was between the 40th and 70th day of gestation, although slight to moderate malformations did occur when lupine was fed to cows before and after this period. The severity of the deformity was not necessarily correlated with the severity of the signs of poisoning. Lupine toxicosis is related to its high alkaloid content. (Author summary modified)

42857

Nielsen, S. W.

**ENVIRONMENTAL POLLUTANTS PATHOGENIC TO ANIMALS.** J. Am. Vet. Med. Assoc., 159(9):1103-1107, Nov. 1, 1971.

Veterinary diagnostic laboratories have detected a number of disease problems caused by environmental pollution. The pollutants and the resulting disease conditions are in many forms. Air pollution due to industrial and automotive exhaust fumes causes damage to the lungs of man and lower animals that closely share his environment, namely, the dog and the cat. Lung lesions caused by prolonged fume or dust inhalation range from anthracosis, emphysema, and fibrosis to lung cancer. Dogs and cats in London have a much higher incidence of oro-pharyngeal cancers than in any other area in the world. Radioactive fallout from the testing of nuclear devices has caused chronic radiation dermatitis and precancerous lesions in cattle, mules, and other animals grazing near test sites. Fluorosis has been observed in cattle and deer on pastures surrounding factories processing clay or other raw products with high fluoride content. Other environmental pollutants which are toxic to animals include nerve gas, chlorinated hydrocarbons, polychlorinated biphenyls, lead, and mercury. Tasks for the veterinary pathologist with regard to the identification and examination of environmental compounds causing pathogenesis are outlined.

42924

**EFFECT OF AIR POLLUTION ON FARM ANIMALS.** In: Air Pollution Manual. Part I. Evaluation. Detroit, American Industrial Hygiene Assoc., 1960, Chapt. 6, p. 63-71. 97 refs.

The susceptibility of animal species to air pollutants will vary according to the specific contaminant in question. In addition to different species susceptibilities, individual animal variations also exist within each species. The lesions produced by air pollutants depend on the toxic property of the pollutants, the dosage rate, the duration of the exposure, and the susceptibility of the animal. Criteria are listed for the diagnosis of injury by air pollutants. It is important in investigating the effects of air pollutants on farm animals to ascertain whether any abnormal condition found is the result of the pollutants in question or some other stress. Nutritional disorders, metabolic diseases, mineral deficiencies, and accidental poisoning are considered. Adequate information is needed on the dosage range of the contaminants to which the animals are subjected, and a careful meteorological study of the area should be included. Tissue samples may provide an important source of data when animal injury has resulted from specific known pollutants. The effects of arsenic, fluorides, lead, molybdenum, and sulfur dioxide on farm animals are discussed, including threshold limit values and toxic tolerances.

42945

Tenconi L. T. and G. Agocella

**CHEMOTHERAPY OF EXPERIMENTAL LEAD POISONING. I. EFFECTS OF LEAD POISONING ON THE METABOLISM OF TRYPTOPHAN TO NICOTINIC ACID IN RATS.** (Studio sulla chemotherapia dell intossicazione sperimentale da piombo. Nota l-Effetti dell avvelenamento da piombo sul metabolismo triptofano-acido nicotinico nel ratto). Text in Italian. Acta Vitaminol. (Milan), 20:189-194, 1966. 10 refs.

The effects of lead poisoning on the tryptophannicotinic acid metabolic pathway were studied with reference to pyridoxine deficiency, which apparently occurs in lead-intoxicated rabbits, in order to determine parameters for use in chemotherapeutic tests in experimental saturism. Rats were given 300 mg/kg/day lead acetate for 30 days; coproporphyrins and xanthurenic acid in urine were determined at 10-day intervals. Coproporphyrin elimination increased from the start of the feeding while xanthurenic acid, an index of pyridoxine deficiency, was initially unchanged and did not diminish until after the 30th day of feeding. Kynurenic acid, orthoamino-hippuric acid, kynurenine, acetylkynurenine, 3-OH-kynurenine, and N1-methylnicotinamide were unchanged. Lead intoxication in rats does not produce the changes in tryptophan metabolism, manifested by pyridoxine deficiency, observed in rabbits, but the increased elimination of coproporphyrin does point to a defect in porphyrin metabolism attributable to lead poisoning in both rat and rabbit. A metabolic disturbance in the tryptophan-nicotinic acid pathway can be assumed even in rats, although it may only take the form of a blockage of the first metabolic stage. The reduced elimination of tryptophan metabolites by poisoned rats (11, compared with 27 micro M in controls) could also be attributed to reduced amino acid absorption. Histologic examination revealed lesions in the intestinal wall of the poisoned rats probably associated with changes in the intestinal microflora.

43226

Aschbacher, P. W.

**AIR POLLUTION RESEARCH NEEDS WITH ANIMALS.** Preprint, Air Pollution Control Assoc., Pittsburgh, Pa., 31p., 1972. 107 refs. (Presented at the Air Pollution Control Association, Annual Meeting, 65th, Miami Beach, Fla., June 18-22, 1972, Paper 72-153.)

Based on published reports, air pollution problems relating to livestock are identified. These are discussed under two categories: pollutants from industrial-urban sources affecting livestock, and pollutants originating from animal production units. The available knowledge concerning these problems is briefly described. Air pollution from industrial sources affecting farm livestock is usually the result of accumulation of the pollutant on forage in a localized area surrounding the source, and the animals affected are primarily herbivores. Specific pollutants discussed in this regard are fluorine, lead, molybdenum, cadmium, and arsenic. In the second category, available information on specific pollutants identified as arising from various livestock production systems is presented. In any animal production system, volatile compounds from decomposing manure may be released into the atmosphere. In some cases, these gases may have adverse effects on the animals in the housing unit, or they may possess such odors as to be considered a public nuisance. Gases present in poultry, swine, and cattle housing units are identified. Of all problems identified, extensive information is available only for fluorosis, and in all cases the knowledge to assess the situation completely is lacking. (Author abstract modified)

43279

Warnick, Stephen L. and Henry L. Bell

**THE ACUTE TOXICITY OF SOME HEAVY METALS TO DIFFERENT SPECIES OF AQUATIC INSECTS.** J. Water Pollution Control Federation, 41(2):280-284, Feb. 1969. 12 refs.

The acute toxicity was determined of the salts of copper, zinc, cadmium, lead, iron, nickel, cobalt, chromium, and mercury to three species of aquatic insects as a first step in the development of criteria for protecting these important fish-food organisms. The three species of insects used were: the stonefly, (Plecoptera) Acroneuria lycorias; the mayfly, (Ephemeroptera) Ephemerella subvaria; and the caddisfly, (Trichoptera) Hydropsyche betteni. Ten individuals of each species were used in each metal concentration and control. Analysis of the killed insects revealed significant amounts of metal had been absorbed. Ephemerella was the most sensitive to all the metals, copper being the most toxic at 0.32 mg/l (48-hr median tolerance limit (TLm), followed by iron at 0.32 mg/l (96-hr TLm); cadmium, chromium, and mercury at 2.0 mg/l, and cobalt at 16 mg/l, (all 96-hr TLm). Mercury also was toxic to Acroneuria at 33.5 mg/l, and cobalt to Hydropsyche at 64.0 mg/l, (also 96-hr TLm). In all other cases the test organisms lived beyond 96 hr, even at concentrations up to 64.0 mg/l, indicating that the aquatic insects may not be as sensitive to the heavy metals as are fish.

43342

Glater, Ruth Ann B. and Louis Hernandez, Jr.

**LEAD DETECTION IN LIVING PLANT TISSUE USING A NEW HISTOCHEMICAL METHOD.** J. Air Pollution Control Assoc., 22(6):463-467, June 197 20 refs.

A simple and rapid method for identifying and distinguishing lead from other heavy metals in living plants has been developed using sodium rhodizonate which forms a scarlet precipitate with lead at approximately pH 2.8. Hand sections of plant tissues are treated with rhodizonate reagent, buffered, and examined microscopically. Those cells and tissues contaminated with lead turn scarlet--color intensity being directly related to concentration. Lead may be detected in quite low concentrations (in the order of 10 ppm) and may be observed

in situ; its entry and movement through plant can thus be followed. A disadvantage of the method is that the color does not persist beyond a few hours. In an area of moderate traffic of Downey, California (Southeast Los Angeles), lead was found abundantly on leaves as well as on roots of garden-grown lettuce; origin of this lead presumed to be from car exhausts. (Author abstract modified)

43511

Stoefen, D.

**LEAD-INDUCED FETAL ALTERATIONS IN GRAZING CATTLE? (Bleibedingte Keimschaeden beim Weidevish)? Text in German. Zuchthygiene, 4(4):169-173, 1969. 32 refs.**

Observations and experiments on the effects of lead on animals and man are reviewed. The daily lead intake by grazing cattle may lie at 112-167 micrograms/kg body weight. Doses of 1 mg/day or 14 micrograms/kg body weight have had a pathological effect. The toxic effect is dependent on endogenous or exogenous fluctuations in the blood lead level, caused by local factors, rather than on the blood level itself, which is largely constant. Psychic, and particularly fetal, effects appear much earlier than physiopathological ones. Lead represents a major fetal hazard. The synthesis of ribonucleic acids is inhibited by lead which also penetrates the fetus. Malfunction of the ovary, menstruation problems, sterility, omotocia, and increased infant mortality due to lead were observed. High lead doses had teratogenic effects in animal tests. Brain damages in infants such as hydrocephalus, idiocy, spasms, infantilism, and rachitis were found. Atrophy of the seminiferous tubules, damages of the parenchyma in sex glands, and reduced spermatogenesis were observed. Oral doses of six times 0.002 mg/kg and six times 200 mg/kg body weight had largely the same effects (damaged testes and sperms, edemas in interstitial tissues, and necrosis of seminiferous tubules). Sensibilization of allergenics and inhibition of immunologic reactions by lead were revealed.

43721

Lee, J. A.

**LEAD POLLUTION FROM A FACTORY MANUFACTURING ANTI-KNOCK COMPOUNDS.** Nature, 238(5360):165-166, July 21, 1972. 9 refs.

In a study of the edaphic factors affecting certain grassland communities in Cheshire, significant lead levels were found in vegetation in the vicinity of a factory manufacturing anti-knock compounds which consist of tetraethyl and tetramethyl lead. Moss species found in abundance at the sample sites were collected and their mean lead content was taken as a measure of the lead accumulated in the ground layer. At sites where three or more species were sampled there was fairly good correspondence in the lead content of the species. Samples of Holcus lanatus were also taken. There was a rapid decline in the lead concentration in the vegetation away from the factory in the first 400 m and a slower decline in the next 400 m. At 800 m, however, the amount of lead in the mosses was between two and three times that in the same species collected in rural areas far from any industry. Concentrations as great as 286 ppm were observed in a pasture downwind of the factory; this was nearly three times as much as in roadside samples from central Manchester. A sample of Holcus lanatus from immediately outside the factory had a lead content of 1838 ppm. Some of the contents recorded in Holcus lanatus are likely to be highly toxic to herbivores.

43782

Briggs, D.

**POPULATION DIFFERENTIATION IN MARCHANTIA POLYMORPHA L. IN VARIOUS LEAD POLLUTION LEVELS.** Nature (London), 238(5360):166-167, July 21, 1972. 7 refs.

A preliminary study of lead levels in populations of the liverwort Marchantia polymorpha L. is presented. The liverwort is relatively common in most shady streets in the center of Glasgow and Edinburgh and is also found in country districts. Eleven samples of Marchantia and the soil 1 to 2 cm beneath them were collected along a transect running north-west from central Glasgow to a point 13 km from the city. The lead content of plant digests and soil extracts was determined by atomic absorption spectrophotometry. High lead levels were found in Marchantia and in soils from the centers of Glasgow and Edinburgh, and in samples from Chatsworth, Dunoon, and Beattock which are away from large urban areas but near roads. There was usually a greater concentration of lead in the liverwort than in the soil, and high levels of lead in the Marchanti thalli were usually associated with high lead values in the soil. Four populations were studied to see if plants are differentially sensitive to lead in the medium. The three city clones grew equally well on lead agar and control medium, but the Milngavie plants, which grow in an area exposed to less lead contamination, grew significantly less well on lead agar in comparison with the control. It seems likely that lead tolerant genotypes have a selective advantage in city regions. Marchantia polymorpha, which contains higher lead levels than the bryophytes used in previous studies, could perhaps be a valuable indicator species.

44071

Ganje, T. J. and A. L. Page

**LEAD CONCENTRATIONS OF PLANTS, SOIL, AND AIR NEAR HIGHWAYS.** Calif. Agr., 26(4):7-9, April 1972.

Lead found in and on crops in highway proximity tests in Southern California was caused principally by aerial depsoition. Substantial amounts of lead were removed from exposed plant tissues by distilled water washing. Amounts of lead in and on crops were influenced by distance from the highway, extent of plant surface exposed, external plant characteristics, duration of plant exposure, motor vehicle traffic density, and direction of prevailing winds. In soils and suspended air particulates, lead concentration was influenced by distance from highways and the direction of prevailing winds. Crops surveyed included lima bean, corn, sugar beet, tomato, wheat, alfalfa, and oranges.

44588

Zook, B. C., R. M. Sauer, and F. M. Garner

**LEAD POISONING IN AUSTRALIAN FRUIT BATS. (Pteropus poliocephalus).** J. Am. Vet. Med. Assoc., 157(5):691-694, Sept. 1, 1970. 11 refs.

Lead poisoning was diagnosed in three Australian fruit bats who died in their indoor cage three months after they were received at the National Zoological Park. Diagnoses were indicated by the discovery of large acid-fast intranuclear inclusion bodies in renal and hepatic cells, and toxic amounts of lead in tissues. The nuclei of about 10 to 15% of proximal convoluted tubular cells and hepatocytes were enlarged, up to twice the dimensions of adjacent nuclei, and nucleoli and chromatin were marginated to the nuclear membrane. The large size of the inclusion bodies seemed to parallel the high amount of lead accumulated in the livers of the animals, 500

ppm. The source of the lead was found to be paint on the walls of the bat cage which had been peeling. It is thought that certain idiopathic diseases of zoo primates and some illnesses of other zoo animals may also be the result of lead poisoning.

45056

Holtzman, Richard B.

**RA 226 AND THE NATURAL AIRBORNE NUCLIDES PB 210 AND PO 210 IN ARCTIC BIOTA.** In: Radiation Protection. Part 2. W. S. Snyder (ed.), New York, Pergamon Press, 1968, p. 1087-1096. 20 refs.

In order to better determine the characteristics and effects on humans of arctic biota with high concentrations of lead (210) and polonium (210), these nuclides, along with their long-lived predecessor, radium (226), were measured in lichens, in bone and muscle of caribou and other arctic animals, and in Eskimo placenta. The Ra (226) with concentrations 1/3 to 1/50 of the other nuclides, cannot be the direct source of the other nuclides. In caribou bone the Po (210) was in radioactive equilibrium with the Pb (210) and averaged about 11.7 pCi/g ash, twice the Pb (210) in reindeer bone. The Pb (210) content of muscle of both species was 10pCi/kg (wet). By contrast, the Po (210) content was much greater, about 200 pCi/kg. A definite seasonal decrease was noted in the lead in muscle during the second half of the year. Similar variations were indicated for polonium in muscle and for lead in bone. The high levels in caribou are attributed to the high fallout levels of these nuclides in lichens, their winter forage, which contain (in dry weight) 6 pCi and 12 pCi Pb (210)/g. The other animals exhibited appreciably lower concentrations in bone and muscle. Wolf, which consumes large quantities of caribou, exhibited activities in bone of 1 pCi/g ash, about that observed in some Eskimo bone. The Po (210) content of wolf muscle was about the same as that of caribou, 200 pCi/kg, but the Pb (210) was only about 1 pCi/kg. Similar, but less dramatic, differences were observed in Eskimo placenta. Estimates of uptake show that Eskimos could acquire sufficient of the long-lived Pb (210) to double the total skeletal radiation dose (rad) over that of Midwesterners. However, despite the high concentrations of Po (210) in meat, direct intake accounts for only a relatively small increase in total dose. (Author abstract)

# I. EFFECTS-MATERIALS

00305

R. E. Johnson, A. T. Rossano, Jr., R. O. Sylvester

**DUSTFALL AS A SOURCE OF WATER QUALITY IMPAIRMENT.** J. Sanit. Eng. Div., Am. Soc. Civil Engrs. 92, (SA 1) 245-67, Feb. 1966. (Presented at the Third Annual Meeting, Pacific Northwest International Section, Air Pollution Control Association, Vancouver, British Columbia, Nov. 2-4, 1965.)

An investigation was made of dustfall during the months of June, July, and August, 1964, in Seattle, Washington, and surrounding areas, to determine effects of dustfall on reservoir water quality. Several components of dustfall were measured at 46 stations located within Seattle and suburbs. Methods of sampling and analysis are described. Dustfall rates and their significance in terms of water quality, source, and meteorological factors are examined. It is concluded that while water quality is not affected appreciably at the present time, an increase in dustfall in the future from uncontrolled sources could be a threat to drinking water quality. Lead appears to be the main constituent that has significance as a water quality contaminant.

02176

J. P. Lodge, Jr. and E. R. Frank.

**EVAPORATED METAL FILMS AS INDICATORS OF ATMOSPHERIC POLLUTION - II RESISTANCE MEASUREMENTS.** Intern. J. Air Water Pollution 6, 215-21, 1962.

Thin metallic films were tested as integrating indicators of total atmospheric corrosiveness. The change in electrical resistance was used as the index of the rate of attack. The metals used were aluminum, copper iron and lead. Gross atmospheric features associated with the accumulation of substances in air that are corrosive to metals appear to be directly related to the rate of resistance change. This behavior is most striking in aluminum. A simple, inexpensive technique is provided for the continuous recording of corrosion rate.

03735

J. P. Lodge, Jr. B. R. Havlik

**EVAPORATED METAL FILMS AS INDICATORS OF ATMOSPHERIC POLLUTION.** Intern. J. Air Water Pollution. 3, (4) 249-52, 1960.

The use of evaporated metal films a few hundredths of a micron in thickness is proposed. Glass slides covered with films of aluminum, iron, lead, copper, and silver were prepared and exposed in the Cincinnati area. Corrosion products were identified by means of X-ray diffraction and microchemical methods. Corrosion results in an increase in light transmission by the film, which can be taken as a quantitative measure of corrosion. Preliminary results showed aluminum to be the most dependable indicator of general stmospheric corrosiveness, although silver appeared specifically sensitive to a small group of pollutants, such as halogens, ozone, and sulfur compounds. Lead corroded so rapidly as to be difficult to interpret while iron was shown to be responsive primarily to relative humidity. Fair correlations were obtained with independent measures of pollution level. Some exploratory work was done on the measurement of the elect*ical resistance of the films. (Author abstract)

06355

H. H. Copson, 'Chairman.'

**REPORT ON SUBCOMMITTEE VI ON ATMOSPHERIC CORROSION - 1957 TEST PROGRAM.** (In: Atmospheric exposure of nonferrous metals and alloys.) Proc. Am. Soc. Testing Materials, Philadelphia, Pa., 1959. Vol. 59, 1-7.

Committee B-3, in 1956, initiated a series of atmospheric corrosion tests of 77 alloys containing 9 basis metals including some of the newer commercial metals such as titanium, tantalum, and molybdenum. Each alloy was exposed in triplicate for each exposure period at all four sites with one exception: sufficient tantalum was available for exposure only at Kure Beach, N. C., and Newark, N. J. Tables containing code for atmospheric exposure location, chemical analyses, initial tension test data and exposure dates are appended.

06357

J. S. Pettibone, 'Chairman' W. H. Ailor

**REPORT OF SUBCOMMITTEE VI ON ATMOSPHERIC CORROSION - 1957 TEST PROGRAM: TWO-YEAR EXPOSURES.** (In: Atmospheric exposure of nonferrous metals and alloys) Proc. Am. Soc. Testing Materials, Philadelphia, Pa., 1962. Vol. 62, 18-33.

This report is concerned with the data obtained from the 2-year removal of exposed and control panels of the 77 alloys of nine basic metals of the 1957 program plus three additional aluminum alloys tested under the same program requirements by the Aluminium Development Assn. at five test sites in England. One alloy (super purity aluminum --ASTM Code No. 87) is under test at the four ASTM sites and the five sites in England. Tables showing the exposure periods for the alloys, two year data 1957 test program by alloy and exposure site and cleaning procedures are included. The test program is discussed, including atmospheric exposure, exposure periods, test panels, identification, laboratory tests prior to exposure, and evaluation of corrosion damage. The participating companies are listed.

22128

Slomyanskaya, F. B.

**DURABILITY OF METALS UNDER OPERATING CONDITIONS IN VARIOUS SULFUR REMOVAL EQUIPMENT.** (Stoykost' metallov v usloviyakh raboty ryada appa ratov seroochistki). Text in Russian. In: Korroziya i iznos konstruktsionnykh materialov khimicheskogo mashinostroyeniya. F. F. Khimushina, (ed.) Moscow, 1958, p. 111-132. 10 refs.

The corrosion resistance of metals in saturated and regenerated sulfite-bisulfite solutions at 20-95 C was studied. Type Kh18N12M2T steel was the most durable metal tested and is recommended for lining absorbers. Aluminum was found suitable for contact with liquid and gaseous phases in the absorber; double cladding is recommended for parts sub-

ject to heavy wear. At operating temperatures below 50 C, aluminum alloy Al4 is recommended for use in contact with saturated ammonium sulfite-bisulfite solutions; aluminum, or any of its silicon alloys, with regenerated solutions. Copper content of the aluminum alloys should be minimal. Support elements in filter presses may be made of 1Kh18N9T steel. Lead containing 0.5% antimony is recommended for the construction of coolers operating in regenerated ammonium sulfite-bisulfite solution at 90-95 C.

31377

Elliot, P. and T. K. Ross

**SOME ASPECTS OF THE PERFORMANCE OF RARE EARTH MODIFIED NICKEL-BASE ALLOYS IN HOT CORROSION CONDITIONS.** Werkstoffe Korrosion, 22(6):531-540, 1971. 14 refs. (Presented at the Tagung der Arbeitsgruppe, Korrosion durch heisse Gase und Verbrennungsprodukte Duesseldorf, West Germany, Dec. 9-10, 1970.)

Much of the effort concerned with superalloy development for gas turbine application is associated with the capability of the alloy to combat a particular form of surface attack associated with the combined presence of sodium, vanadium, lead or other contaminants present in combusted fuel atmospheres. This process generally referred to as hot corrosion is similar to, but considerably more severe than, high temperature oxidation. Rare earth additions to superalloys exposed to hot corrosion conditions have shown some benefits but some perform better than others for specific alloy systems. Studies of the performance of rare earth modified nickel-base alloys in sulfur dioxide atmospheres indicated that it is the oxide which is responsible for this hot corrosion resistnace.

32921

Sjoberg, J. W. and A. I. Rozmanith

**FUEL VARIABLES AND CORROSION RESISTANT MATERIALS FOR AUTOMOTIVE EXHAUST THERMAL REACTORS.** Materials Prot. Performance, 10(9):31-34, Sept. 1971. 3 refs.

The effect of several fuel variables on oxidative corrosion of metals in automotive exhaust gas afterburners was determined for the normal thermal reactor operating range of 1700 to 1800 F. At 1750-1800 F, when used in conjunction with tetraethyl lead antiknock additives, phosphorus tends to significantly increase corrosion of afterburner metals. The lead and required halogen scavengers also significantly increases corrosion. Sulfur, within reasonable concentration limits, has little effect on high temperature oxidation in a thermal reactor. Halogens tend to mitigate the corrosion promoting properties of lead. The less highly alloyed metals showed a direct variation in oxidation rate with average maximum cycle temperature. The more highly alloyed materials did not appear to be greatly affected by average maximum cycle temperature until a critical temperature was reached at which further increases greatly increased oxidation rate. The ferritic alloys containing chromium and aluminum probably have adequate oxidation resistance to make them useful for afterburner parts not subject to temperatures exceeding 1700-1750 F. Coatings are indicated to improve the oxidation resistance of the less expensive ferritic alloys. Electron probe micrographs of the oxidation scale indicate that metals achieve oxidation resistance in thermal reactor environments in the classic manner by formation of a protective layer of chromium or aluminum oxide adjacent to the metal surface. (Author summary modified)

33802

Kautz, K.

**CAUSES FOR CORROSIONS IN INCINERATORS FOR DOMESTIC REFUSE.** (Korrosionsurasachen in Hausmuellverbrennungsanlagen). Text in German. Mitt. der Grosskesselbetr., 51(5):396-402, Oct. 1971. 18 refs.

Incinerators for domestic refuse suffer from corrosion due to chlorine compounds. Hydrogen chloride reacts with components of the coating of the pipes, the steel, and the steel s oxide layer. The flue gas contains chlorides, oxygen, sulfates, carbon dioxide, and sulfur dioxide. Silicon compounds, oxides (including aluminum and iron oxides), calcium sulfate, and alkaline metal sulfates are also emitted. Lead can occur as lead sulfate or lead chloride. Hydrogen chloride is produced by the burning of polyvinyl chloride.

36051

Godfrey, Douglas and Richard L. Courtney

**INVESTIGATION OF THE MECHANISM OF EXHAUST VALVE SEAT WEAR IN ENGINES RUN ON UNLEADED GASOLINE.** Preprint, Society of Automotiv Engineers, Inc., New York, 16p., 1971. 8 refs. (Presented at the Automotive Engineering Congress, Detroit, Mich., Jan. 11-15, 1971, Paper 710356.)

Valve seat wear or sinkage or recession was observed in eight engines run on unleaded fuel. Detailed studies of valve seat wear were undertaken in a 302-cu in. V-8 engine run for 10.25 hours at wide-open throttle on a dynamometer stand. The seat was oxidized and flaky, and the valve face was spotted with hard oxide nodules. Results indicate that during operation the oxide flakes adhere to the valve face to form nodules which become embedded in the metal. With the embedded nodules, the valve wears the cast iron seat by abrasion. Loads, rotation, and temperatures are often influencing factors. The use of leaded fuel in another engine formed a lead oxide-lead sulfate product on the hot valve face and a Pb (chlorine 0.75-bromine 0.25)2 product on the cooler seat. These compounds are high-temperature solid film lubricants which, by coating the surface, inhibit cast iron oxidation and also prevent material transfer. (Author abstract)

# J. EFFECTS-ECONOMIC

03288

W. W. Sabin and R. K. Scales.

**EVALUATION OF USE VS. NON-USE OF TETRA-ETHYL LEAD IN GASOLINE.** Ethyl Corp., Detroit, Mich., Refinery Technology Division. (Presented at the Symposium on Environmental Lead Contamination, Public Health Service, Washington, D.C. Dec. 13-15, 1965.) Mar. 1966. pp. 95-108. GPO 0-210-345; HEW 1440

The economic aspects for and against the use of lead anti-knocks are discussed in this paper. Author concluded that the omission of lead anti-knocks would increase cost of manufacturing of gasoline, approaching the quality of today's to 2.6 cents/gallon for the U.S. refining industry. This is a 30 percent increase in the manufactured cost of 8.5 cents/gallon for an efficient large refinery. Principal components of the increased cost of gasoline are the increased consumption of petroleum raw materials (185,000,000 barrels/year) and the enormous capital investment (3 billion dollars) in new process facilities that would be required. The type of gasolines which would have to be produced without lead would be less satisfactory than today's fuels and would require serious consideration with regard to certain problem areas. Small independent refiners would be unable to compete in the gasoline manufacturing business if anti-knocks were unavailable to them as a means of producing competitive anti-knock quality. These refiners would be forced out of the petroleum refining business.

03289

M. J. Sterba.

**REFINING TO PRODUCE GASOLINES OF REDUCED LEAD CONTENT.** Universal Oil Products Co., Des Plaines, Ill. (Presented at the Symposium on Environmental Lead Contamination, Public Health Service, Washington, D.C., Dec. 13-15, 1965.) Mar. 1966. PP. 113-30. GPO 0-210-345; HEW 1440

In the variations of the generalized situations considered in this discussion, the estimated incremental manufacturing cost to the refiner for making an unleaded gasoline of current octane number quality ranged from 1.1 to 1.5 cents/Gal. above what it costs to make current gasolines. This incremental cost will vary, both above and below the range indicated, depending on the refinery size, its type, its location, crude characteristics, crude supply situation, products made, price structures, labor costs, accounting methods, and many other factors. The important conclusion to be made is that it is possible to make unleaded gasolines, but at costs that must be passed on to the driving public. In order to market the same amount and quality of clear gasoline as the refiner presently sells of leaded gasoline, he must either market less of distillates or residual fuel, or process more crude oil. Based on estimates made for a 50,000 BSD refinery, the U.S. refining industry would be required to make a capital investment of 1.5 to 2 billion dollars. This is to be compared with annual expenditures of the order of 500 million dollars for normal refinery expansion and modernization.

21749

Weidensaul, T. Craig and Norman L. LaCasse

**STATEWIDE SURVEY OF AIR POLLUTION DAMAGE TO VEGETATION - 1969.** Pennsylvania State Univ., University Park, Center for Air Environment Studies, PHS Grant AP 00002, 1970, 52p. 3 refs.

During the summer of 1969, a statewide survey of air pollution damage to vegetation was conducted to assess economic losses incurred on food and fiber crops in Pennsylvania. Most incidents occurred in areas of greatest agricultural activity. The greatest economic losses were observed on vegetable, fruit, and agronomic crops, followed by lawns, ornamentals, greenhouse flowers, and forest trees. The suspected major pollutants, based on associated economic losses, appear to be as follows: oxidants, sulfur oxides, lead, hydrogen chloride, particulates, herbicides, and ethylene. The total amount of direct economic loss was estimated to be more than 3.5 million dollars. Indirect losses accounted for an additional 8 million dollars. These losses include known profit losses to growers, costs of reforestation of denuded land, known greater relocation costs, and substitution of lower value crops for higher value ones. Other indirect effects are stream silting, erosion, farm abandonment, and loss in aesthetic values. (Author abstract modified)

22358

McLeod, W. J.

**IMPACT OF GASOLINE VOLATILITY AND OLEFIN REDUCTION ON THE REFINER.** American Petroleum Inst., New York, Div. of Refining, Proc. Am. Petrol. Inst., Sect. III, vol. 50:498-513. 1970. 3 refs. (Presented at the American Petroleum Institute, Division of Refining, Midyear Meeting, 35th, Houston, Tex., May 13-15, 1970.)

Two studies investigating the air pollution benefits of gasoline modification and the required cost to the refiner are reviewed. Possible refinery methods for modifying gasoline are described. One method, known as front-end saturation, involves replacing the olefins with comparable paraffins. Another method involves reducing the vapor pressure (volatility) of the gas. The effects of front-end saturation on smog problems are reviewed. Unfortunately, neither the long-range nor the short-range benefits are significant. Legislation relevent to gasoline and to emission standards is reviewed. Reducing vapor pressure is more expensive and less effective than front-end saturation. It is reasonably certain that costs will be much higher in unleaded than in leaded gasoline because of the difference in effect of olefin saturation on leaded and unleaded octane ratings.

26765

Downing, Paul B. and Lytton Stoddard

**BENEFIT/COST ANALYSIS OF AIR POLLUTION CONTROL DEVICES FOR USED CARS.** In: Project Clean Air. California Univ., Riverside, Dept. of Economics, Research Proj. S-10, Vol. 3, 44p., Sept. 1, 1970. 2 refs.

The costs and effectiveness of alternative automotive air pollution control devices currently available for addition to used cars are determined. The list of devices has been expanded to include some devices which are currently under development or could be developed if it were desirable. Other methods of control such as fuel changes are not considered. The study separately calculates costs and emissions during the years 1970, 1975, 1980, and 1985 for each of California's eleven air sheds. Emissions are calculated for the three major pollutants, hydrocarbons, carbon monoxide, and oxides of nitrogen. The devices studies include tune-up, evaporation, spark advance, afterburner, catalytic muffler, and exhaust recycle. Thei/emission reductions are presented in tabulated form. The cost effectiveness of alternative devices is calculated from emission reductions, from information on annual capital, operation, and maintenance costs, and from estimates of the age distribution of automobiles in each air shed. The used car emission problem is inherently short-ranged. Increasingly strict emission standards for new cars can be assumed. As the decade progresses, the composition of the used car population will change toward lower potential emission cars. The role of used car emission control, then, is to speed the reduction in total emission levels that are already anticipated from present new car control efforts. The criteria of cost effectiveness when combined with a limited budget for air pollution control are likely to dictate the use of different devices on different age groups of cars and the total neglect of some cars. Financing of the expense of emission controls must be carefully considered both in terms of resources available for control efforts and the equity of cost distribution. It is perhaps not reasonable to expect all car owners to be able to finance their own control devices. It is certain that the presence of lead in gasoline contributes to pollution through the fouling of emission-control devices. Proper cleaning detergents, on the other hand, can contribute to the efficient operation of control devices. Clearly encouragement of new 'clean' fuels is necessary for lower levels of used car emissions. (Author abstract modified)

27968

Dabelstein, Werner

**PROBLEMS PRESENTED BY LEAD IN GASOLINE.** (Zur Problematik der Benzinverbleiung). Text in German. Erdoel Kohle (Hamburg), 24(1):37-40, Jan. 1971. 16 refs.

The various aspects and implications of lead additives in motor fuels are discussed such as the effects of lead alkylates on the anti-knock performance of modern motor fuels, the consequences of the elimination of lead additives on manufacturing costs, on engine life and design. The recently published report about elevated levels of lead in the blood of city employees of Frankfurt/M. is not considered conclusive proof of impairment of human health because similar levels were found in the blood of inhabitants of New Guinea who are not exposed to internal combustion engine exhaust gases (26 microg/100 ml blood and 22 microg/100 ml blood respectively). The difficulties which the lowering of harmful pollutant levels from internal combustion engines present are due to the circumstance that all measures designed to lower the emission of CO and of hydrocarbons before and during combustion lead to increased generation of nitrogen oxides and thus only control measures instituted after combustion are effective. A viable alternative to the use of lead compounds in gasoline is the use of lead-free gasolines with a low octane number in engines with a high piston displacement and small compression. Such engines generate less nitrogen oxides and run noiselessly. The German Federal Ministry of the Interior and the petroleum industry reached an agreement whereby the lead content would be reduced to 0.4 g/l as o 1 January 1972 and to 0.15 g/l as of January 1977.

30329

**CONFERENCE ON THE PUBLIC ACTION AGAINST POLLUTION.** (Convegno sul tema L intervento pubblico control l inquinamento). Text in Italian. Riv. Combust., 24(10):453-454, Oct. 1970.

A brief summary is given of a meeting held June 18-19, 1970 in Rome, sponsored by two corporations, on the responsibility of the public in pollution control. A 175-page report was presented to the public, and the meeting was thrown open to discussion. The thrust of the presentation indicated that the two corporations expect the public to shoulder most of the financial burden for pollution control, since it is the public which primarily benefits from the preservation of the environment. Estimates of the cost of eliminating the principle forms of air and water pollution in Italy called for an investment cost of 609 billion lire (about one billion dollars) in 1970, decreasing to 243.7 billion lire (389 million dollars) in 1980. The operating and maintenance costs are 47.6 billion lire (76 million dollars) for 1970, increasing to a projected 714.3 billion lire ($1,143,000,000) or 888.8 billion lire ($1,422,000,000) by 1985, according to two differing estimates. One criticism of these figures is that they assume the immediate implementation of certain measures that the industries involved do not consider feasible at present. For instance, the plan calls for the use of catalytic afterburners and lead-free gasoline in the automotive and petroleum industries, both of which consider these improvements unattainable at the moment. The study assumes an investment for catalytic exhaust manifolds and the additional annual cost of lead-free gasoline. Investment costs are also given for the metallurgical industries, nonmetallurgical industries related to mining, chemical industries, thermoelectric plants, and domestic heating. The figures for domestic heating assume that the heating plants are already adequately equipped with pollution controls in accordance with the Italian anti-smog law (No. 615).

30696

LeSourd, D. A., M. E. Fogel, A. R. Schleicher, T. E. Bingham, R. W. Gerstle, E. L. Hill, and F. A. Ayer

**COMPREHENSIVE STUDY OF SPECIFIED AIR POLLUTION SOURCES TO ASSESS THE ECONOMIC EFFECTS OF AIR QUALITY STANDARDS. VOL. I. (FINAL REPORT).** Research Triangle Inst., Durham, N. C., Operations Research and Economics Div., APCO Contract CPA 70-60, RTI Proj. OU-534, Rept. FR-OU-534, 395p., Dec. 1970. 328 refs. NTIS: PB 197647

Air pollution control costs for mobile sources are presented on a national basis and in terms of unit investment and annual operating and maintenance costs as well as total annual operating and maintenance costs. The analyses cover the estimated emissions and control costs for new cars for Fiscal Year 1967 through Fiscal Year 1976. Control costs for each stationary source, except for residential heating, are shown for 298 metropolitan areas by investment and annual expenditures by Fiscal Year 1976. The impact of control on selected industries and the Nation are also determined. Finally, an extensive bibliography is included. The pollutants from mobile sources selected for analysis are hydrocarbons, carbon monoxide, nitrogen oxides and particulates. The six pollutants for which control cost estimates are made for stationary sources are particulates, sulfur oxides, carbon monoxide, hydrocarbons, fluorides, and lead. Emission standards applied are considered stringent in comparison with many currently in use throughout the Nation. Mobile sources include automobiles and light and heavy-duty trucks. Stationary sources studied include solid waste disposal, commercial and institutional heating plants, industrial boilers, residential heating plants, steam- electric

power plants, asphalt batching, brick and tile, coal cleaning, cement, elemental phosphorus, grain handling and milling (animal feed), gray iron, iron and steel, kraft (sulfate) pulp, lime, petroleum products and storage, petroleum refineries, phosphate fertilizer, primary non-ferrous metallurgy (aluminum, copper, lead and zinc), rubber (tires), secondary nonferrous metallurgy, sulfuric acid, and varnish. Data essential for defining metropolitan areas, emission control standards, and relevant process and air pollution control engineering characteristics required to support the cost analyses for each source and the cost impact on each industrial process are presented and analyzed in separate appendixes to this report. (Author abstract modified)

31518

Gerhold, C. G.

**STATEMENT.** Public Health Service, Washington, D. C., Symp. Environ. Lead Contamination, 1965, p. 109-111. (Dec. 13-15.) NTIS: PB 198104

The technical feasibility of producing an unleaded gasoline, as well as the magnitude of the refining industry s higher investment and operating costs and crude oil requirements, would probably be reflected in the form of increased prices for gasoline sold to the motoring public.

31720

Aalund, Leo

**EPA PINPOINTS REFINING EXPENDITURES.** Oil Gas J., 69(33):40-46, Aug. 16, 1971.

Environmental Protection Agency schedules for removing lead from gasoline could cost refiners from $1.5 to $3.7 billion by 1980. Of the four schedules offered by EPA, the one with the smallest economic impact on the industry is a three-grade0 marketing system: 93 RON low-lead fuel (unleaded after 1973); 94 RON regular grade (zero to three g lead/gal); and 100 RON premium grade (zero to three g lead/gal). In terms of raw materials (butanes, natural gasolines, and crude oil), the schedule will require only a 2.42% increase over a two-grade marketing system with a maximum of three g lead gal. The schedule will require the following capacities (in million b/d) in 1976 and 1980, respectively: crude distillation, 15.2 and 18.5; coking 1.4 and 2.0; cat cracking, 3.6 and 3.6 hydrocracking, 1.1 and 1.6; cat reforming, 3.0 and 3.8; alkylation, 0.9 and 12.; extraction, 1.2 and 1.5; isomerization, 0.1 and 0.1. These requirements compare favorably with those of the two-grade system. The national added cost of the three-grade system over the two-grade would be only 0.22 cent/gal of gasoline in 1976 and 1980.

32241

Sabin, W. W. and R. K. Scales

**EVALUATION OF USE VS. NON-USE OF TETRA-ETHYL LEAD IN GASOLINE.** Public Health Service, Washington, D. C., Symp. Environ. Lead Contamination, 1965, p. 95-108. (Dec. 13-15.) NTIS: PB 198104

Economic aspects of the use of lead anti-knock compounds in gasoline are discussed. Data are presented for the refining industry raw material intake and product distribution for the base case using lead and a case simulating how the industry would be forced to operate if lead anti-knock compounds were unavailable. Raw material prices and product values assumed for this study also are shown. Processing equipment and operating costs for the various types of processing considered in this study are also indicated, as well as the throughput of material for various petroleum-refining processes. Properties of gasolines produced in the lead case and in the case with no lead are shown. The cost of making gasolines approaching the quality of today s gasolines without using lead anti-knocks is estimated to be 2.6 cents/gal for the U. S. refining industry as a whole. This is a 30% increase in the manufactured cost of gasoline.

34370

**PERSPECTIVE.** Chem. Age (New York), 103(2725):11-12, 20, Oct. 8, 1971.

The removal of lead from gasoline should have little long-term effect on the European chemical industry, although ethylene and aromatics prices may fluctuate between 1975-1980. However, the flexibility of European refineries and improvements in reforming technology could allow increased aromatics production at present costs. Demand for naptha as feed for catalytic reformers may result in a slight tightening of supply. For the petrochemicals industry, this will be offset by the reduced value of low octane light naptha likely to be offered to the industry. Reduction in lead levels will create a $50 million/yr market for catalytic exhaust afterburners and also major opportunities for processes and catalysts to produce alternate octane boosting components. Legislation is being enforced or is impending to control or reduce the amount of lead in gasoline in Sweden, West Germany, France, and the USSR. There are still no lead-free fuels on sale in Europe and only a few reduced leaded fuels, as higher-octane and higher-priced products have been the main priority of oil companies.

34828

Culberson, S. Frank, T. E. Ware, Jr., and John R. Dosher

**PRODUCTION OF UNLEADED GASOLINE.** Pace Co. Consultants and Engineers, Houston, Tex., 121p., July 8, 1970. 2 refs. NTIS: COM-71-00566

Increased costs of producing reduced-lead or unleaded gasoline were derived for seven combinations of reduced lead and/or octanes for each of three refining situations: a 200,000 barrels-per-stream-day Gulf Coast refinery; a 15,000 B/SD mid-continent refinery; and an 80,000 B/SD west coast refinery. Economics were also developed for two new refineries producing high yields of present specification gasoline (with lead) and 90 research octane number unleaded gasoline, respectively, in order to determine the cost of producing extra volumes of gasoline that would be needed for certain exhaust emission control strategies, e.g., thermal converters and lower-octane gasoline. In general, the costs of reduced-lead gasoline are lower for the 80,000 B/SD refinery, most expensive in the 15,000 B/SD refinery, and intermediate for the 200,000 B/SD refinery. The amount of aromatics and the motor octane number of unleaded gasoline are important factors affecting cost changes. The high production costs in a small refinery would put small refiners at a severe competitive disadvantage and possibly force some closings.

34970

**AN ECONOMIC ANALYSIS OF PROPOSED SCHEDULES FOR REMOVAL OF LEAD ADDITIVES FROM GASOLINE.** Bonner and Moore Associates, Inc., Houston, Texas, Environmental Protection Agency Contract 68-02-0050, 223p., June 25, 1971. 31 refs. NTIS: PB 201133

A feasibility study was made of gasoline lead removal schedules. Eleven proposal schedules were grouped into two classes, one related to a two-pump marketing system, the other to a three pump system. The feasibility analysis examined approximate capital costs, pool octane numbers, aro-

matics concentrations, prime blending component requirements, and year-to-year rates of increase in gasoline volume times octane. The basic study technique employed linear programming models because of their inherent ability to seek out an economic optimum among the myriad and conflicting choices of equipment selection, operating conditions, intermediate feedstock allocation, and finished product blending.

35391

Dept. of Commerce, Washington, D. C., Technical Advisory Board Panel on Automotive Fuels and Air Pollution

**THE ECONOMICS OF UNLEADED GASOLINE. AN APPENDIX.** 78p., Nov. 1970. NTIS: COM 71-00568

In order to develop raw economic data needed to evaluate various lead control proposals, two independent conclusions were obtained on the economics of increasing refinery octane capacity without lead, from a survey by questionnaire of the refinery industry and from a refinery simulation study using linear programming techniques. Based on these results, a model was constructed to weigh cost functions against legislative demands for unleaded fuel from 1970-1980, to weigh these demands for unleaded fuel on the construction industry, and to assess various marketing factors. The model generated an estimate of the value for total investment required and provided a convenient plot of the decay rates of total lead used nationally in gasoline production for various strategies from 1970-80. The magnitude of the effects of fuel penalties on the over-all economics of lead reduction was also assessed. Results indicate the low cost of producing low-octane low- and unleaded gasolines relative to some industry estimates. In general, these preliminary results identify the three-pump strategy as the most cost-effective in minimizing the impact of a lead reduction program. It also appears that retaining some lead in present regular (94) and premium (100) gasolines in the near term offers distinct advantages in terms of refinery investment demand.

36592

Moore, J. F.

**COSTS OF REMOVING LEAD FROM GASOLINE.** Preprint, American Institute of Chemical Engineers, New York, 14p., 1971. (Presented at the American Institute of Chemical Engineers, National Meeting, 68th, Houston, Tex., March 4, 1971, Paper 77b.)

The costs that will be incurred by the oil industry and consumers if unleaded gasoline becomes the standard automotive fuel are discussed. For a typical refinery, the cost of producing unleaded gasoline will increase by approximately 2.7 cents/gal. This increase is composed of added costs totaling 3.5 cents/gal, partly offset by a saving of .8 cents/gal. The added costs are due to repayment on the investment in new facilities, the added chemicals and utilities for refining at more severe levels, and the added crude oil that must be processed in producing a constant volume of gasoline. Offsetting cost factors are the energy value of by-products that have been downgraded from gasoline quality and the savings in the cost of tetraethyl lead (TEL). Refinery investment to produce quality gasoline without TEL will be about $5.5 billion. Costs for the extra crude oil needed will not increase between 92 and 93 octane but will rise rapidly with higher octane. Distribution costs and gasoline mileage losses will make the total added cost of unleaded gasoline to the consumer 5.7 cents. Assuming that 35 cents/gal is the base price, this is a 15% increase in gasoline costs.

37409

Prescott, James H.

**LEAD-FREE GAS: THE OPTIONS.** Chem. Eng., 79(4):32-34, Feb. 21, 1972.

If the Federal government follows tht least demanding schedule (A) for removal of lead from gasoline, oil companies will have to invest at least $2 billion more by 1980, and motorists will be paying $6.5 billion more annually for gasoline. The most rapid rapid feasible schedule (L) would double the additional investment to $4 billion and force motorists to spend $8 billion more/yr. A 1%/yr higher growth rate in gasoline demand than the 2.8% projected would add $125 million/yr to schedule A and $150 million to schedule L. These estimates do not include the increasing capital investment costs for air and water pollution control on new and existing process units. For new units for lead-restriction schedules, control costs will range from $50-300 million by 1976.

37734

Struth, Bert W.

**THE IMPACT ON THE CPI OF REMOVING LEAD FROM GASOLINE.** Chem. Technol., 2(2):96-97, Feb. 1972.

Although removal of lead from gasoline will affect the refining industry in predictable ways, its consequences will be felt by the chemical industry in ways that are not immediately obvious. The declining expansion rate of natural gas production will mean that petrochemical producers will have to consider alternative feedstocks to ethane and propane for future ethylene plant expansions. While higher liquid recoveries are anticipated, the costs for ethane and propane will increase. An inevitable increase in fuel gas prices above current levels is foreseen. Condensates, paraffinic raffinates from aromatic extraction, and light straight run naphthas will become more plentiful as lead is removed from gasoline. The demand for aromatics and alkylates in lead-free gasolines will put price pressures on these materials. The breakdowns of feedstocks and petrochemical production from steam crackers expected by 1980 are given.

38624

Bonner and Moore, Associates, Inc., Houston, Tex.

**AN ECONOMIC ANALYSIS OF PROPOSED SCHEDULES FOR REMOVAL OF LEAD ADDITIVES FROM GASOLINE.** Office of Air Programs Contract 68-02-0050, Rept. APTD-0703, RGH-015, 224p., June 25, 1971. 31 refs. NTIS: PB 201133

The economic impact of various gasoline removal schedules was investigated. These schedules varied in rapidity of lead removal and in the number of gasoline grades produced. Eleven proposal schedules were grouped into two classes, one related to a two- pump market system, the other to a three-pump system. In all cases one grade of gasoline was required to be lead-free by 1974 to satisfy the needs of any 1975 model cars equipped with exhaust reactors requiring unleaded fuel. The basic research octane level of this gasoline was set at 93 RON. A feasibility analysis, which was required for all eleven schedules, examined approximate capital costs, pool octane numbers, aromatic concentrations, prime blending component requirements, and year-to-year rates of increase in gasoline volume times octane. A preliminary selection was made of the slowest and fastest lead removal schedules for three-grade cases and for two-grade cases. Spot year detailed analysis of all schedules was also determined. A detailed summary of the methodology and the conclusions is included. (Author abstract modified)

39941

Alspaugh, M. L., W. M. Hager, and G. H. Unzelman

**THE IMPACT OF PROPOSED LEAD ANTIKNOCK RESTRICTIONS ON THE NATURAL GAS PROCESSOR.** Natural Gas Processors Assoc., Tulsa, Okla., Proc Nat. Gas Process. Assoc., Annu. Conv., 50th, Houston, Tex., 1971, p. 138-147. 1 ref. (March 17-19.)

The effect of proposed lead antiknock restrictions on the natural gas processor was evaluated by applying linear-programming (LP) models to three refining situations: a natural gas processor who manufactures finished motor fuel; a composite Gulf Coast refinery; and a representative mid-continent refinery. The three situations show the direct effect on the natural gas processor who manufactures motor fuel and the effects on the two areas of the U. S. where the majority of natural gasoline is absorbed by the refining industry. Results obtained from various cases run with the three LP models for current operations and several possible future situations are reviewed in detail. Natural gasoline, particularly the C5-C6 hydrocarbons, would have little value in the manufacture of finished motor fuel using presently available processing techniques; and the petroleum refiner would resort to more severe processing to maintain octane quality and, in so doing, would make more light hydrocarbons.

39956

Stormont, D. H.

**U. S. REFINERS INVESTMENT IN CLEANER AIR SOON TO EXCEED $200,000,000.** Oil Gas J., 63(48):54-68, Nov. 29, 1965.

The results of a survey of the air pollution control efforts of 170 petroleum refineries, representing 90.6% of current U. S. domestic capacity, are summarized, including returns by geographic areas, trends in annual expenditures by types of emissions (sulfur compounds, hydrocarbon combustion and recovery, smoke, particulates, odors, and fumes) for 1956 to 1965, research spending, and overall costs. Total annual spending for air conservation, including marketing and transportation, has been on the order of $21 million for 1961-65 and will exceed $41 million in 1966. The West Coast has the highest control expenditures of any refining district because of the more stringent regulations in force there. Spending for odor and fume control, a lesser category in previous years, will exceed all others during 1966, and expenditures for removing sulfur compounds, after a recent leveling-off, will increase markedly. Built-in controls in the design of new processing units are increasing as well as the number of firms having control programs. The cost implications and control effectiveness of regulations requiring the removal of sulfur from residual fuel oil and the production of lead-free motor fuels are evaluated.

42721

Lieder, W. Donald

**COST AND OTHER EFFECTS OF POLLUTION CONTROL.** Preprint, American Inst. of Chemical Engineers, New York, 18p., 1972. 21 refs. (Presented at the American Institute of Chemical Engineers, North Central Regional Meeting, Cleveland, Ohio, April 28, 1972.)

Cost data and economic criteria indicative of the magnitude of pollution problems are presented. The amount of capital spending in the pollution control field varies among industries, and past spending is cited for the chemical, steel, and petroleum industries and electric utilities. Recent reports indicate that estimates of total capital spending in pollution control are escalating rapidly. Operating and maintaining these facilities is still another expense which must be considered and included in the overall accounting. Costs are indicated for the control of sulfur dioxide, lead-free gasoline, and automobile emissions control. Social costs of environmental action are discussed; unemployment, disease, and famine are mentioned. The fact is that the public will ultimately pay these costs, in higher taxes or higher prices.

# K. STANDARDS AND CRITERIA

02580

**MAXIMUM PERMISSIBLE CONCENTRATIONS OF HARMFUL SUBSTANCES IN ATMOSPHERIC AIR POPULATED PLACES.** (Predel' no dopustimye kontsentratsii vrednykh veschestv v atmosfernom vozdukhe naselennykh mest.) Hyg. Sanit. 29, (5) 166-8, May 1964. CFSTI: TT65-50023/5

A list of maximum permissible concentrations of harmful substances in the atmosphere of populated areas in the USSR, as of June 20, 1963.

03007

**CALIFORNIA STANDARDS FOR AMBIENT AIR QUALITY AND MOTOR *VEHICLE EXHAUST (TECHNICAL REPT.)* California State Dept. of Public Health, Berkeley. 1959. 129 pp.**

The salient points in the table of contents are: I. The standards and their significance. II. Technical bases for standards for the quality of ambient air. III. The technical bases for motor vehicle exhaust standards. In establishing the standards, an attempt was made to determine what effects the various pollutants were known to have at various levels of concentration on human health and confort, on animals, and plants, and on visibility. The resulting air quality standards together with data concerning motor vehicle emissions and their reactions then became the bases for motor vehicle exhaust standards. The air standards do not establish a fine line below which is good air and above which is bad air. They indicate the approximate point at which air under some circumstances may produce undesirable effects.

03956

**RECENT DEVELOPMENTS IN ATMOSPHERIC POLLUTION.** Inst. Petrol. Rev. (London), 20(236):273-276, Aug. 1966.

This article reviews what is being done to combat the problem of atmospheric pollution on a world-wide basis. The findings indicate that a reduction in carbon monoxide from gasoline engines and smoke from diesel engines would improve the purity of city air. The WHO has expressed concern about the emission of lead compounds from road vehicles. The Cooperative European Council has formed a Fuels Committee and one of the first problems being considered is atmospheric pollution.

06734

**COMMONWEALTH OF PENNSYLVANIA, DEPARTMENT OF HEALTH, AIR POLLUTION COMMISSION, AMBIENT AIR QUALITY CRITERIA.** 90th Congress 'Air Pollution--1967, Part IV (Air Quality Act)' Senate Committee on Public Works, Washington, D.C., Subcommittee on Air and Water Pollution, May 15-18, 1967.) p. 2396-7.

Ambient air quality criteria are tabulated as set forth in section 5 (f) (8) of the Pennsylvania Air Pollution Control Act of January 8, 1960, P.L. 2119. These criteria were adopted on April 25, 1967 by the Air Pollution Commission. Included in the tabulation are: particulates, lead, beryllium, fluorides, sulfur dioxide, carbon monoxide, and others. References are provided for the sampling and analytical methods employed for each pollutant.

06778

**(INDUSTRY AND ATMOSPHERIC POLLUTION IN GREAT BRITAIN.) Industrie et pollution atmospherique en Grande Bretagne. Centre Interprofessionnel Technique d'Etudes de la Pollution Atmospherique, Paris, France. (1967.) 6 pp. Fr. (Rept. No. CI 310.) (C.I.T.E.P.A. Document No. 24.)**

A summary of the basis of governmental action in Great Britain in the struggle against industrial emissions is outlined. The regulations imposed by the 'Alkali Act' are in most cases based on 'the most practical means.' Standards are given for chimney heights. Statutory limits are given for various materials emitted such as hydrochloric acid, sulfuric acid, nitric acid, hydrogen sulfide, chlorine, arsenic, antimony, cadmium, and lead. The construction of tall buildings tends to reduce the benefits obtained by tall chimneys. A better knowledge of the effects of pollutants should be obtained so as not to burden industry with unnecessary expense in their control. It is urged that international standards for emission be adopted.

08420

Brodovicz, Bey A.

**AIR QUALITY CRITERIA FOR PENNSYLVANIA.** J. Air Pollution Control Assoc., 18(1):21-23, Jan. 1968. 4 refs.

In late 1965 the Pennsylvania Air Pollution Commission appointed a Council of Technical Advisors to develop air quality criteria. Recently this Council set forth its recommendations for ten pollutants. The philosophy of the Council is expressed. The major difficulties and rationale are mentioned. The recommendations are given and the potential use of the criteria is also explained. The establishment of firm guidelines of air quality is based solely on consideration of effects both on health and aesthetics. The criteria are broken into two distinct groups; air basin average and single point measurement. The pollutants included: 1. Suspended particulates (total), 2. Settled particulates (total), 3. Lead (tentative), 4. Beryllium, 5. Sulfates (as H2SO4), 6. Sulfuric acid mist, 7. Fluorides (total soluble, as HF), 8. Sulfur dioxide, 10. Oxidants, 11. Hydrogen sulfide, and 12. Carbon monoxide.

08803

Hunigen, E., and W. Prietsch

**PROBLEMS AND METHODS OF SOLUTION OF ELIMINATING NOXIOUS SUBSTANCES FROM INTERNAL COMBUSTION ENGINES.** ((Probleme und Losungswege der Schadstoffbeseitigung bei Verbrennungsmotoren.)) Translated from German. Technik, (Berlin), 21(6):377-383, June 1966.

The composition of exhaust from internal combustion engines is discussed. Maximum permissible concentrations of harmful components are tabulated for five countries with standards for the following substances: hydrocarbons (benzene, etc.), aldehydes (formaldehyde, etc.), carbon dioxide, sulfur oxides, nitrogen oxides, lead (and tetraethyl lead), mineral oil mist, and carbon. Some equipment for the measurement of air pollutants is touched upon, including a description of an East German continuous sampling apparatus for hydrocarbons, CO, CO2, and O2.

09259

Katz, Morris

**RECENT DEVELOPMENTS IN AMBIENT AIR QUALITY GUIDES IN RELATION TO CONTROL OF ATMOSPHERIC EFFLUENTS.** Pulp Paper Mag. Can. (Gardenvale), 69(4):60-66, Feb. 16, 1968. 11 refs. (Presented at the 3rd Paper Industry Air Stream Improvement Conference, Vancouver, B.C., Oct. 23-26, 1967.)

Major sources of air pollutants are discussed, as well as the need for control of emissions using source emission standards and ambient air quality criteria. Criteria for air quality reflect the nature and magnitude of effects of air pollutants upon the atmospheric environment in general and on visibility, safety, health of man or animals, vegetation and property. These criteria state four levels of pollutant concentration and exposure periods according to the differing effects on the exposed population or receptors, rangin from no direct or indirect influence to symptoms that may be merely adverse, or serious, or of emergency proportions. Ambient air quality guides and standards adopted by several countries are tabulated for CO2, CL2, ethylene, HCl, H2S, oxides of nitrogen, ozone or oxidant, CS2, and SO2. Those of the State of California, State of New York, West Germany, Czechoslovakia, U.S.A., and the U.S. S.R., are reviewed. Air quality standards established in the U.S.S.R. are more stringent than those formulated in West Germany, the U.S.A. (California), and elsewhere. Maximum allowable concentrations for some atmospheric pollutants (industrial) in the U.S.S.R. are also tabulated, including As, CrO3, Pb, Mn, and soot. A brief summary is given of Canadian activities and the salient features of the Ontario Air Pollution Control Act. The existence of these standards implies that stricter measures will be enforced to control emission sources in the future.

11746

G. J. Stopps

**AIR QUALITY CRITERIA -- LEAD.** (Presented at the Symposium on Air Quality Criteria, June 5, 1968.) J. Occupational Med., 10(9):550-564, Sept. 1968. 50 refs.

The Goldsmith-Hexter regression line indicates that an air level of 10 microgram Pb/cu m leads to a blood level of about 34 microgram %, which corresponds to that normally found in urban communities and is not considered hazardous to health. In the ICRP lung dynamics model, assuming an acceptable pulmonary retention dose of 0.3 mg Pb, the highest acceptable air concentration can be calculated to be 18 microgram. Studies on humans and rats have also indicated that air levels of up to 10 microgram Pb/cu m produce no increase in bone levels and have no harmful effects; in fact, a level of 15.6 microgram Pb/cu m failed to produce an increase in bone levels in rats when the atmosphere was irradiated with ultraviolet. On the basis of these data, 10 microgram/cu m is recommended as a conservative air quality standard for Pb, although the need for such a standard at this time is doubted. Biological monitoring of delta-aminolevulinic acid urine levels is suggested as a convenient way of detecting lead toxicity in human populations.

14443

Knop, W.

**AIR POLLUTION CONTROL IN NON-FERROUS METAL INDUSTRIES. II. PARTICULATE AND GASEOUS EMISSIONS OF THE NON-FERROUS METAL INDUSTRY AND EMISSION STANDARDS.** (Luftreinhaltung im NE-Metall-Betrieb. II. Staub-und gasfoermige Emissionen der NE-Metallindustrie und die Emissionsbegrenzung.) Text in German. Metall., 22(12):1266-1271, Dec. 1968. 21 refs.

In this review article, the West German air pollution laws and regulations as applied to metallurgical plants are compiled and discussed. In the aluminum industry, dust arises both in the production of aluminum oxide from bauxite and in the electrolytic furnaces. The most dangerous component of the waste gas is fluoride of which the maximum allowable concentration is 2.5 mg/cu m. Lead refineries emit considerable amounts of dust, up to 15 g/cu m waste gas, which contains metal compounds in the form of sulfates, oxides, sulfides, and coke dust. The pollutants originating in the various steps of lead production are discussed in detail. The threshold limit value (TLV) of lead is 0.2 mg/cu m. Electrometallurgical furnaces for iron and steel alloys emit very fine dusts (less than 0.4 micrometer), typically up to 250 kg/hr at 10,000 kva capacity. Metal oxides predominate, especially iron and silicon oxides. The waste gases of copper ore refineries contain mostly fly dust and sulfur compounds. The dust contains copper, zinc, and sulfur. Typical concentrations at various stages are listed. The TLV of copper is 1 mg/cu m. Emissions of zinc plants are listed, and waste gas and soot emissions of oil, coke, and coal furnaces are discussed in detail. Special problems are posed by scrap metal refineries, where plastics and varnishes cause air pollution. Typical examples are cited.

16104

Zielhuis, R. L.

**PERMISSIBLE LIMITS FOR INORGANIC LEAD IN INDUSTRY.** T. Soc. Geneesk., 47(22-31):743-748, Oct. 1969. 12 refs. (Presented at the 11th Congress of Occupational Hygiene, Ustinad Lembam, Czechoslovakia, June 1969 and the 16th International Congress of Occupational Health, Tokyo, Japan, Sept. 1969.)

At a conference held in The Netherlands, November 28-29, 1968, permissible limits were established for inorganic lead by the Subcommittee on MAC Values in Industry of the Permanent Commission of the International Association of Occupational Health. Some conclusions of this conference are discussed: the relationship between concentration in air and biochemical parameters; permissible limits for concentration in air and for biochemical parameters; and the possibility of chronic sequelae. Permissible limits of lead in the blood (PbB) are 70 micrograms/100 ml. Permissible limits for concentration in air are 150 micrograms/cu m for a 40 hr wk. Other limits are PbU, 130 micrograms/1; ALA, 10 micrograms/1; and CPU, 300 micrograms/1. The conference concluded that lead poisoning affects physical, mental, or social wellbeing. The possible responses to lead are classified as acceptable, excessive, or dangerous. In an acceptable response, absorption is below permissible limits when poisoning does not occur. In an excessive response, absorption is above permissible limits where poisoning may occur. Absorption in a dangerous response is above permissible limits where poisoning is likely to occur or already exists. It is suggested that standards preventing the occurrence of episodes among workers will prevent long-term sequelae even after many years of continual exposure.

16128

Zielhuis, R. L.

**PERMISSIBLE LIMITS FOR INORGANIC LEAD IN INDUSTRY.** (Pripustne hodnoty testu pro anorganiske olovo v prumyslu). Text in Czech. Pracovni Lekar. (Prague), 21(9):396-400, Sept. 1969. 10 refs.

An international occupational health group organized a conference to determine permissable limits for inorganic lead in industry. The following limits were set for a 40-hr week: 70 micrograms of lead per 100 ml of blood; 130 micrograms of blood per liter of urine; 10 mg of delta-aminolevulinic acid per

liter of urine; 300 micrograms of coproporphyrine per liter of urine; and 150 micrograms of lead per cu meter of air. Because of the wide confidence limits of the calculations, no undue emphasis should be placed upon a sigle test result. These standards prevent the occurrence of poisoning episodes among adult industrial workers and also prevent long term poisoning even after years of continual exposure. (Author summary modified)

16808

Kehoe, Robert A.

**TOXICOLOGICAL APPRAISAL OF LEAD IN RELATION TO THE TOLERABLE CONCENTRATION IN THE AMBIENT AIR.** J. Air Pollution Control Assoc., 19(9):690-703, Sept. 1969. 22 refs.

A review, with extended discussion, of the tolerable concentration of lead in the ambient air is presented. The principal contributions to the literature with respect to the behavior of lead and its inorganic compounds are reviewed. Four major points discussed are: The body burden of Pb in the general population of the U. S.; the disposition of airborne Pb compounds in the human respiratory tract; chemical evidence indicative of approaching or impending danger from the absorption of Pb compounds; and unusual susceptibility to the absorption of Pb at low rates. (A discussion by Harriet L. Hardy is presented at the conclusion of the document.)

18294

Gerhardson, G.

**EXHAUST GASES FROM GASOLINE POWERED VEHICLES.** (Avgaser fran bensindrivna bilar.) Text in Swedish. Kommunikationsdepartmentet ledningsgrupp rorande utvecklingsarbete pa bilavgasomradet, 112p., 1968. 51 refs.

The investigation deals with the occurrence and effects of automotive exhaust smoke, statistical information, trends of development, emission of air pollutants from gasoline fueled automobiles, and available methods to reduce the emissions. The purpose of the survey is to supply information to the Swedish government about air pollution problems from gasoline powered vehicles. The investigation is ended with proposals for reducing the lead content of gasolines. The substances dealt with are carbon monoxide, hydrocarbons, odorous and irritating substances, oxides of nitrogen, and particulates among which lead compounds are discussed. Measurements and calculations show that the pollution level on heavily trafficked streets normally does not reach levels which cause acute health effects by the separate substances. Uncertainty exists concerning synergistic and long- term-exposure effects. Bad odor and soiling are evident inconveniences from auto exhaust gases. Photochemical smog, however, has not occurred in Sweden. The suggested standards by the Guidance Group are 45 grams of carbon monoxide and 2.2 grams of hydrocarbons per dilometer. Corresponding average values are 30 grams carbon monoxide and 1.5 grams of hydrocarbons per kilometer, which means that the emissions will be reduced by about 40 per cent of the present level. For the model year 1973 the group considers that technical development has made it possible to tighten the standards. Sixty per cent reduction of the carbon monoxide and 50 per cent of the hydrocarbons should then be possible. After two more years, in 1975, it should be possible to obtain 70 per cent reduction of the carbon monoxide and 60 per cent of the hydrocarbons.

19750

Pennsylvania State Dept. of Health, Harrisburg, Air Pollution Commission

**PENNSYLVANIA AMBIENT AIR QUALITY STANDARDS.** 6p., Oct. 20, 1969. 10 refs.

Annual, 30-day, 24-hr and/or 1-hr air quality standards are given for 12 pollutants (suspended and settled particulates, lead beryllium, sulfates as H2SO4, sulfuric acid mist, fluorides as HF, sulfur dioxide, nitrogen dioxide, oxidants, hydrogen sulfide, and carbon monoxide) in accordance with the requirements of the Pennsylvania Air Pollution Control Act of 1960. These standards, which will be reviewed at least once a year, are for single-point measurements; they represent minimum, and not necessarily desirable quality. The 24-hr standard for SO2 is 0.10 ppm; for suspended particulates, 195 micrograms/cu m. An antidegradation policy is stated to the effect that where present air quality is significantly higher than the established standards, the difference will be conserved, based on a long range forecast of probable land and air uses in areas of high air quality. Sampling and analytical procedures to be employed for measuring ambient levels are specified for each of the 12 pollutants.

20121

**RECOMMENDATIONS OF PERMISSIBLE CRITERIA OF HAZARDOUS WORKING ENVIRONMENTS BY JAPAN ASSOCIATION OF INDUSTRIAL HEALTH.** 1969. Sangyo Igaku (Jap. J. Ind. Health), 12(2):37-44, Feb. 20, 1970. 15 refs.

The Japanese Association of Industrial Health annually recommends permissible concentrations of toxic gases, vapors, mist, and fumes in the working environment. The 1969 limit values for 86 toxic substances are shown in ppm and/or mg/cu m. Like the Threshold Limit Values established by the American Conference of Governmental Industrial Hygienists (ACGH), the concentrations are time-weighted average concentrations for an eight-hour working day. The table cannot be applied to works where exposure to toxic substances is extremely irregular or short-term. The limit values for butyl acetate, buty alcohol, carbon monoxide, p-dichlorobenzene, ethylene glycol dinitrate, nitrobenzene, hexane, selenium compounds, lead, nitric acid, styrene monomor, toluene, 1,1,1-trichloroethane, and trichloroethylene differ from those of the ACGH. Factors affecting the Japanese decision are discussed in the case of hexane, lead, styrene monomor, and toluene. The article also reviews permissible criteria for noise exposure, thermal standards for high-temperature work, and permissible dust concentrations.

22223

Stoefen, D.

**THE VALIDITY OF THE SOVIET MIK-VALUE FOR LEAD.** (Die Begruendung des sowjetischen MIK-Wertes fuer Blei). Text in German. Arch. Hyg. Bakteriol. (Munich), 152(1):93-96, 1968. 6 refs.

The Soviet MIK value for lead was fixed on the basis of a study published in 1952. It was aimed at avoiding lead accumulation in the organism. Considerably fluctuating figures concerning the lead balance must be used. Subsequent reflexological and physiological tests were published in 1960 and 1961 respectively. In animal tests, 0.00278 and 0.0025 mg/cu m lead dust (daily mean value) were found, as well as changes in the period of latency to optical and acoustical stimuli, changes in the motor reflexes, and coproporphyrin excretion and morphological changes in the cerebrum and the spinal cord. Children had a considerably increased coproporphyrin excre-

tion at a daily 8-hour lead exposure of 0.00102 mg/cu m in the vicinity of factories. The Soviet MIK value for lead (0.0007 mg/cu m) is confirmed; the Soviet MAK value for lead (0.01 mg/cu m) is fixed too high. (Author abstract modified)

24107

Habibi, K., E. S. Jacobs, W. G. Kunz, Jr., and D. L. Pastell

**CHARACTERIZATION AND CONTROL OF GASEOUS AND PARTICULATE EXHAUST EMISSIONS FROM VEHICLES.** Preprint, Air Pollution Control Assoc., Los Angeles, Calif., West Coast Section, 33p., 1970. 24 refs. (Presented at the Air Pollution Control Assoc., West Coast Section, Technical Meeting, 5th, San Francisco, Calif., Oct. 8-9, 1970.)

Work done on the characterization of the particulate matter contained in vehicle exhaust and on the development of systems to control, simultaneously, both gaseous and particulate emissions is described. A total exhaust control system comprising exhaust manifold thermal reactors, exhaust gas recirculation, and particulate traps has been developed. Using present-day leaded gasolines, this system controls hydrocarbons, carbon monoxide, nitrogen oxides and exhaust particulate emissions to levels below those proposed for 1975. The system also markedly reduces levels of polynuclear aromatic hydrocarbons and 'tar' in the exhaust. The exhaust particulate trap system reduces lead particulate emissions to 0.03 gram per mile. Such a system, replacing the conventional exhaust system of the vehicle, provides a tenfold reduction of lead particulate emissions. Equipment and techniques have been developed for the characterization and measurement of particulate emissions from vehicles. These techniques are applicable to a study of the solids emitted in the exhaust, such as lead salts, rust and soot. They also are applicable to the determination of the carbonaceous materials, including emitted tars and polynuclear aromatics. Average cars emit about 0.3 to 0.5 gram per mile of filterable particulate material and 0.8 to 1.0 grams per mile of 'tar'. Lead salts account for 0.25 to 0.35 gram per mile of filterable particulate. Over half of the lead salts emitted is associated with particles of greater than 9 micron equivalent diameter, which settle very rapidly in the atmosphere. Under consumer, motorist-type driving conditions, the use of unleaded gasoline will not lower exhaust particulate emission levels to the proposed level of 0.10 grams per mile for 1975. Levels of 0.15 to 0.25 gram per mile of filterable exhaust particulates have been observed with a conventional car operating on unleaded gasoline. Furthermore, there is some suggestion that the use of unleaded gasoline could adversely affect atmospheric visibility and increase 'soiling.' (Author summary modified)

30035

Viland, C. K.

**UNLEADED GASOLINE AND SMOG-FREE AUTOS--HOW AND WHY.** Mines Mag. (Denver), 60(8);6-10, Aug. 1970.

Since 1963, following California s earlier regulations, all new cars sold in the United States were required to have positive crankcase ventilation control. After California imposed limits on carbon monoxide and on unburned hydrocarbons exhausted, these were made mandatory nationwide. The same situation applied to evaporation control and will apply to emissions of oxides of nitrogen. Emissions standards projected to 1975 are summarized. Temperature inversions and smog are mentioned. Future emission control devices comprise recycling, lower compression ratios, improved exhaust gas reactors, ammonia injection, fuel injection, and catalytic mufflers. Lead additives and the effect of eliminating them are reviewed. The manufacture of high octance lead free gasoline is described. Alkylation plants, catalytic hydrodesulfurization, catalytic reforming, and catalytic hydrocracking are cited. Alternative power sources are mentioned.

30069

Plassmann, Eberhard

**IT BEGAN WITH THE SMOG IN CALIFORNIA. CALIFORNIA TEST, EUROPEAN TEST--INTERNATIONAL REGULATIONS OF AUTOMOBILE EXHAUST GAS EMISSIONS.** (Mit dem kalifornischen Smog begann es. Kalifornien- test, Europatest--Internationale Automobilabgas-Reglements). Text in German. Umwelt (Duesseldorf), 1(2):26-30, 1971. 13 refs.

Automobile emissions can be divided into emission from crank case ventilation, emission from evaporation losses (in both cases hydrocarbons are emitted), and emission of carbon monoxide, nitrogen oxides, sulfur oxides, and lead compounds in exhaust gas. Automotive emissions limits have been introduced for the first time in California. To determine the composition of the exhaust gas at the various operating cycles, the California test was worked out. This test comprises seven phases and simulates operating conditions for typical drive through Los Angeles and its suburbs on a dynamometer. The program begins with a cold start. Concentrations of CO, C6H14 for the unburned hydrocarbons, carbon dioxide, and nitrogen oxides are recorded continuously. In 1966, the CO concentration was limited for Otto engines to 1.5% by volume and to 0.275% by volume of unburned hydrocarbons. Further reduction of these limit concentrations are stipulated for the years 1972 to 1974. West Germany has also imposed limits on automotive emissions; the CO concentration of warm engines cannot exceed 4.5%; the hydrocarbon emission cannot exceed 0.15% of the fuel consumption during the test operation. The various European governments are attempting to bring their national legislation in harmony with that of other countries.

33107

**EXPLANATION OF DUST ETC. DISCHARGE STANDARD AS IN AIR POLLUTION CONTROL LAW ENFORCEMENT REGULATIONS.** (Taiki osen boshiho seko kisoku ni miru baijinto no haishutsu kijunchi no kaisetsu). Text in Japanese. Kogai To Taisaku (J. Pollution Control), 7(7):588-590, July 1971.

In Japan, the emission standard for sulfur dioxide is based on diffusion formulas, according to a system of area allocations. The country is divided into eight ranks which represent from between 0.020 and 0.045 ppm maximum ground concentration of SO2, depending upon the degree to which the area has been industrialized. Old facilities must be equipped with electrostatic precipitators, bag filter, multicyclones, or other dust collection equipment, while even stricter standards exist for newly constructed buildings. Even in areas where fuel consumption will double, air pollution levels are to be reduced one-third their present amount in five years. If necessary, more rigid standards may be applied by prefectural governments. Emission standards exist for cadmium, chlorine, hydrogen chloride, fluorine, hydrogen fluoride, lead, and other harmful substances. Standards for fuels also exist, so that they cannot have a sulfur content higher than 1.0-1.5%.

33730

Parkinson, G. S.

**LEAD IN GASOLINE. 3--UK LEVELS.** Petrol. Rev., 25(296):289-290, Aug. 1971.

The lead levels and octane numbers for motor gasoline for each year between 1960 and 1970 are tabulated, derived from

information by suppliers who are responsible en masse for about 90% of gasoline sales in the United Kingdom. Annual UK sales for each grade of gasoline and the average lead levels for all UK sales of the various grades for the period 1960-1970 are included. Since the appearance of BS 4040 Specification for Petrol for Motor Vehicles in 1967, no product sold in the UK has had a lead content in excess of 3.8 g/imperial gal.

34063

Ministry of International Trade and Industry (Japan) Dept. of Thermal Power

**THE CONTENT OF AIR POLLUTION CONTROL LAW REVISIONS AND THEIR APPLICATIONS FOR ELECTRIC WORKS.** (Taikiosen boshiho kaisei no naiyo to denki kosakubutsu ni okeru unyo). Text in Japanese. Karyoku Hatsuden (Thermolelectric Power Generation), 22(10):1107-1113, Oct. 1971.

The 1970 revisions of public nuisance related laws are discussed with regard to purpose, content, application, and enforcement. The range of toxic pollutants was expanded to include cadmium and its compounds, chlorine and hydrogen chloride, fluorine and hydrogen fluoride, bromine fluoride, lead and lead compounds, and nitrogen oxides. Boilers using gases containing more than 0.1% sulfur content, coke furnaces, mineral depositories, mineral conveyors, crushers, graters, and sifters were added to the list of soot and dust creating facilities. Hydrocarbons, lead compounds, and nitrogen compounds were added to the list of toxic automotive emission gases. Emission standards are determined as before by the K figures obtained by the stack gas dispersion formula; but the entire country was divided into classifications according to various K values ranging from 11.7 to 26.3 (maximum allowable concentration of sulfur oxides 0.020 - 0.045 ppm). Soot and other dust particulate emission standards were revised on a large scale. Among electric power generator boilers, heavy oil and gas boilers were classified into three groups: Maximum allowable emission is 0.1 g/N cu m for boilers with more than 200,000 N cu m/h capacity; 0.2 g/N cu m for boilers between 40,000 and 200,000 N cu m; and 0.3 g/N cu m for boilers with less than 40, 000 N cu m/h capacity. These compare with the former 1.0 g/N cu m uniform standard. For low grade coal boilers, the maximum allowable concentration is 0.8 g/N cu m, and for high grade coal boilers, 0.4 g/N cu. Sulfur oxides standards and toxic pollutant emission standards are reviewed by tables.

34377

**COMMENTARIES ON NEW EMISSION STANDARDS BY THE REVISED AIR POLLUTION CONTROL ACT.** (Taiki osen boshiho kaisei ni yoru shin ha ishutsu kijunchi to (shiko kisoku no) setsumei). Text in Japanes. Netsu Kanri (Heat Management and Pollution Control), 23(10):54-57, Oct. 1971.

The maximum allowable concentration of suspended particulates has been greatly reduced by the revised air pollution control act. New emission standards are one third to one tenth of the previous standards in the general categories, and one sixth to one twentieth in special categories. The maximum land surface concentration of sulfur oxide content for the special category area is 0.009 ppm and includes areas where the annual average of suspended particulate concentration is more than 0.15 mg/cu m. In the areas where fuel regulations apply, local ordinances are to set respective standards taking into consideration the areas fuel consumption and seasonal variations. However, the sulfur content of these fuels during combustion is to be within the range of 1.0 to 1.5%. Coke furnaces, mineral depositories, conveyors, crushers, and pulverizer sieves must have dust collection devices, water sprays, and dust cover hoods. Emission standards for sulfur oxides in general and special areas, dusts, and toxic materials such as cadmium, cadmium compounds, chlorine, hydrogen chloride, fluoride, hydrogen fluoride, potassium fluoride, lead, and lead compounds are given by tables.

36346

California Air Resources Board, Sacramento

**LEAD.** In: Proposed Revisions of and Addition to the Ambient Air Quality Standards, p. 1, 16-19, Oct. 21, 1970. 7 refs.

An ambient air quality standard for lead in California is considered for adoption for the first time, as a result of the 1970 annual review of the air quality sections of the State s Health and Safety Code. A maximum of two micrograms/cu m averaged over a 30-day period (and a long-term goal of 1.5 micrograms/cu m averaged over 24 hours) is proposed on the basis of recommendations by the State Department of Public Health because of evidence that at or above such exposures, increased storage of lead will produce detectable metabolic effects. The consequences of such effects are not at present clearly defined but may include a restriction on hemoglobin available to the body for red blood cell functions. Other possible or known effects of high ambient lead levels are noted.

36382

Larsen, Ralph I.

***DETERMINING SOURCE REDUCTION NEEDED TO MEET AIR QUALITY STANDARDS.*** International Union of Air Pollution Prevention Associations, Intern. Clean Air Congr. Proc., London, England, 1966, p. 60-64. 5 refs. (Oct. 4-7, Paper III/8.)

The use of standards and pollutant concentration data to determine the source reduction needed to comply with the standards is examined. The techniques consider concentrations as a function of time and space; degrees of pollutant control necessitated by the standards; background concentrations; secondary pollutants; source type; and mathematical models for predicting pollutant concentrations as a function of source strength, location, and meteorology. Concentration of carbon monoxide, nitrogen oxides, nitric oxide, nitrogen dioxide, oxidants, hydrocarbons, sulfur dioxide, lead, particulates, and sulfates are given for several American cities.

36823

Ministry of Health and Welfare (Japan), Dept. of Environmental Health

**EMISSION STANDARDS OF STACK GASES (TOXIC MATERIALS) BASED ON THE AIR POLLUTION CONTROL LAW.** (Taiki osen boshiho ni motozuku baien (yugai busshitsu) no haishutsu kijun ni tsuite). Text in Japanese. Taiki Osen Nyusu (Air Pollution News), no. 67:3-39, Nov. 1971.

Emission standards for various toxic materials in stack gases, based on the Air Pollution Control Law, are presented in tables. Items reviewed are the dust emission standard; average emissions and dust collection rates according to various types of furnaces and various types of dust creating installations; standards and average emissions for settling particles, suspended particulates, chlorine, and fluorides; and the epidemiological study of the influences of fluorides. The Japanese Air Control Law, WHO indexes, Forecast and Warning systems of New York City, the United States National Primary Secondary Ambient Air Quality Standards Federal Register, Air Pollution Emergencies Episode Criteria, and the

E.P.A Federal Register are included. Also included in table forms are the records of Tokyo air pollution monitoring stations on suspended particulates; total emission quantity by pollutants and by sources; carbon monoxide saturation of hemoglobin and symptoms; influences on the human body of various toxic matter such as sulfur dioxide, sulfuric acid mist, nitrogen dioxide, ozone, and suspended particulates; nitric oxide and NO2 concentration in Tokyo; emission standards for lead and lead compounds; a review of lead emitting industries; total dust particles and the lead content in the main cities of Japan; lead emission standards in various countries, and the 1969 SO2 measurements in various controlled areas in Japan.

38197

Ministry of Health and Welfare (Japan), Public Nuisance Section

**STANDARD OF SOOT AND DUST EMISSION (INJURIOUS SUBSTANCES) BASED ON AIR POLLUTION CONTROL LAW.** (Taikiosen boshiho ni motozuku baien (ugai bussitsu) no haishutsu kijun ni tsuite). Text in Japanese. 69p., May 1971.

Standards of emission of soot and dust, cadmium and its compounds, chlorine and hydrogen chloride, fluorine and its compounds, and lead and its compounds are discussed. The emergency contamination level is mentioned. A summary of the report of the experts conference on the criterion of soot and dust emission includes standards of emission for newly established or existing facilities, the characteristics and collection rate of soot and dust at different emission sources, the consumption of fuel, the amount of soot and dust at six prefectures in 1969, and the standard of emission from the special facilities provided by ordinance. Concentrations in the air, effects on man, the standard value of concentrations in the ambient air or standards of emission were discussed fro Ca, Cl, HCl, F, and Pb. Emergency measures and alarm systems during an emergency in Los Angeles and New York discussed with relation to the Air Pollution Control Law.

38758

**EPA LIKELY WON T DELAY LEAD-OUT TARGET.** Oil Gas J., 70(3):56, 58, 59, Jan. 17, 1972.

Refiners appear to stand little chance of getting a 1-year reprieve in the planned requirement to remove lead from the grade of gasoline by July 1, 1974. An unleaded regular grade of gasoline will be needed, according to the Environmental Protection Agency, to acheive a 90% reduction in emissions of hydrocarbons and carbon monoxide from new autos. EPA believes that the virtually pollution-free car can be achieved only by use of catalytic mufflers, and the mufflers will not work with leaded gasoline, which poisons the catalyst. Evaluation of the prospects for meeting the emissions deadline concluded that the necessary technology was not available. Delay consequences, emissions of nitrogen oxides reduction, and alternative engines are mentioned. The stratified-charge and Wankel engines have been suggested as possibilities for meeting 1975 emission standards.

41682

Ryazanov, V. A. (ed.)

**MAXIMUM PERMISSIBLE CONCENTRATIONS OF NOXIOUS SUBSTANCES IN THE ATMOSPHERIC AIR OF POPULATED AREAS.** In: American Institute of Crop Ecology Survey of USSR Air Pollution Literature. A Second Compilation of Technical Reports on the Biological Effects and the Public Health Aspects of Atmospheric Pollutants. M. Y. Nuttonson (ed.), Vol. 11, Silver Spring, Md., Qmerican Institute of Crop Ecology, 1972, p. 1-5. Translated from Russian. (Also Izv. Akad. Med. Nauk SSSR, vol. 11:201-204, 1968.) NTIS: PB 209478

The maximum allowable concentrations approved by the Assistant Chief Public Health Physician of the USSR are listed. Maximum single and mean daily concentrations of 94 noxious substances are presented, including standards for nitrogen dioxide, aldehydes, aromatic and aliphatic hydrocarbons, ketones, ammonia, organic nitrogen compounds, alcohols, phosphorus compounds, organic and inorganic acids, vanadium compounds, sulfur and organic sulfur compounds, manganese compounds, cyanates, arsenic compounds, chlorinated hydrocarbons, mercury compounds, soot, lead compounds, nontoxic dusts, sulfur dioxide, carbon monoxide, fluorine compounds, chlorine compounds, gasoline, and chromium compounds. Concentration limits for specific combinations of substances are also described.

42039

Japan Environmental Agency, Tokyo, Bureau of Atmospheric Safety

**STRICT LOCAL EMISSION STANDARDS BASED ON AIR POLLUTION CONTROL LAWS.** (Taiki osen boshiho ni motozuku uwanose haishutsu kijun joreishu). Text in Japanese. Sangyo Kogai (Ind. Public Nuisance), 8(6):34-50, June 1972.

Japanese local emission standards, based on air pollution control laws are discussed. By 1972 there were 13 Prefectures in which these standards were applied. New standards are given for cadmium, fluorine, lead, chlorine, hydrogen chloride, and dust. The Prefectures are Akita, Fukushima, Ibaragi, Gun-ma, Saitama, Kanagawa, Toyama, Mie, Osaka, Nara, Okayama, Ehime, and Niigata. The new standards were applied to hydrogen fluoride and silicon fluoride.

42118

Chovin, P.

**AUTOMOBILE POLLUTANTS AND THE URBAN AIR QUALITY.** (Les polluants de l automobile et la qualite de l air des cites). Text in French. Pollut. Atmos. (Paris), 14(54):172-176, April-June 1972.

Current and future automotive emission standards are reviewed, and the activity of the Central Laboratory of the Paris Police Headquarters in the exhaust monitoring area is described. Results of carbon monoxide, nitrogen dioxide, and lead concentration measurements performed in Paris in 1971 are presented. Systematic measurements will also cover suburbs as of 1972. New exhaust emission standards, according to the European cycle specifications, will become effective in October 1972, and further reductions of 20% and 10% in the CO and hydrocarbon emissions will be expectedly imposed in 1972. The imposition of air quality standards has been suggested. Despite the increase in the number of automobiles and the traffic density, particularly in suburban zones, the 1985 emission levels will not exceed the present day values due to the reduction of the specific emissions.

43312

Caretto, L. S. and R. F. Sawyer

**THE ASSIGNMENT OF RESPONSIBILITY FOR AIR POLLUTION.** Preprint, Society of Automotive Engineers, Inc., New York, 7p., 1972. 12 refs. (Presented at the Automotive Engineering Congress, Detroit, Mich., Jan. 10-14, 1972, Paper 720165.)

A simple method of weighting emissions data to provide a relation between source mass emissions and the resulting impact on air pollution is proposed. The importance of the following factors are considered: chemical severity of the pollutant species, source effectiveness, population exposure, and area severity. The selection of these factors is described with particular attention to the obtaining of chemical severity factors from air quality standards. Qualifications upon the use of this weighting scheme are outlined. Application to the Los Angeles and San Francisco Bay areas show that weighted emissions of transportation sources are less than their mass emissions, while weighted emissions of all other pollutant sources are greater than their mass emissions. In both cases, transportation remains the dominant pollution source category. Air quality standards are given for carbon monoxide, oxidant, particulates, sulfur dioxide, nitrogen dioxide, hydrocarbons, and lead for California and the U. S.

44310

Ministry of Health and Welfare, Tokyo (Japan), Dept. of Public Nuisance

**DATA RELATED TO THE AIR POLLUTION CONTROL LAW MINISTRY ORDINANCES (NO. 3). POLLUTANTS STANDARDS SPECIFIED BY ORDINANCES.** (Taiki osen boshiho seishorei kankei shiryo (no. 3). Jorei no yoru yagai busshitsu no kisei jokyo nado). Taiki Osen Nyusu (Air Pollution News), no. 69:2-11, March 1972.

Japanese local emission standards, based on air pollution control laws, are presented in tables. Standards for sulfur oxides, ammonia, chlorinated hydrocarbons, hydrogen cyanide, nitrogen dioxide, hydrogen sulfide, lead, zinc, sulfur dioxide, copper compounds, cadmium, cyanice compounds, phosphorus compounds, and hydrofluoric acid are presented for each Prefecture. The areas of central cities where sulfurless fuel should be used are discussed. The air quality standards of many countries for SO2 and dust concentrations are presented.

44377

Kato, Keiji

**THE PRESENT POLLUTION CONTROL STANDARDS INDEXES (AIR POLLUTION).** (Genjo ni okeru kogai kisei suchi (taiki kankei). Text in Japanese. Kagaku Kogyo (Tokyo), 23(9);1194-1202, Sept. 1972.

A general review is given on the air pollution control standards in Japan. Three categories of pollutants, sulfur oxides, particulates, and harmful substances, such as carbon monoxide, have been subjected to control, and the standards are established. The sulfur oxides emission standards are determined by an equation which consists of two factors, the effective stack height and a district dependent parameter K. The present K values of different districts vary from 7.01 to 18.7. The national environmental standard of particulates is stated by the following two conditions, the hourly average concentration for 24 consecutive hours must be under 0.10 mg/cu m, and the hourly concentration must be under 0.2 mg/cu m. The conditions for CO are: an hourly average for 8 consecutive hours under 10 ppm. The emission standards of other harmful substances, such as cadmium compounds, lead compounds, chlorine and hydrogen chloride, fluorine and fluoro compounds, are also listed.

# L. LEGAL AND ADMINISTRATIVE

00311

**AIR POLLUTION (A SURVEY OF EXISTING LEGISLATION).** Intern. Digest Health Legislation 14, 187-229, 1963.

This report contains a comparative survey of existing legislation for the control of atmospheric pollution, and discusses specific laws and regulations of following countries: Australia, Belgium, Canada, Chile, Czechoslovakia, France, Federal Republic of Germany, Ireland, Jamaica, New Zealand, Poland, England and the United States.

02635

J. H. Boddy and D. Turner

**A DEFINITION OF THE PROBLEM AND SIGNIFICANCE OF AIR POLLUTION FROM PETROL-ENGINED VEHICLES (PART I OF ATMOSPHERIC POLLUTION: A SURVEY OF SOME ASPECTS OF THE EMISSIONS FROM PETROL-ENGINED VEHICLES AND THEIR TREATMENT).** British Technical Council of the Motor and Petroleum Industries, England. Sept. 1965. pp. 1-34.

World-wide legislation is reviewed; the existing and probable restriction on vehicle use and design is presented. The motor vehicle pollutants are detailed. The public health significance is examined. Automotive emissions are compared to those from other sources. Existing legislation in the western and non-Communist world, other than the Californian legislation, imposes negligible restrictions on the gasoline engine at present, but shows indications of imminent action. Legislation in many countries is framed in such a way that regulations against emission from gasoline vehicles could be enforced without major revision of legislation. This is most apparent in recent revisions of legislation, e.g. Ireland, France, and Belgium. When and if the present legislation in the U.K. is successful in controlling pollution from industrial and domestic sources, more attention must inevitably focus on the motor vehicle. The gasoline-engined vehicle makes a major contribution to the following pollutants: carbon monoxide, unburnt hydrocarbons, and oxides of nitrogen. Of these pollutants referred to, carbon monoxide is certainly the most undesirable. Oxides of nitrogen may be more damaging in respect to chronic exposure but evidence is limited. Unburnt hydrocarbons in vapour form appear significant only in relation to photochemical smogs. Heavy hydrocarbons in association with non-particulate matter, like oxides of nitrogen, have possible significance in relation to effects of chronic exposure. The use of lead in gasolines appears to have minor significance as a health hazard in respect to its pollution of the atmosphere. Major attention should be immediately devoted to the reduction of carbon monoxide emission from automotive vehicles. In the interests of clarifying the situation and, as a safeguard against possible legislation of an unnecessarily restrictive nature, the motor and petroleum industries should support research into the significance of such emissions as oxides of nitrogen and heavy hydrocarbons and methods of reducing these.

03536

A. J. Celebrezze

**AUTOMOTIVE AIR POLLUTION III. (A REPORT TO THE U.S. CONGRESS IN COMPLIANCE WITH PUBLIC LAW 88-206, THE CLEAN AIR ACT.) Preprint. 1965.**

Reduced exhaust emissions of hydrocarbons and CO have become a reality in California with the introduction of the 1966-model passenger cars and light commercial vehicles. Recognition of the need for still further control measures is evidenced by the adoption of nitrogen oxide standards by the California Board of Health. The Department of Health, Education, and Welfare is implementing the new responsibilities and authorities conferred by the Motor Vehicle Air Pollution Control Act. Standards for the control of emissions from gasoline-fuelled vehicles are being developed accordingly, to become effective with the 1968 models. Some additional technical information has become available. Further studies of the effect of ambient temperature on exhaust emissions indicate that low temperatures tend to increase hydrocarbons and CO, particularly following cold-engine starts. Preliminary results obtained from a study of the effect of leaded fuels indicate that combustion chamber deposits may not significantly affect the quantities of hydrocarbons and CO emitted in exhaust gases. A survey being conducted to measure CO levels in urban communities suggests that human exposure to CO may be greater than routine atmospheric monitoring data had indicated. A number of new projects are being initiated by the Government to study the performance characteristics of production- type exhaust emission controls in varied environments, to develop more definitive data on exhaust emissions from small cars and diesel-powered vehicles, to learn more about human tolerance of lead and CO, and to effect control of oxides of nitrogen. An expansion of industry research in automotive air pollution and its control is indicated by the recent activities of technical associations. (Author summary)

07952

O. Tope

**HEALTH IMPAIRMENT FROM EXHAUST GASES WITH SPECIAL REFERENCE TO SPECIAL VEHICLES AND POWER EQUIPMENT.** (Gesundheitsschadigungen durch Auspuffgase unter besonderer Berucksichtigung von Spezialfahrzeugen und motorisiertem Gerat.) Text in German. Stadtehygiene (Uelzen/Hamburg), 16(2):29-37, Feb. 1965. (37) refs.

Data on concentrations and effects of lead, carbon monoxide and carcinogenic compounds like benzpyrene were assembled. The maximum allowable concentration of 4 mg lead/cu m is exceed on many urban arterial streets e.g. in center city Philadelphia, Pa., 9.5 mg/cu m were found. Milk from cattle grazing on pastures near highways may be endangered since up to 3000 mg lead/kg grass have been found. But the most dangerous component of exhaust gases is CO which causes impaired vision, fatigue and may lead to heart and brain damage. It thus may become directly responsible for traffic accidents. The maximum allowable concentration value is 0.01% by volume which may be exceeded in heavy traffic in particu-

lar if the driver of an automobile smokes. Organic compounds may lead to lung cancer. Here especially benzpyrene which can be found both in exhaust gases and on road surfaces originating from tar and rubber tires may be incriminated. Control measures such as scrubbers and afterburners on exhausts are described. Their maintenance is tricky and expensive which so far has prevented compulsory use. Particularly hazardous are street cleaning equipment and trash removal trucks since workers must almost constantly be near the exhaust. Similar problems are posed by lawn mowers, chain saws, cranes, tractors, pesticide sprayers and similar equipment. Small engines are very difficult to modify to limit air pollution. The problem of air pollution from engine exhast gases can only be tackled by legislation and technical improvements and innovations.

08196

Kononova, V. A.

**SANITARY CLEARANCE ZONES BETWEEN RESIDENTIAL SECTIONS AND PLACES OF FUEL STORAGE IN SOVKHOZES OF SARATOVSK (OBLAST) TERRITORY. Gigiena i Sanit., 23(6):11-14, 1958. 3 refs. Translated from Russian by B. S. Levine, U. S. S. R. Literature on Air Pollution and Related Occupational Diseases, Vol. 4, p. 188-192, Aug. 1960. CFSTI: TT 60-21913**

The mechanization of agriculture in the Soviet Union is accompanied by the proliferation of centers where automotive agricultural machinery is housed and fuel for the machinery is stored. The prescribed 75 m wide sanitary clearance zone between residential sections and fuel storage centers was evaluated for effectiveness in protecting residents from gasoline fumes and automotive emissions. Tetraethyl lead and hydrocarbons were measured in air and soil at varying distances from the gasoline storage tanks. It was concluded that a sanitary clearance zone of 75 m was inadequate.

08725

Yamamoto, H.

**ON PREVENTION OF LEAD POISONING - THE ENFORCEMENT OF THE PREVEN- TIVE REGULATIONS.** Text in Japanese. Kuki Seijo (Clean Air J. Japan Air Cleaning Assoc., Tokyo) 5(1):11-16, May 1967.

Regulations for the prevention of lead poisoning are discussed in connection with the planned enforcement of these regulations. The new regulations have been worked out to allow also for new types of lead poisoning from new processes and products. Tables show the results of special health examinations conducted on Japanese and British lead workers. The statistics on lead poisoning symptoms of workers in various fields are tabulated. Workers in nonferrous metal refineries showed the highest percentage of symptoms. An- other table lists and describes 18 specific jobs which are most likely to cause lead poisoning. Based on these job categories and work environments, the regulations specify the procetive measures required against lead poisoning.

09009

**REPORT OF ACTIVITIES DURING THE PERIOD OF 1 JULY 1966 TO 30 JUNE 1967.** Kommunikationsdepartementets Expertgrupp foer att Leda ett Utvecklingsarbete pa Bilavgasomradet 17p., 1967. 7 refs. Translated from Swedish. Joint Publications Research Service Washington, D. C., R-8944-D, 17p., Dec. 14, 1967.

The activities of the Communications Ministry expert group in Sweden are summarized. Some of the purposes of the development work are to make more effective measures possible for reducing harmful substances in auto exhaust gases and to supply the techni- cal foundation for formulating the regulations necessary for this. The investigations and studies indlude the following: (1) In- vestigation of driving methods; (2) Measurement of CO in open air; (3) Testing of Swedish antipollution devices for autos; (4) Measurement of exhaust gas emission during cold and warm starting; (5) Study of crankcase ventilation; (6) Study of diesel exhaust gases; (7) Testing of equipment for a mobile laboratory; and (8) Development of a method for analysis of organic lead compounds. Proposed activities for the coming year are also outlined.

11204

Lawson, S. D., J. F. Moore, and J. B. Rather, Jr.

**A LOOK AT LEAD ECONOMICS IN MOTOR GASOLINE.** Preprint, Phillips Petroleum Co., Bartlesville, Okla., Bonner and Moore Associates, Inc., Houston, Texas, and Mobil Oil Corp., New York, 35p. 1967. 7 refs. (Presented at 32nd Midyear Meeting of Refining, Fuels and Emissions, Los Angeles, Calif., May 16, 1967, Paper 36-67.)

The potential economic effects on the domestic refining industry that would result from completely eliminating the use of lead additives in motor gasoline were investigated. A complete technical and economic report containing results as well as a compilation of data is presented.

16200

Yanovskiy, A. G. and Zh. L. Gabinova

**SANITARY PROTECTION OF THE ENVIRONS OF A MAJOR CITY.** (Sanitarnaya okhrana vneshney sredy krupnogo goroda). Text in Russian. In: Sanitation Measures Against Air and Water Pollution in the Planning of Cities. (Ozdorovleniye vozdushnogo i vodnogo basseynov gorodov). Government Committee on Civil Building and Architecture (ed.), Lecture series no. 2, Kiev, Budivel'nik, 1968, p. 18-23.

The USSR Ministry of Public Health, together with the RSFSR Soviet of Ministers and other interested organizations, studied the problems of pollution in Moscow and its vicinity. Conversion to natural gas fuel for thermoelectric plants has reached 70%, and continues to increase. Some 1500 air pollution sources have been located in Moscow. Up to 20% of the territory of the city is subject to harmful air pollution. Measures are being taken to establish sanitary-protective zones for 37 enterprises; 36 sources are being relocated outside of the city; 36 are modifying their production technology, and 274 are installing control equipment. Measures taken to reduce sulfur dioxide, cloride, and carbon monoxide emission from an aluminum refinery and lead from a wire producing plant are given as examples. Each year 27,000 air samples are taken for analysis.

17472

Duemmler, Friedrich

**THE ANTI-AIR POLLUTION ACTIVITIES OF THE TECHNISCHE UEBERWACHUNGS-VEREIN.** (Die Technischen Ueberwachungs-Vereine im Dienste des Immissionsschutzes). Text in German. Tech. Ueberwach (Duesseldorf), 10(10):339-345, Oct. 1970.

One of the most important tasks of the Technische Ueberwachungs-Verein (TUV) is to measure dust emissions by steam plants. By checking the performance of new measuring units and determining whether they fulfill the manufacturer's specifications. Measurements by the TUV taken in 1967 on steam boilers with capacities of up to 25 t/h showed that

plants without dust collectors emitted on the average 560 mg dust/cu m; those with dust collectors, 170 mg/cu m. For plants with more than 100 Gcal/h, the authorities require the installation of automatic measuring devices for dust and sulfur dioxide. In this connection, TUV checks the available units for suitability and calibrates each individual unit. For dust measurements, photometric units were suitable; for SO2 measurements, infrared absorbers and electroconductivity analyzers were selected. In addition to these activities, TUV is presently engaged with fluorine, hydrocarbon, hydrogen sulfide, sulfur trioxide, carbon monoxide, hydrogen chloride, lead, and zinc oxide measurements. In the years 1965-1966, TUV conducted extensive studies of CO and CH content of automobile exhausts in the idling stage. Infrared absorbers were used for the measurements. Ten percent of the vehicles with four-stroke engines emitted more than 8% CO in the idle; but 45% of the vehicles emitted less than 4.5%. Beginning with October 1, 1970, newly registered automobiles with Otto engines may not emit more than 25 g CO and 1,5 g CH per 100 g fuel consumption. TUV will check the new automobiles for compliance with this law. Finally, odor and noise measurements also belong to the activities of the TUV.

17927

Thayer, J. M.

**THE CONTROL OF GRIT, DUST, AND FUME EMISSIONS FROM INDUSTRIAL PROCESSES.** Conf. Filtration Soc., Dust Control Air Cleaning Exhibition, London, 1969, p. 10-15. 8 refs. (Sept. 23-25.)

Atmospheric pollution from industrial sources in England and Wales are controlled in part by the Clean Air Acts of 1956 and 1968 and the Alkali Act of 1906. The 1956 Clean Air Act prescribes standards for the emission of smoke from chimneys and prohibits smoke darker than Ringelmann 2, except for certain specified periods. The 1968 Act adds to this by prohibiting the emission of dark smoke from industrial and trade premises as distinct from chimneys. The 1956 Act deals with dust and soot only in general terms. The 1968 Act, covering emissions of grit and dust from furnaces, applies to a wide range of furnaces burning solid, liquid, or gaseous matter, excluding small domestic boilers. The recommended standards for furnaces burning fuel equivalent to 100 to 50,000 lb per hour of coal are illustrated graphically. Recommendations are also offered for reducing grit and dust emissions from cold blast cupolas at iron foundries. These involve minimizing emissions by suitable arrestors fitted at the top of the shaft or dispersing fumes from chimneys not less than 120-ft high. The Alkali Act is a measure to control emissions from virtually all the heavy chemical industries, the fine chemical industry, petroleum refining, and petro-chemicals, nonferrous metallurgy, iron and steel production, power stations, coke and gas works, and certain ceramic and lime works. The Act provides for the establishment of grit, dust, and fume emission standards and requires suitable equipment for obtaining these standards. Arrestment to a specific standard by dispersal of waste gases at inadequate height is given in some detail for cement works, iron and steel works, lead works, and electricity works.

22583

Dept. of Commerce, Washington, D. C., Technical Advisory Board Panel on Automotive Fuels and Air Pollution

**THE IMPLICATIONS OF LEAD REMOVAL FROM AUTOMOTIVE FUEL. (INTERIM REPORT).** 35p., June 1970. 1 ref.

The effects of lead-containing fuel additives on emissions from gasoline-piston engines are presented. Addition of lead alkyls is the least expensive way to increase the octane rating of motor fuel enabling more powerful and efficient engines to be built, but these additives interfere with the development of exhaust treatment systems, tending to inactivate catalysts. The Panel recommends tha legislation should be enacted to establish the authority of the Federal government to regulate fuel additives, and that Federal tax or subsidy policies concerning automotive fuels should be modified to provide price incentive for the purchase of unleaded and low- leaded fuels. Also, changes in future fuel requirements should be reported by the automobile manufacturers to the regulatory agency at least two years in advance of production, and such information should be made public. The regulatory agency should encourage States to include an auto emission check as part of the State vehicle inspection programs. Catalytic reactors are incompatible with present high levels of lead in gasoline, while lead salts and scavengers tend to corrode the materials in thermal exhaust reactor and plug some recirculation systems proposed for nitrogen oxide control. The net lead effect on increased hydrocarbon emissions is about 20% in rapid mileage accumulations and 7% in typical customer driving. Removal or reduction in lead from gasoline could degrade valves in some present cars, probably result in an increase in the aromatic hydrocarbons, and require that other changes be made in fuel composition to maintain octane levels. Emissions can also be reduced through better maintenance of cars presently on the road. In a recent demonstration, careful tuning of the engines in 43 cars resulted in a reduction of hydrocarbon and carbon monoxide emissions of over 50% at idle. Thermal exhaust-gas reactors, recirculation systems, and catalytic devices are discussed. Costs of lead reduction are included, as well as the status of petroleum refineries.

23234

Bloomfield, J. J., V. M. Trasko, R. R. Sayers, R. T. Page, and M. F. Peyton

**A PRELIMINARY SURVEY OF THE INDUSTRIAL HYGIENE PROBLEM IN THE UNITED STATES.** National Inst. of Health, Washington, D. C., Div. of Industrial Hygiene, Public Health Bull. 259, 132p., 1940. 159 refs.

Industrial hygiene surveys made in the United States from 1936 through 1939 covered existing health services in industrial establishments, exposure to materials and conditions which might influence health, and an inventory of control measures in use. The present study is an analysis of such surveys conducted in 15 states and covering 16,802 plants employing 1487, 244 workers. With reference to safety provisions, it appears that only 25.6% of the workers have the services of a full-time safety director. Hospital facilities are available to only 15% of the workers and first-aid facilities to 51%. Full-time services of a physician are available to 15.5%, while full-time nursing services are provided for 33.3% of the employees. The analysis reveals that although accident records are kept on nearly all workers, sickness statistics are available for only 45.4% of all employees. The analysis of exposures to various materials and conditions of health significance shows that slightly more than 1,000,000 persons in this country are exposed to inhalation of silica dusts and 1,500,000 to silicate dusts. Of the various exposures to metal dusts and fumes, approximately 800,000 persons are handling lead and its compounds, 34,000 are exposed to arsenic and its compounds, and nearly 33,000 to mercury and its compounds. The highest exposure of all is in connection with the agents known to produce dermatitis. Examination of control methods for 1,503,204 exposures shows that 14.3% are provided with local exhaust ventilation, 3.2% with enclosed operations and 3.2% with respiratory protective devices. In the case of certain dusty trades, wet

methods are employed in connection with 3.4% of the exposures. The development of industrial hygiene services, and their integration with state public health agencies, is recommended. (Author abstract modified)

23562

Damon, W. A.

**THE TREATMENT OF WASTE GASES IN CHEMICAL INDUSTRY.** Trans. Inst. Chem. Engrs. (London), 31(1):26-35, 1953. 16 refs. (Presented at the Institute of Chemical Engineers, Midlands Branch Meeting, England, Jan. 31, 1953.)

Statutory control of the atmospheric pollution arising from certain industrial processes is considered, and the possible means of implementing the requirements of the Alkali Act are discussed. Processes are described in which the control of pollution is difficult, and the means adopted to mitigate their effects are explained. The rate at which a gas diffuses when travelling downwind from its point of emission depends on the turbulence of the atmosphere, and this in turn is affected by the wind speed and the temperature gradient. Calculations of Bosanquet and Sutton relating to maximum ground concentrations and chimney discharges are cited. Cement manufacture, pollution by sulfur gases, petroleum refining, requirements for lead works, and various unregistered processes are discussed. Great difficulty has been experienced in the case of a plant for the recovery of magnesia from sea water, by reason of the discharge of a very foggy emission from the kiln chimneys. The discharge of fluorine compounds, coal combustion, pollution by coke ovens, and burning spoilbanks are also considered.

23608

Public Nuisance Control Committee (Japan)

**BASIC POLICY REGARDING THE ESTABLISHMENT OF PUBLIC NUISANCE CONTROL PROGRAM FOR THE OSAKA AREA.** (Osaka chiiki ni kakawaru kogaiboshikeikaku sakutei no kihon hoshin. An). Text in Japanese. Yosui to Haisui (J. Water Waste), 12(9):759-767, Sept. 1, 1970.

A control program is presented which is to be effective throughout Osaka Prefecture which has long been developing as a large industrial area; the enormous economic activity has added much to the pollution problem. Air pollution is severe in the central and Hanshin coastal industrial district, and water pollution is significant in Yodo, Kanzaki, Neya and Yamato Rivers. Water quality in Osaka Bay has deteriorated to the extent of ruining the fishing industry. The ground settling problem in East-Osaka, and the noise from Osaka International Airport have invited many complaints. The pollution levels are to be lowered to within the tabulated limits by 1980. There are many necessary control measures, but the following are especially emphasized in view of the national planning priorities. They are the control measures against stationary air pollution sources, purification of coastal waters and rivers and streams, control of nuisances accompanying automobile traffic, treatment measures for metropolitan and industrial wastes, and the control of airport noises. In addition, surveillance and measurement systems as well as cooperation with th neighboring prefectures are indispensible. Detailed tables are given on the target maximum allowable concentrations of sulfur oxides, suspended particulates, and carbon monoxide in air as well as for cyanides, alkyl mercury, organic phosphorous, cadmium, lead, chromium, arsenic, and mercury in general for water pollution. Values for pH, BOD, SS, DO and coliform bacteria counts are also given. The maximum allowable noise levels for daytime, morning and evening are also listed.

23610

Public Nuisance Control Committee (Japan)

**BASIC POLICY REGARDING THE ESTABLISHMENT OF A PUBLIC NUISANCE CONTROL PROGRAM FOR THE TOKYO AREA.** (Tokyochiiki ni kakawaru kogaiboshikeikaku sakutei no kihonhoshin. An). Text in Japanese. Yosui to Haisui (J. Water Waste), 12(9):750-758, Sept. 1, 1970.

A control program to be effective throughout the Tokyo metropolitan area other than islands in the Pacific Ocean under the jurisdiction of the metropolitan government is presented. The area is a megalopolis with 11.5 million people, and the industrial and economic activities are increasingly exacerbating the pollution problem. Air pollution from automobiles and factories is severe. It originates from the central and Joto areas as well as from factories along the Arakawa River and Sumida River. Water pollutio in Sumida, Naka, and Tama Rivers is also intense. The pollution levels are to be lowered to within the tabulated limits by 1980. The necessary control measures are numerous, but the following are especially emphasized in view of the national planning priorities. They are the control measures against stationary air pollution sources, purification of sea water in the coastal areas and fresh water in rivers and streams, control of nuisances accompanying automobile traffic, control of ground settling (in some areas as deep as four meters), and treatment measures for metropolitan and industrial wastes. In addition, the establishment of nuisance monitoring and measurement system is necessary, and close cooperation with the neighboring prefectures is indispensable. Detailed tables are given on the target maximum allowable concentrations of sulfur oxides, suspended particulates, and carbon monoxide in air as well as cyanides, alkyl mercury, organic phosphorus, cadmium, lead, chromium, arsenic, mercury in general and pH, BOD, SS, DO, and coliform bacteria values for water pollution. The maximum allowable noise levels for daytime, morning and nighttime are also listed.

24214

Public Nuisance Control Committee (Japan)

**BASIC POLICY REGARDING THE ESTABLISHMENT OF PUBLIC NUISANCE CONTROL PROGRAM FOR THE KANAGAWA AREA.** (Kanagawa chiiki ni kakawaru koga boshikeikaku sakutei no kihon hoshin. An). Text in Japanese. Yosui to Haisui (J. Water Waste), 12(9):768-776, Sept. 1, 1970.

A control program to be effective in the area East of Sagami River within Kanagawa Prefecture is presented. This area serves as the mainstay of the Japanese economy, industries such as electric power, steel, petroleum, chemicals and heavy automobile traffic have contributed to the chronic pollution problems. Air pollution in the Taishi and Tajima areas and water pollution in Tama, Tsurumi, and Katabira Rivers as well as Tokyo Bay are extremely severe. The pollutant levels are to be lowered to within the tabulated limits by 1980. There are many necessary control measures, but the following are especially emphasized in view of the national planning priorities. They are the control measures against stationary air pollution sources in Kawasaki, especially purification of coastal waters and rivers and streams, control of nuisances accompanying automobile traffic, and treatment measures for metropolitan and industrial wastes. In addition, surveillance and measurement systems as well as cooperation with the neighboring prefectures are indispensable. Detailed tables are given on the target maximum allowable concentrations of sulfur oxides, suspended particulates, and carbon monoxide in air as well as cyanides, alkyl mercury, organic phosphorus, cadmium, lead, chromium, arsenic, mercury in general, and pH, BOD, SS, DO and coliform bacteria values for water pollution. The max-

imum allowable noise levels for daytime, morning and evening are also listed.

24467

Hueter, F. G., D. S. Barth, and Gottberg

**GERMAN-UNITED STATES COOPERATIVE STUDIES.** Public Health Service, Durham, N. C., National Air Pollution Control Administration and Ministry of Interior, Bonn (West Germany), 9p., 1970 (?).

The concept and development of the 'collaborative air pollution research program' between the Ministry of Interior, West Germany, and the Department of Health, Education, and Welfare of the U. S. are reviewed. It was agreed that research areas for possible collaborative efforts are health effects of automotive exhaust in humans; health and environmental effects of lead, including monitoring programs; studies of the effects of airborne nitrogen oxides; studies of effects of airborne carcinogens; and health effects of asbestos, including the development of monitoring methods. Collaboration will be materialized in the design of the experiments, internal quality control, exchange of information, evaluation and analysis of research results, and the exchange of manuscripts. Examples of collaboration are cited for automotive exhaust as well as carcinogenicity.

24757

**LEAD IN EXHAUST GASES.** (Bleihaltige Abgase). Text in German. Landarzt (Stuttgart), vol. 44:446-449, March 31, 1968.

The lead content of high octane gasolines sold in West Germany fluctuates from 0.13 g Pb/l to 0.510 g Pb/l depending on the composition of the oil distillates used and on the nature of the refining process. In 1965, 5000 tons of lead were emitted into the atmosphere of West Germany in exhaust gases which quantity is expected to increase twofold by 1975. The lead pollution level in German cities is between 1 to 4 micorgram Pb/cu m, in extreme cases 12 microgram Pb/ cu m air, which while not presenting an acute danger nevertheless may develop into one with time. The Russians who have detected genetic changes in the sperm of animals caused by lead have reduced the maximal permissible Pb pollution level to 0.7 microgram/ cu m air while in West Germany this level is 200 microgram/ cu m air largely because American oil research authorities still maintain that lead in the air presents no threat to public health Large refineries possess adequate catalytic reforming facilities and cracking plants to produce high octane gas without the necessity of adding lead compounds to these gasolines. It is the medium sized and small plants which possess no refining facilities of their own who depend for the production of high octane gasoline on lead compounds. Refining adds little to the cost of high octane gasoline and prohibition of the addition of lead compounds to gasoline need not result in higher costs of gasoline.

25288

Middleton, John T.

**AIR POLLUTION CONTROL: SOME LESSONS LEARNED IN THE UNITED STATES.** Preprint, National Academy of Medicine, Mexico City (Mexico), 13p., 1970. (Presented at the Conference on Air Pollution, Mexico City, Feb. 18, 1970.)

In the United States the fundamental philosophy that has evolved in the development of air pollution control programs is that air pollution control begins at the source. One of the approaches that has been developed to carry out this philosophy is the permit system, which requires that anyone who wishes to construct or operate a machine, equipment or other contrivance which may pollute the air obtain the prior permission of a government agency. Standards have been set limiting the emissions from automobiles. The kind and degree of control of stationary sources will vary from area to area depending upon such diverse parameters as climate and weather, degree of industrialization, population density, and topography. It is here that the technique of diffusion modeling plays an important role. Losses to agriculture alone were recently estimated to exceed $325 million annually in the United States, while studies show that an exposure to 12 mg/cu m (10 ppm) carbon monoxide for approximately eight hours may increase the blood carboxyhemoglobin level to produce some decrement in mental performance. A British study found an association between air pollution and deaths from bronchitis and lung cancer in an area where the yearly average sulfur dioxide level was 116 micrograms/cu m (0.04 ppm). Another study found an association between particulate matter and prostatic cancer, while eye irritation has been demonstrated when oxidant levels increase above 100 micrograms/cu m. Hydrocarbons, nitrogen oxides, lead and mercury compounds are also mentioned. Government responsibility on federal state, and local levels is also discussed.

25542

Haar, Ulrich de

**THE MONITORING STATION PROJECT 'KEEPING THE AIR CLEAN'.** (Das Messtellen Projekt 'Reinhaltung der Luft'). Text in German. Umschau (Berlin), 70(23):746-774, Nov. 5, 1970. 3 refs.

The carbon dioxide content in the atmosphere has increased by 16% since the beginning of the century and is expected to double in the first half of the next century. While CO2 does not absorb sunlight, it does absorb night-time long-wave radiation with a resulting increase in atmospheric energy. Increased emission of sulfur dioxide reduced the pH of natural precipitation in the Schwarzwald in Germany from 4.9 in 1965 to 4.5 in 1970 with a resulting decrease of pH in surface waters possessing only a limted buffering capacity and a shift in the hydrobiological equilibrium. It is not enough to measure pollution in highly industrialized areas; pollution spreading to so-called clean air is more dangerous in the long run. For this reason, a network of measuring stations has been established over the Federal German Republic whose objectives are the recording of slow atmospheric changes, the gathering of comparative data for epidemiological studies of population groups from highly polluted areas, and the study of long-term chronic effects of low levels of pollution on humans, plant life, animals, and materials. The data sought include pH, conductivity, dust concentration, soluble and insoluble dust precipitation, chlorine, ammonia, sulfates, CO2, SOx, NO2, F, radioactivity, pollen and spore count, lead level, residual levels of cancerogenic substances and pesticides, N2O, ozone, particle count, SO2 and aerosol spectra, iodine level, heavy metals and terpenes, and the usual meteorological parameters. It is hoped that a similar network will be established all over Europe.

26442

Hillsborough County Planning Commission, Tampa, Fla.

**LAND USE PLANNING. AIR POLLUTION CONTROL.** NAPCA Grant 69C-11ORE, 201p., 1970. 38 refs.

A joint study was undertaken by the Pollution Control Commission and the Planning Commission of Hillsborough County (Florida) to translate ecological principles into current and projected land use planning. Urbanization and the effects of great per capita consumption upon the environmental conditions of

Hillsborough County are discussed. This includes an analysis of urban and rural land use, present and projected population and population distribution, and the economic base. The studies included in this section were undertaken to better understand the social and political climate and decision-making factors which exist within the county. A detailed analysis is presented of the parameters which influence the climatology in Hillsborough County, and an introduction is included to the solutions which are normally available for air pollution control.

27664

**SUMMARY OF 14 LAWS RELATED TO PUBLIC NUISANCE AND THE REMAINING PROBLEMS.** (Kogai kankei 14 hoan no gairyaku to nokosareta mondaiten). Text in Japanese. Yosui to Haisui (J. Water Waste), 13(2):205-209, 1971.

The article discusses the 14 laws related to public nuisance control that were revised during the extra session of the Japanese Diet in 1970. The laws revised include: Basic Law Concerning Public Nuisance Control, Public Nuisance Criminal Justice Law, Air Pollution Control Law, Water Pollution Control Law, Toxic Substance Control Law, Street Traffic Control Law, Ocean Pollution Control Law, Solid Waste Disposal and Sanitation Law, Noise Control Law, and others. The main feature of the revised Basic Law is that the clause including in harmony with the healthy growth of the economy is deleted. For the Air Pollution Control Law, thchanges are as follows: Lead is included in the definition of smoke, and lead and hydrocarbon are added to the definition of automobile exhaust. In the section on emergency measures, the word 'advice' is changed to 'order', in connection with the government's notice to the polluters. Further, the section noting the 'in harmony with the healthy growth of the economy' is delected, and the law is made effective throughout the country, and not merely in designated areas, as was the case before the revision. The Law will go into effect six months after the day of promulgation.

28066

**ENVIRONMENTAL PROTECTION SETS LIMITS ON THE METAL INDUSTRY.** (Umweltschutz setzt Grenzen fuer die Metallwirtschaft). Text in German. Metall., 25(1):99, Jan. 1971.

The project of a South African company to create a copper mine in the Austrian Tyrol was thwarted by the local government in cooperation with Tyrolean and Bavarian groups for combating air pollution. In the summer of 1969, the Hibino Metal Industry Company in Maibara ceased operation of its copper plant because of air pollution. The lead industry will be influenced by the limitation of the lead content in gasoline to 0.4 g/liter beginning with 1972. By October 1975, all refineries must have switched to production of low lead gasoline, to reduce the 7000 tons of lead emitted annually by automobiles.

28099

Kohayakawa, Takashi

**CONTROL OF ENVIRONMENT PRESENT AND FUTURE.** (Kogai taisaku no genjo to shorai). Text in Japanese. Jidosha Gijutsu (J. Soc. Automot. Engrs. Japan), 25(1):46-55, Jan. 1971. 3 refs.

Of all environmental contaminants, automobile exhaust emissions mus take precedence for control measures. Plans for management of the environment must consider development of the following: an analyze for pollutants such as oxidants, measuring instruments and methods for control of waste particles, methods to determine the activity and vaporization of hydrocarbons, an analyzer for nitrogen oxides, equipment and methods for the analysis of heavy metal compounds such as lead, and methods to determine offensive odors. Altering the composition of gasoline components is one method for controllin carbon monoxide and hydrocarbon emissions which result during engin operation. However, the resulting mixture must not be such as to originate new problems. If lead is limited to 1/5th the amount now present in gasoline, it may fulfill this purpose without exceeding the provisional air environmental standard. Carbon monoxide contamination is discussed, as traffic areas indicate extremely high CO concentrations. The relation between secondary products of air pollution and primary wastes is important regarding the future control of hydrocarbons, nitrogen oxides, and sulfur oxides. Photochemical smog in Tokyo differs from that in Los Angeles, as automobile exhaust does not appear to influence its production.

28349

Industrial Engineering Center (Japan)

**DATA FOR THE SEMINAR ON INDUSTRIAL POLLUTIONS PREVENTION COUNTERMEASURES, NO. 1: PROBLEMS AND FUTURE TRENDS IN LEGISLATION RELATED TO INDUSTRIAL POLLUTION PREVENTION.** (Sangyo kogai boshi taisaku semina shiryo, No. 1, sangyo kogai boshi kanren horei no mondaiten to kongo no doko). Text in Japanese. 12p., 1970 (?).

At the 64th Extraordinary Diet session, held from November to December, 1970, 14 laws including the partial amendment of Pollution Countermeasures Fundamental Law, the Air Pollution Prevention Law, and the Water Pollution Prevention Law were passed. With the exception of the law partially amending the Agricultural Chemicals Control Law, all laws were promulgated as of December 25, 1970. Although the Fundamental Law came into force immediately, most of the other laws will become effective six months later due to the time required to prepare ordinances, ministerial regulations, and public notices. A comparison between the old, the new legislation concerning water pollution is given in tabular form, and the scope of each news law is explained. In sections on 'objectives' of the Fundamental Law, Air Pollution Prevention Law, the Water Pollution Prevention Law, and the Noise Control Law, the phrase 'in harmony between living environment and sound level development of economy' is deleted. The system designating special areas for the control of air and water pollution is lifted; control is to be extended to all the areas and public waters in Japan. National minimum discharge standards are established. In the Fundamental Law, soil pollution was stipulated as the seventh typical pollution and a law on 'the prevention of soil pollution for agricultural use' was established. A drastic amendment of the old Cleaning Law was made and the new law on 'treatment and cleaning of wastes' was established. Besides sulfur oxides, soot and dust, chlorine, hydrofluoride, cadmium and lead are controlled under the Air Pollution Prevention Law, while heated and colored water discharge are controlled by the Water Pollution Prevention Law. The range of industry is extended from primary to tertiary. Responsibility of entrepreneurs is clarified in the Fundamental Law to mean that they are to take 'necessary measures to prevent pollution such as treatment of sooty smoke, filthy water, and wastes'. The law on the sharing of pollution-control expenses was established, in keeping with Article 22 of the Fundamental Law, which stipulates the responsibility of entrepreneurs to bear the burden of expenses. Some responsibilities and authority are entrusted by the national government to local autonomous bodies. The future problems are: steps to make

adequate use of land, further improvement in enterprises to prevent pollution, establishment of Environmental Agency, financial assistance to local area, enterprises, legislation on odor, and promotion of technology.

28397

**INSTANT PROGRAM BY THE GERMAN FEDERAL GOVERNMENT FOR THE PROTECTION OF THE ENVIRONMENT.** (Sofortprogramm der Bundesregierung fuer den Umweltschutz). Text in German. Staedtehygiene (Uelzen/Hamburg), 22(1):2-4, Jan. 1971.

On September 17, 1970, the West German Government issued a program for the immediate protection of the environment. The following measures are included in the program: (1) the Ministry of the Interior is ordered to draft a law for protection against emissions; to study the necessity of the creation of a Federal Institute for the protection of emissions; and to place orders for the development of measuring instruments for air pollutants as soon as the necessary funds have been appropriated. In 12 heavily populated areas, 40 to 50 measuring stations shall be erected for the measurement of sulfur dioxide, carbon monoxide, and dust concentrations in the air. All measurements will be forwarded to a computer center. The Ministry of the Interior is to prepare a law limiting the lead content in gasolines to 0.4 g/l. This law is to become effective October 1, 1975.

28869

Dept. of Commerce, Washington, D. C., Technical Advisory Board, Panel on Automotive Fuels and Air Pollution

**THE IMPLICATIONS OF LEAD REMOVAL FROM AUTOMOTIVE FUEL. (INTERIM REPORT).** 35p., June 1970. 1 ref. NTIS: PB 194880

The addition of lead alkyls is the least expensive way to increase the octane rating of motor fuel. However, these additives interfer with the development of exhaust treatment systems, especially those using catalysts. It is recommended that legislation be enacted to establish the authority of the Federal government to regulate fuel additives. Early difinitive action on the part of the Federal government is required to provide conditions conducive to the development of a wide variety of emission control devices and to assure smooth adjustments by the industries affected. Action is recommended that will bring about an incentive for the purchase of the low-lead fuel. Petroleum refiners must also receive adequate warning of contemplated changes in automotive fuel requirements in time to make refinery changes in an orderly manner. The effect of insufficient maintenance of present cars on total vehicle emissions is noted, and it is recommended to encourage states to include an automobile emission check as part of their vehicle inspection programs. Effects of lead removal are considered, as well as emission control technology. Thermal exhaust gas reactors, exhaust gas recirculation systems, and catalytic devices are mentioned. Th cost of lead reduction is indicated, as well as the status of petroleum refineries.

29421

**OUTLINE OF LEGISLATIONS CONCERNING POLLUTIONS PASSED BY THE EXTRAORDINARY DIET SESSION.** (Rinji kokkai seiritsu kogai kankei horitsu yoko). Text in Japanese. 16p., Dec. 21, 1970.

Legislation is outlined including, the Water Pollution Prevention Law, the law which partially amends the Pollution Countermeasure Fundamental Law, the law which partially amends the Air Pollution Law, the Water Pollution Prevention Law, the law which partially amends the Noise Control Law, the Marine Pollution Prevention Law, the law on the sharing of the financial burden for pollution prevention, the law on the punishment of crimes involving pollution harmful to human health, the law concerning waste treatment and cleaning, the law concerning the prevention of soil pollution, the law which partially amends the Sewer law, the law which partially amends the Road Traffic Law, the law which partially amends the Agricultural Chemicals Control Law, and the law which partially amends the Poison and Poisonous Matters Control Law. The definition of pollution is changed to include soil pollution, heated water from thermal generating stations, and paper mill sludge. The phrase, harmony with sound development of economy was delected, and it is now the responsibility of entrepreneurs to dispose of industrial wastes. The system of designating special areas for air and water pollution was abolished, and the emission standard is applicable all over Japan. Besides sulfur dioxide in factory smoke, cadmium, hydrogen fluoride, and lead are specifically mentioned. Governors can limit the use of facilities which emit sooty smoke and advise them to comply with standards on the use of fuel, improve water pollution, and prevent soil pollution. Also, the discharge of oil from vessels is restricted. A person in charge of controlling oil pollution must be designated to each vessel. Of willfull damages to health and life, are punishable by prison terms of detention of less than 2 years or of fines less than 716 dollars. Heavier penalties occur in the case of death or injuries. Individuals and corporations are punishable. Companies must manufacture easily disposable goods. Areas are designated which are feared to be heavily contaminated. Sewers must have a terminal disposal plant, or be connected with the sewer system. The Public Safety Commission can install and control traffic signals, and prohibit traffic, if necessary.

29888

**TOKYO FIGHTS POLLUTION. AN URGENT APPEAL FOR REFORM.** Tokyo, Tokyo Metropolitan Government, 1971, 267p.

The historical background of the emergence of pollution as an environmental problem in Tokyo during and since World War I, which ushered in an era of rapid industrial development, is reviewed. The term kogai was coined to refer to environmental hazards in general; the term, a combination of two characters meaning public and hazard, is a sociological term and does not denote a particular phenomenon. The laws and ordinances on environmental hazards are summarized. Pollution control programs are described, as well as the administration and financing of the government s pollution control policy. Air pollution is classified according to its production mechanisms and sources. Sulfur dioxide, carbon monoxide, photochemical air pollution, and lead pollution are mentioned. Health effects of air pollution are discussed. Water pollution and its control are described, as well as problems due to noise and vibrations. Land subsidence is discussed, and waste disposal is reviewed.

30152

Tokyo Metropolitan Government (Japan)

**PLAN TO DEFEND TOKYO CITIZENS FROM POLLUTIONS.** (Tomin o kogai kara boei suru keikaku). Text in Japanese. 306p., March 1971.

Tokyo has four principles for environmental standards: they are not only conducive to health and safety, but also guarantee pleasant life for citizens; they are not merely policy targets, but also must be put into practice; a period for achievement is set, and necessary plans, steps, and the definite period are

shown the citizens; and they are not mechanically set, but real characteristics will be taken into consideration. The 1964-65 level for air should be maintained, or a level between the first and second stage set by WHO. Basic measures are to eliminate and restrain the sources of pollutants, disperse and dilute pollutants into the atmosphere, and restrain and disperse the concentration of pollution sources. For sulfur dioxide (including a part of nitrogen oxides), high chimney stacks are not quite the answer, so instead fuels must be controlled by a switch to electricity or gas, regional air conditioning, and the utilization of heat wasted at generating stations and garbage incineration plants. For automobile exhaust gas, idling must be controlled, a device to eliminate exhaust gas must be installed, and congestion at intersections, must be eliminated. Also there must be adequate investment on highway construction, restriction of traffic, and allowable exhaust gas volume. Priority use of roads must be established, by road, areas, vehicle type and time period. Garages and parking must be controlled or prohibited. Alternate mass transport systems must be improved, and some roads must give priority to city buses. Although polycentric-type city structure is conducive to traffic dispersion, it may also aggravate the situation. Warehouses and other distribution functions in the center of town should be dispersed, as people move to suburban areas. An environmental standard for SO2 for Tokyo will be achieved by 1973, drastically cutting down SO2 discharge (by 56%). For particulates, the target is a 40% cut of the present level by 1973 from the installation of more dust collectors and the switch to other fuels than oil. Carbon monoxide will be cut, by stringent control of idling. The total of exhausted hydrocarbons and lead from automobiles will be cut to the 1965 level of 47 tons/day by 1973. Periodic checks on gasolines will be made for tetraethyl lead. Also, efforts will be continued after 1973 to cut down these pollutants further.

30620

Kawamoto, Hirotaka

**EXPLANATION OF AIR POLLUTION CONTROL ACT.** (Taiki osen boshiho no kaisetsu). Text in Japanese. Ryusan (J. Sulphuric Acid Assoc., Japan), 24(3):21-31, March 1971.

The Air Pollution Control law passed by the 64th Extraordinary Diet session, aims at control of smoke, dust, exhaust gas, and special matter. Smoke is divided into sooty dust, sulfur oxides, harmful matter, and special harmful matter. Facilities which generate smoke are defined. Sooty dust generated by the incineration of fuel or by the use of electricity is the same as the traditional soot and other dusts; it includes soot, ash, metal, and other oxides generated by combustion. Use of electricity as a heat source implies the electric furnace process, for instance Harmful matter is defined as that generated by combustion, synthesis, decomposition, or other waste disposal methods (except mechanical process). Examples are cadmium, chlorine, fluoride, and lead. Special harmful matter is that generated, for example by combustion of nitrogen oxides. Facilities which generate harmful substances include electrolytic furnaces, reactors, crucibles and converters. Those who want to establish smoke-generating facilities must provide regional authorities with necessary information. Those who do not conform to the smoke standard are punished, ordered to alter their plan, or to abandon it. Mines are excluded from the definition of the facilities which generate smoke, as they come under the more strict Mine Safety Law. The smoke discharge standard is universal throughout Japan. The following smoke environmental standards apply: hourly values must be less than 0.2 ppm for 99% of the total hrs/yr; daily averages must be less than 0.05 ppm for over 70% of the total days/yr; hourly values must be less than 0.1 ppm for over 88% of the total hs/yr; the average annual hourly value cannot exceed 0.05 ppm. In any area, the number of days calling for emergency measures is not to exceed three percent of the total days/hr or to continue beyond three days. The standards are to be realized within 10 year in congested areas and within five years in already polluted areas.

30908

Vogel, Hans

**MAN, HIS ENVIRONMENT AND THE TECHNOLOGY. PARTS II AND III.** (Der Mensch, seine Umwelt und die Technik). Text in German. Chem. Rundschau (Solothurn), 24(15):305, 307, April 14, 1971. and 24(16):322, 324-325, April 21, 1971.

In 1970, President Nixon created the three-member Commission for Environmental Protection and assigned it the task of working out legal and administrative measures for a better environment. By 1980 air polluting automobile exhausts will be reduced by 93%. In August 1970, a Commission for Combatting Air Pollution was created in Tokyo. NATO established a council in 1969 to study the effects of technology on the environment and man. An international academy for the protection of life and the environment will be created in Luxemburg later in 1971. In West Germany, a cabinet subcommittee for environmental problems, under the chairmanship of the Minister of the Interior, was created. Presently, West Germany spends $1.5 million to combat air pollution. As of January 1, 1972, refineries in West Germany must reduce the lead content of gasoline to 0.4 g/l. Postponement to 1975 is likely, however, if reduction becomes too costly or too complicated for the refineries. Environmental protection concerns not only governments and industries, but requires the cooperation of the public. The subject should be included n school curricula.

31454

**THE FIGHT AGAINST POLLUTION OF WATER AND AIR.** (Kampf der Verschmutzung von Wasser und Luft). Text in German. Wasser Luft Betrieb, 15(6):237-238, June 1971.

A new program for environmental protection was worked out by the U. S. government in 1971. The program requests the introduction of a clean air emission charge for the pollution of air by sulfur oxides and also a tax on lead additives for gasolines. The head of the Environmental Protection Agency will have the power to prohibit or limit the use of substances which he considers dangerous. The program favors the creation of a world agency for the protection of the environment. An institute for environmental problems will be created, financed by the government and a number of private foundations. The institute will study measures for protecting the environment.

31957

Nagel, S.

**FOURTH HEARING ENVIRONMENTAL PROTECTION: MAINTENANCE OF CLEAN AIR. DEBATE OVER DEADLINES FOR LEAD LIMITATION--NON-POLLUTING CAR IN FIVE YEARS.** (4. Hearing Umweltschutz: Luftreinhaltung. Tauziehen um Termine fuer Bleibegrenzung--Umwelt Auto erst in fuenf Jahren). Text in German. VDI (Ver. Deut. Ingr.) Nachr. (Berlin), 25(25):2, June 1971.

On June 14, 1971, at the fourth public hearing on environmental pollution, experts testified that the air pollution in industrial centers in the Federal Republic of Germany had reached concentrations hazardous to human health. Air pollution has been proven to cause diseases of the respiratory tract and retard

development in children. Urban atmospheres contain carcinogenic substance which procuce 2.27-3.8 times the incidence of cancer as in rural areas. Maximum emission concentrations have been established for pollutants such as nitrogen oxides, sulfur dioxide, hydrogen sulfide, chlorine, and course dusts. These standards must be periodically verified and updated. The automobile industry is now under pressure to construct engines with lower emissions of pollutants, so that, within three years, carbon monoxide and hydrocarbons will be reduced by 20 to 30%.

32462

Aitken, Allan

**EXHAUST EMISSION LEGISLATION.** J. Automotive Eng., 2(5):9-14, May 1971.

The Engine Engineering Department of the Ford Motor Company in Great Britain has been engaged in the research and control of car emissions for nearly a decade. No fewer than 140 different car engines have been tested. However, the lack of harmony in government legislation adds immeasurably to engineering costs and scatters the talent and expertise engine manufacturers have accrued in this field in many different and often unrelated, directions. Manufacturers must press for international agreements on emission legislation and government direction and, at the same time, continually improve the emission characteristics in products without seriously compromising the tenet of value for money. Vehicle emission test procedures are presented tabularly for various countries including Belgium, Italy, France, West Germany, Sweden, Great Britain, the United States, Canada, and California. Items tested include hydrocarbons, nitrogen oxides, carbon monoxide, particulates, evaporation, crankcase emissions, and lead, at various engine cycles. Legislated emission standards are also given.

32789

Public Nuisance Control Assoc., Tokyo (Japan)

**LAWS AND ORDINANCES RELEVANT TO AIR POLLUTION.** (Taiki osen boshiho seko rei). Text in Japanese. Sangyo Kogai (Ind. Public Nuisance), 7(7):322-331, July 1971.

On the basis of the Air Pollution Prevention Act, regulations have been issued designating pollutants, the maximum permissible emission, emission sources, and pollution areas. Among the materials produced by combustion, synthesis, and decomposition, elements that have been designated as toxic are cadmium and its compounds, chloride and its compounds, fluoride, hydrogen fluoride, and silicon fluoride, lead and its compounds, and nitrogen oxides. Toxic materials emitted by automobiles are carbon monoxide, hydrocarbons, lead compounds, and nitrogen oxides. Toxic material that should be guarded against at the time of accidents at manufacturing plants consist of 28 items including NH3 and HF. The maximum permissible amount of toxic matter concentration per hour at the highest point during the year should be less than 0.1 ppm. Twenty-six kinds of soot producing apparatus and systems are subject to regulations, and five kinds of particulate producing furnaces and apparatus are subject to regulations. Also included are areas subject to sulfur oxides concentration control and areas subject to advice for the use of low-sulfur content fuels.

32865

**PUBLIC NUISANCE AND SAFETY - TENDENCY OF AIR POLLUTION COUNTERMEASURES.** (Kogai, anzen - Taiki osen taisaku no doko). Text in Japanese. Nenryo Kyokaishi (J. Fuel Soc. Japan, Tokyo), 50(530):521-528, June 1971. 162 refs.

Various legislative actions concerning the control of air pollution and studies on measurement methods for air pollution during 1970 are reviewed, along with major developments in desulfurization processes and automotive emission control. Governmental control activities included criteria set for maximum allowable concentration and emission of carbon monoxide, criteria for atmospheric concentration of lead, and ordinances to control dust, CO, and carbon dioxide. The literature review covers studies on air pollution measurement methods and pollution control devices.

32884

Smaller Enterprises Promotion Corp. (Japan)

**AMENDMENT DRAFT AND EXPLANATION OF AIR POLLUTION CONTROL LAW ENFORCEMENT REGULATIONS.** (Taiki osen boshiho sekorei no kaiseian oyobi kaisetsu). Text in Japanese. Preprint, 20p., 1971. (Presented at the Public Nuisance Prevent. Tech. Seminar, Japan, 1971.)

Air pollution control laws and amendments in Japan are examined. Regions are divided into eight classes based on the discharge standard of sulfur dioxide, for which the maximum allowable concentration is 0.020-0.045 ppm at groung level. Industries discharging smoke, cadmium, or lead and boilers burning heavy oils must be equipped with electric dust collectors, bag filters, or multi-cyclones. In certain areas, buildings with central heating must install multi-cyclones or more efficient dust collectors or change to gas or electric heating. The prefectural governments may adopt emission standards stricter than those enforced by the national government. Industries discharging chlorine or fluorine must be equipped with alkali washing devices. Sulfur content in fuels is limited to 1.0-1.5%.

33495

Morgan, George B. and Guntis Ozolins

**AIR QUALITY SURVEILLANCE.** Preprint, Air Pollution Control Office, Cincinnati, Ohio, Div. of Atmospheric Surveillance, 23p., May 21, 1971.

The specific needs for air quality data, the scope and requirements of monitoring activities, and the chief components of ambient air quality surveillance such as sampling-measurement networks, laboratory support, and data handling and analysis were presented. The monitoring conducted by state and local air pollution control agencies is directed toward enforcement activities. The Federal monitoring system provides a uniform data base throughout the country against which all other air quality data can be verified. States must provide adequate monitoring of total suspended particulates, sulfur dioxide, carbon monoxide, nitrogen oxides, oxidants, and total hydrocarbons. The number of sampling stations required depends primarily on existing pollution levels, their geographical and temporal variability, and the size of the region. The number of sampling stations must be adequate to allow definition of the area or areas where ambient concentrations may be expected to exceed those designated in air quality standards. Station locations and sampling site characteristics were discussed. The sampling frequencies for mechanical samplers and the averaging times for automatic samplers are dictated by ambient air quality standards. The frequencies (continuous, daily, or weekly) are given for suspended particulates, lead, polycyclic organic matter, fluorides, SO2, CO, HC, nitrogen dioxide, NOx, and ozone for urban and rural areas. With automatic instrumentation the need for routine laboratory support is greatly reduced but a problem of data transmission, validation, and reduction is introduced. Trends in urban air quality were also reviewed.

33740

Hartkopf, Guenter

**ASPECTS OF THE FEDERAL GOVERNMENT CONCERNING THE POLICY ON ENVIRONMENTAL PROTECTION.** (Aspekte der Bundesregierung zur Umweltschutzpolitik). Text in German. Staedtehygiene (Uelzen/Hamburg), 22(10):225-226, Oct. 1971. (Presented at the Arbeitsgemeinschaft Bonner Aerzte fuer Umweltschutz, 2nd Scientific Meeting, March 24, 1971.)

The present state of measures taken by the German Federal Government for protecting the envrionment is encouraging. A draft of the law for limiting the lead content of gasoline has been put before the German Bundestag. A draft for a federal emission protection law has been completed in the Department of the Interior. Experts look at the function of a Federal Institution as protecting against emissions and other institutions as protecting the environment. The federal government is determined to give the improvement of environmental quality priority over economic growth. Considering the complexity of the problems involving environmental pollution which range from lead contamination by automobile exhaust gases to possible climatic changes through carbon dioxide, the German Federal Government makes use of experience gained in these fields on the international level.

33844

Langmann, R.

**ENVIRONMENTAL PROTECTION FROM THE VIEWPOINT OF THE CITY MUEHLHEIM-RUHR.** (Umweltschutz aus der Sicht der Stadt Muehlheim Ruhr). Text in German. Oeffentl. Gesundheitswesen (Stuttgart), 33(10):658-665, Oct. 1971. 18 refs.

The sources for air pollution in the city Muehlheim-Ruhr are domestic heaters, automobiles, and industry. While the carbon monoxide fraction in waste gases from power plants is one percent, it is three percent at domestic heaters and fluctuates between 0.05 and 13%. A fraction of five percent CO in the hemoglobin lowers the ability to concentrate. Such COHb values can be expected to accumulate during driving in busy streets. In Muehlheim-Ruhr some values have been measured which exceeded 50 ppm. Another pollutant emitted by automobiles, lead, has been found in a concentration of 0.55 mg/sq m/day. No higher lead concentration in the blood of the population in the city has been recorded. Also, 120 mg/sq m/day of zinc has been determined in one section of the city. After the installation of cloth filters, the zinc concentration sank to 0.5 mg/day/sq m. The sulfur dioxide emission has been reduced in Muehlheim-Ruhr by a switch to natural gas. The SO2 concentration measured in this city was 0.21 mg/cu m. A lower ultraviolet radiation was measured in the hazy industrial city of Muehlheim-Ruhr than in neighboring Bielefeld with no industry. Possibilities for assuring environmental protection are discussed with emphasis on health officials, medical personnel, and control agencies.

34033

Bermingham, P. E.

**CURRENT EMISSION STANDARDS AND THE PETROLEUM INDUSTRY.** American Petroleum Inst., New York, Div. of Refining, Proc. Am. Petrol. Inst. Div. Refining, vol. 51:587-610, 1971. 86 refs. (Presented at the Midyear Meeting, 36th, San Francisco, Calif., May 12-14, 1971.)

Environmental laws and regulations applicable to petroleum refining are discussed from a legal point of view. Effluent discharges as affected by the Water Pollution Control Act and its amendments are discussed, as well as oil spills affected by the Water Quality Improvement Act of 1970 and impediments to navigation affected by the Refuse Act of 1889. Pending 1971 water pollution amendments are indicated. Refinery emissions into the ambient air as affected by the Clean Air Act and its amendments are considered. National standards are cited for major pollutants and new stationary sources. Fuel composition including lead in gasoline is discussed. Citizens suits, noise, odors, flares and glares, and thermal pollution are mentioned. (Author abstract modified)

34980

Study Group on Pollution and Inhabitants

**ENVIRONMENTAL POLLUTION AND INHABITANTS MOVEMENT AT ANNAKA CITY.** (Annakashi ni okeru kogai to jumin undo). Text in Japanese. 52p., 1971 (?). 16 refs.

The source of pollution that has caused environmental hazards at Annaka City, Gumma Prefecture is only a metal refining plant. Since the move to pollution was deeply affected by the characteristics of the community, geographical and historical conditions, industrial structure, and damages to soil, crops, plants, and humans were investigated. Countermeasures of the Ministry of Health and Welfare, the Ministry of Trade and Industry, Gumma Prefecture, and Annaka Municipality were discussed. Pollution at Annaka City has been caused by cadmium, zinc, and lead. The Ministry of Health and Welfare made a study from the viewpoint of environmental pollution, health of inhabitants, and source of pollution. Since the illegal act of the Inspectorate Division of the Tokyo Mining District against the mining safety law in regard to an Annaka refining plant, the Ministry of Trade and Industry has been studying the methods of pollution control. Gumma Prefecture and Annaka Municipality have also made continuous investigations on pollution since Ministry of Health and Welfare assigned the city as an investigation-required region in 1969. Twenty-five organizations of inhabitants against environmental pollution and their supporting groups are mentioned. The philosophy of the two major groups are different and antagonistic. One was organized by victims of the region and is against industry. This group is called the Antagonists group. The other is formed by area residents and conservative members of the municipal assembly and is called the Cooperative group. The history of development, organization, the results of activity, and the supporting bodies of both groups were briefly discussed.

35151

Ministry of International Trade and Industry (Japan), Public Nuisance Security Bureau

**POLLUTION CONTROL POLICY OF THE MINISTRY OF INTERNATIONAL TRADE AND INDUSTRY FOR 1972.** (Showa 47-nendo no Tsusho sangyo-sho no kogai taisaku ni tsuite). Text in Japanese. Sangyo Kogai (Ind. Public Nuisance), 7(10):617-626, Oct. 1971.

The 1972 public nuisance control policies and measurement program by the Ministry of International Trade and Industry are discussed with regard to the Ministry s budgets for: investigation and guidance, development of control techniques, expansion of assistance given to industrial pollution control activities, and the promotion of desulfurization systems, industrial waste disposal systems, and small and medium size industries pollution control measures. The total budget for guidance and investigation is $1.147,000, of which the budget for the guidance and education of stack gas treatment technicians is $24,800, and the budget for investigation of industrial complexes for bad odor is $21,100. About $4,061,000 is to be spent toward the development of electric cars and $31,000 for in-

vestigation, calibration, and standardization of air pollution measurement instruments. For installations of desulfurization systems, $28,210,000 will be given as subsidies to industries; $15,500,000 will be spent to eliminate lead from gasoline; and $10,540,000 will be spent for installations of electric power generators using liquified natural gas. Import duties are to be decreased approximately $1.55/kl of desulfurized oil, and 34 cents kl of low sulfur crude oil.

35461

91st Congress

**LEAD-BASED PAINT POISONING PREVENTION ACT.** P. L. 91-695, 3p., Jan. 13, 1971. 7 refs.

The Lead-Based Paint Poisoning Act authorizes the Secretary of Housing and Urban Development to establish a Federal demonstration and research program for the study of lead-based paint poisoning and requires the Secretary of Health, Education, and Welfare to prohibit future use of lead-based paint in Federal or federally assisted construction or rehabilitation. The Act also provides Federal grants to help cities and communities establish intensive local programs for detecting and eliminating the causes of lead-based paint poisoning. Grants for detection programs are not to exceed $3,330,00 in fiscal year 1971 and $6,660,000 in fiscal year 1972. Grants for elimination programs are not to exceed $5,000,000 in fiscal year 1971 and $10,000,000 in fiscal year 1972. Appropriations for the Federal demonstration and research program are $1,670,000 for fiscal year 1971 and $3,340,000 for fiscal year 1972.

35795

Shinmura, Gakushi

**PARTIAL REVISION OF ORDINANCES RELATED TO AIR POLLUTION CONTROL LAWS.** (Taiki osen boshi ho kankei horei no ichibu kaisei nado ni tsuite). Text in Japanese. Nihon Gasu Kyokai-shi (J. Japan Gas Assoc.), 24(9):26-29, Nov. 1971.

Commentaries are made on the main points of revisions in the Air Pollution Control Act passed by the 64th Diet session in the fall of 1970 and ministrial ordinances issued on June 26, 1971 on related matters. The main revisions in the Air Pollution Control Act include: the abolishment of specific control area systems and the application of emission and maximum concentration standards to the entire nation; prerogatives of local governments in issuing more strict emission standards than the national standards when deemed necessary; regulations controlling the use of fuels for especially polluted urban areas; and designation of emission standards for toxic materials and dust particles. Revisions made on the enforcement ordinances give specified toxic materials as cadmium, chlorine, hydrogen chloride, fluorine, hydrogen fluoride, silicon fluoride, lead, and nitrogen oxides. Comments and explanations are given on various dust and soot creating facilities and emission standards, areas with special sulfur oxide emission standards, fuel use control areas, emergency countermeasures, administrative responsibilities, and various technical standards and applications in gas work operations.

35922

Fujitani, Yoshiyasu

**AIR POLLUTION: MEASUREMENT AND CONTROL MEASURE.** (Taiki osen, keisoku to taisaku). Text in Japanese. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 6(1):27-30, 1971. (Presented at the National Council Meeting of Air Pollution Studies, 12th, Nagoya, Japan, Oct. 27-29, 1971.)

Sulfur oxides, particulates, carbon monoxide, hydrocarbon, and nitrogen oxide concentrations and their emission sources are presented for the U. S. in 1966. The U. S. monitoring system is briefly discussed. An automobile maker in Nagoya began an investigation in April 1970, and after one year of preparation, obtained monitoring apparatus and began a two-year continuous monitoring of two cars and two fixed monitoring stations in Nagoya. Sulfur dioxide, dust, nitric oxide, nitrogen dioxide, CO, HC, oxidant, and lead are being measured; the wind direction, velocity, temperature, humidity, the quantities of the sunshine, and precipitation are also measured. Traffic, pollutant concentration, and correlation between pollution, traffic, and meteorological factors will be examined. The patterns of pollution and high fluctuation, if any, will be determined at busy intersections and in Nagoya city as a whole. The method of forecasting will be developed by simulation tests.

36030

Uchida, Sanichiro

**UNLEADED GASOLINE PROBLEMS.** (Gasorin no muenka ni tsuite no mondaiten). Text in Japanese. Nenryo Kyokaishi (J. Fuel Soc. Japan, Tokyo), 50(534):768-777, Oct. 1971. 20 refs.

In Japan, all the lead additives in both regular and premium gasolines are to be removed by April 1, 1974. This will not only have a considerable influence on the refineries both technically and economically, but will also pose many problems for the automobile manufacturers and users of the cars. With regard to petroleum refining, there will be a problem of how to select a suitable octane booster in order to manufacture a well balanced unleaded gasoline. Valve seat recession and knocking troubles will be present in older cars without new devices.

36877

Ministry of Health and Welfare (Japan); Ministry of International Trade and Industry; (Japan); Ministry of Transportation, Tokyo Japan; Japan Police Government Headquarters, Tokyo

**PREVENTIVE MEASURES OF AIR POLLUTION PRODUCED BY LEAD IN AUTOMOBILE EXHAUST GASES - WITH SPECIAL REFERENCE TO LEAD HAZARDS IN YANAGI-CHO, USHIGOME, AND SHINJUKU-KU.** (Jidosha Haikigasu chu no namari ni yoru taikiosen no boshi taisaku ni tsuite - Shinjuku-ku Ushigome Yanagi-cho engai jiken to kanrenshite). Text in Japanese. 59p., June 1970.

A liaison conference was organized by four Japanese ministries to consider countermeasures against so-called Yanagi-cho Hazards. A summary report was presented concerning the data of a liaison conference, and countermeasures by each Ministry. Lead quantity exceeded by 60 micrograms, 100 ml the Labor Ministry standard value in the blood of 13 of 62 inhabitants near the Yanagi-cho, Ushigome. A medical group in a consumers co-operative society in the Bunkyo-ku reported that the hazards were due to lead in automobile exhaust gases. An investigation of the cause of the hazards has been carried out by the Ministry of Health and Welfare. The Ministry told the Tokyo Metropolitan Government that preventive measures for automobile exhaust gases should be administered as far as possible. An origin of the hazards was clarified by the result of the medical examinations. Information is given about lead quantity in the blood, urine, and air, and 15 sets of investigation concerning the effect on the human body, and measurement figures of lead in the environmental air. The mean, highest, and lowest value of lead concentrations in the air were classified by locations, the method of determination, and

the names of investigation reports. One of the countermeasures by the Ministry of International Trade and Industry was to decrease lead quantity added to the gasoline of automobiles, and to make non-use of lead a long-term project. The problem of a preventive measure of lead hazards by automobile gasoline is being examined by the Ministry of Transportation. The Ministry of Police Administration is striving to consolidate traffic control systems, and to develop a cooperation between traffic control and air pollution monotoring systems.

37193

**A PREVIEW OF THE YEAR 1972, FEDERAL GOVERNMENT INTENSIFIES ENVIRONMENTAL PROTECTION.** (Ausblick auf das Jahr 1972. Bundesregierung intensiviert Umweltschutz). Text in German. Wasser Luft Betrieb, 15(12):431-433, Dec. 1971.

The Cabinet of the Federal Government approved a program for the protection of the environment. An advisory panel and an information center concerning all questions of environmental pollution shall be created. For combating air pollution, the Federal Government drafted the Federal Emission Protection Law which calls out for more research and development in the field. It strives to reduce emission of pollutants by Otto engines to one tenth of the average values emitted in 1969. The reduction shall be achieved in steps and shall be completed by 1980. A first step is a limitation of the emission of carbon monoxide and hydrocarbons. A second important step is the law limiting the lead content of gasolines. Other limitations of pollutants found in exhaust gases are in preparation.

37392

**THE PROBLEM OF THE LEADED GASOLINE LAW.** (Zur Problematik des Benzinbleigesetzes). Text in German. Erdoel Kohle (Hamburg), 24(9):605-606, Sept. 1971.

A West German law of Aug. 8, 1971 that requires the maximum lead content in spark-ignition motor fuel to be 0.15 g/l as of 1976 is criticized. The reduced octane values would require new expensive refinery processes and modifications in motor designs, while used car engines would create a serious problem. Also fuel imports would be affected, despite the provisions of the law. A lead filter, equivalent in its effect with the law, is being developed by the Associated Octel Co. Ltd., London. This law does not rule out a common solution by the European Economic Community in the future. Experts of this organization found the fuel lead content of 0.4-0.45 g/l acceptable from a hygienic point of view. A further reduction of the lead content as envisaged for 1976 might even increase dangers due to increased amounts of aromatic compounds in gasoline.

37423

Ruckelshaus, William D.

**ENVIRONMENTAL PROTECTION AGENCY. (40 CRF PART 80). REGULATION OF FUELS AND FUEL ADDITIVES. LEAD AND PHOSPHORUS ADDITIVES IN MOTOR VEHICLE GASOLINE.** Federal Register, 37(36):3882-3884, Feb. 23, 1972. 3 refs.

The Environmental Protection Agency has determined that emission products from lead and phosphorus additives will significantly impair the performance of emission control systems, including catalytic converters, being developed to meet the 1975-1976 motor vehicle emission standards. To provide for the availability of essential lead- and phosphorus-free gasolines by 1975, the EPA proposes to regulate the lead and phosphorus content of regular and premium gasolines, beginning Jan. 1974. The proposed regulations are presented as a new Part 80 to be added to Title 40 of the Code of Federal Regulations. The regulations are divided into two parts, one containing general provisions and the other the controls applicable to gasoline refiners, distributors, and retailers and to motor vehicle manufacturers. The liability for violations is outlined.

37497

Saylor, Louis F.

**PUBLIC HEALTH REPORT.** Calif. Med., 115(1):106-107, July 1971. 5 refs.

Since 1954 the California Dept. of Public Health has conducted research on the effects of air pollution on health, and the application of such research to determine what upper limits need to be imposed on pollutants to protect the health. The first scientifically supported air quality standards in the nation were developed by the department in 1959. Among other health reactions, the effects of oxidants on asthma and lung function were investigated, as well as research on the body burdens of lead and carbon monoxide. However, technology alone without significant changes in our mode of life will not provide air of sufficient purity to avoid deleterious effects on health. Long- range community planning is needed, as well as air pollution health warning systems and continuing research.

37521

Shiobara, Yoichi

**AIR POLLUTION NEAR YANAGICHO INTERSECTION CAUSED BY AUTO EXHAUSTS AND URBAN REDEVELOPMENT - A VOICE OF A RESIDENT.** (Yanagicho no kotsu kogai to toshi saikaihatsu - Jumin no hatsugen). Text in Japanese. Jurisuto (Jurist), no. 492:92-98, Nov. 10, 1971.

Atmospheric lead pollution, caused by the large amount of traffic in the Yanagicho area, has caused symptoms of lead poisoning such as nausea, forgetfulness, inertia, and change of character among residents living near the Yanagicho Intersection. Ten countermeasures against lead pollution would be prohibition of the use of lead as a gasoline additive; antipollution devices; prompt compensation of all personal and property damages caused by auto exhaust fumes; the establishment of a green-belt and widened pavements; the transfer of pollution regulative powers to the local governments; an amendment of the pollution regulations in order to put the residents interests before industries profits; enforcement of a no-car day in the Yanagicho area; establishment of special environmental standards of Workmen s Health for the Yanagicho area; construction of underpasses for automobiles; and examination and prompt medical treatment of lead pollution victims. Urban redevelopment projects near Yanagicho intersections have not been adequately studied for commercial use in the Yanagicho area. Residents should participate in urban renewal plans; adequate guidance and explanation is needed by urban renewal authorities.

37560

**RETROSPECT ONTO TECHNICS AND RESEARCH 1971.** (Rueckblick auf Technik und Forschung 1971). Text in German. VDI (Ver. Deut. Ingr.) Nachr. (Berlin), 25(52):1-2, Dec. 29, 1971

Progress has been made in the Federal Republic of Germany in 1971 with regard to dedusting. Dedusting equipment is used in nearly every branch of industry, so that the dust load in the air has decreased. Great problems however are caused by air

pollution like sulfur dioxide, carbon monoxide, and nitrogen oxides. Gas washing methods for SO2 are still in a state of experimentation and the refineries are opposed to a desulfurization of the fuel because of costs. The reduction of CO and NOx is similarly difficult. The main producer of these harmful gasses is the car motor. A concentration of CO and NOx which is harmful to human health is reached and even exceeded in rush hours of densely populated cities. A limitation of CO in exhaust gas has been in effect since Oct. 1971, however, there is none for NOx. In Aug. 1971 a gasoline-lead act became effective which provides a reduction of the toxic metal organic lead additives. Another law against air pollution, the emissions protection law, is in preparation.

37717

Engelkes, G.

**DECONTAMINATION OF WASTE GASES IN SWEDEN.** (Abgasentgiftung in Schweden). Text in German. Gesundheitsw. Desinfekt. (Hamburg), 63(11):172-173, Nov. 1971.

Since 1969, decontamination of gasoline has been in progress in Sweden by means of a gradual reduction of its lead content. Within the next few years, the use of gas with any lead content at all will become illegal. By 1972, all new motor vehicles have to be equipped with a purification device for engine exhaust gases. All other, older cars are being checked once a year for the correct setting of carburetors to ensure the highest possible degree of combustion. Drivers are obligated to shut down the engine after three minutes of idle running. This regulation could result in a problem for taxis and buses, considering the discomfort which shutting off the heating system can bring about for drivers and passengers. For this reason, taxi stations, bus stops, and bus terminals are electrically heated, so that heated air can be conveyed from there to the inside of the vehicles. As part of official inspection procedure in Sweden, a certain apparatus is inserted into the exhaust pipe for determination of the composition of the waste gases. If unsatisfactory conditions are found, they have to be attended to and the car has then to be presented again for inspection. Injection pumps for diesel engines must be set so that the exhaust gas conditions remain tolerable even at maximum load. The law prescribes that the pump has to be sealed by the work shop or service garage after setting.

38669

Osaka Prefectural Government (Japan), Div. of Atmosphere

**AIR POLLUTION CONTROL LAW INSTRUCTIONAL DATA.** (Taiki osen boshiho setsumei shiryo). Text in Japanese. 14p., 1971.

Instructions and explanations are given concerning the air pollution control law and the main points of revisions. The organization and system of the law are explained by a flowchart. Regulations are applicable to stack gases including sulfur oxides, soot, general and special toxic gases, special toxic materials, and dust particles. With regard to emission standards, sulfur oxide emission standards are categorized in eight groups and are determined locally. Stack gas, soot, and toxic gas emission standards are determined nationally, and special emission standards are applicable to soot and special toxic gases. Violations in all categories of stack gases are subject to penalties. Standards for special toxic materials are determined case by case at the time of accident. Dust emission standards are determined depending on the structure, use, and maintenance of facilities. These last two items are not subject to penalty. The method of enforcement of improvement orders and the period of improvements are reviewed by a table. Items and facilities that require registration and reporting are reviewed by a table. Facilities designated as soot and stack gas emission sources are reviewed by a table. Emission standards with regard to categories and usage, the old and new standards, and control areas are reviewed by tables and maps. Emission standards of special toxic materials such as cadmium and compounds, chlorine, hydrogen chloride, fluorine, hydrogen and silicon fluorides, and lead and compounds, are reviewed by a table. Dust creating facilities and their management standards are given.

38757

**EPA RELEASES LEAD PHASEOUT PROPOSAL.** Oil Gas J., 70(9):38-39, Feb. 28, 1972. 2 refs.

The Environmental Protection Agency has published proposed regulations aimed at a 60-65% reduction in the use of lead additives in motor gasoline by mid-1977. Marketers will be required to offer a lead-free, phosphorus-free grade of at least 91 research octane number at stations accounting for about 80-85% of sales in the U. S. EPA concluded that additives will interfere with catalytic mufflers likely to be used to meet emission standards for 1975 and 1976 model autos, and also that atmospheric lead above 2 micrograms/cu m, averaged over a period of 3 mo or longer, constitutes a health hazard. Costs are mentioned, as well as the objections to the proposed regulations.

39640

Thum, Ernest E.

**SMOKE LITIGATION IN SALT LAKE CITY.** Chem. Met. Eng., 22(25):1145-1150, June 23, 1920.

Another stage in the smoke litigation involving smelters operating in the Salt Lake Valley, Utah, ended on Feb. 21, 1920, when a Federal judge signed an interlocutory decree permitting, under certain conditions, the continued operation of the American Smelting and Refining Co. plant at Murray and the United States Smelting Co. plant at Midvale. After the original suit of 409 farmers in 1906, the Murray plant immediately erected a large baghouse for eliminating solid particles from the gas. This was in line with the contention that the damage was largely due to compounds of sulfur and arsenic which condensed on particles of soot or other solid matter and settled with them to the ground. The company also made the proper financial settlements with the complaining farmers and agreed to construct an extensive dust chamber at the roaster department to cool the gases from those operations. The United States Smelting Co. claimed that its newly perfected Sprague process of introducing zinc oxide into the smoke would remove all cause for crop injury. At the same time the zinc would neutralize sulfuric acid, forming with it a solid which would be caught by the bags. The court also stipulated that the Midvale plant must remove all solids from its roaster and blast-furnace gases, discharging all smoke through a single smokestack free of lead, copper, arsenic, and antimony compounds and all traces of sulfur trioxide. The fate of the other plants in the region is indicated. Both American Smelting and Refining Co. and United States Smelting Co. have maintained investigating staffs during the litigation period to study the question of smoke injury in general and to operate experimental farms near the smelters. Factors modifying smoke damage, sulfur dioxide injury, and economic loss are discussed.

40486

**ELIMINATION OF LEAD FROM AUTOMOBILE GASOLINES.** (Elimination du Plomb des Essences pour Automobiles). Text in French. Protectio Vitae, no. 1:30, 1972.

The International Society for Research into Civilization Diseases and Vital Substances issued a new resolution concerning the fight against the toxic effects of lead. It states that lead content in gasoline should be reduced as soon as practically possible. Instead of the present general limit of 0.4 to 0.6 g/l, one should aim for a reduction to 0.2 g/l in 1972, and 0.1 g/l in 1974. Vehicles now taxed on the basis of cylinder volume, should be so taxed to encourage changes in design favorable to a decrease in pollution. There should be higher taxation on lead bearing gasoline. Display and storing of food in the open in streets with heavy traffic should be prohibited. Effective measures should be taken for protection against the dangers of highly toxic organic lead compounds; for prohibition of use of lead carrying gasoline for cleaning; for protection of persons with regard to inhaling, and to exposure of their skin to toxic compounds. Possibilities of replacing tetraethyl lead as antiknock agent in gasoline by a different additive should be studied. Routine recording, on a world wide scale, of lead content in the atmosphere should occur. Other studies, including research into the biological effect of lead present in traces only, should be made.

40520

Wallden, Ingwald and Gerhard Salingen

**LEAD IN PETROL. CONSEQUENCES FOR CONSUMERS AND INDUSTRY.** (Bly i bensin. Konsekvenser foer konsument och industri). Text in Swedish. Mod. Kemi., 5(4):26-31, April 1972. 9 refs.

The viewpoints of the gasoline and the car industries concerning lead in gasoline are presented. The need for an adjustment in research and development programs is stressed. This is believed necessary to avoid incorrect investments and decisions which may restrain international trade and traffic. A new Danish thermal catalytic exhaust cleaning system with good performance at a reasonable cost is discussed. A recently introduced bill is also discussed which calls for the gradual reduction of lead in gasoline to .4 g/l by 1973 and .15 g/l before 1976. The recommendation is from the National Swedish Nature Conservancy Board and the Government Poison Board. (Author summary modified)

41289

Bonner and Moore Associates, Inc., Houston, Tex.

**TAX SYSTEMS TO SUPPORT REDUCTION OF LEAD CONTENT IN MOTOR GASOLINES.** Environmental Protection Agency Contract 68-02-0050-3 72p., July 29, 1971. 2 refs. NTIS: PB 203953

Four lead content reduction schedules were selected from a previously conducted added cost study for further analysis to explore the use of taxation as an implementation device. Differences between the schedules provide for removal of lead from conventional 94-octane and 100-octane grades at different rates over a 10 year period. The basic role of taxation is to raise the price of leaded gasoline so that the price of the unleaded or low-leaded gasoline is competitive with the leaded regular. This taxation can take the form either of a per-gallon tax on fuel containing lead, a flat tax per pound of lead used in gasoline additive, or a combination of the two. The least demanding reduction schedule can be met only through the use of a cent-per-gallon tax on gasoline. This method would increase taxes for the leaded grades and all grades equal to or greater than 94-octane while decreasing the tax on the new third grade 93-octane grade. The more demanding schedules are most effectively met through a direct tax on lead additives. Lead is taxed and an excise tax credit of one-half cent/gal is allowed on all unleaded gasoline below conventional regular octane. Regulation on lead levels would be required if a gasoline tax is used to implement these schedules. Results of imposing all three tax methods are described in detail.

41557

Ulled, Armando

**ENVIRONMENTAL POLLUTION AND THE ECONOMY.** (La contaminacion ambiental y la economia). Text in Spainish. Ingenieria, Mexico City, 73(1018):25-29, Aug. 1971. 4 refs.

Various aspects of environmental pollution are discussed. Included are topics such as the main pollutants occurring in the environment, who is involved in the pollution problem, the role of the government in organizing the measures to be taken in the control of pollution, the contribution of the World Health Organization in this matter, and a review of solutions found by some of the European countries in the fight for the preservation of the ecology. Detection and monitoring of air pollutants is assuming a character of international concern. The World Health Organization has provided recently for a world system of air pollution monitoring including nonpolluted regions such as the polar areas. Attention is focused on six elements such as sulfur dioxide, solid particles, carbon monoxide, photochemical smog, nitrogen oxides, and lead. Data are fed into a central computer system connected with an alarm facility to be triggered whenever certain pollutant levels are exceeded at a given point of the world map. The economical aspects of the pollution problem carry a national character in that they depend on the specific features of each country s economy and ecology.

41703

Philberth, Bernhard, Karl Philberth, and Helmut Borcherdt

**ENVIRONMENTAL PROTECTION THROUGH TAX POLICY. PROPOSALS ON GASOLINE AND AUTOMOBILE TAXES.** (Umweltschutz durch Steuerpolitik. Vorschlaege zum Thema Mineraloel- und Kfz-Steuern). Text in German. Staedtehygiene (Uelzen/Hamburg), no. 4:101-103, 1972.

Proposals on tax policies as a means of environmental protection are outlined with special application to transportation. The principle of high taxes on products causing great damages to the environment should be applied also to the automobile industry. In order to establish maximum allowable concentrations for heavy metals in the air, a surtax of approximately 0.33 cents per promille of lead in the gasoline should be imposed, which would stimulate the development of new engine designs operating on lead- free gasoline. Increased benzopyrene and carbon monoxide contents as a result of lead-free gasoline would not occur in the exhausts from diesel and Wankel engines. Surtaxes on each engine model, in proportion to the specific damage caused to the environment, would stimulate the design of cars causing less damage to the environment. Since the taxes on private transportation are still too low, the taxes on automobiles and gasoline should be increased to subsidize public transportation.

42016

**THE REDUCTION OF THE ADMISSIBLE LEAD CONTENT IN GASOLINES.** (Zur Herabsetzung des zulaessigen Bleianteils in Kraftstoffen). Text in German. Metall (Berlin), 26(5):495-496, May 1972.

The law passed singly and isolatedly by the Government of the Federal Republic of Germany limiting the lead content of fuels might have unfavorable consequences for free trade within the European community. The mineral oil industry and automobile industry of the other member states will be forced to a special

production of gasolines and cars for the German market. This will be a burden to the industries of the member states rather than for the German industry. The Commission thinks that environmental protection is of vital interest for the entire Community, but all measures taken should be in due proportion. The differences in the opinion of experts is an indication that not much is known to date about the harmfulness of lead and the aromatics used to replace the lead. Single acts on the national level are detrimental to the Community and enhance the difficulties faced by the Community in its strive to arrive at a uniform policy in the field of environmental pollution. The Community is sponsoring a study program which should lead to the issuance of emission standards fit for all member states.

42041

**THE ELIMINATION OF LEAD FROM LEAD-CONTAINING BENZENE.** Protectio Vitae, 1972:89, 1972.

After a short transitional period to allow process modifications, the lead concentrations in benzene should be reduced. The ultimate goal should be the complete elimination of lead as soon as possible. Structural motor modifications should be started immediately. The quantity of lead in benzene should be taxed. The exhibition and storage of unpacked foodstuffs near motor roads must be prohibited. The use of leaded benzene in dry cleaning should be prohibited. Feasibility studies of replacement of leaded benzene with other fuels or of the replacement of lead with other additives are needed. Effective use must be made of present facilities to determine lead levels in the environment. Studies concerning the epidemiology of acute, chronic, and latent lead poisoning are necessary in order to establish the limits of admissible lead content in the environment, the biosphere, and the human organism.

42169

Wolff, Hans-Christian

**THE TIME, THE COOPERATION AND PROTESTS FROM THE COMMON MARKET PARTNERS. THE SECOND STAGE OF THE GASOLINE LEAD LAW.** (Die Zeit, die Zumsammenarbeit und Proteste aus der EWG. Die zweit Stufe des Benzin-Bleigesetzes). Text in German. Umwelt (Duesseldorf), 2(3):50-51, June-July 1972.

The first stage of the gasoline-lead-law went into effect on Jan. 1, 1972. The lead concentration in all gasolines was reduced to 0.4 g/l. The legislation came too rapidly for the mineral oil industry. The construction of new refineries to meet the deadline was impossible. A lowering of the gasoline quality was unavoidable. There was no time for a study of the effect on the 15 million automobiles already in operation. It is suggested that the deadline for the second stage of the lead-law should be reconsidered. This is particularly justified in view of the results of the recent extensive study by the National Academy of Science in the U. S. The study found that the lead concentration of the air in the U. S., whose traffic density is much higher than that in Europe, has not yet reached a level which is acutely dangerous to the population.

42873

**AIR POLLUTION PROBLEMS.** (Problem der Luftverschmutzung). Text in German. In: Bericht der Bundesrepublik Deutschland ueber die Umwelt des Menschen. p. 53-61, May 1972.

Problems of and measures planned in West Germany to control air pollution are outlined. Air pollution, particularly due to carbon monoxide, sulfur and nitrogen oxides, fluorine, heavy metals, dust, and odors, represent health and corrosion hazards. Model experiments to elaborate adequate pollution abatement measures have been carried out. Clean air maintenance plans, including regional programs, the set-up and extension of monitoring networks, the use of low-emission raw materials, fuels, technologies, equipment, dust separators, gas cleaning equipment, and high stacks will be the basic means of abating air pollution. Further pollution standards, implying limitations on fuel sulfur content, will be introduced. Partial desulfurization of fuel and Diesel oil has been applied. The emissions from Otto engined vehicles will be successively reduced to 1/10 of the 1969 level by 1980. Carbon monoxide and hydrocarbon emissions have been limited as a first step, followed by a lead emission standard in 1971, requiring a maximum concentration of 0.4 g/l which will be further reduced to 0.15 g/l in 1976. As the possibilities to control emissions from conventional engines are limited, studies on new power sources are promoted. Radioactivity as created by human activity is negligible in comparison with the background level.

44044

Freeman, A. Myrick III and Robert H. Haveman

**RESIDUALS CHARGES FOR POLLUTION CONTROL: A POLICY EVALUATION.** Science, 177(4046):322-329, July 1972. 28 refs.

Growing interest has been directed toward one alternative strategy for controlling environmental pollution; that strategy is the creation of economic incentives for pollution control by levying taxes or charges on wastes (residuals) discharged to the environment. Many proposals have been made which would directly or indirectly raise the cost of discharging harmful wastes to the environment. Their aim is to induce firms, municipalities, and individuals subject to the charges of wastes to curb their discharges and ultimately to reduce the damages caused by these discharges. Much debate has focused on the efficacy, feasibility, and effectiveness of residuals charges. To dispell confusion, correct misconceptions, and put the more substantive of the criticisms into proper perspective, the residuals charge strategy is compared with the relevant alternative, direct regulation of discharges through permits backed by an administrative and judicial enforcement system, representative of present policies in air and water pollution control. Some of the areas of comparison were: differences in regulation and enforcement, measurement of discharges, cost of pollution control, industrial reaction, effect on inflation and other economic aspects, environmental management, and administration. Experiments are recommended to test some forms of residuals charges, such as a federal charge on emissions of sulfur oxides or a tax on lead additives, or establishment of a river basin authority with responsibilities for air, water, and solid wastes.

44219

**ENVIRONMENTAL PROTECTION REQUIRES NEW THINKING.** (Umweltschutz erfordert Umdenken). Text in German. Metall. (Berlin), 26(7):763, July 1972.

General problems of environmental protection and international cooperation in this area are reviewed. Ecological impacts of economic and technical activities should have priority above economic expansion. The initial steps in an environmental program have been taken recently in West Germany. Emission standards have been imposed, and the lead content in gasoline has been limited to 0.04 g/l since January 1972, with a further reduction to 0.15g/l to take effect in 1976. International cooperation in matters of environmental protection, including the specific problems of underdeveloped nations, is a necessi-

ty. An environmental alarm and information system will be set up in a joint effort of 22 nations belonging to the Organization for Economic Cooperation and Development (OECD).

44325

Kwon, Sook Pyo

**AIR POLLUTION IN JAPAN AND ITS CONTROL.** (Ilbon eu daegi oyum gwo gue gwanri siltae). Text in Korean. Taehan Uihak Hyophoe Chapchi (J. Korean Med. Assoc.), 14(10):729-734, Oct. 1971. 8 refs.

Sulfur dioxide, oxides of nitrogen, suspended particulates (lead, cadmium, and zinc), hydrocarbons, and total oxidants were measured in several cities such as Tokyo, Osaka, Sapporo, Kawajaki, and Kita-kyushu. Some were measured between 1967-1969 and others during 1964-1969. Sulfur dioxide decreased in three cities but stayed about the same in Tokyo, Osaka, and 17 other cities. In general, carbon monoxide increased between 1964-1969. Rapid increase in nitric oxide and nitrogen dioxide was observed in Tokyo. A slight decrease in suspended particulates was observed in 1969 from 1968. Levels of total hydrocarbon and oxidants also increased in Tokyo between 1969-70. Asthma and other respiratory diseases are cited. In 1970, the city of Tokyo set 0.05 ppm and 20 ppm as the tolerance level for SO2 and CO respectively. Since not enough is known about the effect of oxides of nitrogen, a study has been carried out since 1970. Effects of smog are mentioned, such as 5208 patients admitted during 1970. In 1972, the Anti-pollution Act of June 1968 was revised to give more power of control to the government. It also extended the list of chemicals or pollutants which come under regulatory restrictions and set national standards instead of local standards. Provisions for more strict enforcement are included. The restriction level for CO is set at 1.5% (when idle 4.5%) for new cars. In Japan, high octane gas contains 2.2 cc/gal tetraethyl lead and regular gas has 1.1 cc/gal. A national monitoring network was established in major cities in 1965. In 1971, there were 13 cities. An effort is being made to lower the sulfur content level in oil. The objective is 2.45% in 1972, 1.2% in 1973, and 0.8% in 1979.

44376

Brabander, L. De and R. Dieleman

**REGULATIONS FOR THE CONTROL OF AIR POLLUTION BY AUTOMOBILE ENGINES IN EUROPE. GENERAL TRENDS.** (Maatregelen ter bestrijding van de luchtverontreiniging door benzinemotoren in Europa. Algemene tendensen). Text in Flemish. Ingenieursblad, 40(15-16):436-438, 1971.

Regulations for the control of air pollution by automobile engines and general trends in Europe are outlined. Reducing the gasoline lead content, improving automobile designs, good carburetor adjustment, and proper maintenance are regarded as the basic means of controlling automotive exhausts. The gasoline lead content is reduced to 0.4 g/l in West Germany as of 1972. International regulations for spark ignition engines have been adopted by France and Czechoslovakia. Four different types of exhaust tests have been introduced. The carbon monoxide and hydrocarbon emissions during test type I may be 100-220 g and 8-12.8 g, respectively. The CO emission is limited to 4.5% during stationary drive in test type II, while test type III is concerned with crankcase gas hydrocarbon in relation to the fuel consumption. Test type II has been adopted by France, and both test type II and test type III were introduced in West Germany in 1969, while test type I was adopted there in Oct. 1970. Carburetor adjustment to reduce CO emissions has been required for all cars in Sweden since July 1970, and similar measures are expected to be taken in Belgium, where a network of inspection stations will be able to perform two million inspections in 1972. The influence of dilution, engine speed, and temperature on CO emission measurements is being studied in Belgium.

44499

Tokyo Metropolitan Environmental Protection Research Inst. (Japan)

**AIR POLLUTION.** In: Environmental Protection Summary in Tokyo. p. 1-15, Feb. 1972.

The general state of air pollution in Tokyo, major sources and emissions, effects of pollution on human health and vegetation, and abatement measures adopted by the metropolitan government are reviewed. The major pollutants are sulfur dioxide emitted from factories and commercial buildings using heavy oil; carbon monoxide, hydrocarbons, nitrogen oxides, and lead in automobile exhausts; and oxidants. In 1970, SO2 concentration exceeded the ambient standard (0.05 ppm) in the central business districts and industrial areas. Attacks of chronic bronchitis were more prevalent in these areas than in districts with lower concentrations; and plant species vulnerable to air pollution were rapidly disappearing. A 10-year plan was issued by the government with regard to expansion of the surveillance network; procedures and conditions for alerts; control through substituting low sulfur oil for heavy oil and conversion to gas or electric power; and automotive emission control through operating criteria, traffic control, urban redevelopment, and grade separation. The problems involved in legislating and enforcing abatement regulations are reviewed.

# M. SOCIAL ASPECTS

01073

V.G. MacKenzie

**AIR POLLUTION - WHOSE PROBLEM? Preprint. (Presented at A Panel Discussion on Air Pollution at the Board of Directors Meeting, National Petroleum Refiners Association, Washington, D.C., Sept. 20, 1965.)**

The need for conservation of air as a natural resource is discussed, with emphasis on the role of the petroleum industry. Wats and means for improving on past patterns of conservation effort through Federal authority under the Clean Air Act, establishment of automotive emission standards, and application of technology to control of sulfur oxides and automotive emissions are delineated. Attention is called to the need for research on oxides of nitrogen and lead contamination. It is suggested that business leaders, by their leadership in research and education, can play a significant part in alieviating environmental health problems.

29432

Fisher, Fred

**POLITICAL ASPECTS OF POLLUTION CONTROL.** Inst. of Environmental Sciences, Mt. Prospect, Ill., Proc. Inst. Environ. Sci. Annu. Tech. Meet., 17th, Los Angeles, Calif., 1971. p. 9-12. 3 refs. (April 26-30.)

The issue of environmental pollution and control is a classic example of the political process in action in which those making demands (the public and public agencies) are confronted by those who oppose the demands and have the political power (corporate polluters, large and small). Large corporate polluters will do nothing, or next to nothing, to prevent injury to the public health except when they are forced to do it. In opposing the demands, these polluters use influence, authority, power, and mobilization of bias in non-decision techniques to thwart the demands from becoming issues and reaching the decision-making process. For example, gasoline companies are making claims that they have solved the problem of automotive air pollution by the reduction or removal of tetraethyl lead. Thus, they hope to thwart further decisions by convincing the public there is no longer a problem. However, lead additives are being replaced by other additives that pollute the air, and lower octane ratings mean that more gasoline is needed to power the car. Also, automobile manufacturers believe that if they did not think of an invention, it cannot be good, such as Japanese pollution control systems. Two methods can be used to combat the efforts of polluters who use the political system to prevent decisions: lobbying and maximum feasible participation. The Delaware Valley Citizens Council for Clean Air lobbyed for an obtained strong pollution standards. Maximum feasible participation usually involves a comprehensive project funded and run by a segment of government that is not directly concerned.

33904

Perrine, R. L.

**OIL AND ECOLOGY -- THE NEED FOR A NEW OUTLOOK.** Preprint, American Inst. of Mining, Metallurgical, and Petroleum Engineers, Inc., Dallas, Tex., Society of Petroleum Engineers, 12p., 1970. 39 refs. (Presented at the American Institute of Mining, Metallurgical, and Petroleum Engineers, Society of Petroleum Engineers, Annual Fall Meeting 45th, Houston, Tex., Oct. 4-7, 1970, Paper SPE 2952.)

The nature of the air pollution problem as it pertains to the petroleum industry is considered, and a new educational framework which may make the solution of future problems easier is described. Photochemical air pollution in Los Angeles and the effect of automobile emissions are cited. Automotive emission reduction, the removal of lead from gasoline, and cost estimates for lead removal are considered. The need for a new breed of problem-solver is seen. A Doctor of Environmental Science and Engineering is suggested, which would combine physical, earth, and biological sciences with engineering. There must be an extensive internship program, with work under guidance on important problems in the real, industrial world.

35206

Barltrop, Donald and N. J. P. Killala

**FACTORS INFLUENCING EXPOSURE OF CHILDREN TO LEAD.** Arch. Disease Childhood (London), vol. 44:476-479, 1969. 10 refs.

Paint samples from 56 homes of 103 children aged one to 14 years were obtained. The lead content of the samples was related to the age of the building and to the social class of the family: 53% of the samples contained more than one percent of lead. Old houses, and families of low social class, were frequently associated with indoor paints of high lead content. Lead paint applied several decades ago, if infrequently covered by other paint, may continue to provide a potential hazard. Detection and removal of lead paint in situ should, therefore, be the aim in preventing lead poisoning of children from this source. (Author summary modified)

# N. GENERAL

03674

J. P. Lodge, Jr.

**AIR POLLUTION (REVIEW OF APPLICATION OF ANALYSIS).** *Anal. Chem. 33(5):3R-13R, Apr. 1961.*

This review covers the years 1959 and 1960, which have seen great activity in the air pollution research field. It supplements the previous review, with the exception that the growth of the literature has been so great that explicit coverage of radioactive pollutants has been omitted from this review. The trend toward increased interest in automotive exhaust and atmospheric carcinogens, noted in the previous review, has continued. In addition, there has been a renewal of interest in atmospheric lead. For the most part, these observations hold only for the United States. The bulk of research in Europe continues to be directed toward improved methods for measurement and control of sulfur dioxide and dust. Meetings and conferences were numerous. The annual symposia organized by the Committee on Air Pollution, American Chemical Society, featured sessions on automotive exhaust and on polynuclear hydrocarbons in 1959, and on photochemistry and fine particles in 1960. The Air Pollution Control Association continued its regular schedule of meetings. A conference on air pollution research was sponsored by the U.S. Public Health Service in New Orleans in early 1960, continuing a series of meetings intended primarily for the Public Health Service contractors and grantees in the field. More specialized meetings included a conference on dust in Vienna, one on adhesion of fine particles at Leatherhead, England, and a symposium at Oxford on atmospheric diffusion and turbulence. Increasing public interest in air pollution resulted in the publication of a large number of papers intended primarily for public consumption. These are too numerous and in general too lacking in novelty to warrant mention here. On the other hand, a substantial number of books and review articles of a general nature were published having high scientific merit.

04052

R. Haddad and J. J. Bloomfield

**ATMOSPHERIC POLLUTION IN LATIN AMERICA.** Bol. Ofic. Sanit. Panam. 58, 241-9, Sept. 1964. Sp. (Tr.) (Presented at the Inter-Regional Symposium on Criteria for Air Quality and Methods of Measurement, Geneva, Switzerland, Aug. 6-12, 1963.)

Latin America is an area which is experiencing a very rapid population and industrial expansion. Although this growth is very irregular, the cities which exceed a million inhabitants and the industrial concentration in them is growing yearly. This phenomenon has resulted in serious problems of air pollution in Sao Paulo, Brazil, Santiago, Chile, Mexico City, Mexico, which are in need of further investigation and control as quickly as possible. There are potential problems in Buenos Aires, Argentina, and in all those large metropolitan centres which are growing and industrializing rapidly. The situation created in Lima, Peru, because of the fishmeal industry, seems to be fairly well controlled. The greatest necessity is to train personnel capable of conducting studies in measuring air quality and controlling the contamination of the air. There is also a necessity to create a consciousness of the seriousness of the problem among government authorities and the public in general. It is hoped that the future development of the Institute of Occupational Health and Air Pollution Research in Santiago, Chile, will contribute effectively to achieve these objectives.

04212

S. Abe

**THE PRESENT STATUS OF AIR POLLUTION.** Clean Air Heat Management (Tokyo) 15, (7-8) 7-18, Aug. 1966. Jap.

The present status of air pollution in Japan is given naming the kinds of contaminants and their origin, factors affecting contamination density, and various types of smog. The types of contaminants are: 1) minute particles (less than 1 micron in size) such as found in soot, carbon, ashes, dust; 2) coarse particles (greater than 1 micron in size), as found in dust, ashes, and minerals; 3) reactive substances found in mist, fog, and vapor such as SO2, SO3, H2S, CO2, CO, NO2, N2O3, O3, aldehydes, HCl, NH3, HF, Pb, Hg, Cd, As, Be and 3, 4-benzpyrene. The contaminants originate from factories, chemical plants, power stations, domestic heating, public baths, hotels, laundries, dry cleaning establishments, hospitals, schools, and public buildings. Also discussed are the human factors affecting air pollution such as public awareness and interest, seasonal, weekly, and daily changes in heating and cooking. Meteorological aspects are covered such as wind direction and velocity, turbu- lence, temperature, rain and snow. The types of smog found in New York, London, Los Angeles, Pittsburgh, and Yokkaichi are described. Graphs and tables list symptoms and diseases affecting plants and humans and give the density of dust particles and SO2 in the main cities of Japan. Data on the sulfur content of various oils produced by Japanese refineries and on the number of Japanese automobiles produced is included for information on emission sources of pollutants.

04649

Blifford, I. H., Jr. and G. O. Meeker

**A FACTOR ANALYSIS MODEL OF LARGE SCALE POLLUTION.** Atmos. Environ. 1(2):147-157, March 1967.

Based on data obtained from the U.S. Public Health Service National Air Sampling Network for the years 1957-1961, factor analysis techniques were used to produce a pollution model for 30 U.S. cities. Orthogonal models obtained from Varimax and Quartimax solutions and an oblique solution (Oblimax) were similar. The first four principal factors were tentatively assigned to pollution from heavy industry, automobiles, fuel burning, and petroleum refining on the basis of their chemical composition. These four factors account for about 70 percent of the variance while another 20 per cent appears to be due to widespread use of plating materials. Regression of the derived factors (factor scores) on the 30 sampling locations indicates general agreement with the known character of the sites and with other studies of individual pollution components. (Authors' abstract)

05313

Chow, T. J., and C. C. Patterson

**CONCENTRATION PROFILES OF BARIUM AND LEAD IN ATLANTIC WATERS OFF BERMUDA.** Earth Planet. Sci. Lett. 1, (6) 397-400, Nov. 1966.

The purpose of this study was, a) to look for indications of industrially produced lead in Atlantic waters and, b) to compare the vertical profiles of barium and lead in these waters with those in the Pacific. Bermuda island was chosen as the site because it is removed from industrial sources of lead. Surface waters of the harbor and lagoon were sampled as well as water from various depths. A modified isotope dilution procedure was used for lead and barium analyses. Concentrations of these substances are given at various depths of Atlantic, Pacific, and Mediterranean waters. It is concluded that the contrast between lead and barium profiles near Bermuda demonstrates that significant amounts of industrial lead aerosols are washed out of the atmosphere directly onto the surface of the oceans. The Pacific and Mediterranean data suggest that lead pollutants have penetrated to depths of about 500m, while the Atlantic data indicate that lead contamination diminishes toward the open ocean.

06992

R A. Mostyn A. F. Cunningham

**THE DETERMINATION OF LEAD IN GASOLINE BY ATOMIC ABSORPTION SPECTROSCOPY.** Chemical Inspectorate, London, (England). (C.I. Memorandum No. 178.) (Sept. 1965). 7 pp.

Experimental conditions for the determination of the tetraethyl-lead (TEL) content of samples of gasoline have been investigated, using the atomic absorption spectrophotometer. A method is proposed, using only 2 ml. of sample, whih is rapid and accurate over the concentration range 0 - 6 ml. TEL per gallon. (Authors' summary, modified)

08273

**AIR POLLUTION AND THE UBIQUITOUS AUTO.** Environ. Sci. Technol., 1(11):878-880, Nov. 1967.

The recent report of the Commerce Department0s Panel on Electrically Powered Vehicles is discussed. 'The Automobile and Air Pollution: A Program for Progress' details 16 specific recommendations to serve as a basis for immediate action. There is an urgent need for more extensive information regarding the significance of specific and combined air pollutants on public health. Little is known of the social and economic costs of air pollution. The entire area of meteorological effects of air pollutants is speculative at present and only a beginning has been made in the design of meaningful research programs. The panel feels that 0the Federal Government should continue to establish standards for all harmful automotive emissions and realistic timetables for the achievement of such standards.0 Lead emissions particularly concerned the panel, because of possible impact on human health, increased levels of hydrocarbon in auto exhaust; modification of atmospheric processes; and deactivation of catalysts or absorbants which may be necessary to reduce emission of other pollutants. The panel feels that the emission standards should specify total mass of specific pollutants. The National Center for Air Pollution Control in its current organization does not appear appropriate for effective action. The panel would like to see an advisory board at the highest departmental level. The use of low pollution performance criteria rather than detailed product specification in the vehicle procurement process would provide strong incentives To meet future emission standards, more and better technology must be developed. The panel feels that: During the next decade, in the normal course of events, no significant reduction in total air pollution will be achieved through the introduction of unconventional low-polluting vehicles. Gas turbines are reasonable alternatives to internal combustion engines in the large sizes used in trucks, trains, and buses. Hybrid power plants might provide satisfactory performance. Because two separate energy sources are needed, such hybrids might be too expensive for private passenger autos.

09780

Environmental Science Services Corp., Stamford, Conn.

**AIR POLLUTION CONTROL PRIMER.** 35 p., ((1968)).

The main sources of air pollution are combustion processes, especially internal combustion engines. In a general manner the following are discussed: causes and effects of air pollution; legal aspects; automobile emissions; fossil fuels and lead additives; and control equipment and its market potential.

11871

Hashimoto, Michio

**AIR POLLUTION PROBLEMS BY AUTOEXHAUST IN JAPAN.** Preprint, Ministry of Health and Welfare, Tokyo, Japan, Bureau of Environmental Sanitation, 7p., 1968 (?).

Current air pollution measurement and control programs are presented with special focus on automobile exhausts. Since 1964, the National Hygiene Laboratory of the Ministry of Health and Welfare has operated 3 continuous air monitoring stations to determine carbon monoxide, nitric oxide, particulate matter, nitrogen dioxide, sulfur dioxide, and lead concentrations. Simultaneously, the wind speed, direction, temperature, and humidity were recorded and traffic counts were taken. The C0 and nitrogen oxides concentrations were on an upward trend while the particulate matter decreased. Based on the experience of the 3 monitoring stations, a National Air Sampling Network Program was inaugurated in 1965. The network will comprise 20 stations, 7 of which are already in operation. In 1966, a special diffusion study using the air tracer system was carried out. In 1965, a study of the effects of air pollution by automobile exhausts on humans was conducted. People living along busy streets as well as 20-year-old nonsmokers and non-smoking policemen were selected for the study. The air pollution concentration (spot tests) was likewise measured. A significant difference of the carboxyhemoglobin content was found between people living in the polluted area and the control group. Pulmonary function tests revealed a slightly higher function. In 1966, emission standards for all new car models were established. In December of 1967, idling adjustment screw conditioning was recommended for all used cars.

14772

Weaver, Neill K.

**ATMOSPHERIC CONTAMINANTS AND STANDARDS. STATUS REPORT.** J. Occupational Med., 11(9):455-461, Sept. 1969. 23 refs.

The Federal Air Quality Act of 1967 furnishes the methodology for the abatement of air pollution. Its provisions include the designation of air quality control regions and the issuance of air quality criteria and control technology documents, which will be followed by the promulgation of ambient air standards and emission standards at regional, state, and local levels. The atmospheric pollutants of current major concern are sulfur oxides, particulates, nitrogen oxides, hydrocarbons, oxidants, carbon monoxide, fluorine, and lead. Their toxic and other

deleterious effects, exhibited at various concentration-time exposures, can be related to levels reached by the individual contaminants in the air of cities. While such an evaluation does not allow for possible interactions between pollutants, it appears that sulfur dioxide, oxidants, and carbon monoxide may be harmful to human health when the agents are concentrated, as in focal areas of emission or during sustained meteorologic inversions. Gains to be achieved by controlling these and other contaminants during non- peak conditions are probably derived from aesthetic, economic, and welfare benefits rather than health. Abatement procedures should eliminate rises in pollutant levels beyond the average ranges generally present in urban ambient air. (Author summary modified)

17260

**CHEMICAL ASPECTS OF ATMOSPHERIC POLLUTION.** (Les aspects chimiques de la pollution atmospherique). Text in French. Ind. Chim. Belge, 34(9):739-744, 1969. 21 refs. (Presented at a Symposiom Sponsored by the International Union of Pure and Applied Chemistry, Cortina d'Ampezzo, Italy, July 9-10, 1969.)

The symposium papers to be published in the journal 'Pure and Applied Chemistry' covered the following topics: the toxic aspects of atmospheric pollution and recommended limits on concentrations of 24 pollutants; a method of determining the surface area of very small particles; simple methods of separating aerosols by particle size; the influence of certain substances on the transport of hydrohysable ions; the deletorious effect of fluorides on the flora and, indirectly, on the fauna as well; techniques for sampling, isolation, and quantitative analysis of F compounds; different varieties of 'smog'; a method for correcting benzo(a)pyrene determination for the concomitant benzo(k)fluoranthene; polycyclic aromatic hydrocarbons in the exhaust gas of internal-combustion engines; applications of analytic methods for determining polycyclic compounds; several methods of determination of Pb compounds in air; and a survey of the distribution of traces of pollutants in the atmosphere. Oxygen obtained by distillation of liquefied air is polluted by automobile-exhaust and industrial waste gases. The application of the interface electrode of extremely high sensitivity in air pollution studies and the use of mathematical models in air pollution investigations which would reduce the cost and expenditure of time required for an extensive test program were also covered.

18005

Hinch, Nylds

**AIR POLLUTION.** J. Chem. Educ., 46(2):93-95, Feb. 1969. 4 refs.

The consideration of the air we breathe has been one of the most fundamental and profitable endeavors in scientific, philosophical, and medical thought. This is a discussion of the historical aspects of air pollution. Many of the specific substances that have been identified as air pollutants are discussed briefly.

20548

Dreisbach, Robert H.

**AIR POLLUTION.** In: Handbook of the San Francisco Region. Palo Alto, Calif., Environment Studies, 1969, p. 284-309. 29 refs.

The major types of air pollutants in the San Francisco Bay area, and their sources and effects, are discussed. Such respiratory diseases as bronchitis, emphysema, influenza, pneumonia, and tuberculosis have a close relationship with the level of air pollution. A strong correlation of lung cancer exists in men who smoke, and the incidence of lung cancer in California has increased from 15/100,000 in 1950 to 26.7/100,000 in 1967. Automobiles are the largest source of carbon monoxide. The presence of CO in the blood reduces the availability of oxygen to the tissues in two ways: by direct combination with hemoglobin to reduce the amount of hemoglobin available to carry oxygen, and by preventing the release of some of the oxygen at the low oxygen partial pressure present in body tissues. It is believed that long-term exposure to CO may contribute to chronic disease. Missile fuels, explosives, cigarettes, and agricultural wastes liberate nitrogen oxides. Long exposure to 50 ppm nitrogen dioxide has caused inflammatory changes in the lungs, and higher concentrations have been fatal. Sulfur oxides come from fuel oil combustion, petroleum refining, and from the chemical and metallurgical industries. Hydrogen sulfide is produced by bacterial action on sewage effluents containing large amounts of sulfur compounds, and it can cause eye irritation and sensory loss. The constituents present in particulate matter include lead, beryllium, carbon, other metals, and organic particulates. Their sources and effects on human health are also discussed.

28088

Bouquiaux, J.

**AIR POLLUTION TRACEABLE TO FUELS: ITS PREVENTION ITS MONITORING.** (La pollution atmospherique par les combustibles; sa prevention; sa surveillance). Text in French. Arch. Belges Med. Social Hyg., Med. Travail Med Legale (Brussels), 28(6):593-410 June 1970. 6 refs.

The conditions under which pollutants are produced by the combustion of fuels, their action on animal and plant life and on materials, the means by which such pollution can be prevented, and the means of surveillance commonly used to study this type of pollution are described. Among the types of pollutants discussed are carbon monoxide, sulfur dioxide, nitrogen oxides, various organic products such as the aldehydes and aromatic polycyclic hydrocarbons, dusts and aerosols, lead compounds, and photochemical smog. Pollution can be combatted in three ways: processing of the fuel before burning, improvement of burners and heating equipment, purification of waste gases before release. A general description is also given of zoning laws, other legal means of regulation, and educational programs. Surveillance is exercised at 2 levels: at the source and in the general environment. In years 1950-1951, the loss per capita per year in the United States due to the total effects of pollution on health, civilization, building materials, meteorological conditions, etc. amounted to $10, or a total of 1 1/2 billion dollars for the entire country. Similar per capita figures are given for Great Britain and France.

28803

Abelson, Philip H.

**MAN-MADE ENVIRONMENTAL HAZARDS. 1. HOW MAN SHAPES HIS ENVIRONMENT.** Am. J. Public Health, 58(11):2043-2049, Nov. 1968. 17 refs. (Presented at the American Public Health Association, Annual Meeting, 95th, Miami Beach, Fla., Oct. 24, 1967.)

Our affluent society, which produces many items for the consumer, has not given sufficient attention to the disposal of waste. Coal or residual oil burned to produce electricity, for example, causes substantial amounts of sulfur to pollute the air. Major exhaust emissions resulting from imperfect motor vehicle fuel combustion include carbon dioxide, carbon monoxide, gasoline, oxides of nitrogen, aldehydes and acids,

nitrogen-containing organics, phenols, particulate matter, and lead salts. Exposure to 120 ppm carbon monoxide for one hour may be a serious health risk. Nitrogen dioxide is a respiratory system irritant. Airborne particulate matter may affect the health directly when it is inhaled or when it contains toxic substances such as the carcinogen, benzopyrene. The combination of airborne chemicals with particulate matter, sunlight, and adverse meteorological conditions can form smog or airborne sulfuric acid. Results of individual toxic agents are additive. Tobacco smoking hazards are increased when the individual is subject to urban air pollution. The growing carbon dioxide concentration in the atmosphere may slow heat loss from the earth, resulting in warmer climates. At the same time, the presence of particulate matter in the air partially reflects sunlight back into space, causing a cooling effect. The hazards of water pollution and exposure to radiation are also discussed. Other products of our affluent living patterns include noise pollution and social pollution (overcrowding). The impact of these factors is not easily evaluated.

37225

Eschenbach, Dieter

**SCIENCE AND TECHNOLOGY 1971, VIEWED IN RETROSPECT.** (Wissenschaft und Technik 1971. Eine Rueckschau). Text in German. Umschau (Frankfurt), 71(26):971-973, Dec. 1971.

The dominating theme in science and technology in 1971 was environmental pollution. However, the extent of the discussion of this subject was not matched by action. The lead content was reluctantly reduced from 0.5 g tetraethyl lead per liter gasoline to 0.4 g. The industry found this reduction too abrupt and unacceptable. The European literature concerning all other aspects of air pollution provides no advancement. According to a test by the West German Automobile Club, all presently existing (in West Germany) exhaust gas decontaminators are not capable of significantly reducing the emitted toxic gases. In the U. S., such units have been successfully in operation for over two years.

43824

Preuss, Harold P.

**TECHNICAL DEVELOPMENTS IN 1971. PART 2. ORGANIC (PAINT) COATINGS, PROCESSES AND EQUIPMENT.** Metal Finishing, 70(2):49-75, Feb. 1972 300 refs.

Literature concerning technical developments in the following areas is reviewed: resin developments (acrylic, nylon, silicone, urethanes, and vinyls); other raw material developments (additives, pigments, and solvents); surface preparation; coatings; protection against corrosion (mildew defacement); paint handling and application (coil coating, electrocoating, electron beam curing, powder coatings, and containers); paint removal, testing, and analysis; ecology; and health, safety, and the law (lead, mercury, air quality legislation, product labeling, and consumerism).

# AUTHOR INDEX


## A

AALUND L *J-31720
AALUND L R *A-31136, *A-39067
ABDULLA M *G-42884
ABE E A-33710
ABE, S *G-07396, *N-04212
ABELSON P H *N-28803
ABERNETHY, R F *A-06351
ACCOMAZZO, M A F-03799, F-08207
ACOCELLA G *G-35174
ADAMS W E *B-35778
ADAMSON, D L *C-06045
ADLER S F *B-26243
AGARKOVA N A *B-15208
AGNEW W G *B-17906, *B-32355
AGOCELLA G *H-42945
AIDAROV, T K *C-06881, C-06894
AILOR, W H I-06357
AIRTH, J M D-00697
AISAKI G D-27257
AITKEN A *L-32462
AIZAWA K B-29204
AIZAWA R C-26336
AIZENBERG B SH *B-35478
AJEMIAN R S C-38973
AKAMATSU K D-27257
AKAMATSU M C-25015, C-43448
AKASHI N *C-31933, C-37689, D-43962
AKASHI Y *G-44087
AKATSUKA K *G-28171
AKINO K D-41975
AKIYAMA A G-27253
AKIYAMA J *D-30892
AKIYAMA K G-37722
ALBAHARY C G-32216
ALBAHARY, C *G-03892
ALBERS A *F-13879
ALEKSANDROV YU A *F-34607
ALESSIO L G-21037
ALEXANDER, L T H-01523
ALI A W *A-45274
ALKIRE H L *D-37026
ALKYLATION AND ISOMERIZAT A-36535
ALLEN R R *B-28865
ALLEN, G L *B-03754
ALOJ S G-05671, G-36251
ALPERSTEIN, M *A-08039
ALPERT J J *G-32737
ALSPAUGH M L *J-39941
AMBROSI, L *G-11552
ANDERSON D H C-41908
ANDERSON W L *H-36991
ANDO T D-33114
ANDREV, V D-10634
ANTAL A *G-11630
ANTWEILER H *G-38869
ANZANI R C-38778
APIDIANAKIS J C D-19822
ARAKI K D-27257
ARAKTINGI Y E *C-41612
ARDEVAN E G-11630
ARDOINO V G-24784
ARIAS L I G-34837
ARMSTRONG D W A-28862, *G-28011
ARONSON A L A-33350, *H-33362, *H-35209
ARVIK J H F-44332
ASAKINO K *A-43966
ASAKOYA K A-31934
ASAKUNO K D-37191
ASAOKA T D-36909
ASARO F C-40724
ASCHBACHER P W *H-43226
ASHBY H A B-28860
ASHIDA S D-30182
ASHIYA N C-29419
ASKEY W E B-36453
ASSAF G *E-21182
ATKINS P R *D-16791, *D-24952, *E-23743, E-27116, *E-32158
ATTALA, R G-01757
AUBREY, K V D-03526
AUGHEY H *C-25431
AULT W U *A-30428
AUTELITANO D G *A-33169
AYER F A J-30696

## B

BABA A *A-34774
BACH W *A-37015
BAETGE H H *H-32224
BAGLEY G E H-18521
BAILEY B A-33350
BAILEY B S *A-33626
BAINBRIDGE C A *B-25334
BAKALOV, D D-08275, D-09240
BAKER R C *A-45092
BAKI L G-44255
BAKULIN V N *E-24166
BALASSA, J J G-01731, *G-01923
BALKE S *A-26552, *A-37648
BALL G V *G-35211
BAMBRICK W E B-21040
BARANOV, V I *D-00261
BARATTA, E J G-00873
BARBIER J C *B-22436
BARKLEY W G-18417
BARLTROP D *G-18503, *G-18518, *G-35377, *G-37023, *M-35206
BARNARD P G *B-43937
BARNEA M *G-29588, *G-38616
BARNES H M C-17048
BARNES W R *C-24337
BARRIERO O C *G-35225
BARRIOS C G-20287
BARRON A V JR *B-34025
BARROWS, H L *H-07742
BARRY P S I *G-32787, *G-37630, *G-38579
BARTELS T T C-16123
BARTH D S G-25068, L-24467
BARUSCH M R *F-14995
BASECQZ J M *G-40057
BASHIROVA F N *H-19620
BASTRESS E K A-45092, *B-22890
BATTIFORA H A G-34851
BATTISTINI V G-32834
BAUERLE G L *B-30717
BAUMANN, R *D-02133
BAYARD M A D-31775
BAZELL R J *G-34059, *H-30931
BECKER K *A-29782, *B-30010
BECKER K H *A-29786
BECKER R O *G-21070
BECKERT J *G-40492
BECKMAN E W *B-42817
BEDOV I S B-15208
BEGEMAN C R A-26645
BEGEMAN, C R *B-01851, *D-04938, *D-10612, D-11028
BEILSTEIN D H *A-42726
BELIKOV A G B-35478
BELKNAP E L *G-36551
BELL A G *A-36082, *A-44821
BELL H L *H-43279
BELLELLI, E D-10595
BELOUSOVA A E *B-33157
BENINI F *E-40164
BENKOE A *G-36740
BENNETT C F C-12943
BENNETT, P A A-05171
BENSON C S *E-24109
BENSON, C S D-04646, *E-00834
BENSON, H E B-03337
BERDYEV, K B *D-08438
BERG E W G-21070
BERG, B A *G-06704
BERGMAN W B-25301
BERITIC T *G-37297
BERLIN E G-31228
BERMAN E *C-33338
BERMAN, E *G-01756
BERMINGHAM P E *L-34033
BERNHART A *A-16156
BERNHART A P *A-34018
BERNSTEIN L S *B-35223, *B-36578
BESNER D *E-27116
BESSIS M C G-39863
BETTONEY W E *B-42829
BEVERIDGE T R A-34788
BHACCA N S C-41612
BIENER K *G-31899
BIENSTOCK, D *B-03337
BIENVENUE L L B-42131
BIERIG J L *B-31341
BIERSTEKER K *A-39367, *D-16345
BIKKER M A C-30593
BINGHAM E *G-18417
BINGHAM T E J-30696
BINNS W *H-42715
BLACK E N IV *B-36453
BLACK W E C-27075
BLACKMORE D R *B-42330
BLAKNEY J H B-39333, B-42886
BLANCHARD L E JR *A-30067
BLANCHARD, R L *C-00125
BLANDER M F-13911
BLANKSMA L A *G-42716
BLEMEL, K G *E-01821
BLIFFORD, I H JR *N-04649
BLOKKER P C *G-37788
BLOOM S G G-30831
BLOOMFIELD J J *L-23234
BLOOMFIELD, J J N-04052
BLUMER W *G-23876

BODDY, J H *L-02635
BOERTITZ S H-38332
BOGEN D D-31325
BOGEN D C *C-26955, *D-42247
BOLANOWSKA W *G-32041
BOLANOWSKA, W *G-06814
BOLOTOV M P *A-28210
BONSIGNORE D *G-23582, *G-24784
BONZANINO, A *G-04196
BOOKER D V *F-13451
BORCHERDT H L-41703
BORGHETTI A *G-40697
BORJESSON B G-32129
BORJESSON, B F-11582
BORLAND J E A-35919
BOUQUIAUX J *N-28088
BOURBON P *C-26467
BOUSSER, J *G-11462
BOVAY E *H-33922, *H-39408
BOVE J L C-42139, *D-17058
BOWERS P H A-31323
BOWMAN H R *C-40724
BOYLAND E G-36935
BOYLEN G W JR G-34436
BRABANDER L D *L-44376
BRACHACZEK W A-33822, *D-43468
BRADOW, R L A-08039
BRANCACCIO A G-39621
BRANDT A D C-27294
BRANDT C S *H-17215
BRANDT M A-37176, B-31604, *C-24119
BRATZEL M P JR *F-45295
BRAUNSTEIN J F-13911
BRAVO H *D-19433, *D-25107
BREAULT H J G-32737
BRESSERS J G-42136
BREWER, L W *C-09333
BRIEF, R S *C-02164
BRIGGS D *H-43782
BRILEY A M G-39867
BRILL A B G-34837
BRINGMANN G *G-45159
BROBECK W M *B-34381
BROCKHAUS A G-33779, G-37685
BRODOVICZ, B A *K-08420
BRONDINE V *G-41097
BROOKS R E *G-44381
BROWETT, E V *C-05977
BROWN A S G-41847
BROWN B R B-30633
BROWN G H-32736
BROWN W J A-14461
BRUCKENSTEIN S F-14008, F-14039
BRUIN A D *G-28024, *G-35792, *G-36932
BRUNE D *C-11626
BRUNN, L W B-03337
BRUNNER, M *A-08972
BRYCE SMITH D *A-29872, *G-31537
BRYK, P *A-03982
BRYSON R A *E-24570
BUCHBERG, H *G-00177
BUCHER, K *A-09210
BUCHET J P G-40057
BUCK W B *H-35234, *H-36196
BUCKUP H *G-44251
BUEHLMEYER G G-40492
BUKHANOVSKII D L B-35478
BULLOCK J D *G-18494
BULLOCK, J *D-12099
BURENIN N S *D-26387
BURGESS W G-30198
BURNHAM C D *C-18007, *D-27241
BURTNER R E *B-33550, *B-44470
BUSCH, K A G-00148, G-00473
BUSEY W M G-34841
BUTT, E M G-00662
BUXBAUM J *G-36354
BYALKO, N K G-09484
BYERLY R JR C-38165
BYERS R K *G-35438
BYLINSKY G *G-25705

## C

CADOFF B C C-38165
CALAPAJ G G A-15599
CALLISEN H G-11808
CALVERY H O *G-36765, *G-42737
CAMBRAY, R S *E-03841
CAMPAU R M B-37042
CAMPBELL K I *G-34841
CAMPBELL M H A-24281
CANTWELL E N B-24722
CAPOROSSI J C *D-27096
CARETTA E C-38778
CARETTO L S *A-26763, *K-43312
CARLBERG J R C-38973, *G-44696
CARLETON R S B-41922
CARLSON G D *C-27075
CARPENTER J L G-36934
CARPENTER K E *A-35398, *F-35378, *F-35379, *H-36265
CARPENTER S J G-35219
CARPIO G D *G-41872
CARR R C A-25581
CARROLL R E *A-27595
CARSWELL F G-32834
CARTASEGNA C G-24784
CARTER M D G-20687
CASSADY G G-34947
CASSELLS D A K *G-35559
CASTANEDO A G-44867
CASTELLANI BISI C F-17949
CASTELLINO N *G-05671, *G-36251
CASTELLINO, N *G-01500, *G-10793
CASTRO M P A-39035
CATCOTT, E J G-00597
CATE J L JR *C-34106, *C-42437
CATES M M G-34836
CATIZONE O *G-18502
CATTELAIN C *B-35303
CATTON M J *G-32747
CAVATORTA A G-40697
CELEBREZZE, A J *B-01484, *L-03536
CERNIK A A *C-43337
CERVI G E-40164
CHADWICK R C *H-33985
CHAKRABARTI C L *F-45295
CHAKRABARTI, C L *C-00056
CHAMBERLAIN A C *E-38666, F-13451, H-33985
CHAMBERLAIN R I G-34436
CHAMBERS L A *D-44234
CHARLSON R J *A-16766, *B-33994
CHASE E W A-30759
CHATIGNY M A *C-26275
CHAYKA, P A *G-09493
CHEATHAM J S *G-18508
CHEKLICH G E *A-33378
CHERNOUSOVA K G *C-19857
CHESTERS G E-21796
CHESTERS, G *H-12647
CHILKO D M D-24414, H-17218
CHISNALL K T *H-37912
CHISOLM J J *G-36152
CHISOLM J J JR G-32487, G-32737, *G-35380, *G-35387, *G-35560, *G-36207
CHLADKOVA D G-24192
CHNG K M A-45092
CHO B Y *C-43587
CHOBOT E F JR G-18508
CHOLAK J A-40314, *G-18501, *G-19159, G-42757
CHOLAK, J *A-12624
CHOVIN P *D-16684, *K-42118
CHOVIN, P *D-08568, D-08821, *G-13059
CHOW T J A-15205, *A-19684, A-19955, A-21722, *A-23239, *A-25295, *C-12943, *C-21948, *C-35396, *C-42160, *D-23658
CHOW, T J F-00841, *N-05313
CHRISTIAN C M C-28895
CHULINA, N A *G-09484
CIPRIANO J M *A-41604
CLARK, R L *G-06151
CLASEN R A G-34851
CLAY A J *A-30001
CLINK W L D-36562
COENEN R *A-40981
COGBILL E C *C-41825
COGHI, L *D-10595
COHEN E *C-42084
COHRS, F *H-11452
COLA M *F-17949
COLACINO M *E-31895
COLAMUSSI V E-40164
COLEMAN A B G-32737
COLEMAN L E B-39333, B-42886
COLUCCI J M *A-26645
COLUCCI, J M *D-04938, *D-10612, *D-11028
COMMINS, B T D-00985, D-03526
COMPTON W A B-39275
CONLEE, C J *D-01673
CONNOLLY R B-37042
CONNOR J J *H-39204
CONTA L D *B-34457
CONTE J F A-14033
CONTNER, G L G-00473
CONWAY J G C-40724
COOPER P *G-28256
COPSON, H R *I-06355
COQUELET N L G-28205
CORBEIL R J A-22941, *A-42377
CORBIN R G-33605
CORN M *E-32155, *G-38721
CORNER E S *A-31596
CORONA L T D-19433
COSTESQUE L M *H-42250
COSTIN I *G-44255
COSYNS J B-22436
COTE W A B-35540, D-36562
COTHERN C R C-34407
COULSON, D M C-00855
COURTNEY R L I-36051
COUTURAUD J C E-29946
CRABLE J V C-27294, *G-44696
CRAIG J C C-26275
CRAIG P P *A-27113, *G-31228
CRAMER K G-32129, *G-32408, G-32738
CRAMER, K *F-11582, *G-00821, G-02202
CRANE R A A-35123
CREASON J G-23801
CREMER, J E *G-01341
CRIDER W L A-15295
CRISTEA I *H-30033
CROSS F L JR *A-31632, *D-20191
CROSS J L G-30831
CROUSE W W *A-36080
CRUCE W L R G-34895
CRUMP N L *C-16123
CRUZ J A M *H-16270
CUCU M G-29588
CUFFE, S T *A-05067
CULBERSON S F *J-34828
CULHANE, F R *B-08562
CUMMING R L C G-32834
CUMMINS, R L D-01673
CUNNINGHAM A R A-31596
CUNNINGHAM J C J *F-14743

*CUNNINGHAM, A F *N-06992*

## D

DABELSTEIN W *A-28394, *J-27968
DAESSLER H G *H-38332
DAINES R H *D-24414, H-17218
DAINTRY S H *B-30633
DAL CANTON A G-40697
DALAKMANSKI, Y D-08275, D-09240
DAMON W A *L-23562
DAMS R G-42136
DANIELSON L *A-23280
DANILOVA Y I *F-13635
DARLING F F *H-41733
DARROW D K *G-45165
DAVIS W H *G-27801
DAWSON A B *H-34830
DAWSON J B *F-13705
DAY, C L *D-08279
DE PEDRINI, C *G-04196
DE TRAVERSE P M G-28205
DECKER R R A-35919
DEDOLPH R *A-32748, *H-17217
DEDOLPH R R H-14786
DEDOLPH, R R *H-09448
DEHM R L C-41908
DEKRESTER, A J *G-00993
DELAVAULT R E A-14135, H-30921, H-39287
DELVES H T *G-34246
DELWAIDE P *G-15703
DEPELCHIN, A H-12536
DEQUIDT J *G-37731
DERIVAUX, J H-12536
DERRIEN M B-22436
DESBAUMES P G-30009, G-39406
DEVLIN E L H-32736
DEVOTO, G D-08810
DI NUNNO, C G-11552
DICK D *F-44332
DICKSON J C B-34846
DIDIO, S L G-00662
DIELEMAN R *L-44376
DIGGS, D R D-01315
DIMITRIADES B *A-17339
DIMITRIEV M T *D-34008
DINGLE A N *E-22754
DISHART K T *B-22414
DITTRICH T R *C-34407
DIYEV N P F-13943
DJORDJEVIC, SR *G-09253
DJURIC D *A-34068, C-42137, *G-36283, *G-41731, *H-27352
DODDS E C *G-35559
DODO H *G-40532
DOELLING R P *A-44682, *B-33542, *B-42819
DOLGNER R G-31319
DOMRACHEV G A *F-36524
DONAGI A A-23316
DONOHUE J J A-35818
DORBES P C-26467
DOSHER J R J-34828
DOWNING P B *J-26765
DOYLE, G J F-05849
DRAGO R J A-31632, D-20191
DRAKE J F *B-44742
DRDKOVA, S *G-08381
DREESSEN W C *A-28862
DREISBACH R H *N-20548
DRESSEL W M B-43937
DREYHAUPT F J A-25125
DRISCOLL J C-38973
DROZDOVA, V M *E-10215
DRUCKER M A D-27096
DUBOIS, L *D-00697, *D-09432
DUCE R A D-28920, D-32350, D-35725, D-35861, E-28586
DUCE, R A D-04646
DUCKERING G E *G-36093
DUEKER M H-32224
DUEMMLER F *L-17472
DUFFY L J *A-41959
DUKE C R *C-43587
DUKE F R *F-14868
DUKES C E G-36935
DULFU R H-30033
DULFU V H-30033
DUMITRIU, C G-11580
DUNNING J M *G-39833
DUPREY, R L *A-09686
DURSZT J G-30334
DUVAL C F-17585
DWYER F G B-33386

## E

EARL J L A-19684, A-23239, *C-12943, C-42160
EBEL R H *B-23697
EBENS R J H-39204
ECCLESTON B H A-17339, *A-23789
EDA S *A-29539, *A-29787
EDINGER J G C-26275
EDWARDS T I *A-28862
EGAN D A *H-27386
EGE J F JR *C-25793
EGEBACK K E *A-44464
EGIZAROV A A B-33157
EIBIHARA T G-30395
*EINBRODT H J C-16367, *D-15789,* *D-15823, *G-12984, *G-26931
EINBRODT, H J *D-08502, *G-12070
EISENBUD M D-17340
EJIRI S A-29787
EL HOSARY A A F-16659
ELLEN R P *A-17365
ELLIOT P *I-31377
ELLIS D J *F-13705
ELLIS J C *A-40455
ELLIS, L D G-01812
ELLIS, R W *G-02191
ENDO M D-36909
ENDO R *D-17106, *D-28233
ENDO Y D-29814, *D-32727, D-32883, D-36486
ENGDAHL R B A-33087
*ENGEL R E *G-23715, *G-31528*
ENGELKES G *L-37717
ERDMAN J A H-39204
ERHARDT, W H H-12647
ERLEBACH W E A-30428
ERMAKOV E V *G-15731
ESCH G J V *G-43615
ESCHENBACH D *N-37225
ESHLEMAN A *H-27063
ETTINGER M B *A-33293
ETTINGER, M B *A-03280
EVERETT N R A-41959
EVERETT, J L *D-08279
EVSEEV A M F-17161
EWING R C *B-24186

## F

FAES, M H G-08683
FAIRHALL L T *C-26145, *G-32608
FAIRHILL L T *H-34901
FAITH, W L D-05573
FAORO, R B D-05551
FATZER R *B-32822
FAUST W J B-14604, *B-37150, *B-44473
FEDORCHENKO I M *F-27348
FEENAN, J J B-00015
FEICHT F L *B-32633, *C-32975
FELDMAN F *G-36957
FELT A E A-14461, *A-27458, *A-35199
FENSTERSTOCK, J C *D-05551
FERM V H *G-35219
FERRANDO R *G-13159
FERRI, E S *G-00873
FERRIS B JR G-30198
FERRIS, B G JR *G-07162
FERSEN O V *A-38522
FIELDNER A C *G-37119, *G-39193
FINE M M B-43937
FINELLI V N *F-44164
FINK G B *G-44385
FINKLEA J F G-24716, G-39179, *G-41894
FINN B J H-27391
FINNIGAN F T *B-44614
FIRST M W *B-31441
FIRST, M W *G-03287
FISH R A *A-41945
FISHER C E *B-23540
FISHER F *M-29432
FITE L E C-33042
FITZEK J *C-16367
FLEK J G-45005
FLENGAS S N *F-16595
FLESCH, J P *C-09888
FLETCHER K *C-30928, H-39287
FLETCHER K W H-30921
FLETCHER R S B-22890
FOCKE R J *A-17304
FOGEL M E J-30696
FONG C W *F-43245
FONTAN J *D-45218, E-29946
FONTANGES R G-40688
FORESTER G C-26275
FORSTER E J *B-37619
FORZIATI A F A-33350
FOURNIER P E G-28205
FOWLER, D G *G-05697
FRANCHINI I G-40697
FRANCIS C W *E-21796
FRANCIS H E A-31632, D-20191
FRANCIS, C W *H-12647
FRANK, E R I-02176
FRANK, N R G-07162
FRANKE, W *F-05440
FREDERICK F P *B-22834
FREE E E *H-40590
FREED V H *A-31324
FREEMAN A M III *L-44044
FREEMAN R *G-34701, *G-35463
FREISER H C-38973
FREITS G S F-13635
FRENCH M C G-40014
FREUDE H *B-35018
FREUDENTHAL P C D-17340
FRIBERG L *G-26356
FRIEND W K G-32737
FRIGIERI P *C-38778
FRISTEDT B I G-42884
FRITSCH W A-40981
FRITZSCHE H C-33178
FRONDIZI C A A-25581
FRYBOURG M *B-42166
FUCHS E J *B-42702
FUGAS M *C-25440
FUJII J A-29661, D-28629, D-28650, *E-38118
FUJII T C-37514, *D-43962, *G-44087
FUJINAGA T *C-32534
FUJITA M *F-42772
FUJITANI Y *L-35922
FUJIWARA M *D-42367
FUJIWARA T *C-32718

FUKAMI T A-32523
FUKAYA K A-36006, C-27681, C-28755, C-29419, C-30786, D-28634
FUKUBAYASHI H B-40709
FUKUDA J D-27648
FUKUDA M *G-37722
FUKUDA T D-36288, D-37320
FUKUI S A-36006, C-27681, *C-28126, C-28755, C-29419, C-30786, *C-32476
FUKUOKA S *D-29647
FUKUSHIMA T D-29814
FULLER F T *A-13524
FULLERTON P M G-32747, *G-34832, *G-39883
FUNAYAMA Y A-29539
FUQUAY J J *E-29688
FURUKAWA Y D-36820
FUSAMURA N *B-31317
FUSSELL D R *A-22976

## G

GABINOVA Z L L-16200
GAEKE, G C JR C-05787
GAGLIARDI J C *A-14462, *A-35353
GAGLIARDI, J C *A-04460
GALENKO N P B-19725
GALLE P *G-18515, G-32216
GALLOPOULOS N E *B-36145
GAMMELGARD P N *A-31520
GANHE T J H-25374
GANJE T J H-35827, *H-44071
GARBER K *H-31010
GARCIA ESCOLAR L *A-39035
GARCZYNSKI, H G-06814
GARDNER C O *B-19331
GARDNER, J W *A-01868
GARNER F M G-32746, H-44588
GARRO F *G-43531
GARTENMANN E *B-33932, *B-39404
GATTI, L G-04196
GAULTIER M *G-28205
GAVASHELI SH G *E-44999
GAVRILESCU, N *G-11580
GEHRI D C B-37222
GELIUS, R *B-00899, *F-05440
GENDEREN H V *H-24667
GENDERNALIK S A B-29126
GEORGII H W *D-32945
GERBER A F *A-44682, B-33542
GERHARDSON G *K-18294
GERHOLD C G B-24696, B-28865, *J-31518
GERNET, E V *C-08145
GERSTLE R W J-30696
GERSTLE, R W A-05067
GERVAIS P G-28205
GHANNAM F E A-14462
GHELBERG N W *G-44255
GIAUME L *A-38022
GIBSON H J B-35778, B-39333, B-42886
GIBSON, F H A-06351
GIBSON, F W *A-10749
GIEVER P M C-27294, *D-29655
GIEVER, P M *C-09476
GILARDI, E F *C-06107
GILBERT L F B-29126
GILES W *B-36144
GILFILLAN, S C *G-05478
GILL J E C-26275
GILLETTE D A *E-35207
GILLETTE R *G-34649
GILLULY R H *G-23167
GILMOUR, T C G-00662
GLATER R A B *H-43342
GO F D-43962, G-44087
GODANI E A-38022
GODFREY D *I-36051
GODWIN T F-36067
GOEL P K B-40411
GOETZMANN S A-40981
GOLDBERG A G-32834, G-34847
GOLDBERG E D A-35788
GOLDSMITH J R *G-16810, *G-18549, *G-23768, *G-27291
GOLDSMITH, J R *G-00020, *G-08411
GOLDSTEIN G *G-43277
GOLLI V *G-34092
GOMEZ, M *G-09408
GOODACRE C L *A-22825
GOODMAN G T *C-30113
GORALCZYK B-38727
GORBUNOVA K N B-22492
GORDON C C *H-41892
GORDON G M B-34313, B-35478
GOROSHKO B B D-26387
GOSHGARIAN, B B *F-07451
GOSSMANN, H H *G-09261
GOTTBERG G-25068, L-24467
GOYER R A *G-23926, *G-31493, *G-34836, G-34914
GRABECKI J *G-34175
GRAJPEL A *C-41968
GRANDJEAN E *A-38891
GRANTHAM L F *B-35352, *B-37222
GRAOVAC LEPOSAVIC L A-34068, G-36283, G-41731
GRAVEN R G *B-41793
GRAY P *G-18502
GREENBURG L C-27294, *G-24603
GREENGARD, J *G-01754
GRENNARD A H *B-19637
GRIECO B *G-30468
GRIECO, B G-01500
GRIFFING M E A-35477, *A-35919
GRIGOREV, Z E *G-08949
GRISWOLD S S *A-42377
GRISWOLD, S S *B-00107
GROFFMAN D M *C-29297
GROSS G P *B-41608
GROSSERJ *D-31396
GROSSKLAUS D *G-40355
GROULX P R D-19822
GROUVEN H *H-23581
GRUEN D M F-14008, F-14039
GUALTIEROTTI R *G-40634
GUBAUIDULLIN, G S B-06493
GUERRINI A E-31895
GUICHERIT R *C-30290
GUILLAUME P G-32216
GUILLAUME, J *G-03892
GUINEE V F G-35587
GUINN V P *C-44210
GUPTA C P B-32938, *B-40411
GUPTA D R *B-32938
GUSAROV V N B-15208
GUSS S B *H-26276

## H

HAAR U D *L-25542
HAAR, G L T *H-09448
HAAS T *G-37964
HABIBI K *A-39609, *K-24107
HADDAD, R *N-04052
HADUCH T G-34175
HAEGER ARONSEN B *G-42884
HAILER K E A-28560
HAILEY D M C-17048
HALEY T J *G-27084, *G-40022
HALEY, T J *G-06059
HALL C A *A-14461
HALL S K *G-35811
HALLBERG, L G-02202
HALLEY J H *A-35224
HALLOWS R L *B-25781
HALSTEAD R L H-27391
HAMA A *B-22520
HAMAGUCHI T G-26528, G-26775
HAMAMURA N D-36288, *D-37320
HAMBLIN R J J *B-14604
HAMILTON E I *A-18510
HAMILTON W L *A-34647
HAMMER D I *G-24716, G-31528, *G-39179, *G-41894
HAMMETT F S *H-40335
HAMMOND P B *A-23058, H-20237, H-35209
HAMMOND, W F *B-09798
HAMPEL A G-37229
HANCOCK E E *B-37042
HANKIN L *G-39095
HANSELL W A *D-19144
HANSON G P *H-26055
HANSON L A-22367
HARA N *C-03034
HARADA M A-26134
HARASHIMA, S *G-05780
HARDISON L C *B-32248
HARDY H L *G-33234, *G-34436
HARDY, H L *G-03286
HARING C M *H-40591
HARLEY J H *G-17214
HARLEY, N *H-01523
HARMELIN M *F-17585
HARMSEN H *A-44227
HARPUR E G-33605
HARRIS V G G-32737
HARRISON M J G G-32747
HARRISON P R *D-27621, *D-35489, *D-39914
HARROLD G C *C-25932
HARROLD G G *G-32625
HARTKOPF G *L-33740
HARUKI T G-27253
HASAN J *G-40316
HASAN, J *G-06985, *G-07740, G-07892
HASEGAWA H G-40532
HASEGAWA T A-29661, *C-29464, *C-31304, *C-32892, *C-34017, *D-21015, *D-28629, *D-28650, *D-36009, E-38118
HASHIMOTO C G-27253
HASHIMOTO H *B-34071, *D-27257, G-27253
HASHIMOTO K *B-17525
HASHIMOTO M G-27253, *N-11871
HASHIMOTO N D-36820
HASHIZUME G C-25015, C-43448
HASKIN L A E-21796
HASS G M G-34851
HATTORI D M C-18007
HATTORI S G-26528, *G-26775
HAUPT G B-20740
HAUT H V *C-39762, *H-39328
HAVEMAN R H *L-44044
HAVLIK, B R I-03735
HAWKES A S *A-30027, *A-31088
HAYAFUKU M *D-30410
HAYAKAWA K *C-39069
HAYAKAWA M D-36288, D-37320, D-37366
HAYASHI H *A-42080
HECKER L G-20198
HEIDBREDER, G A G-08326
HEILENZ, S G-09261
HEIMANN H *G-31517
HEIMANN, H *G-07423
HEITNER WIRGUIN C C-26503
HELLER A *D-14762, *D-15573
HELLWIG A *D-29515
HENDRICKS N V *G-24314

HENDRICKS R H G-24716, G-39179, G-41894
HENDRICKSON E R C-27294
HENRY W M A-30759
HENSON C G *B-35476
HERIC E L *F-14138
HERINGTON H R B-32248
HERN D H C-41490
HERNANDEZ L *H-43342
HERNBERG S *G-22637, *G-26886, *G-28010, G-40316, G-41717
HERNBERG, S G-06985, *G-07740, *G-07892
HEROS R *D-43693
HESSELBERG, H E D-01315
HETTCHE, O *A-09393
HEUSGHEM C G-15703
HEXTER A C G-18549
HEXTER, A C *G-08411
HICKMAN J R *G-35568
HIGLEY L W B-40709
HIKICHI H A-29539, A-29787
HILL E L J-30696
HILL, W H *C-01607, *C-01608
HIMI K C-36840, C-36841
HIMI Y *D-29152
HINCH N *N-18005
HINDAWI I J *H-41891
HINKAMP J B *A-35477
HINNERS T A G-39179
HINNERS, R G G-00473
HIRAFUNE K *D-30326
HIRATA K D-38133
HIRO M E-30073
HIROBE H D-28326, D-37202
HIROKAWA R B-39333, B-42886
HIRONO T D-37191
HIROTA M G-31351
HIRSCHLER D A *B-32364, B-35778
HISHIDA K *A-20652, *A-32875, *D-29382, *D-29416
HITCHCOCK, L B *D-05573
HOARE D E *F-39901
HOBBS M E C-41825
HOCHHEISER, S *D-00005
HODY, G L F-07451
HOEGGER D *B-32424
HOEKSTRA J *B-25377
HOFER, L J E *B-00015
HOFFMAN G L D-35861
HOFMANN H P G-18046
HOFREUTER, D H *G-00597
HOGAN A W *A-26191
HOLDEN F R C-25932
HOLMA B G-26356
HOLMES P D C-32058
HOLTZ J L G-44696
HOLTZMAN R A-32748, H-17217
HOLTZMAN R B A-11702, E-22959, *F-27752, *G-21766, G-31040, H-14786, *H-45056
HOLTZMAN, R B H-09448
HOMMA K *B-29664
HOMMA, K *A-06220, *C-03037
HONDA T A-29936, D-33114
HONMA K *B-26532, *C-27829, *C-36840, C-36841
HONMA S *G-42661
HOOG H *A-24080
HOOLBOOM H G-36932
HORI M D-25881, D-31014, D-36820
HORIGUCHI S G-33372
HORIUCHI K *G-26260, *G-29815, *G-33372
HORN K D-31396
HORSTMAN, S W D-00005
HORTON R J M *A-32035, G-24716, G-31528
HOSHIAI T G-29663
HOSLER, C R *C-01249, *E-05713
HOUSSET H G-28205
HOWELL M C G-34436
HRSAK J C-25440
HU J N A-37176, B-31604
HUENIGEN E C-22927
HUERTAS M L E-29946
HUETER F G *G-25068, *L-24467
HUETER, F G *G-00473
HUEY N A *D-41888
HUFFMAN C JR *A-41890
HUKUSHIMA H D-30892
HULTBERG H *H-23258
HUNIGEN, E *K-08803
HUNT C M C-38165
HUNT W F JR *G-23801
HURN R W A-17339, A-23789, *A-27249
HURSH J B *G-18046, *G-20990
HUTCHINSON T C *H-42250
HWANG J Y *C-29226, *C-30707
HYDE J L *A-24281
HYLAND R G B-28860
HYMAN M H *B-31221, *B-35816

## I

ICHIHARA M G-27490
ICHIJO M *B-35296
IGOSHI Y A-31934
IGUCHI M D-29385
IIDA T *B-39333, B-42886
IKEDA H B-42886, D-27257
IKEDA J B-39333
IKEDA S G-29129
IKI S A-36846, *D-27188, *D-27675
ILCEWICZ F H F-27752, G-21766, *G-31040
IMADA M A-41145
IMAI S *C-38682
INAI H G-38867, *G-45288
INGRAHAM T R F-16595
INNES W B *C-44165
INOKOSHI Y *A-43966
INOUE H D-36288, D-37320
INOUE K D-43962, G-44087
INOUE T D-27257
INOUYE T *F-29400
IONESCU A G-11630
IOSIF, C *H-10318
IRIYOSHI M G-27253
ISHIDA K D-36288, D-37320
ISHIHARA H D-40716
ISHII T *C-24617, *C-24618, *C-25013, *C-42020
ISHIKAWA K D-37202
ISHIKAWA T D-37202
ISHIMARU M B-39333, B-42886
ISHINISHI N *D-29153, G-40435
ISHINISHI S *D-30025
ISIZAKI M *C-29810
ISOARD P *G-40688
ISOGAI Y A-32523
ITO E *D-28620, *D-28785, D-36474, D-37366, D-38133
ITO H A-29539, A-29787, A-32523
ITO K C-38682
ITO S D-28528
ITO T G-27253
ITO Y F-29400
IVANOVA A A F-39522
IVERSON M L F-14868
IWASAKI T B-31317
IWATA H *G-31351
IZUMIGAWA S D-27831

## J

JAAKKOLA T G-19881
JACOBS E S K-24107
JACOBS M B G-24603
JACOBZINER, H *G-01755
JAGEL K I *B-33386
JAIMEE A *B-33388
JAMES L F H-42715
JASKULLA N C-22927, *E-37953
JAWOROWSKI Z *A-25417
JEFFERIES D J *G-40014
JENSEN W N *G-39863
JENSEN, D A *A-01624
JENSEN, W N G-01812
JERARDINO M *G-20287
JERNIGAN E L *D-35725
JESSER B W *B-27824
JIKIHARA S C-37693
JO E B-42886
JO S B-39333
JO S H *B-31314
JOHN M K *A-35065
JOHN W *C-44479
JOHNS D R *G-32624
JOHNSON M G G-34943
JOHNSON R H A-36080
JOHNSON, R E *I-00305
JOHNSTONE M S D-23658
JONES J R E *H-34831
JONES, A R C-02164
JONES, J F G-06151
JONES, J H *G-06151
JONES, M H G-00177
JORDI A *G-27085
JOSHI M S H-35827
JOSHI, L U *D-10756
JOST D D-32945
JOTANI F F-17689
JUNG F *G-32218
JUNGREIS E *C-14758
JUST J *D-20642
JUTZI W *D-34933, *D-39405

## K

KADAN, E *D-02133
KADOYA N D-28634
KAHL H *D-30858
KAHN E H-18520
KAIFER R C-44479
KAJI K *B-38614
KALSTEIN A *A-39152
KALTSTEIN A *G-44176
KAMAKURA K D-28620
KANABROCKI E C-18007
KANAMARU T D-28326, D-37202
KANEKO Y *B-37116
KANNO S A-36006, C-27681, C-28755, *C-30635, C-30786, D-28634, E-36487
KANO S C-15562
KANTELO M V C-26955
KAPLAN E G-36207
KAPLAN, E G-00740
KARUHN R B-34740, B-39272
KARWETA S A-29572, H-32338
KASAMATSU G *A-31133
KASHIKI M *C-44129
KASHIMIZU T E-36487
KASSOWITZ H *G-39503
KASTIEN H *C-37971
KASUTANI K C-27681
KATAGIRI Y G-31351
KATAYAMA H *A-26134, B-39333, B-42886

KATO K *K-44377
KATO S B-31314
KATO Y *B-21324
KATZ M C-27294, *H-08884
KATZ, M *D-04996, *K-09259
KAURANEN P *G-19881
KAUTZ K F-34297, *I-33802
KAWAI K G-27253
KAWAI M G-31351
KAWAI S *D-30182
KAWAMOTO H *L-30620
KAWAMURA T D-29814
KAWANAMI, Y *D-07198
KAWARAYA T G-27253
KAWASAKI G D-28653, D-29385
KAWASE Y *D-28528
KAZANTZIS G G-32747
KEARBY K K B-35223, B-36578
KEATON C M *H-42207
KEELER R F H-42715
KEENAN R G *C-26145
KEENAN, R G G-00597
KEENE J A A-36082, *A-44821
KEHOE R A A-40314, *C-16382, *G-19159, *G-31584, *G-33864, *G-42757, *K-16808
KEHOE, R A *G-03283, *G-05483
KELINMAN M T D-34805
KELLER J G *A-34031
KELLER T H-16655, *H-25878, *H-28471, *H-32423, *H-32654, *H-39409
KELLEY, E B G-00740
KELLOGG H H *A-41518
KENDLER J *A-23316, *C-26503
KENLINE, P A *D-01673
KENNARD T G *B-44742
KENNEDY W R *D-35407
KENT W L *B-44614
KEPPLER J F *G-32749
KERIN D C-42137, *H-31185, *H-35880
KERIN Z A-34068, *C-42137, G-36283, *H-17978, H-27352, H-31185
KERLEY R V A-27458, A-35199
KERTESZ SARINGER M D-41520
KESBERGER H A-40981
KETTNER H C-15563, D-14762, D-15573, *D-28369, *F-15618, *G-37229
KETTNER, H D-09726
KHORGUANI V G E-29699
KHRGIAN A KH E-29699
KIBOKU M D-26535
KIFUNE I *A-33710
KILLALA N J P G-18518, M-35206
KIMBERLEY J L *B-37845
KIMURA J C-37608, D-37518
KIMURA M *A-29364, *A-44252
KINCHEN J C C-19313
KING E G-34902
KINNY H *G-12984
KIRSCH H F-34297
KISHIMOTO M G-27253
KISTLER J *B-43515
KITAMURA T D-31669
KITANO H *B-31496
KITANO T D-28528
KITASE M D-36474, D-37366
KITAZAWA S D-30182
KITAZUME M D-32727, D-32883
KITCHING W *F-43245
KIYOURA R *A-35052, *A-37166, *D-28653, *D-29385
KLEIN M *G-33605
KLEINERT R *A-28336
KLEINMAN A *H-35410
KLEINMAN M T C-27106, D-22553, D-24316, D-27105, D-31332, *D-43558
KLOKE A *H-24788
KLOSTERKOETTER W D-15789
KNAUER A D-31396
KNEIP T J *C-38973, *D-17340
KNIPRATH E *B-38727
KNOCKAERT, O E *G-08683
KNOP W *K-14443
KNUECHEL F *H-40024
KOBAYAKAWA T *A-24156, A-26134, *B-19808, *B-25894
KOBAYASHI J *H-14489, *H-27489
KOBAYASHI M G-29129
KOBAYASHI Y D-25881, *D-29744, *D-29918, *D-31014, *D-36820, *E-30073, *G-29816
KOBAYSSHI Y *A-30513
KODAMA Y G-40435
KOEPERNIK K L *B-35703
KOEPPE D E *H-17038
KOGAN, B A G-08326
KOHAYAGAWA T *A-27858
KOHAYAKAWA T *L-28099
KOHGO T D-17106, D-28233
KOIDE M *A-35788
KOLESNIKOVA T KH E-29910, F-39522

KOMECHI T D-30494
KOMEIJI T A-31934
KOMEJI T *D-44063
KOMETANI T Y *C-42139
KOMISSAROV O G *B-34313
KOMURA, S *G-08566
KONDO H D-31669
KONDO M *B-31985, D-31669
KONO T D-41975
KONONOVA, V A *L-08196
KONOPINSKI, V J *D-01089, D-01673, *D-02750
KONOPKA A P *B-32319
KONOVALOV G S *E-29910, *F-39522
KOP M A-34068, G-36283
KOPITO L *G-39867
KOPPIUS O G *C-25432
KORN M *C-29512
KORNREICH L C-38973
KORTEMME H G-12984, G-26931
KORTEMME, H G-12070
KOSHI S B-29664, *C-21862
KOSHI, S C-03037
KOSMIDER, S *F-11570
KOVALEV V P B-35478
KOWALSKI T D-27241
KOYAMA M C-32534
KOYAMA T D-29191
KOZLOWSKI, W *D-10380
KRAJEWSKI B *D-42742, *D-43388
KRAMER B G-41818
KRASNIEWSKI J D-27241
KRASNOPEVTSEV YU P D-44996
KRAUT H *G-33052
KRIGMAN M R G-23926, G-34836
KROES R *G-43615
KRUGER P *D-23864, E-32158
KRUMM A A G-34841
KUBO K *C-26848, D-28620, D-28785, *D-36474, *D-38133
KUBODERA T A-31934, A-43966
KUBOTA, J *G-10434
KUDO T D-27880
KUEHN M *B-34611
KUEHN R *G-45159
KUEHNER, A G-09019
KUMAJO K *G-45293
KUMASHIRO K *A-32492
KUMAZAWA Y *C-19501
KUMLER K C-38973
KUMLER, K D-10612
KUMMER J T A-33822, D-43468
KUNITAKE E *G-40435
KUNZ W G JR K-24107
KUPCHIK G J C-27294
KURAMOTO T D-28653, D-29385
KURCATOVA, G *D-10634
KURIHARA M B-29204
KURODA H B-37116
KUROKI M *D-26535
KURONO S G-27253
KUROSAKA K G-44087
KUROSAKA Y D-43962
KUSUMOTO M *C-27358
KUWATA S D-27257
KUYKENDALL W E C-33042
KWON S P *L-44325

## L

LAAMANEN A *D-23388, *D-24351, *D-35940, *D-37264
LACASSE N L *H-17225, H-27111, J-21749
LACHNIT V *G-40068
LACY G A *B-39492
LAFFERTY W L JR *A-36535
LAGARIAS, J S *B-07606
LAGERWERFF J V *A-45072, *H-17216, *H-21794, *H-28379
LAHMANN, E *C-10556, *D-10554
LAJTHAY J *A-38543
LAMANNA P G-30468
LAMANNA, P *G-01500
LAMBERT, G *C-06920
LAMBIE, J A *G-07551
LANDAU E *D-16839
LANDER D W *C-41908
LANE N M G-31528
LANE, R E *G-06174
LANGE G *G-41737
LANGE, A *B-10558
LANGER G *E-33873
LANGFORD J C *E-33225
LANGHEIN J A-40981
LANGMANN R D-28369, *L-33844
LANGMANN, R *D-09726
LARIONOV A V B-19725
LARSEN A A H-32736
LARSEN R I *K-36382
LARSEN, R I *A-00962
LARSON G *B-44853
LAUWERYS R G-40057
LAVESKOG A A-24031, A-44464, *C-26505, *D-25055, *D-41664
LAWSON, S D *L-11204
LAWTHER, P J D-00985
LAYMAN E M G-44463
LAZAR, V A G-10434
LAZRUS A L *A-26454
LE PAGE J F B-22436
LEAR W P *A-39603
LEBBE, J *D-08821
LECH J F C-41138
LEE J A *H-43721
LEE L *B-31246
LEE R E JR *A-15295
LEE, R E JR *D-07985, *D-11202
LEE, R L JR *D-12049
LEEDS E B G-36934
LEH H O H-24788, *H-36611
LEHMANN E *D-15575
LEHNERT G *A-40759, *G-26883, *G-37933, *G-40295, *G-44746
LEHNERT, G *G-09019
LEIGH, D A *G-06028
LEIGHTON, P A *D-00969
LEIKKANEN H E *B-42817
LEMERCIER G G-40688
LEMMENMEYER, W K *B-09231
LENANE D L A-37176, B-31604

LEONARD D L G-23926
LEPOW M *G-30686
LEPSOE R *B-32260
LESOURD D A *J-30696
LESPAGNOL A G-37731
LEVIN A A G-30831
LEVIZZANI G G-29256
LEWIS E F *H-41461
LEWIS K H *H-33201
LEWIS T R *H-41893
LEWIS, K H *A-03279
LEWIS, W M *D-12099
LI T M F-39901
LICHTMAN H C G-36957
LIDEN K C-11626
LIEDER W D *J-42721
LIEGEOIS, F *H-12536
LIFFERS R D-15823
LILIUS H G-22637
LILLS, R *G-11580
LIMTIACA L P G-44696
LIN FU J S *G-34095
LINCH A L *G-20687, G-32749
LIND B *G-44053
LINDBERG W *G-13625
LINDH, K G G-00177
LINDSAY R *B-36081, *B-36721
LININGER R L *D-28920
LIST R J E-28799
LISUNOVA, T S *G-04251
LITTLE, J B *G-05280
LITTLEFIELD J B *B-32633
LIVINGSTON H K *A-24281
LOB M *G-29286, *G-30009, *G-33903, *G-39406
LOCKE J K H-20062
LOCKE L N *H-18521
LOCKHART L B JR *A-45274
LOCKHART, L B JR *C-01249, *C-05243, *D-01355
LODGE J P JR A-26454
LODGE, J P JR *I-02176, *I-03735, *N-03674
LODWICK, J R *B-05300
LOEBSACK T *A-35078
LOFGREN A D-37264
LOFTIN H P *C-28895
LOGAN J O *B-24696
LOHS K *C-26274
LORANGE E A-26454
LORD E E G-35438
LORENZ G *C-39168
LOSEE, F G-10434
LOUCKS R H *A-26925, *D-27429
LOURIE R S *G-44463
LOWES F J *B-29920
LOYGUE A M G-28205
LUCAS H F JR A-11702, G-21766, H-14786
LUCAS H JR A-32748, H-17217
LUCAS, H F JR H-09448
LUCUS H F JR E-22959
LUDWIG, F L *C-00855, *D-00976, D-07600
LUDWIG, J H *D-01315
LUKE, C L *C-11042
LUND C *G-33527
LUNDGREN D A *C-31258, *C-35494, *D-22829
LUTMER, R F *G-00148
LUTZ G *G-30831
LYLES, G C-05787
LYNN D A D-16839
LYNN, D A D-05277, E-06841

## M

MAASSEN W D-28369
MACHATA, G *C-10561
MACHE K G-37964
MACHTA L *E-28799
MACKENZIE E J H-31801
MACKENZIE, V G *M-01073
MACKIW V N *F-13534
MACLEAN A J *H-27391
MACLEOD W D C-26275
MACPHERSON J H F-14995
MAEDA H G-37722
MAENO M *H-21018, *H-41800, *H-42336

MAES, G L G-08683
MAGA, J A D-01315
MAGNO P J *D-19822
MAGYAR M C-42139
MAHADEVAN, T N *D-10756
MAHLER, E A J *B-03125
MAIENTHAL E J *C-20891
MAJER J R *C-43737
MAJOR E G-44255
MAKHONKO E P C-44995
MAKOTCHENKO V M *G-37028
MALAKHOV S G D-44996
MALCOLM, D *G-06177
MALEMUD C J G-36957
MALER A R A-35919
MALIN H M *C-38755
MALLATT R C A-39610
MALMSTROM, R *A-03982
MALOOF C C G-34436
MALSCHAERT F P *A-34442, *B-44341
MANARY O J B-27371
MANDORF G G-32129
MANDORF, G F-11582
MANDRIOLI P D-25635
MANGANELLI, R M C-06107
MANGE P W A-45274
MANINGER R C C-26275
MANITA M D *C-29595
MANNING D L *F-13911
MAO P *G-34791
MAPPES *G-42698
MAPPES, R *C-03770
MARCOTTE F G-40688
MARENCO A *D-45218
MARIAN P H-30033
MARKLAND J H-37912, *H-37926
MARRACCINI, L *D-08810
MARSDEN, E *G-07169
MARTEN G C *H-20237
MARTIN R *B-24184
MARTY A M *E-29946
MASAHIRO H D-29918
MASTALL H G-40295
MATRAKHIN G A B-35478
MATSAK, V G *F-03525, *F-06648
MATSCHINER H C-33178
MATSCHINER, H *C-05456
MATSON W R D-28920, D-35489
MATSON, W R *C-10528
MATSUE T A-31133
MATSUHO S D-27257
MATSUI T D-28326, D-37202
MATSUMOTO K *B-30154, *B-37195
MATSUMOTO M D-27188
MATSUMOTO Y D-28233
MATSUMURA T C-21338, D-15175, D-15314, D-16576
MATSUO Y D-28650
MATSUOKA C *D-31669
MATSUTOMI T D-26535
MATSUURA A *F-37213
MATSUYAMA S G-27253
MATSUZAWA S C-26336
MATTHES D *A-30604
MATTHEWS, G A G-06028
MATTSSON S C-11626
MAUER P G-44696
MAXFIELD M E G-25328, G-32749
MAXIMUM PERMISSIBLE CONCE *K-41682
MAY H *A-25125
MAY P G-34836
MAYER L *A-27180
MAYR B *B-33741
MAZIARKA S D-20642
MCALLISTER R G *G-34114
MCCABE L C *A-35168
MCCABE L J *F-36076
MCCABE, L C B-03754
MCCALDIN R O *A-31649
MCCALDIN, R O *A-03278
MCCAUSLAND E D H-32736
MCCOLLUM W A JR B-37222
MCCONNELL W J G-39193
MCCRONE W C *C-35695
MCCULLOCH E C *H-34237
MCDONALD J H G-34851
MCELROY M W A-26763
MCJONES R W *A-22941
MCKEE H C *C-17180, *C-32058
MCLAUGHLIN M G-25328
MCLEOD W J *J-22358
MCMULLEN, T B *D-05551
MCNAY B E A-35224
MCNESBY J R *C-38165
MCNULTY O G-23801
MEDEIROS R W *A-34040
MEDRAS K G-36747
MEEK S F *C-25932, *G-32625
MEEKER, G O *N-04649
MEEKER, J E D-05623
MEGONNELL W H *A-20545
MEGUERIAN, G H *F-09745, F-09745
MEGURO T D-31014
MEHANI S *G-34951
MEHANI, S *G-00902
MEIKLE J C H-41461
MEISEL S L A-33350, *B-33403
MEKLER L I B-33157
MELLIN G G-22637
MELTON C W *A-30759
MENDEN E E *F-44164
MENENDEZ M D-41033
MERCER T T G-20990
MESSINA N V B-39333, *B-42886
METSALA, P G-07740
MEYER J H C-33731, C-38914
MEYER K F *H-40591
MEYER W E *B-29605
MIANO, S *G-00736
MICHELAKIS A M G-34114
MIDDLETON J T *B-28377, *L-25288
MIESCH A T *A-41890
MIESSNER, H *H-11467
MIETTINEN J K G-19881
MIEVILLE, R L *F-09745
MIKHEEV, V A *B-06493
MIKITA J J *B-24722, *B-34035
MILHAUD G *G-13159
MILIC D H-32291
MILIC S *G-37540, G-40021, G-41731
MILLAR J A *G-32834
MILLER J E A-34647
MILLER J W *H-34901
MILLER R J H-17038
MILLER, R G G-00148
MILLICAN F K G-44463
MILLS A L *G-29493
MILLS G A *B-44906

MILMORE, B K *G-08326
MINAMIDANI H B-42886
MINAMIYA H B-39333
MIRANDO, E H *G-09408
MISHIMA M *G-29663
MISHURIN YA V B-35478
MITCHELL R I A-30759, G-31452
MITCHELL R L F-43436
MITCHELL, R I *G-03282
MITCHLEY B C V G-36935
MITSUGI H *C-25015, *C-43448
MITSUKI H D-29191
MIURA H *G-29958
MIURA M *B-28172
MIYAGAWA A D-27257, G-27253
MIYAMOTO T *B-30944
MIZUHARA K D-27257, *G-27253
MIZUNO K *C-40407
MIZUTANI H D-37366
MOESCHLIN S *G-42759
MOKELER C J C-30707
MOLLER, M C-10556, D-10554
MOLNAR J J G-34791
MOMOTANI H C-27358
MONKMAN L D-25107
MONKMAN, J L D-00697, D-09432
MOOD E W D-27096
MOORE C E C-18007, D-27241, *D-39535

MOORE J F G-23926, *J-36592
MOORE, J F L-11204
MOORHEAD J C-21459
MORAN J B *B-27371
MOREL MAROGER L G-18515, G-32216
MORENO G D G-39863
MOREO L G-29256
MORGAN G B *A-23561, *L-33495
MORGAN J M G-35211, *G-35217
MORGAN, G B C-08661
MORGAN, G M *C-06643
MORI T B-39333, B-42886
MORII F H-14489, H-27489
MORITA H G-27253
MORLIN Z *D-41520
MOROZUMI K G-29129
MORRIS W E *A-36084, *A-45136
MORRISON D L G-30831
MORROW J J *G-34847
MORSE T *B-27503
MORTSTEDT S E *A-44464, *B-44750
MOSER C E *B-20735
MOSS W D G-32749
MOSSMAN D B G-32787
MOSTYN, R A *N-06992
MOTOYAMA M C-25015, C-43448
MOTT W E *C-33055
MOTTO C K H-17218
MOTTO H D-24414
MOTTO H L *H-17218
MOYERS J L *D-35861
MUELLER F *A-30976
MUELLER P K *A-41145, *C-17179, *H-36197
MULLER, R B-00899
MULLER, T *D-08812
MUNCACI E G-11630
MUNIAK S E *G-33497
MUNIDASA M D-28653
MUNISADA M D-29385
MUNSELL M W B-39333, B-42886
MURAMATSU F D-29152
MURAMATSU T C-36840, C-36841
MURAMOTO S H-14489, H-27489
MURANAKA H D-27257, G-27253
MURASHOV B F G-15731
MURASHOV, B F *G-09486
MURATA M *D-28326, *D-37202
MURAYAMA, H *G-05475
MURO L A *G-34914
MUROZUMI M *A-15205, *A-19955, *A-21722, *G-29789
MUROZUMI, M *F-00841
MURPHY R P *D-30860, *D-32055
MURPHY, E M B-03337
MURRAY E F G-42716
MUSCHTER W D-30858
MUSHA S C-24617, C-24618, C-25013
MUSSER G S *B-28860
MUTSAARS P M *A-40947
MYERS P A-33350
MYERS P S *A-23250, *A-33365, A-35484

## N

NAGATA M *D-27648
NAGATA R D-30410, *D-30494, *D-37191

NAGATA T *D-41975
NAGAYAMA S A-29539, A-29787
NAGEL S *G-32484, *L-31957
NAGOYA S B-31317
NAGY S G-44255
NAITO N D-28653, D-29385
NAKA K D-28326, D-37202
NAKAAKI K D-06148, D-36503
NAKAGAWA Y D-29191
NAKAHASHI N G-27253
NAKAMURA H G-14492
NAKAMURA K D-36288, D-37320
NAKAMURA M *D-36486
NAKAMURA T G-27253
NAKANISHI K G-27253
NAKANO K C-28621, *D-28635, D-30410, D-30494, D-41975, D-44063
NAKANO W D-36806
NAKASHIMA S H-14489, H-27489
NAKAZAWA M *E-36487
NALL K L A-39603
NAMER R G-33605
NANCE, J T *B-09798
NANJO M C-15562
NAPIER J C B-39275
NARDI B A-38022
NATHANS M W *E-31852
NATHANSON B C-42139
NEBEL, G J A-05171
NEEDLEMAN H L *G-36534
NEELY G E *H-41891
NEIBURGER, M D-05573
NELSON E *B-36523
NELSON J L A-26763
NELSON N *G-31524
NELSON, H M F-07451
NERI T M G-40697
NESTORESCU, B G-11580
NEUBERT H *G-23887
NEWTON D F-13451
NEZAMI, M *C-06920
NICHIPORENKO O S F-27348
NICHOLS G B A-26441
NIELSEN K L G-30831
NIELSEN S W *H-42857
NIKKANEN J G-22637, G-26886, G-28010, *G-41717
NINOMIYA J S *B-25301
NISHI T *D-37288
NISHIDA K A-29936, *D-33114
NISHIHARA T B-42886
NISHII S *G-19940
NISHIMARU, M C-03893
NISHIMURA T D-27188
NISHIYAMA K A-29539, A-29787
NISKIHARA T B-39333
NIX J *F-36067
NOBE K B-30717, B-31246, B-32392
NOBE, K F-03799
NOGAMI Y C-19501
NOIRFALISE A G-15703
NOMA M D-36288, D-37320
NONOMURA T D-30182
NORBYE J P *A-42980
NORDMAN C H G-26886
NORRIS H B G-44696
NORTON R J N G-41894
NOUSHI H *D-27831
NOVAK L A-34068, G-36283
NOVARINI A G-40697
NOWEIR M H *G-24428
NOZAKI, K *G-04877
NULMAN R D-25107
NURULLAYEV, D K D-05260
NUSBAUM, R E *G-00662
NYE L J J *G-34738
NYHOLM, E A-03982

## O

O CONNELL M J G-42716
O CUILL T H-27386
O HARRA B M *B-25781
O NEILL D *B-19710
ODAIRA T *A-17325, *D-15610, D-28635, D-37191
ODAIRO T C-28621
OELERT H H *B-37234
OELSCHLAEGER W *H-38743
OESCHGER H E-28799
OGATA M A-32492, *G-45293
OGAWA R C-36840, C-36841
OGAWA S G-27253
OGIWARA I D-27257
OGLESBY S JR *A-26441
OHBA H *A-43776
OHIRA T *A-31934, D-41975
OHM H J *G-24573
OHMORI K D-29814, G-14492, *G-27490, H-28529
OHNO T D-29814
OHSHINO A *D-43962
OIKAWA K C-36588, *C-36698, *C-36703, C-36840, *C-36841, C-37608, *D-36688, *D-37518
OKA K *C-37514, *C-42043, D-43962, G-44087
OKAMOTO S G-27253
OKASHITA H C-32718
OKI I *D-25758
OKUBO Y *C-37608, D-37518
OKUNO T D-43962
OKUYAMA Y D-28650
OMANG S H *C-32474
OMURA K G-27490
OOMICHI S F-37213
ORANSKY S G-36957
ORNING, A A A-05067
ORTON W T *G-20704
OSHIMA S C-44129
OSTERLI V P *H-26092
OTSUKA Y *D-28634
OTTO J *C-13122
OTTOBONI F *H-18520
OUI G G-37722
OURA M *C-32829
OYAKE T D-17106, D-28233
OYANGUREN, H *G-01512
OYASU R *G-34851
OZAKI T B-29656
OZOLINS G A-23561, L-33495

## P

PADRTA F G *A-35818

PADUCHEV V V *F-13943
PAGE A L *H-25374, *H-35827, *H-44071
PAGE R T A-28862, L-23234
PAHNKE A J *A-14033, *B-42829
PAHNKE, A J *A-09355
PALMA T V D *B-41922
PALMBY A K C-24719
PALMISANO P A *G-34947
PALUCH J *A-29572, *H-32338
PARKER A *A-43346
PARKINSON G S *K-33730
PARRY E P *C-41490
PARTANEN T D-24351, D-35940
PARTANEN T J D-37264
PARUNGO F P *D-21684
PASTELL D L K-24107
PASZTOR G G-30334
PATTERSON C A-15205, A-19955, A-21722
PATTERSON C C *A-21069, *A-26891, *E-30676
PATTERSON D J *A-40776
PATTERSON K *G-37420
PATTERSON R K A-15295
PATTERSON, C F-00841
PATTERSON, C C *G-00642, *N-05313
PATTERSON, R K *D-07985, D-11202, D-12049
PATTERSON, R L JR C-05243, D-01355
PATTISON J N *B-42290
PAUKOVIC R C-25440
PAULSON G L *G-34895
PAVLOVICH, N V D-08438
PEARCE A W *A-36623
PEARSON E F C-43720
PECORA L *G-39621
PEIRSON, D H *E-03841
PELL S G-25328
PENKETT S A E-38666
PENNAROLA R G-30468
PENTSCHEW A *G-36964, *G-39503, *G-43531
PEREZ, E *G-01512
PERIN G C-33255
PERIN, G *C-09953
PERLA, V G-10793
PERLSTEIN, M A *G-01757
PERRINE R L *M-33904
PERRY R *C-43737
PERVUNINA R I *C-44995
PETERING H G F-44164
PETERS B *A-35484
PETROVA, A *D-08275, *D-09240
PETROVA, N V *G-04251
PETROVSKY D D G-41818
PETTIBONE, J S *I-06357
PEYTON M F L-23234
PFITZER E A G-18417, G-24428, G-27416

PFITZER, E *G-01812
PHILBERTH B *L-41703
PHILBERTH K L-41703
PIEHL F J A-41959
PIERCE J O *C-33731, *C-38914
PIERRARD J M A-16766, *A-35123, B-33994
PIERSON W R *A-33822, *D-43468
PINES A G *G-26720, *G-41695
PINES I *C-32169
PINKERTON C G-23801
PIOTROWSKI H D A-40981
PIOTROWSKI J G-32041
PIOTROWSKI, J *G-06814
PISCATOR M G-26356, *G-44053
PITTS J N JR *B-26269, *G-16820
PLASSMANN E A-25125, *K-30069
PLATT M *A-45092
PLESS L G *A-36083, *B-41112
PLUMLEE L A G-31528
POLIAN, G C-06920
POLLITZER E L *F-40387
POSKITT R W A-36084, A-45136
POTT F *G-33779, *G-37685, G-38869
POUNDS C A *C-43720
POWELL H E *B-40709
PRASAD C R *F-44032
PRENDERGAST W D *G-43559
PREROVSKA I *G-24192, *G-45005
PREROVSKA, I *G-08381
PRERVOSKA I *G-43196
PRESCOTT J H *J-37409
PREUSS H P *N-43824
PRIETSCH W *C-22927, E-37953
PRIETSCH, W *K-08803
PRINDLE, R A *G-00375
PROCTOR P D *A-34788
PROCTOR W G C-41612
PURSALL B K *A-15769, *C-42775
PURTYMUN W D D-35407
PURVES D *H-22926, *H-31801, *H-37977

PYLE W R B-35816

## R

RABINOVITZ M *G-43532
RABINOWITZ M B *C-45235
RADFORD E P G-18417
RADFORD, E P JR *G-05280
RADZIMIRSKI S *A-42212
RAINS D W *H-33112
RAMAN A K S B-35223, B-36578
RAO V K *F-44032
RASSBACH W *F-15413
RASSWEILER G M *A-24718
RATHER, J B JR L-11204
RAUSA G A-15599, C-33255
RAY B J D-35725
RAYZACHER B *B-28108
RAZUMOV, V A *C-06881, *C-06894
READE M J C-43737
REDERS K A-36082, A-44821
REGAN C J *G-24961
REICHEL F *G-21266
REILAND W H A-36080
REINHART W H A-28862
REISER L G-36957
RENSHAW G D *C-43720
RENZETTI, N A D-05573, *F-05849
REPETTO M *D-41033
REPLOH H D-15789, G-26931
REPLOH, H D-08502, G-12070
RESCH W *D-28178
REUSMANN G *C-42312
REYNOLDS, D D-08279
RHEA J O D-21684
RHYNE B G-23926
RICHET G *G-32216
RICHTER R H H *G-33910, *H-39407
RICHTER U B-32760, *B-35035, B-37750
RIGGAN W B G-39179
RINEHART W E *B-29126
RIXMANN W *A-28560, *B-37938
ROBBINS J A *A-37312
ROBERTS T M C-30113
ROBERTS W O *E-29445
ROBINSON E *E-30863
ROBINSON J W *C-17048, *C-23571, C-28895, C-41612
ROBINSON, E C-00855, D-00976, *D-07600
ROBINSON, J W C-00056
ROCCHI B *F-28908
RODRIGUEZ TORRES R G-40769
ROE F J C *G-36935
ROEBISCH G *C-15734
ROENSCH M M *B-44882
ROGERS J D JR A-36084, *A-45136
ROGERS J E *B-42300
ROGERS, L H D-05573, G-00020
ROLF L C-29512
ROLLA A *C-41016
ROMANOVSKY J C *A-27943
RONDIA D *G-33607, *G-42881
ROSCHIG M *C-33178
ROSCHIG, M *C-05456
ROSENBLUM W I *G-34943
ROSS T K I-31377
ROSSANO, A T JR I-00305
ROSSENBECK M *A-34341, *A-36527, *A-38330
ROSSINI F D *A-33350
ROTH J F *B-34536, *B-35814
ROTH R P G-20087, G-29329
ROTH Z G-45005
ROTHCHILD H B G-41847
ROUNDS, F G *A-05171
ROUSSEL A *G-44254
ROVENTA, A G-11580
ROZENSHTEYN I S *B-22492
ROZHAYSKIY G S B-34313
ROZMANITH A I B-33388, I-32921
RUCH W E D-29655
RUCKELSHAUS W D *L-37423
RUEB F *B-25013
RUHLING A A-22370, *C-18302, *D-23971, *D-35010, *H-17681, *H-23435, *H-28289
RUIZ SALAZAR A *G-44867
RUOF C H *B-42886
RUOF H B-39333
RUSSELL D R *B-28699
RYAZANOV V A *K-41682
RYLANDER R G-26356
RYSS M A B-15208
RZEPKA, J D-10380

## S

SABIN W W *J-32241
SABIN, W W *J-03288
SACHDEV S L *C-22975, *F-13839
SACHS H K *G-42716
SAIKI Y E-36487
SAITA G *G-29256
SAITO H G-27490, H-28529
SAITO K *G-38867, *G-45288
SAITO T B-39333, B-42886
SAITO, K *G-07396
SAKABE, H C-03037
SAKAMOTO T D-17106
SAKURAI T B-39333, B-42886
SALINGEN G L-40520
SALOOJA K C *A-18211
SALOOJA, K C *F-09578
SALTZMAN B E *C-26707, C-27294
SALVIA J D A-21069
SAMSON P C A-35818
SANDERS L W *G-32613
SANDSTEAD H H G-34114, *G-34837, *G-40312
SANDULACHE L G-11630
SANGL H *G-44294
SANO I *A-14945, *E-36038, *F-19823
SARUTA K D-29814, D-36486
SARUTA, N *D-06760
SASAKI K *B-29204
SASAKI T D-30182
SATO A D-21869, *D-27880, D-30326, D-36806
SATO Y G-29129
SATO, N G-03893

SATTLER E L G-18046
SAUER R M *G-32746, *H-44588
SAUNDERS, A W JR C-05243, D-01355
SAUNDERS, L W *G-05025
SAVILLE J M H-32736
SAWANO T D-06148
SAWINSKY A *G-30334
SAWYER R F A-25581, *A-38625, *K-43312
SAYERS M H P *G-43337
SAYERS R R A-28862, *G-37119, *G-39193, L-23234
SAYLOR L F *L-37497
SAYLOR W A B-44742
SCALES R K J-32241
SCALES, R K J-03288
SCANLON J *G-43725, *G-44364
SCARBERRY J E C-19313
SCHAEFER V J *A-23620, *E-19058, *E-36714
SCHAFER, L J *A-12624, D-01089
SCHALLER K H G-37964, G-40295, *G-44746
SCHALLER, K H *G-09019
SCHARF, P B *F-07451
SCHEDLING J A *D-28097
SCHEDLING, J A D-02133
SCHEEL THOMSEN, A *G-11468
SCHENCK R *F-13879, *F-15413
SCHERZ R G G-32737
SCHLADITZ R A-40981
SCHLAEPFER W W *G-08999
SCHLATTER C G-33910
SCHLATTER CH H-39407
SCHLEICHER A R J-30696
SCHLIPKOETER *G-41368
SCHLIPKOETER H W *G-31319, *G-33778
SCHMITT N *H-32736
SCHNECK T JR C-26275
SCHNEIDER D E B-33388
SCHOENBECK H *H-32335
SCHRAUB A G-18046
SCHRENK H H B-32633, *C-32975
SCHROEDER H A A-21109, *D-27174, G-18494, *G-28834, *G-35055, *G-45165
SCHROEDER, H A *G-01731, *G-01923, *G-12075
SCHUBERT R H W *G-44294
SCHUCHT F *H-32224
SCHUCK E A *H-17182, *H-20062
SCHUCKER, G W *G-00740
SCHUETZE C *G-39161
SCHULDT, A F *B-03232
SCHULTE H F D-35407
SCHULZ U *B-32760, *B-37750
SCHULZE H D D-29515
SCHULZE W H *G-41847
SCHWANECKE R *A-38331
SCHWARTZ, C H A-05067
SCHWARZ E H-38743
SCHWARZENBEK E F *B-37173
SCHWIND G F *B-41544
SCHWING R C *B-43333
SCIARAFFA P L *C-37175
SCOTT A N B F-13451
SECCHI G C *G-21037
SEDIVEC V G-45005
SEEGALL M I *B-39275
SEELEY J L *F-44332
SEIDEL G H *B-28060
SEKI H G-37722
SEKI Y G-45273
SEKIGUCHI Y E-36487
SELANDER S *G-32129, *G-32738
SELANDER, S *F-11582, G-00821, *G-02202
SELEZNEVA YE S *E-29699
SELLENT R *G-11808
SEMSCH R D G-32737
SENECHAL R G A-30428
SENHAUSER D A G-32696
SENICAR L G-41731
SENKO E E E-24166
SERVICE G R B-30717
SETO T D-27831
SEVCIK J J A-41959
SEVERS R K *D-44234, *D-44580
SHALNOVA K G F-36524
SHAMIRZAYEV, S Y *D-05260
SHAMS EL DIN A M *F-16659
SHAPIRO I M G-36534
SHAW C F *H-40590
SHEMYAKINA Z N B-13982
SHERWOOD P T *A-31323
SHIBKO S I *G-41895
SHIBUSAWA Y A-26134
SHIGEMORI N D-29153, D-30025
SHIGETA T *F-41787
SHIIO H C-40407
SHIKHVARGER F D *C-25979
SHILINA A I C-44995, D-44996
SHIMA H D-28326, D-37202
SHIMIZU T G-27253
SHIMIZU Y D-36288, D-37320
SHINMURA G *L-35795
SHINOZAKI Z A-31934
SHIOBARA Y *L-37521
SHIRAI T *B-44003
SHIRAKAWA K *G-17470
SHO, K G-03893, *G-03897
SHOLTS R A B-39333, B-42886
SHROFF G L *B-34846
SHULTZ, J F B-00015
SHUPE J L *H-42715
SHUSHUNOV V A F-34607
SHVAROV V N B-13982
SHWACHMAN H G-39867
SHY C M G-24716, G-39179, G-41894
SIEBENBERG S C-42139, D-17058
SIEGEL R D A-45092
SIEGEL S M H-27063
SIES W *A-33667
SIGWORTH H JR A-35484
SILVER W *G-40769
SILVERMAN L *C-25793
SILVESTRONI A G-39621
SIMKIN E A B-33157
SIMPSON B H A-33350, B-25301, *B-33366
SIMS J D H-39204
SINGER M J *A-22367
SINGH DEV R *F-34297
SINISTRI C *F-17882
SIVIERI G E-40164
SJOBERG J W B-33388, *I-32921
SKALA H A-35818
SKOGERBOE R K F-44332
SLOMYANSKAYA F B *I-22128
SMITH D S *A-25581
SMITH F R G-41847
SMITH G W *C-24719
SMITH H D G-32737
SMITH J R B-36453
SMITH L L B-40709
SMITH M E JR E-28799
SMITH R D-16839
SMITH R G *G-20198, *G-26915, *G-33202, *G-37040
SMITH W H *H-30424, *H-41143
SMITH, B M *F-10599
SMITH, R D-05551
SMITH, R G *G-03285
SNEED R C G-34947
SNITZ F L A-37312
SNODDERLY D M G-34895
SNYDER L J *C-24337
SNYDER, L J *C-06072
SOBECKI M F *G-42957
SOBEL A E *G-41818
SOBEL R *G-40317
SOKOLOV, V V *G-09484
SONE A *D-16539
SOOD S K *B-34740, *B-39272
SOREM S S *B-35688
SORENSEN C B-31246
SORENSEN L L C *B-32392
SOUKUP A V *A-41889
SOULAGES, N L *C-01230
SOURIRAJAN, S *F-03799, *F-08207
SPADARO J A G-21070
SPAIN D M *G-32696
SPECHT A W H-21794
SPECTER M J *G-35587
SPEIZER F E *G-30198
SPENCER, E F B-09798
SPENGLER G *B-20740
SPICER, G S E-03841
SPIES H W *G-14156
SPINAZZOLA, A *D-08810
SQUIRE, E C *A-09355
ST JOHN J L *H-34237
STA ANA E G-36957
STACEY M J *A-29127
STAFFORD GAFFNEY W *A-27272
STALEVICH D D *E-40157
STAMATOVIC S *H-32291
STAN R G-34092
STANKOVIC M G-37540, *G-40021
STANKOVIC M K *G-34066
STANKOVIC, M G-09253
STANLEY R L H-36197
STANLEY T D-25107
STANT E G G-34837
STARA J F G-23715
STARIKOV B G E-24166
STARKMAN E S *A-28873
STARKMAN, E S *A-01565
STARLIPER A G *B-43937
STEEL, J *G-03654
STEFANIN E G-34092
STEIGERWALD, B J *D-05277, *E-06841
STEINER R L C-41908
STEINHAGEN W K *B-21762
STEINKE I *C-29133
STENSON J H-23258
STEPANOV A S B-31390
STEPHENS E R C-26275
STEPHENS J W B-36453
STEPHENS R E E-35264
STEPHENS, J D *C-06045
STERBA M J *B-31519, B-37150, *B-44473

STERBA, M J *J-03289
STERN A C *C-27294
STETTLER, L E F-10599
STEVER H G *C-40631
STEWART P L H-36991
STICKSEL P R *A-33087
STINSON L E B-37619
STOCKS, P *D-03526, *G-03086
STODDARD L J-26765
STOEFEN D A-36541, *B-29414, *G-21423, *G-22222, *G-31303, *G-31962, *G-44508, *H-43511, *K-22223
STOFEN, D *G-10856
STOKELD R W A-36535
STOKINGER H E *A-31525, *G-26477
STOKINGER, H E *G-03281
STOPPS G J A-33350, E-31852, *G-25328, *G-33374
STOPPS, G I *K-11746

STORMONT D H *J-39956
STORY R V G-19159
STRAFUSS A C H-35209
STREHLOW C D D-17340
STRESEMANN E *A-17778
STRUNZ W *A-31315
STRUTH B W *A-34177, *J-37734
STYRO B I E-29699
SUDAR S B-42131
SUGAI R A-33710
SUGAWARA N D-17106, D-28233
SUGAWARA V *C-25535
SUGIMAE A A-29661, C-29464, C-31304, C-32892, C-34017, D-21015, D-28629, D-28650, D-36009, E-38118
SUGITA M *G-45273
SULZBERGER M B *G-39826
SULZMANN G P C-26275
SUN H G-11808
SUNDERMAN, F W JR *G-01797
SUZUKA T A-29936, D-33114
SUZUKI S *A-42791, *G-30355
SUZUKI T *A-32523, D-36909, *G-17244, G-29663
SVISTOV, P F E-10215
SWAIN R E *A-24285
SWAINE D J *F-43436
SWANN C D *C-42775
SYLVESTER, R O I-00305
SZADKOWSKI D G-40295
SZADKOWSKI, D G-09019
SZAJNAR J G-20198
SZCZENIOWSKI B *B-35535

## T

TABOR, E C *D-05623
TADA O A-19598, *A-35957, *C-27556, *D-06148, *D-36503, *G-13154, *G-24081
TADA, O *C-06112
TAGUCHI K *C-37689, D-43962, G-44087
TAHARA I D-31669
TAIKISHIMA T D-30892
TAIRA K G-29958
TAIRAFUNE K *D-21869, *D-36806
TAKADA N D-29191
TAKADA S D-30182
TAKAHASHI K G-45273
TAKAHASHI M D-21869, D-27880, D-30326, D-36806
TAKAHASHI T *F-17689
TAKAISHI S G-27253
TAKAKUWA E G-38867, G-45288
TAKAMATSU K E-36487
TAKATA N C-25015, *C-43448
TAKEDA K D-31669
TAKENOBU Y D-30182
TAKESHI F E-30073
TAKEUCHI J D-28620
TAKEYAMA Y G-27253
TAKIGAWA T G-27253
TALIAFERRO H R *A-39610
TAMURA S D-25758
TANAKA K A-36006, B-37116, *C-27681, *C-28755, *C-29419, *C-30786, D-28634
TANAKA M G-14492
TANAKA T C-36840, C-36841
TANAKA, D *G-03635, G-03893
TANI M *C-42360
TANIMOTO F B-31496
TANIZAKI A G-27490, H-28529
TANSY M F *G-20087, *G-29329
TARUNIN B I F-34607
TATE, G M JR D-00005
TATEISHI R *G-26528, G-26775
TATSUMI S *D-40716
TAYLOR J A G-34841
TECH G G-40492
TEICHMAN, T D-00697, *D-09432
TEISINGER J *G-26483, *G-43196, *G-45005
TEISINGER, J *G-09535
TENCONI L T *H-42945
TEPPER L B *D-36195, *G-27416, *G-31442
TEPPER, L B *G-03284
TER HAAR G A-32748, A-33350, H-17217, *H-17220, *H-24947
TER HAAR G L A-11702, *A-37176, *B-31604, *D-31775, *E-22959, *E-35264, *H-14786, *H-33364
TERADA K *A-38819
TERRY R T G-34837
TERZUOLO D *G-30328
TESHIROGI N *B-29656
THALMAYER C E *F-14008, *F-14039
THAMANN F *A-40314, *G-42757
THAYER J M *L-17927
THILLIEZ G *C-19276
THILLIEZ, G *D-07649
THOM N G *D-24162
THOM, G W *B-03232
THOMAS A B-36081, B-36721
THOMAS B G H G-37119, G-39193
THOMAS R W L *E-42720
THOMAS, H V *G-08326
THOMAS, R S D-09432
THOMPSON R J C-38973
THUM E E *L-39640
TIETJEN G G-32749
TIKHONOVA Z I *F-13461
TIMARU J G-11630
TIMS J M *A-31085
TINARD H *B-37275
TIPSON, R S *F-00058
TIPTON, I H *G-12075
TOKIDA T F-19823
TOKOS J V C-24337
TOLA S G-26886, G-41717
TOMASHEFSKI J F *G-31452
TOMASHEFSKI, J F *G-03282
TOMIDA B *D-36288
TOMINAGA H *C-43763
TOMITA B D-37320
TOMITA K G-27253
TOMIZUKA K *B-29531
TOMOTO F D-27648
TOMOTO N *D-44063
TOMSON N M *H-28448
TOMUS R G-44255
TONKELAAR W A M D *C-30593
TONOMURA M *C-15562, C-21338, D-15314, D-16576
TOPE, O *L-07952
TOPOROVA V V F-13943
TORGE H E-37953
TORNER G G-44255
TOYAMA T C-27358
TOYODA J D-27257
TOYOSHIMA K D-37320
TRASKO V M *L-23234
TRINKS, W B-10558
TROJANOWSKA B G-32041
TRUCCO R C-38778
TRUFAKIN V A E-24166
TRUFFERT, L *D-08821, *G-13059
TRYBULA E A-27180
TSESSARSKII V N B-35478
TSO, T C *H-01523
TSUCHIHIRA K *C-41763
TSUCHIYA K D-25881, D-29918, *G-28170, G-29816, *G-37941, *G-39989, *G-42098
TSUCHIYA, K *G-03893, *G-05780
TSUDA S *C-41719
TSUJIKAWA T D-37202
TSUKIYAMA H C-32718
TSUNETOSHI Y G-27253
TUDDENHAM, W M C-06045
TUFTS B J *C-23657
TUNCAY O C G-36534
TURNER T H *B-44283
TURNER, D *L-02635
TURNESCU B G-34092
TUSCHIYA K *G-45273
TUZHILINA, A A D-08438
TYLER C *A-18297
TYLER G A-22370, C-18302, *C-25222, D-23971, D-35010, H-17681, H-28289

## U

UBISCH H V *A-30414
UBL, Z *C-09983
UCHEVATKINA T S E-40157
UCHIDA K *B-25155
UCHIDA S *B-35080, *L-36030
UCHINUMA K *B-30498
UCHIYAMA Y B-29656
UEDA K *G-30395
UENISHI Y D-28653, D-29385
UENO Y F-19823
ULLED A *L-41557
ULLMAN W W *A-30674
ULLMANN W W *A-31313
ULLUCCI P A C-30707
ULMER D D *G-27614
ULMER W T G-21266
ULRICH C E G-42957
UMEHARA K *D-36909
UMEZAWA M D-36909
UNCKELL F G-40492
UNZELMAN G H J-39941
URBANOWICZ H G-34175
URLAUB A *A-29516
URSU P G-38616
URTA G G-34847
URUSHIYAMA Y A-33710
URYU K G-27490
UYEHARA O A A-35484

## V

VAAST D G-37731
VADIC V C-25440
VAIL, E H G-00740
VALENTIN H G-37964
VALKONEN S G-26886
VALLANCE J H-37926
VALLEE B L G-27614
VAN ARTSDALEN E R *F-14510
VAN PETEGHEM C G-42136
VAN STEEN J E A-40947
VANDEN BERG R H C-24119
VANDENABEELE W J *E-45050
VANHOORNE M *G-42136
VARDI J B-35223, B-36578
VARYUKHIN V A F-36524
VASILYEV V I B-34313
VDOVICHENKO V T *B-19725
VENDRAMINI R *A-15599
VENTURINI P D A-26763, *B-31819, *B-31825
VERGNANO C G-24784
VERNET D *B-40723
VETTE J I *E-24549
VIETS, F H B-03754
VIGDORCHIK, E A *C-08130
VIHKO, V *G-06985, G-07740, G-07892
VILAND C K *K-30035

VILENSKII, V D D-00261
VIMERCATI, F *G-11552
VINTON, W H JR G-01731, G-01923
VITTORI O *C-23096
VITTORIA O *D-25635
VIVONA F M E-31895
VOGEL H *A-29096, *L-30908
VOLCHOK H L C-27106, *D-22553, *D-24316, *D-27105, *D-31325, *D-31332, *D-42742, *D-43388, *D-43558
VOLVHOK H L *D-34805
VORONIN G F *F-17161

## W

W M HAGER J-39941
WADA A D-28620, D-28785, *D-37366, *D-37394
WADA O *G-29825, *G-35021, *G-41124
WAGMAN J A-15295, *D-21906
WAGMAN, J D-07985, D-11202, D-12049
WAGNER T O *A-35050
WAGNER, G D-02133
WAINERDI R E *C-33042
WAKAMATSU S E-36487
WALDRON, H A *G-00808, G-00993
WALFORD J G-34902
WALKER A O *C-12993
WALKER, J A *A-02636
WALKER, R L F-10599
WALLDEN I *L-40520
WALLER, R E *D-00985
WALSH A D F-39901
WALSH M P A-44682, B-33542
WARE T E JR J-34828
WARNICK S L *H-43279
WARREN H V *A-14135, *H-30921, *H-39287
WARTERESIEWICZ M *H-32322
WATANABE H *D-29191
WATANABE N B-29656, B-39333, B-42886
WATANABE S D-36288
WATANABE Y D-27257, G-27253
WATANABE, H *G-05475
WAXMAN H S *G-43532
WEAVER E E *A-14459, A-35353
WEAVER N K *G-34406, G-34841, *G-37180, *N-14772
WEBB J C *C-19313
WEBB P R A-30759
WEBBER M D *H-42607
WEBER M *G-33052
WEBSTER C C *H-19604
WEBSTER S H A-28862, *C-28017
WEGNER H *A-31395
WEIDENSAUL T C *H-27111, *J-21749
WEINBERGER, L W D-05277
WEISS S *H-30225
WEISZ, H C-05787
WELBERGEN J *B-38287
WELCH H V *B-24553
WELLS A E *A-40583, *D-40584
WESOLOWSKI J J *C-44479
WEST P W C-14758, C-22975, *F-13839
WEST W *A-24996
WEST, P W C-00056, *C-05787
WESTERLUND K A-30414
WESTERMAN, M P *G-01812
WESTPHAL J D-15575
WESTPHALEN J *C-42312
WETCH J R *B-42131
WETHERILL G W *C-45235
WEXLER I B *G-41818
WEY R J G-18494
WHITE M T JR B-39333, B-42886
WHITE W F *B-35342
WIDMARK G *A-24031
WIECK A G G-37964
WIESER P H *D-25089
WIEST E C G-20687
WIETHAUP H *G-45196
WIGG E E B-35223, B-36578
WIKLANDER L *A-36032
WILKS E H-39287
WILLIAMS H *G-41847
WILLIAMS M *G-34709
WILLIAMS M K *G-34902
WILLIAMS, J D *G-06028
WILLIAMS, M K *G-00810
WILSON J A B-28860
WILSON JONES R A *B-21303
WILSON, K W G-00177
WINCHESTER J W A-26925, D-27429, D-27621, D-28920, *D-32350, D-35489, *E-28586
WINCHESTER, J W *D-04646, *D-11184
WINCK, W D-08502
WINDEBANK C S A-36623
WINDOM H L *C-23646
WINTRINGHAM J S B-35778
WISE H B-30950
WISHART D J *B-27876
WITHROW L *A-24718
WITSCHI H *G-34789
WOBITH F G-21266
WODKOWSKI C S A-35353
WOERNER F D-25089
WOLFF H C *L-42169
WOLFF J *A-34350
WOLKONSKY P M *G-21259
WOLOCHOW H W C-26275
WOLOWICZ F R G-44696
WOOD R C-29297
WOODRIFF R *C-41138
WOODWARD C C-17048
WOODWORTH J A B-36081
WORCESTER A *A-42726
WOZNICZEK H *A-22579
WRIGHT L T A-39610
WYSZYNSKA H D-20642

## X

XINTARAS C *G-24288, *G-42957
XINTARAS, C *D-05820, G-00597

## Y

YAGYU H *G-29129, G-37722
YAKOVLEV V V F-15493
YAMADA S D-27648, *G-41067
YAMAGA S D-29814, *G-14492, *H-28529
YAMAKAWA T *A-42791
YAMAKI J N B-39333
YAMAKI N *A-37372, *A-40677, B-30154, B-42886
YAMAKI, N *D-08591
YAMAMOTO A D-27257
YAMAMOTO K D-27257
YAMAMOTO T *A-29936, A-31934, A-43966, *C-26336, F-41787
YAMAMOTO, H *L-08725
YAMANAKA T *B-29058, *B-29898
YAMAOKA, S G-05475
YAMASHITA E *C-37693
YAMATE N C-21338, *C-24644, *C-32833, *D-15175, *D-15314, *D-16576
YAMAUCHI T *F-42772
YAMAZAKI H D-30410, D-37191, D-41975
YAMAZAKI K D-27831
YAMAZAKI S G-29129
YAMAZAKI V C-25535
YAMAZOE S *C-44129
YANAGIHARA S *B-24813, *B-35166
YANOVSKIY A G *L-16200
YANT W P G-37119, G-39193
YARRINGTON R M *B-21040, B-26243
YATSUMAKI A-26134
YAZAKI S B-29204
YEAGER, D A-12624
YEGOROV V V C-44995, *D-44996
YEMEL YANOV B V *B-13982
YOCOM J *D-36562
YOCOM J E *B-35540
YODER, J D C-02164
YOKOHATA A C-41719
YOKOYAMA A G-27253
YOLLES R S *B-30950
YONEYAMA E *D-29814, D-32727, *D-32883, D-36486
YORK C R D-37026
YOSHIDA E *B-31364
YOSHIDA H D-27257, G-27253
YOSHIDA K D-37202
YOSHIKAWA H *G-38580, *G-42022
YOSHIMURA K G-44087
YOSHIMURA K I D-43962
YOSHINAGA S *A-36846, D-27188
YOSHITANI K A-36006, C-28755, C-30786
YOSHITANI N D-28634
YOSIM S J B-35352
YOUNG L T H-18521
YOUNG P L B-31341
YUGE S D-28528

## Z

ZAIA J A G-18494
ZAIKO V P B-15208
ZAPP J A *B-32036
ZAREMBOK I G-18494
ZATEK J E *C-23596
ZAWIRSKA B *G-36747
ZEDDA, S D-08810
ZEILINGER K *A-41738
ZEITZ A H *B-29625
ZEMSKOV I F *B-31390
ZENZ, C *G-06704
ZESCHMANN E G B-36081
ZHDANOV A K *F-15493
ZHIGALOVSKAYA T N *C-44995, *D-44996
ZIEGLER C A C-37175
ZIELHUIS R L *G-35118, G-35792, *G-44395, *K-16104, *K-16128
ZIELINSKI M G-29588
ZIERMANN P B-33741
ZIMDAHL R L F-44332
ZIMMER, C E *C-08661
ZOLLER W H D-35861
ZOLLER, W H *D-04646
ZOOK B C G-32746, *G-36934, *H-44588
ZORE V A *F-13461
ZUBER R H-32654, *H-40368
ZULIANI G *C-33255
ZUTAUT D W A-35477
ZWEIBAUM F *C-21459

# SUBJECT INDEX

## A


ABATEMENT A-23280, A-26552, A-32621, A-32875, A-33350, A-33963, A-36623, A-37166, A-39367, A-41035, A-41654, A-45145, B-28377, B-30633, B-31314, B-31496, B-35018, B-39404, B-39492, B-42330, D-09726, D-29416, D-30860, D-32055, D-35025, D-38110, D-42120, G-30328, G-34059, J-30329, J-42721, K-03956, K-34063, L-23608, L-23610, L-24214, L-25288, L-26442, L-28349, L-28397, L-29421, L-30152, L-30620, L-30908, L-31454, L-32462, L-32789, L-32865, L-32884, L-33740, L-34033, L-34980, L-35795, L-36877, L-37497, L-37560, L-37717, L-38669, L-40486, L-40520, L-41557, L-42016, L-42041, L-42873, L-44044, L-44219, L-44325, L-44499, M-29432

ABSENTEEISM G-32735

ABSORPTION A-18211, A-21069, A-23280, A-40314, B-03337, B-19331, B-25033, B-28699, B-29204, B-30944, B-31364, B-35296, B-37222, C-00056, C-05977, C-06107, C-06112, C-08145, C-21459, C-27556, C-30635, C-30928, C-32058, C-32169, E-38666, G-00642, G-02191, G-03283, G-03284, G-03285, G-05002, G-06028, G-19881, G-20087, G-20198, G-23167, G-23768, G-24603, G-26260, G-28024, G-29493, G-29789, G-30686, G-31319, G-31442, G-33372, G-33779, G-33864, G-34902, G-36283, G-36551, G-37685, G-38580, G-38869, G-39826, G-42957, G-44364, H-17215, H-17216, H-17217, H-17218, H-17220, H-17681, H-17978, H-20062, H-20237, H-21018, H-24788, H-24947, H-25878, H-26092, H-27352, H-28379, H-28529, H-32224, H-34830, H-35827, N-09780

ABSORPTION (GENERAL) A-12751, A-12823, A-34774, A-35052, B-03337, B-16053, B-28172, B-32260, E-12777, I-22128, N-09780

ACETALDEHYDE F-07451, F-09578, G-00177

ACETIC ACID A-37190, C-06894, F-00058, F-06648, F-09578, G-03892, G-03893, G-04196, G-26483, G-34851, G-36934, G-39883

ACETONE C-09333, F-03525, F-06648, F-09578, G-00177, K-02580

ACETYLENES B-00063, C-23596, J-03289

ACID SMUTS A-35957, B-35476

ACIDS A-05067, A-09686, A-10749, A-12751, A-12823, A-23561, A-26441, A-29786, A-31315, A-32875, A-34018, A-35052, A-35224, A-35957, A-37166, A-37190, A-37721, A-39462, A-42676, B-03337, B-07606, B-26600, B-28172, B-29058, B-31985, B-34025, B-35476, B-35703, B-38727, B-43937, C-00125, C-00855, C-06894, C-08661, C-09333, C-09983, C-23657, C-26274, C-26467, C-28126, C-30360, C-31258, C-31304, C-32476, C-35494, C-38670, C-39136, C-41719, C-41763, C-42139, C-42928, D-03441, D-05260, D-07198, D-10634, D-26387, D-27096, D-29382, D-29416, D-31396, D-34008, D-36806, D-38133, D-41979, E-24570, E-32155, E-36038, F-00058, F-06648, F-09578, G-00375, G-00708, G-03892, G-03893, G-04196, G-07162, G-08411, G-24314, G-26483, G-31319, G-32735, G-32738, G-34851, G-35174, G-36093, G-36934, G-38721, G-38869, G-39621, G-39883, G-44294, G-44433, G-44867, H-08884, H-11452, H-11467, H-26055, H-27111, H-30225, H-32224, H-39690, H-42250, H-42607, H-42945, I-33802, J-21749, J-30696, K-02580, K-06734, K-06778, K-08420, K-09259, K-11746, K-19750, K-20121, K-33107, K-34063, K-34377, K-36823, K-38197, K-41682, K-42039, K-44310, K-44377, L-00311, L-17472, L-28349, L-29421, L-32789, L-35795, L-38669, L-39640, N-04052, N-04212, N-09780, N-20548, N-28803

ACROLEIN A-37190, G-00177, G-07162, K-02580

ACUTE A-35957, G-01797, G-03286, G-06814, G-07162, G-11580, G-21266, G-29129, G-30686, G-31493, G-31584, G-32487, G-32608, G-34406, G-34436, G-35225, G-35387, G-35560, G-37180, G-38867, G-38869, G-40634, G-40688, G-41847, G-42098, G-42136, G-44867, H-11452, H-11467, H-41461, H-43279

ADAPTATION G-26477, G-29825, L-07952

ADMINISTRATION A-01868, A-12624, A-24031, A-25125, A-27858, A-31136, A-31313, A-31323, A-32621, A-33087, A-33963, A-33965, A-36623, A-36664, A-38625, A-39367, A-40776, A-40981, A-41035, A-41145, A-42791, B-01851, B-20735, B-28730, B-30633, B-31314, B-31496, B-31690, B-32364, B-32424, B-33386, B-33388, B-33542, B-33550, B-34457, B-36721, B-37116, B-39404, B-42702, B-43575, B-44283, B-44470, C-18007, C-22927, C-30360, C-38755, C-41016, C-44479, D-00005, D-00017, D-00974, D-01089, D-02133, D-03410, D-03441, D-04996, D-05167, D-05573, D-05623, D-05820, D-08568, D-12049, D-12099, D-16539, D-16839, D-19144, D-22553, D-23971, D-24351, D-25107, D-26387, D-27096, D-27105, D-27174, D-27621, D-28097, D-29416, D-29655, D-30656, D-30858, D-30860, D-31325, D-31332, D-31396, D-32055, D-32945, D-34008, D-34933, D-35407, D-35940, D-36009, D-36195, D-36288, D-36449, D-36806, D-37394, D-38110, D-38133, D-39081, D-39405, D-39914, D-40363, D-40997, D-41033, D-41887, D-41975, D-41979, D-42120, D-42122, D-42742, D-42921, D-43316, D-43558, D-44059, D-44170, D-44234, D-44330, D-44580, E-29445, E-32155, G-00740, G-08411, G-09253, G-12038, G-14156, G-16820, G-23715, G-24877, G-25068, G-27961, G-29815, G-29816, G-30181, G-31528, G-34095, G-34436, G-34895, G-35118, G-36207, G-37229, G-37788, G-44254, G-44395, G-44463, H-27111, H-40368, H-43226, J-30329, J-39956, K-03007, K-03956, K-36346, K-36823, L-03536, L-08725, L-09009, L-16200, L-22583, L-23234, L-23608, L-23610, L-24214, L-24467, L-25288, L-25542, L-26442, L-28397, L-28869, L-29888, L-30152, L-30908, L-31454, L-32462, L-33495, L-33844, L-35151, L-35461, L-35795, L-35922, L-36877, L-37193, L-37423, L-37497, L-37521, L-38757, L-40486, L-40520, L-41557, L-42041, L-42873, L-44044, L-44499, M-01073, M-33904, N-03674, N-04052, N-04649, N-08273, N-11871

ADSORPTION A-35818, A-42791, B-03337, B-21762, B-31341, B-31390, B-44003, C-06072, C-26707, E-45050, F-10599, G-00177, G-09019, G-24603, N-09780

ADSORPTION (GENERAL) A-35052

ADULTS A-17778, A-29872, A-31313, D-01315, D-08568, D-08812, D-08821, D-44330, F-11570, G-00705, G-00808, G-00810, G-00821, G-01512, G-03283, G-05780, G-06174, G-06704, G-08326, G-08381, G-08566, G-08949, G-09261, G-10434, G-10793, G-10856, G-11580, G-12075, G-20287, G-23876, G-24192, G-25328, G-27084, G-27253, G-29129, G-29958, G-30672, G-31228, G-31584, G-31899, G-32738, G-32747, G-32787, G-33372, G-33527, G-33903, G-34066, G-34092, G-34709, G-34738, G-35211, G-35560, G-35811, G-36152, G-38579, G-39406, G-40022, G-41067, G-41847, G-42098, G-42884, N-11871

ADVECTION E-21182

ADVISORY SERVICES A-33965, D-30860, D-32055, G-34649, L-30908, L-35151, L-37193, N-09780

AEROSOL GENERATORS E-36038, F-19823, F-29400

AEROSOLS A-01624, A-01868, A-14945, A-15205, A-19684, A-21722, A-25295, A-26891, A-26925, A-40981, A-41145, A-42676, A-45072, B-00107, B-29664, B-30124, B-33994, B-39272, C-00855, C-01249, C-05243, C-06881, C-06894, C-06920, C-08145, C-09888, C-09983, C-12943, C-19313, C-19857, C-21862, C-21948, C-27829, C-29595, C-31258, C-33042, C-33055, C-39168, C-40724, C-42137, C-45235, D-00976, D-01355, D-04646, D-07600, D-10634, D-11184, D-11202, D-20642, D-21684, D-21906, D-22829, D-23658, D-23864, D-26387, D-27429, D-28920, D-31014, D-32350, D-34008, D-35489, D-39914, D-44996,

E-19058, E-22959, E-23743, E-28586, E-30073, E-30676, E-31895, E-32155, E-32158, E-35207, E-36038, E-38666, E-42720, F-00841, F-05849, F-07451, F-10599, F-13451, F-19823, F-29400, G-00177, G-00375, G-00642, G-03282, G-04877, G-09493, G-16820, G-18046, G-31524, G-32484, G-32735, G-33778, G-36354, G-37229, G-38616, G-39161, G-40688, H-08884, H-27063, H-31185, K-02580, K-16808, L-00311, N-03674, N-09780, N-28088

AFRICA B-03337, F-16659, G-12075, G-16810, G-24428, M-01073

AFTERBURNERS A-14459, A-22825, A-23250, A-26134, A-26763, A-27858, A-28560, A-29127, A-30604, A-31324, A-33378, A-34442, A-35353, A-35484, A-35818, A-36083, A-37372, A-38522, A-39067, A-39462, A-40677, A-45092, B-00063, B-01484, B-03125, B-05214, B-09231, B-14604, B-20735, B-20844, B-21040, B-21762, B-23540, B-23697, B-24184, B-24696, B-24722, B-24813, B-25155, B-25377, B-25470, B-25894, B-26243, B-28286, B-28699, B-28730, B-28865, B-29204, B-30229, B-30498, B-31364, B-31496, B-31819, B-31825, B-32355, B-33366, B-33386, B-33388, B-33403, B-34025, B-34035, B-34457, B-35018, B-35703, B-35778, B-35821, B-36145, B-36523, B-36578, B-36721, B-37042, B-37116, B-37150, B-37234, B-37275, B-37408, B-37845, B-37938, B-38287, B-38614, B-39275, B-39333, B-40411, B-40723, B-40785, B-41608, B-41922, B-42330, B-42886, B-43333, B-44341, B-44473, G-34059, G-41737, I-32921, J-26765, J-30329, J-34370, K-24107, K-38758, L-07952, L-09009, L-28869, L-37423, L-38757, L-40520, N-09780

AGE D-09240, D-36195, F-11570, G-08381, G-09261, G-09408, G-12070, G-12075, G-16810, G-20287, G-21766, G-26720, G-26931, G-27253, G-29129, G-30181, G-32696, G-32787, G-33372, G-33910, G-34092, G-34832, G-34851, G-35217, G-35219, G-36152, G-39406, G-42463, G-44053, G-44463, G-45273, H-32423, H-32736, K-16808

AIR CONDITIONING EQUIPMENT B-35540, C-38165, D-27187, D-36562, L-30152

AIR POLLUTION EPISODES A-24156, A-32875, D-03441, D-29416, D-32055, D-37026, D-39081, G-00375, G-07423, G-24603, G-31493, G-38616, G-44087, G-44867, G-45196, H-08884, H-11467, H-36196, K-36823, K-38197, L-37497, L-44499, N-14772, N-18005

AIR POLLUTION FORECASTING A-33087, A-45092, D-26535, D-32912, K-36382, L-35922

AIR QUALITY CRITERIA A-27943, A-32621, A-35676, B-25894, B-34457, D-29416, D-31669, G-12038, G-16810, G-16820, G-23768, G-27084, G-33903, G-34406, G-34895, H-32335, K-08420, K-09259, K-16808, K-36823, K-43312, N-14772, N-43824

AIR QUALITY MEASUREMENT PROGRAMS A-01868, A-12624, A-25125, A-31313, A-33087, A-33963, A-33965, A-39367, A-41035, A-41145, B-01851, B-28730, B-30633, C-18007, C-22927, C-30360, C-41016, C-44479, D-00005, D-00017, D-00974, D-01089, D-02133, D-03410, D-03441, D-04996, D-05167, D-05573, D-05623, D-05820, D-08568, D-12049, D-12099, D-16539, D-16839, D-22553, D-23971, D-24351, D-26387, D-27096, D-27105, D-27174, D-27621, D-28097, D-29416, D-29655, D-30656, D-30858, D-30860, D-31325, D-31332, D-31396, D-32055, D-32945, D-34008, D-34933, D-35407, D-35940, D-36009, D-36195, D-36288, D-36449, D-36806, D-37394, D-38110, D-38133, D-39081, D-39405, D-39914, D-40363, D-40997, D-41033, D-41887, D-41975, D-41979, D-42120, D-42122, D-42742, D-42921, D-43316, D-43558, D-44059, D-44170, D-44234, D-44330, D-44580, E-32155, G-08411, G-09253, G-16820, G-27961, G-30181, G-34436, G-35118, G-37229, H-27111, K-03007, K-36823, L-09009, L-23608, L-23610, L-24214, L-25542, L-26442, L-28397, L-33495, L-35151, L-35922, L-41557, L-42873, L-44499, N-03674, N-04052, N-04649, N-11871

AIR QUALITY MEASUREMENTS A-00962, A-01868, A-02636, A-03278, A-06351, A-13524, A-15599, A-16766, A-17325, A-17339, A-18297, A-19598, A-19684, A-21109, A-21722, A-24031, A-26645, A-26925, A-28560, A-28873, A-29516, A-29572, A-30414, A-30513, A-30759, A-31525, A-31649, A-31934, A-32035, A-32447, A-32621, A-32875, A-33822, A-33965, A-34018, A-34068, A-35052, A-35123, A-35168, A-35788, A-35953, A-37015, A-37176, A-38891, A-39152, A-39610, A-40455, A-40583, A-41035, A-41145, A-41654, A-45145, B-22414, B-28377, B-30633, B-31341, B-31604, B-32938, B-33366, B-33542, B-33550, B-33994, B-35540, B-37150, B-42829, B-44660, B-44750, C-00855, C-03770, C-05977, C-06072, C-06107, C-08661, C-10528, C-10556, C-12943, C-18007, C-18302, C-19313, C-22927, C-23096, C-23646, C-25222, C-25535, C-26467, C-26505, C-30360, C-31258, C-31304, C-32474, C-35396, C-35494, C-37514, C-37608, C-37693, C-38165, C-38755, C-38778, C-39136, C-39168, C-39762, C-40724, C-41016, C-41763, C-42043, C-42928, C-44479, C-45235, D-00005, D-00017, D-00697, D-00974, D-00976, D-00985, D-01089, D-01315, D-01673, D-02133, D-03410, D-03441, D-03526, D-04996, D-05167, D-05260, D-05277, D-05551, D-05573, D-05623, D-05820, D-06148, D-06760, D-07198, D-07600, D-07985, D-08275, D-08438, D-08502, D-08568, D-08591, D-09432, D-10380, D-10595, D-10612, D-10756, D-11028, D-11184, D-11202, D-12049, D-12099, D-14762, D-15175, D-15314, D-15573, D-15575, D-15610, D-15789, D-15823, D-16345, D-16539, D-16576, D-16684, D-16791, D-16839, D-17058, D-17106, D-17340, D-19144, D-19433, D-19822, D-20191, D-20642, D-21015, D-21869, D-21906, D-22290, D-22553, D-22829, D-23388, D-23658, D-23864, D-23971, D-24162, D-24316, D-24351, D-24414, D-24463, D-24952, D-25055, D-25107, D-25635, D-25758, D-25881, D-26044, D-26054, D-26287, D-26387, D-26535, D-27096, D-27105, D-27174, D-27187, D-27188, D-27191, D-27257, D-27429, D-27621, D-27648, D-27672, D-27675, D-27831, D-27880, D-28097, D-28178, D-28233, D-28326, D-28369, D-28528, D-28620, D-28629, D-28634, D-28635, D-28650, D-28653, D-28785, D-29152, D-29153, D-29191, D-29382, D-29385, D-29416, D-29465, D-29515, D-29647, D-29655, D-29744, D-29814, D-29918, D-30025, D-30182, D-30326, D-30410, D-30493, D-30494, D-30656, D-30858, D-30860, D-30892, D-31014, D-31325, D-31332, D-31396, D-31669, D-31775, D-32055, D-32350, D-32727, D-32883, D-32912, D-32945, D-33114, D-33576, D-34008, D-34805, D-34933, D-35010, D-35025, D-35407, D-35489, D-35725, D-35861, D-35940, D-36009, D-36195, D-36288, D-36449, D-36474, D-36486, D-36503, D-36562, D-36688, D-36806, D-36820, D-36909, D-37026, D-37191, D-37202, D-37264, D-37288, D-37320, D-37366, D-37369, D-37394, D-37518, D-38110, D-38133, D-39405, D-39535, D-39914, D-39988, D-40118, D-40363, D-40574, D-40584, D-40716, D-40997, D-41033, D-41520, D-41664, D-41887, D-41888, D-41975, D-41979, D-42120, D-42122, D-42247, D-42367, D-42742, D-42921, D-43316, D-43388, D-43693, D-43962, D-44059, D-44063, D-44170, D-44234, D-44330, D-44580, D-44996, D-45218, E-00834, E-05713, E-23743, E-27116, E-29445, E-30073, E-30863, E-32155, E-32158, E-35207, E-35264, E-36487, E-36714, E-37953, E-38118, E-38666, E-40164, E-44813, F-03799, F-05849, G-00076, G-00177, G-00902, G-04251, G-05780, G-08326, G-09253, G-19159, G-21423, G-23801, G-24428, G-24603, G-26260, G-26310, G-27291, G-29129, G-29958, G-30181, G-30328, G-30334, G-30395, G-30671, G-31351, G-32735, G-32905, G-33497, G-34059, G-34436, G-34895, G-34902, G-35041, G-35055, G-36093, G-36283, G-37040, G-37229, G-37788, G-37942, G-38580, G-39179, G-44087, G-44251, G-44255, G-45273, H-10318, H-11157, H-23435, H-25374, H-28471, H-32423, H-32736, H-35827, H-36197, H-37977, H-38743, H-39690, H-42250, H-44071, I-00305, K-03007, K-16808, K-36382, K-36823, K-38197, K-42118, L-00311, L-08196, L-24757, L-33844, L-35922, L-36877, L-44325, L-44499, N-03674, N-04649

AIR QUALITY STANDARDS A-00962, A-22579, A-29516, A-30604, A-30976, A-31315, A-32447, A-32621, A-33169, A-34341, A-35957, A-36527, A-37190, A-37721, A-39152, A-39367, A-40677, A-45092, B-28730, B-35166, B-44882, C-41719, D-00005, D-02133, D-08275, D-08568, D-27831, D-32055, D-32883, D-32945, D-33576, D-35025, D-39988, D-40363, E-23743, E-44999, G-00020, G-03285, G-03654, G-05780, G-08381, G-08683, G-16820, G-25068, G-25705, G-26915, G-28170, G-29129, G-29815, G-30000, G-31280, G-31537, G-32905, G-33903, G-34406, G-34649, G-34951, G-35042, G-37180, G-38580, G-38721, G-40485, G-40492, G-41097, G-41737, G-42098, G-44176, H-28448, H-36611,

J-27968, K-02580, K-03007, K-06734, K-06778, K-08803, K-09259, K-11746, K-14443, K-16128, K-19750, K-20121, K-22223, K-33107, K-34063, K-34377, K-36346, K-36382, K-36823, K-38197, K-41682, K-43312, K-44310, L-00311, L-07952, L-23608, L-23610, L-24214, L-24757, L-28066, L-28099, L-30152, L-32789, L-32865, L-32884, L-33495, L-35795, L-37497, L-37521, L-38669, L-38757, L-44325, L-44499, N-14772

AIR RESOURCE MANAGEMENT B-27824, B-28377, L-23562, L-26442, L-28066, L-28099, L-28349, L-41557

AIR-FUEL RATIO A-01565, A-01624, A-05171, A-17304, A-19598, A-22941, A-23250, A-24829, A-27249, A-27272, A-27858, A-28873, A-29516, A-30604, A-33378, A-34774, A-35481, A-35484, A-41035, A-44252, A-45092, B-03754, B-09231, B-18053, B-20740, B-20844, B-22414, B-23697, B-24182, B-24696, B-25155, B-26269, B-27876, B-28865, B-29058, B-30944, B-31314, B-31690, B-32355, B-32938, B-33741, B-34457, B-35018, B-35778, B-36081, B-36145, B-37195, B-37234, B-37275, B-37938, B-40411, B-41608, B-43333, G-19940, G-39161

AIRCRAFT A-16156, A-20927, A-23620, A-33087, A-35676, A-38625, A-40677, A-42679, A-45092, B-22890, B-29628, C-19313, D-06788, E-29445, F-07451, F-14995, L-00311

AIRPORTS A-20927, A-35676, A-38625, A-45092, B-22890, D-06788, E-01821, L-23608

AITKEN COUNTERS C-08130

ALABAMA D-00005, D-05623, G-03086

ALASKA D-04646, D-32350, E-00834, E-24109, E-28586

ALCOHOLS A-24829, A-27458, A-35199, A-35477, A-35481, A-37190, B-01484, B-05300, B-29414, B-34611, B-35535, B-41608, C-09333, C-09983, C-38670, C-39136, C-39516, C-42928, D-26387, F-06648, F-07451, F-09578, F-09745, F-28908, F-39901, G-07162, G-18508, G-35387, G-39883, K-02580, K-20121, K-41682, N-28803

ALDEHYDES A-02636, A-05067, A-08039, A-09686, A-15599, A-17778, A-19598, A-22579, A-23561, A-23789, A-24829, A-27180, A-27249, A-27458, A-31315, A-34018, A-34774, A-35199, A-35353, A-35477, A-35957, A-37015, A-37190, A-37372, A-38625, A-42080, A-42212, A-43346, A-45145, B-01484, B-26269, B-29126, B-29625, B-32938, B-35166, C-06112, C-09333, C-09983, C-26274, C-26275, C-26707, C-27294, C-32476, C-32534, C-38670, C-42928, D-01673, D-03441, D-05573, D-06788, D-08812, D-10634, D-30860, D-32055, D-33114, D-34008, F-07451, F-09578, F-39901, G-00177, G-00375, G-07162, G-13059, G-16820, G-24603, G-32735, G-34895, G-35118, G-37229, G-44254, K-02580, K-08803, K-41682, N-04212, N-28088, N-28803

ALERTS D-29416, D-39081, K-36823, K-38197, L-37497, L-44499

ALFALFA G-05483, G-07396, H-08884, H-25878, H-27391, H-41891

ALIPHATIC HYDROCARBONS A-05171, A-08039, A-14461, A-23280, A-26925, A-27249, A-31085, A-31596, A-33822, A-34040, A-34177, A-34774, A-35050, A-35078, A-35353, A-35477, A-35919, A-35957, A-36527, A-36535, A-36664, A-38330, A-38331, A-40455, A-41738, A-42377, A-42980, A-43966, A-44252, A-44464, A-44682, A-44821, A-45136, B-00015, B-00063, B-01851, B-03337, B-05214, B-19725, B-20735, B-22414, B-22436, B-22834, B-24696, B-27503, B-29414, B-30154, B-31221, B-31246, B-31341, B-32392, B-32822, B-33542, B-33550, B-33932, B-35080, B-35112, B-35688, B-35816, B-37150, B-37173, B-37619, B-37938, B-39333, B-39404, B-41793, B-42702, B-42829, B-44470, B-44473, B-44882, C-01230, C-23596, C-26274, C-33178, C-38670, C-41719, D-01089, D-01673, D-19433, D-30860, D-43468, F-03799, F-05440, F-06648, F-08207, F-09578, F-09745, F-17689, F-28908, F-39901, F-41787, G-00177, G-03892, G-16820, G-33607, G-38867, G-39883, G-44867, H-08884, H-26055, H-27111, J-03289, J-21749, J-22358, J-31720, J-34370, J-38624, K-03007, K-09259, K-20121, K-33730, K-41682, L-11204, L-36030, L-37392, L-38757, L-41289, N-03674

ALKALINE ADDITIVES A-12751, A-12823, A-34774, A-35052, B-03337, B-25377, B-34025, E-12777, L-23562

ALKALIZED ALUMINA (ADSORPTION) A-35052

ALLERGIES G-00375, G-26477, G-31351, G-39826

ALPHA PARTICLES B-05214, C-00125, C-01249, C-06920, C-27294, D-03441, G-07169

ALTITUDE A-15205, A-26645, A-34647, A-38625, B-09231, C-01249, C-06920, C-19313, C-33055, D-01355, D-05573, D-08275, D-09240, D-14762, D-17058, D-21684, D-21906, D-23864, D-24316, D-25089, D-25881, D-27105, D-28097, D-28634, D-28635, D-28650, D-29918, D-30410, D-31332, D-32945, D-33114, D-34805, D-35725, D-36449, D-36474, D-37366, D-41520, D-43388, D-43558, D-45218, E-01821, E-03841, E-05713, E-06841, E-24109, E-24166, E-27116, E-30073, E-33225, E-36487, E-37953, E-38118, E-38666, G-08326, G-16820, G-33497, H-28529, H-32423, H-39409, L-23562

ALUMINUM A-09686, A-34018, A-34916, A-34921, A-35168, A-39462, A-41518, A-42676, A-43271, B-00107, B-03125, B-03754, B-09798, B-21324, B-32248, B-32319, C-15734, D-04996, D-08502, F-10599, G-00177, G-00662, G-31319, H-08884, I-02176, I-03735, I-06355, I-06357, I-22128, I-32921, J-30696

ALUMINUM COMPOUNDS A-26441, A-45072, B-03337, B-31246, B-34536, B-35703, C-05787, C-16367, C-22975, C-38778, C-41612, C-41825, C-41908, C-41968, C-42928, C-44210, C-44995, D-04996, D-08502, D-27174, D-44580, E-10215, E-29910, F-43436, G-19159, G-40688, K-14443

ALUMINUM OXIDES B-00015, B-00063, B-25377, B-30717, B-32392, C-42928, D-15789, F-03799, F-08207, F-17689, G-40068, H-42336, I-33802

ALVEOLI D-35025, D-36688, F-13451, G-03282, G-18417, G-26356, G-31517, G-33497

AMIDES G-39883

AMINES A-31085, B-03337, B-05300, C-38670, C-39136, C-42928, F-03525, F-06648, G-00821, G-03892, G-34436, G-35387

AMINO ACIDS A-34068, A-35953, G-03892, G-22637, G-23768, G-29256, G-29825, G-30686, G-31899, G-34175, G-34847, G-35225, G-35560, G-36152, G-36932, G-36957, G-37731, G-37941, G-37964, G-39621, G-40021, G-40057, G-40295, G-40492, G-43532, G-44395, H-42945

AMMONIA A-09686, A-33350, A-34018, A-35052, A-35957, B-03337, B-35223, B-36578, B-39275, C-09983, C-26274, C-28126, C-32534, C-38670, C-39136, C-41763, D-04996, D-08812, D-21906, D-29416, D-41033, D-41979, F-05849, F-06648, F-07451, G-07162, G-24314, G-24603, H-08884, H-40368, K-41682, K-44310, L-25542, L-32789, N-04212

*AMMONIUM CHLORIDE* A-35957, A-38819, B-28172

AMMONIUM COMPOUNDS A-09686, A-33350, A-34018, A-35052, A-35957, A-37176, A-38819, B-03337, B-28172, B-31604, B-33157, B-35223, B-35703, B-36578, B-39275, C-09888, C-09983, C-26274, C-28126, C-32534, C-38165, C-38670, C-39136, C-41763, D-04996, D-08812, D-21906, D-29416, D-41033, D-41979, E-38666, F-05849, F-06648, F-07451, G-07162, G-24314, G-24603, H-08884, H-23581, H-40368, I-22128, K-41682, K-44310, L-25542, L-32789, N-04212

ANALYTICAL METHODS A-04460, A-05067, A-09355, A-09393, A-13524, A-15599, A-23789, A-25295, A-29516, A-29539, A-29661, A-29936, A-32523, A-32621, A-34647, A-35065, A-35788, A-36006, A-38022, A-39035, A-40947, A-41604, A-43966, B-00899, B-20844, B-27371, B-30717, B-31317, B-31690, B-32392, B-39272, B-39275, C-00056, C-00125, C-00855, C-01230, C-01607, C-01608, C-02164, C-03034, C-05456, C-05787, C-05977, C-06045, C-06072, C-06112, C-06881, C-06894, C-08145, C-08661, C-09333, C-09476, C-09953, C-09983, C-10528, C-10556, C-11042, C-11626, C-12993, C-14758, C-15563, C-15734, C-16123, C-16367, C-17771, C-18007, C-18302, C-19276, C-19501, C-20891, C-20945, C-21338, C-22975, C-23096, C-23571, C-23596, C-24119, C-24337, C-24617, C-24618, C-24644, C-24719, C-25013, C-25440, C-25535, C-25932, C-25979, C-26274, C-26275, C-26336, C-26467, C-26503, C-26505, C-26698, C-26707, C-26848, C-26955, C-27075, C-27106, C-27294, C-27556, C-27681, C-28017, C-28126, C-28621, C-28755, C-28895, C-29226, C-29297, C-29419, C-29464, C-29595, C-30290, C-30360, C-30593, C-30635, C-30707, C-30786, C-30928, C-31258, C-31933, C-32058, C-32169, C-32474, C-32476, C-32534, C-32829, C-32833, C-32892, C-33042, C-33055, C-33178, C-33255, C-33338, C-33731, C-34017, C-34407, C-35494, C-36588, C-36698, C-36703,

C-37514, C-37608, C-37689, C-37971, C-38670, C-38682, C-38755, C-38914, C-38973, C-39069, C-39136, C-39168, C-39516, C-39762, C-40407, C-41138, C-41490, C-41612, C-41719, C-41763, C-41825, C-41908, C-41968, C-42020, C-42043, C-42084, C-42139, C-42160, C-42312, C-42360, C-42437, C-42775, C-42928, C-43448, C-43720, C-43737, C-43763, C-44129, C-44165, C-44210, C-44479, C-44995, C-45235, D-00005, D-00697, D-00974, D-00976, D-00985, D-01089, D-02133, D-03410, D-03526, D-04646, D-07649, D-07985, D-08275, D-08438, D-08502, D-08568, D-08810, D-09240, D-09726, D-10595, D-10612, D-10756, D-11028, D-11184, D-11202, D-12049, D-14762, D-15573, D-16576, D-16791, D-21684, D-21869, D-22290, D-25055, D-25635, D-25881, D-27241, D-27621, D-28097, D-28178, D-28528, D-28620, D-28629, D-28650, D-28653, D-28785, D-28920, D-29153, D-29744, D-29814, D-29918, D-30860, D-31014, D-31325, D-32350, D-32727, D-32883, D-32912, D-32945, D-35010, D-35489, D-35861, D-36449, D-36486, D-36688, D-36820, D-36909, D-37202, D-37264, D-37366, D-37369, D-37518, D-39081, D-39535, D-39914, D-40716, D-41664, D-42122, D-43388, D-43468, D-43558, D-43962, D-44059, D-44330, D-44580, D-44996, E-10215, E-22754, E-28586, E-29688, E-31852, E-45050, F-00841, F-05849, F-07451, F-09745, F-11582, F-13461, F-13839, F-14008, F-14039, F-14510, F-15618, F-16595, F-16659, F-34607, F-34948, F-36067, F-37213, F-39522, F-42772, F-43436, F-44332, F-45295, G-00177, G-00662, G-00902, G-01797, G-02191, G-03635, G-08683, G-09019, G-09261, G-12070, G-16820, G-19881, G-20287, G-20687, G-21070, G-23582, G-23801, G-24573, G-24603, G-28011, G-29329, G-29663, G-29816, G-31040, G-32129, G-32749, G-33165, G-33605, G-34246, G-34836, G-34847, G-35042, G-35055, G-35560, G-36534, G-39179, G-41368, G-41894, G-42136, G-42661, G-43337, G-44696, G-44746, H-12647, H-14489, H-25967, H-28379, H-28529, H-30424, H-30921, H-31801, H-32224, H-38743, H-39204, H-39287, H-39328, H-40368, H-41143, H-42607, H-43342, H-43782, I-03735, K-06734, K-08420, K-08803, L-32865, N-03674, N-06992, N-17260, N-43824

ANEMIA A-22579, A-31313, G-00705, G-00708, G-00808, G-00810, G-00993, G-01754, G-03635, G-05475, G-05780, G-07551, G-09484, G-23926, G-32624, G-33374, G-33607, G-33910, G-34832, G-34847, G-35211, G-40532, G-41097, G-42098, G-43559, G-44867, H-33362, H-34830, H-39407, K-16808

ANIMALS A-03279, A-17778, A-23058, A-24285, A-27458, A-31315, A-34018, A-35398, A-37190, A-45072, A-45145, B-01484, B-29414, B-32424, C-00125, C-33042, C-33055, C-45235, D-01315, D-41887, F-11570, F-35379, G-00076, G-00148, G-00177, G-00375, G-00473, G-00597, G-00662, G-00705, G-00708, G-00736, G-00740, G-00808, G-00810, G-00821, G-00873, G-00902, G-00993, G-01341, G-01500, G-01512, G-01731, G-01754, G-01755, G-01756, G-01757, G-01797, G-01812, G-01923, G-02191, G-02202, G-03086, G-03281, G-03282, G-03283, G-03284, G-03285, G-03286, G-03287, G-03635, G-03654, G-03897, G-04196, G-05002, G-05671, G-08999, G-09253, G-09493, G-11468, G-11580, G-11808, G-12038, G-12075, G-12646, G-13159, G-14156, G-14492, G-17214, G-18417, G-18494, G-18502, G-18515, G-19881, G-20087, G-20198, G-21259, G-23167, G-23715, G-23926, G-24288, G-26260, G-26356, G-26483, G-27107, G-27490, G-27614, G-27801, G-28024, G-29329, G-29588, G-30468, G-30671, G-30672, G-31442, G-32041, G-32746, G-32834, G-33052, G-33374, G-33527, G-33607, G-33779, G-33910, G-34791, G-34832, G-34836, G-34841, G-34851, G-34914, G-34943, G-35055, G-35174, G-35219, G-35225, G-36251, G-36354, G-36740, G-36747, G-36765, G-36934, G-36935, G-37119, G-37685, G-37722, G-37788, G-38616, G-38867, G-38869, G-39193, G-39503, G-39621, G-39863, G-40014, G-40068, G-40312, G-40355, G-40688, G-41818, G-42737, G-42957, G-43277, G-43531, G-43615, G-44087, G-44254, G-44381, G-44385, G-45005, G-45196, G-45288, G-45293, H-08884, H-10318, H-11452, H-11467, H-12536, H-16270, H-18481, H-18520, H-18521, H-23258, H-24667, H-25967, H-26092, H-26276, H-27063, H-27386, H-28105, H-28448, H-30033, H-30931, H-31185, H-32291, H-32736, H-33201, H-33362, H-33922, H-34237, H-34830, H-34831, H-34901, H-35209, H-35234, H-36196, H-36197, H-36265, H-36991, H-37912, H-39407, H-39408, H-40024, H-40368, H-40591, H-41461, H-41892, H-41893, H-42715, H-42857, H-42924, H-42945, H-43226, H-43279, H-43511, H-44588, H-45056, K-03007, K-11746, K-16808, L-00311, L-07952, L-34980, N-04212, N-09780

ANNUAL A-03278, A-30976, A-31395, A-31649, A-32447, B-32355, C-30360, D-00974, D-01315, D-06760, D-07198, D-08568, D-08591, D-11028, D-15610, D-16839, D-25881, D-26044, D-27672, D-27675, D-29153, D-29515, D-29655, D-30025, D-30860, D-31014, D-32945, D-33576, D-35010, D-36820, D-37026, D-37264, D-37288, D-39535, D-41888, D-43558, G-32735, H-11157, H-17225, J-39956, K-19750, K-34377, L-30620

ANTHRACENES A-01565, A-26645, A-35481, B-41608, C-32058, D-03526, D-04938, D-11028, F-00058, F-06648, G-40688

ANTHRACOSIS G-26528, G-26775

ANTIBODIES G-07162

ANTIDOTES G-23876, G-28256, G-34114, G-34436, G-35387, G-35463, G-36152, G-36740, G-36934, H-34831, H-35209

ANTIGENS G-07162

ANTIMONY COMPOUNDS A-05067, A-06220, A-06351, A-24285, B-26532, B-37750, B-38727, C-06045, C-27294, C-36703, D-00974, D-05167, D-27174, F-06648, G-35042, G-35055, G-45165, H-37912, K-06778, L-39640

AREA EMISSION ALLOCATIONS K-33107, K-34377, L-32884

AREA SURVEYS A-12624, A-25125, A-33963, A-39367, A-41035, B-30633, C-22927, C-30360, C-41016, C-44479, D-01089, D-03410, D-03441, D-04996, D-05573, D-05623, D-08568, D-12099, D-16539, D-22553, D-23971, D-24351, D-27621, D-29416, D-30656, D-30858, D-30860, D-31325, D-32055, D-32945, D-34008, D-34933, D-35940, D-36009, D-36195, D-36288, D-36449, D-36806, D-37394, D-38110, D-38133, D-39081, D-39405, D-39914, D-40363, D-40997, D-41033, D-41887, D-41975, D-41979, D-42120, D-42122, D-44059, D-44234, D-44330, D-44580, E-32155, G-09253, G-27961, G-30181, G-34436, G-37229, H-27111, L-28397, N-03674, N-04052, N-11871

ARIZONA D-07600

AROMATIC FRACTIONS A-30759

AROMATIC HYDROCARBONS A-05171, A-08972, A-09355, A-09393, A-14461, A-26100, A-29127, A-29936, A-30027, A-31085, A-31934, A-33626, A-33822, A-34177, A-35123, A-35199, A-35353, A-35477, A-35818, A-35919, A-36084, A-36535, A-36541, A-36664, A-37372, A-38331, A-38891, A-39610, A-40455, A-41738, A-43966, A-44252, A-44682, A-45145, B-00063, B-01851, B-05300, B-17906, B-19637, B-20740, B-20844, B-22414, B-22834, B-24696, B-26269, B-29126, B-29414, B-29625, B-31221, B-31341, B-32938, B-33628, B-33932, B-35112, B-35535, B-35688, B-35816, B-37150, B-37173, B-42290, B-44473, C-03034, C-05456, C-06112, C-06894, C-09333, C-09888, C-09983, C-27294, C-32534, C-38670, C-39136, C-44165, D-06788, D-10612, D-11028, D-20642, D-30182, D-43468, F-00058, F-03525, F-05440, F-06648, F-07451, F-13839, F-28908, F-41787, G-00177, G-07162, G-28205, G-39826, H-42857, J-34370, J-34828, J-34970, J-38624, K-02580, K-08803, K-20121, K-24107, K-41682, L-11204, L-37392, N-28088

ARSENIC COMPOUNDS A-24285, A-40583, A-41889, A-41890, B-37750, B-38727, C-09333, C-09983, C-19857, C-25431, C-26707, C-27294, C-30635, C-32718, C-33338, C-39136, C-39516, C-42437, C-42928, C-43720, D-03410, D-27188, D-27880, D-31396, D-40574, D-40584, D-41887, D-41888, F-06648, G-01512, G-03086, G-07423, G-17470, G-23715, G-24314, G-24716, G-31280, G-32608, G-33374, G-35042, G-36765, G-38580, G-38616, G-39179, G-39833, G-39883, G-41894, G-41895, G-42022, G-42737, G-44364, H-07742, H-08884, H-11452, H-11467, H-23581, H-32224, H-32736, H-34237, H-34901, H-38332, H-39690, H-40590, H-41891, H-41893, H-42924, H-43226, K-06778, K-09259, K-14443, K-41682, L-23234, L-23608, L-23610, L-24214, L-39640, N-04212

ARSINE G-24314

ASBESTOS A-23561, A-27272, A-39367, B-03754, B-44283, C-40631, G-07423, G-13625, G-21259, G-25068, G-27085, G-40068, G-44395, H-40368, L-24467

ASBESTOSIS G-13625, G-27085, G-40068

ASHES A-33087, B-31364, B-39333, D-04996, D-27188, D-37288, D-40716, G-20704, G-38721, H-28448, L-00311, L-30620, N-04212

ASIA A-14945, A-17325, A-19598, A-19955, A-20652, A-21722, A-23316, A-24156, A-26100, A-26134, A-27858, A-29364, A-29539, A-29661, A-29787, A-29936, A-30513, A-31133, A-31136, A-31934, A-32492, A-32523, A-32875, A-33710, A-33963, A-33965, A-34774, A-35052, A-35957, A-36006, A-36846, A-37166, A-37372, A-37721, A-38819, A-40677, A-41035, A-42080, A-42791, A-43776, A-43966, A-44252, B-17525, B-19808, B-21324, B-22520, B-24813, B-25155, B-25894, B-26532, B-28172, B-28730, B-29058, B-29204, B-29531, B-29656, B-29664, B-29898, B-30154, B-30498, B-30944, B-31314, B-31317, B-31364, B-31496, B-31985, B-32938, B-34071, B-35080, B-35296, B-35821, B-37116, B-37195, B-37468, B-38614, B-39333, B-40411, B-42886, B-44003, C-03034, C-06112, C-15562, C-19501, C-21338, C-21862, C-24617, C-24618, C-24644, C-25013, C-25015, C-25535, C-26336, C-26503, C-26848, C-27358, C-27556, C-27681, C-27829, C-28126, C-28621, C-28755, C-29419, C-29464, C-29810, C-30360, C-30635, C-30786, C-31304, C-31933, C-32476, C-32534, C-32718, C-32829, C-32833, C-32892, C-34017, C-36588, C-36698, C-36703, C-36840, C-36841, C-37514, C-37608, C-37689, C-37693, C-38670, C-38682, C-39069, C-39136, C-39516, C-40407, C-41719, C-41763, C-42020, C-42043, C-42360, C-43448, C-43763, C-44129, D-06148, D-06760, D-07198, D-08591, D-10756, D-15175, D-15314, D-15610, D-16539, D-16576, D-17106, D-21015, D-21869, D-22290, D-25089, D-25758, D-25881, D-26044, D-26054, D-26287, D-26535, D-27187, D-27188, D-27191, D-27257, D-27648, D-27672, D-27675, D-27831, D-27880, D-28233, D-28326, D-28528, D-28620, D-28629, D-28634, D-28635, D-28650, D-28653, D-28785, D-29152, D-29153, D-29191, D-29382, D-29385, D-29416, D-29465, D-29647, D-29744, D-29814, D-29918, D-30025, D-30182, D-30326, D-30410, D-30493, D-30494, D-30656, D-30892, D-31014, D-31669, D-32727, D-32883, D-32912, D-33114, D-33576, D-35025, D-36009, D-36288, D-36474, D-36486, D-36503, D-36688, D-36806, D-36820, D-36909, D-37191, D-37202, D-37288, D-37320, D-37366, D-37369, D-37394, D-37518, D-38110, D-38133, D-39081, D-39988, D-40118, D-40363, D-40716, D-40997, D-41975, D-41979, D-42120, D-42122, D-42367, D-43316, D-43962, D-44059, D-44063, D-44330, E-21182, E-30073, E-31852, E-36038, E-36487, E-38118, F-17689, F-19823, F-29400, F-37213, F-41787, F-42772, F-44032, G-00375, G-03286, G-03635, G-03893, G-03897, G-05475, G-05780, G-07396, G-07423, G-08566, G-09408, G-09535, G-12075, G-13154, G-14492, G-16810, G-17244, G-17470, G-19304, G-19940, G-24081, G-26260, G-26310, G-26528, G-26775, G-27253, G-27490, G-27961, G-28170, G-28171, G-29129, G-29663, G-29789, G-29815, G-29816, G-29825, G-29958, G-29963, G-30181, G-30355, G-30395, G-30671, G-30672, G-31351, G-32735, G-32905, G-33165, G-33372, G-35021, G-35041, G-37722, G-37941, G-37942, G-38580, G-38867, G-39989, G-40435, G-40532, G-41067, G-41124, G-42022, G-42098, G-42661, G-44087, G-44433, G-45273, H-14489, H-21018, H-27489, H-28105, H-28529, H-41800, H-42336, K-20121, K-33107, K-34063, K-34377, K-36823, K-38197, K-42039, K-44310, K-44377, L-08725, L-23608, L-23610, L-24214, L-27664, L-28099, L-28349, L-29421, L-29888, L-30152, L-30620, L-30908, L-32789, L-32865, L-32884, L-34980, L-35151, L-35795, L-35922, L-36030, L-36877, L-37521, L-38669, L-44325, L-44499, N-04212, N-11871

ASPHALT A-09686, A-39462, B-00107, D-05260, G-13625, H-30225, J-30696

ASPHYXIATION G-24314

ASPIRATORS C-08145, C-32474, C-38778, D-08275, D-08438, D-10612, D-10756, D-34933

ASTHMA A-30513, D-03441, G-00375, G-07423, G-09253, G-13625, G-26477, G-27291, G-30181, G-32735, G-41067, G-41097, G-44433, L-37497, L-44325

ATMOSPHERIC MOVEMENTS A-29787, A-30513, A-39367, A-40583, B-28730, B-44283, C-00855, C-02164, C-21948, C-23646, C-26848, C-27829, C-40724, D-00005, D-03410, D-03441, D-04996, D-05623, D-07198, D-08502, D-08568, D-08821, D-09240, D-10634, D-12099, D-15789, D-16791, D-16839, D-17340, D-23864, D-24414, D-26054, D-26387, D-26535, D-27187, D-27672, D-28629, D-28650, D-29655, D-29814, D-30410, D-32912, D-33114, D-35489, D-35725, D-36009, D-36449, D-36474, D-36806, D-37026, D-37366, D-37369, D-37394, D-39081, D-39988, D-40584, D-42122, D-42247, D-43962, D-44059, D-44996, E-00834, E-01821, E-05713, E-12777, E-21182, E-24109, E-24166, E-27116, E-30073, E-37953, E-38118, E-40157, E-44813, E-45050, G-29129, G-44087, H-32224, H-33985, H-35827, L-08196, L-23562, L-35922, N-04212, N-11871

ATTACK RATES G-07169, G-27085

AUSTRALIA A-27272, B-27876, D-30860, D-32055, F-43245, G-34701, G-34738, G-35463

AUTOMATIC METHODS B-24186, B-28730, B-30633, C-21338, C-22927, C-30290, C-32833, C-43587, D-30860, D-32055, D-32350, D-33114, D-40363, D-40997, D-42247, D-44059, G-29663, L-33495

AUTOMOBILES A-00962, A-01868, A-03278, A-03280, A-04460, A-05171, A-08039, A-08972, A-09210, A-09686, A-12624, A-14461, A-15295, A-15599, A-17778, A-19598, A-20545, A-22976, A-23250, A-23280, A-23316, A-23561, A-23789, A-24156, A-24829, A-24996, A-26100, A-26552, A-26645, A-26763, A-27272, A-27458, A-27943, A-28560, A-29096, A-29127, A-29661, A-29782, A-29786, A-30604, A-30759, A-30976, A-31085, A-31133, A-31136, A-31313, A-31315, A-31323, A-31395, A-31596, A-32035, A-32447, A-32492, A-32621, A-33087, A-33169, A-33350, A-33365, A-33378, A-33667, A-33710, A-33822, A-33965, A-34018, A-34040, A-34350, A-34442, A-34774, A-35078, A-35123, A-35353, A-35477, A-35481, A-35484, A-35919, A-35953, A-36080, A-36082, A-36083, A-36084, A-37176, A-37372, A-38522, A-38543, A-38891, A-39609, A-39754, A-40314, A-40677, A-41035, A-42080, A-42679, A-43966, A-44227, A-45136, B-00015, B-00063, B-09231, B-17906, B-20844, B-22414, B-23697, B-24182, B-25301, B-25894, B-28377, B-28730, B-29656, B-29898, B-30154, B-30633, B-30944, B-30950, B-31221, B-31314, B-31341, B-31364, B-31496, B-31519, B-31604, B-31819, B-31825, B-31985, B-32355, B-32822, B-33366, B-33386, B-33388, B-33403, B-33542, B-33550, B-33657, B-34035, B-34457, B-34536, B-35018, B-35223, B-35476, B-35535, B-36144, B-36523, B-36721, B-37195, B-37234, B-37275, B-37468, B-37619, B-37845, B-38287, B-39404, B-41112, B-44660, B-44750, C-21948, C-24617, C-32058, C-32829, C-43587, C-44479, D-00969, D-03410, D-03526, D-04646, D-08275, D-08568, D-08591, D-10595, D-11028, D-12099, D-16539, D-16684, D-16791, D-24414, D-25055, D-26287, D-26535, D-27187, D-27188, D-27191, D-27257, D-27672, D-27675, D-27831, D-28528, D-28650, D-29655, D-29744, D-30860, D-31014, D-31669, D-31775, D-32055, D-32350, D-32883, D-32912, D-32945, D-33114, D-34008, D-34933, D-36503, D-36909, D-37394, D-39535, D-39914, D-39988, D-40118, D-41033, D-43962, D-44330, E-23743, E-30073, E-30676, E-31895, E-38666, F-00058, F-08207, F-14995, G-00076, G-00148, G-00375, G-00597, G-00708, G-10856, G-11468, G-19940, G-21423, G-27253, G-29129, G-29789, G-30156, G-30328, G-30355, G-30671, G-30672, G-31319, G-31517, G-31528, G-31899, G-32484, G-32905, G-33165, G-33497, G-33607, G-33778, G-33910, G-34059, G-34406, G-35811, G-36354, G-37942, G-37964, G-39095, G-40485, H-21794, H-25878, H-28529, H-33364, H-36611, J-26765, J-30329, J-30696, J-38624, K-24107, K-30069, L-07952, L-09009, L-17472, L-23608, L-23610, L-24214, L-24757, L-25288, L-30152, L-30908, L-31957, L-32462, L-32789, L-32865, L-33844, L-35151, L-36030, L-37521, L-37717, L-41703, L-44325, M-33904, N-04212, N-04649, N-08273, N-09780, N-20548

AUTOMOTIVE EMISSION CONTROL A-00962, A-01565, A-01624, A-01868, A-05171, A-14033, A-14461, A-14462, A-16156, A-17304, A-17365, A-19598, A-20545, A-20927, A-22825, A-22941, A-22976, A-23250, A-23280, A-23316, A-24281, A-24829, A-24996, A-26134, A-26763, A-27249, A-27272, A-27858, A-28560, A-28873, A-29364, A-29516, A-30067, A-30604, A-31133, A-31323, A-31324, A-32621, A-32875, A-33350, A-33365, A-33378, A-33626, A-34031, A-34350, A-34442, A-34774, A-35050, A-35199, A-35353, A-35477, A-35481, A-35484, A-35818, A-36080, A-36082, A-36083, A-36084, A-36623, A-36664, A-37176, A-37372, A-38330, A-38331, A-38522, A-38543, A-39067, A-39603, A-39609, A-39610, A-39754, A-40455, A-40677, A-40776, A-41035, A-41654, A-41738, A-42080, A-42377, A-42980, A-43776, A-44252, A-44682, A-44821,

A-45092, B-00015, B-00063, B-01484, B-01851, B-03754, B-05214, B-09231, B-13982, B-14604, B-17906, B-18053, B-19331, B-19637, B-19710, B-19808, B-20735, B-20740, B-20844, B-21040, B-21303, B-21762, B-22414, B-22834, B-22890, B-23540, B-23697, B-23923, B-24182, B-24184, B-24696, B-24722, B-24813, B-25096, B-25155, B-25377, B-25894, B-26153, B-26243, B-26269, B-27503, B-27850, B-27876, B-28059, B-28060, B-28108, B-28286, B-28699, B-28730, B-28860, B-28865, B-29058, B-29531, B-29605, B-29656, B-29898, B-29920, B-30010, B-30154, B-30498, B-30944, B-30950, B-31221, B-31314, B-31341, B-31364, B-31496, B-31519, B-31604, B-31690, B-31819, B-31825, B-31985, B-32355, B-32364, B-32822, B-32938, B-33366, B-33386, B-33388, B-33403, B-33542, B-33550, B-33628, B-33741, B-33994, B-34035, B-34381, B-34457, B-34536, B-34611, B-34740, B-35018, B-35080, B-35166, B-35223, B-35352, B-35476, B-35688, B-35703, B-35778, B-35814, B-35816, B-35821, B-36081, B-36144, B-36145, B-36523, B-36578, B-36721, B-37042, B-37116, B-37150, B-37195, B-37222, B-37234, B-37275, B-37408, B-37619, B-37845, B-37938, B-38287, B-38614, B-39272, B-39275, B-39333, B-39404, B-39492, B-40411, B-40723, B-40785, B-41112, B-41544, B-41608, B-41922, B-42131, B-42166, B-42300, B-42330, B-42702, B-42886, B-43333, B-43575, B-44003, B-44341, B-44470, B-44473, B-44614, B-44660, B-44750, B-44882, B-44906, D-00969, D-08568, D-08591, D-29744, F-03799, F-08207, G-19940, G-25328, G-30328, G-39161, J-26765, J-27968, J-30696, J-31518, J-32241, J-34828, J-34970, J-42721, K-18294, K-24107, K-30035, K-38758, L-03536, L-07952, L-09009, L-22583, L-28099, L-28869, L-31957, L-32865, L-35151, L-36030, L-37193, L-37423, L-37521, L-37560, L-37717, L-40520, L-41289, L-44376, L-44499, M-29432, M-33904, N-37225

AUTOMOTIVE EMISSIONS A-00962, A-01565, A-01624, A-01868, A-02636, A-04460, A-05171, A-08039, A-08972, A-09210, A-09355, A-09393, A-09686, A-12624, A-14033, A-14459, A-14461, A-14462, A-14945, A-15295, A-15599, A-15769, A-16156, A-16766, A-17304, A-17325, A-17339, A-17365, A-17778, A-19598, A-19684, A-20545, A-20927, A-21109, A-22367, A-22579, A-22825, A-22941, A-22976, A-23058, A-23250, A-23280, A-23316, A-23561, A-23620, A-23789, A-24031, A-24156, A-24829, A-24996, A-25125, A-25295, A-25581, A-26100, A-26134, A-26191, A-26552, A-26645, A-26763, A-26891, A-26925, A-27113, A-27180, A-27249, A-27272, A-27458, A-27595, A-27858, A-27943, A-28560, A-28873, A-29096, A-29127, A-29364, A-29516, A-29661, A-29782, A-29786, A-29872, A-30001, A-30027, A-30067, A-30414, A-30604, A-30674, A-30759, A-30976, A-31085, A-31133, A-31136, A-31315, A-31323, A-31395, A-31934, A-32492, A-32621, A-32875, A-33169, A-33350, A-33365, A-33378, A-33667, A-33710, A-33822, A-33965, A-34018, A-34040, A-34341, A-34350, A-34442, A-34647, A-34774, A-35050, A-35052, A-35078, A-35123, A-35199, A-35353, A-35477, A-35481, A-35484, A-35676, A-35818, A-35919, A-35953, A-36032, A-36082, A-36083, A-36527, A-36541, A-36664, A-37015, A-37166, A-37176, A-37312, A-37372, A-37648, A-38522, A-38543, A-38625, A-38891, A-39152, A-39367, A-39603, A-39609, A-39610, A-39754, A-40677, A-40759, A-40776, A-40981, A-41035, A-41654, A-41738, A-41945, A-42080, A-42212, A-42377, A-42679, A-42791, A-43776, A-43966, A-44227, A-44252, A-44464, A-44682, A-45092, A-45274, B-00015, B-00063, B-01484, B-01851, B-05214, B-09231, B-17906, B-18053, B-19331, B-19637, B-20735, B-20844, B-21040, B-21303, B-21762, B-22414, B-22436, B-22890, B-23540, B-23697, B-24182, B-24184, B-24696, B-24813, B-25096, B-25155, B-25301, B-25377, B-25894, B-26153, B-26243, B-26269, B-27371, B-27503, B-27876, B-28286, B-28377, B-28699, B-28730, B-28860, B-29126, B-29204, B-29414, B-29531, B-29605, B-29625, B-29628, B-29656, B-29898, B-29920, B-30154, B-30498, B-30633, B-30944, B-30950, B-31221, B-31314, B-31364, B-31441, B-31496, B-31519, B-31604, B-31690, B-31819, B-31825, B-31985, B-32355, B-32424, B-32822, B-32938, B-33366, B-33386, B-33388, B-33403, B-33542, B-33550, B-33657, B-33932, B-33994, B-34035, B-34381, B-34457, B-34536, B-34611, B-34740, B-35018, B-35080, B-35166, B-35223, B-35352, B-35476, B-35535, B-35688, B-35778, B-35814, B-35816, B-35821, B-36081, B-36145, B-36523, B-36578, B-36721, B-37116, B-37195, B-37222, B-37234, B-37275, B-37408, B-37468, B-37845, B-37938, B-38287, B-38614, B-39272, B-39275, B-39333, B-39404, B-39492, B-40411, B-40723, B-41112, B-41544, B-41608, B-41922, B-42131, B-42166, B-42300, B-42330, B-42817, B-42819, B-42829, B-42886, B-44003, B-44283, B-44341, B-44470, B-44660, B-44750, B-44882, B-44906, C-02164, C-06112, C-06643, C-08661, C-09476, C-09953, C-15562, C-17179, C-17180, C-18302, C-21948, C-22927, C-24617, C-24618, C-24644, C-26275, C-26505, C-28621, C-28755, C-29595, C-32058, C-32829, C-33055, C-35695, C-37175, C-42020, C-42775, C-43587, C-44165, C-44479, C-45235, D-00969, D-00976, D-00985, D-01315, D-01673, D-02133, D-02750, D-04646, D-04938, D-05260, D-05277, D-05820, D-06148, D-08275, D-08438, D-08568, D-08591, D-08810, D-08812, D-08821, D-09240, D-09726, D-10554, D-10595, D-10612, D-11028, D-12099, D-15573, D-15575, D-15610, D-16539, D-16684, D-16791, D-16839, D-17106, D-19433, D-21015, D-24162, D-24414, D-24952, D-25055, D-25635, D-25881, D-26287, D-26535, D-27174, D-27187, D-27188, D-27191, D-27257, D-27429, D-27621, D-27672, D-27675, D-27831, D-28173, D-28233, D-28326, D-28369, D-28523, D-28620, D-28634, D-28635, D-28650, D-28920, D-29382, D-29385, D-29416, D-29465, D-29515, D-29647, D-29655, D-29744, D-29918, D-30494, D-30860, D-31014, D-31669, D-31775, D-32055, D-32350, D-32883, D-32912, D-32945, D-33114, D-34008, D-35025, D-35725, D-35861, D-36449, D-36474, D-36486, D-36503, D-36820, D-36909, D-37191, D-37288, D-37366, D-37394, D-38110, D-38133, D-39081, D-39405, D-39914, D-39988, D-40118, D-40716, D-40997, D-41033, D-41664, D-41979, D-43693, D-43962, D-44063, D-44330, E-00834, E-01821, E-06841, E-19058, E-23743, E-27116, E-29699, E-30073, E-30676, E-31895, E-33873, E-35207, E-35264, E-36714, E-37953, E-38118, E-38666, E-44813, E-45050, F-00058, F-03799, F-05849, F-08207, F-17689, G-00020, G-00076, G-00148, G-00177, G-00375, G-00473, G-00597, G-05541, G-07169, G-08326, G-08411, G-11468, G-12038, G-12075, G-13059, G-14492, G-16810, G-16820, G-17244, G-19304, G-19940, G-20704, G-21266, G-21423, G-23715, G-23876, G-24081, G-24877, G-24961, G-25068, G-25328, G-25705, G-26260, G-27253, G-27291, G-28010, G-29129, G-29493, G-29789, G-29825, G-29963, G-30000, G-30156, G-30198, G-30328, G-30355, G-30671, G-30672, G-31228, G-31319, G-31517, G-31528, G-31537, G-31899, G-32484, G-32905, G-33165, G-33497, G-33607, G-33778, G-33903, G-33910, G-34059, G-34406, G-34436, G-34649, G-34709, G-34895, G-35118, G-35811, G-36354, G-37040, G-37119, G-37180, G-37630, G-37788, G-37933, G-37942, G-37964, G-38579, G-38721, G-38869, G-39095, G-39161, G-39193, G-39406, G-40014, G-40295, G-40355, G-40435, G-40485, G-40634, G-41737, G-42091, G-42881, G-44176, G-44251, G-44254, G-44508, H-07742, H-08884, H-16655, H-17225, H-17681, H-19604, H-20062, H-21018, H-24667, H-24788, H-24947, H-25878, H-26276, H-27063, H-28105, H-28289, H-28471, H-28529, H-30424, H-32423, H-32654, H-33364, H-33922, H-35827, H-36197, H-36611, H-39204, H-39407, H-39408, H-39409, H-40540, H-42857, H-43342, I-32921, J-26765, K-03007, K-03956, K-08803, K-09259, K-11746, K-18294, K-24107, K-30069, K-34063, K-36346, K-42118, K-43312, L-00311, L-02635, L-03536, L-07952, L-08196, L-09009, L-17472, L-22583, L-23608, L-23610, L-24214, L-24467, L-24757, L-25288, L-27664, L-28066, L-30152, L-30620, L-30908, L-31957, L-32462, L-32789, L-35922, L-36877, L-37193, L-37392, L-37521, L-37560, L-37717, L-40520, L-41703, L-42873, L-44376, L-44499, M-01073, M-33904, N-03674, N-04212, N-09780, N-11871, N-17260, N-20548, N-28803, N-37225

AUTOPSY F-11570, G-00662, G-00873, G-01797, G-12070, G-26528, G-32746, G-36747, G-39193, G-44053, G-44696, H-18520, H-40591

## B

BACTERIA C-33055, G-35042, G-41097, G-44254, G-45159

BAFFLES B-29920

BAG FILTERS A-10749, A-24285, A-40583, A-42726, A-432/1, B-00107, B-03125, B-03754, B-08562, B-09798, B-21324, B-22492, B-22520, B-25470, B-25781, B-26600, B-30124, B-32319, B-34025, B-34313, B-35035, B-35478, D-05260, K-33107, L-23562, L-32884
BALLOONS E-24549
BARIUM COMPOUNDS A-05067, A-06351, A-27595, B-25377, C-25431, C-32718, D-04996, D-05167, D-27174, E-10215, F-14868, F-16659, F-17949, G-17470, H-36991, N-05313
BARLEY H-27489, H-41891, H-42207
BASIC OXYGEN FURNACES A-09686, A-26441, B-03232, B-35342
BATTERY MANUFACTURING A-03278, A-28862, A-31649, A-32035, A-35065, C-26467, G-00821, G-00902, G-03281, G-03286, G-03287, G-03635, G-03893, G-05780, G-11552, G-19304, G-20704, G-24428, G-30831, G-32408, G-32738, G-33374, G-34902, G-39989, H-20237
BELGIUM A-30027, A-31088, A-34442, A-40947, B-44341, G-00375, G-07423, G-08683, G-08949, G-33607, G-40057, G-42136, G-42881, L-00311, L-02635, L-32462, L-44376, N-28088
BENZENE-SOLUBLE ORGANIC MATTER A-30759, B-35540, D-00005, D-00017, D-00974, D-01673, D-03410, D-05167, D-05573, D-05623, D-11028, D-19144, D-21869, D-30656, D-35407, D-36562, D-37026, D-42122, D-44234, N-04649
BENZENES A-05171, A-29936, A-31934, A-35818, A-36541, A-43966, B-01851, B-29414, B-31341, B-35535, C-05456, C-06894, C-09333, C-38670, C-39136, D-06788, D-11028, F-03525, F-05440, F-06648, F-07451, F-28908, G-00177, G-07162, G-28205, K-02580, K-08803, K-20121
BENZO(3-4)PYRENE A-01565, A-05067, A-09393, A-16156, A-19598, A-35078, B-01851, B-41608, C-30290, C-39762, D-00985, D-01673, D-03410, D-03526, D-04938, D-06760, D-06788, D-08568, D-08821, D-11028, D-16684, D-17106, D-28233, D-34008, D-43693, D-44059, F-00058, G-00375, G-03086, G-07162, G-41097, G-44176, H-39328, L-02635, L-07952, N-04052, N-04212
BENZOPYRENES A-01565, A-05067, A-09393, A-16156, A-19598, A-26645, A-29786, A-30759, A-34018, A-35078, A-35481, A-35919, A-42212, B-01851, B-33932, B-41608, C-26707, C-27294, C-30290, C-32058, C-39762, D-00985, D-01673, D-03410, D-03526, D-04938, D-06760, D-06788, D-08568, D-08821, D-11028, D-16684, D-17106, D-25107, D-28097, D-28233, D-34008, D-43693, D-44059, F-00058, G-00375, G-03086, G-07162, G-33607, G-33778, G-38869, G-40634, G-40688, G-41097, G-44176, H-39328, L-02635, L-07952, L-41703, N-04052, N-04212
BERYLLIOSIS A-00962, A-01868, A-03278, A-04460, B-00015, B-00063, B-00899, B-01851, B-03232, C-00056, C-00125, C-00855, C-01230, C-01249, C-01607, C-01608, C-02164, C-03037, C-03770, D-00005, D-00017, D-00261, D-00697, D-00969, D-00974, D-00976, D-00985, D-01089, D-01315, D-01355, D-01673, D-02133, D-02750, D-03410, D-03526, D-04646, E-00834, E-01821, E-03841, F-00841, F-03799, G-00076, G-00177, G-00597, G-00642, G-00662, G-00873, G-00902, G-00993, G-01512, G-01797, G-01812, G-02191, G-03635, G-05002, G-13625, G-35055, I-00305, I-02176, I-03735, K-03007, L-00311, N-03674
BERYLLIUM D-03526, G-00375, G-03086, G-07162, G-07423, K-06734, K-08420
BERYLLIUM COMPOUNDS A-05067, A-06351, A-27595, C-09333, C-09476, C-21459, C-22975, C-30360, C-36698, C-40631, C-42928, D-03526, D-04996, D-05167, D-20642, D-22290, D-27174, D-27188, D-35407, D-42122, E-10215, E-28799, F-34948, G-00375, G-07162, G-13625, G-25705, G-27085, G-29963, G-32608, G-35042, G-35055, G-38580, G-38616, G-38721, G-40068, G-44696, G-45165, K-06734, K-08420, K-19750, N-04212, N-20548
BESSEMER CONVERTERS A-09686
BETA PARTICLES B-34313, C-00125, C-01249, C-05243, C-06920, C-09333, C-11626, C-27294, C-43587, D-00017, D-00974, D-01355, D-03441, D-10756, D-25089, D-32350, D-42921, E-05713, E-22754, G-07169
BIO-ASSAY C-32058, C-33042, G-09261, G-23926
BIOCLIMATOLOGY G-00375, G-33778
BIOPSY G-01812, G-32216
BIRDS G-20087, G-29329, G-33527, G-33910, G-37119, G-37722, G-39193, H-18521, H-24667, H-27063, H-36991
BIRMINGHAM,ALABAMA D-00005, D-05623
BISMUTH B-15208, C-06045, C-10528, C-15734, E-05713
BISMUTH COMPOUNDS A-06351, C-10528, C-21459, C-36698, C-44995, D-05167, D-25758, D-27174, D-27621, D-39914, E-24166, E-29910, F-14008, F-14039, F-39522, G-18046, G-35055, G-39833, H-38743
BLAST FURNACES A-09686, A-10749, A-13524, A-26441, B-06493, B-22520, B-24553, B-32319, B-35303, B-43515, C-41968
BLENDING A-29127, A-31934, A-35199, B-24186, B-30154, B-31341, B-34846, J-34970
BLOOD CELLS A-29872, A-35957, C-26955, C-27556, C-28017, D-34008, F-13451, G-00708, G-00808, G-00810, G-00821, G-00993, G-01756, G-01812, G-02202, G-05475, G-05780, G-06151, G-06985, G-07162, G-07396, G-07551, G-07740, G-07892, G-08566, G-09408, G-09484, G-10434, G-11462, G-11552, G-13059, G-15703, G-18046, G-19881, G-21037, G-22637, G-23582, G-24784, G-26310, G-26477, G-26720, G-26883, G-26886, G-27085, G-27416, G-28010, G-28024, G-28205, G-29815, G-30334, G-30672, G-31228, G-31351, G-31493, G-31899, G-32041, G-32129, G-32216, G-32218, G-32487, G-32624, G-32696, G-33234, G-33910, G-34789, G-34841, G-34847, G-34914, G-35380, G-35811, G-36251, G-36934, G-37023, G-39095, G-39863, G-39989, G-40316, G-41695, G-41717, G-41737, G-41872, G-42463, G-42881, G-42884, G-43277, G-43337, G-43531, G-43532, G-43725, G-44254, G-44255, G-44508, H-10318, H-28105, H-33362, H-34830, H-35209, H-36991, H-39407, K-16808, K-36346
BLOOD CHEMISTRY A-18510, A-31313, A-36527, B-32424, B-37845, C-05977, C-16382, C-33055, D-08568, D-24463, D-36195, D-44330, F-11582, G-00020, G-00076, G-00473, G-00597, G-00642, G-00705, G-00810, G-01754, G-01755, G-01756, G-03285, G-03635, G-03893, G-03897, G-05025, G-05475, G-06151, G-06177, G-06814, G-07396, G-07551, G-07740, G-07892, G-08326, G-08381, G-08411, G-09019, G-09486, G-09493, G-09535, G-10793, G-11462, G-11580, G-13059, G-14492, G-18503, G-18549, G-19159, G-20287, G-22637, G-23768, G-26720, G-26886, G-26915, G-29286, G-29493, G-29815, G-29825, G-29958, G-30009, G-30672, G-30686, G-31228, G-31351, G-31584, G-31899, G-32129, G-32218, G-32624, G-32696, G-32737, G-32738, G-32747, G-32749, G-32834, G-33202, G-33374, G-33607, G-33903, G-33910, G-34066, G-34095, G-34246, G-34709, G-34841, G-34902, G-35021, G-35217, G-35387, G-35560, G-35587, G-36152, G-36354, G-36932, G-36957, G-37023, G-37297, G-37420, G-37540, G-37722, G-37788, G-37933, G-37941, G-37964, G-38579, G-38867, G-38869, G-39095, G-39179, G-39193, G-39406, G-39621, G-39989, G-40022, G-40057, G-40295, G-40532, G-41737, G-42098, G-42136, G-42661, G-42698, G-42716, G-42757, G-42759, G-43337, G-44251, G-44254, G-44255, G-44294, G-45273, G-45293, H-10318, H-30931, H-31185, H-33922, H-34830, H-35234, H-43511, J-27968, K-11746, L-36877
BLOOD GAS ANALYSIS A-23058, C-27556, D-08568, G-00473, G-11808, G-13059, G-21266, G-27253, G-39406
BLOOD PRESSURE G-11580, G-35055, G-36551, G-41872
BLOOD VESSELS A-35957, C-01608, F-11570, G-08381, G-11580, G-32041, G-33910, G-43337, G-43531, G-44381
BLOWBY A-01624, A-08972, A-26763, A-32875, A-35484, A-41035, B-01851, B-28699, B-31496, B-36145, B-44003, C-32058, N-20548
BODY FLUIDS C-01608, C-16382, D-01315, G-00076, G-00597, G-00708, G-09535, G-10434, G-10793, G-12984, G-14492, G-32625, G-34789, G-36957, G-40697, G-41695, G-41818, G-44746
BOILERS A-05067, B-00107, B-28108, B-34025, B-35476, D-05260, D-30860, D-32055, D-32912, J-30696, K-06778, K-34063, L-23610, L-32884
BONES A-23058, A-27113, A-34341, A-36527, C-00125, C-26955, G-00148, G-00473, G-00662, G-00808, G-01754, G-01756, G-01812, G-03897, G-05002, G-05483, G-06151, G-09261, G-09484, G-12075, G-16810, G-20198, G-21070, G-21766, G-23768, G-26483, G-26915, G-27416, G-27614, G-29493, G-30000, G-30156, G-30395, G-30672, G-31303, G-31319, G-31491, G-32041, G-32484, G-32696, G-32737, G-32787, G-33779, G-33910, G-35219, G-36152, G-36534, G-36934, G-37685, G-37722, G-38579, G-38869, G-39095, G-39833, G-39863, G-39989, G-41368, G-41818, G-44251,

G-45005, H-11452, H-11467, H-28105, H-28448, H-33922, H-34237, H-34901, H-39407, H-39408, H-40368, H-42715, H-45056, K-11746, K-16808
BORON COMPOUNDS A-06351, C-42928, E-29910, E-29946, G-35042, H-22926, H-31801, H-37977
BREATHING A-29872, C-09333, G-04877, G-07169, G-13625, G-15703, G-17214, G-20087, G-20198, G-26260, G-27490, G-30000, G-30181, G-30198, G-31452, G-32735, G-33497, G-33779, G-33864, G-34951, G-42463, G-44381, L-07952
BREATHING APPARATUS G-36093
BRICKS H-11157, J-30696
BROMATES C-42020
BROMIDES A-04460, A-17304, A-22367, A-29786, A-34040, B-39275, C-00855, C-32718, D-04646, D-32350, F-06648, F-13911, F-14510, F-14868, G-33779, G-34841, G-37685, G-39883
BROMINATED HYDROCARBONS D-32350, F-06648
BROMINE A-26925, A-34018, A-37312, D-27429, D-28920, D-31775, D-34008, D-43468, E-24109, E-28586, G-07162
BROMINE COMPOUNDS A-04460, A-17304, A-22367, A-29786, A-33822, A-34040, B-39275, C-00855, C-32718, C-33042, C-38778, C-40724, C-42020, C-43763, C-44479, D-04646, D-11184, D-32350, D-35725, D-35861, E-29910, F-06648, F-13911, F-14510, F-14868, G-16820, G-33779, G-34841, G-37685, G-39883, K-34063
BRONCHI A-35957, G-05280, G-31452
BRONCHITIS A-27943, A-35957, D-32055, E-38666, G-00375, G-00473, G-03086, G-03282, G-07423, G-09253, G-13625, G-23167, G-27291, G-28256, G-30198, G-34092, G-40068, G-40634, G-41124, H-08884, H-11467, L-25288, L-44499, N-04052, N-20548
BRONCHOCONSTRICTION G-07423
BRONCHODILATORS G-04196
BROWNIAN MOVEMENT E-32155, G-03282
BUBBLE TOWERS B-16053
BUDGETS L-35151
BUILD-UP RATES A-00962, C-23646, C-25222, D-34933, G-34059, G-36283, H-25374, H-32423, H-36197
BUILDINGS A-30414, B-35540, C-32169, C-38165, D-03526, D-06148, D-08438, D-12099, D-16684, D-29465, D-36449, D-36503, D-36562, G-37229, H-01523, H-17216, H-17217, H-17218, H-17220, H-17681, H-24947, H-35880
BUSES A-05171, A-08972, A-22976, A-34018, A-39603, B-34381, D-04646, D-08275, G-00708, G-21423, N-08273
BUTADIENES A-33822, B-01851, D-43468, F-06648
BUTANES A-34177, F-09578, G-44867, J-31720
BUTENES A-05171, A-08039, G-16820
BUTYNES J-03289
BY-PRODUCT RECOVERY A-12751, A-12823, A-24285, A-35224, B-03232, B-03337, B-06493, B-15208, B-16053, B-26600, B-31221, B-32260, B-33157, B-34071, B-35296, B-35816, B-38727, B-40709, B-43937, B-44853, E-12777, N-09780
BYSSINOSIS G-27085

## C

CABBAGE C-00125, G-05541, H-17220, H-17978, H-20062, H-37977, H-40540
CADMIUM A-06220, B-17525, C-06045, C-10528, C-11042, C-15734, D-00017, D-00974, D-07985, D-11202, D-12049, D-20191, F-06648, F-10599, G-01731, G-01923, G-08683, G-10434, H-07742, H-32338, L-35795
CADMIUM COMPOUNDS A-05067, A-18297, A-21109, A-27595, A-29539, A-29787, A-30513, A-31632, A-33965, A-36846, A-37721, A-39367, A-41889, A-41890, A-45072, B-32260, C-05787, C-09333, C-10528, C-11042, C-20891, C-22975, C-25222, C-27075, C-28126, C-30113, C-30360, C-30635, C-30707, C-31933, C-32476, C-33338, C-34407, C-36588, C-36698, C-36703, C-36840, C-36841, C-37608, C-37689, C-38670, C-39136, C-39516, C-41719, C-41763, C-41908, C-42020, C-42084, C-42139, C-42312, C-42360, C-42437, C-42928, C-43720, C-43763, C-44995, D-04996, D-05167, D-07985, D-09432, D-11184, D-17340, D-23971, D-25881, D-27174, D-27188, D-27621, D-27648, D-27831, D-28653, D-29153, D-29191, D-30025, D-30182, D-30326, D-30493, D-30892, D-31014, D-31325, D-32727, D-35010, D-35489, D-36288, D-36474, D-36486, D-36688, D-36806, D-36820, D-37191, D-37320, D-37518, D-39914, D-41887, D-41888, D-41975, D-42122, D-42367, D-43316, D-43388, D-44234, D-44580, D-44996, E-36487, E-44813, F-13635, F-13839, F-14008, F-14039, F-14510, F-14868, F-16595, F-17882, F-29400, F-44164, G-01731, G-03897, G-07162, G-08683, G-17470, G-23167, G-23715, G-23801, G-24716, G-27961, G-28256, G-28834, G-29816, G-30181, G-31280, G-32608, G-35042, G-35055, G-38580, G-38721, G-39179, G-40068, G-41894, G-41895, G-42022, G-42098, G-44053, G-44364, G-45165, H-07742, H-14489, H-21794, H-23435, H-27489, H-28379, H-32322, H-32736, H-36265, H-36991, H-41800, H-41891, H-41892, H-41893, H-42336, H-43226, H-43279, K-06778, K-14443, K-33107, K-34063, K-34377, K-38197, K-42039, K-44310, K-44377, L-23608, L-23610, L-24214, L-28349, L-29421, L-30620, L-32789, L-32884, L-34980, L-35795, L-38669, L-44325, N-04212
CALCIUM COMPOUNDS A-29572, A-30759, B-03337, B-05300, B-25377, B-31317, B-33157, C-05977, C-16367, C-29512, C-38778, C-39168, C-41612, C-41825, C-41908, C-41968, C-42928, D-04996, D-08502, D-09432, D-15789, D-16684, D-21869, D-23971, D-24351, D-27880, D-30326, D-35010, D-35940, D-44580, F-13705, F-14510, F-14868, F-16659, F-34297, F-34948, G-03892, G-06028, G-08566, G-12038, G-26483, G-30181, G-32624, G-35380, G-36765, G-40688, G-41818, H-27391, H-32224, H-34831, H-34901, H-35209, H-36991, H-41461, H-42336, I-00305, I-33802
CALCIUM SULFATES G-08566, G-12038, H-32224, I-33802
CALIBRATION METHODS A-36006, C-01249, C-03770, C-09888, C-19501, C-23571, C-23657, C-30593, C-30635, C-34017, C-34106, C-37175, C-37971, C-38755, C-38778, C-38914, C-38973, C-39168, C-40407, C-40631, C-42437, C-43737, D-00976, D-07649, D-22290, D-29152, E-22754, F-42772, G-20687, G-32749, G-41368
CALIFORNIA A-03278, A-09393, A-19684, A-29516, A-34442, A-35168, A-39603, A-40583, B-00107, B-03754, B-19710, B-34381, B-35688, B-37195, B-43575, B-44470, B-44853, C-00855, C-06072, C-40724, C-44479, C-45235, D-00969, D-00976, D-01315, D-02750, D-03441, D-05573, D-07600, D-10612, D-16791, D-16839, D-22829, D-23658, D-24463, D-36195, D-40584, F-05849, G-00020, G-00076, G-00375, G-00662, G-03282, G-05002, G-07162, G-08326, G-09535, G-16820, G-27291, G-37040, H-18520, H-25967, H-33112, H-35827, H-40590, H-40591, H-44071, K-03007, K-09259, K-11746, K-30069, K-36346, K-38197, K-43312, L-00311, L-02635, L-32462, L-37497, M-33904, N-04212, N-20548
CANADA A-04460, A-06351, A-14135, A-16156, A-34018, A-35065, B-00063, B-01851, B-18053, B-29628, B-32260, B-35535, C-00855, C-01607, C-01608, C-03037, C-30928, D-01673, D-09432, D-44170, F-08207, F-16595, F-45295, G-00076, G-00148, G-00177, G-00473, G-01797, G-33605, H-08884, H-18481, H-27391, H-30921, H-32736, H-39287, H-42250, H-42607, K-09259, L-32462
CANCER A-17778, A-31395, A-45145, C-32058, D-16345, G-00375, G-00873, G-01797, G-03086, G-07169, G-07423, G-13625, G-26528, G-26775, G-34791, G-34851, G-35055, G-36747, G-36935, G-38869, G-39826, G-40068, G-40634, G-41097, G-41124, G-41737, G-43615, G-44176, G-44254, G-44395, H-42857, L-07952, L-25288, L-31957, N-20548
CANNING B-44853
CARBON BLACK A-26441, A-34774, A-35052, A-37176, A-39462, A-42212, B-08562, B-31390, C-40407, C-42043, E-35264, G-00177, G-26775, G-30181, K-08803
CARBON DIOXIDE A-05067, A-16156, A-23250, A-23620, A-27180, A-27249, A-28873, A-29096, A-29786, A-31315, A-34018, A-35078, A-38625, A-45145, B-27371, B-30717, B-30944, B-31690, B-31985, B-32938, B-35018, B-35166, B-35476, B-39275, B-44283, B-44660, C-06112, C-16123, C-22927, C-32534, C-41719, D-02133, D-06148, D-06788, D-27191, D-32055, D-32912, E-00834, E-06841, E-24109, E-29445, E-30863, E-31895, F-07451, F-34297, F-39901, G-00375, G-01341, G-04877, G-07162, G-19940, G-40634, G-44867, H-32224, H-32423, I-33802, K-08803, K-09259, K-24107, K-30069, L-00311, L-25542, L-32865, N-03674, N-04052, N-04212
CARBON DISULFIDE A-24281, B-03337, B-19725, C-09983, F-06648, G-07162, G-08381, G-39883, K-02580, K-09259, L-00311, L-23562
CARBON MONOXIDE A-00962, A-01565, A-01624, A-01868, A-02636, A-04460, A-05067, A-08972, A-09210, A-09355, A-09393, A-09686, A-14033, A-14459, A-15599, A-15769, A-16156, A-16766, A-17304, A-17325, A-17365, A-17778,

A-19598, A-20545, A-20927, A-22579, A-22825, A-22941, A-22976, A-23250, A-23316, A-23561, A-23620, A-23789, A-24156, A-24996, A-25581, A-26134, A-26645, A-26763, A-27180, A-27249, A-27272, A-27943, A-28560, A-28873, A-29096, A-29516, A-29786, A-30414, A-30513, A-30604, A-30976, A-31133, A-31315, A-31323, A-31395, A-32447, A-32621, A-32875, A-33087, A-33169, A-33378, A-33710, A-33963, A-33965, A-34018, A-34350, A-34442, A-34774, A-35078, A-35353, A-35481, A-35484, A-35676, A-36623, A-37015, A-37166, A-38522, A-38543, A-38625, A-38819, A-38891, A-39152, A-39603, A-39754, A-40677, A-40776, A-40981, A-41035, A-41654, A-41738, A-41945, A-42080, A-42212, A-42377, A-42676, A-42679, A-43346, A-43776, A-44227, A-44252, A-44682, A-45092, A-45145, A-45274, B-00015, B-00063, B-00107, B-01484, B-01851, B-03337, B-05214, B-09231, B-14604, B-17906, B-18053, B-19331, B-19808, B-20735, B-21762, B-22890, B-23697, B-24182, B-24722, B-24813, B-25155, B-25894, B-26153, B-27371, B-27503, B-27824, B-27876, B-28377, B-28699, B-28730, B-28865, B-29126, B-29605, B-29898, B-30154, B-30498, B-30717, B-30944, B-30950, B-31246, B-31314, B-31364, B-31496, B-31690, B-31819, B-31825, B-31985, B-32260, B-32355, B-32364, B-32938, B-33366, B-33386, B-33388, B-33403, B-33741, B-34035, B-34381, B-34611, B-35018, B-35166, B-35476, B-35540, B-35778, B-35821, B-36081, B-36523, B-37116, B-37222, B-37845, B-37938, B-38287, B-38614, B-39275, B-39492, B-41544, B-41608, B-42330, B-42817, B-43333, B-44003, B-44283, B-44341, B-44660, B-44750, B-44882, B-44906, C-02164, C-06112, C-09476, C-09983, C-16123, C-22927, C-23596, C-24644, C-26274, C-26707, C-27294, C-30290, C-32058, C-32534, C-32829, C-41719, C-41763, C-42775, C-42928, D-00005, D-00969, D-00985, D-01673, D-03441, D-04938, D-05260, D-05573, *D-06148*, *D-06760*, D-06788, D-07198, D-08275, D-08438, D-08568, D-08591, D-08812, D-08821, D-09240, D-09726, D-10612, D-10634, D-11028, D-15575, D-15610, D-16345, D-16539, D-16684, D-16839, D-17058, D-17106, D-19433, D-24162, D-26287, D-26387, D-26535, D-27187, D-27191, D-27257, D-27672, D-27675, D-28233, D-28528, D-28634, D-28635, D-29416, D-29465, D-29655, D-29744, D-30494, D-30860, D-31396, D-31669, D-32912, D-32945, D-33114, D-33576, D-35025, D-36009, D-36503, D-36562, D-36909, D-37288, D-37366, D-37394, D-38110, D-39081, D-39988, D-40118, D-40997, D-41033, D-41979, D-42120, D-43316, *D-43962*, D-44063, *D-44330*, E-27116, E-30073, E-30863, E-36487, E-37953, E-44813, F-07451, F-08207, F-09578, F-17689, G-00020, G-00177, G-00375, G-00473, G-03282, G-07162, G-07423, *G-08381*, *G-08411*, *G-10793*, *G-12038*, G-12646, G-13059, G-13154, G-13625, G-16820, G-17244, G-19940, G-21259, G-21266, G-23876, G-24288, G-24314, G-24603, G-24961, G-26310, G-26477, G-27085, G-27107, G-27291, *G-27801*, G-29129, G-30156, G-30328, G-30355, G-30671, G-30672, G-31319, G-31452, G-32484, G-32905, G-33607, G-33778, G-34406, G-34841, G-34895, G-35118, G-37180, G-37229, G-37788, G-37942, G-38616, G-38721, G-40634, G-41097, G-41737, G-42881, G-44087, G-44176, G-44254, G-44381, G-44395, J-26765, J-27968, J-30696, K-02580, K-03007, K-03956, K-06734, K-08420, K-08803, K-18294, K-19750, K-20121, K-30035, K-30069, K-36382, K-36823, K-38758, K-41682, K-42118, K-43312, K-44377, L-02635, L-03536, L-07952, L-09009, L-16200, L-17472, L-22583, L-23608, L-23610, L-24214, L-25288, L-25542, L-28099, L-28397, L-29888, L-30152, L-31957, L-32462, L-32789, L-32865, L-33495, L-33844, L-35922, L-37193, L-37497, L-37560, L-41557, L-41703, L-42873, L-44376, L-44499, M-01073, N-03674, N-04052, N-04212, N-08273, N-11871, N-14772, N-18005, N-20548, N-28088

CARBON TETRACHLORIDE F-03525, F-06648, G-44385

CARBONATES B-03232, B-10558, B-28286, B-31317, B-35352, B-37222, C-14758, C-29512, D-04996, D-31775, F-05440, F-16659, F-34297, G-32625, G-34943, H-34901

CARBONYLS B-05300, F-07451, F-09578, G-01797, G-23167, G-24314

CARBOXYHEMOGLOBIN A-00962, A-27272, A-27943, A-30513, A-39152, A-43776, D-06148, D-08568, D-08821, D-24162, G-00810, G-10793, G-13059, G-13154, G-17244, G-21259, G-24961, G-27253, G-27291, G-29129, G-31319, G-32905, G-33607, G-33778, G-37180, G-37942, G-41737, G-42881, G-44395, K-08420, K-36823, L-25288, L-33844, N-11871, N-20548

CARBURETION A-34442, A-35484, A-41738, B-09231, B-14604, B-18053, B-19637, B-20844, B-21303, B-23540, B-23697, B-23923, B-24182, B-28108, B-28730, B-30154, B-30944, B-31690, *B-32355*, *B-33388*, *B-34035*, *B-34457*, B-34611, B-35018, B-35778, B-36081, B-36523, B-37195, B-37275, B-38287, B-41608, B-44341, D-08568, G-39161, L-37717, L-44376

CARBURETOR EVAPORATION LOSSES A-01565, A-02636, A-08972, A-16156, A-17304, A-17365, A-22941, A-22976, A-26191, A-42377, B-17906, B-18053, B-19637, B-20735, B-20844, B-21762, N-20548

CARCINOGENS A-00962, A-01565, A-01624, A-03278, A-17778, A-26645, A-27458, A-29096, A-31395, A-35078, A-45145, B-26269, C-00855, C-01249, C-03770, C-22975, C-32058, D-00697, D-00969, D-00974, D-00976, D-00985, *D-01089*, *D-01315*, *D-01673*, *D-03410*, D-03526, D-11028, D-20642, D-24162, D-34008, E-00834, E-01821, E-03841, F-00841, F-03799, G-00076, G-00148, G-00177, G-00473, G-00642, G-00662, *G-00873*, G-00902, G-00993, G-01512, G-01812, G-03893, G-25068, G-26775, G-32484, G-33607, G-34851, G-35118, G-36935, *G-38616*, G-38869, G-40068, G-40634, G-41737, G-43615, G-44176, *I-00305*, *L-00311*, *L-07952*, *L-24467*, L-31957

CARDIOVASCULAR DISEASES A-27595, D-31396, F-11570, G-00375, G-01923, G-07162, G-08381, G-09486, G-10793, G-11580, G-13625, G-23167, G-23801, G-24192, G-25328, G-26477, G-27291, G-34895, G-35055, G-35463, G-36964, G-38580, G-40634, G-40769, G-44176, G-45196, H-08884, N-20548

CASCADE SAMPLERS A-15295, A-29661, A-30759, B-25301, C-00855, C-09888, C-27358, C-31258, C-31304, C-35494, C-37689, D-04646, D-07985, D-11184, D-11202, D-12049, D-21906, D-28650, D-28920, D-30182, D-32350, D-35489, D-36009, D-37518, E-35207

CATALYSIS A-14459, *A-26134*, *A-26763*, A-29127, A-31324, A-33365, A-34177, A-34774, A-35353, A-37372, A-38331, A-42791, B-00015, B-00063, B-05214, B-05300, B-09231, B-13982, B-19725, B-21040, B-22436, B-25033, B-25377, B-26153, B-26243, B-27503, B-29058, B-29204, B-29605, B-29898, B-30154, B-30498, B-30717, B-30950, B-31246, B-31496, B-31819, B-31825, B-32392, B-33386, B-34035, B-34536, B-34611, B-35223, B-35814, B-36453, B-36578, B-37173, B-37275, B-37408, B-37845, B-39275, B-40723, B-41922, B-44906, C-01230, F-00058, F-03799, F-08207, F-09578, F-17689, F-36524, F-40387, G-00177, G-06985, G-25328, G-38869, J-03289, K-30035, L-11204

CATALYSTS A-14459, A-26134, A-29127, A-31324, A-33365, A-34177, A-38331, B-00015, B-00063, B-05214, B-05300, B-09231, B-13982, B-25033, B-25377, B-26153, B-26243, B-29058, B-29204, B-29605, B-29898, B-30154, B-30498, B-30950, B-31246, B-31496, B-32392, B-34035, B-34536, B-34611, B-35223, B-35814, B-36453, B-36578, B-37173, B-37275, B-37408, B-37845, B-39275, B-40723, C-01230, F-00058, F-03799, F-08207, F-09578, F-36524, G-00177, G-06985, G-38869, L-11204

CATALYTIC ACTIVITY A-14459, A-26763, A-34774, A-35353, A-37372, A-42791, B-00063, B-05214, B-21040, B-22436, B-27503, B-30154, B-31246, B-33386, B-34536, B-35223, B-35814, B-36578, B-39275, B-41922, F-03799, F-09578, F-17689, G-06985, J-03289

CATALYTIC AFTERBURNERS A-14459, A-22825, A-23250, A-26134, A-26763, A-29127, A-31324, A-33378, A-35353, A-35484, A-35818, A-37372, A-39067, A-40677, A-45092, B-00063, B-01484, B-05214, B-09231, B-14604, B-20735, B-20844, B-21040, B-21762, B-23540, B-23697, B-24696, B-24813, B-25377, B-25894, B-26243, B-28699, B-28730, B-28865, B-29204, B-30229, B-30498, B-32355, B-33366, B-33386, B-33403, *B-34025*, *B-34035*, B-35018, B-35703, B-36145, B-36523, B-36578, B-36721, B-37042, B-37116, B-37150, B-37234, B-37275, B-37408, B-37845, B-38287, B-38614, B-39275, B-39333, B-40411, B-40723, B-40785, B-41608, B-41922, B-42886, B-44341, B-44473, G-34059, J-26765, J-30329, J-34370, K-38758, L-07952, L-09009, L-28869, L-37423 L-38757, L-40520, N-09780

CATALYTIC OXIDATION A-14459, A-22825, A-27858, A-30604, A-31136, A-35052, B-00015, B-00063, B-03337, B-13982, B-19331, B-21762, B-25033, B-25096, B-25377, B-26153, B-28865, B-29204, B-30229, B-30950, B-31314, B-31364, B-32260, B-32392, B-33386, B-33403, B-34536, B-34611, B-35018, B-35223, B-35814, B-36578, B-38287, B-39275, B-44906, C-44165, F-03799, F-08207, F-17689, G-00177
CATS H-28105, H-42857
CATTLE G-00375, G-13159, G-17214, G-33910, G-38616, H-10318, H-11452, H-11467, H-12536, H-26276, H-27063, H-27386, H-31185, H-32291, H-32736, H-33201, H-33362, H-33922, H-35209, H-36196, H-37912, H-39407, H-39408, H-40024, H-40591, H-41461, H-42715, H-42857, H-43226, H-43511, L-07952
CELL GROWTH G-18502, G-30671, G-31319, G-32484, G-33234, G-34832, G-34914, G-34943, G-34947, G-37119, G-39193, G-44254, G-45288, H-38332, H-39407, L-31957
CELL METABOLISM G-31493, G-32487, G-34789, G-34791, G-40316, G-42884, G-43277, G-43532, H-08884
CELLS A-29872, A-35957, C-26955, C-27556, C-28017, D-34008, F-13451, G-00708, G-00808, G-00810, G-00821, G-00993, G-01756, G-01812, G-02202, G-05475, G-05780, G-06151, G-06985, G-07162, G-07169, G-07396, G-07551, G-07740, G-07892, G-08566, G-08999, G-09408, G-09484, G-10434, G-11462, G-11552, G-13059, G-15703, G-18046, G-18417, G-18515, G-19881, G-21037, G-22637, G-23582, G-23926, G-24784, G-26310, G-26356, G-26477, G-26720, G-26883, G-26886, G-27085, G-27416, G-28010, G-28024, G-28205, G-29815, G-30334, G-30468, G-30672, G-31228, G-31351, G-31493, G-31899, G-32041, G-32129, G-32216, G-32218, G-32487, G-32624, G-32696, G-33234, G-33910, G-34789, G-34791, G-34836, G-34841, G-34847, G-34914, G-34943, G-35380, G-35811, G-36251, G-36934, G-37023, G-39095, G-39863, G-39989, G-40316, G-41695, G-41717, G-41737, G-41872, G-42091, G-42463, G-42881, G-42884, G-43277, G-43337, G-43531, G-43532, G-43725, G-44251, G-44254, G-44255, G-44508, H-10318, H-18521, H-28105, H-33362, H-34830, H-34901, H-35209, H-36991, H-38332, H-39407, H-40335, H-44588, K-16808, K-36346
CEMENTS A-26441, A-31395, A-34018, A-39462, C-08130, D-21869, D-27880, D-30326, D-30860, D-41979, H-11157, J-30696, L-17927, L-23562
CENTRIFUGAL SEPARATORS A-03982, A-05067, A-09686, A-39462, A-39609, A-43271, B-03754, B-15208, B-22492, B-25155, B-28172, B-31985, B-32319, B-33403, B-34025, B-35342, B-35778, B-44341, D-00976, D-05260, K-33107, L-23562, L-32884, N-09780
CERAMICS A-09686, A-35078, A-37190, A-38819, A-40314, B-00107, G-33605, G-35568, G-42757
CERIUM COMPOUNDS C-05243, D-43388
CESIUM COMPOUNDS C-05243, C-09333, C-34407, D-10756, D-43388
CHARCOAL B-03337, B-08562, B-13982, B-30944, C-05977, C-06072, D-01089, D-35861
CHEMICAL BONDS F-00058, F-13911, F-14743, F-43245, G-01797, G-34789
CHEMICAL COMPOSITION A-01868, A-02636, A-06351, A-17325, A-17339, A-19598, A-21722, A-28560, A-28873, A-29516, A-30759, A-31934, A-35788, A-37176, A-39610, A-40455, A-41145, B-22414, B-31341, B-31604, B-33542, B-33550, B-35540, B-37150, B-44660, C-05977, C-06072, C-06107, C-10528, C-18302, C-23096, C-23646, C-31258, C-35396, C-35494, C-38778, C-39136, C-39168, C-41016, D-00005, D-00017, D-00974, D-01673, D-03410, D-05167, D-05573, D-05623, D-08275, D-11028, D-11184, D-12049, D-15575, D-15789, D-15823, D-17340, D-19144, D-21015, D-21869, D-21906, D-27648, D-27880, D-30182, D-30656, D-30892, D-31775, D-35407, D-35489, D-35725, D-35940, D-36009, D-36288, D-36474, D-36486, D-36562, D-37026, D-37191, D-37202, D-37264, D-37288, D-37320, D-38133, D-40716, D-41033, D-41975, D-42122, D-43316, D-43693, D-44059, D-44234, E-32155, E-38666, F-05849, G-19159, G-33497, G-35041, G-35055, H-35827, H-37977, H-38743, H-42250, N-04649
CHEMICAL METHODS A-15599, A-25295, A-39035, A-41604, B-00899, B-27371, B-39272, C-00125, C-01607, C-05456, C-05977, C-06072, C-06881, C-08661, C-09333, C-09983, C-10528, C-16123, C-16367, C-18007, C-18302, C-20891, C-21338, C-23596, C-24119, C-24617, C-25013, C-25979, C-26274, C-26275, C-26336, C-26467, C-26698, C-26707, C-26955, C-27106, C-27556, C-29464, C-30290, C-30635, C-31258, C-31933, C-32169, C-32476, C-32534, C-32829, C-32833, C-33178, C-33255, C-36698, C-36703, C-39762, C-41490, C-42020, C-42084, C-42312, C-42775, D-00697, D-01089, D-02133, D-03526, D-04646, D-07985, D-08275, D-08438, D-08502, D-08810, D-09240, D-10595, D-11184, D-15573, D-16576, D-25881, D-27621, D-28097, D-28178, D-28620, D-28785, D-28920, D-29814, D-29918, D-30860, D-31014, D-32350, D-35489, D-36688, D-36820, D-39914, D-43388, D-43468, D-43962, D-44059, F-05849, F-07451, F-14008, F-14039, F-14510, F-16595, F-16659, F-34948, F-36067, G-00902, G-08683, G-24603, G-32129, G-34836, G-43337, H-32224, H-39328, I-03735, K-08420, N-03674, N-06992
CHEMICAL REACTIONS A-00962, A-01868, A-03982, A-09210, A-09355, A-10749, A-12751, A-12823, A-15295, A-17339, A-17778, A-19598, A-23561, A-23789, A-26441, A-27272, A-27458, A-27943, A-29127, A-29364, A-29786, A-30027, A-30067, A-30513, A-31324, A-31934, A-32875, A-34774, A-35078, A-35199, A-35353, A-35788, A-39610, A-40455, A-40677, A-42080, A-42791, A-44227, A-45145, A-45274, B-00015, B-00063, B-03337, B-05300, B-19808, B-20735, B-22436, B-24722, B-24813, B-26269, B-28377, B-29204, B-30717, B-31246, B-31317, B-31985, B-32938, B-33403, B-33542, B-34035, B-34536, B-35018, B-35223, B-35296, B-35814, B-36578, B-38727, B-39275, B-40411, B-41112, B-42290, B-43333, B-43937, C-00125, C-00855, C-01230, C-32058, C-36703, C-44165, D-00005, D-00969, D-11184, D-24162, D-29416, D-31775, D-32055, D-34008, D-35025, D-38110, D-39081, E-12777, E-29699, E-33873, E-38666, E-45050, F-00058, F-03799, F-05849, F-08207, F-09578, F-09745, F-13534, F-13879, F-13943, F-15413, F-16659, F-17585, F-17882, F-17949, F-34297, F-34607, F-34948, F-36524, F-37213, F-39901, F-44032, G-00148, G-00177, G-00375, G-01341, G-07162, G-16820, G-27291, G-34406, G-40634, G-44087, G-44364, H-08884, H-17038, H-19604, I-32921, I-36051, J-03289, K-03007, L-03536, L-28099, L-29888, L-32789, M-33904, N-03674, N-18005
CHEMISTS D-30860, D-32055
CHICAGO C-18007, D-07600, D-11184, D-27621, D-39535, D-39914, G-01754, G-01757, G-42716
CHILDREN A-27113, A-29872, A-31313, A-32875, D-03441, D-08275, D-09240, D-10380, D-27096, D-32912, D-41887, G-00736, G-00740, G-01512, G-01754, G-01755, G-01756, G-01757, G-03283, G-03286, G-05002, G-06174, G-09408, G-11630, G-18518, G-20704, G-24716, G-27084, G-29816, G-30672, G-30686, G-30831, G-31228, G-31493, G-31528, G-31537, G-31962, G-32484, G-32487, G-32735, G-32737, G-32787, G-32834, G-33165, G-33372, G-33374, G-33605, G-34059, G-34095, G-34701, G-34709, G-34738, G-35041, G-35055, G-35377, G-35380, G-35387, G-35438, G-35463, G-35560, G-35587, G-35792, G-35811, G-36152, G-36207, G-36534, G-36957, G-37023, G-37731, G-37941, G-38579, G-39095, G-39867, G-40022, G-40317, G-40769, G-41847, G-41894, G-42098, G-42884, G-43725, G-44087, G-44433, G-44463, L-31957, M-35206
CHLORATES F-34948
CHLORIDES A-04460, A-15295, A-17304, A-29786, A-34040, A-35788, A-42676, B-35296, C-00855, C-09333, C-23096, C-23657, C-26707, C-27294, C-30360, C-38670, C-39762, D-04646, D-05167, D-16684, D-21906, D-32350, F-06648, F-14008, F-14510, F-14868, F-16595, F-17882, F-29400, F-36524, G-07162, G-18502, G-32218, G-36093, G-44381, H-17038, H-33985, I-33802, K-34063, L-16200, L-32789, L-35795, N-04052
CHLORINATED HYDROCARBONS C-39136, D-32350, F-03525, F-06648, G-13154, G-39826, G-44381, G-44385, H-24667, H-42857, I-33802, K-20121, K-41682, K-44310
CHLORINE A-06351, A-09686, A-26925, A-31315, A-34018, A-37312, A-37721, B-31390, C-09983, C-11042, C-26275, C-28126, C-38670, C-41719, C-42928, D-04996, D-27429, D-28920, D-32912, E-24109, E-28586, G-07162, G-24314, G-38616, H-08884, H-39328, K-06778, K-33107, K-34063, K-42039, K-44377, L-00311, L-25542, L-30620, L-31957, L-32884, L-35795, L-38669
CHLORINE COMPOUNDS A-04460, A-15295, A-17304, A-29786, A-34040, A-35788, A-35957, A-37721, A-42676,

B-35296, C-00855, C-09333, C-23096, C-23657, C-26707, C-27294, C-28126, C-30360, C-32476, C-38670, C-38778, C-39136, C-39762, C-41612, C-41719, D-04646, D-05167, D-11184, D-16684, D-21906, D-24351, D-32350, D-35940, F-06648, F-14008, F-14510, F-14868, F-16595, F-17882, F-29400, F-34948, F-36524, G-07162, G-16820, G-18502, G-24314, G-32218, G-34841, G-36093, G-44381, H-17038, H-33985, H-40368, I-33802, K-09259, K-34063, K-34377, K-36823, K-38197, K-41682, L-16200, L-28349, L-32789, L-35795, L-38669, N-04052
CHLOROFORM F-06648
CHLOROPLASTS B-03754
CHLOROSIS H-08884, H-16655
CHROMATES C-09333, C-29810, F-14868, F-16659, G-32608, G-32625, H-33985, K-09259
CHROMATOGRAPHY A-05067, A-09355, A-13524, A-23789, A-29516, A-29936, A-40947, A-43966, B-27371, B-30717, B-31690, C-01230, C-01607, C-01608, *C-06112*, *C-08145*, C-09333, C-09953, C-16123, C-19276, C-23596, C-26275, C-26505, C-26707, C-27294, C-28126, C-29595, C-30635, C-32058, C-32476, C-32534, C-32829, C-37971, C-38670, C-39069, C-41719, C-42437, C-42928, C-43448, D-00985, D-03410, D-03526, D-08275, D-08438, D-11028, D-25055, D-29744, D-30860, D-36909, D-40716, D-41664, D-44330, F-07451, G-00177, G-35560, N-03674
CHROMIUM B-00063, D-00017, D-00974, D-03526, D-07985, D-11202, D-12049, G-00662, G-01731, G-01923, H-07742, I-32921, N-04649
CHROMIUM COMPOUNDS A-05067, A-06351, A-18297, A-22370, A-36846, B-03337, B-05300, B-30717, B-31364, B-35703, C-05787, C-09333, C-29810, C-30360, C-38670, C-38778, C-39136, C-39516, C-41825, C-41908, C-41968, C-42928, C-44210, C-44995, D-04996, D-05167, D-07985, D-17340, D-22290, D-23388, D-23971, D-24351, D-26387, D-27188, D-27648, D-27831, D-28653, D-30182, *D-30493*, *D-31325*, *D-35010*, D-35940, D-36486, D-36688, D-36820, D-37026, D-37191, D-37264, D-37518, D-41975, D-44580, D-44996, E-44813, F-14868, F-16595, F-16659, F-36067, G-01731, G-01797, G-26528, G-26775, G-28834, G-30181, G-30395, G-32608, G-32625, G-32735, G-38580, G-39833, G-40068, G-42022, G-44696, H-07742, H-23435, H-33985, H-36991, H-41800, H-43279, K-09259, K-41682, L-23608, L-23610, L-24214, N-04649
CHROMIUM OXIDES B-00015, B-00063, B-05214, B-30154, F-00058, F-09578, F-17689
CHROMOSOMES G-07169, G-26883, G-34914, G-44251
CHRONIC A-31324, A-35957, D-03441, D-09726, E-30676, F-11570, G-00375, G-00473, G-03282, G-06059, G-07162, G-07423, G-08381, G-08949, G-08999, G-09484, G-09486, G-11552, G-11580, G-15731, G-20704, G-21259, G-21266, G-27291, G-27614, G-29129, G-30198, G-30671, G-30686, G-30831, G-31228, G-31493, G-32487, G-32608, G-33527, G-33910, G-34092, G-34114, G-34406, G-34436, G-34701, G-34738, G-34832, G-34841, G-35211, G-35380, G-35387, G-35463, G-35714, G-36152, G-36207, G-36747, G-36765, G-37028, G-37180, G-37731, G-38616, G-38869, G-39867, G-40068, G-40312, G-40634, G-40688, G-41067, G-41124, G-41872, G-41895, G-42098, G-42759, G-42957, G-43196, G-43277, G-43531, G-44254, G-44746, G-44867, H-11452, H-11467, H-18481, H-32736, H-33362, H-34830, L-44499, N-20548
CHRYSENES F-00058, G-40688
CILIA G-07162
CINCINNATI A-03278, A-12624, C-09888, D-01089, D-01315, D-01673, D-02750, D-07600, D-07985, D-11202, D-12049, D-16839, D-24463, D-36195, G-00076, G-37040, K-11746
CINDERS D-10380, D-16684
CIRCULATORY SYSTEM A-23058, A-29096, A-34341, A-35957, C-01608, F-11570, G-01923, G-04196, G-06151, G-06814, G-08381, G-10434, G-10793, G-11580, G-12075, G-13059, G-19159, G-32041, G-32216, G-32484, G-33910, G-35463, G-36964, G-38867, G-39989, G-43337, G-43531, G-44254, G-44381, G-44385, G-44395, G-45196, H-34830, H-35209
CITIZENS GROUPS D-30860, G-33903, L-34980, M-29432
CITRUS H-20062
CITY GOVERNMENTS D-00005, D-03410, D-28097, G-34059, K-43312
CLAY A-39462, H-32224
CLEAN AIR ACT A-01868, A-37166, A-41945, D-44170, K-09259, L-34033, M-01073, N-14772
CLOUD SEEDING D-21684, E-19058, E-36714, E-40157, E-44999
CLOUDS A-35078, C-44995, D-00261, D-04996, D-21684, D-29647, D-39988, E-19058, E-29445, E-29688, E-29699, E-31895, E-32155, E-32158, E-36714
COAL A-03278, A-05067, A-06351, A-09686, A-23239, A-29786, A-30428, A-30674, A-31649, A-34018, A-34341, A-34774, A-35052, A-37166, A-39367, A-39462, A-43346, B-03232, B-03337, B-30633, B-34025, C-08130, C-23096, C-42160, C-43763, D-05260, D-08591, D-27188, D-27621, D-27672, D-30182, D-31396, D-35025, E-00834, E-24109, G-00076, G-12038, G-31528, G-34092, G-35811, G-44696, H-19620, H-23581, J-30696, K-34063, L-00311, N-18005
COAL CHARACTERISTICS A-06351, A-23239, A-34774, B-03337, C-42160
COAL PREPARATION B-03337
COAL TARS L-07952
COBALT COMPOUNDS A-05067, A-18297, A-36846, B-00063, B-30154, B-31364, C-05787, C-10528, C-11042, C-27358, C-42360, C-44210, C-44995, D-00974, D-03526, D-05167, D-23971, D-27174, D-27188, D-35010, D-39535, D-42367, D-43316, D-44580, E-29910, F-13705, F-13839, F-16595, F-36067, F-39522, F-43436, G-35041, G-38580, G-40068, G-42022, H-07742, H-11452, H-23435, H-36991, H-42250, H-43279
CODES K-06778, K-14443, K-36346
COFFEE-MAKING A-09686, N-04052
COKE A-26441, A-34774, A-43271, A-43346, B-29628, B-32260, B-36453, K-34377
COLLECTORS A-03982, A-05067, A-09686, A-39462, A-39609, A-42726, A-43271, B-03125, B-03754, B-06493, B-15208, B-21324, B-22492, B-24722, B-25155, B-28172, B-29920, B-31985, B-32248, B-32319, B-33403, B-34025, B-35342, B-35778, B-44341, B-44742, C-05977, C-06072, D-00976, D-05260, D-35025, D-37320, K-33107, K-34377, L-17472, L-23562, L-30152, L-32884, L-37560, N-09780
COLLOIDS F-35379
COLORADO D-16839, D-21684, E-33873
COLORIMETRY A-05067, A-32523, B-30717, B-31317, B-39272, B-39275, C-00855, C-02164, C-03034, *C-05977*, C-06072, C-06112, C-06881, C-06894, C-09333, C-09983, C-14758, C-15563, C-16123, C-17771, C-20945, C-23096, C-24337, C-25440, C-25932, C-25979, C-26467, C-26503, C-26698, C-26848, C-28017, C-29297, C-30290, C-30928, C-32476, C-33731, C-37514, C-38670, C-38755, C-38914, C-38973, C-42043, C-42928, D-00005, D-00985, D-02133, D-03410, D-16791, D-25635, D-30860, D-32912, D-37366, D-42122, D-43962, F-09745, F-37213, G-23582, G-24603, G-33165, G-34246, G-34847, H-38743, H-43342, K-08420
COLUMN CHROMATOGRAPHY C-26707, *C-32058*, *C-39069*, *D-03410*, *D-03526*, D-11028
COMBUSTION A-08039, A-23561, A-24281, A-26100, A-27249, A-27272, A-33087, A-33365, A-34774, A-35788, A-38625, A-38819, B-19637, B-20735, B-23697, B-27503, B-28060, B-30944, B-31364, B-33741, B-35018, B-37195, B-39492, B-44283, B-44742, C-08145, C-36703, D-00005, D-08502, F-05440, F-08207, F-09578, F-09745, F-17689, F-39901, G-08683, G-24603, H-42607, L-00311, L-09009
COMBUSTION AIR A-05067, A-10749, A-26763, A-27249, A-30067, A-30604, A-34774, A-38819, A-41738, B-14604, B-28699, B-31819, B-31825, B-32938, B-35018, B-35476, B-37042, B-37195, B-42300, B-43333, F-08207, L-09009
COMBUSTION GASES A-09355, A-09686, A-12751, A-12823, A-23620, A-24080, A-24285, A-26441, A-26645, A-29096, A-29539, A-29787, A-30674, A-31136, A-31315, A-31632, A-32875, A-33087, A-35224, A-36623, A-37166, A-37190, A-38819, A-38891, A-40583, A-40677, A-41945, A-42676, B-00107, B-03337, B-03754, B-09231, B-09798, B-15208, B-16053, B-22492, B-25377, B-25470, B-26600, B-27824, B-28172, B-29628, B-30229, B-31985, B-32248, B-32355, B-32760, B-34025, B-35035, B-35303, B-35476, B-35478, B-37222, B-38727, B-43515, B-44742, B-44853, B-44906, C-06112, C-09476, C-33055, C-36588, C-36840, C-36841, C-38670, C-39136, C-44210, D-05260, D-08591, D-10380, D-20191, D-26054, D-27174, D-30182, D-30860, D-32055, D-32912, D-39914, D-40574, D-40584, D-41979, E-12777, E-24109, F-07451, F-34297, G-00375, G-09019, G-09408, G-12038, G-20704,

G-30181, G-31319, G-34092, G-39161, H-08884, H-11452, H-14489, H-26276, H-31185, H-39690, H-42857, I-31377, I-33802, K-06778, K-14443, K-34063, K-36823, L-17927, L-23562, L-29421, L-30620, L-35151, L-38669, N-09780
COMBUSTION PRODUCTS A-05067, A-09355, A-09686, A-12751, A-12823, A-23561, A-23620, A-24080, A-24285, A-26441, A-26645, A-29096, A-29539, A-29787, A-30428, A-30674, A-31136, A-31315, A-31632, A-31649, A-32875, A-33087, A-35224, A-35788, A-36623, A-37166, A-37190, A-38819, A-38891, A-40583, A-40677, A-41945, A-42676, A-43346, B-00107, B-03337, B-03754, B-09231, B-09798, B-15208, B-16053, B-22492, B-25377, B-25470, B-26600, B-27824, B-28172, B-29628, B-30229, B-31364, B-31985, B-32248, B-32260, B-32355, B-32760, B-34025, B-35035, B-35303, B-35476, B-35478, B-37222, B-38727, B-39333, B-42702, B-43515, B-44742, B-44853, B-44906, C-06112, C-09476, C-23096, C-33055, C-36588, C-36840, C-36841, C-38670, C-39136, C-44210, D-04996, D-05260, D-05551, D-08591, D-10380, D-16684, D-20191, D-26054, D-27174, D-27188, D-30182, D-30860, D-32055, D-32912, D-35025, D-37288, D-39914, D-40574, D-40584, D-40716, D-41979, E-00834, E-12777, E-24109, F-00058, F-05440, F-07451, F-34297, G-00076, G-00375, G-09019, G-09408, G-12038, G-20704, G-30181, G-31319, G-31528, G-34092, G-38721, G-39161, G-41737, H-08884, H-11452, H-14489, H-26276, H-28448, H-31185, H-39690, H-42857, I-31377, I-33802, K-06778, K-09259, K-14443, K-34063, K-36823, L-00311, L-16200, L-17927, L-23562, L-23608, L-23610, L-24214, L-29421, L-30620, L-32789, L-35151, L-38669, L-44499, N-04212, N-09780, N-28803
COMMERCIAL AREAS C-15562, C-32058, D-01315, D-04938, D-06760, D-08821, D-10612, D-12049, D-15823, D-27188, D-27648, D-27675, D-29515, D-30025, D-30860, D-31014, D-32055, D-32727, D-36009, D-36195, D-36562, D-36820, D-37264, D-38110, G-09408, G-23801, G-30000, H-40591, H-41800, H-42336, L-44499
COMMERCIAL EQUIPMENT B-00107, B-16053, C-03037, C-09888, D-02133
COMMERCIAL FIRMS A-41959, B-24184, B-31314, B-31690, B-32364, G-30156, J-30329, L-44044, M-01073, M-29432
COMMON COLD G-07423, G-13625
COMPLAINTS D-39081, D-44330, M-29432

COMPLIANCE G-07162
COMPRESSED GASES A-24080, A-31133, A-35052, A-35484, A-42377, A-44464, B-28699, B-28730, B-30154, B-31496, B-33932, B-35816, B-36721, L-35151
COMPRESSION B-44882, C-43448
COMPUTER PROGRAMS A-25125, B-27371, B-31690, C-41908, J-03288, J-34970, N-04649
COMPUTERS C-29512, C-41908, D-44234, J-39941
CONCRETE A-09686, B-00107, B-03754
CONDENSATION B-00015, B-41544, C-32718, C-44165, E-24570, E-29699, E-33873, F-44164, G-24603
CONDENSATION (ATMOSPHERIC) A-23620, A-26191, A-29096, A-35078, A-41145, B-20735, B-31221, B-35816, B-44283, C-44995, D-00261, D-04996, D-07198, D-09726, D-10634, D-21684, D-25635, D-28920, D-29647, D-39988, E-00834, E-19058, E-24109, E-24570, E-28586, E-29445, E-29688, E-29699, E-30863, E-31895, E-32155, E-32158, E-33873, E-36714, E-40157, I-02176, L-33844, N-04212
CONNECTICUT A-30674, A-31313, B-35540, D-27096, H-30424, H-41143
CONSTRUCTION MATERIALS A-09686, A-26441, A-31395, A-34018, A-39462, B-00107, B-03754, B-34035, B-35778, C-08130, D-05260, D-21869, D-27880, D-30326, D-30860, D-41979, G-13625, G-38616, H-11157, H-30225, J-30696, L-00311, L-17927, L-23562
CONTACT PROCESSING A-10749, A-42791, L-23562
CONTINUOUS AIR MONITORING PROGRAM (CAMP) A-01868, D-12049, D-16839, D-44170
CONTINUOUS MONITORING A-26645, B-30154, B-30633, B-30950, B-44750, C-00855, C-06112, C-16382, C-19276, C-21338, C-23596, C-24644, C-27294, C-28621, C-28895, C-32534, C-32833, C-40724, C-44165, D-04996, D-11202, D-12049, D-15575, D-16839, D-27672, D-27675, D-28650, D-28785, D-29647, D-30326, D-30860, D-31396, D-32055, D-35025, D-36009, D-36562, D-37366, D-38110, D-41975, D-42122, D-43316, E-32155, G-00177, G-31584, G-32608, G-33864, G-34406, G-34791, G-34841, G-36093, G-36747, G-38869, K-08803, K-30069, L-17472, L-33495, L-35922, L-41557, N-11871
CONTRACTING B-44283
CONTROL AGENCIES A-36664, B-25096, D-19144, D-30860, G-31528, J-31720, K-38758, L-09009, L-17472, L-31454, L-32865, L-33495, L-33844, L-35151, L-41557, N-08273, N-09780
CONTROL EQUIPMENT A-03982, A-05067, A-06220, A-09686, A-10749, A-12751, A-12823, A-14459, A-14945, A-15599, A-20652, A-20927, A-22825, A-23250, A-24156, A-24285, A-26134, A-26441, A-26763, A-27858, A-28560, A-28862, A-29127, A-29661, A-30604, A-31324, A-33378, A-34442, A-35052, A-35168, A-35353, A-35484, A-35818, A-36083, A-37372, A-38522, A-39067, A-39462, A-39609, A-40583, A-40677, A-42726, A-43271, A-45092, B-00063, B-00107, B-01484, B-03125, B-03232, B-03337, B-03754, B-05214, B-05300, B-06493, B-07606, B-08562, B-09231, B-09798, B-10558, B-14604, B-15208, B-16053, B-17525, B-19331, B-19808, B-20735, B-20844, B-21040, B-21324, B-21762, B-22492, B-22520, B-23540, B-23697, B-24184, B-24553, B-24696, B-24722, B-24813, B-25033, B-25155, B-25334, B-25377, B-25470, B-25781, B-25894, B-26243, B-26532, B-26600, B-28172, B-28286, B-28699, B-28730, B-28865, B-29204, B-29664, B-29920, B-30124, B-30229, B-30498, B-31364, B-31496, B-31690, B-31819, B-31825, B-31985, B-32248, B-32319, B-32355, B-32633, B-32760, B-33157, B-33366, B-33386, B-33388, B-33403, B-33628, B-34025, B-34035, B-34313, B-34457, B-35018, B-35035, B-35303, B-35342, B-35352, B-35476, B-35478, B-35540, B-35703, B-35778, B-35821, B-36145, B-36523, B-36578, B-36721, B-37042, B-37116, B-37150, B-37234, B-37275, B-37408, B-37750, B-37845, B-37938, B-38287, B-38614, B-39272, B-39275, B-39333, B-40411, B-40723, B-40785, B-41544, B-41608, B-41922, B-42131, B-42330, B-42886, B-43333, B-43515, B-44003, B-44341, B-44470, B-44473, B-44742, B-44750, C-00855, C-01249, C-03034, C-03770, C-05243, C-05977, C-06072, C-06112, C-08130, C-08145, C-10556, C-11042, C-19313, C-19501, C-23096, C-24337, C-25015, C-25793, C-26145, C-26698, C-26955, C-27556, C-27829, C-28621, C-29595, C-31258, C-31304, C-31933, C-32058, C-32474, C-32718, C-32892, C-33255, C-34106, C-34407, C-36588, C-36840, C-36841, C-37514, C-37693, C-38165, C-41612, C-41908, C-42043, C-42139, C-42360, C-42437, C-43448, C-43587, D-00005, D-00976, D-01089, D-01355, D-03410, D-05260, D-08275, D-08502, D-09432, D-10612, D-10756, D-11028, D-15789, D-16576, D-27187, D-28097, D-31332, D-32350, D-34933, D-35025, D-36562, D-37320, D-42247, E-12777, E-32155, F-05440, G-00177, G-01512, G-03086, G-04196, G-06704, G-08566, G-31040, G-34059, G-41737, H-24947, H-35880, I-00305, I-32921, J-26765, J-30329, J-34370, K-06778, K-24107, K-33107, K-34377, K-38758, L-00311, L-07952, L-09009, L-17472, L-23234, L-23562, L-28869, L-30152, L-32884, L-33844, L-37392, L-37423, L-37560, L-38757, L-40520, L-42873, N-09780
CONTROL METHODS A-00962, A-01565, A-01624, A-01868, A-02636, A-04460, A-05067, A-05171, A-09355, A-09686, A-10749, A-12751, A-12823, A-14033, A-14459, A-14461, A-14462, A-15769, A-16156, A-17304, A-17339, A-17365, A-18211, A-19598, A-20545, A-20927, A-21069, A-21109, A-22825, A-22941, A-22976, A-23058, A-23250, A-23280, A-23316, A-23789, A-24080, A-24156, A-24281, A-24285, A-24718, A-24829, A-24996, A-25295, A-25581, A-26100, A-26134, A-26191, A-26552, A-26763, A-26891, A-27249, A-27272, A-27458, A-27595, A-27858, A-28336, A-28394, A-28560, A-28862, A-28873, A-29127, A-29364, A-29516, A-29539, A-29782, A-29786, A-29872, A-30027, A-30067, A-30414, A-30604, A-30674, A-30976, A-31085, A-31088, A-31133, A-31136, A-31323, A-31324, A-31520, A-31525, A-31596, A-31934, A-32523, A-32621, A-32875, A-33169, A-33350, A-33365, A-33378, A-33626, A-33667, A-33963, A-33965, A-34031, A-34040, A-34177, A-34341, A-34350, A-34442, A-34774, A-35050, A-35052, A-35123, A-35199, A-35224, A-35353, A-35477, A-35481, A-35484, A-35818, A-35919, A-36080, A-36082, A-36083, A-36084, A-36527, A-36541, A-36623, A-36664, A-37166, A-37176, A-37312, A-37372, A-37648, A-38330, A-38331, A-38522, A-38543, A-38625, A-38759, A-38819, A-39035, A-39067, A-39367, A-39603, A-39609,

A-39610, A-39754, A-40314, A-40455, A-40583, A-40677, A-40759, A-40776, A-41035, A-41518, A-41654, A-41738, A-41945, A-41959, A-42080, A-42377, A-42676, A-42791, A-42980, A-43346, A-43776, A-44252, A-44464, A-44682, A-44821, A-45092, A-45136, A-45145, B-00015, B-00063, B-00107, B-00899, B-01484, B-01851, B-03232, B-03337, B-03754, B-05214, B-05300, B-06493, B-09231, B-09798, B-13982, B-14604, B-15208, B-16053, B-17906, B-18053, B-19331, B-19637, B-19710, B-19725, B-19808, B-20735, B-20740, B-20844, B-21040, B-21303, B-21719, B-21762, B-22414, B-22834, B-22890, B-23540, B-23697, B-23923, B-24182, B-24184, B-24186, B-24696, B-24722, B-24813, B-25033, B-25096, B-25155, B-25301, B-25377, B-25781, B-25894, B-26153, B-26243, B-26269, B-26600, B-27371, B-27503, B-27824, B-27850, B-27876, B-28059, B-28060, B-28108, B-28172, B-28286, B-28377, B-28699, B-28730, B-28860, B-28865, B-29058, B-29126, B-29204, B-29414, B-29531, B-29605, B-29628, B-29656, B-29898, B-29920, B-30010, B-30124, B-30154, B-30229, B-30498, B-30944, B-30950, B-31221, B-31314, B-31317, B-31341, B-31364, B-31390, B-31441, B-31496, B-31519, B-31604, B-31690, B-31819, B-31825, *B-31985, B-32036, B-32260,* B-32355, B-32364, B-32392, B-32424, B-32822, B-32938, B-33157, B-33366, B-33386, B-33388, B-33403, B-33542, B-33550, B-33628, B-33657, B-33741, B-33932, B-33994, B-34025, B-34035, B-34071, B-34381, B-34457, B-34536, B-34611, B-34740, B-34846, B-35018, B-35080, B-35112, B-35166, B-35223, B-35296, B-35303, B-35342, B-35352, B-35476, B-35478, B-35535, B-35540, B-35688, B-35703, B-35778, B-35814, B-35816, B-35821, B-36081, B-36144, B-36145, B-36453, B-36523, B-36578, B-36721, B-37042, B-37116, B-37150, B-37173, B-37195, B-37222, B-37234, B-37275, B-37408, B-37468, B-37619, B-37845, B-37938, B-38287, B-38614, B-38727, B-39272, B-39275, B-39333, B-39404, B-39492, B-40411, B-40709, B-40723, B-40785, B-41112, B-41544, B-41608, B-41793, B-41922, B-42131, B-42166, B-42300, B-42330, B-42702, B-42817, B-42819, B-42829, B-42886, B-43333, B-43575, B-43937, B-44003, B-44283, B-44341, B-44470, B-44473, B-44614, B-44660, B-44742, B-44750, B-44853, B-44882, B-44906, C-00056, C-00125, C-00855, C-05977, C-06072, C-06107, C-06112, C-08130, C-08145, C-21459, C-26707, C-27556, C-27681, C-28755, C-29419, C-29810, C-30635, C-30928, C-32058, C-32169, C-35494, C-38165, C-42775, C-43587, C-44165, D-00969, D-04646, D-05277, D-08275, D-08568, D-08591, D-23658, D-24952, D-27096, D-27174, D-28369, D-29647, D-29744, D-32350, D-32912, D-33114, D-35861, D-36562, D-36820, D-39405, D-43962, D-44996, E-00834, E-12777, E-23743, E-30676, E-31895, E-32155, E-32158, E-35207, E-35264, E-38666, E-44813, E-45050, F-03799, F-05440, F-08207, F-09745, F-10599, F-14995, F-17689, F-28908, F-34297, F-40387, F-41787, F-44032, G-00177, G-00642, G-02191, G-03282, G-03283, G-03284, G-03285, G-03287, G-03654, G-04196, G-04251, G-05002, G-06028, G-06177, G-06704, G-08566, G-09019, G-10856, G-14492, G-19304, G-19881, G-19940, G-20087, G-20198, G-22222, G-23167, G-23768, G-24603, G-24877, G-25328, G-26260, G-28024, G-29286, G-29493, G-29789, G-29825, G-30156, G-30328, G-30671, G-30672, G-30686, G-30831, G-31228, G-31319, G-31442, G-31491, G-31517, G-31537, G-31899, G-32613, G-32738, G-33372, G-33607, G-33779, G-33864, G-34059, G-34175, G-34436, G-34649, G-34895, G-34902, G-34951, G-35568, G-36283, G-36354, G-36551, G-37229, G-37420, G-37685, G-37788, G-37933, G-38579, G-38580, G-38867, G-38869, G-39161, G-39826, G-40485, G-41847, G-42091, G-42957, G-44364, G-44867, H-17215, H-17216, H-17217, H-17218, H-17220, H-17681, H-17978, H-20062, H-20237, H-21018, H-24788, H-24947, H-25878, H-26092, H-27352, H-28379, H-28529, H-30921, H-32224, H-32654, H-33364, H-34830, H-35827, H-36197, H-36611, I-22128, I-32921, I-36051, J-03288, J-22358, J-26765, J-27968, J-30329, J-30696, J-31518, J-32241, J-34828, J-34970, J-35391, J-36592, J-37409, J-37734, J-38624, J-39941, J-39956, J-42721, K-18294, K-24107, K-30035, K-33730, K-36346, K-38758, L-03536, L-07952, L-09009, L-11204, L-22583, L-23234, L-23562, L-26442, L-28099, L-28397, L-28869, L-30908, L-31454, L-31957, L-32865, L-33740, L-35151, L-36030, L-37193, L-37423, L-37521, L-37560, L-37717, L-38757, L-40486, L-40520, L-41289, L-41703, L-42016, L-42041, L-42873, L-44376, L-44499, M-01073, M-29432, M-33904, N-06992, N-09780, N-28088, N-37225

CONTROL PROGRAMS A-31136, A-31323, A-32621, A-33963, A-33965, A-42791, B-01851, B-20735, B-30633, B-31314, B-31496, B-32424, B-39404, D-03441, D-08568, D-30860, D-32055, G-00740, G-31528, G-34095, G-34895, G-36207, J-30329, J-39956, K-03007, L-23608, L-23610, L-24214, L-25288, L-28869, L-29888, L-30152, L-31454, L-32462, L-33844, L-35151, L-35461, L-35922, L-36877, L-37193, L-37497, L-37521, L-40486, L-40520, L-42041, L-42873, M-01073, M-33904, N-11871

CONTROLLED ATMOSPHERES C-06107, C-16123, G-00473, G-09493, H-33364

CONVECTION (ATMOSPHERIC) E-00834, E-24109, E-24166, E-40157

COOLING A-23561, B-09798, B-35778, B-36145, C-06643, C-44210, E-24109, E-40157, F-27348

COPPER A-09686, A-24285, A-29787, A-34916, A-35168, A-39462, A-42676, A-43271, B-00063, B-00107, B-03754, B-08562, B-09798, B-17525, B-25470, B-32248, B-32319, B-32760, B-35035, B-35296, B-37222, B-37750, B-40709, C-10528, C-11042, C-15734, D-00017, D-00974, D-03526, D-07985, D-10634, D-11202, D-12049, F-07451, F-10599, F-13534, F-27348, G-00662, G-01512, G-03086, G-10434, H-07742, H-08884, H-11467, *H-39690, I-02176, I-03735,* I-06355, I-06357, J-30696, L-28066, N-04649

COPPER ALLOYS A-35168, A-42676, B-00107, B-03754, B-09798, B-17525, B-25470, B-32248, B-40709, I-06357

COPPER COMPOUNDS A-03982, A-05067, A-06351, A-12751, A-12823, A-18297, A-22370, A-24285, A-26441, A-26454, A-29539, A-29787, A-35224, A-36846, A-45072, B-00063, B-03337, B-05214, B-05300, B-08562, B-30154, B-30717, B-31246, B-32392, B-33157, B-34536, B-35223, B-35296, B-35703, B-35814, B-36578, B-38727, B-39275, B-40709, B-43937, C-05787, C-06045, C-08145, C-10528, C-11042, C-19313, C-19501, C-20891, C-22975, C-24119, C-25535, C-25979, C-27075, C-28126, C-30113, C-30360, C-30635, C-31304, C-31933, C-32892, C-34407, C-37608, C-37689, C-37693, C-38682, C-38778, C-39136, C-39516, C-41825, C-41908, C-41968, C-42020, C-42084, C-42139, C-42360, C-43720, C-43763, C-44995, D-03526, D-04996, D-05167, D-07985, D-09432, D-11184, D-17340, D-21869, D-23388, D-23971, D-24351, D-27174, D-27188, D-27621, D-27648, D-27831, D-27880, D-28326, D-28629, D-28653, D-29191, D-30182, D-30326, D-30493, D-30656, D-30892, D-31325, D-32055, D-32727, D-35010, D-35489, D-35940, D-36288, D-36474, D-36486, D-36806, D-36820, D-37191, D-37202, D-37264, D-37288, D-37320, D-39914, D-41975, D-42122, D-42367, D-43316, D-44059, D-44234, D-44996, E-10215, E-12777, E-29910, E-40157, E-44813, F-03799, F-08207, F-13461, F-13635, F-13705, F-13839, F-14743, F-16595, F-17689, F-35378, F-36067, F-39522, F-43436, F-44164, G-19159, G-24716, G-30181, G-35041, G-36093, G-39179, G-39833, G-40688, G-41894, G-42022, G-44053, G-44696, H-08884, H-22926, H-23258, H-23435, H-30921, H-31010, H-31801, H-32224, H-32322, H-34831, H-36265, H-36991, H-37977, H-39287, H-39690, H-41461, H-41733, H-42250, H-42336, H-43279, K-14443, K-44310, L-39640, N-04649

CORE OVENS B-00107

CORN H-17038, H-17218, H-17220, H-36991

CORONA B-07606, B-35035

CORROSION A-28210, A-33626, B-03337, B-05300, B-07606, B-30498, B-33388, B-33932, B-41112, B-42290, D-37026, H-39690, I-02176, I-03735, I-06355, I-06357, I-22128, I-31377, I-32921, I-33802, I-36051, N-43824

COSMIC RAYS E-24549, E-32155

COSTS A-00962, A-12751, A-12823, A-17304, A-23280, A-24829, A-26134, A-26441, A-28394, A-30976, A-31085, A-31395, A-31596, A-33350, A-34031, A-34921, A-36664, A-37166, A-38330, A-38331, A-38543, A-38625, A-39067, A-39462, A-39603, A-39610, A-41654, A-42377, A-42980, B-13982, B-18053, B-24184, B-24696, B-25470, B-25781, B-26153, B-27824, B-28286, B-28865, B-29605, B-29625, B-30154, B-30229, B-31221, B-31341, B-31519, B-31819, B-32248, B-32319, B-33403, B-34846,

B-35112, B-36453, B-36721, B-37173, B-37845, B-38287, B-39275, B-39404, B-40785, B-42166, B-42290, B-42829, B-44742, B-44882, D-11184, D-30860, E-12777, F-14995, G-22222, J-03288, J-03289, J-21749, J-22358, J-26765, J-27968, J-30329, J-30696, J-31518, J-31720, J-32241, J-34370, J-34828, J-34970, J-35391, J-36592, J-37409, J-37734, J-38624, J-39956, J-42721, K-18294, L-11204, L-22583, L-28869, L-30908, L-35151, L-36030, L-38757, L-40520, L-41289, L-44044, M-01073, M-33904, N-08273, N-09780
COTTON H-08884
COTTON GINNING A-39462
COTTONS B-09798, C-08130, C-08145, G-07162
COUGH G-24314, G-30181, G-32696, G-32905, G-35041, G-40435, G-41737, G-44087, G-44176
COUNTY GOVERNMENTS B-00107, D-03410
CRANKCASE EMISSIONS A-01565, A-01624, A-08972, A-16156, A-17304, A-22976, A-26763, A-32621, A-32875, A-35484, A-36083, A-41035, A-42212, B-01484, B-01851, B-09231, B-17906, B-18053, B-21762, B-23697, B-28699, B-30498, B-31364, B-31496, B-31819, B-32355, B-35018, B-36145, B-36721, B-37116, B-39333, B-39492, B-40411, B-41112, B-41544, B-42300, B-44003, B-44341, B-44660, B-44750, C-32058, D-00969, K-30069, L-09009, L-32462, L-44376, N-20548
CRANKCASE VENTILATION AIR A-17304, B-09231, B-30498, B-32355, B-41544, B-44750
CRITERIA A-12823, A-24996, A-27943, A-30001, A-32621, A-35676, A-36527, A-40455, B-25894, B-32424, B-33932, B-34457, B-39404, C-30635, D-29416, D-31669, D-44580, E-12777, G-12038, G-13159, G-16810, G-16820, G-23768, G-27084, G-31524, G-33903, G-34406, G-34895, H-32335, J-38624, K-03956, K-08420, K-09259, K-16808, K-24107, K-33730, K-36382, K-36823, K-43312, L-32865, L-32884, L-37717, L-44499, N-14772, N-43824
CROP SPRAYING G-27801, G-33374
CROPS A-03279, A-26552, A-29787, A-30428, A-32748, A-34018, A-36032, B-32036, C-00125, C-21948, C-30113, C-33042, C-45235, G-00375, G-00708, G-00808, G-00810, G-00821, G-00873, G-00993, G-01756, G-01812, G-03286, G-05483, G-07169, G-07396, G-10434, G-17214, G-28256, G-31319, G-33910, G-39095, G-40355, H-01523, H-07742, H-08884, H-09448, H-11467, H-12647, H-14489, H-14786, H-17038, H-17215, H-17216, H-17217, H-17218, H-17220, H-20237, H-24947, H-25878, H-27111, H-27391, H-27489, H-28471, H-30931, H-31010, H-31185, H-32322, H-32335, H-32654, H-32736, H-33112, H-33201, H-33362, H-33364, H-33922, H-33985, H-35827, H-36197, H-36611, H-36991, H-37912, H-38332, H-39408, H-40024, H-40368, H-41891, H-41892, H-42207, H-43721, H-44071, J-21749
CRYSTAL STRUCTURE C-23657, C-29810, E-24109, E-29688, F-13911, F-34297
CUMULATIVE METHODS C-26503, C-38755, D-26044, D-27672, D-29655, D-37026, D-40363, D-40997, D-44059, G-02191, G-24603, G-35041, I-02176
CUPOLAS A-20652, A-26441, B-00107, B-03754, B-09798, B-32248, B-44742, D-21015, L-17927, L-23562
CYANATES K-41682
CYANIDES A-29787, C-23096, C-32534, C-38670, C-39136, C-39516, F-07451, G-07162, G-24314, G-24603, G-39826, K-44310, L-23608, L-23610, L-24214
CZECHOSLOVAKIA A-01868, A-06220, C-00056, C-00855, C-01249, C-01607, C-03037, C-03770, C-09983, D-00969, D-00976, D-00985, D-01355, D-02750, D-03526, E-00834, E-01821, F-00841, G-00177, G-00473, G-01731, G-01756, G-01797, G-03283, G-08381, G-09535, G-24192, G-26483, G-26883, G-43196, G-45005, I-02176, I-03735, K-09259, L-44376, N-04649

## D

DATA ANALYSIS D-10380, D-42921, J-35391, L-33495, N-04649
DATA HANDLING SYSTEMS A-25125, B-27371, B-31690, C-00855, C-33042, C-40724, C-41908, D-10380, D-42921, G-29816, J-03288, J-34970, J-35391, L-33495, N-04649
DECISIONS D-40574
DECOMPOSITION A-42791, B-03337, B-29204, B-33403, E-45050, F-09745, F-17949, F-44032, L-32789
DENSITY A-29539, A-30513, B-03337, B-07606, B-31317, C-31258, C-32534, C-43763, D-15575, D-29416, E-00834, E-30073, E-36038, G-02191, G-05475, G-31351, G-33864
DEPOSITION A-29572, A-29782, A-30674, A-34341, A-36032, A-37372, B-31221, D-27174, D-28369, D-35010, E-30676, E-31852, G-12070, G-18046, G-20990, G-24603, G-26775, G-26931, G-30000, G-30468, G-31452, G-31528, G-32041, G-33372, G-33497, G-36354, G-38869, H-19604, H-33922, H-34901, H-35827, H-44071
DESIGN CRITERIA A-06220, A-10749, A-24996, A-26441, A-39603, A-42980, B-01851, B-08562, B-09798, B-19331, B-22520, B-23540, B-23697, B-24553, B-24722, B-25033, B-25334, B-26243, B-29204, B-29920, B-30229, B-31690, B-31819, B-31825, B-31985, B-32248, B-32364, B-32760, B-33386, B-34025, B-34035, B-34381, B-35303, B-35478, B-35778, B-36453, B-37042, B-37222, B-37275, B-38614, B-38727, B-41544, B-41922, B-42131, B-42300, C-01607, C-03037, C-09888, C-11626, C-17180, C-19276, C-21459, C-23596, C-27358, C-32833, C-41490, C-43587, E-44813, G-11808
DESULFURIZATION OF FUELS A-24080, A-29127, A-31136, A-31934, A-34177, A-34774, A-35052, A-35199, A-37166, A-38331, A-39067, B-03337, B-19725, B-24186, B-27824, B-30154, B-31221, B-31341, B-34846, B-37150, B-44906, J-34970, K-30035, L-35151, L-37560, L-42873, N-09780, N-28088
DETROIT A-26645, D-04938, D-04996, D-10612, D-11184, D-35489
DIAGNOSIS A-28862, B-29414, B-44882, C-32058, C-33042, F-11570, F-11582, G-00662, G-00705, G-00708, G-00873, G-01797, G-01812, G-05025, G-06028, G-06177, G-07396, G-09261, G-11552, G-11580, G-12070, G-13154, G-15731, G-17470, G-18508, G-18518, G-22637, G-23582, G-23926, G-24081, G-26528, G-28170, G-28171, G-29256, G-30181, G-30686, G-31528, G-31584, G-31899, G-32216, G-32608, G-32624, G-32696, G-32737, G-32746, G-32747, G-33202, G-33234, G-34436, G-34738, G-34837, G-34841, G-34914, G-35041, G-35217, G-35438, G-35463, G-35559, G-35560, G-36152, G-36207, G-36747, G-36932, G-36934, G-36957, G-37040, G-37119, G-38867, G-39095, G-39193, G-39867, G-39989, G-40021, G-40022, G-40057, G-40532, G-40769, G-41695, G-41872, G-42698, G-42716, G-43196, G-43559, G-44053, G-44696, H-18520, H-18521, H-27111, H-33201, H-35234, H-40591, H-42924, L-36877
DIESEL ENGINES A-01565, A-01624, A-01868, A-08972, A-09393, A-09686, A-15769, A-19598, A-22976, A-23316, A-26134, A-26763, A-27249, A-27272, A-28560, A-29786, A-30604, A-32621, A-33087, A-34018, A-34774, A-41654, A-41738, A-42080, A-43346, A-44464, B-01484, B-09231, B-17906, B-20740, B-23923, B-28060, B-30944, B-34457, B-44750, C-32058, C-42775, D-03410, D-08812, D-08821, D-12099, D-24162, D-27174, D-39988, F-00058, G-19940, G-30328, K-03956, K-08803, L-03536, L-07952, L-09009, L-37717, N-04052, N-08273, N-09780
DIFFRACTION C-29810, C-35494
DIFFUSION C-01249, C-19313, C-26275, D-10380, D-11202, D-30410, D-40584, D-41887, E-03841, E-05713, E-21182, E-24166, E-27116, E-28799, E-29688, E-29946, E-30073, E-31852, E-32155, E-35207, E-37953, E-38118, E-38666, E-44813, E-45050, F-14008, H-28105, H-28529, H-33922, H-42250, K-34063, L-23562, L-25288, L-32884, N-11871
DIFFUSION MODELS D-10380, E-03841, E-27116, E-28799, E-35207, E-37953, E-44813, E-45050, K-34063, L-25288
DIGESTION G-28834, G-31493, H-26276
DIGESTIVE SYSTEM A-22579, A-35957, D-09240, G-00993, G-01341, G-01500, G-01756, G-01797, G-01923, G-03086, G-03286, G-03893, G-04196, G-05002, G-05475, G-06814, G-07169, G-07396, G-08411, G-09493, G-10434, G-10793, G-12075, G-14492, G-16810, G-23768, G-27614, G-29588, G-30468, G-30672, G-31228, G-31491, G-32787, G-33372, G-33779, G-33910, G-35055, G-35225, G-35559, G-36251, G-36934, G-37297, G-37685, G-38867, G-39095, G-39989, G-40014, G-40022, G-40068, G-40485, G-41737, G-42098, G-42881, G-43559, G-44254, G-44385, G-45005, G-45288, G-45293, H-08884, H-10318, H-11452, H-11467, H-16270, H-18521, H-28105, H-28448, H-30033, H-33362, H-33922, H-34237, H-34830, H-35209, H-35234, H-36196, H-36991, H-39408, H-41893, H-44588
DIGITAL METHODS C-39168
DIOLEFINS A-08039, A-33822, B-01851, D-43468, F-06648, H-08884, K-09259
DIPHENYLS C-03034, F-13839

DISCOLORATION D-37026
DISPERSION A-11702, A-23561, A-25417, A-29096, A-35052, A-35919, A-40583, A-41145, A-45274, B-01851, B-20735, C-01249, C-19313, C-23646, C-25222, C-26275, C-28621, C-33042, C-33055, C-38165, D-10380, D-11202, D-23388, D-23864, D-23971, D-24351, D-27187, D-29918, D-30410, D-30860, D-32912, D-33114, D-35010, D-35725, D-40584, D-41887, E-01821, E-03841, E-05713, E-21182, E-22754, E-23743, E-24166, E-27116, E-28586, E-28799, E-29688, E-29946, E-30073, E-30863, E-31852, E-32155, E-32158, E-33225, E-35207, E-36038, E-37953, E-38118, E-38666, E-40164, E-44813, E-45050, F-14008, G-19940, G-29816, G-30468, G-30831, H-08884, H-24667, H-28105, H-28529, H-32224, H-33922, H-36197, H-39408, H-42250, K-34063, L-23562, L-25288, L-30152, L-32884, N-11871
DISPERSIONS F-35379
DISPLACEMENT F-36524
DISSIPATION RATES A-00962, E-38666
DISSOCIATION A-44227, F-17949, F-34297
DISTILLATE OILS A-38022
DIURNAL A-12624, A-26645, A-30414, A-30674, A-30976, A-31649, A-32035, A-41145, B-28730, B-30633, B-32355, C-00855, C-02164, C-30593, C-37608, C-44479, D-03441, D-04996, D-07198, D-08275, D-09240, D-10554, D-10612, D-11028, D-16839, D-17058, D-21015, D-22829, D-25758, D-25881, D-26044, D-26054, D-27187, D-27191, D-27648, D-27672, D-27675, D-28178, D-28369, D-28528, D-28620, D-28629, D-28634, D-28785, D-29647, D-29918, D-30182, D-30326, D-30494, D-30858, D-30860, D-30892, D-31332, D-31669, D-32055, D-33576, D-34008, D-34805, D-35025, D-35489, D-36009, D-36486, D-36562, D-37026, D-37191, D-37320, D-39988, D-40584, D-40997, D-41664, D-42122, D-42247, D-43962, E-01821, E-05713, E-24166, E-30073, E-35207, E-38118, G-00148, G-02191, G-05002, G-16820, G-30468, G-30671, G-30672, G-33864, G-34895, G-34902, G-35792, G-37630, G-37942, G-41731, G-41895, G-44381, H-33201, K-19750, K-41682, L-30620, L-33495
DOGS F-11570, G-11468, G-33374, G-33910, G-36934, G-37119, G-39193, G-42737, H-35209, H-39407, H-42857
DOMESTIC HEATING A-33087, A-33965, A-40981, A-43346, A-44227, B-19808, B-28108, C-41016, D-00005, D-17340, D-30858, D-31325, D-34008, D-41033, G-03086, G-31319, G-33607, J-30329, J-30696, L-00311, L-32884, L-33844, N-04052, N-04212, N-09780
DONORA D-05623, G-00375, G-07162, G-07423, N-18005
DROPLETS C-28755, E-22754, E-23743, E-24109, E-29688, E-32158
DRUGS G-00708, G-00821, G-01754, G-01756, G-02202, G-03892, G-04196, G-05671, G-06028, G-11468, G-23876, G-27085, G-28256, G-31962, G-32624, G-34095, G-34114, G-34436, G-34947, G-35217, G-35387, G-35463, G-36152, G-36740, G-36934, G-36935, G-38869, G-39095, G-40022, G-41872, G-42716, H-34831, H-35209
DRY CLEANING A-34018, N-04212
DRYING C-32474, H-32322
DUMPS A-03278, A-31649, H-37912
DUST FALL A-29572, C-23646, C-25535, C-38755, C-41763, D-00005, D-04996, D-06760, D-07198, D-10380, D-15789, D-15823, D-16539, D-16684, D-16791, D-21015, D-23388, D-23971, D-24351, D-26044, D-26054, D-27191, D-27648, D-27672, D-27675, D-27880, D-28097, D-30182, D-30493, D-30858, D-30860, D-32055, D-32727, D-35010, D-35407, D-35940, D-37026, D-37264, D-37288, D-38110, D-39405, D-40363, D-40716, D-41888, D-41979, D-44170, E-23743, E-32155, E-32158, G-23801, G-24603, G-30395, G-35041, G-39179, H-10318, H-42250, I-00305, K-36823
DUSTS A-03278, A-09393, A-12624, A-13524, A-15205, A-19955, A-20652, A-21722, A-26441, A-28210, A-29661, A-29787, A-30414, A-31395, A-31525, A-33169, A-33710, A-33965, A-34774, A-35078, A-37190, A-38543, A-38819, A-39152, A-39462, A-40583, A-40981, A-42080, A-42676, A-42726, A-43271, A-44464, B-03125, B-03232, B-03754, B-07606, B-08562, B-09798, B-15208, B-17525, B-22520, B-24553, B-26600, B-28172, B-28730, B-30633, B-32319, B-32633, B-32760, B-32822, B-33157, B-34071, B-34313, B-35296, B-35342, B-35478, B-37750, B-38727, B-40709, B-43515, B-43937, B-44283, B-44750, C-01608, C-03037, C-03770, C-05977, C-08130, C-09983, C-10556, C-10561, C-15563, C-16367, C-25431, C-26274, C-26698, C-27358, C-28017, C-28755, C-29464, C-29595, C-30290, C-30360, C-31933, C-32534, C-32718, C-32975, C-36588, C-37608, C-37689, C-37693, C-37971, C-38165, C-38778, C-41763, C-41908, C-41968, C-45235, D-02133, D-03441, D-04996, D-05277, D-06148, D-06760, D-07198, D-08438, D-08502, D-09432, D-10380, D-10634, D-14762, D-15610, D-15789, D-15823, D-16684, D-17106, D-20642, D-21869, D-25089, D-25758, D-26387, D-26535, D-27187, D-27257, D-28097, D-28233, D-28326, D-28653, D-29152, D-29191, D-29382, D-29385, D-29416, D-29515, D-29814, D-30025, D-30182, D-30656, D-30858, D-30860, D-31396, D-32055, D-32912, D-32945, D-33114, D-34008, D-34933, D-37518, D-38110, D-38133, D-39405, D-39988, D-41520, D-41975, D-42122, D-43693, D-43962, D-44059, D-44330, D-44996, E-03841, E-19058, E-21796, E-24570, E-29445, E-29910, E-32155, E-36714, G-00810, G-00902, G-01512, G-03892, G-04196, G-05002, G-07162, G-07551, G-08566, G-09253, G-09408, G-12070, G-12984, G-18417, G-19940, G-20704, G-24081, G-26477, G-26775, G-29129, G-30000, G-30181, G-31319, G-31351, G-32484, G-32696, G-32905, G-33778, G-34092, G-34951, G-35568, G-38721, G-39095, G-41067, G-42463, G-44087, G-44251, G-44254, G-44433, G-44508, G-44696, H-08884, H-10318, H-11157, H-19604, H-20062, H-21018, H-26276, H-28448, H-30225, H-30921, H-31010, H-32322, H-32338, H-36197, H-38332, H-39690, H-40368, H-42857, I-00305, K-06778, K-14443, K-20121, K-33107, K-34063, K-34377, K-36823, K-38197, K-41682, K-42039, L-00311, L-02635, L-17472, L-17927, L-23234, L-23562, L-25542, L-28349, L-28397, L-30152, L-30620, L-31957, L-32865, L-32884, L-35795, L-35922, L-37560, L-38669, L-42873, N-03674, N-04052, N-04212, N-11871, N-28088
DYNAMOMETERS A-04460, A-14461, A-35123, A-37176, B-00063, B-01851, B-27371, B-30154, B-31604, B-31690, B-36081, F-08207, G-00177, I-36051, K-30069

## E

ECONOMIC LOSSES A-00962, A-17304, A-30001, A-34018, B-31519, G-30831, H-27111, J-21749, J-31518, J-32241, J-38624, J-39941, L-25288, L-39640, L-44044, N-09780, N-28088
EDUCATION A-40776, G-34095, L-35151, M-01073, M-33904, N-28088
ELECTRIC CHARGE A-02636, B-05300, C-09888, C-25979, C-30360, E-06841, E-29688
ELECTRIC FURNACES A-06220, A-09686, A-26441, B-00107, B-03754, B-09798, B-15208, B-34071, B-35342, D-37320, L-30620
ELECTRIC POWER PRODUCTION A-05067, A-24080, A-26441, A-30513, A-31315, A-33087, A-34018, A-34788, A-35052, A-37166, A-38891, A-39462, A-40677, A-40981, A-43346, B-00107, B-03337, B-21324, B-28108, B-28377, B-34025, B-37222, B-44906, C-44210, D-05260, D-05551, D-30860, D-31396, D-32912, D-38110, E-00834, G-00375, G-03281, J-30329, J-30696, J-42721, K-06778, K-34063, L-00311, L-17472, L-17927, L-23562, L-23610, L-24214, L-29421, L-30152, L-30620, L-32884, L-33844, L-35151, N-04052, N-04212, N-09780
ELECTRIC PROPULSION A-26763, A-30604, A-30976, A-32621, A-38543, A-39603, A-40776, A-41518, A-44227, B-28699, B-30944, B-32355, B-33366, B-34457, B-37275, B-39492, B-42166, B-44882, G-30831, G-41847, H-36196, L-07952, L-35151, N-08273, N-09780
ELECTRICAL MEASUREMENT DEVICES C-01607, C-01608, C-09888, C-42312, D-39914
ELECTRICAL PROPERTIES A-02636, B-03337, B-05300, B-07606, B-10558, B-32760, B-35035, B-37750, C-09888, C-25979, C-26145, C-30360, C-32474, C-44995, E-06841, E-29688, F-16595, G-03635, H-42250, I-02176
ELECTRICAL RESISTANCE B-10558, B-32760, B-35035, B-37750, I-02176
ELECTROCHEMICAL METHODS B-39272, C-01607, C-05456, C-05977, C-06881, C-09983, C-10528, C-16123, C-18007, C-20891, C-21338, C-23596, C-24617, C-25013, C-25979, C-26275, C-26336, C-26467, C-27556, C-29464, C-30290, C-31933, C-32534, C-32833, C-33255, C-39762, C-41490, C-42020, C-42084, C-42312, C-42775, D-00697, D-04646, D-10595, D-11184, D-16576, D-25881, D-27621, D-28097, D-28178, D-28620, D-28785, D-28920, D-29814, D-29918, D-31014, D-32350, D-35489, D-36688, D-36820, D-39914, D-43468,

D-43962, D-44059, F-14008, F-14039, F-14510, F-16595, F-16659, F-34948, G-08683, G-43337, H-39328, I-03735, N-03674
ELECTROCONDUCTIVITY ANALYZERS C-00855, C-06112, C-32534, D-04996, D-27672, D-30860, D-36562, D-42122, E-32155, L-17472
ELECTROLYSIS A-42676, B-03337, C-25979, C-44995, F-15493
ELECTRON MICROSCOPY A-06220, C-03037, C-08145, C-09888, C-26275, C-35494, C-35695, C-42928, D-00976, E-32155, G-00177, G-08999, G-39863, G-44381, I-03735
ELECTROSTATIC PRECIPITATORS A-05067, A-09686, A-10749, A-24285, A-26441, A-39462, A-42726, A-43271, B-00107, B-03125, B-03232, B-03754, B-07606, B-09798, B-10558, B-17525, B-19331, B-24553, B-25470, B-26532, B-26600, B-32248, B-32319, B-32633, B-32760, B-33157, B-33403, B-34025, B-35035, B-35476, B-37750, C-05977, C-06112, C-08145, C-23096, C-25015, C-26145, C-26698, C-27556, C-43448, D-05260, D-08502, D-15789, F-05440, G-01512, K-06778, K-33107, L-23562, L-32884, N-09780
EMISSION INVENTORIES A-03278, A-30513, A-35052, B-33366, D-03410, D-05551, D-10380, D-39914, K-36823
EMISSION STANDARDS A-22825, A-24156, A-24996, A-26134, A-26763, A-27272, A-29516, A-30604, A-33378, A-34442, A-35050, A-35168, A-36527, A-36664, A-37190, A-38522, A-38625, A-39367, A-39609, A-40455, A-40776, A-41654, A-41959, A-42679, A-43776, B-20844, B-24722, B-25096, B-28377, B-28699, B-28730, B-29414, B-29605, B-30944, B-31496, B-31819, B-31825, B-33386, B-33388, B-34381, B-34457, B-34611, B-35166, B-35778, B-36081, B-36523, B-36578, B-37195, B-37938, B-39492, B-40785, B-42330, B-44750, B-44882, C-41719, D-00005, D-32055, D-41979, D-42367, F-00841, G-00020, G-12075, G-30328, G-35118, J-22358, J-30696, K-06778, K-09259, K-16104, K-18294, K-24107, K-30035, K-30069, K-33107, K-34063, K-34377, K-36382, K-36823, K-38197, K-38758, K-42039, K-42118, K-44310, K-44377, L-03536, L-17927, L-25288, L-28349, L-29421, L-31957, L-32462, L-32865, L-32884, L-34033, L-35795, L-37560, L-38669, L-38757, L-42016, L-42873, L-44219, L-44376, M-01073, N-09780, N-11871, N-14772
EMISSIVITY E-05713, F-00841
EMPHYSEMA G-00375, G-03282, G-07423, G-13625, G-23167, G-26477, G-28256, G-31452, G-40634, G-41124, G-44381, H-08884, H-11452, H-11467, N-20548
*ENFORCEMENT PROCEDURES* A-38625, B-29628, B-32424, D-32912, G-35714, K-06778, L-08725, L-29421, L-30620, L-35795, L-37423, L-38669, L-44044, L-44499, M-29432, N-08273
ENGINE DESIGN MODIFICATION A-20545, A-20927, A-22825, A-23250, A-26763, A-32621, A-36084, A-38522, A-38543, A-39603, A-40677, A-40776, A-41654, A-42980, A-43776, A-45092, B-09231, B-18053, B-19637, B-19710, B-20735, B-20844, B-21303, B-21762, B-22414, B-22890, B-23540, B-23697, B-24182, B-24184, B-24696, B-25096, B-27503, B-27850, B-30944, B-31314, B-31364, B-31819, B-31825, B-32355, B-32938, B-33366, B-33550, B-33628, B-34381, B-34457, B-35018, B-35166, B-35821, B-36523, B-36721, B-37195, B-37275, B-37938, B-39492, B-40411, B-42330, B-42886, B-44660, D-29744, J-26765, J-27968, K-24107, L-07952, L-44376
ENGINE EXHAUSTS A-01565, A-01624, A-01868, A-02636, A-04460, A-05171, A-08039, A-08972, A-09210, A-09355, A-09686, A-12624, A-14033, A-14459, A-14461, A-14462, A-15295, A-15599, A-16156, A-16766, A-17304, A-17365, A-19598, A-20545, A-20927, A-21109, A-22367, A-22825, A-22941, A-22976, A-23058, A-23280, A-23316, A-23789, A-24031, A-24156, A-24996, A-25581, A-26100, A-26134, A-26552, A-26763, A-26891, A-26925, A-27249, A-27272, A-27458, A-27595, A-27858, A-28560, A-28873, A-29096, A-29127, A-29516, A-29661, A-29782, A-29872, A-30001, A-30027, A-30067, A-30414, A-30604, A-30674, A-30759, A-30976, A-31085, A-31133, A-31136, A-31395, A-32621, A-32875, A-33169, A-33350, A-33365, A-33378, A-33667, A-33710, A-33822, A-33965, A-34018, A-34040, A-34350, A-34442, A-34774, A-35078, A-35199, A-35353, A-35477, A-35481, A-35484, A-35676, A-35818, A-35919, A-35953, A-36082, A-36083, A-36527, A-36541, A-36664, A-37015, A-37166, A-37176, A-37312, A-37372, A-37648, A-38522, A-38543, A-38625, A-38891, A-39367, A-39610, A-39754, A-40677, A-40759, A-40776, A-40981, A-41035, A-41654, A-41738, A-41945, A-42212, A-42377, A-42679, A-43966, A-44227, A-44252, A-44464, A-44682, A-45092, B-00015, B-00063, B-01484, B-01851, B-05214, B-09231, B-17906, B-18053, B-19331, B-19637, B-20735, B-21040, B-21762, B-22414, B-22890, B-23540, B-23697, B-24182, B-24184, B-24696, B-25096, B-25301, B-25377, B-25894, B-26153, B-26243, B-27371, B-27503, B-28286, B-29126, B-29204, B-29414, B-29656, B-29898, B-29920, B-30154, B-30498, B-30633, B-30944, B-30950, B-31221, B-31314, B-31364, B-31441, B-31496, B-31604, B-31819, B-31825, B-31985, B-32355, B-32938, B-33366, B-33386, B-33388, B-33403, B-33542, B-33550, B-33657, B-33932, B-34035, B-34381, B-34457, B-34536, B-34611, B-34740, B-35018, B-35223, B-35352, B-35476, B-35688, B-35778, B-35814, B-35816, B-35821, B-36081, B-36721, B-37116, B-37195, B-37222, B-37234, B-37275, B-37408, B-37468, B-37845, B-37938, B-38287, B-38614, B-39272, B-39275, B-39404, B-39492, B-40411, B-40723, B-41112, B-41608, B-41922, B-42131, B-42817, B-42819, B-42829, B-44003, B-44283, B-44341, C-02164, C-06643, C-09476, C-17179, C-17180, C-18302, C-21948, C-22927, C-24617, C-24618, C-24644, C-26505, C-28755, C-29595, C-32058, C-32829, C-33055, C-37175, C-42020, C-42775, C-43587, C-44165, D-00969, D-01315, D-01673, D-02750, D-04646, D-04938, D-05277, D-05820, D-08275, D-08438, D-08568, D-08591, D-08812, D-08821, D-10554, D-10595, D-12099, D-15610, D-16539, D-16791, D-16839, D-17106, D-21015, D-24414, D-24952, D-25055, D-25635, D-25881, D-26535, D-27174, D-27187, D-27188, D-27191, D-27257, D-27429, D-27672, D-27675, D-27831, D-28233, D-28326, D-28528, D-28620, D-28634, D-28635, D-29382, D-29515, D-29647, D-29918, D-30860, D-31669, D-31775, D-32055, D-32350, D-32883, D-32912, D-32945, D-33114, D-34008, D-35861, D-36449, D-36474, D-36486, D-36503, D-36820, D-36909, D-37191, D-37288, D-37366, D-37394, D-38110, D-38133, D-39081, D-39405, D-39988, D-40118, D-40716, D-40997, D-41664, D-41979, D-43693, D-44063, E-00834, E-01821, E-06841, E-23743, E-30073, E-30676, E-31895, E-37953, E-38118, E-45050, F-00058, F-03799, F-05849, F-08207, F-17689, G-00020, G-00076, G-00148, G-00177, G-00375, G-00473, G-00597, G-05541, G-07169, G-08326, G-08411, G-11468, G-12075, G-13059, G-19304, G-19940, G-20704, G-21266, G-21423, G-23715, G-24961, G-25068, G-25328, G-25705, G-26260, G-27253, G-27291, G-29129, G-29789, G-29825, G-30156, G-30355, G-30671, G-30672, G-31228, G-31319, G-31517, G-31537, G-31899, G-32905, G-33165, G-33497, G-33607, G-33778, G-34406, G-34436, G-34895, G-35118, G-35811, G-36354, G-37180, G-37630, G-37788, G-37933, G-37942, G-37964, G-39095, G-39161, G-39193, G-40355, G-40435, G-41737, G-42881, G-44176, G-44254, G-44508, H-07742, H-08884, H-17225, H-19604, H-24667, H-24788, H-24947, H-25878, H-26276, H-27063, H-28105, H-28289, H-28471, H-28529, H-32654, H-33364, H-33922, H-35827, H-36611, H-39407, H-39408, H-39409, H-40540, H-42857, H-43342, I-32921, J-26765, K-03007, K-08803, K-11746, K-24107, K-30069, K-34063, K-36346, K-42118, L-03536, L-07952, L-08196, L-09009, L-24757, L-27664, L-30152, L-30620, L-30908, L-31957, L-32462, L-36877, L-37193, L-37392, L-37521, L-37560, L-40520, L-41703, L-44376, L-44499, M-33904, N-03674, N-04212, N-09780, N-11871, N-17260, N-20548, N-37225
ENGINE OPERATING CYCLES A-01565, A-02636, A-04460, A-05171, A-19598, A-20927, A-23316, A-26134, A-27272, A-29661, A-31133, A-32875, A-33169, A-34442, A-35477, A-35481, A-35676, A-35919, A-36082, A-36083, A-37176, A-38625, A-39609, A-39754, A-44464, A-44821, A-45092, A-45136, B-01484, B-09231, B-25155, B-25301, B-26153, B-28730, B-29656, B-30950, B-31496, B-31604, B-31825, B-32938, B-33388, B-36081, B-37042, B-38614, B-40411, B-41112, B-41608, B-42702, B-44470, B-44660, B-44750, C-32829, C-42020, D-08568, D-08591, D-30860, D-32055, E-35264, F-08207, G-00177, G-19940, I-32921, K-30069, L-03536, L-09009, L-30152, L-32462, L-37717

ENGINE OPERATION MODIFICATION A-01565, A-01624, A-05171, A-16156, A-17304, A-19598, A-22941, A-23250, A-24281, A-24829, A-27249, A-27272, A-27858, A-28560, A-28873, A-29516, A-30067, A-30604, A-31133, A-32621, A-33378, A-34442, A-34774, A-35481, A-35484, A-35818, A-36084, A-38522, A-38543, A-40677, A-40776, A-41035, A-41654, A-41738, A-42377, A-43776, A-44252, A-45092, B-01851, B-03754, B-09231, B-14604, B-18053, B-19637, B-20735, B-20740, B-20844, B-21303, B-21762, B-22414, B-22890, B-23540, B-23697, B-23923, B-24182, B-24696, B-25096, B-25155, B-26269, B-27876, B-28108, B-28730, B-28860, B-28865, B-29058, B-30010, B-30154, B-30498, B-30944, B-31314, B-31690, B-32355, B-32938, B-33366, B-33388, B-33741, B-34035, B-34457, B-34611, B-35018, B-35166, B-35778, B-36081, B-36145, B-36523, B-36578, B-36721, B-37042, B-37116, B-37195, B-37222, B-37234, B-37275, B-37845, B-37938, B-38287, B-39492, B-40411, B-40785, B-41112, B-41608, B-42330, B-42886, B-43333, B-44341, B-44882, D-08568, D-29744, G-19940, G-39161, J-26765, K-24107, L-07952, L-37717, L-44376
ENGINEERS A-41518, D-30860, D-32055, L-09009, L-35151
ENZYMES A-35953, A-40759, D-27096, G-03286, G-06985, G-07892, G-08411, G-08999, G-21037, G-22637, G-23582, G-24784, G-25705, G-26483, G-26886, G-27416, G-27614, G-28010, G-28024, G-29493, G-29588, G-31228, G-31491, G-32487, G-32834, G-33234, G-33374, G-33607, G-34114, G-34791, G-34836, G-34847, G-36251, G-36932, G-37040, G-37540, G-37722, G-37941, G-38579, G-39621, G-40021, G-40057, G-40068, G-40312, G-40316, G-40355, G-41872, G-42091, G-42759, G-42881, G-42884, G-43196, G-43277, G-43725, G-44254, G-44255, G-44385, G-44395, H-08884, K-36346
EPIDEMIOLOGY A-17778, A-45145, C-42137, D-16345, D-27096, D-29655, G-00375, G-01512, G-01755, G-03086, G-07169, G-08411, G-16810, G-18549, G-21259, G-22222, G-23768, G-31228, G-32735, G-32834, G-34092, G-34709, G-34738, G-35587, G-38579, G-38616, G-38869, G-39179, G-40697, G-41097, G-41124, G-41737, G-44053, G-44254, G-44867, H-18520, K-22223, K-36823
EPITHELIUM G-05280, G-34791
EQUIPMENT CRITERIA A-24996, B-34457
EQUIPMENT STANDARDS K-34063, L-35151, L-38669
ESTERS C-09333, F-09578, F-13839, G-09493, K-20121
ETHERS A-08039, F-03525, F-06648, F-09578, G-00177
ETHNIC FACTORS G-18508, G-34095
ETHYL ALCOHOL B-35535, F-06648
ETHYLENE A-08039, A-26925, A-35957, B-22414, B-31246, B-32392, C-38670, F-06648, G-03892, G-39883, H-08884, H-26055, H-27111, J-21749, J-34370, K-03007, K-09259
EUROPE A-00962, A-01868, A-02636, A-03280, A-03982, A-06220, A-06351, A-08972, A-09393, A-14135, A-15599, A-15769, A-17778, A-18211, A-18297, A-18510, A-22370, A-22579, A-22976, A-23280, A-24031, A-24080, A-25125, A-26552, A-26645, A-27180, A-28210, A-28336, A-28394, A-28560, A-29096, A-29127, A-29516, A-29572, A-29782, A-29786, A-29872, A-30001, A-30027, A-30414, A-30604, A-30976, A-31085, A-31088, A-31315, A-31323, A-31395, A-32447, A-33169, A-33667, A-34068, A-34341, A-34350, A-34442, A-35052, A-35078, A-35398, A-35953, A-36032, A-36082, A-36527, A-36541, A-36623, A-37015, A-37166, A-37190, A-37648, A-38022, A-38330, A-38331, A-38522, A-38543, A-38759, A-38891, A-39035, A-39152, A-39367, A-40759, A-40947, A-40981, A-41604, A-41654, A-41738, A-41945, A-42212, A-42679, A-43346, A-44227, A-44464, A-44821, B-00015, B-00063, B-00899, B-03125, B-03337, B-09231, B-10558, B-13982, B-15208, B-19637, B-19725, B-19808, B-20740, B-21303, B-21719, B-22436, B-22492, B-25033, B-25096, B-25334, B-26243, B-26600, B-27503, B-28059, B-28060, B-28108, B-28699, B-29414, B-30010, B-30229, B-30633, B-31390, B-31690, B-32260, B-32424, B-32760, B-32822, B-33157, B-33628, B-33741, B-33932, B-34313, B-34611, B-35018, B-35035, B-35112, B-35303, B-35476, B-35478, B-35703, B-36081, B-36721, B-37195, B-37234, B-37275, B-37408, B-37750, B-37938, B-38287, B-38727, B-39404, B-42166, B-42330, B-43515, B-44283, B-44341, B-44660, B-44750, C-00056, C-00125, C-00855, C-01230, C-01249, C-01607, C-01608, C-03037, C-03770, C-05456, C-06881, C-06894, C-08130, C-08145, C-09953, C-09983, C-10556, C-10561, C-11626, C-13122, C-15563, C-15734, C-16367, C-17771, C-18302, C-19276, C-19857, C-20945, C-22927, C-25222, C-25440, C-25979, C-26274, C-26467, C-26505, C-29133, C-29297, C-29512, C-29595, C-30113, C-30290, C-30593, C-32169, C-32474, C-33178, C-33255, C-37971, C-38778, C-39168, C-39762, C-41016, C-41968, C-42084, C-42137, C-42312, C-42775, C-43737, C-44995, D-00005, D-00017, D-00261, D-00969, D-00974, D-00976, D-00985, D-01089, D-01355, D-02133, D-02750, D-03526, D-05260, D-06788, D-07649, D-08275, D-08279, D-08438, D-08502, D-08568, D-08810, D-08812, D-08821, D-09240, D-09726, D-10380, D-10554, D-10595, D-10634, D-14762, D-15573, D-15575, D-15789, D-15823, D-16345, D-16684, D-20642, D-23388, D-23971, D-24351, D-25055, D-25089, D-25635, D-26387, D-28097, D-28178, D-28369, D-29515, D-30858, D-31396, D-32945, D-34008, D-34933, D-35010, D-35940, D-37264, D-39405, D-41033, D-41520, D-41664, D-43693, D-44996, D-45218, E-00834, E-01821, E-03841, E-10215, E-24166, E-28799, E-29699, E-29910, E-29946, E-31852, E-31895, E-37953, E-38666, E-40157, E-40164, E-44999, F-00058, F-00841, F-03525, F-03799, F-05440, F-06648, F-09578, F-11570, F-11582, F-13635, F-13705, F-13879, F-13943, F-14743, F-15413, F-15493, F-15618, F-17161, F-17585, F-17882, F-17949, F-27348, F-28908, F-34297, F-34607, F-35378, F-35379, F-36524, F-39522, F-39901, F-43436, G-00148, G-00177, G-00375, G-00473, G-00873, G-01341, G-01500, G-01731, G-01756, G-01797, G-03086, G-03282, G-03283, G-03892, G-04196, G-04251, G-06814, G-06985, G-07162, G-07423, G-07740, G-07892, G-08381, G-08683, G-08949, G-09019, G-09253, G-09261, G-09484, G-09486, G-09493, G-09535, G-10793, G-10856, G-11462, G-11468, G-11552, G-11630, G-12070, G-12075, G-13159, G-13625, G-15731, G-16810, G-18503, G-18515, G-18518, G-19881, G-20704, G-21037, G-21266, G-21423, G-22222, G-22637, G-23582, G-23876, G-23887, G-24192, G-24573, G-24784, G-24961, G-25068, G-26356, G-26483, G-26720, G-26883, G-26886, G-26931, G-27085, G-28010, G-28024, G-28205, G-28256, G-29256, G-29286, G-29493, G-29588, G-30000, G-30009, G-30156, G-30328, G-30334, G-30468, G-31303, G-31319, G-31491, G-31537, G-31899, G-31962, G-32041, G-32129, G-32216, G-32218, G-32408, G-32484, G-32738, G-32747, G-32787, G-32834, G-33052, G-33527, G-33607, G-33778, G-33779, G-33903, G-33910, G-34066, G-34092, G-34175, G-34246, G-34709, G-34789, G-34832, G-34847, G-34902, G-34951, G-35118, G-35174, G-35377, G-35559, G-35792, G-36093, G-36251, G-36283, G-36740, G-36747, G-36932, G-36935, G-37023, G-37229, G-37297, G-37540, G-37630, G-37685, G-37731, G-37788, G-37933, G-37964, G-38579, G-38616, G-38869, G-39161, G-39406, G-39503, G-39621, G-39863, G-39883, G-40014, G-40021, G-40057, G-40068, G-40295, G-40485, G-40492, G-40634, G-40688, G-41368, G-41695, G-41717, G-41737, G-41857, G-42136, G-42698, G-42759, G-42881, G-42884, G-43196, G-43559, G-43615, G-44053, G-44176, G-44251, G-44254, G-44255, G-44294, G-44395, G-44508, G-44746, G-45005, G-45159, G-45196, H-01523, H-10318, H-11157, H-11452, H-11467, H-16270, H-16655, H-17681, H-17978, H-19604, H-19620, H-22926, H-23258, H-23435, H-23581, H-24667, H-24788, H-25878, H-27352, H-27386, H-28289, H-28448, H-28471, H-30033, H-30225, H-31010, H-31185, H-31801, H-32224, H-32291, H-32322, H-32335, H-32338, H-32423, H-32654, H-33922, H-33985, H-34831, H-35880, H-36265, H-36611, H-37912, H-37926, H-37977, H-38332, H-38743, H-39328, H-39407, H-39408, H-39409, H-40024, H-40368, H-41461, H-41733, H-42945, H-43511, H-43721, H-43782, I-02176, I-03735, I-06355, I-06357, I-22128, I-31377, I-33802, J-03288, J-03289, J-27968, J-30329, J-34370, K-02580, K-03007, K-06778, K-08803, K-09259, K-11746, K-14443, K-16104, K-16128, K-18294, K-22223, K-30069, K-33730, K-41682, K-42118, L-00311, L-02635, L-03536, L-07952, L-08196, L-08725, L-09009, L-16200, L-17472, L-17927, L-23562, L-24467, L-24757, L-25542, L-28066, L-28397, L-30908, L-31454, L-31957, L-32462, L-33740, L-33844, L-37193,

L-37392, L-37560, L-37717, L-40486, L-40520, L-41703, L-42016, L-42169, L-42873, L-44219, L-44376, M-35206, N-03674, N-04212, N-04649, N-06992, N-17260, N-18005, N-28088, N-37225
EVAPORATORS A-06220
EXCESS AIR A-05067, A-30067, A-38819, A-41738, B-28699, B-35018, B-35476, F-08207
EXCRETIONS C-01607, C-01608, C-16382, D-01315, D-27096, G-01500, G-01756, G-02191, G-02202, G-03283, G-04196, G-05002, G-05475, G-05483, G-05671, G-06028, G-06814, G-07162, G-07396, G-07551, G-13154, G-18046, G-18518, G-19159, G-26260, G-26483, G-27084, G-29815, G-29958, G-32041, G-32216, G-32613, G-32624, G-33903, G-34436, G-34841, G-35021, G-35174, G-35211, G-35377, G-35387, G-36152, G-36740, G-36932, G-37023, G-37229, G-37420, G-37540, G-37731, G-37788, G-37941, G-37964, G-39621, G-40492, G-41695, G-41872, G-42757, G-42759, G-43196, G-45273, H-33201, H-34830, H-35209, H-40024, K-16808
EXHAUST SYSTEMS A-20927, B-09798, B-19808, B-25033, B-25334, B-31690, B-35303, B-35478, B-43515, G-04196, G-06704, G-08566, K-34377, L-23234
EXPERIMENTAL EQUIPMENT A-03982, A-06220, B-01851, B-39272, B-39275, C-09888, C-10528, C-11626, C-32975, C-39168, C-43587, F-13534, G-41368
EXPERIMENTAL METHODS A-06220, A-30428, A-36082, A-40947, A-41604, B-39272, C-06881, C-09983, C-10528, C-23571, C-24119, C-24337, C-24617, C-25013, C-29810, C-31933, C-33178, C-34017, C-38914, C-38973, C-40724, C-41138, C-41490, C-41908, C-43737, C-44479, D-01355, D-07649, D-10612, D-10756, D-39914, E-06841, F-05849, F-07451, F-11570, F-14138, F-36067, G-03283, G-06985, G-08381, G-09019, G-18501, G-32613, G-32749, G-34066, G-34246, G-35560, G-40021, G-40057, G-41368, G-43531, H-18521, I-02176, I-06355, I-06357
EXPLOSIONS C-05243, D-00261, D-01355, D-25089, D-31332, D-34805, D-42742, D-43388, D-43558, E-03841
EXPOSURE CHAMBERS G-00148, G-00177, G-00473, G-01797, G-09493, G-24288, G-29588, G-30672, G-34841, G-38869, G-44254, H-09448
EXPOSURE METHODS A-32748, C-06881, C-16382, F-11570, G-01731, G-05025, G-05483, G-07162, G-08411, G-18046, G-18494, G-26356, G-28024, G-33779, G-33864, G-34841, G-34851, G-34914, G-34943, G-35225, G-36251, G-36747, G-36935, G-37119, G-38869, G-39193, G-39621, G-40057, G-42737, G-44254, G-45293, H-34901, H-35209, H-39408, H-42715, I-06355, I-06357
EYE IRRITATION A-35078, A-35957, B-22436, C-32058, D-00969, D-02750, D-03441, D-05573, G-00177, G-00375, G-05475, G-07423, G-24314, G-27291, G-30181, G-32735, G-37942, G-40435, G-41737, G-44176, G-44433, L-07952, L-25288, N-20548
EYES A-22579, A-35957, D-35025, G-00177, G-01757, G-13059, N-20548

## F

FADING C-06107, D-37026
FALLOUT A-35052, B-05300, C-05243, C-09333, D-00261, D-31325, D-35010, D-43558, G-07169, H-01523, H-12647, H-36197, H-41733, H-42857
FANS (BLOWERS) B-09798, B-31690, B-35478, G-06704
FARMS A-12624, A-35065, D-08279, D-40584, E-36714, H-19604, H-26276, H-28471, H-37912, H-43226
FEASIBILITY STUDIES A-35676, B-20735, B-28860, B-31825, B-36453, D-39914, J-34970, J-38624, L-44044
FEDERAL GOVERNMENTS A-01868, A-27943, A-31136, A-32447, A-34442, A-40455, A-40981, B-29628, B-32424, B-44283, D-32055, G-25705, G-31528, G-34059, G-35714, J-27968, J-37409, K-33107, K-43312, L-17927, L-22583, L-23234, L-24467, L-27664, L-28349, L-28397, L-28869, L-29421, L-30908, L-31454, L-32865, L-32884, L-33495, L-33740, L-35461, L-36877, L-37193, L-37423, L-38669, N-08273, N-14772
FEED LOTS A-37190, H-43226
FEES D-30860, D-32055, L-31454
FEMALES B-37845, D-27096, D-31396, G-00597, G-00662, G-03086, G-03283, G-07892, G-08326, G-08949, G-09261, G-09408, G-12070, G-26720, G-26931, G-27253, G-32787, G-33052, G-33234, G-34092, G-35225, G-35463, G-35792, G-36747, G-37964, G-40022, G-40435, G-42884, G-44053, G-44385
FERROALLOYS A-39462, A-43271
FERTILIZER MANUFACTURING A-24285, A-34018, A-34788, A-35078, A-39462, D-41033, H-32291
FERTILIZING A-34788, A-45072, H-01523, H-08884, H-36197, H-37977, H-41733
FIELD TESTS A-09355, A-14459, A-14461, A-14462, A-15205, A-16766, A-30428, A-35484, A-36080, A-36083, B-29898, B-35814, B-37042, C-41138, C-44479, D-00976, D-02750, D-32350, E-32158, G-29129, G-43337, H-32224, I-02176, I-06355, I-06357, K-18294
FILTER FABRICS A-09686, A-29661, A-39462, B-00107, B-03754, B-08562, B-09798, B-26532, B-29664, B-32248, B-32319, B-32760, B-34025, B-34313, C-01249, C-08145, C-10556, C-19313, C-26145, C-27556, C-28621, C-31304, C-31933, C-32474, C-32718, C-32892, C-36840, C-36841, C-37514, C-41612, C-42043, C-42360, D-00005, D-03410, D-09432, D-16576, F-05440, G-00177, H-35880, L-33844
FILTERS A-06220, A-09686, A-10749, A-14945, A-15599, A-20652, A-24285, A-29661, A-35168, A-39462, A-40583, A-42726, A-43271, B-00107, B-03125, B-03754, B-08562, B-09798, B-10558, B-15208, B-21324, B-22492, B-22520, B-25033, B-25334, B-25470, B-25781, B-26532, B-26600, B-29664, B-30124, B-32248, B-32319, B-32760, B-33403, B-33628, B-34025, B-34313, B-35035, B-35476, B-35478, B-35540, B-38614, B-41544, B-42131, C-00855, C-01249, C-03034, C-03770, C-05243, C-05977, C-06072, C-06112, C-08130, C-08145, C-10556, C-11042, C-19313, C-19501, C-25793, C-26145, C-26955, C-27556, C-27829, C-28621, C-29595, C-31258, C-31304, C-31933, C-32058, C-32474, C-32718, C-32892, C-33255, C-34106, C-34407, C-36588, C-36840, C-36841, C-37514, C-37693, C-41612, C-41908, C-42043, C-42139, C-42360, C-42437, C-43448, C-43587, D-00005, D-01355, D-03410, D-05260, D-09432, D-10612, D-10756, D-11028, D-16576, D-28097, D-31332, D-32350, D-34933, D-36562, D-42247, F-05440, G-00177, G-03086, G-31040, H-24947, H-35880, I-00305, K-33107, L-23562, L-32884, L-33844, L-37392, N-09780
FINLAND G-41717
FIRING METHODS A-05067, A-10749, A-26763, A-27249, A-30067, A-30604, A-33378, A-34774, A-38819, A-41738, A-44464, A-45092, B-14604, B-28699, B-31819, B-31825, B-32938, B-35018, B-35476, B-36081, B-37042, B-37195, B-40411, B-42300, B-43333, F-08207, G-35568, L-09009, N-28088
FLAME AFTERBURNERS A-22825, A-28560, A-31324, A-40677, B-20844, B-24722, B-24813, B-25894, B-30229, B-33366, B-33388, B-33403, B-34025, B-34035, B-35018, B-36523, B-36721, B-37116, B-37275, B-37938, B-38287, B-39333, B-40411, B-40785, B-41608, B-44341, I-32921, L-07952, L-09009, L-28869, N-09780
FLAME IONIZATION DETECTOR A-05067, A-09355, A-23789, A-29516, A-40947, B-31690, C-01230, C-06112, C-19276, C-23596, C-29595, C-32829, C-41719, D-44330, F-07451
FLAX G-00708, G-00808, G-00810, G-00821, G-00993, G-01756, G-01812, G-03286
FLORIDA L-26442
FLOUR PROCESSING G-34092
FLOW RATES A-06220, A-12751, B-22520, B-31604, B-32392, B-34740, B-35223, B-35352, B-36145, B-36578, B-43515, C-01249, C-08145, C-21862, C-25793, C-27829, C-35494, C-37689, C-37693, C-38165, C-39069, C-44165, D-01089, D-01355, D-19433, E-44813, F-03525, F-08207, F-19823, G-04877
FLOWERS H-08884, H-41891, J-21749
FLOWMETERS G-30198
FLUID FLOW A-06220, A-12751, B-22520, B-31604, B-32392, B-34740, B-35223, B-35352, B-36145, B-36578, B-37042, B-43515, C-01249, C-08145, C-21862, C-25793, C-27829, C-35494, C-37689, C-37693, C-38165, C-39069, C-44165, D-01089, D-01355, D-19433, E-44813, F-03525, F-08207, F-19823, G-04877
FLUORANTHENES A-05067, C-26707, C-27294, C-32058, D-25107, F-00058, G-40688
FLUORENES F-00058
FLUORESCENCE C-17048, C-19501, C-23571, C-25015, C-29595, C-32058, C-32718, C-32829, C-33055, C-34106, C-34407, C-37175, C-38778, C-40407, C-40724, C-41016, C-42437, C-43448, C-43763, C-44479, D-29152, D-42122, D-44059, F-09745, F-42772, G-00375
FLUORIDES A-23561, A-27595, A-29786, A-34018, A-35078, A-45145, C-09333, C-23096, C-23657, C-26274, C-26707, C-27294, C-32476, C-38670, C-39762, C-41719, C-41763, D-03410, D-05167,

D-16345, D-32350, F-06648, F-34948, G-00375, G-24603, G-32608, G-43277, H-08884, H-11157, H-11452, H-19604, H-26055, H-26092, H-32291, H-32736, H-38332, H-42857, H-42924, I-00305, J-30696, K-06734, K-08420, K-34063, K-34377, K-36823, L-32789, L-33495, L-35795, L-38669, N-04212, N-17260
FLUORINATED HYDROCARBONS F-06648, G-34851
FLUORINE A-06351, A-31315, A-37190, A-37721, C-09476, C-09983, C-11626, C-38670, C-41763, C-42928, D-31396, G-07162, G-13159, G-38616, G-39833, H-35880, H-39328, K-06734, K-33107, K-34063, K-42039, K-44377, L-25542, L-30620, L-32884, L-35795, L-38669, L-42873, N-14772
FLUORINE COMPOUNDS A-23561, A-27595, A-29786, A-34018, A-35078, A-37721, A-42676, A-45145, C-06112, C-09333, C-09476, C-23096, C-23657, C-26274, C-26707, C-27294, C-32476, C-32534, C-38670, C-39136, C-39516, C-39762, C-41719, C-41763, D-03410, D-05167, D-16345, D-28097, D-32350, D-33576, E-29910, F-06648, F-34948, G-00375, G-24603, G-32608, G-38616, G-38721, G-43277, H-08884, H-11157, H-11452, H-19604, H-26055, H-26092, H-32291, H-32736, H-35880, H-38332, H-40368, H-42857, H-42924, H-43226, I-00305, J-30696, K-02580, K-06734, K-08420, K-34063, K-34377, K-36823, K-38197, K-41682, K-44377, L-17472, L-23562, L-32789, L-33495, L-35795, L-38669, N-04212, N-17260
FLUOROSIS H-08884, H-26092, H-32291, H-42857, H-43226
FLY ASH A-05067, A-09686, A-26441, A-30428, A-31632, A-34774, A-39462, B-00107, B-07606, B-09798, B-10558, B-25470, B-34025, B-35476, B-37222, C-25535, C-26274, D-05260, D-24351, D-32055, F-34297, G-00642, G-03086, G-07162, G-12038, H-11157, H-11467, H-37977, H-38332, L-00311, N-09780
FOG A-41145, B-44283, D-10634, E-00834, E-24109, E-24570, E-29445, E-32155, I-02176, N-04212
FOOD AND FEED OPERATIONS A-03279, A-09686, A-34018, A-39367, A-39462, B-32036, B-44853, G-34092, J-30696, N-04052
FOODS A-03279, A-18510, A-25417, A-26552, A-30674, A-31313, A-32035, A-32748, A-37190, A-40314, B-32036, B-32424, C-00125, C-26955, C-44210, D-27096, D-36195, G-00642, G-03283, G-03287, G-05002, G-05541, G-08566, G-10434, G-13159, G-15703, G-19881, G-27084, G-28834, G-31528, G-33779, G-33910, G-34943, G-34947, G-35568, G-35714, G-35792, G-35811, G-36765, G-37420, G-37788, G-38579, G-38580, G-39095, G-39989, G-40355, G-41895, G-42757, G-44381, H-14786, H-18481, H-24947, H-27386, H-31185, H-32291, H-32736, H-33201, H-33364, H-33922, H-36196, H-36991, H-37977, H-39407, H-39408, H-40024, H-40368, H-41893, H-42924, L-07952
FORESTS A-37190, D-00974, H-39409
FORMALDEHYDES A-05067, A-15599, A-23561, A-35957, C-09333, C-09982, C-26707, C-27294, C-32476, C-38670, D-10634, D-30860, D-34008, F-39901, G-00177, K-02580, K-08803
FORMIC ACID A-37190, F-06648
FRACTIONATION A-15295, A-35065, F-44164
FRANCE B-00899, B-03337, B-22436, B-26243, B-28108, B-35112, B-35303, B-37275, B-42166, B-44283, C-19276, C-26467, D-06788, D-07649, D-08568, D-08821, D-10554, D-16684, D-43693, D-45218, E-29946, F-17585, G-11462, G-13159, G-18515, G-28205, G-29286, G-32216, G-37731, G-39863, G-40485, G-40688, G-44254, J-03288, K-42118, L-03536, L-32462, L-40486, L-44376, N-17260
FREE RADICALS B-05300
FREEZING C-06643
FRUITS F-13461, G-31528, H-07742, H-14489, H-20062, H-25878, H-27489, H-30225, H-33201, H-35410, H-35880, H-40368, H-44071, J-21749
FUEL ADDITIVES A-02636, A-04460, A-09355, A-14459, A-14461, A-17339, A-20545, A-21109, A-22976, A-23058, A-23280, A-23789, A-24156, A-24281, A-24718, A-24829, A-25295, A-25581, A-26100, A-26134, A-26191, A-26552, A-26763, A-26891, A-27249, A-27272, A-27458, A-27595, A-28336, A-28394, A-28560, A-28873, A-29127, A-29364, A-29516, A-29782, A-29786, A-29872, A-30027, A-30067, A-30604, A-30674, A-31085, A-31088, A-31133, A-31136, A-31324, A-31520, A-31525, A-31596, A-31934, A-32523, A-32875, A-33350, A-33365, A-33378, A-33626, A-33667, A-34031, A-34040, A-34177, A-34341, A-35123, A-35199, A-35353, A-35477, A-35481, A-35818, A-35919, A-36080, A-36082, A-36083, A-36084, A-36527, A-36541, A-36664, A-37176, A-37312, A-37372, A-37648, A-38330, A-38331, A-38522, A-38759, A-39035, A-39610, A-39754, A-40455, A-40677, A-40759, A-40776, A-41518, A-41738, A-41959, A-42791, A-43346, A-44821, A-45136, B-01484, B-05300, B-14604, B-19637, B-19710, B-20735, B-20740, B-20844, B-21303, B-21719, B-22414, B-23923, B-24184, B-24186, B-24696, B-24813, B-25096, B-25155, B-25301, B-25894, B-26269, B-27371, B-27503, B-28059, B-28060, B-29126, B-29414, B-29531, B-29656, B-29898, B-30010, B-30154, B-30498, B-30944, B-30950, B-31221, B-31314, B-31341, B-31364, B-31441, B-31496, B-31519, B-31604, B-32036, B-32355, B-32424, B-32822, B-33366, B-33386, B-33388, B-33403, B-33542, B-33550, B-33628, B-33657, B-33741, B-33932, B-33994, B-34025, B-34457, B-34536, B-34611, B-34846, B-35018, B-35080, B-35112, B-35476, B-35535, B-35688, B-35816, B-36144, B-36145, B-36453, B-36578, B-36721, B-37150, B-37173, B-37195, B-37234, B-37408, B-37468, B-37619, B-37845, B-39492, B-40723, B-40785, B-41112, B-41608, B-41793, B-42166, B-42300, B-42702, B-42817, B-42819, B-42829, B-42886, B-43333, B-43575, B-44614, B-44882, C-27681, C-28755, C-29419, C-29810, C-43587, D-04646, D-05277, D-08275, D-23658, D-27096, D-27174, D-28369, D-29647, D-32350, D-35861, D-36820, E-30676, E-31895, E-35264, F-05440, F-09745, F-14995, F-28908, F-40387, F-41787, F-44032, G-10856, G-14492, G-22222, G-24877, G-25328, G-29286, G-29789, G-29825, G-30156, G-30671, G-30672, G-30831, G-31228, G-31491, G-31517, G-31537, G-31899, G-32613, G-33607, G-33779, G-34059, G-34436, G-34649, G-36354, G-37420, G-37788, G-37933, G-38579, G-38867, G-40485, G-42091, G-44867, H-30921, H-33364, H-36197, H-36611, I-32921, I-36051, J-22358, J-26765, J-30329, J-31518, J-32241, J-34828, J-35391, J-36592, J-37409, J-37734, J-38624, K-30035, K-33730, K-36346, L-03536, L-11204, L-22583, L-28397, L-28869, L-30908, L-31454, L-33740, L-36030, L-37423, L-37521, L-37560, L-38757, L-40486, L-41289, L-41703, L-42016, L-42041, M-29432, N-06992, N-37225
FUEL CELLS A-30976, B-34457, L-07952
FUEL CHARGING A-33378, A-44464, B-35018, B-36081, B-40411
FUEL CRITERIA A-30001, A-36527, A-40455, B-32424, B-33932, B-39404, J-38624, K-33730, L-37717
FUEL EVAPORATION A-01565, A-01624, A-02636, A-08972, A-16156, A-17304, A-17339, A-17365, A-22941, A-22976, A-23789, A-26100, A-26191, A-26763, A-32621, A-32875, A-34018, A-34350, A-36083, A-39610, A-40776, A-42212, A-42377, B-01484, B-17906, B-18053, B-19637, B-20735, B-20844, B-21762, B-22436, B-23697, B-27503, B-28699, B-30944, B-31364, B-31819, B-32355, B-33550, B-36145, B-36721, B-39492, B-40411, B-41112, B-44003, B-44470, G-21423, K-11746, K-30069, L-00311, L-08196, L-24757, L-32462, N-20548
FUEL GASES A-05171, A-22941, A-24080, A-27249, A-31133, A-33087, A-34774, A-35052, A-35484, A-37166, A-38543, A-39367, A-42377, A-43346, A-44464, B-00107, B-03337, B-19637, B-19725, B-28699, B-28730, B-30154, B-31496, B-33932, B-36721, B-42330, B-44750, D-05260, D-32055, G-19940, H-08884, J-31720, J-39941, K-34063, L-11204, L-16200, L-32884, L-33844, L-35151, L-35795, L-44499
FUEL OIL PREPARATION A-24080, A-29127, A-31934, A-35199, A-37166, A-38331, A-39067, B-24186, B-30154, B-31341, B-34846, J-34970, K-30035, L-42873, N-09780
FUEL OILS A-08972, A-18211, A-27180, A-29127, A-29786, A-30428, A-31136, A-31315, A-34774, A-35052, A-35481, A-36083, A-36623, A-37166, A-38022, A-38891, A-39067, A-43346, B-00107, B-09798, B-20735, B-20844, B-21719, B-28060, B-28108, B-30498, B-31364, B-33932, B-34611, B-39333, B-44660, C-09333, C-32718, C-33178, C-43763, D-05260, D-08591, D-21015, D-24351, D-27188, D-27672, D-28629, D-31325, D-32055, D-35025, D-37191, D-40997, E-00834, E-24109, G-31528, G-34092, G-45159, H-21794, H-36196, H-40368, J-31518, J-31720, K-34063, L-23608, L-29421, L-30152, L-32884, L-35151, L-44325, L-44499, M-01073, N-04212, N-20548

FUEL STANDARDS A-23280, A-31934, A-32447, A-32523, A-33350, A-33667, A-34177, A-34341, A-36527, A-36541, A-36664, A-38331, B-19710, B-25096, B-32424, B-33628, B-33932, B-37195, B-37234, B-42330, D-36820, J-27968, K-33107, K-33730, K-38758, L-22583, L-24757, L-32884, L-35795, L-36030, L-37392, L-37423, L-37717, L-38757, L-40520, L-42016, L-42169, L-42873, L-44325, L-44376, M-01073, N-09780, N-37225
FUEL TANK EVAPORATION A-01565, A-02636, A-08972, A-17304, A-17365, A-22941, A-22976, A-26191, A-42377, B-17906, B-18053, B-19637, B-20844, B-21762, G-21423, L-00311, N-20548
FUELS A-02636, A-03278, A-04460, A-05067, A-05171, A-06351, A-08039, A-08972, A-09355, A-09686, A-14461, A-14462, A-17339, A-18211, A-20545, A-22825, A-22941, A-22976, A-23239, A-23280, A-23316, A-23789, A-24080, A-24281, A-24718, A-24829, A-25295, A-26100, A-26134, A-26191, A-26441, A-26454, A-26891, A-27180, A-27249, A-27272, A-27458, A-27595, A-27858, A-28336, A-28394, A-28560, A-29127, A-29364, A-29782, A-29786, A-29872, A-29936, A-30001, A-30027, A-30067, A-30428, A-30674, A-31085, A-31088, A-31133, A-31136, A-31315, A-31324, A-31520, A-31525, A-31596, A-31649, A-31934, A-32447, A-32523, A-32875, A-33087, A-33350, A-33365, A-33378, A-33626, A-33667, A-34018, A-34031, A-34040, A-34177, A-34341, A-34350, A-34442, A-34774, A-35050, A-35052, A-35123, A-35199, A-35353, A-35477, A-35481, A-35484, A-35788, A-35818, A-35919, A-35953, A-36006, A-36080, A-36082, A-36083, A-36084, A-36527, A-36535, A-36541, A-36623, A-36664, A-37015, A-37166, A-37312, A-37372, A-38022, A-38330, A-38331, A-38522, A-38543, A-38625, A-38759, A-38819, A-38891, A-39035, A-39067, A-39152, A-39367, A-39462, A-39603, A-39609, A-39610, A-39754, A-40455, A-40677, A-40776, A-40947, A-41518, A-41604, A-41654, A-41738, A-41959, A-42080, A-42377, A-42679, A-42791, A-42980, A-43271, A-43346, A-43966, A-44252, A-44464, A-44682, A-44821, A-45136, B-00107, B-00899, B-01484, B-01851, B-03232, B-03337, B-05214, B-05300, B-09798, B-18053, B-19637, B-19710, B-19725, B-20735, B-20844, B-21719, B-21762, B-22414, B-22436, B-22834, B-22890, B-23697, B-23923, B-24182, B-24184, B-24186, B-24696, B-24813, B-25096, B-25155, B-25301, B-25894, B-27503, B-27850, B-28059, B-28060, B-28108, B-28699, B-28730, B-28860, B-28865, B-29126, B-29414, B-29531, B-29605, B-29625, B-29628, B-29898, B-30010, B-30154, B-30498, B-30633, B-31221, B-31314, B-31341, B-31364, B-31441, B-31496, B-31519, B-31819, B-31825, B-32036, B-32248, B-32260, B-32355, B-32424, B-32822, B-33366, B-33386, B-33388, B-33403, B-33542, B-33550, B-33628, B-33657, B-33741, B-33932, B-34025, B-34035, B-34457, B-34536, B-34611, B-34846, B-35018, B-35080, B-35112, B-35223, B-35476, B-35535, B-35688, B-35778, B-35816, B-35821, B-36081, B-36144, B-36145, B-36453, B-36523, B-36721, B-37042, B-37[illegible] B-37173, B-37195, B-37234, B-37[illegible]7408, B-37468, B-37619, B-37845, B-3793[illegible] B-38287, [illegible]39333, B-39404, B-39492, B-40785, B-41112, B-41608, B-41793, B-42166, B-42290, B-42300, B-42330, B-42702, B-42817, B-42819, B-42829, B-42886, B-43333, B-43575, B-44470, B-44473, B-44614, B-44660, B-44750, B-44882, B-44906, C-01230, C-06112, C-08130, C-09333, C-17771, C-18302, C-21948, C-23096, C-23571, C-23596, C-24119, C-24719, C-25013, C-26336, C-26467, C-27681, C-29133, C-29419, C-29810, C-30635, C-30786, C-32718, C-33178, C-40407, C-42160, C-43763, C-44129, C-44165, C-45235, D-00005, D-03410, D-04646, D-05260, D-05551, D-06788, D-08275, D-08438, D-08591, D-12099, D-21015, D-23658, D-24351, D-27174, D-27188, D-27621, D-27672, D-28369, D-28629, D-29647, D-30182, D-31325, D-31396, D-32055, D-32350, D-35025, D-35861, D-35940, D-36820, D-37026, D-37191, D-40716, D-40997, D-42122, D-43962, E-00834, E-24109, E-30676, F-03799, F-05440, F-08207, F-09745, F-14995, F-40387, F-41787, F-44032, F-45295, G-00076, G-00177, G-01341, G-05002, G-10856, G-12038, G-14492, G-16820, G-19304, G-19940, G-24603, G-24877, G-25328, G-27490, G-28171, G-29286, G-29493, G-29825, G-30156, G-30328, G-30671, G-30672, G-30831, G-31228, G-31491, G-31517, G-31528, G-31537, G-33779, G-34059, G-34092, G-34406, G-34436, G-34649, G-35118, G-35811, G-36354, G-37119, G-37180, G-37420, G-38579, G-38867, G-39161, G-39193, G-40295, G-40485, G-41097, G-41847, G-42091, G-42881, G-44508, G-44696, G-45159, G-45288, H-08884, H-17218, H-19620, H-21794, H-23581, H-36196, H-36197, H-36611, H-40368, I-32921, I-36051, J-03288, J-03289, J-22358, J-27968, J-30329, J-30696, J-31518, J-31720, J-32241, J-34370, J-34828, J-34970, J-35391, J-36592, J-37409, J-37734, J-38624, J-39941, J-42721, K-03956, K-09259, K-11746, K-18294, K-24107, K-30035, K-33107, K-33730, K-34063, K-34377, K-38197, K-38758, K-41682, K-44310, L-00311, L-08196, L-09009, L-11204, L-16200, L-23562, L-23608, L-24757, L-28066, L-28099, L-28397, L-29421, L-30152, L-30908, L-31454, L-32789, L-32884, L-33740, L-33844, L-34033, L-35151, L-35795, L-36030, L-36877, L-37193, L-37392, L-37423, L-37521, L-37717, L-38757, L-40486, L-40520, L-41289, L-41703, L-42041, L-42169, L-44219, L-44325, L-44376, L-44499, M-01073, M-33904, N-04052, N-04212, N-04649, N-06992, N-09780, N-18005, N-20548, N-28088, N-37225
FUMES A-06220, A-13524, A-31525, A-35168, A-35957, A-40583, A-43271, B-00107, B-03125, B-03754, B-09798, B-17906, B-24553, B-25334, B-25781, B-26532, B-26600, B-28172, B-31317, B-32633, C-05977, C-08130, C-09333, C-14758, C-25793, C-26145, C-26698, C-27556, C-28017, C-32975, C-36840, D-07198, D-32055, F-10599, G-00705, G-00810, G-00902, G-03282, G-04196, G-04877, G-06704, G-09408, G-24081, G-31452, G-34092, G-34951, G-38721, G-45293, H-11467, H-36197, H-37912, H-42857, J-39956, K-06778, K-20121, L-00311, L-08196, L-17927, L-23234
FUMIGATION E-05713, H-08884
FUNGI G-00375, N-43824
FURNACES A-05067, A-06220, A-09686, A-10749, A-13524, A-20652, A-26441, A-33087, A-34018, A-35224, A-39462, A-40583, A-42726, A-43346, B-00107, B-03232, B-03754, B-06493, B-07606, B-08562, B-09798, B-15208, B-22492, B-22520, B-24553, B-25334, B-25470, B-25781, B-30633, B-32248, B-32319, B-32760, B-34071, B-35303, B-35342, B-39272, B-43515, B-43937, B-44742, C-41968, D-21015, D-32055, D-37320, D-40574, G-00375, K-14443, K-34063, K-34377, K-36823, L-00311, L-17927, L-23562, L-30620, L-32789

## G

GAMMA RADIATION B-05214, C-40631, C-43763, C-44210, D-24316, D-25758, D-31332, D-34805, D-42742, D-43558, E-24549, F-13451, G-07169
GAS CHROMATOGRAPHY A-05067, A-09355, A-23789, A-29516, A-29936, A-40947, A-43966, B-27371, B-30717, B-31690, C-01230, C-06112, C-09333, C-09953, C-16123, C-19276, C-23596, C-26505, C-28126, C-29595, C-30635, C-32058, C-32534, C-32829, C-38670, C-39069, C-41719, D-08438, D-25055, D-29744, D-36909, D-40716, D-41664, D-44330, F-07451, G-00177
GAS SAMPLING A-09355, A-13524, A-28873, A-37176, B-27371, B-31604, C-06072, C-06112, C-09333, C-12993, C-16123, C-24644, C-26275, C-27358, C-32476, C-32718, D-00985, D-01673, D-08438, D-08568, D-09240, D-32912, D-36562, D-42742, E-44999, G-00902, K-08420, N-03674
GAS TURBINES A-20927, A-24996, A-26763, A-27249, A-28560, A-30604, A-32621, A-33087, A-39603, A-45092, B-09231, B-23923, B-28699, B-30944, B-32355, B-33366, B-34457, B-39492, B-42166, B-44882, I-31377, N-08273
GASES A-24080, A-28873, A-31133, A-35052, A-35484, A-40583, A-42377, A-44464, B-03337, B-28172, B-28699, B-28730, B-30154, B-31496, B-33932, B-35816, B-36721, B-37173, C-17048, C-29595, D-00005, D-22829, D-35861, E-29688, G-07162, G-24314, G-29588, I-22128, L-35151
GASOLINES A-02636, A-03278, A-04460, A-05171, A-08972, A-09355, A-14461, A-14462, A-17339, A-18211, A-22825, A-22941, A-22976, A-23280, A-23316, A-23789, A-24080, A-24281, A-24718, A-24829, A-25295, A-26100, A-26134, A-26191, A-26454, A-26891, A-27180, A-27272, A-27458, A-27858, A-28336, A-28394, A-28560, A-29127, A-29782, A-29872, A-29936, A-30001, A-30027, A-30067, A-30428, A-30674, A-31085, A-31088, A-31133, A-31136, A-31324,

A-31520, A-31525, A-31596, A-31649, A-31934, A-32447, A-32523, A-32875, A-33350, A-33365, A-33378, A-33626, A-33667, A-34018, A-34031, A-34040, A-34177, A-34341, A-34350, A-34442, A-35050, A-35123, A-35199, A-35353, A-35477, A-35481, A-35484, A-35818, A-35919, A-35953, A-36006, A-36080, A-36082, A-36083, A-36084, A-36527, A-36535, A-36541, A-36623, A-36664, A-37015, A-37312, A-37372, A-38022, A-38330, A-38331, A-38522, A-38543, A-38759, A-38891, A-39035, A-39067, A-39152, A-39609, A-39610, A-39754, A-40455, A-40677, A-40776, A-40947, A-41518, A-41604, A-41654, A-41738, A-41959, A-42080, A-42377, A-42679, A-42791, A-42980, A-43346, A-43966, A-44252, A-44464, A-44682, A-44821, A-45136, B-00899, B-01484, B-01851, B-05214, B-05300, B-18053, B-19637, B-19710, B-20735, B-20844, B-21719, B-21762, B-22414, B-22436, B-22834, B-23697, B-23923, B-24182, B-24184, B-24186, B-24696, B-24813, B-25096, B-25155, B-25301, B-25894, B-27503, B-27850, B-28059, B-28108, B-28865, B-29126, B-29414, B-29531, B-29625, B-29628, B-30010, B-30154, B-31221, B-31314, B-31341, B-31364, B-31441, B-31496, B-31519, B-31819, B-31825, B-32036, B-32355, B-32424, B-32822, B-33386, B-33388, B-33403, B-33542, B-33550, B-33628, B-33657, B-33741, B-33932, B-34035, B-34457, B-34536, B-34846, B-35018, B-35080, B-35112, B-35223, B-35535, B-35688, B-35778, B-35816, B-35821, B-36081, B-36144, B-36145, B-36453, B-36523, B-36721, B-37042, B-37150, B-37173, B-37195, B-37234, B-37275, B-37408, B-37468, B-37619, B-37845, B-37938, B-38287, B-39333, B-39404, B-39492, B-40785, B-41112, B-41608, B-41793, B-42166, B-42290, B-42300, B-42330, B-42702, B-42817, B-42819, B-42829, B-42886, B-43333, B-43575, B-44470, B-44473, B-44614, B-44882, B-44906, C-01230, C-17771, C-18302, C-21948, C-23571, C-23596, C-24119, C-24719, C-25013, C-26336, C-26467, C-27681, C-29133, C-29419, C-29810, C-30635, C-30786, C-40407, C-42160, C-44129, C-44165, C-45235, D-04646, D-05260, D-05551, D-08275, D-08438, D-08591, D-12099, D-23658, D-27174, D-28369, D-29647, D-32350, D-35861, D-36820, D-40716, E-00834, E-24109, E-30676, F-05440, F-08207, F-09745, F-40387, F-41787, F-44032, G-00076, G-00177, G-01341, G-05002, G-10856, G-14492, G-19304, G-19940, G-24877, G-25328, G-27490, G-28171, G-29286, G-29493, G-29825, G-30156, G-30328, G-30671, G-30672, G-30831, G-31228, G-31491, G-31517, G-31537, G-33779, G-34059, G-34092, G-34406, G-34436, G-34649, G-35118, G-35811, G-36354, G-37119, G-37180, G-37420, G-38579, G-38867, G-39161, G-39193, G-40295, G-40485, G-41097, G-42091, G-42881, G-44508, G-45159, G-45288, H-17218, H-21794, H-36197, H-36611, I-32921, I-36051, J-03288, J-03289, J-22358, J-27968, J-30329, J-31518, J-31720, J-32241, J-34370, J-34828, J-34970, J-35391, J-36592, J-37409, J-37734, J-38624, J-39941, J-42721, K-03956, K-11746, K-18294, K-24107, K-30035, K-33730, K-38758, K-41682, L-08196, L-09009, L-11204, L-24757, L-28066, L-28099, L-28397, L-30152, L-30908, L-31454, L-33740, L-34033, L-35151, L-36030, L-36877, L-37193, L-37392, L-37423, L-37521, L-37717, L-38757, L-40486, L-40520, L-41289, L-41703, L-42041, L-42169, L-44219, L-44325, L-44376, M-01073, M-33904, N-04052, N-06992, N-37225

GENETICS G-26477, G-34914, G-44364, H-26055

GEORGIA D-19144

GERMANY A-09393, A-17778, A-25125, A-26552, A-28336, A-28394, A-28560, A-29096, A-29516, A-29782, A-29786, A-30001, A-30604, A-30976, A-31395, A-32447, A-33667, A-34341, A-34350, A-35078, A-35953, A-36082, A-36527, A-36541, A-37015, A-37190, A-37648, A-38330, A-38331, A-38522, A-38759, A-39152, A-40759, A-40981, A-41738, A-44227, A-44821, B-10558, B-20740, B-25033, B-28059, B-28060, B-29414, B-30010, B-32760, B-33628, B-33741, B-34611, B-35018, B-35703, B-37234, B-37408, B-37750, B-37938, B-38287, B-38727, C-05456, C-10556, C-10561, C-13122, C-15563, C-15734, C-16367, C-22927, C-26274, C-29133, C-29512, C-33178, C-39168, C-39762, C-42312, D-08502, D-09726, D-10554, D-14762, D-15573, D-15575, D-15789, D-15823, D-25089, D-28369, D-29515, D-30858, D-31396, D-32945, D-34008, E-37953, F-05440, F-11570, F-13879, F-15413, F-15618, F-34297, G-09019, G-09261, G-10856, G-12070, G-21266, G-21423, G-22222, G-23876, G-23887, G-24573, G-25068, G-26931, G-30000, G-30156, G-31303, G-31319, G-31491, G-31962, G-32218, G-32484, G-33052, G-33778, G-33779, G-34175, G-36740, G-37229, G-37685, G-37933, G-37964, G-38869, G-39161, G-39503, G-40295, G-40492, G-41368, G-41737, G-42698, G-44176, G-44251, G-44294, G-44508, G-44746, G-45159, G-45196, H-11452, H-11467, H-23581, H-24788, H-30225, H-31010, H-32224, H-32335, H-36611, H-38332, H-38743, H-39328, H-40024, H-43511, I-31377, I-33802, J-27968, K-08803, K-09259, K-14443, K-22223, K-30069, L-00311, L-02635, L-07952, L-17472, L-24467, L-24757, L-25542, L-28066, L-28397, L-30908, L-31454, L-31957, L-32462, L-33740, L-33844, L-37193, L-37392, L-37560, L-41703, L-42016, L-42169, L-42873, L-44219, L-44376, N-37225

GLADIOLI H-08884

GLANDS G-03897, G-09486, G-12075, G-12984, G-16810, G-34837, G-35055, G-36747, G-37028, G-40312, G-41695, H-11452, H-28105, H-35209

GLASS FABRICS A-09686, A-29661, B-00107, B-03754, B-09798, B-29664, B-32319, C-01249, C-08145, C-10556, C-19313, C-26145, C-27556, C-28621, C-31304, C-31933, C-32718, C-32892, C-36840, C-36841, C-37514, C-41612, C-42043, C-42360, D-00005, D-03410, D-09432, D-16576, F-05440, H-35880

GLUE MANUFACTURING A-34018

GOATS H-32291, H-39407, H-43226

GOVERNMENTS A-01868, A-27943, A-31136, A-32447, A-34442, A-39367, A-40455, A-40981, B-00107, B-18053, B-29628, B-32424, B-44283, D-00005, D-03410, D-03441, D-28097, D-30860, D-32055, G-25705, G-31528, G-34059, G-35714, J-27968, J-37409, K-03007, K-06778, K-08420, K-19750, K-33107, K-36346, K-42039, K-43312, K-44310, L-08725, L-17927, L-22583, L-23234, L-24467, L-25288, L-27664, L-28349, L-28397, L-28869, L-29421, L-29888, L-30908, L-31454, L-32865, L-32884, L-33495, L-33740, L-35461, L-36877, L-37193, L-37423, L-37521, L-38669, L-41557, L-42169, L-44044, L-44499, M-29432, N-08273, N-14772

GRAIN PROCESSING A-39462, B-44853, J-30696

GRANTS L-35461

GRAPES H-30225

GRAPHITE C-08130, C-10528, C-29464

GRASSES A-30428, A-32748, A-34018, C-21948, C-30113, C-45235, G-00375, G-17214, H-09448, H-11467, H-14786, H-17215, H-17217, H-17218, H-20237, H-30931, H-31010, H-31185, H-32736, H-33362, H-33985, H-36197, H-36611, H-37912, H-41891, H-41892, H-43721

GRAVITY SETTLING A-09686, E-35207

GREAT BRITAIN A-02636, A-09393, A-14135, A-15769, A-18211, A-18510, A-22976, A-24080, A-29127, A-29872, A-31085, A-31323, A-35398, A-36082, A-36623, A-41945, A-42679, A-43346, A-44821, B-21303, B-25334, B-26600, B-27503, B-28699, B-30633, B-31690, B-35476, B-36081, B-36721, B-42330, B-44283, C-29297, C-30113, C-42775, C-43737, D-00985, D-03526, D-08279, D-10554, E-03841, E-38666, F-09578, F-13705, F-14743, F-35378, F-35379, F-39901, G-00375, G-03086, G-07162, G-07423, G-18503, G-18518, G-20704, G-24961, G-28256, G-29493, G-31537, G-32747, G-32787, G-32834, G-34246, G-34709, G-34832, G-34847, G-34902, G-34951, G-35377, G-35559, G-36093, G-36935, G-37023, G-39883, G-40014, G-41857, G-43559, H-11157, H-19604, H-31801, H-33985, H-36265, H-37912, H-37926, H-37977, H-41461, H-41733, H-43721, H-43782, I-06355, I-06357, K-06778, K-08803, K-33730, L-00311, L-02635, L-08725, L-17927, L-23562, L-32462, M-35206, N-04212, N-06992, N-18005

GREENHOUSES H-01523, H-17216, H-17217, H-17218, H-17220, H-17681, H-24947

GROUND LEVEL A-15205, A-34647, B-09231, C-01249, C-19313, C-33055, D-01355, D-09240, D-14762, D-21684, D-21906, D-23864, D-25089, D-25881, D-27105, D-29918, D-31332, D-32945, D-33114, D-34805, D-35725, D-36474, D-37366, D-41520, D-43388, D-43558, E-01821, E-03841, E-05713, E-24109, E-24166, E-27116, E-30073, E-33225, E-36487, E-38666, G-08326, G-33497, H-32423, L-23562

GUINEA PIGS A-17778, G-00375, G-00473, G-12038, G-26356, G-33052, G-33910, G-34832, G-37119, G-38869, G-39193, G-39863

## H


HALOGEN GASES A-06351, A-09686, A-26925, A-31315, A-34018, A-37190, A-37312, A-37721, A-38625, B-14604, B-31390, B-33388, B-34536, B-35352, B-35814, B-37222, C-09476, C-09983, C-11042, C-11626, C-12993, C-24337, C-26275, C-28126, C-38670, C-41719, C-41763, C-42928, D-04996, D-27429, D-28920, D-31396, D-31775, D-32912, D-34008, D-43468, E-00834, E-24109, E-28586, G-07162, G-13159, G-24314, G-38616, G-39833, H-08884, H-30225, H-35880, H-39328, I-03735, I-32921, K-06734, K-06778, K-33107, K-34063, K-42039, K-44377, L-00311, L-25542, L-30620, L-31957, L-32884, L-35795, L-38669, L-42873, N-14772

HALOGENATED HYDROCARBONS C-39136, D-32350, F-03525, F-06648, G-13154, G-34851, G-39826, G-44381, G-44385, H-24667, H-42857, I-33802, K-20121, K-41682, K-44310

HAMSTERS G-35219, G-43615

HARBORS C-30635, D-38110, H-25967, L-23608, L-23610, L-24214

HAWAII D-23864, D-28920, D-32350, D-35725, E-28586, H-27063

HAZE A-23620, A-29096, B-20735, B-31221, B-35816, D-07198, D-09726, D-28920, E-28586, E-32155, E-33873, L-33844

HEADACHE A-35957, G-09486, G-23876, G-24314, G-30181, G-31351, G-31491, G-31537, G-35041, G-40435, G-41737, G-41872, G-43559, L-07952

HEALTH IMPAIRMENT A-00962, A-17365, A-27113, A-27272, A-27943, A-31313, A-32621, A-32875, A-34068, A-35957, A-39152, B-01484, B-27503, B-28377, B-31441, B-32355, B-32938, B-33628, D-00969, D-02750, D-03441, D-44330, E-30676, E-38666, G-00177, G-00473, G-00642, G-01757, G-04251, G-05002, G-05025, G-05475, G-07162, G-07396, G-07423, G-07551, G-08949, G-09253, G-11630, G-24314, G-24603, G-26720, G-26915, G-27084, G-27253, G-30334, G-30671, G-31228, G-31280, G-31303, G-31319, G-31491, G-31528, G-31962, G-32487, G-32624, G-32696, G-32834, G-33234, G-33778, G-33864, G-34649, G-34832, G-35041, G-35118, G-36354, G-37040, G-37942, G-38867, G-39161, G-40316, G-40355, G-40485, G-40634, G-42098, G-44395, G-44433, G-45196, H-11452, H-11467, H-27063, K-03007, K-08420, L-02635, L-07952, L-31957, L-33844, L-38757, N-18005, N-28088, N-28803

HEALTH STATISTICS D-03441, D-27096, G-00705, G-00736, G-00740, G-00902, G-01757, G-05541, G-13625, G-23887, G-26720, G-26775, G-27085, G-35587, G-38579, L-08725

HEARINGS B-24696, B-24722, G-25328, K-06734

HEART F-11570, G-01923, G-06814, G-10434, G-12075, G-35463, G-38867, G-44254, G-44385, H-34830, H-35209

HEAT CAPACITY A-35199, B-03337

HEAT OF COMBUSTION A-27249, A-33365

HEAT TRANSFER A-23561, A-35224, B-09798, B-33657, B-35778, B-36145, C-06643, C-44210, E-24109, E-29445, E-40157, F-27348, F-34297

HEMATOLOGY A-00962, A-18510, A-23058, A-27272, A-27943, A-28862, A-30513, A-31313, A-31324, A-32447, A-36527, A-39152, A-43776, B-32424, B-37845, C-05977, C-16382, C-27556, C-33055, C-33338, D-01315, D-06148, D-08568, D-08821, D-24162, D-24463, D-28369, D-36195, D-44330, F-11582, F-13451, G-00020, G-00076, G-00473, G-00597, G-00642, G-00705, G-00808, G-00810, G-00993, G-01754, G-01755, G-01756, G-02202, G-03285, G-03635, G-03893, G-03897, G-04196, G-05002, G-05025, G-05475, G-05483, G-06151, G-06177, G-06814, G-06985, G-07396, G-07551, G-07740, G-07892, G-08326, G-08381, G-08411, G-09019, G-09253, G-09408, G-09484, G-09486, G-09493, G-09535, G-10793, G-10856, G-11462, G-11580, G-11808, G-13059, G-13154, G-14492, G-16810, G-17244, G-18503, G-18549, G-19159, G-19881, G-20287, G-21259, G-21266, G-22637, G-23768, G-24081, G-24961, G-25328, G-26260, G-26310, G-26720, G-26886, G-26915, G-27253, G-27291, G-27961, G-28205, G-29129, G-29256, G-29286, G-29329, G-29493, G-29663, G-29789, G-29815, G-29825, G-29958, G-30009, G-30181, G-30334, G-30672, G-30686, G-31228, G-31319, G-31351, G-31491, G-31493, G-31584, G-31899, G-32129, G-32218, G-32624, G-32696, G-32737, G-32738, G-32747, G-32749, G-32834, G-32905, G-33202, G-33374, G-33607, G-33778, G-33864, G-33903, G-33910, G-34066, G-34095, G-34246, G-34709, G-34841, G-34895, G-34902, G-34943, G-35021, G-35217, G-35387, G-35560, G-35587, G-36152, G-36354, G-36932, G-36934, G-36957, G-37023, G-37040, G-37119, G-37180, G-37297, G-37420, G-37540, G-37722, G-37788, G-37933, G-37941, G-37942, G-37964, G-38579, G-38867, G-38869, G-39095, G-39179, G-39193, G-39406, G-39621, G-39989, G-40022, G-40057, G-40295, G-40532, G-41737, G-41818, G-42098, G-42136, G-42661, G-42698, G-42716, G-42757, G-42759, G-42881, G-42884, G-43337, G-43532, G-44251, G-44254, G-44255, G-44294, G-44395, G-44746, G-45273, G-45293, H-10318, H-30931, H-31185, H-33922, H-34830, H-35234, H-36991, H-39407, H-43511, J-27968, K-08420, K-11746, K-16808, K-36346, K-36823, L-25288, L-33844, L-36877, N-11871, N-20548

HEMEON AUTOMATIC SMOKE SAMPLERS C-01608

HEMOGLOBIN INTERACTIONS G-00705, G-00808, G-00810, G-00993, G-03635, G-05002, G-07396, G-16810, G-21266, G-25328, G-28205, G-31228, G-31491, G-31493, G-32218, G-32624, G-32747, G-33607, G-34895, G-35021, G-41737, G-42881, G-42884, G-43532, G-44254, G-45273, K-16808, K-36346, N-20548

HEPTANES F-05440, F-06648, F-09745, F-41787

HEPTENES G-00177

HERBICIDES H-27111

HERBS H-42715

HEXANES A-05171, A-38331, F-03799, F-06648, F-08207, F-09578, G-00177, K-20121

HEXENES F-08207, G-00177

HI-VOL SAMPLERS A-29661, A-33710, B-25301, C-00855, C-10556, C-19313, C-19501, C-25015, C-25440, C-26848, C-27075, C-31933, C-34407, C-36588, C-37608, C-42360, C-43448, D-00974, D-03410, D-08810, D-09432, D-14762, D-15573, D-23864, D-25881, D-28528, D-28620, D-28629, D-28650, D-28653, D-29655, D-30025, D-30182, D-30326, D-30656, D-31014, D-32883, D-36009, D-36288, D-36449, D-36486, D-36688, D-36820, D-37191, D-37202, D-37320, D-37369, D-39914, D-41975, D-42122, D-43962, D-44059, D-44330, E-36487, E-38118, G-00597, G-24603, G-35041, K-08420, N-04212

HIGHWAYS A-12624, A-21109, A-22367, A-30428, A-32035, A-32492, A-33822, A-35078, A-35953, A-36083, A-41035, B-19331, B-29898, B-32424, B-41112, C-26467, C-30593, C-32058, C-39762, C-45235, D-02750, D-04938, D-06148, D-08279, D-10612, D-15610, D-16791, D-16839, D-24414, D-24952, D-26287, D-27187, D-27257, D-28369, D-28634, D-28785, D-29647, D-31014, D-31669, D-31775, D-33114, D-36688, D-37369, D-37394, D-39535, D-39988, D-40118, D-40997, D-43693, D-43962, E-23743, E-27116, E-30676, E-32158, E-37953, E-45050, G-05002, G-08326, G-16810, G-27253, G-29129, G-30009, G-31351, G-32905, G-37933, G-37942, G-39406, G-40014, G-40068, G-40355, G-40485, G-41737, G-44254, G-44433, G-45196, H-16655, H-17182, H-17216, H-17217, H-17218, H-17220, H-17225, H-17681, H-20062, H-21794, H-24788, H-24947, H-25374, H-25878, H-26055, H-26092, H-26276, H-27391, H-28289, H-28379, H-28471, H-28529, H-30424, H-31185, H-32423, H-33364, H-33922, H-35410, H-35827, H-36611, H-39204, H-39408, H-39409, H-40024, H-40368, H-40540, L-07952, L-30152, L-33844

HOGS G-13159, H-12536, H-40591, H-43226

HORMONES G-03897, G-09486, G-31491, G-34837, G-36740, G-36747, G-36935, G-40312, G-41695, H-08884

HOURLY A-41035, B-28730, D-06148, D-07198, D-11028, D-15610, D-22829, D-26054, D-27191, D-27257, D-28178, D-28634, D-29416, D-29647, D-29744, D-29918, D-30410, D-30860, D-30892, D-31669, D-33114, D-33576, D-35489, D-36474, D-37394, D-39988, D-42122, E-30073, E-38118, G-29816, G-30671, G-30672, K-19750, K-44377, L-30620, L-32789

HOUSTON D-44234, D-44580

HUMANS A-03279, A-17778, A-21069, A-23058, A-23280, A-25417, A-27113, A-27272, A-28394, A-29872, A-30513, A-30674, A-31313, A-31315, A-31323, A-31324, A-31395, A-32447, A-32621, A-32875, A-33963, A-33965, A-34018, A-34068, A-34341, A-35078, A-35957, A-37015, A-45145, A-45274, B-01484, B-28377, B-29414, B-32424, B-35476, B-37845, C-00125, C-15562, C-16382, C-26274, C-36588, D-01315, D-03441, D-08275, D-08568, D-08812, D-08821,

D-09240, D-10380, D-16345, D-[illegible]869, D-27096, D-27174, D-28369, D-[illegible]655, D-31396, D-32055, D-32912, D-36195, D-36503, D-36688, D-41887, D-44330, E-30676, E-38666, F-11570, F-11582, G-00076, G-00177, G-00375, G-00597, G-00662, G-00705, G-00708, G-00736, G-00740, G-00808, G-00810, G-00821, G-00873, G-00902, G-00993, G-01512, G-01754, G-01755, G-01756, G-01757, G-01812, G-02191, G-02202, G-03086, G-03281, G-03282, G-03283, G-03284, G-03285, G-03286, G-03287, G-03635, G-03654, G-04196, G-05002, G-05475, G-05483, G-05780, G-06028, G-06151, G-06174, G-06704, G-06814, G-06985, G-07169, G-07423, G-07551, G-07740, G-07892, G-08326, G-08381, G-08566, G-08949, G-09019, G-09253, G-09261, G-09408, G-09484, G-09486, G-09535, G-10434, G-10793, G-10856, G-11552, G-11580, G-11630, G-12070, G-12075, G-14156, G-14492, G-15731, G-16810, G-17214, G-18046, G-18503, G-18515, G-18518, G-18549, G-19159, G-19881, G-20287, G-20704, G-20990, G-21266, G-21423, G-21766, G-23582, G-23768, G-23801, G-23876, G-23887, G-24081, G-24192, G-24428, G-24573, G-24603, G-24716, G-24784, G-25068, G-25328, G-26260, G-26310, G-26477, G-26483, G-26528, G-26720, G-26775, G-26883, G-26886, G-26915, G-26931, G-27084, G-27107, G-27253, G-27291, G-27416, G-27801, G-28010, G-28024, G-28205, G-28834, G-29129, G-29286, G-29789, G-29816, G-29825, G-29958, G-29963, G-30156, G-30181, G-30198, G-30328, G-30334, G-30355, G-30395, G-30672, G-30686, G-30831, G-31228, G-31303, G-31319, G-31351, G-31442, G-31452, G-31493, G-31524, G-31528, G-31537, G-31584, G-31899, G-31962, G-32041, G-32129, G-32216, G-32408, G-32484, G-32487, G-32608, G-32613, G-32625, G-32696, G-32735, G-32737, G-32738, G-32747, G-32787, G-32834, G-32905, G-33052, G-33165, G-33202, G-33234, G-33372, G-33374, G-33497, G-33527, G-33605, G-33607, G-33778, G-33864, G-33903, G-33910, G-34059, G-34066, G-34092, G-34095, G-34114, G-34175, G-34246, G-34406, G-34436, G-34649, G-34701, G-34709, G-34738, G-34789, G-34832, G-34837, G-34851, G-34902, G-34947, G-34951, G-35021, G-35041, G-35055, G-35118, G-35211, G-35217, G-35219, G-35225, G-35377, G-35380, G-35387, G-35438, G-35463, G-35559, G-35560, G-35568, G-35587, G-35792, G-35811, G-36093, G-36152, G-36207, G-36354, G-36534, G-36551, G-36747, G-36932, G-36957, G-36964, G-37023, G-37028, G-37119, G-37297, G-37420, G-37540, G-37630, G-37731, G-37788, G-37933, G-37941, G-37964, G-38579, G-38580, G-38616, G-38721, G-39095, G-39161, G-39179, G-39193, G-39406, G-39867, G-40021, G-40022, G-40057, G-40068, G-40316, G-40317, G-40435, G-40532, G-40634, G-40769, G-41067, G-41097, G-41695, G-41731, G-41737, G-41847, G-41872, G-41894, G-41895, G-42022, G-42098, G-42463, G-42757, G-42759, G-42884, G-43277, G-43725, G-44053, G-44087, G-44255, G-44364, G-44385, G-44433, G-44463, G-44867, G-45165, G-45273, H-11467, H-18481, H-18520, H-27063, H-32423, H-32736, H-33201, H-35209, H-43511, H-45056, J-27968, K-03007, K-08420, K-11746, K-16808, K-36346, K-38197, L-00311, L-07952, L-08725, L-31957, L-34980, L-36877, L-44325, L-44499, M-35206, N-04212, N-09780, N-11871

HUMIDITY A-35078, B-32760, B-37750, B-44283, C-00855, C-26274, C-30360, C-43587, D-00005, D-05277, D-05573, D-08502, D-25635, D-26387, D-26535, D-39988, D-42122, E-06841, E-29699, E-31895, E-40157, E-40164, F-03525, G-00177, G-44087, H-08884, H-11157, H-26055, H-39690, L-35922, N-11871

HYDRAZINES C-00125

HYDROCARBONS A-00962, A-01565, A-01624, A-01868, A-02636, A-04460, A-05067, A-05171, A-08039, A-08972, A-09210, A-09355, A-09393, A-09686, A-14033, A-14459, A-14461, A-14462, A-15769, A-16156, A-18211, A-19598, A-20545, A-20927, A-22579, A-22825, A-22941, A-22976, A-23250, A-23280, A-23316, A-23561, A-23620, A-24156, A-24829, A-24996, A-25581, A-26100, A-26645, A-26763, A-26925, A-27180, A-27249, A-27272, A-27458, A-27943, A-28560, A-28873, A-29127, A-29516, A-29786, A-29936, A-30027, A-30513, A-30604, A-30759, A-30976, A-31085, A-31315, A-31323, A-31395, A-31596, A-31934, A-32447, A-32621, A-32875, A-33087, A-33169, A-33378, A-33626, A-33822, A-33963, A-33965, A-34018, A-34040, A-34177, A-34350, A-34442, A-34774, A-35050, A-35078, A-35123, A-35199, A-35353, A-35477, A-35481, A-35484, A-35818, A-35919, A-35957, A-36084, A-36527, A-36535, A-36541, A-36623, A-36664, A-37015, A-37176, A-37372, A-38330, A-38331, A-38522, A-38543, A-38625, A-38891, A-39152, A-39367, A-39462, A-39603, A-39610, A-39754, A-40455, A-40677, A-40776, A-40981, A-41035, A-41654, A-41738, A-41945, A-42080, A-42212, A-42377, A-42679, A-42980, A-43346, A-43776, A-43966, A-44227, A-44252, A-44464, A-44682, A-44821, A-45092, A-45136, A-45145, B-00015, B-00063, B-00107, B-01851, B-03337, B-05214, B-05300, B-09231, B-14604, B-17906, B-18053, B-19637, B-19710, B-19725, B-19808, B-20735, B-20740, B-20844, B-21762, B-22414, B-22436, B-22834, B-22890, B-23540, B-23697, B-24182, B-24696, B-24722, B-24813, B-25155, B-25894, B-26153, B-26269, B-27371, B-27503, B-27824, B-27876, B-28286, B-28377, B-28699, B-28730, B-28865, B-29126, B-29414, B-29605, B-29625, B-29898, B-30154, B-30498, B-30944, B-30950, B-31221, B-31246, B-31314, B-31341, B-31364, B-31604, B-31690, B-31819, B-31825, B-31985, B-32355, B-32364, B-32392, B-32822, B-32938, B-33366, B-33386, B-33388, B-33403, B-33542, B-33550, B-33628, B-33741, B-33932, B-34035, B-34381, B-35018, B-35080, B-35112, B-35166, B-35476, B-35535, B-35688, B-35778, B-35816, B-35821, B-36081, B-36523, B-37116, B-37150, B-37173, B-37195, B-37234, B-37619, B-37845, B-37938, B-38287, B-38614, B-39333, B-39404, B-39492, B-40411, B-41608, B-41793, B-42166, B-42290, B-42330, B-42702, B-42817, B-42819, B-42829, B-43333, B-44003, B-44341, B-44470, B-44473, B-44660, B-44750, B-44882, B-44906, C-01230, C-03034, C-05456, C-06112, C-06894, C-09333, C-09476, C-09888, C-09983, C-23596, C-24644, C-26274, C-26707, C-27294, C-29595, C-30290, C-32058, C-32534, C-32829, C-33178, C-38670, C-39136, C-39762, C-41719, C-42775, C-42928, C-44165, D-00969, D-00985, D-01089, D-01673, D-03410, D-03441, D-03526, D-04938, D-05573, D-06148, D-06760, D-06788, D-07198, D-08568, D-08821, D-09432, D-09726, D-10612, D-11028, D-15575, D-15610, D-16345, D-16684, D-17106, D-19433, D-20642, D-24162, D-24351, D-25107, D-27257, D-28097, D-28233, D-29382, D-29744, D-30182, D-30656, D-30860, D-31396, D-32055, D-33576, D-34008, D-38110, D-40997, D-42921, D-43316, D-43468, D-43693, D-44059, D-44330, E-00834, E-32155, E-37953, E-38118, E-38666, E-44813, F-00058, F-03525, F-03799, F-05440, F-05849, F-06648, F-07451, F-08207, F-09578, F-09745, F-13839, F-17689, F-28908, F-39901, F-41787, F-43245, F-44032, G-00020, G-00177, G-00375, G-00473, G-03086, G-03892, G-07162, G-16820, G-23715, G-23876, G-24603, G-28171, G-28205, G-30156, G-30328, G-30355, G-31319, G-32484, G-33607, G-33778, G-34406, G-37180, G-37788, G-37942, G-38721, G-38867, G-38869, G-39161, G-39826, G-39883, G-40634, G-40688, G-41097, G-41737, G-42881, G-44087, G-44176, G-44867, H-08884, H-26055, H-27111, H-39328, H-40368, H-42857, J-03289, J-21749, J-22358, J-26765, J-27968, J-30696, J-31720, J-34370, J-34828, J-34970, J-37734, J-38624, J-39956, K-02580, K-03007, K-08803, K-09259, K-18294, K-20121, K-24107, K-30035, K-30069, K-33730, K-34063, K-36382, K-38758, K-41682, K-43312, L-02635, L-03536, L-07952, L-08196, L-09009, L-11204, L-17472, L-22583, L-25288, L-27664, L-28099, L-30152, L-31957, L-32462, L-32789, L-33495, L-35922, L-36030, L-37193, L-37392, L-38757, L-41289, L-41703, L-42873, L-44325, L-44376, L-44499, M-01073, N-03674, N-04052, N-04212, N-08273, N-09780, N-14772, N-17260, N-18005, N-20548, N-28088, N-28803

HYDROCHLORIC ACID A-29786, A-31315, A-37721, A-42676, B-38727, C-00125, C-28126, C-30360, C-39136, C-41719, C-41763, D-29416, D-31396, G-07162, G-31319, G-36093, G-44433, H-08884, H-27111, I-33802, J-21749, K-06778, K-09259, K-33107, K-34063, K-34377, K-38197, K-42039, K-44377, L-00311, L-17472, L-35795, L-38669, N-04212

HYDROCYANIC ACID C-26274, C-32476, G-24314

HYDRODESULFURIZATION A-24080, A-29127, K-30035, N-09780

HYDROFLUORIC ACID A-23561, A-29786, A-31315, A-37721, C-23657, C-28126, C-31304, C-32476, C-38670,

C-41763, D-29416, D-34008, D-36806, D-41979, G-00375, G-07162, G-31319, G-44867, H-11452, H-11467, H-26055, H-30225, K-06734, K-06778, K-19750, K-33107, K-34063, K-34377, K-42039, K-44310, L-28349, L-29421, L-32789, L-35795, L-38669, N-04052, N-04212
HYDROGEN A-34774, B-31221, B-35816, D-10634, D-30860, F-00058, F-39901, G-07162, G-24314, K-02580
HYDROGEN SULFIDE A-23561, A-24281, A-29787, A-31315, A-34018, A-35788, A-45145, B-03337, B-28172, C-06107, C-06112, C-09983, C-26275, C-28126, C-32476, C-32534, C-38670, C-38755, C-41763, C-42928, D-00005, D-03441, D-04996, D-31396, D-32055, D-34008, D-41979, G-24314, G-24603, G-32735, G-38616, G-44867, H-08884, K-02580, K-06734, K-06778, K-08420, K-09259, K-19750, K-44310, L-00311, L-17472, L-23562, L-31957, N-04052, N-04212, N-20548
HYDROGENATION A-29127, A-42791, B-22436, C-01230
HYDROSPHERE A-25417, C-33055, D-34805, E-10215
HYDROXIDES B-03337, B-29920, B-35703, F-06648, F-09578, G-32218
HYPOXIA A-15599

## I

ICE A-15205, A-19955, A-21722, A-23620, A-26191, C-06643, D-21684, E-00834, E-24109, E-33873, E-36714, E-40157
ILLINOIS C-18007, D-07600, D-11184, D-27241, D-27621, D-39535, D-39914, G-01754, G-01757, G-33497, G-42716, H-36991
IMMUNOLOGY G-00473, G-07162, G-29588, G-44254, G-44255
IMPINGERS A-05067, B-32633, B-35352, C-00855, C-11042, C-25932, C-26145, C-26467, C-26698, C-27556, C-28755, C-32975, D-28528, D-30182, D-36009, D-43962, G-20687, G-24603
INCINERATION A-09686, A-26441, A-29786, A-31632, A-31649, A-34018, A-39462, B-00107, B-30124, D-03441, D-20191, G-23167, G-31319, G-31528, G-33607, G-35811, G-39161, G-44087, I-33802, L-30152, N-04052
INDIANA D-05623, D-11184, D-27621, D-39914
INDOOR A-38625
INDUSTRIAL AREAS A-29539, A-29787, A-31315, A-31395, A-35065, A-35078, A-35398, A-40583, C-22927, C-26274, C-26467, C-30113, C-32169, C-36588, C-39762, C-44479, D-01315, D-03526, D-06760, D-07198, D-07600, D-08279, D-08502, D-08821, D-09726, D-10380, D-12049, D-15823, D-21869, D-26044, D-26054, D-26387, D-27187, D-27188, D-27648, D-27675, D-27880, D-28326, D-28369, D-28653, D-29153, D-30025, D-30326, D-30858, D-30860, D-30892, D-31014, D-31396, D-32055, D-32912, D-33576, D-34008, D-35940, D-36009, D-36195, D-36288, D-36486, D-36688, D-37026, D-37264, D-37320, D-37369, D-38110, D-38133, D-40584, D-41979, D-44059, G-08381, G-09408, G-11630, G-20287, G-23801, G-26886, G-26931, G-27085, G-30672, G-32787, G-34709, G-37731, G-40688, G-41067, G-41737, G-44087, G-44255, G-44867, H-19620, H-30921, H-31010, H-31185, H-32224, H-35880, H-37926, H-37977, H-40590, H-41800, H-42250, H-42336, I-00305, K-33107, L-08196, L-23608, L-23610, L-24214, L-33844, L-44499
INERTIAL SEPARATION B-35342, C-35494
INFANTS A-23058, G-00736, G-09408, G-10856, G-12075, G-30395, G-32216, G-32787, G-33527, G-34947, G-35438, G-36964, G-37964, G-43725, G-44364, H-43511
INFLUENZA N-20548
INFRARED RADIATION C-17048, C-40631, E-29445
INFRARED SPECTROMETRY A-04460, A-05067, A-23789, A-29516, A-33822, A-43966, B-39275, C-06045, C-17048, C-32829, C-35494, C-38165, D-00985, D-08568, D-09726, D-11028, D-36562, D-37366, D-39081, D-43468, D-43962, D-44330, F-05849, F-07451, G-00177, G-24603, K-08420, L-17472
INGESTION A-25417, A-28394, A-40314, D-19822, F-36076, G-01754, G-01755, G-01756, G-01757, G-05478, G-05541, G-07169, G-08999, G-15703, G-17214, G-18518, G-19881, G-20087, G-20198, G-23768, G-23926, G-26260, G-29789, G-31584, G-33372, G-33779, G-33864, G-34851, G-35211, G-35217, G-35380, G-35438, G-35463, G-35568, G-35714, G-35792, G-36207, G-36534, G-36765, G-37788, G-37964, G-38580, G-38869, G-39095, G-40068, G-40317, G-41895, G-42463, G-42737, G-42757, G-42957, G-44381, G-45288, H-26276, H-33362, H-34901, H-35234, H-39408, H-40024, H-42715, L-35461
INHALATION THERAPY G-18417, G-29129, G-30672
INHIBITION B-05300, D-27096, F-44032, G-07892, G-21037, G-24784, G-26886, G-27614, G-28010, G-28024, G-32487, G-32834, G-37040, G-39621, G-40057, G-40312, G-43277, G-43532, G-43725, H-31010, H-39409, H-43511, I-36051
INORGANIC ACIDS A-09686, A-10749, A-12751, A-12823, A-23561, A-26441, A-29786, A-31315, A-32875, A-35052, A-35224, A-37166, A-37721, A-39462, A-42676, B-03337, B-26600, B-28172, B-29058, B-31985, B-34025, B-35476, B-38727, B-43937, C-00125, C-00855, C-08661, C-09983, C-23657, C-26467, C-28126, C-30360, C-31258, C-31304, C-32476, C-38670, C-39136, C-41719, C-41763, C-42139, C-42928, D-05260, D-07198, D-10634, D-26387, D-29382, D-29416, D-31396, D-34008, D-36806, D-38133, D-41979, E-24570, E-32155, E-36038, F-00058, G-00375, G-07162, G-08411, G-31319, G-32735, G-36093, G-38721, G-38869, G-44433, G-44867, H-08884, H-11452, H-11467, H-26055, H-27111, H-30225, H-32224, H-39690, H-42250, H-42607, I-33802, J-21749, J-30696, K-02580, K-06734, K-06778, K-08420, K-09259, K-19750, K-20121, K-33107, K-34063, K-34377, K-36823, K-38197, K-41682, K-42039, K-44310, K-44377, L-00311, L-17472, L-28349, L-29421, L-32789, L-35795, L-38669, L-39640, N-04052, N-04212, N-09780, N-20548
INSPECTION A-34442, A-39367, A-40776, B-44750, G-06177, L-28869, L-37717
INSTRUMENTATION A-40947, B-20735, C-00855, C-01607, C-01608, C-03037, C-16123, C-25432, C-26275, C-30290, C-32975, C-33055, C-36698, C-36703, C-38778, C-40631, C-41138, C-41908, C-42084, C-43587, C-43737, D-01673, E-06841, E-10215, E-44813, G-04877, G-09019, G-41368, K-08803, L-33495
INTERMITTENT MONITORING C-12943, C-24644, D-08812, D-09240, D-14762, D-15575, D-30858, L-33495
INTERNAL COMBUSTION ENGINES A-01565, A-01624, A-01868, A-04460, A-05171, A-08039, A-08972, A-09210, A-09355, A-09393, A-09686, A-15769, A-19598, A-20545, A-20927, A-22579, A-22941, A-22976, A-23250, A-23316, A-24281, A-24718, A-24996, A-25581, A-26134, A-26552, A-26763, A-26925, A-27249, A-27272, A-27943, A-28394, A-28560, A-28873, A-29364, A-29516, A-29782, A-29786, A-30604, A-30976, A-31133, A-31596, A-32621, A-33087, A-33365, A-33378, A-33626, A-33667, A-33710, A-34018, A-34040, A-34442, A-34774, A-35353, A-35484, A-37648, A-38522, A-38543, A-39603, A-39754, A-41654, A-41738, A-42080, A-42212, A-42980, A-43346, A-44464, B-00015, B-01484, B-01851, B-05214, B-05300, B-09231, B-17906, B-20740, B-20844, B-21303, B-21762, B-23540, B-23923, B-24813, B-25377, B-26153, B-26243, B-27876, B-28059, B-28060, B-28286, B-28699, B-29204, B-29531, B-29656, B-29920, B-30944, B-31221, B-31819, B-31825, B-32355, B-32822, B-33366, B-33403, B-33741, B-33932, B-34457, B-34611, B-34740, B-35778, B-35821, B-36081, B-36144, B-36145, B-37150, B-37195, B-37938, B-39272, B-42300, B-42330, B-42817, B-42819, B-44473, B-44660, B-44750, B-44882, C-22927, C-28755, C-32058, C-42775, D-03410, D-04646, D-08438, D-08568, D-08810, D-08812, D-08821, D-09726, D-12099, D-24162, D-24351, D-25055, D-27174, D-28369, D-34008, D-39988, F-00058, F-03799, F-08207, F-09745, F-14995, F-28908, G-00020, G-08411, G-10856, G-19940, G-23167, G-30328, G-33165, G-34406, G-35118, H-25878, H-28471, I-36051, J-27968, K-03956, K-08803, K-38758, L-02635, L-03536, L-07952, L-09009, L-22583, L-37392, L-37717, L-41703, L-44376, N-04052, N-08273, N-09780, N-20548
INTERNATIONAL A-32621, A-38625, B-36721, D-27105, E-29445, G-30328, K-03956, K-30069, L-00311, L-09009, L-31454, L-32462, L-41557, L-42016, L-44219, L-44376
INTESTINES G-01500, G-03086, G-08411, G-09493, G-31491, G-33779, G-37685, H-16270, H-33362, H-35209
INVERSION A-45274, D-03410, D-03441, D-04646, D-04996, D-10380, D-10634, D-19144, D-23864, D-30410, D-30860, D-32945, E-00834, E-01821, E-12777, E-19058, E-22959, E-24109, E-29445, E-30676, G-07162, G-33778, G-44867, K-30035, N-09780, N-18005

IODIDES A-29786, C-06643, C-23096, D-04646, E-40157, E-44999
IODIMETRIC METHODS C-09333, C-26698, C-26955, C-32476, C-32829, D-01089, D-09240, G-24603
IODINE C-11626, C-12993, C-24337, D-28920, E-28586, L-25542
IODINE COMPOUNDS A-26191, A-29786, C-05977, C-06643, C-09333, C-23096, C-27294, C-42020, C-44129, D-01089, D-04646, D-11184, D-21684, E-29910, E-36714, E-40157, E-44999, F-10599, G-34837, G-40312
IONIZATION D-34008, G-07169
IONS A-37312, B-05300, B-31604, C-06045, C-10528, C-25222, C-30635, C-32534, C-41490, C-44995, D-05277, D-24351, D-28326, E-06841, E-10215, E-29946, E-32155, F-13839, F-13911, F-14008, F-14039, F-14510, F-14868, F-16659, F-17585, F-17882, F-34948, F-44164, G-32735, G-43532, H-23258, H-36265, H-36991
IRELAND H-27386
IRON A-09686, A-34788, A-39462, A-43271, B-00063, B-03232, B-03754, B-07606, B-21324, B-29656, B-34071, B-35296, B-35342, B-35778, B-37222, B-43937, C-10528, C-11042, C-15734, D-00005, D-00017, D-00974, D-05623, D-07985, D-08502, D-11202, D-12049, D-21869, D-27880, D-29153, D-29191, D-30326, D-30860, D-35940, D-37320, D-38110, F-10599, G-00662, G-15703, G-41067, H-08884, I-02176, I-03735, I-22128, I-32921, I-33802, J-30696, L-17927, L-23608, L-24214, N-04649
IRON COMPOUNDS A-03982, A-05067, A-26454, A-30414, A-30759, A-34647, A-35123, A-41889, B-03337, B-05300, B-20740, B-30010, B-35296, B-35814, B-36144, B-38727, B-43515, B-43937, C-05787, C-06045, C-06894, C-10528, C-11042, C-16367, C-19313, C-19501, C-20891, C-22975, C-23096, C-25535, C-27075, C-28126, C-30360, C-31258, C-31304, C-31933, C-32718, C-32892, C-34407, C-35494, C-37693, C-38682, C-38778, C-39136, C-39516, C-41016, C-41612, C-41825, C-41908, C-41968, C-42020, C-42360, C-42928, C-43763, D-04996, D-05167, D-05623, D-07985, D-08275, D-08502, D-09432, D-10380, D-21015, D-21869, D-22290, D-22829, D-23971, D-27174, D-27648, D-27831, D-27880, D-28326, D-28629, D-28653, D-29152, D-29153, D-29191, D-30025, D-30182, D-30326, D-30493, D-30656, D-31014, D-32055, D-35010, D-36288, D-36474, D-36486, D-36688, D-36820, D-37026, D-37191, D-37202, D-37320, D-37518, D-38133, D-41975, D-42122, D-42367, D-42921, D-43316, D-43388, D-44059, E-10215, E-29910, E-44813, F-16595, F-34297, F-35378, F-36067, F-44164, G-24314, G-27107, G-30181, G-32735, G-34847, G-36093, G-38869, G-39833, G-40068, G-40688, G-42136, G-43532, G-44696, H-08884, H-16270, H-23435, H-32224, H-35880, H-36265, H-36991, H-39690, H-42250, H-42336, H-43279, K-14443, N-04649
IRON OXIDES A-03982, B-00063, B-03232, B-30154, B-41544, C-06045, C-25793, D-04996, D-06760, D-15789, E-36038, F-17689, H-42336, I-33802, K-14443
IRRADIATION CHAMBERS A-23789, D-32350, E-29946, G-00148, G-00473
ISOBUTANES A-34177
ISOPENTANES B-00015, B-00063, F-06648, G-00177
ISOTOPES A-11702, A-18510, A-23239, A-25295, A-25417, A-30428, B-34313, C-00125, C-01249, C-01608, C-05243, C-06920, C-09333, C-21948, C-23646, C-27106, C-27294, C-27829, C-32534, C-33042, C-33055, C-34106, C-35396, C-42160, C-43587, C-43763, C-45235, D-00261, D-01355, D-22553, D-23658, D-23864, D-25089, D-25758, D-43388, D-45218, E-03841, E-05713, E-21182, E-21796, E-22754, E-22959, E-24166, E-28799, E-31852, E-33225, F-00841, F-13451, F-13943, F-27752, G-01500, G-05280, G-07169, G-18046, G-19881, G-30468, G-32041, G-34789, G-34837, G-36251, G-40312, H-01523, H-12647, H-33985, H-45056, N-05313
ITALY A-15599, A-33169, A-38022, B-25096, C-09953, C-33255, C-38778, C-41016, D-08810, D-10554, D-10595, D-25635, E-31895, E-40164, F-17882, F-17949, F-28908, G-10793, G-11552, G-21037, G-23582, G-24784, G-29256, G-30328, G-30468, G-35174, G-36251, G-39621, G-40634, H-42945, J-30329, L-32462

## J

JAPAN A-14945, A-17325, A-19598, A-19955, A-20652, A-21722, A-24156, A-26100, A-26134, A-27858, A-29364, A-29539, A-29661, A-29787, A-29936, A-30513, A-31133, A-31136, A-31934, A-32492, A-32523, A-32875, A-33710, A-33963, A-33965, A-34774, A-35052, A-35957, A-36006, A-36846, A-37166, A-37372, A-37721, A-38819, A-40677, A-41035, A-42080, A-42791, A-43776, A-43966, A-44252, B-17525, B-19808, B-21324, B-22520, B-24813, B-25155, B-25894, B-26532, B-28172, B-28730, B-29058, B-29204, B-29531, B-29656, B-29664, B-29898, B-30154, B-30498, B-30944, B-31314, B-31317, B-31364, B-31496, B-31985, B-34071, B-35080, B-35296, B-35821, B-37116, B-37195, B-37468, B-38614, B-39333, B-42886, B-44003, C-03034, C-06112, C-15562, C-19501, C-21338, C-21862, C-24617, C-24618, C-24644, C-25013, C-25015, C-25535, C-26336, C-26848, C-27358, C-27556, C-27681, C-27829, C-28126, C-28621, C-28755, C-29419, C-29464, C-29810, C-30360, C-30635, C-30786, C-31304, C-31933, C-32476, C-32534, C-32718, C-32829, C-32833, C-32892, C-34017, C-36588, C-36698, C-36703, C-36840, C-36841, C-37514, C-37608, C-37689, C-37693, C-38670, C-38682, C-39069, C-39136, C-39516, C-40407, C-41719, C-41763, C-42020, C-42043, C-42360, C-43448, C-43763, C-44129, D-06148, D-06760, D-07198, D-08591, D-15175, D-15314, D-15610, D-16539, D-16576, D-17106, D-21015, D-21869, D-22290, D-25758, D-25881, D-26044, D-26054, D-26287, D-26535, D-27187, D-27188, D-27191, D-27257, D-27648, D-27672, D-27675, D-27831, D-27880, D-28233, D-28326, D-28528, D-28620, D-28629, D-28634, D-28635, D-28650, D-28653, D-28785, D-29152, D-29153, D-29191, D-29382, D-29385, D-29416, D-29465, D-29647, D-29744, D-29814, D-29918, D-30025, D-30182, D-30326, D-30410, D-30493, D-30494, D-30656, D-30892, D-31014, D-31669, D-32727, D-32883, D-32912, D-33114, D-33576, D-35025, D-36009, D-36288, D-36474, D-36486, D-36503, D-36688, D-36806, D-36820, D-36909, D-37191, D-37202, D-37288, D-37320, D-37366, D-37369, D-37394, D-37518, D-38110, D-38133, D-39081, D-39988, D-40118, D-40363, D-40716, D-40997, D-41975, D-41979, D-42120, D-42122, D-42367, D-43316, D-43962, D-44059, D-44063, D-44330, E-30073, E-36038, E-36487, E-38118, F-17689, F-19823, F-29400, F-37213, F-41787, F-42772, G-00375, G-03286, G-03635, G-03893, G-03897, G-05475, G-05780, G-07396, G-07423, G-08566, G-09535, G-13154, G-14492, G-17244, G-17470, G-19304, G-19940, G-24081, G-26260, G-26310, G-26528, G-26775, G-27253, G-27490, G-27961, G-28170, G-28171, G-29129, G-29663, G-29789, G-29815, G-29816, G-29825, G-29958, G-29963, G-30181, G-30355, G-30395, G-30671, G-30672, G-31351, G-32735, G-32905, G-33165, G-33372, G-35021, G-35041, G-37722, G-37941, G-37942, G-38580, G-38867, G-39989, G-40435, G-40532, G-41067, G-41124, G-42022, G-42098, G-42661, G-44087, G-44433, G-45273, H-14489, H-21018, H-27489, H-28105, H-28529, H-41800, H-42336, K-20121, K-33107, K-34063, K-34377, K-36823, K-38197, K-42039, K-44310, K-44377, L-08725, L-23608, L-23610, L-24214, L-27664, L-28099, L-28349, L-29421, L-29888, L-30152, L-30620, L-30908, L-32789, L-32865, L-32884, L-34980, L-35151, L-35795, L-35922, L-36030, L-36877, L-37521, L-38669, L-44325, L-44499, N-04212, N-11871
JET AIRCRAFT A-23620, B-22890, D-06788, E-29445

## K

KANAGAWA PREFECTURE C-39136, G-44433, H-42336
KEROSENE A-34774, A-39603, C-17771, G-45159
KETONES A-08039, A-22579, A-23561, A-31315, A-42080, B-32938, C-06894, C-09333, C-26274, C-42928, C-44129, F-03525, F-06648, F-09578, G-00177, K-02580, K-41682
KIDNEYS A-23058, A-35957, G-00821, G-01341, G-01756, G-01923, G-03286, G-06174, G-06814, G-09535, G-10434, G-11580, G-12075, G-14492, G-16810, G-18515, G-23167, G-23768, G-23926, G-26483, G-27416, G-27614, G-30468, G-30686, G-31228, G-31493, G-32216, G-32487, G-34114, G-34738, G-34791, G-34836, G-34841, G-35021, G-35055, G-35211, G-35380, G-35792, G-35811, G-36207, G-36251, G-36747, G-36765, G-36935, G-37023, G-37722, G-37731, G-38867, G-40068, G-40485, G-42737, G-43559, G-43615, G-44053, G-45005, G-45288, G-45293, H-11467, H-16270,

H-18521, H-28105, H-30033, H-33922, H-34901, H-35209, H-36991, H-39408, H-41893, H-44588
KILNS A-03982, A-20652, A-38819, B-03232, B-32248, D-32055, H-08884, L-23562
KONIMETERS C-08130
KRAFT PULPING A-09686, A-26441, A-39462, B-29628, C-33055, D-03410

## L

LABORATORY ANIMALS A-03279, A-17778, A-23058, A-27458, B-01484, B-29414, C-00125, D-01315, F-11570, G-00076, G-00148, G-00177, G-00375, G-00473, G-00597, G-00662, G-00705, G-00708, G-00736, G-00740, G-00808, G-00810, G-00821, G-00873, G-00902, G-00993, G-01341, G-01500, G-01512, G-01731, G-01754, G-01755, G-01756, G-01757, G-01797, G-01812, G-01923, G-02191, G-02202, G-03086, G-03281, G-03282, G-03283, G-03284, G-03285, G-03286, G-03287, G-03635, G-03654, G-03897, G-04196, G-05002, G-05671, G-08999, G-09493, G-11468, G-11808, G-12038, G-12075, G-12646, G-14156, G-14492, G-18417, G-18494, G-18502, G-18515, G-20198, G-21259, G-23167, G-23715, G-23926, G-24288, G-26260, G-26356, G-26483, G-27107, G-27490, G-27614, G-28024, G-29588, G-30468, G-30671, G-30672, G-31442, G-32041, G-32746, G-32834, G-33052, G-33374, G-33527, G-33779, G-33910, G-34791, G-34832, G-34836, G-34841, G-34851, G-34914, G-34943, G-35174, G-35219, G-35225, G-36251, G-36740, G-36747, G-36765, G-36934, G-36935, G-37119, G-37685, G-37788, G-38867, G-38869, G-39193, G-39503, G-39621, G-39863, G-40014, G-40312, G-40688, G-41818, G-42737, G-42957, G-43277, G-43531, G-43615, G-44254, G-44381, G-45005, G-45288, G-45293, H-28105, H-28448, H-34901, H-35209, H-39407, H-42857, H-42945, K-03007, K-11746, K-16808, L-00311, N-04212
LABORATORY FACILITIES B-27371, B-31690, C-08661, C-09333, C-09983, D-11184, E-32158, G-11808, G-16820
LACQUERS A-37190, G-03654
LAKES D-00974, D-11184, E-29910, E-35207, H-23258, I-00305
LANDFILLS B-30124
LARYNX H-33362, H-40591
LASERS C-17048, C-26275, E-30863
LATIN AMERICA A-40314, G-41872, G-42757, G-44867, L-41557
LAUNDERING (COAL) B-03337
LAUNDRIES N-04212
LEAD PEROXIDE CANDLE C-26503, C-38755, D-26044, D-27672, D-29655, D-37026, D-40363, D-40997, D-44059, G-24603, G-35041
LEAVES A-30428, A-32748, C-18302, C-39762, D-08279, D-32912, D-40716, G-30671, G-44433, H-01523, H-07742, H-08884, H-11157, H-27489, H-28529, H-30931, H-31010, H-32338, H-32423, H-32654, H-33364, H-33922, H-35880, H-38743, H-39328, H-39408, H-41143, H-41800, H-42250, H-42336
LEGAL ASPECTS A-01565, A-01868, A-20545, A-22976, A-23280, A-29787, A-29936, A-30001, A-30604, A-31323, A-31520, A-32621, A-32875, A-33667, A-33963, A-33965, A-34031, A-34177, A-34341, A-34442, A-35050, A-35052, A-35168, A-36535, A-36664, A-37166, A-38625, A-39067, A-39152, A-39367, A-40455, A-41035, A-41654, A-41945, A-43776, B-00107, B-18053, B-24696, B-24722, B-28059, B-28377, B-28699, B-29628, B-30633, B-31364, B-31496, B-31690, B-32424, B-33628, B-33932, B-35112, B-35166, B-35688, B-36721, B-37150, B-39404, B-42330, B-44742, C-39516, C-41763, D-00969, D-03410, D-03441, D-19144, D-29416, D-30860, D-32055, D-32912, D-35025, D-38110, D-40574, D-42367, D-44170, F-41787, G-16820, G-25328, G-30328, G-34059, G-34436, H-28471, J-22358, J-34370, J-35391, J-37409, J-39941, K-03007, K-06734, K-06778, K-09259, K-14443, K-19750, K-33107, K-34063, K-34377, K-36346, K-36823, K-38197, K-42039, K-44310, L-00311, L-02635, L-07952, L-08196, L-08725, L-16200, L-17927, L-22583, L-23562, L-24757, L-26442, L-27664, L-28349, L-28397, L-28869, L-29421, L-29888, L-30620, L-31957, L-32462, L-32789, L-32865, L-32884, L-33740, L-34033, L-34980, L-35461, L-35795, L-37193, L-37392, L-37423, L-37521, L-37560, L-37717, L-38669, L-38757, L-39640, L-40486, L-40520, L-41289, L-41557, L-42016, L-42041, L-42169, L-42873, L-44044, L-44325, L-44376, L-44499, M-01073, M-29432, N-04052, N-09780, N-14772, N-28088, N-43824
LEGISLATION A-01565, A-01868, A-20545, A-22976, A-23280, A-30604, A-31323, A-32621, A-32875, A-33667, A-33965, A-34031, A-34341, A-35050, A-35052, A-37166, A-39152, A-39367, A-41945, B-18053, B-28059, B-28377, B-28699, B-29628, B-30633, B-31496, B-31690, B-32424, B-33628, B-35112, B-35688, B-36721, B-37150, B-39404, B-42330, D-00969, D-03410, D-19144, D-30860, D-32055, D-32912, D-35025, D-44170, G-16820, G-30328, G-34059, G-34436, J-22358, J-34370, K-03007, K-06778, K-09259, K-14443, K-34063, K-34377, K-36823, K-38197, K-42039, K-44310, L-00311, L-02635, L-07952, L-17927, L-22583, L-23562, L-27664, L-28349, L-28397, L-28869, L-29421, L-30620, L-32462, L-32789, L-32865, L-32884, L-33740, L-34033, L-34980, L-35461, L-35795, L-37193, L-37392, L-37560, L-38669, L-40520, L-42016, L-42169, L-44325, M-01073, N-14772, N-28088, N-43824
LETTUCE C-00125, H-17218, H-17220, H-17978, H-41892
LEUKEMIA G-44254
LEUKOCYTES G-05780, G-26883, G-27085, G-30334, G-34914, G-41695, H-10318
LIFE SPAN G-01923, G-40068
LIGHT RADIATION A-05067, A-23561, A-29096, A-35078, B-30633, B-32938, C-06107, C-06920, C-17048, C-21459, C-40631, D-11028, D-29647, E-24109, E-24570, E-29445, E-29699, E-29946, E-30863, E-31895, E-32155, G-00148, G-00177, G-00375, G-16820, G-30395, G-31319, G-38616, H-11157, K-11746, L-33844, L-35922
LIGHT SCATTERING A-16766, B-39272, C-32474, D-22829, E-30863, E-32155, E-35264, E-42720, G-04877
LIME B-32248, H-08884
LIMESTONE A-35052, C-29512, H-26276
LINE SOURCES D-23388, D-24351, E-45050
LIPIDS F-11570, G-00473, G-08381, G-24192, G-34789, G-44254
LIQUIDS A-03280, A-25417, A-26454, A-32035, A-41889, A-45092, B-03337, B-29058, B-32036, B-35018, B-37173, B-40411, C-26955, C-28755, C-32058, C-44165, D-25635, F-03525, F-06648, F-14008, F-14138, F-14510, F-14743, F-14868, F-15493, F-17161, F-34948, F-36067, G-05002, G-10434, G-35811, H-09448, H-14786, H-17217, I-22128
LITHIUM COMPOUNDS A-06351, B-35352, C-21459, C-30360, C-34106, C-39168, F-14008, F-16659
LITIGATION D-40574, L-34033, L-39640
LIVER A-35957, D-09240, G-00993, G-01341, G-01500, G-01756, G-01797, G-01923, G-06814, G-09493, G-10434, G-10793, G-12075, G-14492, G-16810, G-23768, G-27614, G-29588, G-30468, G-30672, G-31228, G-32787, G-35055, G-35225, G-36251, G-38867, G-39989, G-40014, G-40068, G-40485, G-41737, G-42881, G-44254, G-44385, G-45005, G-45288, G-45293, H-11452, H-16270, H-18521, H-28105, H-28448, H-30033, H-33922, H-35234, H-36991, H-39408, H-41893, H-44588
LOCAL GOVERNMENTS D-03441, D-32055, G-35714, K-42039, K-44310, L-32884, L-33495, L-35461, L-37521, L-38669, L-44499
LONDON A-09393, A-41945, B-30633, D-00985, G-00375, G-07162, G-07423, N-04212, N-18005
LOS ANGELES A-03278, A-09393, A-35168, B-00107, B-03754, B-44470, B-44853, C-00855, C-06072, D-00969, D-00976, D-01315, D-02750, D-03441, D-05573, D-07600, D-10612, D-16839, D-22829, D-23658, D-24463, D-36195, F-05849, G-00020, G-00076, G-00375, G-00662, G-03282, G-05002, G-07162, G-08326, G-37040, H-35827, H-44071, K-09259, K-11746, K-38197, K-43312, M-33904, N-04212
LOUISIANA G-00375
LOWER ATMOSPHERE A-26645, C-06920, C-19313, D-05573, D-17058, D-21684, D-21906, D-23864, D-24316, D-25881, D-28097, D-28634, D-28635, D-28650, D-29918, D-30410, D-34805, D-36474, D-37366, D-41520, D-45218, E-03841, E-05713, E-06841, E-24166, E-27116, E-36487, G-08326, G-16820, H-28529, H-32423
LUBRICANTS A-04460, A-36080, A-36083, A-37190, A-37372, A-38625, B-36145, B-39333, B-42702, B-42886, F-42772, H-36196
LUNG CANCER A-17778, D-16345, G-00375, G-00873, G-01797, G-03086, G-07169, G-07423, G-13625, G-26528, G-26775, G-38869, G-40068, G-40634, G-41097, G-41124, G-41737, G-44176,

G-44395, H-42857, L-07952, L-25288, N-20548
LUNG CLEARANCE F-13451, G-18046, G-26356, G-31452
LUNGS A-21069, A-35957, A-36527, D-27174, D-35025, D-36688, F-13451, G-00473, G-00902, G-01797, G-01923, G-03282, G-07169, G-12070, G-12075, G-12984, G-16810, G-18046, G-18417, G-20990, G-24314, G-26356, G-26528, G-26775, G-26931, G-27614, G-29789, G-30156, G-30181, G-30468, G-31319, G-31452, G-31517, G-31528, G-32625, G-33497, G-33779, G-34951, G-37685, G-38867, G-39989, G-40688, G-44254, G-44381, G-44508, G-44696, G-44867, G-45293, H-11467, H-28105, K-11746, N-20548
LYMPHOCYTES G-11552, G-41695, G-43277

## M

MAGNESIUM A-35168, A-43271, B-00107, B-03754, C-10528, C-15734, D-07985, D-11202, D-12049, F-06648, F-10599, I-06355, I-06357
MAGNESIUM COMPOUNDS B-03337, C-06045, C-10528, C-25793, C-30113, C-41825, C-41908, C-41968, C-42928, C-44210, D-04996, D-05167, D-07985, D-09432, D-21869, D-23971, D-35010, D-43388, D-44234, D-44580, F-13705, F-14868, F-34297, F-34948, G-01797, G-30181, G-32608, G-40688, G-42022, G-44696, H-08884, H-36991, H-42336
MAGNETOHYDRODYNAMICS (MHD) A-43346
MAINTENANCE A-27272, A-33626, A-34442, A-36083, A-40583, B-01484, B-25781, B-26153, B-28108, B-35303, B-35478, B-35688, B-36721, B-41922, B-42829, J-30329, J-30696, L-22583, L-28869, L-37717, L-44376
MALES D-08568, D-08812, D-27096, D-31396, G-00076, G-00375, G-00597, G-00662, G-00810, G-00902, G-00993, G-02191, G-03086, G-03283, G-06985, G-07551, G-07892, G-08326, G-08381, G-08949, G-09261, G-09408, G-09484, G-10434, G-23801, G-24716, G-26720, G-27253, G-31899, G-32041, G-32625, G-32696, G-32787, G-32905, G-33052, G-33234, G-34092, G-35217, G-36747, G-41894, G-42884, G-44053, G-44385
MANAGEMENT PERSONNEL L-09009
MANGANESE B-00063, C-15734, C-29464, D-00005, D-00017, D-00974, D-03526, G-00177, G-00662, G-07423, H-08884, N-04649
MANGANESE COMPOUNDS A-05067, A-06351, A-18211, A-26454, A-36846, A-41889, A-45072, B-00015, B-00063, B-03337, B-20740, B-21719, B-30010, B-30154, B-30229, B-35476, C-05787, C-06045, C-08145, C-09983, C-19501, C-24719, C-27075, C-27358, C-28126, C-30360, C-31304, C-32718, C-32892, C-34017, C-37608, C-37693, C-38682, C-38778, C-39136, C-39516, C-41825, C-41968, C-42020, C-42360, C-42928, C-44995, D-03526, D-04996, D-05167, D-05551, D-17340, D-21015, D-21869, D-22290, D-23388, D-23971, D-24351, D-26387, D-27174, D-27188, D-27648, D-27831, D-27880, D-28326, D-28629, D-28653, D-29153, D-29191, D-29385, D-30025, D-30182, D-30326, D-30493, D-30656, D-31325, D-35010, D-35940, D-36288, D-36474, D-36486, D-36688, D-36806, D-36820, D-37191, D-37202, D-37264, D-37288, D-37320, D-37518, D-41975, D-42122, D-42367, D-43316, D-43388, D-44059, D-44234, D-44996, E-10215, E-29910, E-36487, E-44813, F-13461, F-13705, F-16595, F-17689, F-34297, F-36067, F-39522, F-43436, G-00177, G-08566, G-13625, G-17470, G-19159, G-28256, G-30181, G-30395, G-32608, G-32735, G-38580, G-38616, G-38869, G-40068, G-42022, G-44696, H-08884, H-23435, H-35880, H-36991, H-42250, H-42336, K-02580, K-09259, K-41682, N-04649
MANGANESE DIOXIDE (JAPANESE) A-34774, A-35052
MANGANESE SULFATES G-08566
MANUAL C-24644, C-43587
MAPPING A-26454, C-25222, D-16684, D-44234, D-44580
MARYLAND D-37026, G-00740, G-41847
MASS SPECTROMETRY A-23239, A-43966, C-26275, C-26505, C-35396, C-38778, C-43737, C-45235, D-23658, D-25055, D-41664, E-31852, F-07451
MASS TRANSPORTATION D-02133, L-09009
MASSACHUSETTS D-01673, D-28920, D-32350, D-35861, E-28586, G-03286, G-34436
MATERIALS DETERIORATION A-18211, A-28210, A-32621, A-33626, A-34018, A-35199, A-36080, A-36083, A-45145, B-03337, B-05300, B-07606, B-28377, B-29656, B-30498, B-31221, B-33388, B-33657, B-33932, B-35080, B-35476, B-36144, B-36145, B-37468, B-41112, B-42290, B-42702, B-42829, B-44614, C-06107, D-37026, D-43468, G-38616, G-45196, H-35880, H-39409, H-39690, I-02176, I-03735, I-06355, I-06357, I-22128, I-31377, I-32921, I-33802, I-36051, K-09259, L-00311, N-03674, N-28088, N-43824
MATHEMATICAL ANALYSES A-15599, A-39603, A-44821, B-22834, B-33386, B-33994, B-36144, C-00855, C-06107, C-10528, C-29419, C-38165, C-38914, D-00969, D-00976, D-05167, D-05277, D-10380, D-19433, D-24351, E-00834, E-01821, E-24166, E-29445, E-30863, E-32155, E-35207, E-37953, E-40157, E-42720, F-13911, F-27348, F-34607, G-16810, G-30831, G-33372, G-39179, H-36197, H-36265, J-34970, J-35391, K-36382, K-44377, N-04649, N-17260
MATHEMATICAL MODELING B-22834, B-33386, C-10528, C-38165, D-10380, E-01821, E-29445, E-32155, E-35207, E-40157, G-30831, G-39179, H-36197, J-34970, J-35391, K-36382, N-04649, N-17260
MAXIMUM ALLOWABLE CONCENTRATION A-22579, A-29516, A-30604, A-30976, A-31315, A-32447, A-33169, A-34341, A-35957, A-36527, A-37190, A-37721, A-39152, B-35166, C-41719, D-02133, D-08275, D-08568, D-27831, D-32055, D-32883, D-33576, E-44999, G-00020, G-03285, G-03654, G-05780, G-08381, G-08683, G-28170, G-29129, G-29815, G-30000, G-31537, G-32905, G-33903, G-38580, G-38721, G-40485, G-40492, G-41737, G-42098, G-44176, H-28448, H-36611, J-27968, K-02580, K-06734, K-06778, K-08803, K-09259, K-11746, K-14443, K-16128, K-19750, K-20121, K-22223, K-33107, K-34063, K-34377, K-36346, K-36823, K-41682, L-00311, L-07952, L-23608, L-23610, L-24214, L-24757, L-32789, L-32865, L-32884, L-35795, L-37497, L-38669, L-38757
MBTH METHOD C-32476
MEASUREMENT METHODS A-01868, A-05067, A-09393, A-12624, A-18297, A-25417, A-26454, A-26645, A-29539, A-31323, A-32523, A-33293, A-33350, A-33710, A-33963, A-33965, A-34350, A-35919, A-37721, A-40947, A-41945, A-41959, A-45145, B-00063, B-20735, B-20844, B-24186, B-28377, B-28730, B-30154, B-30633, B-30950, B-39272, B-44750, C-00125, C-00855, C-01249, C-03037, C-03770, C-06072, C-06107, C-06112, C-06643, C-06881, C-06920, C-08130, C-09333, C-09476, C-09888, C-09983, C-10528, C-10556, C-11042, C-12943, C-13122, C-15562, C-15734, C-16382, C-18007, C-19276, C-21338, C-21459, C-22927, C-23571, C-23596, C-24618, C-24644, C-24719, C-25431, C-25432, C-25979, C-26274, C-26275, C-26336, C-26503, C-26707, C-27106, C-27294, C-28126, C-28621, C-28755, C-28895, C-29419, C-29512, C-29595, C-30290, C-30360, C-32058, C-32169, C-32534, C-32833, C-33055, C-33178, C-34106, C-35396, C-36588, C-37175, C-38165, C-38755, C-38778, C-39168, C-39762, C-40631, C-40724, C-41719, C-41763, C-42137, C-42437, C-43587, C-43763, C-44165, C-44479, D-00261, D-00974, D-02750, D-03526, D-04938, D-04996, D-05167, D-05277, D-06148, D-07649, D-08812, D-08821, D-09240, D-10756, D-11202, D-12049, D-14762, D-15573, D-15575, D-16839, D-17058, D-21684, D-24162, D-24463, D-26044, D-27105, D-27187, D-27672, D-27675, D-28650, D-28785, D-29647, D-29655, D-30326, D-30858, D-30860, D-31332, D-31396, D-32055, D-32350, D-32912, D-33114, D-34008, D-34805, D-35025, D-36009, D-36562, D-37026, D-37366, D-38110, D-40363, D-40574, D-40997, D-41975, D-42122, D-42247, D-43316, D-43388, D-44059, D-44330, E-06841, E-24549, E-32155, E-33873, E-42720, E-44813, F-00841, F-07451, F-27752, F-29400, G-00177, G-02191, G-04877, G-18046, G-20687, G-20990, G-24603, G-25068, G-27416, G-29663, G-29958, G-30831, G-31584, G-32608, G-33864, G-34406, G-34791, G-34841, G-34895, G-34951, G-35041, G-36093, G-36152, G-36747, G-38869, G-39179, G-40021, G-43277, G-43337, G-44433, G-44746, H-39690, I-02176, I-06355, K-08420, K-08803, K-11746, K-30069, K-42118, L-17472, L-24467, L-25542, L-28099, L-32462, L-32865, L-33495, L-35151, L-35922, L-41557, L-44219, N-06992, N-11871, N-28088
MEDICAL FACILITIES G-06985, G-36207

MEDICAL PERSONNEL G-27291, G-32624, G-32737, G-36207, G-41124, G-44395, G-44463, L-23234, L-33844
MEETINGS B-25096, B-32036, B-39333, E-29699, G-27416, G-29963, G-31524, J-30329, K-38197, L-31957, L-36877, N-08273
MEMBRANE FILTERS C-02164, C-06894, C-08661, C-23096, C-23657, C-25015, C-26467, C-26707, C-26848, C-27106, C-27358, C-27556, C-28621, C-30707, C-32476, C-33731, C-37175, C-37514, C-38778, C-38914, C-42043, D-01089, D-01315, D-02133, D-04646, D-07600, D-07985, D-09432, D-21684, D-22553, D-24316, D-25635, D-28528, D-31775, D-34805, D-35861, D-37518, D-42742, D-44996, E-32155, F-07451, F-34948, G-00076, G-00177, G-20687, G-24603
MEMBRANES A-35957, G-06985, G-07892, G-09493, G-32218, G-40068, G-40316, G-41737
MERCAPTANS A-24281, A-45145, C-38755, C-39136, D-41979, F-09745, G-07162
MERCURY C-05977, C-06045, C-10528, F-06648, F-11570, G-07423
MERCURY COMPOUNDS A-06351, A-23561, A-29787, A-31313, A-39367, A-45072, B-31390, C-05977, C-06045, C-09333, C-11626, C-25431, C-26275, C-28126, C-30635, C-32476, C-32534, C-32718, C-33042, C-33338, C-38670, C-39136, C-39516, C-40631, C-42437, C-44210, D-07649, D-27188, D-32912, F-06648, F-11570, G-13154, G-13625, G-17470, G-27085, G-27801, G-31280, G-32218, G-32608, G-34789, G-35042, G-35055, G-37028, G-38580, G-39833, G-39883, G-44364, G-44381, G-45165, H-36265, H-41143, H-41733, H-42857, H-43279, K-41682, L-23608, L-23610, L-24214, L-25288, N-43824
METABOLISM A-23058, A-29872, A-31313, A-40759, C-16382, G-00808, G-02191, G-03281, G-03283, G-03897, G-05002, G-05475, G-05483, G-05671, G-06814, G-09486, G-10793, G-12984, G-13154, G-15703, G-16810, G-26477, G-26483, G-27291, G-27614, G-27801, G-28834, G-29588, G-29815, G-29816, G-29958, G-30686, G-31528, G-31962, G-32041, G-32216, G-32624, G-32737, G-32738, G-33778, G-33910, G-34709, G-35021, G-35174, G-35225, G-35792, G-36207, G-36354, G-36747, G-36957, G-36964, G-37023, G-37119, G-37229, G-37933, G-38579, G-39621, G-40021, G-40057, G-40485, G-41872, G-42091, G-42759, G-42884, G-43531, G-44053, G-44395, G-45005, H-27391, H-38332, H-39407, H-41461, H-42924, H-42945, K-36346
METAL COMPOUNDS A-00962, A-01565, A-01624, A-01868, A-02636, A-03278, A-03279, A-03280, A-03982, A-04460, A-05067, A-05171, A-06220, A-06351, A-08039, A-08972, A-09210, A-09355, A-09393, A-09686, A-10749, A-11702, A-12624, A-12751, A-12823, A-13524, A-14033, A-14135, A-14459, A-14461, A-14462, A-14945, A-15205, A-15295, A-15599, A-15769, A-16156, A-16766, A-17304, A-17325, A-17339, A-17365, A-17778, A-18211, A-18297, A-18510, A-19598, A-19684, A-19955, A-20545, A-20927, A-21069, A-21109, A-21722, A-22367, A-22370, A-22579, A-22825, A-22941, A-22976, A-23058, A-23239, A-23250, A-23280, A-23316, A-23561, A-23620, A-23789, A-24031, A-24080, A-24156, A-24281, A-24285, A-24718, A-24829, A-24996, A-25295, A-25417, A-25581, A-26100, A-26134, A-26191, A-26441, A-26454, A-26552, A-26645, A-26763, A-26891, A-26925, A-27113, A-27180, A-27249, A-27272, A-27458, A-27595, A-27858, A-27943, A-28210, A-28336, A-28394, A-28560, A-28862, A-28873, A-29096, A-29127, A-29364, A-29516, A-29539, A-29572, A-29661, A-29782, A-29786, A-29787, A-29872, A-29936, A-30001, A-30027, A-30067, A-30414, A-30428, A-30513, A-30604, A-30674, A-30759, A-30976, A-31085, A-31088, A-31133, A-31136, A-31313, A-31315, A-31323, A-31324, A-31395, A-31520, A-31525, A-31596, A-31632, A-31649, A-31934, A-32035, A-32447, A-32492, A-32523, A-32621, A-32748, A-32875, A-33087, A-33169, A-33293, A-33350, A-33365, A-33378, A-33626, A-33667, A-33710, A-33822, A-33963, A-33965, A-34018, A-34031, A-34040, A-34068, A-34177, A-34341, A-34350, A-34442, A-34647, A-34774, A-35050, A-35052, A-35065, A-35078, A-35123, A-35168, A-35199, A-35224, A-35353, A-35398, A-35477, A-35481, A-35484, A-35676, A-35788, A-35818, A-35919, A-35953, A-35957, A-36006, A-36032, A-36080, A-36082, A-36083, A-36084, A-36527, A-36535, A-36541, A-36623, A-36664, A-36846, A-37015, A-37166, A-37176, A-37190, A-37312, A-37372, A-37648, A-37721, A-38022, A-38330, A-38331, A-38522, A-38543, A-38625, A-38759, A-38819, A-38891, A-39035, A-39067, A-39152, A-39367, A-39603, A-39609, A-39610, A-39754, A-40314, A-40455, A-40583, A-40677, A-40759, A-40776, A-40947, A-40981, A-41035, A-41145, A-41518, A-41604, A-41654, A-41738, A-41889, A-41890, A-41945, A-41959, A-42080, A-42212, A-42377, A-42679, A-42726, A-42791, A-42980, A-43346, A-43776, A-43966, A-44227, A-44252, A-44464, A-44682, A-44821, A-45072, A-45092, A-45136, A-45145, A-45274, B-00015, B-00063, B-00899, B-01484, B-01851, B-03232, B-03337, B-05214, B-05300, B-06493, B-08562, B-09231, B-09798, B-10558, B-13982, B-14604, B-17906, B-18053, B-19331, B-19637, B-19710, B-19725, B-19808, B-20735, B-20740, B-20844, B-21040, B-21303, B-21719, B-21762, B-22414, B-22436, B-22492, B-22834, B-22890, B-23540, B-23697, B-23923, B-24182, B-24184, B-24186, B-24553, B-24696, B-24722, B-24813, B-25033, B-25096, B-25155, B-25301, B-25334, B-25377, B-25470, B-25894, B-26153, B-26243, B-26269, B-26532, B-27371, B-27503, B-27824, B-27850, B-27876, B-28059, B-28060, B-28108, B-28172, B-28286, B-28377, B-28699, B-28730, B-28860, B-28865, B-29058, B-29126, B-29204, B-29414, B-29531, B-29605, B-29625, B-29628, B-29656, B-29664, B-29898, B-29920, B-30010, B-30124, B-30154, B-30229, B-30498, B-30633, B-30717, B-30944, B-30950, B-31221, B-31246, B-31314, B-31317, B-31341, B-31364, B-31390, B-31441, B-31496, B-31519, B-31604, B-31690, B-31819, B-31825, B-31985, B-32036, B-32260, B-32355, B-32364, B-32392, B-32424, B-32633, B-32822, B-32938, B-33157, B-33366, B-33386, B-33388, B-33403, B-33542, B-33550, B-33628, B-33657, B-33741, B-33932, B-33994, B-34025, B-34035, B-34071, B-34313, B-34381, B-34457, B-34536, B-34611, B-34740, B-34846, B-35018, B-35035, B-35080, B-35112, B-35166, B-35223, B-35296, B-35303, B-35342, B-35352, B-35476, B-35535, B-35540, B-35688, B-35703, B-35778, B-35814, B-35816, B-35821, B-36081, B-36144, B-36145, B-36453, B-36523, B-36578, B-36721, B-37042, B-37116, B-37150, B-37173, B-37195, B-37222, B-37234, B-37275, B-37408, B-37468, B-37619, B-37750, B-37845, B-37938, B-38287, B-38614, B-38727, B-39272, B-39275, B-39333, B-39404, B-39492, B-40411, B-40709, B-40723, B-40785, B-41112, B-41544, B-41608, B-41793, B-41922, B-42131, B-42166, B-42290, B-42300, B-42330, B-42702, B-42817, B-42819, B-42829, B-42886, B-43333, B-43515, B-43575, B-43937, B-44003, B-44283, B-44341, B-44470, B-44473, B-44614, B-44660, B-44742, B-44750, B-44882, B-44906, C-00125, C-00855, C-01230, C-01607, C-01608, C-02164, C-03034, C-03037, C-03770, C-05243, C-05456, C-05787, C-05977, C-06045, C-06072, C-06107, C-06112, C-06643, C-06894, C-08130, C-08145, C-08661, C-09333, C-09476, C-09888, C-09953, C-09983, C-10528, C-10556, C-10561, C-11042, C-11626, C-12943, C-12993, C-13122, C-14758, C-15562, C-15563, C-16123, C-16367, C-16382, C-17048, C-17179, C-17180, C-17771, C-18007, C-19276, C-19313, C-19501, C-20891, C-20945, C-21338, C-21459, C-21862, C-21948, C-22927, C-22975, C-23096, C-23571, C-23596, C-23646, C-23657, C-24119, C-24337, C-24617, C-24618, C-24644, C-24719, C-25013, C-25015, C-25222, C-25431, C-25432, C-25440, C-25535, C-25793, C-25932, C-25979, C-26145, C-26274, C-26275, C-26336, C-26467, C-26503, C-26505, C-26698, C-26707, C-26848, C-26955, C-27075, C-27106, C-27294, C-27358, C-27556, C-27681, C-27829, C-28017, C-28126, C-28621, C-28755, C-28895, C-29133, C-29226, C-29297, C-29419, C-29464, C-29512, C-29810, C-30113, C-30290, C-30360, C-30593, C-30635, C-30707, C-30786, C-30928, C-31258, C-31304, C-31933, C-32058, C-32169, C-32474, C-32476, C-32534, C-32718, C-32829, C-32833, C-32892, C-32975, C-33042, C-33055, C-33178, C-33255, C-33338, C-33731, C-34017, C-34106, C-34407, C-35396, C-35494, C-35695, C-36588, C-36698, C-36703, C-36840, C-36841, C-37175, C-37514, C-37608, C-37689, C-37693, C-37971, C-38165, C-38670, C-38682, C-38755, C-38778, C-38914, C-38973, C-39069, C-39136, C-39168, C-39516, C-39762, C-40407, C-40631, C-40724, C-41016, C-41138, C-41490, C-41612, C-41719, C-41763, C-41825,

C-41908, C-41968, C-42020, C-42043, C-42084, C-42137, C-42139, C-42160, C-42312, C-42360, C-42437, C-42775, C-42928, C-43448, C-43587, C-43720, C-43737, C-43763, C-44129, C-44165, C-44210, C-44479, C-44995, C-45235, D-00261, D-00969, D-00974, D-01089, D-01315, D-01355, D-01673, D-02133, D-02750, D-03410, D-03441, D-03526, D-04646, D-04938, D-04996, D-05167, D-05260, D-05551, D-05573, D-05623, D-05820, D-06148, D-06760, D-06788, D-07198, D-07600, D-07649, D-07985, D-08275, D-08279, D-08438, D-08502, D-08568, D-08591, D-08810, D-08812, D-08821, D-09240, D-09432, D-09726, D-10380, D-10554, D-10595, D-10612, D-10756, D-11028, D-11184, D-14762, D-15175, D-15314, D-15573, D-15575, D-15610, D-15789, D-15823, D-16345, D-16539, D-16576, D-16684, D-16791, D-16839, D-17058, D-17106, D-17340, D-19144, D-19433, D-19822, D-20642, D-21015, D-21684, D-21869, D-21906, D-22290, D-22553, D-22829, D-23388, D-23658, D-23864, D-23971, D-24162, D-24316, D-24351, D-24414, D-24463, D-24952, D-25055, D-25089, D-25107, D-25635, D-25758, D-25881, D-26054, D-26287, D-26387, D-26535, D-27096, D-27105, D-27174, D-27187, D-27188, D-27191, D-27241, D-27257, D-27429, D-27621, D-27648, D-27672, D-27675, D-27831, D-27880, D-28097, D-28178, D-28233, D-28326, D-28369, D-28528, D-28620, D-28629, D-28634, D-28635, D-28650, D-28653, D-28785, D-28920, D-29152, D-29153, D-29191, D-29382, D-29385, D-29416, D-29465, D-29515, D-29647, D-29655, D-29744, D-29814, D-29918, D-30025, D-30182, D-30326, D-30410, D-30493, D-30494, D-30656, D-30858, D-30860, D-30892, D-31014, D-31325, D-31332, D-31396, D-31669, D-31775, D-32055, D-32350, D-32727, D-32883, D-32912, D-32945, D-33114, D-33576, D-34008, D-34805, D-34933, D-35010, D-35025, D-35407, D-35489, D-35725, D-35861, D-35940, D-36009, D-36195, D-36288, D-36449, D-36474, D-36486, D-36503, D-36562, D-36688, D-36806, D-36820, D-36909, D-37026, D-37191, D-37202, D-37264, D-37288, D-37320, D-37366, D-37369, D-37394, D-37518, D-38110, D-38133, D-39081, D-39405, D-39535, D-39914, D-39988, D-40118, D-40574, D-40584, D-40716, D-40997, D-41033, D-41520, D-41664, D-41887, D-41888, D-41975, D-41979, D-42120, D-42122, D-42247, D-42367, D-42742, D-42921, D-43316, D-43388, D-43468, D-43558, D-43693, D-43962, D-44059, D-44063, D-44170, D-44234, D-44330, D-44580, D-44996, D-45218, E-00834, E-01821, E-10215, E-12777, E-19058, E-21182, E-21796, E-22754, E-22959, E-23743, E-24109, E-24166, E-24549, E-24570, E-27116, E-28586, E-28799, E-29445, E-29688, E-29699, E-29910, E-29946, E-30073, E-30676, E-30863, E-31852, E-31895, E-32155, E-32158, E-33225, E-33873, E-35207, E-35264, E-36038, E-36487, E-36714, E-37953, E-38118, E-38666, E-40157, E-40164, E-44813, E-44999, E-45050, F-00058, F-00841, F-03525, F-03799, F-05440, F-05849, F-06648, F-08207, F-09578, F-09745, F-10599, F-11570, F-11582, F-13451, F-13461, F-13635, F-13705, F-13839, F-13879, F-13911, F-13943, F-14008, F-14039, F-14138, F-14510, F-14743, F-14868, F-14995, F-15413, F-15493, F-15618, F-16595, F-16659, F-17585, F-17689, F-17882, F-17949, F-27752, F-28908, F-29400, F-34297, F-34607, F-34948, F-35378, F-36067, F-36076, F-36524, F-37213, F-39522, F-39901, F-40387, F-41787, F-42772, F-43245, F-43436, F-44032, F-44164, F-44332, F-45295, G-00020, G-00076, G-00148, G-00177, G-00375, G-00473, G-00597, G-00642, G-00705, G-00708, G-00808, G-00810, G-00821, G-00873, G-00902, G-00993, G-01341, G-01500, G-01512, G-01731, G-01754, G-01755, G-01756, G-01757, G-01797, G-02191, G-02202, G-03281, G-03282, G-03283, G-03284, G-03285, G-03286, G-03287, G-03635, G-03892, G-03897, G-04196, G-04251, G-04877, G-05002, G-05025, G-05280, G-05475, G-05478, G-05483, G-05541, G-05671, G-05697, G-05780, G-06028, G-06059, G-06151, G-06174, G-06177, G-06704, G-06814, G-07162, G-07169, G-07396, G-07551, G-07740, G-07892, G-08326, G-08381, G-08411, G-08566, G-08683, G-08949, G-08999, G-09019, G-09253, G-09261, G-09408, G-09484, G-09486, G-09493, G-10793, G-10856, G-11468, G-11552, G-11580, G-11630, G-11808, G-12038, G-12070, G-12075, G-12646, G-12984, G-13059, G-13154, G-13159, G-13625, G-14156, G-14492, G-15731, G-16810, G-16820, G-17214, G-17244, G-17470, G-18046, G-18417, G-18494, G-18501, G-18502, G-18503, G-18508, G-18515, G-18518, G-18549, G-19159, G-19304, G-19881, G-19940, G-20087, G-20198, G-20287, G-20687, G-20704, G-20990, G-21037, G-21259, G-21266, G-21423, G-21766, G-22222, G-22637, G-23167, G-23582, G-23715, G-23768, G-23801, G-23876, G-23887, G-23926, G-24081, G-24192, G-24288, G-24314, G-24428, G-24573, G-24603, G-24716, G-24784, G-24877, G-24961, G-25068, G-25328, G-25705, G-26260, G-26310, G-26356, G-26477, G-26483, G-26528, G-26720, G-26775, G-26883, G-26886, G-26915, G-26931, G-27084, G-27085, G-27107, G-27253, G-27291, G-27416, G-27490, G-27614, G-27801, G-27961, G-28010, G-28011, G-28024, G-28170, G-28171, G-28256, G-28834, G-29129, G-29256, G-29286, G-29329, G-29493, G-29588, G-29663, G-29789, G-29815, G-29816, G-29825, G-29958, G-29963, G-30000, G-30009, G-30156, G-30181, G-30198, G-30328, G-30334, G-30355, G-30395, G-30468, G-30671, G-30672, G-30686, G-30831, G-31040, G-31228, G-31280, G-31303, G-31319, G-31351, G-31442, G-31452, G-31491, G-31493, G-31517, G-31524, G-31528, G-31537, G-31584, G-31899, G-31962, G-32041, G-32129, G-32216, G-32218, G-32408, G-32484, G-32487, G-32608, G-32613, G-32624, G-32625, G-32696, G-32735, G-32737, G-32738, G-32746, G-32747, G-32749, G-32787, G-32834, G-32905, G-33052, G-33165, G-33202, G-33234, G-33372, G-33374, G-33497, G-33527, G-33605, G-33607, G-33778, G-33779, G-33864, G-33903, G-33910, G-34059, G-34066, G-34092, G-34095, G-34114, G-34175, G-34246, G-34406, G-34436, G-34649, G-34701, G-34709, G-34738, G-34789, G-34791, G-34832, G-34836, G-34837, G-34841, G-34847, G-34851, G-34895, G-34902, G-34914, G-34943, G-34947, G-34951, G-35021, G-35041, G-35042, G-35055, G-35118, G-35174, G-35211, G-35217, G-35219, G-35225, G-35377, G-35380, G-35387, G-35438, G-35463, G-35559, G-35560, G-35568, G-35587, G-35714, G-35792, G-35811, G-36093, G-36152, G-36207, G-36251, G-36283, G-36354, G-36534, G-36551, G-36740, G-36747, G-36765, G-36932, G-36934, G-36935, G-36957, G-36964, G-37023, G-37028, G-37040, G-37119, G-37180, G-37229, G-37297, G-37420, G-37540, G-37630, G-37685, G-37722, G-37731, G-37788, G-37933, G-37941, G-37942, G-37964, G-38579, G-38580, G-38616, G-38721, G-38867, G-38869, G-39095, G-39161, G-39179, G-39193, G-39406, G-39503, G-39621, G-39826, G-39833, G-39863, G-39867, G-39883, G-39989, G-40014, G-40021, G-40022, G-40057, G-40068, G-40295, G-40312, G-40316, G-40317, G-40355, G-40435, G-40485, G-40492, G-40532, G-40634, G-40688, G-40697, G-40769, G-41067, G-41097, G-41124, G-41368, G-41695, G-41717, G-41731, G-41737, G-41818, G-41847, G-41857, G-41872, G-41894, G-41895, G-42022, G-42091, G-42098, G-42136, G-42463, G-42661, G-42698, G-42716, G-42737, G-42757, G-42759, G-42881, G-42884, G-42957, G-43196, G-43277, G-43337, G-43531, G-43532, G-43559, G-43615, G-43725, G-44053, G-44087, G-44176, G-44251, G-44254, G-44255, G-44294, G-44364, G-44381, G-44385, G-44395, G-44433, G-44463, G-44508, G-44696, G-44746, G-44867, G-45005, G-45159, G-45165, G-45196, G-45273, G-45288, G-45293, H-01523, H-07742, H-08884, H-09448, H-10318, H-11157, H-11452, H-11467, H-12536, H-12647, H-14489, H-14786, H-16270, H-16655, H-17038, H-17182, H-17215, H-17216, H-17217, H-17218, H-17220, H-17225, H-17681, H-17978, H-18481, H-18520, H-18521, H-19604, H-19620, H-20062, H-20237, H-21018, H-21794, H-22926, H-23258, H-23435, H-23581, H-24667, H-24788, H-24947, H-25374, H-25878, H-25967, H-26055, H-26092, H-26276, H-27063, H-27111, H-27352, H-27386, H-27391, H-27489, H-28105, H-28289, H-28379, H-28448, H-28471, H-28529, H-30033, H-30225, H-30424, H-30921, H-30931, H-31010, H-31185, H-31801, H-32224, H-32322, H-32335, H-32338, H-32423, H-32654, H-32736, H-33112, H-33201, H-33362, H-33364, H-33922, H-33985, H-34237, H-34830, H-34831, H-34901, H-35209, H-35234, H-35410, H-35827, H-35880, H-36196, H-36197, H-36265, H-36611, H-36991, H-37912, H-37926, H-37977, H-38332, H-38743, H-39204, H-39287, H-39328, H-39407, H-39408, H-39409, H-39690, H-40024, H-40335, H-40368, H-40540, H-40590, H-40591, H-41143, H-41461, H-41733,

H-41800, H-41891, H-41892, H-41893, H-42207, H-42250, H-42336, H-42607, H-42715, H-42857, H-42924, H-42945, H-43226, H-43279, H-43342, H-43511, H-43721, H-43782, H-44071, H-44588, H-45056, I-00305, I-31377, I-32921, I-33802, I-36051, J-03288, J-03289, J-21749, J-22358, J-26765, J-27968, J-30329, J-30696, J-31518, J-31720, J-32241, J-34370, J-34828, J-34970, J-35391, J-36592, J-37409, J-37734, J-38624, J-39941, J-39956, J-42721, K-02580, K-03007, K-03956, K-06734, K-06778, K-08420, K-08803, K-09259, K-11746, K-14443, K-16104, K-16128, K-16808, K-18294, K-19750, K-20121, K-22223, K-24107, K-30035, K-30069, K-33107, K-33730, K-34063, K-34377, K-36346, K-36382, K-36823, K-38197, K-38758, K-41682, K-42039, K-42118, K-43312, K-44310, K-44377, L-00311, L-02635, L-03536, L-07952, L-08196, L-08725, L-09009, L-16200, L-17472, L-22583, L-23234, L-23608, L-23610, L-24214, L-24467, L-24757, L-25288, L-25542, L-27664, L-28099, L-28349, L-28397, L-28869, L-29421, L-29888, L-30152, L-30620, L-30908, L-31454, L-31957, L-32462, L-32789, L-32865, L-32884, L-33495, L-33740, L-33844, L-34033, L-34980, L-35151, L-35461, L-35795, L-36030, L-36877, L-37193, L-37392, L-37423, L-37497, L-37521, L-37560, L-37717, L-38669, L-38757, L-39640, L-40486, L-40520, L-41289, L-41557, L-41703, L-42016, L-42041, L-42169, L-42873, L-44044, L-44219, L-44325, L-44376, L-44499, M-01073, M-29432, M-33904, M-35206, N-04052, N-04212, N-04649, N-05313, N-06992, N-08273, N-09780, N-11871, N-14772, N-17260, N-18005, N-20548, N-28088, N-28803, N-37225, N-43824

METAL FABRICATING AND FINISHING A-03280, A-20652, A-31525, A-32035, A-35078, A-35957, A-39462, A-42726, B-03125, B-03754, B-09798, B-10558, B-17525, B-21324, B-31441, B-32319, B-35035, B-38727, B-43515, B-44853, C-10561, C-25222, D-03526, D-10380, D-21869, D-30326, D-30892, G-00821, G-00902, G-03281, G-03287, G-06704, G-08566, G-08949, G-09253, G-09408, G-24428, G-30334, G-30831, G-34092, G-36093, G-41067, G-41731, G-42136, H-07742, H-08884, H-11467, H-17978, H-23581, H-31010, H-32291, J-30696, J-42721, K-14443, L-00311, L-34980

METAL POISONING A-06220, A-21109, A-23058, A-24285, A-27113, A-28862, A-31313, A-35953, A-35957, A-36527, A-40759, B-32260, B-32424, C-01607, C-01608, C-33338, D-08275, D-08812, F-11570, F-11582, G-00076, G-00642, G-00705, G-00708, G-00736, G-00740, G-00808, G-00810, G-00821, G-00902, G-00993, G-01341, G-01512, G-01754, G-01755, G-01756, G-01757, G-01812, G-01923, G-02202, G-03283, G-03286, G-03635, G-03654, G-03892, G-03893, G-03897, G-04196, G-04251, G-04877, G-05025, G-05475, G-05478, G-05483, G-05541, G-05671, G-05697, G-05780, G-06028, G-06059, G-06174, G-06177, G-06704, G-06985, G-07169, G-07396, G-07551, G-07740, G-07892, G-08381, G-08411, G-08566, G-08683, G-08949, G-08999, G-09019, G-09253, G-09261, G-09408, G-09484, G-09486, G-09493, G-10793, G-10856, G-11462, G-11468, G-11552, G-11580, G-13625, G-15703, G-17470, G-18515, G-18518, G-20704, G-21423, G-22637, G-23167, G-23582, G-23887, G-23926, G-24192, G-24716, G-24784, G-24961, G-26310, G-26477, G-26483, G-26528, G-26720, G-26883, G-26886, G-26915, G-27084, G-27085, G-27416, G-28170, G-28205, G-28256, G-29256, G-29493, G-29789, G-29963, G-30686, G-31228, G-31280, G-31351, G-31442, G-31452, G-31491, G-31493, G-31517, G-31524, G-31528, G-31537, G-31584, G-31899, G-31962, G-32041, G-32216, G-32218, G-32408, G-32487, G-32608, G-32624, G-32625, G-32696, G-32737, G-32738, G-32746, G-32747, G-32834, G-33202, G-33234, G-33374, G-33497, G-33527, G-33605, G-33607, G-33910, G-34059, G-34095, G-34114, G-34436, G-34649, G-34701, G-34709, G-34738, G-34791, G-34832, G-34836, G-34837, G-34841, G-34914, G-34943, G-34947, G-35021, G-35042, G-35055, G-35174, G-35211, G-35217, G-35225, G-35380, G-35387, G-35438, G-35463, G-35559, G-35560, G-35568, G-35587, G-35711, G-36093, G-36152, G-36207, G-36283, G-36740, G-36747, G-36932, G-36934, G-36957, G-36964, G-37023, G-37028, G-37119, G-37297, G-37420, G-37731, G-37788, G-38579, G-39095, G-39193, G-39406, G-39621, G-39863, G-39867, G-39989, G-40021, G-40022, G-40057, G-40068, G-40295, G-40312, G-40317, G-40435, G-40485, G-40492, G-40697, G-40769, G-41067, G-41695, G-41818, G-41847, G-41857, G-41872, G-42022, G-42098, G-42716, G-42737, G-42759, G-43196, G-43337, G-43531, G-43559, G-44251, G-44294, G-44463, G-44508, G-44746, G-44867, G-45005, H-08884, H-10318, H-11467, H-12536, H-16270, H-18481, H-18520, H-18521, H-26092, H-26276, H-27063, H-30033, H-30931, H-32291, H-32736, H-33362, H-34830, H-34831, H-35209, H-36196, H-36265, H-37912, H-40591, H-41461, H-42945, H-43511, H-44588, K-11746, K-16104, L-08725, L-35461, L-37521, M-35206

METALS A-01565, A-01868, A-03278, A-03280, A-03982, A-06220, A-09210, A-09686, A-10749, A-13524, A-20652, A-24285, A-29787, A-31649, A-34018, A-34788, A-34916, A-34921, A-35168, A-39462, A-40677, A-41518, A-42676, A-42726, A-43271, B-00015, B-00063, B-00107, B-01851, B-03125, B-03232, B-03337, B-03754, B-07606, B-08562, B-09798, B-15208, B-16053, B-17525, B-21324, B-22492, B-22520, B-25334, B-25377, B-25470, B-25781, B-26600, B-29058, B-29656, B-30124, B-30154, B-30717, B-31317, B-31819, B-31825, B-32248, B-32319, B-32760, B-34035, B-34071, B-35035, B-35296, B-35303, B-35342, B-35478, B-35778, B-37173, B-37222, B-37408, B-37750, B-39275, B-40709, B-43937, B-44853, C-00056, C-00125, C-01230, C-01249, C-01607, C-01608, C-03037, C-05456, C-05977, C-06045, C-06072, C-06643, C-06881, C-06894, C-06920, C-08130, C-08661, C-09983, C-10528, C-10556, C-10561, C-11042, C-14758, C-15734, C-18302, C-19857, C-29464, C-30360, D-00005, D-00017, D-00261, D-00697, D-00974, D-00976, D-00985, D-01089, D-01315, D-01355, D-01673, D-02750, D-03526, D-04996, D-05277, D-05551, D-05623, D-05820, D-07600, D-07985, D-08275, D-08279, D-08438, D-08502, D-08568, D-08821, D-09240, D-10612, D-10634, D-10756, D-11028, D-11202, D-12049, D-12099, D-20191, D-21869, D-26054, D-27880, D-29153, D-29191, D-30326, D-30860, D-30892, D-35940, D-37320, D-38110, D-44330, E-03841, E-05713, E-06841, F-00841, F-03525, F-06648, F-07451, F-09578, F-10599, F-11570, F-11582, F-13534, F-17161, F-19823, F-27348, F-35378, F-35379, F-36524, F-40387, G-00020, G-00076, G-00148, G-00177, G-00375, G-00473, G-00597, G-00642, G-00662, G-00736, G-00740, G-00993, G-01500, G-01512, G-01731, G-01797, G-01812, G-01923, G-02191, G-02202, G-03086, G-03283, G-03284, G-03654, G-03892, G-03893, G-03897, G-04877, G-05002, G-05475, G-05478, G-05483, G-05541, G-05697, G-05780, G-06028, G-06059, G-06174, G-06177, G-06704, G-06985, G-07162, G-07396, G-07423, G-07551, G-07740, G-07892, G-08326, G-08381, G-08411, G-08566, G-08683, G-08949, G-08999, G-09019, G-09253, G-09261, G-09408, G-09484, G-09486, G-09493, G-09535, G-10434, G-10856, G-11462, G-11468, G-11552, G-11580, G-11630, G-12070, G-15703, G-21070, G-27107, G-28205, G-31319, G-36093, G-41067, H-01523, H-07742, H-08884, H-09448, H-10318, H-11157, H-11467, H-12647, H-17978, H-26276, H-32291, H-32338, H-39690, I-02176, I-03735, I-06355, I-06357, I-22128, I-32921, I-33802, J-30696, K-06734, K-08420, K-11746, K-36823, L-07952, L-08725, L-11204, L-17927, L-23562, L-23608, L-24214, L-28066, L-35795, L-35922, N-03674, N-04649, N-06992, N-08273

METEOROLOGICAL INSTRUMENTS D-03410, E-24549

METEOROLOGY A-01868, A-03280, A-11702, A-15205, A-18510, A-19684, A-19955, A-21069, A-21722, A-23561, A-23620, A-26191, A-26454, A-29096, A-29787, A-30513, A-31315, A-33293, A-33822, A-33963, A-34647, A-35078, A-35788, A-36032, A-37166, A-37190, A-38625, A-39367, A-40583, A-41145, A-45092, B-09231, B-19808, B-20735, B-28377, B-28730, B-31221, B-31690, B-32760, B-33550, B-35816, B-37750, B-44283, C-00855, C-02164, C-06920, C-18302, C-19313, C-21948, C-22927, C-23646, C-26274, C-26848, C-27829, C-30360, C-33042, C-40724, C-43587, C-44995, D-00005, D-00261, D-00969, D-02133, D-03410, D-03441, D-04646, D-04938, D-04996, D-05277, D-05573, D-05623, D-07198, D-08502, D-08568, D-08821, D-09240, D-09726, D-10634, D-12099, D-15789, D-16576, D-16791, D-16839, D-17340, D-19433, D-21015, D-21684, D-22829, D-23658, D-23864, D-23971, D-24414, D-24952, D-25089,

D-25635, D-26054, D-26387, D-26535, D-27187, D-27191, D-27648, D-27672, D-28620, D-28629, D-28650, D-28920, D-29647, D-29655, D-29814, D-29918, D-30182, D-30410, D-30860, D-31325, D-32055, D-32727, D-32912, D-33114, D-34008, D-34805, D-35489, D-35725, D-35861, D-36009, D-36449, D-36474, D-36806, D-37026, D-37288, D-37366, D-37369, D-37394, D-39081, D-39405, D-39988, D-40584, D-41979, D-42122, D-42247, D-43693, D-43962, D-44059, D-44996, E-00834, E-01821, E-03841, E-05713, E-06841, E-10215, E-12777, E-19058, E-21182, E-21796, E-22754, E-22959, E-23743, E-24109, E-24166, E-24570, E-27116, E-28586, E-28799, E-29445, E-29688, E-29699, E-29910, E-30073, E-30676, E-30863, E-31895, E-32155, E-32158, E-33873, E-35207, E-36714, E-37953, E-38118, E-38666, E-40157, E-40164, E-44813, E-44999, E-45050, F-03525, F-35379, G-00076, G-00177, G-00375, G-19940, G-23801, G-29129, G-29789, G-31040, G-32129, G-32735, G-32905, G-33778, G-34092, G-37420, G-38616, G-40485, G-42463, G-44087, H-08884, H-11157, H-11452, H-12647, H-14786, H-17225, H-17681, H-23258, H-26055, H-28289, H-31010, H-32224, H-33112, H-33364, H-33922, H-33985, H-35827, H-39287, H-39408, H-39690, H-42250, H-42924, I-00305, I-02176, K-36382, L-03536, L-08196, L-23562, L-25288, L-25542, L-26442, L-33844, L-35922, N-04052, N-04212, N-08273, N-11871

METHANES A-34774, A-42377, A-44252, B-03337, B-19725, B-30154, C-01230, C-41719, D-19433, D-30860, F-06648, F-17689, F-39901

MEUSE VALLEY G-00375, G-07423

MEXICO A-40314, G-42757, G-44867, L-41557

MICE A-17778, G-00148, G-00375, G-00473, G-01731, G-12075, G-23167, G-30671, G-34914, G-34943, G-38869, G-40014, G-40688, G-43615, G-44254

MICHIGAN A-26645, A-40776, D-04938, D-04996, D-10612, D-11184, D-29655, D-35489

MICROMETEOROLOGY A-23561, D-26387, D-26535, E-24570, E-29445, E-29910, E-35207, L-25288, L-26442

MICROORGANISMS C-32058, C-33055, G-00375, G-35042, G-41097, G-44254, G-45159, N-43824

MICROSCOPY B-27371, B-44614, C-08130, C-09888, C-10561, C-23657, C-26698, C-29512, C-35695, G-06151, G-18515, G-39863

MIDDLE ATMOSPHERE D-24316

MILK A-03279, A-37190, B-32424, G-08566, G-33910, G-34943, G-36765, H-31185, H-32291, H-33201, H-33922, H-39407, H-39408, H-40024, L-07952

MINERAL PROCESSING A-13524, A-26441, A-31395, A-34018, A-34068, A-35398, A-37190, A-39462, A-40314, A-42726, A-43346, B-00107, B-03125, B-03337, B-03754, B-31441, B-32248, C-03037, D-03441, D-05260, D-10380, D-21869, D-27880, D-30326, D-30860, D-32055, D-35940, D-41979, F-35378, F-35379, G-01512, G-03892, G-04251, G-09261, G-33052, G-34092, G-36283, G-39095, G-44696, H-07742, H-11157, H-11467, H-14489, H-19620, H-26276, H-27386, H-31185, H-32322, H-32338, H-35880, H-37912, H-37926, J-30329, J-30696, K-14443, K-34063, K-34377, L-17927, L-23562, L-28066

MINERAL PRODUCTS A-23561, A-27272, A-35052, A-39367, A-39462, B-03754, B-34313, B-44283, C-06045, C-08130, C-10528, C-29464, C-29512, C-40631, G-07423, G-13625, G-21259, G-25068, G-27085, G-40068, G-44395, H-26276, H-32224, H-39204, H-40368, L-24467

MINING A-34068, A-35398, A-40314, A-43346, B-31441, F-35378, F-35379, G-01512, G-04251, G-39095, G-44696, H-07742, H-11467, H-19620, H-27386, H-37912, H-37926, J-30329, L-28066

MISSILES AND ROCKETS A-27595, F-07451, G-07551, N-20548

MISSOURI A-01868, A-02636, A-03982, B-00063, B-03337, C-45235, D-36449, E-00834, F-03525, F-03799, G-02191, G-03635, H-39204, I-02176

MISTS A-35957, A-39462, B-07606, B-28172, B-34611, C-09333, D-07198, D-29382, E-32155, E-36038, G-03282, G-12038, G-31452, G-32735, H-41891, K-08803, K-20121, K-36823, N-04212

MOBILE A-33350, B-34025, B-39275, C-22927, C-25431, C-25432, D-00976, D-02750, G-31524, J-30696

MOLYBDENUM D-00017, D-00974, D-03526, F-10599, F-13534, G-00662, G-03086, I-06355, I-06357

MOLYBDENUM COMPOUNDS A-05067, A-06351, C-36698, C-38682, C-44995, D-04996, D-05167, D-27174, D-44996, E-29910, F-39522, F-43436, G-13159, G-32608, H-11452, H-23435, H-36991, H-39287, H-42924, H-43226

MONITORING A-12624, A-26645, A-31323, A-33293, A-33710, A-34350, A-41945, A-41959, A-45145, B-28730, B-30154, B-30633, B-30950, B-44750, C-00855, C-06112, C-12943, C-16382, C-18007, C-19276, C-21338, C-22927, C-23596, C-24644, C-25431, C-25432, C-26275, C-27294, C-28621, C-28895, C-29419, C-32534, C-32833, C-40631, C-40724, C-44165, D-04996, D-05167, D-07649, D-08812, D-09240, D-11202, D-12049, D-14762, D-15575, D-16839, D-17058, D-24162, D-24463, D-27672, D-27675, D-28650, D-28785, D-29647, D-30326, D-30858, D-30860, D-31396, D-32055, D-34008, D-35025, D-36009, D-36562, D-37366, D-38110, D-41975, D-42122, D-43316, E-32155, G-00177, G-20687, G-25068, G-30831, G-31584, G-32608, G-33864, G-34406, G-34791, G-34841, G-34895, G-36093, G-36152, G-36747, G-38869, G-39179, G-43277, G-43337, H-39690, K-08803, K-11746, K-30069, K-42118, L-17472, L-24467, L-25542, L-33495, L-35922, L-41557, L-44219, N-11871

MONTANA A-41889, A-41890, D-03410, D-41887, D-41888, G-41894, G-41895, H-41891, H-41892, H-41893

MONTHLY A-30513, B-30633, D-00974, D-01315, D-03441, D-04996, D-06760, D-08279, D-15610, D-23388, D-24414, D-26044, D-27241, D-27648, D-28650, D-29655, D-29744, D-30656, D-30858, D-30860, D-31325, D-31396, D-32727, D-32945, D-33576, D-35025, D-36009, D-37026, D-37288, D-37369, D-38133, D-39535, D-40363, D-40997, D-42247, D-42742, D-43558, E-12777, G-20687, H-33112, K-19750

MORBIDITY D-03441, D-16345, F-35379, G-00473, G-00736, G-01755, G-03286, G-05541, G-07162, G-09408, G-38616, G-39833, G-40634, G-41737, H-30033

MORTALITY A-27595, A-31313, A-31395, C-45235, D-16345, D-31396, D-32055, G-00473, G-00736, G-00873, G-01731, G-01755, G-01923, G-03086, G-03286, G-07162, G-23167, G-23801, G-33527, G-33605, G-34095, G-35055, G-35387, G-35714, G-36747, G-38616, G-38867, G-40634, G-41737, G-42716, G-44867, H-18520, H-43511, N-04052, N-20548

MOUNTAINS A-19684, D-00974, D-31396, E-31895, H-33922

MOUTH G-03893, G-05475, G-07396

MULTIPLE CHAMBER INCINERATORS A-31632

MUTATIONS G-28256, G-34914, G-35118, G-35219, G-40355, G-41097, H-42715, H-43511

## N

NAPHTHALENES F-00058, F-06648

NAPHTHENES A-38331, B-31341, J-03289

NASHVILLE G-00375

NATIONAL AIR SAMPLING NETWORK (NASN) A-41145, B-01851, C-18007, D-00017, D-00974, D-05167, D-05820, D-27174, D-27621, D-42921, D-44580, E-32155, G-08411, N-04649

NATURAL GAS A-22941, A-24080, A-27249, A-33087, A-34774, A-35052, A-37166, A-38543, A-39367, A-42377, A-43346, B-00107, B-19725, B-28699, B-28730, B-33932, D-32055, G-19940, H-08884, J-31720, J-39941, L-11204, L-16200, L-33844, L-35151, L-44499

NAUSEA A-35957, G-01757, G-09408, G-31351, G-32624, G-41737, G-43559

NECROSIS H-26055

NERVOUS SYSTEM A-18510, A-22579, A-23058, A-29096, A-29872, A-31313, A-35953, A-35957, G-00375, G-01341, G-01754, G-01757, G-03286, G-06174, G-06814, G-07162, G-07396, G-08999, G-09486, G-10856, G-12075, G-12646, G-15731, G-17470, G-18494, G-18502, G-18508, G-23167, G-24288, G-26720, G-27107, G-27416, G-28256, G-29588, G-29789, G-30671, G-30686, G-31228, G-31493, G-31537, G-31962, G-32041, G-32216, G-32484, G-32487, G-32696, G-32737, G-32746, G-32747, G-32834, G-33778, G-33910, G-34095, G-34436, G-34709, G-34832, G-34851, G-34943, G-34947, G-35021, G-35055, G-35380, G-35438, G-35463, G-35714, G-35811, G-36152, G-36207, G-36934, G-36964, G-37023, G-38867, G-39095, G-39503, G-39883, G-39989, G-40022, G-40485, G-41737, G-41847, G-41872, G-42091, G-42098, G-42716, G-42881, G-42957, G-43531, G-43559, G-43725, G-44385, G-44867, G-45288, H-08884, H-10318, H-27063, H-30033, H-33362, H-35234, H-40591, H-43511, K-16808, L-33844

NETHERLANDS A-39367, G-43615, G-44395

NEUTRAL CONDITION E-45050
NEUTRON ACTIVATION ANALYSIS C-11626, C-33042, C-33055, C-44210, C-44479, D-11184, D-28920, D-32350, D-35861, D-43468, E-22754, E-28586, G-42136, H-25967
NEW JERSEY A-30428, D-16839
NEW MEXICO D-35407
NEW ORLEANS G-00375
NEW YORK CITY A-26645, C-42139, D-10612, D-11028, D-16839, D-17058, D-17340, D-31325, E-44813, G-00375, G-01755, G-07423, G-34059, G-34895, G-35587, H-30931, K-38197, N-04212
NEW YORK STATE A-26645, C-42139, D-01673, D-10612, D-11028, D-16839, D-17058, D-17340, D-31325, E-44813, G-00375, G-01755, G-07423, G-34059, G-34895, G-35587, H-30931, K-09259, K-38197, N-04212
NICKEL A-35168, B-09798, B-34035, B-37222, C-01230, C-10528, C-11042, C-15734, D-00017, D-00974, D-03526, D-11202, F-10599, G-00662, G-01731, G-01797, H-07742, H-08884, I-06355, I-06357, N-04649
NICKEL COMPOUNDS A-05067, A-06351, A-18297, A-22370, A-26454, A-27595, A-36846, B-35223, B-36578, C-05787, C-10528, C-21459, C-22975, C-30113, C-30360, C-32892, C-38778, C-39136, C-39516, C-41908, C-42360, C-42928, C-44210, C-44995, D-03526, D-04996, D-05167, D-17340, D-22290, D-23388, D-23971, D-24351, D-27174, D-27188, D-27831, D-28653, D-30182, D-30493, D-30656, D-31325, D-35010, D-35940, D-36486, D-36820, D-37191, D-37202, D-37264, D-37518, D-42122, D-42367, D-43316, D-44580, D-44996, E-29910, E-36487, E-44813, F-13839, F-16595, F-36067, F-39522, F-43436, G-01731, G-01797, G-23167, G-24314, G-26528, G-26775, G-30181, G-31280, G-32735, G-35042, G-35055, G-38580, G-39833, G-44364, G-44696, G-45165, H-07742, H-08884, H-21794, H-23435, H-36991, H-41800, H-42250, H-42336, H-43279, I-31377, N-04649
NITRATES A-15295, A-17778, A-23561, A-32621, A-37176, B-31604, B-32938, C-23096, C-24644, C-26274, C-30360, C-31258, C-35494, C-42020, D-00017, D-00974, D-01673, D-05167, D-05573, D-21869, D-21906, D-22829, D-28326, D-37202, D-42122, D-42921, F-00058, F-05440, F-05849, F-13911, F-14008, F-14138, F-14868, F-16659, F-17585, F-17882, F-34948, G-00375, G-07162, G-16820, G-32218, G-43277, G-45159, H-11157, H-26055, H-32654, I-00305, K-20121, N-04649
NITRIC ACID A-09686, B-29058, C-26467, C-30360, C-31258, D-05260, F-00058, G-32735, G-44433, H-42607, K-06778, K-20121
NITRIC OXIDE (NO) A-01565, A-01624, A-08039, A-09393, A-15769, A-19598, A-22976, A-23316, A-23561, A-25581, A-28873, A-29516, A-29786, A-30513, A-33963, A-34350, A-35957, A-38625, A-38891, A-39603, A-41738, A-45145, B-00107, B-18053, B-24813, B-27876, B-30717, B-30944, B-30950, B-31246, B-32938, B-35018, B-35223, B-36081, B-36578, B-37195, B-37222, B-39275, B-41608, B-44750, C-09476, C-32534, C-38755, D-03441, D-06760, D-06788, D-15610, D-16684, D-17106, D-27257, D-27672, D-27675, D-28233, D-29744, D-30410, D-30860, D-33114, D-33576, D-36806, D-40118, D-44330, G-00020, G-00177, G-00473, G-16820, G-23876, G-29129, G-32735, G-37942, G-41737, H-32322, K-36382, K-36823, L-35922, L-44325, N-11871
NITRITES F-00058, F-17585
NITROGEN A-37721, A-41945, C-41612, F-03799, F-19823
NITROGEN DIOXIDE (NO2) A-01565, A-09393, A-09686, A-19598, A-23316, A-23561, A-26763, A-29786, A-30513, A-33169, A-33963, A-35957, A-38891, A-39603, A-43776, A-45092, A-45145, B-00107, B-01484, B-30717, B-44750, C-00855, C-09333, C-09476, C-09983, C-17048, C-22927, C-26707, C-27294, C-28126, C-32534, C-38670, C-38755, D-00017, D-06148, D-06760, D-06788, D-08812, D-15610, D-16345, D-16539, D-16684, D-17106, D-19144, D-26287, D-26387, D-26535, D-27257, D-27672, D-27675, D-28233, D-29385, D-29744, D-30410, D-30860, D-31396, D-32912, D-33114, D-33576, D-34008, D-36503, D-36806, D-40118, D-41887, D-44330, E-30863, E-37953, F-07451, G-00020, G-00473, G-12038, G-16820, G-21259, G-23715, G-29129, G-32735, G-34841, G-37942, G-41097, G-41124, G-41737, G-43277, G-44087, G-44381, H-26055, K-06734, K-06778, K-08420, K-19750, K-36382, K-36823, K-41682, K-42118, K-43312, K-44310, L-33495, L-35922, L-44325, N-04212, N-09780, N-11871
NITROGEN OXIDES A-00962, A-01565, A-01624, A-01868, A-02636, A-04460, A-05067, A-08039, A-08972, A-09210, A-09355, A-09393, A-09686, A-14033, A-15599, A-15769, A-16156, A-16766, A-17325, A-17365, A-17778, A-19598, A-20545, A-20927, A-22579, A-22941, A-22976, A-23250, A-23316, A-23561, A-23620, A-23789, A-24996, A-25581, A-26134, A-26763, A-27180, A-27249, A-27272, A-27943, A-28560, A-28873, A-29096, A-29516, A-29786, A-30513, A-30604, A-30976, A-31315, A-31323, A-31395, A-32447, A-32621, A-32875, A-33087, A-33169, A-33378, A-33963, A-33965, A-34018, A-34350, A-34442, A-34774, A-35481, A-35484, A-35676, A-35957, A-36083, A-36623, A-37015, A-37721, A-38522, A-38543, A-38625, A-38891, A-39152, A-39603, A-39754, A-40677, A-40776, A-40981, A-41654, A-41738, A-41945, A-42080, A-42212, A-42377, A-42679, A-43346, A-43776, A-44227, A-44252, A-45092, A-45145, B-00107, B-01484, B-05214, B-14604, B-17906, B-18053, B-19808, B-20844, B-21762, B-22890, B-23697, B-24182, B-24696, B-24722, B-24813, B-25155, B-25894, B-26153, B-27371, B-27824, B-27876, B-28286, B-28377, B-28699, B-28730, B-28860, B-28865, B-29058, B-29605, B-30717, B-30944, B-30950, B-31246, B-31314, B-31364, B-31690, B-31819, B-31825, B-32355, B-32364, B-32938, B-33366, B-33386, B-33388, B-33403, B-34035, B-34381, B-35018, B-35223, B-35476, B-35778, B-35821, B-36081, B-36145, B-36523, B-36578, B-37116, B-37195, B-37222, B-37845, B-37938, B-38287, B-39275, B-39492, B-40411, B-41112, B-41544, B-41608, B-42131, B-42166, B-42330, B-44003, B-44283, B-44341, B-44750, B-44906, C-00855, C-06112, C-09333, C-09476, C-09983, C-16123, C-17048, C-22927, C-24644, C-26274, C-26707, C-27294, C-28126, C-30290, C-32476, C-32534, C-32829, C-38670, C-38755, C-39136, C-40631, C-41719, C-41763, C-42775, C-42928, D-00005, D-00017, D-00969, D-01673, D-02133, D-03441, D-04996, D-05573, D-06148, D-06760, D-06788, D-07198, D-08438, D-08812, D-10634, D-15610, D-16345, D-16539, D-16684, D-17106, D-19144, D-24162, D-26287, D-26387, D-26535, D-27257, D-27672, D-27675, D-28097, D-28233, D-28634, D-29382, D-29385, D-29744, D-30410, D-30860, D-31396, D-32055, D-32912, D-33114, D-33576, D-34008, D-35025, D-36503, D-36806, D-36909, D-37366, D-37394, D-38110, D-40118, D-40997, D-41887, D-41888, D-42120, D-43316, D-43962, D-44330, E-30863, E-37953, E-38666, F-00058, F-06648, F-07451, G-00020, G-00177, G-00375, G-00473, G-07162, G-12038, G-13059, G-16820, G-17244, G-21259, G-23715, G-23876, G-24314, G-24603, G-27801, G-29129, G-30156, G-30328, G-30355, G-32735, G-34406, G-34841, G-34895, G-35118, G-37180, G-37788, G-37942, G-38616, G-38721, G-40634, G-41097, G-41124, G-41737, G-43277, G-44087, G-44176, G-44254, G-44381, H-08884, H-11157, H-19604, H-26055, H-32322, H-40368, J-26765, J-27968, J-30696, K-02580, K-03007, K-06734, K-06778, K-08420, K-08803, K-09259, K-18294, K-19750, K-24107, K-30035, K-30069, K-34063, K-36382, K-36823, K-38758, K-41682, K-42118, K-43312, K-44310, L-00311, L-02635, L-03536, L-24467, L-25288, L-25542, L-28099, L-30152, L-30620, L-31957, L-32462, L-32789, L-32865, L-33495, L-35795, L-35922, L-37560, L-41557, L-42873, L-44325, L-44499, M-01073, N-04052, N-04212, N-09780, N-11871, N-14772, N-18005, N-20548, N-28088
NITROGEN TRIOXIDE (NO3) C-09476, C-32534
NITROMETHANE H-11157
NITROUS ACID H-32224
NITROUS ANHYDRIDE (N2O3) N-04212
NITROUS OXIDE (N2O) B-30717
NON-INDUSTRIAL EMISSION SOURCES A-03278, A-03280, A-09686, A-12624, A-23561, A-24080, A-26441, A-26925, A-27595, A-30674, A-31632, A-31649, A-32035, A-33087, A-33293, A-33965, A-34647, A-34774, A-34788, A-35398, A-37190, A-39462, A-40314, A-40981, A-41889, A-41945, A-43346, A-44227, A-45072, B-18053, B-19808, B-27824, B-28108, B-30124, B-35342, B-42886, C-30635, C-33042, C-33055, C-35396, C-38670, C-41016, C-44210, D-00005, D-00969, D-03410, D-03441, D-03526, D-04646, D-08275, D-08438, D-08502, D-08568, D-08591, D-08810, D-08821, D-12099, D-17340, D-20191, D-30858, D-31325, D-34008, D-35407, D-37026,

D-37369, D-38110, D-41033, D-41887, D-41979, D-42120, E-00834, E-29445, E-33225, E-36714, F-07451, F-35378, F-35379, F-36076, G-00597, G-00642, G-00708, G-01754, G-01755, G-01756, G-01757, G-03086, G-05002, G-07551, G-08411, G-20704, G-27801, G-29816, G-30671, G-31319, G-31528, G-33374, G-33607, G-35811, G-36283, G-37788, G-38721, G-39095, G-42757, H-01523, H-08884, H-24667, H-27489, H-32291, H-32736, H-34830, H-34831, H-36196, H-36197, H-37912, H-37977, H-41733, H-43226, I-00305, I-33802, J-30329, G-08566, G-08683, G-08949, G-09486, G-11552, G-11580, G-13154, G-18515, G-19304, G-20687, G-23582, G-23887, G-24081, G-24192, G-24428, G-25328, G-25705, G-26528, G-26720, G-26775, G-26883, G-26886, G-26915, G-27084, G-27085, G-28011, G-28024, G-28205, G-29129, G-29815, G-29958, G-29963, G-30198, G-30334, G-30672, G-31351, G-31899, G-32129, G-32216, G-32408, G-32608, G-32613, G-32624, G-32625, G-32696, G-32738, G-32747, G-32749, G-32787, G-32905, G-33052, G-33202, G-33374, G-33527, G-33903, G-34059, B-32392, B-33542, B-33550, B-33932, B-35112, B-35688, B-37150, B-44470, C-23596, C-26274, C-33178, C-38670, D-43468, F-06648, F-08207, F-41787, G-00177, G-03892, G-16820, G-39883, H-08884, H-26055, H-27111, J-03289, J-21749, J-22358, J-34370, K-03007, K-09259, N-03674

OPEN BURNING *A-09686, A-31649,* A-39462, D-03410, E-29445, G-33607, G-39095

OPEN HEARTH FURNACES A-09686, A-26441, B-00107, B-03232, B-03754, B-07606, B-09798, B-34071, B-43515, G-00375, I-00311

OXIDANTS A-00962, A-01868, A-17365, A-27943, A-30513, A-32621, A-32875, A-34018, A-40677, A-42080, B-01484, B-28377, B-31690, C-09476, C-26275, C-27294, C-32476, C-32534, C-40631, C-41763, D-00005, D-00969, D-03441, D-05573, D-19144, D-28097, D-29647, D-32055, D-33576, D-34008, D-39081, D-39988, D-43316, F-00058, G-16820, G-35118, G-38616, G-44087, H-08884, B-31819, B-31825, B-31985, B-32260, B-32355, B-32364, B-32392, B-32633, B-32938, B-33366, B-33386, B-33388, B-33403, B-33741, B-34035, B-34071, B-34381, B-34536, B-34611, B-35018, B-35035, B-35166, B-35223, B-35303, B-35342, B-35476, B-35540, B-35778, B-35821, B-36081, B-36145, B-36523, B-36578, B-37116, B-37195, B-37222, B-37750, B-37845, B-37938, B-38287, G-30355, G-30671, G-30672, G-31319, G-31452, G-32484, G-32625, G-32735, G-32905, G-33607, G-33778, G-33779, G-33864, G-34406, G-34841, G-34895, G-35041, G-35118, G-37180, G-37229, G-37685, G-37788, G-37942, G-38616, G-38721, G-38869, G-40068, G-40634, G-41097, G-41124, G-41737, G-42881, G-43277, G-44087, G-44176, G-44254, G-44381, G-44395, G-44422, G-44606

G-35463, G-36207, G-39095, G-42463, H-36196, H-44588, L-35461, M-35206, N-43824
PAPER CHROMATOGRAPHY C-08145, C-32058, C-42437, C-43448, D-11028
PAPER MANUFACTURING A-09686, A-26441, A-39462, C-33055, D-03410, L-29421
PARIS B-03337, D-06788, D-08568, D-08821, D-16684, D-43693, G-32216, K-42118
PARTICLE COUNTERS C-06643, C-08130, C-09888, C-26275, C-29512, C-39168, C-43587, D-05277, D-21684, E-33873, G-35041, K-08803
PARTICLE GROWTH A-23620, A-39609, C-26848, D-24952, E-19058, E-23743, E-29699, E-29946, E-32158, E-35207, E-36714, E-40157
PARTICLE SHAPE A-06220, C-08130, C-09476, C-09888, C-29512, E-00834, E-32155
PARTICLE SIZE A-03278, A-06220, A-12624, A-14945, A-15295, A-16766, A-23561, A-23620, A-26925, A-29661, A-30674, A-30759, A-31324, A-34341, A-35168, A-36527, A-37176, A-37312, A-37372, A-39609, A-41145, B-07606, B-08562, B-09798, B-25301, B-25470, B-26532, B-28377, B-29664, B-31604, B-32633, B-34740, B-35342, B-35352, B-39272, C-00855, C-03037, C-05243, C-08130, C-08145, C-09476, C-09888, C-10561, C-14758, C-17179, C-21862, C-23096, C-23646, C-26275, C-26848, C-27358, C-27829, C-31258, C-31304, C-35494, C-36588, C-36703, C-36840, C-37689, C-39168, D-00976, D-01355, D-04646, D-07600, D-07985, D-10612, D-11184, D-11202, D-12049, D-21684, D-21906, D-22829, D-24414, D-24952, D-27429, D-28629, D-28650, D-28920, D-29191, D-30182, D-34933, D-35489, D-36009, D-36562, D-36688, D-37518, E-00834, E-22754, E-24109, E-29688, E-29946, E-30073, E-32155, E-32158, E-35207, E-35264, E-36038, E-38118, E-38666, F-07451, F-19823, G-00177, G-03282, G-04877, G-05002, G-07162, G-16810, G-21259, G-29493, G-30000, G-31452, G-31517, G-31528, G-32625, G-33864, G-40688, G-45293, H-28105, H-28471, K-16808, K-24107, N-03674, N-04212, N-09780, N-17260
PARTICULATE CLASSIFIERS A-03278, A-06220, A-12624, A-14945, A-15295, A-16766, A-23561, A-23620, A-26925, A-29661, A-30674, A-30759, A-31324, A-34341, A-35168, A-36527, A-37176, A-37312, A-37372, A-39462, A-39609, A-41145, B-07606, B-08562, B-09798, B-25301, B-25470, B-26532, B-28377, B-29664, B-31604, B-32633, B-34740, B-35342, B-35352, B-39272, C-00855, C-02164, C-03037, C-05243, C-08130, C-08145, C-09476, C-09888, C-10561, C-14758, C-17179, C-21862, C-23096, C-23646, C-26275, C-26848, C-27358, C-27829, C-29512, C-31258, C-31304, C-35494, C-35695, C-36588, C-36703, C-36840, C-37689, C-39168, C-42928, D-00976, D-01355, D-04646, D-07600, D-07985, D-10612, D-11184, D-11202, D-12049, D-21684, D-21906, D-22829, D-24414, D-24952, D-27429, D-28629, D-28650, D-28920, D-29191, D-30182, D-34933, D-35489, D-36009, D-36562, D-36688, D-37518, E-00834, E-22754, E-24109, E-29688, E-29946, E-30073, E-32155, E-32158, E-35207, E-35264, E-36038, E-38118, E-38666, F-07451, F-19823, G-00177, G-03282, G-04877, G-05002, G-07162, G-16810, G-21259, G-29493, G-30000, G-31452, G-31517, G-31528, G-32625, G-33864, G-40688, G-45293, H-28105, H-28471, K-16808, K-24107, N-03674, N-04212, N-09780, N-17260, N-18005
PARTICULATE SAMPLING A-05067, A-39609, B-01851, B-27371, C-00855, C-01249, C-03037, C-05243, C-06072, C-06112, C-08130, C-08145, C-08661, C-09333, C-11042, C-12943, C-19313, C-20891, C-23657, C-26698, C-26848, C-27106, C-30593, C-30707, C-31304, C-32058, C-32474, C-33255, C-34017, D-00985, D-01089, D-01355, D-01673, D-03410, D-04646, D-04938, D-05167, D-07600, D-07985, D-08438, D-09432, D-10756, D-11028, D-27621, D-30656, D-34933, D-44996, E-01821, E-35207, F-07451, F-10599, G-00076, G-00902, K-08420, N-03674
PARTICULATES A-00962, A-01565, A-01624, A-01868, A-02636, A-03278, A-03982, A-05067, A-06220, A-08972, A-09210, A-09393, A-09686, A-12624, A-13524, A-14945, A-15205, A-15295, A-16766, A-17339, A-19684, A-19955, A-20652, A-20927, A-21722, A-22825, A-22941, A-22976, A-23250, A-23316, A-23561, A-23620, A-24156, A-25295, A-26441, A-26645, A-26763, A-26891, A-26925, A-27180, A-27249, A-27272, A-27458, A-27858, A-27943, A-28210, A-29127, A-29661, A-29786, A-29787, A-30067, A-30414, A-30428, A-31323, A-31324, A-31395, A-31525, A-31632, A-31934, A-32447, A-32621, A-32875, A-33087, A-33169, A-33350, A-33710, A-33822, A-33963, A-33965, A-34018, A-34647, A-34774, A-35078, A-35123, A-35168, A-35353, A-35484, A-35676, A-35957, A-36623, A-36846, A-37166, A-37176, A-37190, A-37312, A-37372, A-38543, A-38625, A-38819, A-39152, A-39367, A-39462, A-39603, A-39609, A-39610, A-40583, A-40677, A-40776, A-40981, A-41145, A-41654, A-41945, A-42080, A-42377, A-42676, A-42726, A-43271, A-43346, A-44464, A-45072, A-45092, A-45145, A-45274, B-00107, B-01484, B-01851, B-03125, B-03232, B-03754, B-07606, B-08562, B-09798, B-10558, B-15208, B-17525, B-17906, B-18053, B-19710, B-19808, B-20735, B-20740, B-22436, B-22520, B-22890, B-24553, B-24813, B-25033, B-25301, B-25334, B-25470, B-25781, B-25894, B-26269, B-26532, B-26600, B-27371, B-28060, B-28172, B-28286, B-28377, B-28730, B-29126, B-29664, B-29920, B-30124, B-30633, B-30944, B-31317, B-31364, B-31604, B-31985, B-32319, B-32355, B-32364, B-32633, B-32760, B-32822, B-32938, B-33157, B-33366, B-33403, B-33542, B-33550, B-33932, B-33994, B-34025, B-34071, B-34313, B-34611, B-34740, B-35035, B-35166, B-35296, B-35342, B-35352, B-35476, B-35478, B-35540, B-37222, B-37750, B-38727, B-39272, B-39404, B-39492, B-40709, B-42300, B-42829, B-43515, B-43937, B-44283, B-44470, B-44742, B-44750, B-44906, C-00855, C-01249, C-01608, C-02164, C-03037, C-03770, C-05243, C-05787, C-05977, C-06072, C-06112, C-06881, C-06894, C-06920, C-08130, C-08145, C-09333, C-09476, C-09888, C-09983, C-10528, C-10556, C-10561, C-12943, C-14758, C-15563, C-16367, C-17179, C-17180, C-18007, C-19313, C-19857, C-21862, C-21948, C-23096, C-23657, C-25015, C-25431, C-25440, C-25535, C-25793, C-25979, C-26145, C-26274, C-26275, C-26698, C-26848, C-27075, C-27106, C-27294, C-27358, C-27556, C-27829, C-28017, C-28621, C-28755, C-29226, C-29297, C-29464, C-29595, C-30290, C-30360, C-30707, C-31258, C-31304, C-31933, C-32474, C-32534, C-32718, C-32892, C-32975, C-33042, C-33055, C-34017, C-34407, C-35494, C-35695, C-36588, C-36698, C-36703, C-36840, C-37608, C-37689, C-37693, C-37971, C-38165, C-38755, C-38778, C-39168, C-40724, C-41763, C-41908, C-41968, C-42137, C-42139, C-42928, C-43448, C-44479, C-45235, D-00005, D-00017, D-00697, D-00969, D-00974, D-00976, D-00985, D-01089, D-01315, D-01355, D-01673, D-02133, D-02750, D-03410, D-03441, D-03526, D-04646, D-04938, D-04996, D-05167, D-05260, D-05277, D-05551, D-05573, D-05623, D-06148, D-06760, D-07198, D-07600, D-07985, D-08275, D-08438, D-08502, D-08591, D-09432, D-10380, D-10612, D-10634, D-10756, D-11184, D-11202, D-12049, D-12099, D-14762, D-15610, D-15789, D-15823, D-16345, D-16684, D-16791, D-16839, D-17106, D-17340, D-19144, D-19433, D-20642, D-21015, D-21684, D-21869, D-21906, D-22829, D-23388, D-23658, D-23864, D-24162, D-24351, D-25089, D-25635, D-25758, D-26054, D-26387, D-26535, D-27187, D-27241, D-27257, D-27429, D-27621, D-27648, D-27672, D-27880, D-28097, D-28233, D-28326, D-28369, D-28620, D-28629, D-28634, D-28650, D-28653, D-28785, D-28920, D-29152, D-29153, D-29191, D-29382, D-29385, D-29416, D-29515, D-29647, D-29655, D-29814, D-30025, D-30182, D-30326, D-30410, D-30493, D-30494, D-30656, D-30858, D-30860, D-30892, D-31014, D-31396, D-31669, D-32055, D-32350, D-32912, D-32945, D-33114, D-33576, D-34008, D-34805, D-34933, D-35010, D-35025, D-35407, D-35489, D-35725, D-35861, D-35940, D-36009, D-36195, D-36288, D-36449, D-36474, D-36486, D-36562, D-36688, D-36806, D-36820, D-37026, D-37191, D-37202, D-37288, D-37320, D-37369, D-37394, D-37518, D-38110, D-38133, D-39081, D-39405, D-39535, D-39914, D-39988, D-40118, D-40363, D-40574, D-40584, D-40716, D-40997, D-41033, D-41520, D-41887, D-41888, D-41975, D-41979, D-42122, D-42921, D-43468, D-43693, D-43962, D-44059, D-44170, D-44234, D-44330, D-44580, D-44996, E-00834, E-03841, E-06841, E-19058, E-21796, E-22754, E-22959, E-23743, E-24109, E-24570, E-27116, E-28586, E-29445, E-29688, E-29910, E-30073, E-30676,

E-30863, E-31895, E-32155, E-32158, E-33225, E-35207, E-35264, E-36038, E-36487, E-36714, E-38118, E-38666, E-42720, E-44813, F-00841, F-03799, F-05440, F-05849, F-07451, F-10599, F-13451, F-19823, F-27348, F-29400, F-34297, F-37213, G-00020, G-00076, G-00177, G-00375, G-00642, G-00705, G-00810, G-00902, G-01512, G-03086, G-03282, G-03892, G-04196, G-04877, G-05002, G-06704, G-07162, G-07551, G-08411, G-08566, G-09253, G-09408, G-09493, G-12038, G-12070, G-12984, G-16810, G-16820, G-18046, G-18417, G-19304, G-19940, G-20704, G-24081, G-26260, G-26477, G-26775, G-27291, G-29129, G-29588, G-30000, G-30181, G-30328, G-31319, G-31351, G-31452, G-31524, G-32484, G-32696, G-32735, G-32905, G-33497, G-33607, G-33778, G-33864, G-34092, G-34406, G-34895, G-34951, G-35118, G-35568, G-36354, G-37180, G-37229, G-37942, G-38580, G-38616, G-38721, G-38869, G-39095, G-39161, G-39826, G-40634, G-40688, G-41067, G-41097, G-42136, G-42463, G-44087, G-44251, G-44254, G-44433, G-44508, G-44696, G-45293, H-08884, H-10318, H-11157, H-11452, H-11467, H-19604, H-19620, H-20062, H-21018, H-26276, H-27063, H-27111, H-28448, H-30225, H-30921, H-31010, H-31185, H-32322, H-32338, H-35827, H-36197, H-37912, H-37977, H-38332, H-39690, H-40368, H-40590, H-40591, H-41891, H-42336, H-42857, H-44071, I-00305, J-21749, J-22358, J-30696, J-39956, K-02580, K-03007, K-03956, K-06734, K-06778, K-08420, K-08803, K-09259, K-14443, K-16808, K-18294, K-19750, K-20121, K-24107, K-30035, K-30069, K-33107, K-34063, K-34377, K-36382, K-36823, K-38197, K-41682, K-42039, K-43312, K-44310, K-44377, L-00311, L-02635, L-08196, L-09009, L-17472, L-17927, L-23234, L-23562, L-23608, L-23610, L-24214, L-25288, L-25542, L-27664, L-28099, L-28349, L-28397, L-29421, L-29888, L-30152, L-30620, L-31957, L-32462, L-32789, L-32865, L-32884, L-33495, L-35795, L-35922, L-37560, L-38669, L-39640, L-41557, L-42873, L-44325, M-33904, N-03674, N-04052, N-04212, N-04649, N-08273, N-09780, N-11871, N-14772, N-17260, N-18005, N-20548, N-28088, N-28803

PATHOLOGICAL TECHNIQUES F-11570, G-00873, G-01797, G-06704, G-08999, G-18515, G-23926, G-26356, G-26775, G-30468, G-32216, G-32787, G-34791, G-34832, G-34836, G-34841, G-34943, G-37119, G-40316, G-40688, G-41872, G-44254, H-08884, H-16270, H-34901, H-43511

PENNSYLVANIA A-03278, A-23239, D-01315, D-05623, D-07600, D-16839, D-24463, D-36195, E-01821, G-00076, G-00375, G-00736, G-07162, G-07423, G-29329, G-36534, G-37040, H-26276, H-27111, J-21749, K-06734, K-08420, K-19750, N-04212, N-18005

PENTANES A-05171, A-38331, B-00015, B-00063, B-05214, F-06648, F-09578, G-00177

PENTENES G-00177

PERCHLORIC ACID C-00125, H-42607

PERMEABILITY D-36562, G-40316, G-43531, H-32224

PERMITS A-39367, L-25288, L-38669, L-44044

PEROXIDES A-15769, A-18211, B-05300, C-42928, D-30860, F-00058

PEROXYACETYL NITRATE A-23561, C-24644, C-26274, G-16820, G-43277, H-26055

PEROXYACYL NITRATES A-17778, A-23561, A-32621, B-32938, C-24644, C-26274, G-00375, G-07162, G-16820, G-43277, H-11157, H-26055

PERSONNEL A-34788, A-41518, C-08661, D-30860, D-32055, G-00736, G-00740, G-27291, G-30672, G-32624, G-32737, G-32905, G-36207, G-41124, G-44395, G-44463, L-09009, L-23234, L-33844, L-35151, M-33904

PERYLENES A-05067, C-32058, D-00985, D-03526, F-00058

PEST CONTROL A-31649

PESTICIDES A-03279, A-23561, A-39367, A-40314, A-40981, A-45072, A-45145, B-31441, C-26274, D-03441, G-00642, G-05002, G-05541, G-07423, G-27801, G-33374, G-35811, G-43277, G-44385, H-07742, H-08884, H-24667, H-34237, H-36196, H-36197, H-41733

PETER SPENCE PROCESS (CLAUS) L-23562

PETROLEUM DISTRIBUTION A-41959, C-33255, D-03441, G-32613, G-34406, G-35559, G-39161, J-32241, J-39956, L-34033, L-37423, M-33904

PETROLEUM PRODUCTION A-26441, A-29127, A-30513, A-41959, A-43346, B-00107, B-28060, B-28108, D-01315, D-03441, D-24463, E-40164, G-01341, J-22358, J-27968, J-34828, L-24757, L-34033, M-01073, M-33904, N-04649

PETROLEUM REFINING A-09686, A-24080, A-26441, A-29127, A-29786, A-30513, A-31085, A-31136, A-31520, A-34031, A-34177, A-35050, A-36527, A-36535, A-36541, A-36664, A-37166, A-38330, A-38331, A-39067, A-39367, A-39462, B-00107, B-20844, B-22834, B-24184, B-24186, B-27824, B-29628, B-31221, B-31341, B-31496, B-31519, B-33932, B-34846, B-35080, B-35816, B-36453, B-37150, B-37173, B-39404, B-41793, B-44473, B-44853, B-44906, C-33055, D-28326, D-30860, D-38110, E-40164, F-40387, G-29286, G-32613, G-34649, G-44867, H-18520, J-03288, J-03289, J-30329, J-31518, J-31720, J-32241, J-34370, J-34828, J-34970, J-35391, J-36592, J-37409, J-37734, J-39941, J-39956, J-42721, L-11204, L-17927, L-23562, L-28869, L-30908, L-34033, L-36030, L-37423, M-33904, N-04052, N-04649, N-20548

PETUNIAS H-41891

PH A-18510, A-29572, A-31315, A-37166, A-45072, B-28060, C-08661, C-09333, C-38682, D-04996, D-21869, D-24351, D-37288, D-41888, D-42122, F-16659, F-34948, F-36076, G-08683, G-41717, H-23258, H-24947, H-26276, H-27391, H-28379, H-32224, H-32338, H-36197, H-39287, H-42250, L-25542

PHENANTHRENES C-32058, D-03526, F-00058

PHENOLS A-24829, A-27458, A-35199, A-35477, A-35481, A-37190, B-05300, B-41608, C-09983, C-38670, C-39136, C-39516, C-42928, D-26387, F-06648, F-09745, G-39883, K-02580, N-28803

PHENYL COMPOUNDS A-33822, C-03034, C-06894, C-09888, C-32534, D-43468, F-13839, H-42857, K-02580, K-20121

PHENYLS A-33822, C-09888, C-32534, D-43468, H-42857, K-02580, K-20121

PHILADELPHIA A-03278, D-01315, D-07600, D-16839, D-24463, D-36195, E-01821, G-00076, G-00736, G-29329, G-36534, G-37040

PHOSPHATES A-45072, B-29920, F-34948, G-32218, G-36935, G-39883, H-07742, H-17038, H-27391, I-00305

PHOSPHORESCENCE C-32058

PHOSPHORIC ACID A-09686, A-39462

PHOSPHORUS COMPOUNDS A-06351, A-26441, A-39610, A-45072, B-05300, B-14604, B-25033, B-29920, B-30229, B-31364, B-33388, B-37468, B-40785, B-41608, B-44614, C-26503, C-30360, D-28326, F-06648, F-34948, G-24314, G-32218, G-36935, G-39833, G-39883, G-41818, H-07742, H-17038, H-27391, H-36991, I-00305, I-32921, K-41682, K-44310, L-37423, L-38757

PHOTOCHEMICAL REACTIONS A-00962, A-01868, A-09210, A-09355, A-15295, A-17339, A-17778, A-19598, A-23561, A-23789, A-27272, A-27458, A-27943, A-29364, A-29786, A-30027, A-30067, A-30513, A-31934, A-32875, A-34774, A-35078, A-35199, A-35353, A-39610, A-40455, A-40677, A-42080, A-44227, A-45145, A-45274, B-03337, B-19808, B-20735, B-22436, B-26269, B-28377, B-31317, B-32938, B-33542, B-42290, C-00855, C-32058, C-44165, D-00005, D-00969, D-24162, D-29416, D-32055, D-34008, D-35025, D-38110, D-39081, E-29699, E-33873, E-38666, F-05849, G-00148, G-00375, G-16820, G-27291, G-34406, G-40634, G-44087, H-08884, H-19604, K-03007, L-03536, L-28099, L-29888, M-33904, N-03674, N-18005

PHOTOELECTRIC PHENOMENA A-35078, C-25431, C-39168, E-24549

PHOTOGRAPHIC METHODS B-44614, C-25431, G-30468

PHOTOIONIZATION D-34008

PHOTOMETRIC METHODS A-26454, A-32523, A-40947, B-39272, C-06881, C-09333, C-10556, C-15734, C-21459, C-23571, C-24719, C-26275, C-28126, C-29595, C-32169, C-32534, C-33178, C-38755, C-41719, D-15573, E-42720, G-00177, G-29663, G-29958, G-44433, G-44746, L-17472

PHOTOOXIDATION A-00962, A-29786, C-00855, D-00005, D-00969, D-34008, G-27291

PHOTOSYNTHESIS A-35078, G-27801, H-08884, H-32423, H-32654, H-38332, H-39409

PHTHALIC ACID F-06648

PHYSICAL STATES A-03280, A-15205, A-19955, A-21722, A-23620, A-24080, A-25417, A-26191, A-26454, A-28873, A-31133, A-32035, A-35052, A-35484, A-40583, A-41889, A-42377, A-44464, A-45092, B-03337, B-28172, B-28699, B-28730, B-29058, B-30154, B-31390, B-31496, B-32036, B-33932, B-35018,

B-35352, B-35816, B-36721, B-37173, B-40411, B-41544, B-44660, C-05977, C-06072, C-06643, C-09333, C-17048, C-23596, C-26955, C-27556, C-28755, C-29595, C-32058, C-44165, D-00005, D-21684, D-22829, D-25635, D-35861, E-00834, E-24109, E-29688, E-33873, E-36714, E-40157, F-03525, F-06648, F-08207, F-10599, F-14008, F-14138, F-14510, F-14743, F-14868, F-15413, F-15493, F-17161, F-34948, F-35379, F-36067, G-05002, G-07162, G-08949, G-10434, G-24314, G-27490, G-29588, G-35811, G-36093, G-41067, H-09448, H-14786, H-17217, I-22128, L-35151
PHYTOTOXICANTS A-00962, A-45145, D-00969, H-08884, H-27111
PILOT PLANTS B-08562, B-35478
PINTO BEANS D-05573, H-17978, H-41891
PITTSBURGH D-05623, N-04212
PLAINS D-04646
PLANNING AND ZONING A-38625, A-41654, B-28377, K-33107, K-34377, L-08196, L-16200, L-26442, L-32884, L-37521, L-44499, N-28088
PLANS AND PROGRAMS A-01868, A-12624, A-25125, A-31136, A-31313, A-31323, A-32621, A-33087, A-33963, A-33965, A-39367, A-41035, A-41145, A-42791, B-01851, B-20735, B-28730, B-30633, B-31314, B-31496, B-32424, B-39404, B-43575, C-18007, C-22927, C-30360, C-38755, C-41016, C-44479, D-00005, D-00017, D-00974, D-01089, D-02133, D-03410, D-03441, D-04996, D-05167, D-05573, D-05623, D-05820, D-08568, D-12049, D-12099, D-16539, D-16839, D-22553, D-23971, D-24351, D-26387, D-27096, D-27105, D-27174, D-27621, D-28097, D-29416, D-29655, D-30656, D-30858, D-30860, D-31325, D-31332, D-31396, D-32055, D-32945, D-34008, D-34933, D-35407, D-35940, D-36009, D-36195, D-36288, D-36449, D-36806, D-37394, D-38110, D-38133, D-39081, D-39405, D-39914, D-40363, D-40997, D-41033, D-41887, D-41975, D-41979, D-42120, D-42122, D-42742, D-42921, D-43316, D-43558, D-44059, D-44170, D-44234, D-44330, D-44580, E-32155, G-00740, G-08411, G-09253, G-16820, G-27961, G-30181, G-31528, G-34095, G-34436, G-34895, G-35118, G-36207, G-37229, H-27111, J-30329, J-39956, K-03007, K-03956, K-36823, L-08725, L-09009, L-16200, L-23608, L-23610, L-24214, L-24467, L-25288, L-25542, L-26442, L-28397, L-28869, L-29888, L-30152, L-30908, L-31454, L-32462, L-33495, L-33844, L-35151, L-35461, L-35922, L-36877, L-37193, L-37497, L-37521, L-40486, L-40520, L-41557, L-42041, L-42873, L-44499, M-01073, M-33904, N-03674, N-04052, N-04649, N-08273, N-11871
PLANT DAMAGE A-00962, A-17778, A-24285, A-32621, A-34018, A-37190, A-45145, B-01484, B-28377, B-32355, B-32938, C-32058, D-03441, D-05573, D-40574, E-30676, E-38666, G-00375, G-27291, G-27801, G-36354, G-38616, G-45196, H-07742, H-08884, H-14489, H-16655, H-17225, H-19604, H-23581, H-26055, H-27063, H-27111, H-30225, H-31010, H-32224, H-32322, H-32335, H-32423, H-35880, H-38332, H-39408, H-39409, H-39690, H-40590, H-41891, H-41892, H-42250, H-43721, J-21749, K-08420, L-25288, L-34980, L-39640, L-44499, N-04212, N-17260, N-28088
PLANT GROWTH A-35078, G-27801, H-08884, H-17038, H-19620, H-26055, H-28379, H-30225, H-31010, H-32322, H-32335, H-32338, H-32423, H-32654, H-33112, H-37977, H-38332, H-39409, H-42207, H-42336
PLANT INDICATORS A-18297, A-22370, C-18302, C-25222, C-30113, C-39762, D-08279, D-35010, F-27752, H-16655, H-17681, H-19604, H-23435, H-28289, H-28448, H-32423, H-35410, H-39328, H-43782
PLANTS (BOTANY) A-00962, A-03279, A-12624, A-14135, A-18510, A-22370, A-26552, A-29572, A-29787, A-30428, A-31315, A-32748, A-33963, A-33965, A-34018, A-34068, A-35065, A-36032, A-37190, A-45072, A-45145, A-45274, B-22492, B-32036, B-32424, C-00125, C-18302, C-21948, C-30113, C-30928, C-33042, C-33055, C-39762, C-42137, C-42312, C-45235, D-03441, D-05573, D-08279, D-23971, D-32912, D-40716, D-41887, F-13461, F-27752, G-00177, G-00375, G-00708, G-00808, G-00810, G-00821, G-00873, G-00993, G-01756, G-01812, G-03286, G-05483, G-05541, G-07169, G-07396, G-10434, G-17214, G-19881, G-27084, G-28256, G-30671, G-31319, G-31528, G-33910, G-36283, G-38616, G-39095, G-39406, G-40014, G-40355, G-41895, G-42757, G-44433, H-01523, H-07742, H-08884, H-09448, H-11157, H-11467, H-12647, H-14489, H-14786, H-16655, H-17038, H-17182, H-17215, H-17216, H-17217, H-17218, H-17220, H-17681, H-17978, H-19604, H-20062, H-20237, H-21018, H-21794, H-23435, H-23581, H-24788, H-24947, H-25374, H-25878, H-26092, H-27111, H-27352, H-27391, H-27489, H-28105, H-28289, H-28379, H-28448, H-28471, H-28529, H-30225, H-30424, H-30921, H-30931, H-31010, H-31185, H-31801, H-32291, H-32322, H-32335, H-32338, H-32423, H-32654, H-32736, H-33112, H-33201, H-33362, H-33364, H-33922, H-33985, H-34237, H-35410, H-35827, H-35880, H-36197, H-36611, H-36991, H-37912, H-37926, H-37977, H-38332, H-38743, H-39204, H-39287, H-39328, H-39408, H-39409, H-40024, H-40335, H-40368, H-40540, H-41143, H-41800, H-41891, H-41892, H-42207, H-42250, H-42336, H-42607, H-42715, H-43342, H-43721, H-43782, H-44071, H-45056, J-21749, K-03007, K-08420, L-00311, N-04212
PLASTICS C-00855, G-00148, G-00473, G-39161, I-33802, N-43824
PLATING A-03280
PLATINUM B-03337, B-25377, B-29058, B-30154, B-30717, B-31819, B-31825, B-37173, B-37408, B-39275, C-30360, F-10599, F-40387, L-11204
PLETHYSMOGRAPHY G-12038
PLUME BEHAVIOR E-05713, E-30863, H-08884
PLUTONIUM COMPOUNDS C-27106, C-27829, D-43388
PNEUMOCONIOSIS B-43515, G-12984, G-13625, G-26528, G-26775, G-27085, G-32608, G-40068, G-41067, G-41097
PNEUMONIA A-35957, G-00473, G-03086, G-32735, G-40068, G-40688, G-44176, G-44381, H-40591, N-20548
POINT SOURCES C-28621, D-23388, D-24351
POLAROGRAPHIC METHODS B-39272, C-01607, C-05456, C-05977, C-06881, C-09983, C-16123, C-18007, C-20891, C-21338, C-24617, C-25013, C-26336, C-26467, C-27556, C-31933, C-32534, C-32833, C-33255, C-39762, C-41490, C-42020, C-42084, D-00697, D-04646, D-10595, D-16576, D-25881, D-28097, D-28178, D-28620, D-28785, D-29814, D-29918, D-31014, D-32350, D-36688, D-36820, D-43962, D-44059, G-08683, G-43337, H-39328
POLLENS A-34018, E-22754, G-00375, G-07162, G-26477, G-38721
POLLUTION PRECURSORS D-05551
POLYMERIZATION J-03289
POLYNUCLEAR COMPOUNDS A-01565, A-05067, A-08972, A-09393, A-16156, A-19598, A-24829, A-26645, A-27180, A-27458, A-29786, A-30759, A-33087, A-34018, A-35078, A-35199, A-35353, A-35481, A-35818, A-35919, A-42212, B-01851, B-05300, B-17906, B-26269, B-29126, B-31364, B-32938, B-33932, B-37150, B-37234, B-41608, B-44473, C-06112, C-09476, C-26707, C-27294, C-29595, C-30290, C-32058, C-39762, D-00985, D-01673, D-03410, D-03526, D-04938, D-05573, D-06760, D-06788, D-08568, D-08821, D-09432, D-10612, D-11028, D-16684, D-17106, D-25107, D-28097, D-28233, D-31396, D-34008, D-43693, D-44059, F-00058, F-06648, G-00375, G-03086, G-07162, G-30328, G-31319, G-33607, G-33778, G-38869, G-40634, G-40688, G-41097, G-44176, H-39328, L-02635, L-07952, L-33495, L-41703, N-04052, N-04212, N-17260, N-28088
PORTABLE C-08130, C-23596, C-32975, C-40724, D-30860, D-36562, D-40584, G-34902
POTASSIUM COMPOUNDS A-32492, A-37190, B-26243, B-35352, C-23096, C-24337, C-38778, C-41825, D-23971, D-35010, D-44580, F-06648, F-13911, F-14008, F-16659, F-17882, G-07740, G-21037, H-36991, K-34377
POTATOES H-17218, H-17220, H-17978
POTENTIOMETRIC METHODS C-23596, C-30290, C-39762, F-14008, F-14039, F-16659, H-39328
POULTRY A-17778, G-13159, G-18502, G-40355, H-12536, H-30033, H-39407, H-43226
POWER CYCLES E-00834, K-06778
POWER SOURCES A-01565, A-01624, A-01868, A-04460, A-05171, A-08039, A-08972, A-09210, A-09355, A-09393, A-09686, A-15769, A-19598, A-20545, A-20927, A-22579, A-22941, A-22976, A-23250, A-23316, A-24281, A-24718, A-24996, A-25581, A-26134, A-26552, A-26763, A-26925, A-27249, A-27272, A-27943, A-28394, A-28560, A-28873, A-29364, A-29516, A-29782, A-29786, A-30604, A-30976, A-31133, A-31596, A-32621, A-33087, A-33365, A-33378

A-33626, A-33667, A-33710, A-34018, A-34040, A-34442, A-34774, A-35353, A-35484, A-37648, A-38522, A-38543, A-38625, A-39603, A-39754, A-40776, A-41518, A-41654, A-41738, A-42080, A-42212, A-42980, A-43346, A-44227, A-44464, A-45092, B-00015, B-01484, B-01851, B-05214, B-05300, B-09231, B-17906, B-18053, B-20740, B-20844, B-21303, B-21762, B-23540, B-23697, B-23923, B-24813, B-25377, B-26153, B-26243, B-27876, B-28059, B-28060, B-28286, B-28699, B-29204, B-29531, B-29605, B-29656, B-29920, B-30944, B-31221, B-31819, B-31825, B-32355, B-32822, B-33366, B-33403, B-33741, B-33932, B-34381, B-34457, B-34611, B-34740, B-35778, B-35821, B-36081, B-36144, B-36145, B-36721, B-37150, B-37195, B-37275, B-37938, B-39272, B-39492, B-42166, B-42300, B-42330, B-42817, B-42819, B-44473, B-44660, B-44750, B-44882, C-22927, C-28755, C-32058, C-42775, D-00969, D-02133, D-03410, D-04646, D-08438, D-08568, D-08810, D-08812, D-08821, D-09726, D-12099, D-24162, D-24351, D-25055, D-27174, D-28369, D-34008, D-39988, F-00058, F-03799, F-08207, F-09745, F-14995, F-28908, G-00020, G-08411, G-10856, G-19940, G-23167, G-30328, G-30831, G-33165, G-34406, G-35118, G-41847, H-25878, H-28471, H-36196, I-31377, I-36051, J-27968, K-03956, K-08803, K-30035, K-38758, L-02635, L-03536, L-07952, L-09009, L-22583, L-35151, L-37392, L-37717, L-41703, L-42873, L-44376, L-44499, N-04052, N-08273, N-09780, N-20548

PRECIPITATION A-03280, A-11702, A-15205, A-19955, A-21069, A-21722, A-23620, A-26454, A-30513, A-31315, A-33293, A-34647, A-35078, A-35788, A-36032, A-37166, A-41145, C-06920, C-18302, C-23646, C-33042, C-44995, D-00005, D-02133, D-04646, D-05623, D-07198, D-08502, D-09240, D-15789, D-16791, D-21015, D-21684, D-23658, D-23971, D-24952, D-25089, D-27191, D-27648, D-28620, D-29647, D-29814, D-29918, D-30182, D-31325, D-32727, D-37288, D-39405, D-39988, D-42247, D-44996, E-00834, E-01821, E-03841, E-05713, E-10215, E-19058, E-21796, E-22754, E-22959, E-23743, E-24166, E-24570, E-28799, E-29445, E-29688, E-29910, E-30073, E-30676, E-30863, E-31895, E-32155, E-32158, E-36714, E-40157, E-44999, E-45050, F-35379, G-23801, G-29789, G-31040, G-32129, G-37420, G-40485, G-42463, H-12647, H-14786, H-17681, H-23258, H-28289, H-31010, H-33112, H-33364, H-33985, H-42250, I-00305, I-02176, L-25542, L-35922, N-04212

PRESSURE A-05171, A-33365, A-42791, B-22520, B-37173, B-42300, B-44003

PRESSURE (ATMOSPHERIC) B-09231, D-08502, D-34805, E-24109

PRIMARY METALLURGICAL PROCESSING A-03982, A-09686, A-10749, A-12751, A-12823, A-24285, A-26441, A-26891, A-29539, A-29572, A-29786, A-29787, A-30513, A-31525, A-32035, A-34068, A-34788, A-34916, A-34921, A-35168, A-35224, A-39462, A-40314, A-40583, A-41889, A-41890, A-42676, A-42726, A-43271, B-00107, B-03232, B-03337, B-03754, B-08562, B-10558, B-15208, B-16053, B-21324, B-22492, B-22520, B-24553, B-25334, B-25470, B-25781, B-26600, B-30124, B-32036, B-32248, B-32260, B-32319, B-32750, B-33157, B-34071, B-35296, B-35303, B-35342, B-35478, B-37750, B-40709, B-43937, C-08145, C-10561, C-42137, C-44479, C-45235, D-03410, D-05623, D-21869, D-26054, D-27880, D-29153, D-29191, D-30326, D-30860, D-37320, D-38110, D-40574, D-40584, D-41887, E-12777, F-13534, G-03281, G-03892, G-03893, G-04196, G-11630, G-24428, G-31319, G-31528, G-34709, G-36283, G-37731, G-44255, H-10318, H-11467, H-18481, H-19620, H-20237, H-23435, H-26276, H-27489, H-32224, H-32335, H-32736, H-33112, H-33362, H-35880, H-39690, H-40590, H-40591, H-41891, H-41892, H-41893, H-42250, J-30696, K-05778, K-14443, L-17927, L-23552, L-23610, L-24214, L-39640, N-20548

PRIMATES G-12038, G-12646, G-32746, G-34841, G-37119, G-39193

PRINTING A-31525, A-32035, G-03281, G-03654, G-05780, G-28024, G-33527, G-37540, G-40492

PROCESS MODIFICATION A-05067, A-10749, A-26763, A-27249, A-30067, A-30604, A-33378, A-34774, A-36623, A-38819, A-41738, A-44464, A-45092, B-14604, B-19808, B-28699, B-31819, B-31825, B-32938, B-35018, B-35476, B-36031, B-37042, B-37195, B-40411, B-42300, B-42330, B-43333, B-44853, F-08207, F-40387, G-08566, G-34175, G-35568, J-22358, J-39941, L-09009, L-28099, N-28088

PROPANES A-27249, A-34774, A-44464, B-31221, G-44867

PROPELLER AIRCRAFT B-22890, D-06788, F-07451

PROPENES A-08039

PROPIONALDEHYDES G-00177

PROPOSALS A-36664, B-43575, D-05573, D-25107, G-24877, G-34436, G-44395, K-36346, L-09009, L-22583, L-23234, L-31454, L-37423, L-37521, L-38757, L-40486, L-42041

PROTECTIVE MASKS G-04196, G-08566, L-23234

PROTEINS A-34068, A-35953, C-42928, F-11570, F-11582, G-00993, G-03635, G-03892, G-08381, G-22637, G-23768, G-27614, G-29256, G-29825, G-30686, G-31303, G-31491, G-31493, G-31899, G-32129, G-32218, G-34175, G-34789, G-34836, G-34847, G-35225, G-35560, G-36152, G-36251, G-36932, G-36957, G-37731, G-37941, G-37964, G-39621, G-40021, G-40057, G-40295, G-40492, G-41695, G-43532, G-44254, G-44255, G-44395, G-45273, H-42945

PROTOZOA C-32058

PUBLIC AFFAIRS D-03441, D-30860, D-39081, D-44330, G-00740, G-32408, G-33903, G-34095, G-41067, L-00311, L-22583, L-34980, L-37193, L-37521, M-01073, M-29432, N-04212, N-09780

PUBLIC INFORMATION D-03441, G-00740, G-32408, G-34095, G-41067, L-00311, L-22583, L-37193, L-37521, M-01073, N-04212, N-09780

PULMONARY EDEMA A-35078, G-00375, G-26477, G-41737, H-08884, H-11452, H-11467

PULMONARY FUNCTION D-36503, G-00375, G-00473, G-07162, G-21259, G-21266, G-27253, G-27291, G-30198, G-32735, G-32905, G-35041, G-37942, G-38869, G-42136, H-34831, L-37497, N-11871, N-20548

PULMONARY RESISTANCE G-00375, G-07162, G-32735

PULSE RATE G-30671

PULVERIZED FUELS A-05067

PYRENES A-01565, A-05067, A-09393, A-16156, A-19598, A-26645, A-29786, A-30759, A-34018, A-35078, A-35481, A-35919, A-42212, B-01851, B-33932, B-41608, C-26707, C-27294, C-30290, C-32058, C-39762, D-00985, D-01673, D-03410, D-03526, D-04938, D-06760, D-06788, D-08568, D-08821, D-11028, D-16684, D-17106, D-25107, D-28097, D-28233, D-34008, D-43693, D-44059, F-00058, G-00375, G-03086, G-07162, G-33607, G-33778, G-38869, G-40634, G-40688, G-41097, G-44176, H-39328, L-02635, L-07952, L-41703, N-04052, N-04212

PYROLYSIS B-03337, F-13534

## Q

QUARTZ B-34313

QUESTIONNAIRES A-40981, D-44330, G-05475, G-08326, G-30181, G-30198, G-32905, G-35041, I-06355, J-35391, K-03007

QUINOLINES C-15734, F-06648

QUINONES C-06894, F-06648

## R

RABBITS G-11808, G-14492, G-26356, G-26483, G-27490, G-28024, G-30671, G-31442, G-33527, G-33910, G-35225, G-36740, G-37119, G-39193, G-39503, G-39621, G-39863, G-45005, H-42945

RADIATION COUNTERS C-01249, D-00261, D-31332, D-32350, D-34805, E-24549, G-18046, G-20990

RADIATION MEASURING SYSTEMS A-25417, B-00063, C-00125, C-01249, C-06920, C-25431, C-25432, C-26707, C-27106, C-33055, C-34106, C-37175, C-42437, C-44479, D-00261, D-00974, D-10756, D-27105, D-31332, D-32350, D-34805, D-43388, E-24549, F-00841, G-00177, G-18046, G-20990

RADIOACTIVE RADIATION A-25417, A-30428, A-35052, A-37648, A-41945, A-45145, B-00063, B-05214, B-05300, B-27371, B-34313, C-00125, C-01249, C-01607, C-01608, C-05243, C-06920, C-09333, C-11042, C-11626, C-26707, C-27106, C-27294, C-27829, C-29810, C-32534, C-33042, C-33055, C-34407, C-35494, C-36588, C-36698, C-37175, C-38778, C-40407, C-40631, C-40724, C-41016, C-42160, C-42437, C-43448, C-43587, C-43763, C-44210, C-44479, D-00017, D-00261, D-00974, D-01355, D-03441, D-05167, D-10756, D-19822, D-22553, D-24316, D-25089, D-25758, D-27105, D-31325, D-31332, D-32350, D-34088, D-34805, D-35010, D-35407, D-37026, D-42742, D-42921, D-43388,

D-43558, D-45218, E-03841, E-05713, E-21182, E-22754, E-22959, E-24166, E-24549, E-28799, E-31852, E-32155, F-00841, F-13451, G-00873, G-01500, G-07162, G-07169, G-19881, G-20990, G-27801, G-28205, G-30468, G-34837, G-36251, G-38721, G-39833, H-01523, H-12647, H-33985, H-36197, H-41733, H-42857, L-25542, N-05313, N-28803

RADIOACTIVE TRACERS A-30428, B-34313, C-01607, C-01608, C-06920, C-33055, C-36588, C-36698, E-03841, E-05713, E-21182, E-22754, E-22959, E-31852, F-00841, F-13451, G-01500, G-20990, G-34837, G-36251, H-01523, N-05313

RADIOGRAPHY C-25015, C-32718, D-29152, G-01754, G-30181, G-30395, G-30468, G-32696, G-32735, G-36934, G-39095

RADIOLOGICAL HEALTH F-13451, G-20990

RADON C-27294, D-10756, E-05713, E-21182, E-24166, G-07169, H-12647

RAIN A-03280, A-11702, A 23620, A-30513, A-31315, A-33293, A-41145, C-18302, C-33042, D-00005, D-05623, D-07198, D-16791, D-21015, D-21684, D-23971, D-24952, D-25089, D-27191, D-27648, D-28620, D-29647, D-29814, D-29918, D-30182, D-32727, D-37288, D-39405, D-39988, D-42247, E-03841, E-19058, E-21796, E-22754, E-22959, E-23743, E-24570, E-29445, E-29688, E-30073, E-32155, E-32158, E-36714, F-35379, G-23801, G-31040, G-40485, H-12647, H-14786, H-23258, H-31010, H-33112, H-33364, I-02176, N-04212

RATS B-29414, G-00473, G-01341, G-01500, G-01797, G-01923, G-03897, G-05671, G-08999, G-09493, G-12038, G-12075, G-12646, G-14156, G-18417, G-18494, G-18515, G-23167, G-23926, G-24288, G-27107, G-29588, G-30468, G-30671, G-30672, G-31442, G-32041, G-32834, G-33779, G-33910, G-34791, G-34836, G-34841, G-34851, G-35174, G-35225, G-36251, G-36747, G-36935, G-37685, G-38867, G-38869, G-39863, G-40312, G-41818, G-42737, G-42957, G-43531, G-44254, G-44381, G-45288, G-45293, H-34901, H-35209, H-42945, K-11746

REACTION KINETICS A-28873, B-20735, B-37750, B-39275, C-10528, F-03799, F-08207, F-09745, F-19823, F-34297, F-34607

REACTION MECHANISMS A-26191, A-33365, A-34040, B-05300, B-26243, B-35476, B-35814, B-38727, C-25222, D-31775, D-34008, F-00058, F-08207, F-09578, F-09745, F-13943, F-16659, F-34297, F-34607, F-36524, F-39901, F-44032, G-09493, G-28024, G-35042, H-26055

RECORDING METHODS A-40947, B-44614, C-25431, C-39168, F-11570, G-30468

REDUCTION A-10749, A-12751, A-12823, A-26441, B-03337, B-05300, B-30717, B-31246, B-31985, B-33403, B-34536, B-35223, B-35814, B-36578, B-39275, B-40411, E-12777, F-09578, F-13534, F-36524, G-07162

REGIONAL GOVERNMENTS A-39367, B-29628, K-33107, K-42039, L-29421, L-32884

REGULATIONS A-29787, A-29936, A-30001, A-31520, A-33667, A-33963, A-34031, A-34177, A-34442, A-35168, A-36535, A-36664, A-39067, A-40455, A-41035, A-41654, A-43776, B-00107, B-31364, B-31496, B-32424, B-33932, B-35166, B-44742, C-39516, C-41763, D-29416, D-30860, D-38110, D-42367, F-41787, G-34059, H-28471, J-35391, J-37409, J-39941, K-06778, K-09259, K-19750, K-34377, K-36346, K-42039, L-00311, L-02635, L-08725, L-24757, L-31957, L-32789, L-32884, L-34033, L-34980, L-35795, L-37423, L-37521, L-37717, L-38669, L-38757, L-40486, L-41289, L-42041, L-42873, L-44044, L-44325, L-44376, N-04052, N-09780

REINLUFT PROCESS (ADSORPTION) A-35052

REPRODUCTION B-29414, G-00473, G-03286, G-10856, G-16810, G-18503, G-30671, G-31228, G-33234, G-33527, G-34914, G-35055, G-35219, G-35714, G-36765, G-37964, G-40022, G-42737, G-44364, H-33362, H-35234, H-39407, H-42715, H-43511

RESEARCH INSTITUTES B-30633, B-43937, D-34008, D-35407, H-24667

RESEARCH METHODOLOGIES A-01868, A-06220, A-39462, B-43937, B-44750, C-01607, C-10528, C-33042, C-36588, C-36698, C-36703, D-10380, D-16345, D-22290, D-29655, E-44813, G-12646, G-31524, G-31584, G-32749, G-33202, G-38869, G-39179, H-12647, H-38743

RESEARCH PROGRAMS A-01868, A-24031, A-25125, A-27858, A-32621, A-33087, A-36623, A-38625, A-40776, A-40981, A-42791, B-01851, B-20735, B-30633, B-31690, B-32364, B-33386, B-33388, B-33542, B-33550, B-34457, B-36721, B-37116, B-42702, B-44283, B-44470, D-03441, D-05820, D-30860, E-29445, G-12038, G-14156, G-23715, G-25068, G-29815, G-29816, G-34095, G-34895, G-37788, G-44254, G-44463, H-40368, H-43226, J-39956, L-03536, L-09009, L-24467, L-32462, L-35151, L-35461, L-37193, L-37497, L-40486, L-40520, L-42041

RESIDENTIAL AREAS A-34647, A-35065, C-15562, C-20891, C-32058, D-01315, D-05167, D-06760, D-07600, D-08438, D-08502, D-08821, D-10612, D-15789, D-15823, D-24162, D-24952, D-27188, D-27648, D-27675, D-28369, D-29515, D-30860, D-31014, D-32055, D-32727, D-32945, D-35940, D-36009, D-36195, D-36486, D-36562, D-36820, D-37264, D-39535, E-23743, E-37953, G-01754, G-08326, G-09253, G-09408, G-23801, G-23876, G-29958, G-30000, G-30672, G-35041, H-41800, H-42336, I-00305, L-08196, M-35206

RESIDUAL OILS A-29786, A-34774, B-33932, C-32718, C-43763, D-28629, D-32055, D-37191, L-32884, L-44499

RESPIRATION G-11630, H-17038, H-32654

RESPIRATORY DISEASES A-00962, A-22579, A-27943, A-30513, A-34018, A-35078, A-35957, B-43515, D-03441, D-05260, D-16345, D-31396, D-32055, D-35025, E-38666, G-00020, G-00375, G-00473, G-01754, G-03086, G-03282, G-07162, G-07423, G-09253, G-11630, G-12984, G-13625, G-14156, G-21259, G-23167, G-24314, G-26356, G-26477, G-26528, G-26775, G-27085, G-27291, G-28256, G-30181, G-30198, G-31452, G-32484, G-32608, G-32696, G-32735, G-32905, G-34092, G-35041, G-38616, G-40068, G-40435, G-40634, G-40688, G-41067, G-41097, G-41124, G-41737, G-44087, G-44176, G-44381, G-44433, G-44867, G-45196, H-08884, H-11452, H-11467, H-40591, H-42857, L-25288, L-31957, L-37497, L-44325, L-44499, N-04052, N-20548

RESPIRATORY FUNCTIONS A-27943, A-29572, A-29782, A-29872, A-30674, A-34341, A-36032, A-37372, B-31221, C-09333, D-27174, D-28369, D-35010, D-36503, E-30676, E-31852, F-13451, F-35379, G-00375, G-00473, G-00902, G-04877, G-07162, G-07169, G-12070, G-13625, G-15703, G-17214, G-17244, G-18046, G-20087, G-20198, G-20990, G-21259, G-21266, G-23768, G-24603, G-26260, G-26356, G-26775, G-26931, G-27253, G-27291, G-27490, G-29815, G-30000, G-30181, G-30198, G-30468, G-31452, G-31517, G-31528, G-32041, G-32735, G-32905, G-33372, G-33497, G-33779, G-33864, G-34951, G-35041, G-36354, G-37942, G-38869, G-42136, G-42463, G-44381, H-19604, H-33922, H-34831, H-34901, H-35827, H-36265, H-44071, L-07952, L-37497, N-11871, N-20548

RESPIRATORY SYSTEM A-21069, A-29096, A-30674, A-35957, A-36527, D-27174, D-35025, D-36688, F-13451, G-00473, G-00902, G-01756, G-01797, G-01923, G-03282, G-05002, G-05280, G-05475, G-07169, G-08411, G-09019, G-09493, G-12070, G-12075, G-12984, G-16810, G-18046, G-18417, G-20990, G-23768, G-24314, G-26356, G-26528, G-26775, G-26931, G-27614, G-29789, G-30156, G-30181, G-30468, G-31319, G-31452, G-31517, G-31528, G-32625, G-33497, G-33779, G-33864, G-34951, G-36354, G-37685, G-38616, G-38721, G-38867, G-39161, G-39989, G-40068, G-40688, G-42098, G-42136, G-44254, G-44381, G-44508, G-44696, G-44867, G-45196, G-45293, H-08884, H-11467, H-28105, H-33362, H-34831, H-40591, K-11746, K-16808, L-07952, N-18005, N-20548

RETENTION A-23280, A-25417, A-29872, A-35953, A-36032, A-40314, C-39762, C-43720, D-03441, D-27174, D-28369, D-41887, F-13451, F-36076, G-00902, G-03282, G-04877, G-06059, G-09261, G-09535, G-14492, G-18549, G-19159, G-20990, G-26260, G-26483, G-26931, G-27490, G-28170, G-29329, G-29493, G-29789, G-30000, G-30672, G-31517, G-32041, G-32484, G-32787, G-33052, G-33778, G-33779, G-33864, G-34951, G-35217, G-35380, G-35792, G-36152, G-36765, G-37119, G-38580, G-38867, G-38869, G-39179, G-39193, G-40014, G-41368, G-41731, G-42022, G-42098, G-42737, G-42757, G-42881, G-44053, G-44176, G-44251, G-44508, G-44696, G-45005, G-45288, G-45293, H-14489, H-14786, H-17978, H-28105, H-28448, H-32654, H-33112, H-33922, H-33985, H-34830, H-35410, H-35880, H-36197, H-37912, H-37926, H-37977, H-38332,

H-38743, H-39328, H-39408, H-39409, H-40335, H-40368, H-40540, H-41143, H-41892, H-41893, H-44071, H-45056, K-11746
RINGELMANN CHART A-35168, L-00311

RIVERS A-03280, A-26891, A-34068, A-35398, C-33042, D-04996, D-37369, F-35378, F-35379, F-39522, L-23608, L-23610, L-24214
ROTARY PISTON ENGINES A-20927, A-27249, A-28560, A-30604, A-38522, A-42980, B-09231, B-30944, B-35821, B-37150, B-44473, D-34008, L-22583
RUBBER A-09210, A-28210, A-33822, A-37190, B-44283, D-43468, H-40368, J-30696, L-07952
RUNNING EVAPORATIVE LOSSES A-08972, B-20844

## S

SAFETY EQUIPMENT B-22520, G-29286, L-23234
SALTZMAN METHOD C-32476, C-38755, D-37366, D-43962, K-08420
SAMPLERS A-05067, A-06220, A-15295, A-29661, A-30759, A-33710, B-25301, B-32633, B-35352, C-00855, C-01608, C-02164, C-03037, C-05243, C-06894, C-08145, C-08661, C-09888, C-09983, C-10556, C-11042, C-19313, C-19501, C-21862, C-23096, C-23657, C-24644, C-25015, C-25440, C-25932, C-26145, C-26275, C-26467, C-26698, C-26707, C-26848, C-27075, C-27106, C-27358, C-27556, C-27829, C-28621, C-28755, C-29464, C-30593, C-30707, C-31258, C-31304, C-31933, C-32474, C-32476, C-32975, C-33731, C-34407, C-35494, C-36588, C-36840, C-36841, C-37175, C-37514, C-37608, C-37689, C-37693, C-38778, C-38914, C-42043, C-42139, C-42360, C-42437, C-43448, D-00974, D-01089, D-01315, D-02133, D-03410, D-04646, D-07600, D-07985, D-08275, D-08438, D-08568, D-08810, D-09432, D-10612, D-10756, D-11184, D-11202, D-12049, D-14762, D-15573, D-21684, D-21906, D-22553, D-23864, D-24316, D-25635, D-25881, D-26044, D-28528, D-28620, D-28629, D-28650, D-28653, D-28920, D-29655, D-30025, D-30182, D-30326, D-30656, D-31014, D-31775, D-32350, D-32883, D-34805, D-34933, D-35489, D-35861, D-36009, D-36288, D-36449, D-36486, D-36562, D-36688, D-36820, D-37191, D-37202, D-37320, D-37369, D-37518, D-39405, D-39914, D-41975, D-42122, D-42742, D-43962, D-44059, D-44330, D-44996, E-03841, E-32155, E-35207, E-36487, E-38118, F-07451, F-34948, G-00076, G-00177, G-00597, G-20687, G-24603, G-29958, G-31351, G-34902, G-35041, K-08420, L-32462, N-04212
SAMPLING METHODS A-05067, A-06220, A-09355, A-13524, A-15295, A-18297, A-26454, A-26645, A-28873, A-29661, A-30759, A-31632, A-32621, A-33710, A-35168, A-35919, A-37176, A-39609, B-01851, B-25301, B-27371, B-31604, B-32633, B-35352, B-41608, C-00855, C-01249, C-01608, C-02164, C-03037, C-05243, C-05977, C-06072, C-06112, C-06894, C-08130, C-08145, C-08661, C-09333, C-09888, C-09953, C-09983, C-10556, C-11042, C-12943, C-12993, C-16123, C-17179, C-17180, C-19313, C-19501, C-20891, C-21862, C-23096, C-23657, C-24644, C-25015, C-25440, C-25793, C-25932, C-26145, C-26275, C-26467, C-26503, C-26698, C-26707, C-26848, C-27075, C-27106, C-27294, C-27358, C-27556, C-27829, C-28017, C-28126, C-28621, C-28755, C-29464, C-30360, C-30593, C-30707, C-31258, C-31304, C-31933, C-32058, C-32474, C-32476, C-32534, C-32718, C-32829, C-32975, C-33255, C-33731, C-34017, C-34407, C-35396, C-35494, C-36588, C-36840, C-36841, C-37175, C-37514, C-37608, C-37689, C-37693, C-38670, C-38778, C-38914, C-41908, C-42043, C-42139, C-42360, C-42437, C-43448, C-44995, C-45235, D-00974, D-00976, D-00985, D-01089, D-01315, D-01355, D-01673, D-02133, D-02750, D-03410, D-03526, D-04646, D-04938, D-05167, D-05277, D-05551, D-07600, D-07985, D-08275, D-08438, D-08568, D-08810, D-09240, D-09432, D-10612, D-10756, D-11028, D-11184, D-11202, D-12049, D-14762, D-15573, D-20642, D-21684, D-21906, D-22553, D-22829, D-23864, D-24316, D-25635, D-25881, D-26044, D-27621, D-28528, D-28620, D-28629, D-28650, D-28653, D-28920, D-29655, D-30025, D-30182, D-30326, D-30656, D-31014, D-31775, D-32350, D-32883, D-32912, D-34805, D-34933, D-35489, D-35725, D-35861, D-36009, D-36288, D-36449, D-36486, D-36562, D-36688, D-36820, D-37191, D-37202, D-37320, D-37369, D-37518, D-39405, D-39914, D-41664, D-41975, D-42122, D-42742, D-43962, D-44059, D-44330, D-44996, E-00834, E-01821, E-03841, E-32155, E-35207, E-36487, E-38118, E-44999, F-05440, F-07451, F-10599, F-34948, G-00076, G-00177, G-00597, G-00902, G-20687, G-24428, G-24603, G-27084, G-29816, G-29958, G-31351, G-31528, G-34902, G-35041, H-30424, H-32224, K-06734, K-08420, L-00311, L-32462, L-33495, N-03674, N-04212, N-17260
SAMPLING PROBES A-37176, D-01089, D-02133, F-10599
SAN FRANCISCO C-00855, C-44479, D-00969, D-02750, D-03441, D-07600, H-25967, K-43312, N-20548
SANITARIANS G-00736, G-00740, G-36207, L-33844, L-35151, M-33904
SCANDINAVIA A-41654, A-44464, B-44660, B-44750, D-41664, G-41717, G-42884, G-44053, G-44508, L-40520, L-44376
SCATTERING (ATMOSPHERIC) D-00005
SCREEN FILTERS B-08562
SCRUBBERS A-09686, A-12751, A-12823, A-20652, A-35052, A-35168, A-39462, B-00107, B-03125, B-03337, B-03754, B-09798, B-16053, B-22492, B-22520, B-25470, B-28172, B-28286, B-30124, B-31985, B-32248, B-32319, B-34025, B-35303, B-35342, B-35352, B-35476, B-39272, B-40785, B-42131, B-43515, B-44742, C-06072, C-24337, C-42043, D-01089, D-05260, E-12777, G-00177, K-34377, L-07952, L-23562, L-32884, L-37560, N-09780
SEA BREEZE B-44283
SEA SALTS A-15205, A-19955, A-21722, E-28586, G-39095
SEALING COMPOUNDS A-35957
SEASONAL A-15205, A-15599, A-19684, A-19955, A-21722, A-26645, A-31649, A-36032, B-30633, B-44283, C-05243, C-40724, D-00974, D-01315, D-02133, D-03526, D-04646, D-04938, D-04996, D-06148, D-07198, D-08275, D-08591, D-09240, D-10595, D-10612, D-10634, D-10756, D-11028, D-17340, D-19822, D-23388, D-24414, D-25089, D-25635, D-25881, D-27241, D-27621, D-27672, D-27675, D-29153, D-29416, D-29647, D-29918, D-30025, D-30410, D-30858, D-30860, D-31325, D-32350, D-34008, D-34933, D-36562, D-36820, D-37026, D-37288, D-40363, D-42247, D-44996, E-03841, E-30676, E-32155, G-00736, G-01755, G-05002, G-29816, G-30395, G-33497, G-34701, G-35377, G-36934, G-37023, G-37941, G-44433, H-17225, H-25878, H-27352, H-28529, H-33112, H-33364, H-33922, H-33985, H-39408, K-34377
SECONDARY AIR B-14604, B-37042, L-09009
SEDIMENTATION A-09686, A-29539, B-35296, B-35342, C-00125, C-00855, C-08130, C-35494, D-24952, D-39405, E-00834, E-23743, E-32155, E-32158, E-35207, E-45050, G-03282
SELENIUM COMPOUNDS B-38727, C-27294, C-42437, D-39535, G-32608, G-42022, H-07742, K-20121
SENATE HEARINGS B-24696, B-24722, G-25328
SETTLING CHAMBERS B-03754, B-33403

SETTLING PARTICLES A-03278, A-09393, A-12624, A-13524, A-15205, A-19955, A-20652, A-21722, A-22941, A-26441, A-27180, A-28210, A-29661, A-29786, A-29787, A-30414, A-31395, A-31525, A-33169, A-33710, A-33965, A-34018, A-34774, A-35078, A-35676, A-36846, A-37190, A-37372, A-38543, A-38819, A-39152, A-39462, A-40583, A-40981, A-41654, A-42080, A-42377, A-42676, A-42726, A-43271, A-44464, B-00107, B-03125, B-03232, B-03754, B-07606, B-08562, B-09798, B-15208, B-17525, B-20740, B-22520, B-24553, B-25033, B-25470, B-26600, B-28060, B-28172, B-28730, B-30633, B-32319, B-32633, B-32760, B-32822, B-32938, B-33157, B-34025, B-34071, B-34313, B-35166, B-35296, B-35342, B-35478, B-35540, B-37750, B-38727, B-40709, B-43515, B-43937, B-44283, B-44750, C-01608, C-03037, C-03770, C-05977, C-08130, C-09983, C-10556, C-10561, C-14758, C-15563, C-16367, C-25431, C-26274, C-26698, C-27358, C-28017, C-28755, C-29464, C-29595, C-30290, C-30360, C-31933, C-32534, C-32718, C-32975, C-36588, C-37608, C-37689, C-37693, C-37971, C-38165, C-38778, C-41763, C-41908, C-41968, C-45235, D-00005, D-02133, D-03441, D-04996, D-05260, D-05277, D-06148, D-06760, D-07198, D-08438, D-08502, D-09432, D-10380, D-10634, D-14762, D-15610, D-15789, D-15823, D-16684, D-17106, D-20642, D-21869, D-25089, D-25758, D-26387, D-26535, D-27187, D-27257, D-28097, D-28233, D-28326, D-28653,

D-29152, D-29191, D-29382, D-29385, D-29416, D-29515, D-29814, D-30025, D-30182, D-30493, D-30656, D-30858, D-30860, D-31014, D-31396, D-32055, D-32912, D-32945, D-33114, D-33576, D-34008, D-34933, D-35025, D-36562, D-37518, D-38110, D-38133, D-39405, D-39988, D-40363, D-41033, D-41520, D-41888, D-41975, D-42122, D-43693, D-43962, D-44059, D-44330, D-44996, E-03841, E-19058, E-21796, E-24570, E-28586, E-29445, E-29910, E-30676, E-32155, E-36714, F-27348, G-00810, G-00902, G-01512, G-03892, G-04196, G-05002, G-07162, G-07551, G-08566, G-09253, G-09408, G-12070, G-12984, G-18417, G-19940, G-20704, G-24081, G-26477, G-26775, G-29129, G-30000, G-30181, G-31319, G-31351, G-32484, G-32696, G-32905, G-33778, G-34092, G-34951, G-35568, G-38721, G-39095, G-41067, G-42463, G-44087, G-44251, G-44254, G-44433, G-44508, G-44696, H-08884, H-10318, H-11157, H-19604, H-19620, H-20062, H-21018, H-26276, H-28448, H-30225, H-30921, H-31010, H-32322, H-32338, H-36197, H-37977, H-38332, H-39690, H-40368, H-42857, I-00305, K-03007, K-06734, K-06778, K-08420, K-09259, K-14443, K-19750, K-20121, K-30069, K-33107, K-34063, K-34377, K-36823, K-38197, K-41682, K-42039, L-00311, L-02635, L-17472, L-17927, L-23234, L-23562, L-25542, L-28349, L-28397, L-29421, L-30152, L-30620, L-31957, L-32789, L-32865, L-32884, L-35795, L-35922, L-37560, L-38669, L-42873, N-03674, N-04052, N-04212, N-09780, N-11871, N-18005, N-28088

SEWAGE A-31632, A-33293, A-40981, A-45072, B-35342, B-42886, C-30635, C-33055, D-20191, D-41979, E-00834, G-39095, H-37977, H-41733, H-43226, L-29421, N-20548

SEWAGE TREATMENT A-33293, D-20191, E-00834

SEWERS D-41979, L-29421

SHEEP G-13159, G-33910, G-38869, H-11467, H-12536, H-32291, H-33362, H-34237, H-35234, H-39407, H-40591, H-43226

SHIPS A-33293, A-43346, D-32055, L-00311, L-29421

SIEVE ANALYSIS C-02164

SILICATES A-15205, A-19955, C-06045, C-23657, C-29226, L-23234

SILICON COMPOUNDS A-15205, A-19955, A-21722, B-03337, B-26243, B-43515, C-06045, C-06072, C-09983, C-23657, C-29226, C-32975, C-34106, C-38778, C-41612, C-41763, C-41908, C-41968, D-04996, D-08502, E-10215, F-06648, F-34607, G-29129, G-34092, G-40688, H-26055, I-33802, K-42039, L-23234, L-32789, L-35795, L-38669

SILICON DIOXIDE A-03982, B-08562, C-09333, C-09983, C-16367, C-29512, C-42928, D-04996, D-15789, D-27880, D-37288, G-34895, G-41097, G-44696, H-39690, H-42336, K-14443

SILICOSIS B-43515, G-12984, G-27085, G-32608, G-41067, G-41097

SILVER COMPOUNDS A-06351, C-00125, C-22975, C-23096, C-30707, C-33042, D-05167, D-21684, D-32350, E-29910, E-40157, F-10599, F-13839, F-14008, F-14039, F-17882, F-17949, F-39522, G-19159

SILVER IODIDE E-40157

SIMULATION B-28377, B-31690, B-42702, C-06107, E-35207, F-07451, G-00177, G-00473, G-38869, H-11157, J-32241, J-35391, L-35922

SINTERING A-10749, A-13524, A-42726, B-08562, B-26600, B-32319, K-06778

SKIN A-35953, A-35957, D-35025, G-03283, G-03284, G-03285, G-05002, G-05280, G-26483, G-30181, G-31442, G-32041, G-34791, G-35055, G-37119, G-39179, G-39826, G-40485, G-44433, G-45005

SKIN CANCER G-00375

SKIN TESTS G-41695

SLAUGHTERHOUSES A-34018

SLUDGE A-31632, A-45072, B-35342, B-42886, C-30635, D-20191, G-39095, H-37977, H-41733

SMOG A-00962, A-01868, A-09210, A-17339, A-22825, A-22976, A-24156, A-27180, A-27272, A-27458, A-27858, A-27943, A-29786, A-30067, A-31934, A-32875, A-33963, A-35078, A-39367, A-39603, A-40677, A-41145, A-42080, A-45274, B-00107, B-01484, B-17906, B-18053, B-19808, B-20735, B-22436, B-25894, B-26269, B-28377, B-32938, B-33542, B-33550, B-33932, B-39404, B-42300, B-44470, C-26274, D-02750, D-03441, D-04996, D-05573, D-07198, D-08591, D-22829, D-24162, D-29382, D-29416, D-29647, D-30860, D-32055, D-35025, D-38110, D-39081, E-00834, E-32155, F-03799, F-05849, G-00177, G-07162, G-16820, G-27291, G-32484, G-34406, G-35118, G-40634, G-41[illegible]97, H-08884, H-11157, H-11467, H-19604, J-22358, K-18294, K-30035, K-30069, L-28099, L-29888, L-41557, L-44325, M-33904, N-03674, N-04212, N-17260, N-18005, N-28088

SMOG INDEX D-07198

SMOKE SHADE A-35168, C-22927, D-00005, D-05277, D-30860, D-32055, G-30328, L-00311

SMOKEMETERS C-26275, C-32534

SMOKES A-01624, A-01868, A-08972, A-20652, A-22976, A-23516, A-26763, A-27180, A-27249, A-27272, A-29787, A-31323, A-32621, A-35168, A-38625, A-39367, A-40583, A-41945, A-43271, A-43346, B-00107, B-09798, B-17525, B-22520, B-25470, B-26600, B-30633, B-30944, B-35476, B-44742, B-44750, C-08130, C-08145, C-25440, C-26274, C-41763, D-00005, D-00985, D-03526, D-05260, D-05277, D-06760, D-08275, D-08591, D-12099, D-16345, D-26054, D-29382, D-30860, D-32055, D-40574, D-40584, D-41033, D-41979, D-44059, E-00834, E-19058, E-32155, E-36038, E-38666, F-05440, G-03086, G-09408, G-30181, G-32735, G-38721, G-39095, G-42136, H-08884, H-11157, H-11452, H-11467, H-19604, H-30225, H-39690, H-40590, H-40591, J-39956, K-03956, L-00311, L-09009, L-27664, L-29421, L-30620, L-32884, L-39640, N-09780, N-20548

SMOKING A-00962, A-30674, A-32035, C-41825, D-01315, D-08568, D-36195, E-38666, F-44164, G-00375, G-00597, G-00642, G-00662, G-00810, G-00873, G-03086, G-05002, G-05280, G-07162, G-07169, G-08326, G-08411, G-09019, G-10793, G-13625, G-21266, G-21766, G-26528, G-26775, G-27291, G-29129, G-29789, G-30181, G-30198, G-31528, G-33607, G-34092, G-37180, G-38580, G-38721, G-40435, G-41097, K-16808, L-07952, N-28803

SNOW A-15205, A-19955, A-21069, A-21722, A-23620, A-34647, A-35788, A-36032, C-06920, C-23646, C-33042, D-04646, D-21684, D-23658, E-19058, E-36714, G-29789, G-37420, N-04212

SOCIAL ATTITUDES A-26552, A-35676, B-31441, D-05260, G-41067, M-01073, M-29432

SOCIO-ECONOMIC FACTORS A-31520, A-33350, A-33965, A-35050, A-35052, A-38759, A-39067, A-45145, B-22834, B-31519, B-32355, B-35112, B-35476, B-35816, B-39404, G-08326, G-18508, G-30328, G-32484, G-32737, G-34059, G-34095, G-36207, G-44463, G-45273, J-30329, J-30696, J-31518, J-31720, J-32241, J-34370, J-34970, J-35391, J-37409, J-37734, J-38624, J-39956, J-42721, L-26442, L-32462, L-36030, L-40520, L-41289, L-41557, L-42016, M-33904, M-35206

SODIUM CARBONATE C-29464, F-16659

SODIUM CHLORIDE C-09888, C-30360, F-00841, F-06648

SODIUM COMPOUNDS B-03337, B-35352, C-09333, C-09888, C-29464, C-30360, C-38778, C-39168, C-41825, D-05167, D-23971, D-28620, D-35010, D-44580, E-36038, F-00841, F-06648, F-13911, F-14008, F-14138, F-14868, F-15493, F-16659, F-17882, G-03892, G-07740, G-21037, G-34837, G-35380, G-35387, H-36991, I-31377

SODIUM HYDROXIDE F-06648

SODIUM SULFITE B-03337

SOILING A-34018, B-42829, H-39409

SOILING INDEX A-35123, B-35540, D-05623, D-35407, D-37026, D-41888, D-44170, E-32155, E-44813

SOILS A-12624, A-14135, A-18510, A-22367, A-25417, A-28210, A-29539, A-29572, A-29787, A-30428, A-32492, A-32748, A-34068, A-35065, A-36032, A-36846, A-37190, A-41890, A-45072, C-21948, C-30113, C-38670, C-39136, C-42137, C-45235, D-10612, D-10756, D-35407, D-40584, D-41887, E-22959, E-30676, E-31852, E-45050, F-43436, F-44332, G-09253, G-20704, G-27084, G-34436, G-36283, G-37420, G-39095, G-42757, G-45159, H-07742, H-09448, H-11157, H-12647, H-14786, H-17182, H-17215, H-17216, H-17217, H-17218, H-17681, H-19604, H-19620, H-20237, H-21794, H-22926, H-23581, H-24667, H-24947, H-25374, H-25967, H-26092, H-27063, H-27352, H-27391, H-28289, H-28379, H-28529, H-30921, H-30931, H-31010, H-31801, H-32224, H-32335, H-32338, H-32736, H-33362, H-33364, H-35827, H-36197, H-36991, H-37926, H-37977, H-39204, H-39287, H-39408, H-39690, H-40590, H-40591, H-41733, H-41891, H-41892, H-42207, H-42250, H-43782, H-44071, L-08196, L-28349, L-29421

SOLAR RADIATION A-23561, A-29096, A-35078, B-30633, B-32938, C-06920, E-24570, E-30863, E-31895, E-32155, G-16820, G-30395, G-38616, L-35922
SOLID WASTE DISPOSAL A-03278, A-26441, A-31632, A-31649, A-34774, A-40981, A-41945, A-45072, B-30124, C-33055, D-03410, D-03441, D-20191, D-37026, F-35378, G-05002, G-20704, G-33607, H-37912, H-41733, I-33802, J-30696, L-29421, L-29888, L-35151, N-04052
SOLIDS A-15205, A-19955, A-21722, A-23620, A-26191, B-03337, B-35018, C-06643, C-32058, D-21684, E-00834, E-24109, E-33873, E-36714, E-40157, F-10599, F-14138, F-15413, G-07162, G-08949
SOLVENTS A-35957, A-38022, B-00107, B-25033, B-30229, C-09333, C-30707, C-44129, F-13839, G-03654, G-16820, G-17470, G-27085, N-04052, N-43824
SOOT A-09393, A-22941, A-27180, A-29786, A-34774, A-35676, A-38819, A-41654, A-42377, B-20740, B-25470, B-28060, B-30633, B-32938, B-34025, B-35166, B-44750, C-09983, C-30290, C-30360, C-41763, D-05260, D-07198, D-08502, D-10634, D-29416, D-30182, D-34008, D-39988, D-41975, G-07162, G-31319, H-11157, H-19604, H-30225, H-37977, H-38332, K-09259, K-30069, K-34063, K-38197, K-41682, L-00311, L-17927, L-28349, L-29421, L-30620, L-32789, L-35795, L-38669, N-04052, N-04212, N-09780, N-18005
SOOT FALL B-30633, D-07198, D-26044, D-40574, G-24603
SOURCE SAMPLING A-31632, C-36588, C-38670, L-00311
SOUTH AMERICA G-41872
SO2 REMOVAL (COMBUSTION PRODUCTS) A-12751, A-12823, A-24080, A-24285, A-31136, A-34774, A-35052, A-35224, A-37166, A-41945, B-03337, B-16053, B-25377, B-26600, B-27824, B-28172, B-29628, B-32260, B-34025, B-44906, E-12777, F-34297, I-22128, L-23562, L-37560, N-09780, N-28088
SPACECRAFT ATMOSPHERES C-16123
SPARK IGNITION ENGINES A-01565, A-01624, A-01868, A-04460, A-05171, A-08039, A-08972, A-09355, A-09393, A-09686, A-23316, A-24281, A-24718, A-26763, A-27249, A-28394, A-28560, A-28873, A-30604, A-32621, A-33365, A-34442, A-35484, A-42080, A-44464, B-00015, B-01484, B-05214, B-05300, B-09231, B-26153, B-28286, B-32355, B-33741, B-34740, B-36081, B-39272, C-42775, D-03410, D-04646, D-08568, D-08810, D-08812, D-08821, D-24162, D-25055, F-03799, F-08207, F-09745, F-28908, G-00020, G-10856, K-08803, L-02635, L-03536, L-07952, L-09009, L-37392, L-44376, N-08273, N-09780
SPARK TIMING A-23250, A-27249, A-27858, A-28560, A-28873, A-34442, A-35481, A-35484, B-20844, B-23697, B-26269, B-27876, B-28108, B-30944, B-31314, B-31690, B-32938, B-33741, B-34035, B-34457, B-36145, B-37042, B-37195, B-37234, B-37275, B-40411, B-41608, B-44341, J-26765
SPECTROMETRY A-04460, A-05067, A-06351, A-14945, A-23239, A-23789, A-24718, A-28873, A-29516, A-29539, A-29936, A-33710, A-33822, A-35818, A-43966, B-27371, B-30717, B-31690, B-39275, C-00056, C-06045, C-06881, C-06920, C-11042, C-17048, C-18007, C-19501, C-19857, C-25015, C-25431, C-25432, C-26275, C-26505, C-27075, C-27556, C-29133, C-29419, C-29464, C-29595, C-30593, C-30635, C-30707, C-31304, C-31933, C-32058, C-32476, C-32534, C-32718, C-32829, C-32892, C-33042, C-33055, C-34017, C-35396, C-35494, C-36588, C-36698, C-38165, C-38778, C-39136, C-39168, C-40724, C-41612, C-41908, C-41968, C-42139, C-43737, C-44210, C-44995, C-45235, D-00976, D-00985, D-03526, D-07600, D-07649, D-08568, D-09726, D-11028, D-23658, D-25055, D-25758, D-30326, D-30656, D-30860, D-31332, D-34805, D-34933, D-35861, D-36009, D-36288, D-36474, D-36486, D-36562, D-36820, D-36909, D-37191, D-37202, D-37366, D-39081, D-39405, D-41520, D-41664, D-42122, D-42742, D-43316, D-43468, D-43952, D-44059, D-44330, E-22754, E-24549, E-31852, E-36487, E-38118, F-00841, F-05849, F-07451, F-13451, F-39522, F-44164, F-44332, F-45295, G-00177, G-01756, G-01797, G-09261, G-10434, G-12075, G-16820, G-18501, G-21070, G-24603, G-32749, G-33165, G-33605, H-21018, K-08420, L-17472, N-06992
SPECTROPHOTOMETRY A-04460, A-05067, A-29661, A-34647, A-35788, A-36006, A-38022, A-40947, A-43966, B-32392, C-00056, C-00855, C-05977, C-06045, C-06072, C-06881, C-08661, C-09333, C-15563, C-18007, C-18302, C-19276, C-19501, C-22975, C-23571, C-24618, C-24719, C-25440, C-25535, C-26336, C-26707, C-26955, C-27294, C-27556, C-27681, C-28126, C-28621, C-28755, C-28895, C-29226, C-29297, C-29595, C-30360, C-30786, C-30928, C-31258, C-31933, C-32474, C-33338, C-33731, C-37608, C-37689, C-38670, C-38682, C-38914, C-38973, C-41138, C-42360, C-43448, C-43720, C-44129, C-44995, C-45235, D-00005, D-00974, D-00985, D-03410, D-03526, D-07649, D-07985, D-09726, D-11028, D-11202, D-12049, D-14762, D-21684, D-22290, D-27241, D-28097, D-28528, D-28620, D-28629, D-28650, D-28653, D-28785, D-29153, D-31014, D-32727, D-32883, D-32912, D-32945, D-35010, D-36449, D-37202, D-37369, D-37518, D-39081, D-44059, D-44330, D-44580, D-44996, E-10215, E-45050, F-07451, F-11582, F-13461, F-13839, F-34607, F-36067, F-44332, F-45295, G-01797, G-09019, G-09261, G-16820, G-19881, G-20287, G-20687, G-23801, G-28011, G-29329, G-29663, G-31040, G-32129, G-32749, G-34245, G-36534, G-41368, G-42661, G-43337, G-44746, H-14489, H-25967, H-28379, H-28529, H-30424, H-40368, H-41143, H-43782, K-08420, N-06992
SPINACH G-05541
SPOT TESTS C-03034, C-05787, C-05977, C-06894, C-12993
SPRAY TOWERS B-28172, B-35303
SPRAYS B-25033
ST LOUIS A-01868, A-02636, A-03982, B-00063, B-03337, D-36449, E-00834, F-03525, F-03799, G-02191, G-03635, I-02176
STABILITY (ATMOSPHERIC) A-45274, C-02164, D-03410, D-03441, D-04646, D-04996, D-10380, D-10634, D-19144, D-21684, D-23864, D-26054, D-30410, D-30860, D-32945, D-41887, E-00834, E-01821, E-05713, E-12777, E-19058, E-22959, E-24109, E-29445, E-30676, E-32158, E-45050, G-07162, G-33778, G-44867, H-17225, K-30035, L-23562, N-09780, N-18005
STACK GASES A-09686, A-12751, A-12823, A-24080, A-24285, A-29096, A-29539, A-29787, A-30674, A-31136, A-31315, A-31632, A-32875, A-35224, A-37166, A-37190, A-40583, A-41945, A-42676, B-03337, B-03754, B-09798, B-22492, B-25470, B-26600, B-27824, B-29628, B-32248, B-32760, B-34025, B-35035, B-35476, B-35478, B-37222, B-38727, B-43515, B-44742, B-44853, B-44906, C-06112, C-09476, C-33055, C-36588, C-36840, C-36841, C-38670, C-39136, C-44210, D-05260, D-08591, D-20191, D-26054, D-27174, D-30182, D-30860, D-32055, D-32912, D-40574, D-40584, D-41979, E-12777, E-24109, F-34297, G-12038, G-20704, G-30181, G-31319, H-08884, H-11452, H-26276, H-31185, H-39690, H-42857, I-33802, K-06778, K-14443, K-34063, K-36823, L-17927, L-29421, L-30620, L-35151, L-38669
STACK SAMPLING A-31632, C-36588, C-38670, L-00311
STACKS A-13524, A-20652, A-24080, A-24285, A-29539, A-31632, A-39367, B-28108, B-30633, B-35476, C-06112, D-29416, G-01512, K-06778, K-44377, L-00311, L-17927, L-30152, L-42873
STAGNATION D-03410, E-01821, E-05713, E-24109
STANDARDS A-00962, A-01868, A-22579, A-22825, A-23280, A-24156, A-24996, A-26134, A-26763, A-27272, A-29516, A-30604, A-30976, A-31315, A-31934, A-32447, A-32523, A-32621, A-33169, A-33293, A-33350, A-33378, A-33667, A-33963, A-33965, A-34177, A-34341, A-34442, A-34647, A-35050, A-35052, A-35168, A-35957, A-36527, A-36541, A-36664, A-37190, A-37721, A-38331, A-38522, A-38625, A-39152, A-39367, A-39609, A-40455, A-40677, A-40776, A-41654, A-41959, A-42679, A-43776, A-45092, B-19710, B-20844, B-24722, B-25096, B-28377, B-28699, B-28730, B-29414, B-29605, B-30944, B-31496, B-31819, B-31825, B-32424, B-33386, B-33388, B-33628, B-33932, B-34381, B-34457, B-34611, B-35166, B-35778, B-36081, B-36523, B-36578, B-37195, B-37234, B-37938, B-39492, B-40785, B-42330, B-44750, B-44882, C-30360, C-41719, D-00005, D-02133, D-08275, D-08568, D-27831, D-29382, D-32055, D-32883, D-32945, D-33576, D-35025, D-36820, D-39988, D-40363, D-41979, D-42367, E-23743, E-44999, F-00841, F-36076, G-00020, G-03285, G-03654, G-05780, G-08381, G-08683, G-12075, G-16820, G-25068, G-25705, G-26915, G-28170, G-29129, G-29815, G-30000, G-30328, G-31280, G-31537, G-32905,

G-33202, G-33903, G-34406, G-34649, G-34951, G-35042, G-35118, G-37180, G-38580, G-38721, G-40485, G-40492, G-41097, G-41737, G-42098, G-44176, H-28448, H-36611, J-22358, J-27968, J-30696, K-02580, K-03007, K-06734, K-06778, K-08803, K-09259, K-11746, K-14443, K-16104, K-16128, K-18294, K-19750, K-20121, K-22223, K-24107, K-30035, K-30069, K-33107, K-33730, K-34063, K-34377, K-36346, K-36382, K-36823, K-38197, K-38758, K-41682, K-42039, K-42118, K-43312, K-44310, K-44377, L-00311, L-03536, L-07952, L-17927, L-22583, L-23608, L-23610, L-24214, L-24757, L-25288, L-28066, L-28099, L-28349, L-29421, L-30152, L-30620, L-31957, L-32462, L-32789, L-32865, L-32884, L-33495, L-34033, L-35151, L-35795, L-36030, L-37392, L-37423, L-37497, L-37521, L-37560, L-37717, L-38669, L-38757, L-40520, L-42016, L-42169, L-42873, L-44219, L-44325, L-44376, L-44499, M-01073, N-08273, N-09780, N-11871, N-14772, N-37225

STATE GOVERNMENTS A-01868, A-34442, D-03410, D-30860, D-32055, G-35714, K-03007, K-08420, K-19750, K-36346, L-33495

STATISTICAL ANALYSES A-09355, B-42817, C-08661, C-10561, C-17179, C-18302, C-33731, C-38914, D-05167, D-05277, D-05551, D-05623, D-08568, D-08591, D-10612, D-12099, D-15575, D-21906, D-26535, D-29655, D-32945, D-35940, D-36009, D-36449, D-44580, E-21796, E-35264, G-06985, G-07423, G-07892, G-08381, G-08411, G-12075, G-19304, G-23801, G-24716, G-26775, G-32749, G-34092, G-34902, G-37941, G-37964, G-40295, G-40492, J-30696

STEAM B-41544, F-08207, G-41067

STEAM ENGINES A-24996, A-30604, A-32621, A-39603, A-40776, B-30944, B-34381, B-34457, B-39492, B-42166

STEAM PLANTS A-05067, A-24080, A-33087, B-28108, E-00834, K-06778, L-17472, L-29421

STEEL A-09686, A-39462, A-43271, B-03232, B-03754, B-07606, B-21324, B-29656, B-34071, B-35342, B-35778, B-37222, B-43937, D-05623, D-21869, D-27880, D-29153, D-30326, D-30860, D-37320, D-38110, G-41067, I-22128, I-33802, J-30696, L-17927, L-23608, L-24214

STERILIZATION G-00473, G-05478

STOMACH G-03086, G-37297, H-34237

STONE A-09686, B-03754

STORAGE BATTERIES A-26763, A-41518, B-30944, B-34457, G-30831, G-41847, H-36196

STRATIFIED CHARGE ENGINES A-33378, B-27876, B-34457, K-38758

STREETS A-09393, A-21109, A-24031, A-28210, A-32875, A-33169, A-33710, A-34647, A-35078, A-35953, A-36032, A-36083, A-41035, A-41654, B-28730, B-41112, C-06643, C-08130, C-10556, C-18302, D-00985, D-01315, D-08438, D-08568, D-08810, D-08812, D-08821, D-09726, D-10554, D-10595, D-11028, D-14762, D-15175, D-15573, D-15575, D-16576, D-17058, D-17106, D-19433, D-24162, D-25055, D-25881, D-27187, D-27191, D-27675, D-28178, D-28233, D-28528, D-28620, D-28635, D-28785, D-29153, D-29416, D-29465, D-29647, D-29814, D-29918, D-30025, D-30494, D-32945, D-34933, D-36449, D-36562, D-36820, D-36909, D-37264, D-37288, D-37366, D-39081, D-39405, D-40716, D-40997, D-41033, D-41520, D-41664, D-42120, D-42247, D-44063, D-44330, E-30073, E-38118, E-44813, G-21266, G-21423, G-23876, G-26310, G-29958, G-30000, G-30198, G-30671, G-31899, G-37933, G-40014, G-40295, G-40485, G-42091, G-42463, G-44508, H-21018, H-23581, H-28529, H-39204, H-40024, H-40368, H-40540, H-41800, H-43782, K-18294, L-07952, L-29421, L-35922, N-11871

STRONTIUM COMPOUNDS A-06351, B-25377, C-05243, C-09333, C-30560, C-39168, C-41825, D-05167, D-23864, D-25089, D-27174, D-30656, D-31325, D-43388, F-13705, F-16659, F-17949, H-33985, H-36991

STUDENTS G-30672

STYRENES A-33822, C-09888, D-43468, K-02580, K-20121

SUBLIMATION C-32058

SUBWAYS D-08821, H-24788

SULFATES A-15295, A-26645, A-35788, A-41145, B-00015, B-03337, B-10558, B-26243, B-38727, B-41544, C-00855, C-09888, C-23096, C-26503, C-29226, C-30360, C-31258, C-35494, C-38165, C-42020, C-42139, D-00017, D-00974, D-01673, D-04938, D-04996, D-05167, D-05551, D-05573, D-05623, D-09432, D-11028, D-12049, D-21869, D-21906, D-22829, D-24351, D-28326, D-30656, D-35940, D-37202, D-37288, D-41888, D-42122, D-42921, E-32155, E-36038, E-38666, F-05849, F-13879, F-13943, F-15413, F-15493, F-17882, F-34297, G-00375, G-32218, G-45159, H-23258, H-32224, H-35880, I-00305, I-33802, K-06734, K-08420, K-19750, K-36382, L-25542, N-04649

SULFHYDRYL COMPOUNDS G-35225

SULFIDES A-03982, A-10749, A-23561, A-24281, A-29787, A-31315, A-34018, A-35788, A-45145, B-03337, B-10558, B-19725, B-28172, B-33157, B-38727, C-06045, C-06107, C-06112, C-09983, C-23096, C-26275, C-28126, C-29512, C-32476, C-32534, C-38670, C-38755, C-41763, C-42928, D-00005, D-03441, D-04996, D-10634, D-31396, D-32055, D-34008, D-41979, E-40157, F-06648, F-07451, F-09745, F-13879, F-13943, F-34948, G-07162, G-08381, G-24314, G-24603, G-32735, G-38616, G-39883, G-44867, H-08884, K-02580, K-06734, K-06778, K-08420, K-09259, K-19750, K-44310, L-00311, L-17472, L-23562, L-31957, N-04052, N-04212, N-20548

SULFITES B-03337, F-17949, G-00177, I-22128

SULFUR COMPOUNDS A-03982, A-08972, A-10749, A-15295, A-23561, A-24281, A-26645, A-29127, A-29787, A-31315, A-34018, A-34788, A-35168, A-35788, A-38625, A-41145, A-42212, A-45145, B-00015, B-03232, B-03337, B-06493, B-10558, B-14604, B-19725, B-26243, B-28172, B-31221, B-33157, B-33388, B-35296, B-35816, B-38727, B-40785, B-41544, B-44742, C-00855, C-06045, C-06107, C-06112, C-09888, C-09983, C-11042, C-16367, C-23096, C-26275, C-26503, C-28126, C-29226, C-29512, C-30360, C-31258, C-32476, C-32534, C-32718, C-35494, C-38165, C-38670, C-38755, C-38778, C-39136, C-39762, C-41612, C-41763, C-42020, C-42139, C-42928, C-43763, D-00005, D-00017, D-00974, D-01673, D-03441, D-04938, D-04996, D-05167, D-05551, D-05573, D-05623, D-09432, D-10634, D-11028, D-12049, D-12099, D-16684, D-21869, D-21906, D-22829, D-24351, D-28326, D-30656, D-31396, D-32055, D-34008, D-35940, D-37202, D-37288, D-40584, D-41888, D-41979, D-42122, D-42921, E-00834, E-32155, E-36038, E-38666, E-40157, F-05849, F-06648, F-07451, F-09745, F-13879, F-13943, F-15413, F-15493, F-17882, F-17949, F-34297, F-34948, G-00177, G-00375, G-07162, G-08381, G-24314, G-24603, G-32218, G-32735, G-38616, G-39883, G-44867, G-45159, H-08884, H-23258, H-23581, H-32224, H-35880, H-39328, I-00305, I-03735, I-22128, I-32921, I-33802, J-39956, K-02580, K-06734, K-06778, K-08420, K-09259, K-19750, K-33107, K-36382, K-41682, K-44310, L-00311, L-17472, L-23562, L-25542, L-31957, N-04052, N-04212, N-04649, N-20548

SULFUR DIOXIDE A-00962, A-01565, A-01624, A-02636, A-03982, A-05067, A-08972, A-09393, A-09686, A-10749, A-12823, A-15295, A-19598, A-22579, A-23250, A-23561, A-24156, A-24281, A-24285, A-29127, A-29786, A-29787, A-30513, A-31315, A-33169, A-34442, A-35078, A-35168, A-35676, A-35788, A-36623, A-37015, A-37190, A-38819, A-38891, A-39367, A-40583, A-40677, A-40981, A-42080, A-42676, A-43776, A-45092, B-00107, B-03125, B-03337, B-03754, B-10558, B-16053, B-19725, B-22520, B-25470, B-26243, B-28108, B-28172, B-28730, B-30124, B-30633, B-31985, B-32355, B-35540, B-43937, B-44750, C-00855, C-09333, C-09476, C-09983, C-17048, C-22927, C-24644, C-26274, C-26707, C-26848, C-27294, C-28126, C-30290, C-32476, C-33055, C-38670, C-38755, C-39136, C-39762, C-40631, C-42928, D-00005, D-00017, D-00969, D-00985, D-02133, D-03410, D-04996, D-05260, D-05551, D-05573, D-05623, D-06148, D-06760, D-06788, D-07198, D-08812, D-10634, D-15610, D-15789, D-16345, D-17106, D-19144, D-26054, D-26387, D-26535, D-27257, D-27672, D-27675, D-27880, D-28233, D-29385, D-29416, D-30858, D-30860, D-30892, D-31396, D-32055, D-32912, D-33114, D-34008, D-36503, D-36562, D-36688, D-36806, D-37288, D-38133, D-40363, D-40574, D-40584, D-40997, D-41887, D-41888, D-41979, D-42122, D-44059, D-44170, E-24109, E-24570, E-30073, E-30863, E-36487, E-38666, F-09745, F-10599, F-13635, F-13943, F-15413, F-17949, F-34297, F-37213, F-43245, G-00177, G-00375, G-03282, G-07423, G-09253, G-12038, G-13159, G-13625, G-14156, G-16820, G-21259, G-24314, G-24603, G-29588, G-31319,

G-31452, G-32735, G-34841, G-37229, G-37942, G-38616, G-38721, G-38869, G-41097, G-41124, G-41737, G-43277, G-44254, H-11157, H-11467, H-19604, H-26055, H-30225, H-31185, H-32224, H-32322, H-35880, H-38332, H-39328, H-39690, H-40368, H-41891, H-41892, H-42250, H-42924, I-31377, I-33802, K-02580, K-03007, K-06734, K-06778, K-08420, K-09259, K-19750, K-33107, K-36382, K-36823, K-41682, K-43312, L-00311, L-16200, L-17472, L-23610, L-24214, L-25288, L-25542, L-28397, L-29421, L-29888, L-30152, L-31454, L-31957, L-32865, L-32884, L-33495, L-33844, L-35922, L-37560, L-41557, L-44325, L-44499, N-03674, N-04052, N-04212, N-09780, N-11871, N-18005, N-20548, N-28088

SULFUR OXIDES A-00962, A-01565, A-01624, A-02636, A-03982, A-05067, A-08972, A-09393, A-09686, A-10749, A-12823, A-15295, A-19598, A-20652, A-22579, A-22976, A-23250, A-23561, A-24136, A-24281, A-24285, A-26441, A-27180, A-29127, A-29786, A-29787, A-30513, A-31315, A-33087, A-33169, A-33963, A-33965, A-34018, A-34442, A-35078, A-35168, A-35676, A-35788, A-36623, A-37015, A-37166, A-37190, A-38543, A-38625, A-38819, A-38891, A-39367, A-39462, A-39603, A-40583, A-40677, A-40776, A-40981, A-42080, A-42676, A-43271, A-43346, A-43776, A-45092, A-45145, B-00107, B-00899, B-03125, B-03337, B-03754, B-10558, B-14604, B-16053, B-17525, B-19725, B-22520, B-25470, B-26243, B-28108, B-28172, B-28286, B-28730, B-30124, B-30633, B-31221, B-31985, B-32355, B-35476, B-35540, B-41544, B-43937, B-44750, C-00855, C-06112, C-09333, C-09476, C-09983, C-17048, C-22927, C-24644, C-26274, C-26707, C-26848, C-27294, C-28126, C-30290, C-32476, C-33055, C-38670, C-38755, C-39136, C-39762, C-40631, C-41719, C-41763, C-42775, C-42928, D-00005, D-00017, D-00969, D-00985, D-02133, D-03410, D-03441, D-04996, D-05260, D-05551, D-05573, D-05623, D-06148, D-06760, D-06788, D-07198, D-08812, D-10634, D-15610, D-15789, D-16345, D-17106, D-19144, D-21015, D-26044, D-26054, D-26387, D-26535, D-27257, D-27672, D-27675, D-27880, D-28233, D-28629, D-29382, D-29385, D-29416, D-30858, D-30860, D-30892, D-31396, D-32055, D-32912, D-33114, D-33576, D-34008, D-35025, D-36503, D-36562, D-36688, D-36806, D-37026, D-37288, D-38110, D-38133, D-40118, D-40363, D-40574, D-40584, D-40997, D-41887, D-41888, D-41979, D-42122, D-43316, D-44059, D-44170, D-44580, E-06841, E-24109, E-24570, E-30073, E-30863, E-36487, E-38666, F-09745, F-10599, F-13635, F-13943, F-15413, F-17949, F-34297, F-37213, F-43245, G-00177, G-00375, G-03282, G-07162, G-07423, G-09253, G-12038, G-13159, G-13625, G-14156, G-16820, G-19940, G-21259, G-24314, G-24603, G-27801, G-29588, G-31319, G-31452, G-32735, G-34841, G-35041, G-37229, G-37942, G-38616, G-38721, G-38869, G-41097, G-41124, G-41737, G-43277, G-44087, G-44254, G-44433, H-11157, H-11467, H-19604, H-26055, H-27111, H-30225, H-31185, H-32224, H-32322, H-35880, H-38332, H-39328, H-39690, H-40368, H-41891, H-41892, H-42250, H-42336, H-42924, I-31377, I-33802, J-21749, J-30696, K-02580, K-03007, K-06734, K-06778, K-08420, K-08803, K-09259, K-19750, K-30069, K-33107, K-34063, K-34377, K-36382, K-36823, K-41682, K-43312, K-44310, K-44377, L-00311, L-16200, L-17472, L-23608, L-23610, L-24214, L-25288, L-25542, L-28349, L-28397, L-29421, L-29888, L-30152, L-30620, L-31454, L-31957, L-32789, L-32865, L-32884, L-33495, L-33844, L-35795, L-35922, L-37560, L-38669, L-39640, L-41557, L-42873, L-44044, L-44325, L-44499, N-03674, N-04052, N-04212, N-09780, N-11871, N-14772, N-18005, N-20548, N-28088

SULFUR OXIDES CONTROL A-12751, A-12823, A-24080, A-24285, A-29127, A-31136, A-31934, A-34177, A-34774, A-35052, A-35199, A-35224, A-36623, A-37166, A-38331, A-39067, A-41945, B-00107, B-03337, B-16053, B-19725, B-20844, B-24186, B-25377, B-26600, B-27824, B-28172, B-28377, B-29628, B-30154, B-31221, B-31341, B-32260, B-34025, B-34846, B-37150, B-44906, D-32912, E- 2777, F-34297, I-22128, J-34970, J-42721, K-30035, L-23562, L-32865, L-35151, L-37560, L-42873, M-01073, N-09780, N-28088

SULFUR TRIOXIDE A-05067, A-08972, A-09686, A-20652, A-24281, A-24285, A-29786, A-31315, A-35078, B-00107, B-00899, B-03337, B-17525, B-22520, B-28172, B-41544, C-26274, C-42928, D-15789, D-26044, D-29416, D-32912, D-34008, D-40363, D-40997, F-34297, G-24603, G-44433, H-39690, H-42336, K-06778, L-17472, L-31454, N-04212, N-09780, N-20548

SULFURIC ACID A-09686, A-10749, A-12751, A-12823, A-26441, A-29786, A-32875, A-35052, A-35224, A-37166, A-39462, B-03337, B-26600, B-28172, B-31985, B-34025, B-35476, B-38727, B-43937, C-00855, C-09983, C-42139, C-42928, D-07198, D-10634, D-26387, D-29382, D-34008, D-38133, E-24570, E-32155, E-36038, G-07162, G-32735, G-38721, G-38869, G-44433, H-11452, H-11467, H-39690, H-42250, J-30696, K-02580, K-06734, K-06778, K-08420, K-19750, K-36823, L-39640, N-09780, N-20548

SUPERCOOLING E-24109

SUPERSATURATION E-32158

SURFACE COATING OPERATIONS A-09686, A-35957, A-37190, B-31441, G-07740, G-32696, G-33527, J-30696, N-43824

SURFACE COATINGS A-09686, A-28210, A-30674, A-31313, A-32035, A-35957, A-37190, B-25033, B-31317, B-31441, G-00740, G-01754, G-01755, G-01757, G-03654, G-07551, G-20704, G-30831, G-32695, G-32746, G-33527, G-33605, G-34435, G-34701, G-34738, G-35463, G-35563, G-36093, G-36207, G-36934, G-39095, G-42463, H-36196, H-44588, I-32921, I-33802, J-30696, L-35461, M-35206, N-43824

SURFACE PROPERTIES A-37312, B-03337, B-05300, B-31390, C-06107, C-43587, F-27348, F-44032, H-35827, I-31377, I-32921, I-36051, N-43824

SURVEY METHODS C-22927, D-01089, D-22553, K-03007, L-41557

SUSPENDED PARTICULATES A-00962, A-01624, A-01868, A-03982, A-05067, A-06220, A-08972, A-09210, A-09686, A-13524, A-17339, A-20652, A-22825, A-22976, A-23316, A-23561, A-24156, A-26441, A-26763, A-27180, A-27249, A-27272, A-27458, A-27858, A-27943, A-29786, A-29787, A-30067, A-30428, A-31323, A-31525, A-31632, A-31934, A-32621, A-32875, A-33963, A-33965, A-34018, A-34774, A-35078, A-35168, A-35957, A-36846, A-37372, A-38625, A-39367, A-39462, A-39603, A-40583, A-40677, A-41145, A-41945, A-42080, A-43271, A-43346, A-45274, B-00107, B-01484, B-03125, B-03754, B-07606, B-09798, B-10558, B-17525, B-17906, B-18053, B-19808, B-20735, B-22436, B-22520, B-24553, B-25334, B-25470, B-25781, B-25894, B-26269, B-26532, B-26600, B-28172, B-28377, B-30633, B-30944, B-31317, B-31604, B-32633, B-32938, B-33542, B-33550, B-33932, B-34025, B-34611, B-35476, B-35540, B-37222, B-39404, B-42300, B-44470, B-44742, B-44750, C-05977, C-08130, C-08145, C-09333, C-09888, C-10556, C-14758, C-18007, C-25015, C-25440, C-25535, C-25793, C-26145, C-26274, C-26698, C-26848, C-27075, C-27556, C-28017, C-28621, C-28755, C-29297, C-30360, C-31933, C-32892, C-32975, C-36588, C-36698, C-36703, C-36840, C-41763, C-43448, D-00005, D-00017, D-00969, D-00974, D-00985, D-01673, D-02750, D-03441, D-03526, D-04996, D-05167, D-05260, D-05277, D-05551, D-05573, D-05623, D-06760, D-07198, D-07985, D-08275, D-08502, D-08591, D-12049, D-12099, D-16345, D-16839, D-17340, D-19144, D-21015, D-22829, D-24162, D-24351, D-26054, D-27241, D-27621, D-27648, D-27672, D-27880, D-28326, D-28620, D-28629, D-28634, D-28650, D-28653, D-28785, D-29152, D-29153, D-29191, D-29382, D-29416, D-29515, D-29647, D-30025, D-30182, D-30410, D-30494, D-30656, D-30858, D-30860, D-30892, D-31014, D-32055, D-33576, D-34933, D-35010, D-35025, D-35407, D-36288, D-36474, D-36486, D-36562, D-36688, D-36806, D-36820, D-37026, D-37191, D-37288, D-37369, D-37394, D-38110, D-39081, D-39405, D-39535, D-39914, D-40118, D-40574, D-40584, D-41033, D-41888, D-41979, D-42122, D-44059, D-44170, D-44234, D-44330, D-44580, E-00834, E-19058, E-22754, E-23743, E-24109, E-29688, E-30073, E-32155, E-32158, E-36038, E-38118, E-38666, F-03799, F-05440, F-05849, F-10599, F-34297, G-00076, G-00177, G-00375, G-00642, G-00705, G-00810, G-00902, G-03086, G-03282, G-04196, G-04877, G-06704, G-07162, G-09408, G-12038, G-16820, G-24081, G-26477, G-27291, G-30181, G-31452, G-32484, G-32735, G-34092, G-34406, G-34895, G-34951, G-35118, G-37942, G-38580, G-38721, G-39095, G-40634, G-41097, G-42136, G-45293, H-08884,

H-11157, H-11452, H-11467, H-19604, H-30225, H-35827, H-36197, H-37912, H-37977, H-38332, H-39690, H-40590, H-40591, H-41891, H-42857, J-22358, J-39956, K-03007, K-03956, K-06734, K-06778, K-08420, K-08803, K-18294, K-19750, K-20121, K-30035, K-30069, K-34377, K-36823, L-00311, L-08196, L-09009, L-17927, L-23234, L-23608, L-23610, L-24214, L-27664, L-28099, L-29421, L-29888, L-30620, L-32884, L-33495, L-35922, L-39640, L-41557, L-44325, M-33904, N-03674, N-04052, N-04212, N-04649, N-09780, N-17260, N-18005, N-20548, N-28088

SWEDEN A-00962, A-03280, A-03982, A-18297, A-22370, A-23280, A-24031, A-30414, A-34341, A-36032, A-41654, A-44464, B-00015, B-00063, B-03337, B-30229, B-44660, B-44750, C-00125, C-00855, C-01230, C-01249, C-01607, C-01608, C-11626, C-18302, C-25222, C-26505, D-00005, D-00017, D-00261, D-00969, D-00974, D-01089, D-01355, D-23971, D-25055, D-35010, D-41664, E-00834, E-03841, F-00058, F-03525, F-03799, F-11582, G-00148, G-00177, G-00873, G-01341, G-01500, G-01797, G-03282, G-26356, G-32129, G-32408, G-32738, G-33527, G-42884, G-44053, G-44508, H-01523, H-17681, H-23258, H-23435, H-28289, J-03289, K-03007, *K-18294*, *L-00311*, L-03536, L-09009, L-32462, L-37717, L-40520, L-44376, N-03674

SYNERGISM B-26269, G-12038, G-21259, G-27801, G-31280, G-31452, G-33234, G-34841, G-34895, G-35042, G-36354, G-36740, G-38869, G-41097, G-41737, G-42737, H-32736, K-41682

SYNTHETIC FIBERS B-08562, B-09798, N-43824

SYNTHETIC RUBBER A-37190

## T

TAR A-34774, A-39609, B-01851, C-26274, D-11028, D-38133, D-40716, H-11157, *H-30225*, *L-07952*

TAXATION A-23280, B-32424, B-39404, L-22583, L-31454, L-35151, L-40486, L-41289, L-41703, L-42041, L-44044, N-09780

TECHNICAL SOCIETIES B-44470, C-38755, I-06355, I-06357, L-03536, L-40486

TEFLON C-00855, G-00148, G-00473

TEMPERATURE A-01868, A-03982, A-05067, A-05171, A-06220, A-15295, A-28560, A-33365, A-34774, A-38819, A-41738, A-42212, A-42791, B-00063, B-05214, B-07606, B-09798, B-10558, B-16053, B-20735, B-22520, B-23697, B-24722, B-25033, B-27876, B-29058, B-30229, B-30498, B-30944, B-31317, B-32392, B-32760, B-32938, *B-33388*, B-34536, B-34740, B-35018, B-35035, B-35223, B-35352, B-35703, B-36145, B-36578, B-37042, B-37750, B-37938, B-39272, B-39492, B-41922, B-43515, B-44003, C-25979, C-30635, C-36703, C-39069, C-42139, C-44165, D-08502, D-27241, E-40157, F-03525, F-03799, F-06648, F-08207, F-09578, *F-09745*, F-15493, F-19823, F-27348, F-29400, *F-34297*, *F-34607*, *H-42607*, *I-22128*, I-31377, I-32921, I-36051, L-44376

TEMPERATURE (ATMOSPHERIC) A-01868, B-31690, B-33550, B-44283, C-02164, C-19313, D-04938, D-05277, D-05573, D-08502, D-10634, D-15789, D-17340, D-25635, D-26387, D-26535, D-27191, D-34805, D-39988, D-42122, D-44059, E-00834, E-06841, E-24109, E-24570, E-29445, E-31895, G-23801, G-33778, G-34092, G-44087, L-03536, L-35922, N-04212, N-11871

TEMPERATURE GRADIENT C-02164, D-03441, D-26054, E-32158, L-23562

TEMPERATURE SENSING INSTRUMENTS A-05067, C-16123, F-09745

TENNESSEE G-00375, G-18508

TENSILE STRENGTH F-06648

TEST ENGINES A-08039, A-14033, A-30759, A-31133, A-36080, A-38625, A-39754, B-00063, B-01851, B-20735, B-29656, B-31690, B-36081, B-36144, B-41608, B-43333, G-00177

TESTING FACILITIES A-08039, A-14033, A-23789, A-30759, A-31133, A-36080, A-38625, A-39754, B-00063, B-01851, B-20735, B-27371, B-29656, B-31690, B-36081, B-36144, B-41608, B-43333, C-00855, C-08661, C-09333, C-09983, D-11184, D-32350, E-29946, E-32158, F-09745, G-00148, G-00177, G-00473, G-01797, G-09493, G-11808, G-16820, G-24288, G-29588, G-30672, G-34841, G-38869, G-44254, H-09448, L-09009

TETRAETHYL LEAD A-03278, A-04460, A-05171, A-08039, A-08972, A-09355, A-14033, A-14459, A-14461, A-14462, A-15205, A-20545, A-21109, A-22367, A-22579, A-22941, A-22976, A-23058, A-23250, A-23280, A-23789, A-24080, A-24281, A-24718, A-24996, A-25295, A-26191, A-26552, A-26763, A-26891, A-26925, A-27113, A-28336, A-28394, A-29364, A-29782, A-29786, A-31133, A-31315, A-31324, A-31934, A-33667, A-34040, A-34341, A-34774, A-35123, A-35919, A-35953, A-36082, A-36527, A-36623, A-37648, A-38022, A-38330, A-40759, A-40776, A-40947, A-41604, A-43966, B-00015, B-00899, B-01851, B-05214, B-05300, B-13982, B-14604, B-19808, B-20740, B-20844, B-21040, B-21303, B-21719, B-22414, B-22436, B-22834, B-23540, B-24182, B-24184, B-24696, B-25096, B-25155, B-25301, B-26153, B-26243, B-27371, B-27503, B-27850, B-28108, B-28286, B-29414, B-30010, B-30950, B-31390, B-32355, B-32424, B-32633, B-32822, B-33932, B-35018, B-35112, B-35535, B-36721, B-37619, B-38614, B-39404, B-40723, B-41922, B-43333, C-05456, C-05977, C-06072, C-08145, C-09953, C-17048, C-17180, C-17771, C-23571, C-24119, C-24337, C-24617, C-24618, C-24719, *C-25013*, *C-26274*, C-26336, C-26467, C-26505, C-28755, C-29419, C-30786, C-33178, C-33255, C-37514, C-39069, C-40407, C-43737, D-01089, D-02750, D-04646, D-05260, D-05820, D-07649, D-08275, D-08810, D-08812, D-09240, D-10554, D-10595, D-16791, D-23658, D-25055, D-27096, D-27429, D-32350, D-34008, D-36820, D-40716, D-41033, D-41664, E-23743, E-40164, F-05440, F-08207, F-09745, F-14995, F-28908, F-34607, F-41787, F-44032, G-00020, G-00148, G-00708, G-01341, G-03283, G-03284, G-03287, G-05002, G-05025, G-05541, G-06059, G-06814, G-07162, G-07169, G-08411, G-09486, G-10856, G-11468, G-13059, G-15731, G-18494, G-21259, G-21423, G-22222, G-23876, G-24314, G-25328, G-27084, G-27490, G-28171, G-29286, G-29825, G-30328, G-30671, G-30831, G-31442, G-32613, G-33607, G-34895, G-35559, G-36740, G-37119, G-38867, G-39161, G-40485, G-40634, G-41737, G-42091, G-44867, G-45288, H-17681, H-24667, H-25878, H-27063, H-28471, H-32423, H-36611, H-40024, H-43721, I-32921, J-03288, J-03289, J-22358, J-26765, J-30329, J-32241, J-34370, J-34828, J-35391, J-36592, J-37409, K-02580, K-08803, K-24107, L-07952, L-08196, L-09009, L-30152, L-37392, L-37717, L-40486, L-41289, M-29432, N-06992, N-09780, N-37225

TEXAS D-44234, D-44580

*TEXTILE MANUFACTURING* A-09686, A-34018, D-05260, G-34092

TEXTILES B-08562, B-09798, B-26532, C-08130, C-08145, G-07162, N-43824

THERMAL RADIATION B-34740, B-39272, C-17048, E-29445, L-34033

THERMISTORS C-16123

THERMOCOUPLES A-05067

THERMODYNAMICS A-34442, B-03337, E-29699, E-31895, E-32158, F-13635, F-14008, F-14039, F-16595, F-17161

THIN-LAYER CHROMATOGRAPHY C-26707, C-32058, C-37971

THIOPHENE F-09745

THRESHOLDS A-36527, A-37015, D-03441, G-00148, G-00177, G-00705, G-00708, G-05002, G-05780, G-20687, G-21423, G-24961, G-26886, G-26915, G-31537, G-33202, G-34066, G-34406, G-34902, G-36354, G-37180, G-37297, G-38721, G-39989, G-40492, G-41124, H-36265, H-42924, K-22223

THUNDERSTORMS E-22959

TIMED FUEL INJECTION A-27249, B-19637, B-20844, B-23697, B-30944, B-32355, B-34457, B-34611, B-36081, B-36523, B-37275, L-07952

TIN A-34921, B-09798, B-32248, B-32760, B-37750, B-40709, D-00005, D-00017, D-00974, F-06648, F-10599, F-17161, G-36093, N-04649

TIN COMPOUNDS A-05067, A-06351, A-21109, B-31390, B-32260, B-35035, B-37750, B-38727, B-40709, C-32892, C-34407, C-36698, C-38682, C-41908, C-42360, D-04996, D-05167, D-05551, D-23388, D-27174, D-27188, D-28629, D-35940, D-37264, D-42367, D-43316, D-44996, E-29910, F-13461, F-34607, F-39522, G-01797, G-17470, G-19159, G-31280, G-35055, G-36093, G-38580, N-04649

TIRES A-09210, D-43468, L-07952

TISSUE CULTURES G-43277

TISSUES A-25417, C-33042, C-33338, G-01341, G-01756, G-01797, G-01812, G-01923, G-03283, G-05002, G-05671, G-06814, G-07162, G-07169, G-10856, G-12075, G-16810, G-18046, G-18503, G-20087, G-20198, G-26483, G-26720, G-26915, G-27416, G-27614, G-29329,

G-31442, G-31452, G-31584, G-32041, G-32787, G-33779, G-34114, G-34436, G-34738, G-34943, G-35380, G-36152, G-36747, G-36765, G-37119, G-37685, G-39193, G-41695, G-43277, G-43531, G-44381, G-44696, H-10318, H-18481, H-28105, H-28448, H-33362, H-34830, H-34901, H-35209, H-35234, H-36991, H-42607, H-42924, H-43342
TITANIUM C-11042, D-00005, D-00017, D-00974, D-03526, G-01731, G-03086, I-06355, I-06357, N-04649
TITANIUM COMPOUNDS A-05067, A-06351, A-36846, C-11042, C-30360, C-34407, C-36698, C-38682, C-38778, C-41825, C-44995, D-03526, D-04996, D-05167, D-05551, D-23388, D-24351, D-27188, D-28326, D-35940, D-37202, D-37264, D-37288, D-42122, E-10215, E-29910, F-44332, G-01731, G-32735, G-44696, H-36991, N-04649
TOBACCO C-33042, G-00873, G-07169, G-28256, H-01523, H-12647, H-41891
TOKYO A-17325, A-30513, A-32875, A-41035, C-37514, C-37608, D-07198, D-08591, D-15175, D-15610, D-27831, D-28635, D-29385, D-29416, D-29465, D-29647, D-30410, D-30493, D-30494, D-32912, D-37191, D-37518, D-39081, D-40363, D-41975, D-44063, D-44330, G-05780, G-26310, G-29129, G-30395, G-37722, H-21018, H-41800, K-36823, L-23610, L-29888, L-30152, L-44499
TOLUENES A-29936, A-31934, A-36541, A-43966, B-22414, B-29414, C-09333, C-38670, C-39136, D-06788, F-03525, F-41787, K-20121
TOMATOES H-17218, H-17220, H-20062
TOPOGRAPHIC INTERACTIONS A-23561, A-35078, A-38625, A-39367, A-40583, B-20735, D-03410, D-03441, D-08568, D-16576, D-26054, D-26387, D-30860, D-36449, D-37026, D-39081, E-12777, E-29445, E-31895, E-44813, G-00375, H-10318, H-11452, H-39287, L-34980
TOXIC TOLERANCES A-03279, A-23280, B-44882, C-01608, D-03441, G-00705, G-00993, G-01341, G-01731, G-02202, G-03283, G-03284, G-03285, G-03286, G-03287, G-03635, G-03654, G-03893, G-03897, G-04196, G-05002, G-06059, G-08566, G-27416, G-28834, G-29789, G-31491, G-31584, G-32608, G-33202, G-33374, G-33864, G-34406, G-34436, G-34951, G-35042, G-37229, G-38869, G-39503, G-40485, G-42022, G-42098, G-44508, H-26055, H-33362, H-36265, H-42924, H-43279, K-03007, K-16808, L-37497, L-44325
TOXICITY A-17365, A-17778, A-18510, A-22579, A-22976, A-23058, A-25417, A-27113, A-27272, A-27595, A-28336, A-28394, A-29096, A-29872, A-30513, A-32447, A-33169, A-34341, A-35953, A-35957, A-36527, A-37015, A-37190, A-37721, A-40759, A-43776, A-45072, A-45274, B-29414, B-31441, B-42290, B-42330, B-44882, C-14758, C-26274, C-32058, C-33042, C-36588, C-42775, D-16345, D-27174, D-36688, E-36038, E-38666, F-07451, G-05025, G-05478, G-05483, G-05541, G-05671, G-06059, G-06174, G-06814, G-06985, G-07169, G-07396, G-07740, G-07892, G-08381, G-08411, G-08566, G-08999, G-10434, G-12075, G-12646, G-13154, G-15703, G-15731, G-17244, G-19940, G-20704, G-21423, G-22222, G-23715, G-23768, G-24314, G-24961, G-25068, G-25705, G-26720, G-26886, G-27084, G-27085, G-27416, G-27614, G-27801, G-27961, G-28171, G-28256, G-29286, G-29493, G-29825, G-30156, G-30355, G-30831, G-31280, G-31442, G-31493, G-31517, G-31524, G-31528, G-31537, G-31584, G-32218, G-32408, G-32608, G-32625, G-32696, G-32737, G-32746, G-33202, G-33234, G-33374, G-33607, G-33778, G-33910, G-34095, G-34175, G-34406, G-34436, G-34789, G-34832, G-34841, G-34895, G-34943, G-35042, G-35055, G-35118, G-35211, G-35387, G-35792, G-35811, G-36093, G-36152, G-36207, G-36551, G-36747, G-36765, G-36957, G-36964, G-37023, G-37028, G-37119, G-37180, G-37229, G-37297, G-37420, G-37540, G-37630, G-37722, G-37788, G-37933, G-37942, G-38579, G-38580, G-38616, G-38721, G-38867, G-38869, G-39095, G-39161, G-39193, G-39503, G-39883, G-39989, G-40022, G-40057, G-40435, G-40485, G-40688, G-41124, G-41695, G-41737, G-41895, G-42022, G-42091, G-42098, G-42463, G-42737, G-42759, G-42881, G-42884, G-43615, G-44087, G-44176, G-44251, G-44254, G-44255, G-44364, G-44381, G-44385, G-44508, G-44867, G-45165, G-45288, H-07742, H-08884, H-10318, H-12536, H-18481, H-27063, H-27386, H-30931, H-32291, H-33362, H-34237, H-34830, H-34831, H-34901, H-35209, H-36197, H-36265, H-37977, H-38332, H-39407, H-39408, H-39409, H-42250, H-42715, H-42857, H-42924, H-43279, H-43511, H-43721, K-11746, K-16808, K-36346, K-36823, K-38197, L-08725, L-37497, L-38669, L-42041, L-44325, N-17260
TRACE ANALYSIS A-05067, C-01607, C-01608, C-05977, C-06072, C-10528, C-11042, C-15734, C-16367, C-20891, C-22975, C-26503, C-27075, C-30593, C-30707, C-31933, C-32534, C-32892, C-33042, C-33055, C-33178, C-33338, C-34017, C-34407, C-38682, C-41138, C-41825, C-41908, C-42084, C-42139, C-42360, C-43720, C-43737, C-44479, C-44995, D-00974, D-03526, D-07649, D-15573, D-22290, D-27621, D-31325, D-35489, D-36486, D-37264, D-39535, D-39914, D-43558, D-44580, D-44996, E-29688, E-31852, F-11582, F-13461, F-15618, F-36067, F-39522, F-43436, G-00662, G-01797, G-09261, G-21070, G-23801, G-24573, G-29816, G-32749, G-35042, G-35055, G-39179, G-41894, G-44696, H-14489, H-30921, H-31801, H-39204, H-39287
TRACERS A-11702, A-35919, C-23646, C-33055, C-38165, E-05713, E-22754, E-27116, E-29688
TRACHEA A-35957, G-30181, G-37685
TRADE ASSOCIATIONS A-36623, B-36721, J-27968, L-03536
TRAINS A-08972, A-38543, A-42679, A-43346, B-44283, G-11468, L-00311, N-08273
TRANSMISSOMETERS C-32534
TRANSPORT A-23561, A-41145, A-45274, C-23646, D-23864, D-23971, D-35010, E-21182, E-22754, E-28586, E-29688, E-31852, E-32158, E-33225, E-45050, G-30831, H-36197
TRANSPORTATION A-00962, A-01565, A-01624, A-01868, A-03278, A-03280, A-04460, A-05171, A-08039, A-08972, A-09210, A-09355, A-09393, A-09686, A-12624, A-14461, A-15295, A-15599, A-15769, A-16156, A-17304, A-17325, A-17778, A-19598, A-20545, A-20927, A-22579, A-22941, A-22976, A-23250, A-23280, A-23316, A-23561, A-23620, A-23789, A-24156, A-24281, A-24718, A-24829, A-24996, A-25581, A-26100, A-26134, A-26552, A-26645, A-26763, A-26925, A-27180, A-27249, A-27272, A-27458, A-27595, A-27943, A-28394, A-28560, A-28873, A-29096, A-29127, A-29364, A-29516, A-29661, A-29782, A-29786, A-30414, A-30604, A-30759, A-30976, A-31085, A-31133, A-31136, A-31313, A-31315, A-31323, A-31395, A-31596, A-32035, A-32447, A-32492, A-32621, A-33087, A-33169, A-33293, A-33350, A-33365, A-33378, A-33626, A-33667, A-33710, A-33822, A-33965, A-34018, A-34040, A-34350, A-34442, A-34774, A-35078, A-35123, A-35353, A-35477, A-35481, A-35484, A-35676, A-35919, A-35953, A-36080, A-36082, A-36083, A-36084, A-36664, A-37176, A-37372, A-37648, A-38522, A-38543, A-38625, A-38891, A-39603, A-39609, A-39754, A-40314, A-40677, A-40776, A-41035, A-41145, A-41518, A-41654, A-41738, A-42080, A-42212, A-42679, A-42980, A-43346, A-43966, A-44227, A-44464, A-45092, A-45136, B-00015, B-00063, B-01484, B-01851, B-05214, B-05300, B-09231, B-17906, B-18053, B-20740, B-20844, B-21303, B-21762, B-22414, B-22890, B-23540, B-23697, B-23923, B-24182, B-24184, B-24813, B-25096, B-25301, B-25377, B-25894, B-26153, B-26243, B-27876, B-28059, B-28060, B-28108, B-28286, B-28377, B-28699, B-28730, B-29204, B-29531, B-29605, B-29628, B-29656, B-29898, B-29920, B-30154, B-30633, B-30944, B-30950, B-31221, B-31314, B-31341, B-31364, B-31496, B-31519, B-31604, B-31819, B-31825, B-31985, B-32355, B-32822, B-33366, B-33386, B-33388, B-33403, B-33542, B-33550, B-33657, B-33741, B-33932, B-34035, B-34381, B-34457, B-34536, B-34611, B-34740, B-35018, B-35223, B-35476, B-35535, B-35778, B-35821, B-36081, B-36144, B-36145, B-36523, B-36721, B-37150, B-37195, B-37234, B-37275, B-37468, B-37619, B-37845, B-37938, B-38287, B-39272, B-39275, B-39404, B-39492, B-41112, B-42166, B-42300, B-42330, B-42817, B-42819, B-44283, B-44473, B-44660, B-44750, B-44882, C-06112, C-06643, C-18302, C-19313, C-21948, C-22927, C-24617, C-26467, C-28755, C-30290, C-30593, C-32058, C-32829, C-42775, C-43587, C-44479, D-00969, D-00985, D-01315, D-02133, D-03410, D-03441, D-03526, D-04646, D-04938, D-05260, D-06788, D-08275, D-08438, D-08568, D-08591, D-08810, D-08812, D-08821, D-09240, D-09726, D-10554, D-10595, D-11028, D-12099, D-15610, D-16539, D-16576, D-16684, D-16791, D-17058, D-19433, D-24162, D-24351,

D-24414, D-24952, D-25055, D-25635, D-25881, D-26287, D-26535, D-27174, D-27187, D-27188, D-27191, D-27257, D-27672, D-27675, D-27831, D-28178, D-28326, D-28369, D-28528, D-28634, D-28635, D-28650, D-29515, D-29655, D-29744, D-29814, D-30860, D-31014, D-31669, D-31775, D-32055, D-32350, D-32883, D-32912, D-32945, D-33114, D-34008, D-34933, D-35940, D-36009, D-36449, D-36503, D-36909, D-37288, D-37366, D-37394, D-39081, D-39535, D-39914, D-39988, D-40118, D-41033, D-41664, D-43693, D-43962, D-44330, E-01821, E-23743, E-27116, E-29445, E-30073, E-30676, E-31895, E-37953, E-38666, E-44813, F-00058, F-03799, F-07451, F-08207, F-09745, F-14995, F-28908, G-00020, G-00076, G-00148, G-00375, G-00597, G-00708, G-03287, G-05002, G-08411, G-10856, G-11468, G-16820, G-19940, G-20704, G-21423, G-23167, G-27253, G-27291, G-29129, G-29789, G-30156, G-30328, G-30355, G-30671, G-30672, G-30831, G-31319, G-31517, G-31528, G-31899, G-32484, G-32905, G-33165, G-33497, G-33607, G-33778, G-33910, G-34059, G-34406, G-35118, G-35811, G-36354, G-37942, G-37964, G-39095, G-40485, G-41847, H-16655, H-17182, H-17216, H-17218, H-17225, H-21794, H-25374, H-25878, H-26276, H-28471, H-28529, H-30424, H-33364, H-36196, H-36611, H-39409, I-31377, I-36051, J-26765, J-27968, J-30329, J-30696, J-38624, K-03007, K-03956, K-08803, K-09259, K-24107, K-30035, K-30069, K-38758, K-43312, L-00311, L-02635, L-03536, L-07952, L-09009, L-17472, L-22583, L-23608, L-23610, L-24214, L-24757, L-25288, L-26442, L-29421, L-30152, L-30908, L-31957, L-32462, L-32789, L-32865, L-33844, L-35151, L-36030, L-37392, L-37423, L-37521, L-37717, L-41703, L-42873, L-44325, L-44376, L-44499, M-33904, N-04052, N-04212, N-04649, N-08273, N-09780, N-20548

TRAPPING (SAMPLING) A-37176, B-31604, C-27358, C-32476, C-32718

TREATED FABRICS B-26532, G-00177

TREATMENT AND AIDS A-28862, B-29414, B-44882, C-25015, C-32058, C-32718, C-33042, D-29152, F-11570, F-11582, G-00662, G-00705, G-00708, G-00821, G-00873, G-01754, G-01755, G-01756, G-01797, G-01812, G-02202, G-03892, G-04196, G-05025, G-05671, G-06028, G-06177, G-06985, G-07396, G-09261, G-09493, G-11468, G-11552, G-11580, G-12070, G-13154, G-15731, G-17470, G-18417, G-18508, G-18518, G-22637, G-23582, G-23715, G-23876, G-23926, G-24081, G-24288, G-26528, G-27084, G-27085, G-28170, G-28171, G-28256, G-29129, G-29256, G-30181, G-30395, G-30468, G-30672, G-30686, G-31528, G-31537, G-31584, G-31899, G-31962, G-32216, G-32608, G-32624, G-32696, G-32735, G-32737, G-32746, G-32747, G-33202, G-33234, G-34095, G-34114, G-34436, G-34738, G-34837, G-34841, G-34914, G-34947, G-35041, G-35174, G-35217, G-35380, G-35387, G-35438, G-35463, G-35559, G-35560, G-36152, G-36207, G-36740, G-36747, G-36932, G-36934, G-36935, G-36957, G-37023, G-37040, G-37119, G-38867, G-38869, G-39095, G-39193, G-39867, G-39989, G-40021, G-40022, G-40057, G-40532, G-40769, G-41695, G-41872, G-42098, G-42698, G-42716, G-42759, G-43196, G-43559, G-44053, G-44696, H-18520, H-18521, H-27111, H-33201, H-34831, H-35209, H-35234, H-40591, H-41461, H-42924, L-36877, M-35206

TREES A-30428, A-34018, A-36032, D-32912, F-27752, G-44433, H-08884, H-12647, H-16655, H-21018, H-23581, H-25878, H-28105, H-28471, H-28529, H-30424, H-31010, H-32338, H-32423, H-32654, H-33922, H-35880, H-38743, H-39408, H-39409, H-41143, H-41800, H-41892, H-42336, J-21749

TRIMETHYLBENZENE G-00177

TRUCKS A-28560, A-30604, A-33087, A-38543, B-05214, B-09231, B-34381, B-37468, D-03410, D-04646, D-08275, G-00708, G-21423, J-30696, L-07952, N-08273

TUBERCULOSIS G-44867, N-20548

TUMORS A-27458, G-01923, G-34791, G-34851, G-36747, G-36935, G-40634, G-40688, G-43615, G-44254, H-11452

TUNNELS A-09393, A-15769, A-33169, A-33822, A-35123, B-44283, C-42775, D-01315, D-01673, D-03526, D-08568, D-08821, D-27187, D-43468, D-43962, G-21423, G-34895, G-44254

TURBIDIMETRY C-06881, C-25979, C-32534, C-43763, I-02176, K-08420

TURBULENCE (ATMOSPHERIC) C-06107, D-24952, D-26387, E-21182, E-24166, E-27116, E-29445, L-23562, N-04212

## U

ULTRASONICS B-31985, B-34740, B-39272

ULTRAVIOLET RADIATION C-40631, D-11028, D-29647, E-24570, E-29699, E-29946, G-00177, G-30395, G-31319, K-11746, L-33844

ULTRAVIOLET SPECTROMETRY A-05067, A-24718, B-31690, C-25432, C-32534, C-32829, D-03526, D-41520, G-00177, G-01797, G-16820, N-06992

UNITED STATES A-06351, A-26100, A-34442, A-35052, A-37015, A-37166, A-39603, A-40314, A-40677, B-09231, B-19808, D-00017, D-00974, D-05167, D-05551, D-10554, D-25089, D-27429, G-06059, G-10434, G-12075, G-16810, G-24081, G-25068, G-37420, I-06355, I-06357, K-08803, K-09259, K-36823, L-00311, L-02635, L-24467, L-30908, L-31454, L-32462, L-35461, L-35922, N-04649

UNIVERSITIES D-04646, M-33904

UPPER ATMOSPHERE E-03841, G-16820

URANIUM COMPOUNDS A-06351, A-18510, A-23239, B-00063, B-05214, C-09333, C-10528, C-27829, C-39168, F-14008, F-14039, G-32608, G-42022

URBAN AREAS A-09393, A-12624, A-14945, A-15599, A-17325, A-19598, A-19684, A-21109, A-22367, A-24031, A-25125, A-26645, A-27113, A-27943, A-28210, A-29096, A-29539, A-29787, A-30414, A-30513, A-30976, A-31315, A-31324, A-31395, A-31649, A-32035, A-32447, A-32492, A-32621, A-32875, A-33169, A-33710, A-33963, A-33965, A-34647, A-35065, A-35078, A-35398, A-35953, A-36032, A-36083, A-36846, A-37190, A-38543, A-38891, A-39152, A-39367, A-40314, A-40583, A-40677, A-41035, A-41145, A-41654, B-27503, B-28730, B-29898, B-32424, B-35540, B-37042, B-37845, B-41112, B-44750, C-00855, C-08661, C-09888, C-15562, C-19313, C-20891, C-22927, C-26274, C-26467, C-26505, C-26848, C-30113, C-32058, C-32169, C-36588, C-37514, C-37608, C-37693, C-39762, C-40724, C-41016, C-42139, C-42360, C-44479, C-45235, D-00017, D-00697, D-00974, D-00976, D-00985, D-01315, D-02750, D-03410, D-03526, D-04646, D-04938, D-05167, D-05260, D-05277, D-05551, D-05820, D-06760, D-07198, D-07600, D-07985, D-08275, D-08279, D-08438, D-08502, D-08568, D-08821, D-09240, D-09432, D-09726, D-10380, D-10554, D-10595, D-10612, D-11028, D-11202, D-12049, D-12099, D-14762, D-15175, D-15314, D-15573, D-15575, D-15610, D-15789, D-15823, D-16539, D-16576, D-16684, D-16791, D-16839, D-17058, D-17106, D-17340, D-19433, D-20642, D-21015, D-21684, D-21869, D-21906, D-22290, D-23388, D-23658, D-24162, D-24952, D-25107, D-25635, D-25881, D-26044, D-26054, D-26287, D-26387, D-26535, D-27096, D-27174, D-27187, D-27188, D-27191, D-27241, D-27621, D-27648, D-27672, D-27675, D-27831, D-27880, D-28097, D-28178, D-28233, D-28326, D-28369, D-28528, D-28620, D-28635, D-28650, D-28653, D-28785, D-29153, D-29382, D-29385, D-29416, D-29515, D-29647, D-29814, D-29918, D-30025, D-30182, D-30326, D-30410, D-30493, D-30494, D-30656, D-30858, D-30860, D-30892, D-31014, D-31396, D-31669, D-32055, D-32350, D-32727, D-32883, D-32912, D-32945, D-33576, D-34008, D-34933, D-35025, D-35489, D-35725, D-35861, D-35940, D-36009, D-36195, D-36288, D-36449, D-36474, D-36486, D-36562, D-36688, D-36806, D-36820, D-36909, D-37026, D-37191, D-37202, D-37264, D-37288, D-37320, D-37366, D-37369, D-37394, D-37518, D-38110, D-38133, D-39081, D-39405, D-39535, D-39988, D-40118, D-40584, D-40716, D-40997, D-41033, D-41520, D-41664, D-41888, D-41975, D-41979, D-42120, D-42122, D-42367, D-42921, D-43693, D-44059, D-44063, D-44170, D-44234, D-44330, D-44996, E-01821, E-06841, E-19058, E-23743, E-24570, E-27116, E-29445, E-30073, E-30676, E-30863, E-31895, E-32155, E-32158, E-35207, E-36487, E-36714, E-37953, E-38118, E-38666, E-44813, G-00076, G-00597, G-00642, G-01754, G-05002, G-08326, G-08381, G-08411, G-09253, G-09408, G-10434, G-11630, G-13625, G-16810, G-18549, G-20087, G-20287, G-21266, G-21423, G-23801, G-23876, G-24716, G-25705, G-26310, G-26528, G-26775, G-26886, G-26931, G-27085, G-27253, G-28010, G-29129, G-29329, G-29789, G-29958, G-30000, G-30181, G-30328, G-30395, G-30671, G-30672,

G-31228, G-31303, G-31491, G-31493, G-31537, G-31899, G-32408, G-32487, G-32735, G-32737, G-32787, G-32905, G-33165, G-34059, G-34092, G-34406, G-34436, G-34649, G-34701, G-34709, G-34895, G-35041, G-35055, G-35587, G-35792, G-35811, G-36207, G-36354, G-36534, G-37040, G-37420, G-37722, G-37731, G-37941, G-37942, G-38579, G-38580, G-38616, G-38721, G-38869, G-39179, G-40068, G-40295, G-40435, G-40485, G-40532, G-40634, G-40688, G-41067, G-41737, G-41894, G-42091, G-42463, G-42716, G-42881, G-44087, G-44176, G-44255, G-44294, G-44508, G-44867, H-08884, H-19620, H-21018, H-22926, H-30921, H-30931, H-31010, H-31185, H-31801, H-32224, H-35880, H-37926, H-37977, H-39690, H-40590, H-40591, H-41143, H-41800, H-42250, H-42336, H-43226, H-43782, I-00305, J-30696, K-11746, K-16808, K-33107, K-36382, K-36823, K-38197, K-42118, K-43312, K-44310, L-07952, L-08196, L-16200, L-23608, L-23610, L-24214, L-26442, L-30152, L-31957, L-33495, L-33844, L-34980, L-35151, L-35461, L-35795, L-35922, L-36877, L-37521, L-38669, L-44325, L-44499, M-35206, N-04649

URINALYSIS A-00962, A-03279, A-28862, A-31313, A-31525, A-32035, A-34068, B-01484, C-00125, C-05977, C-09333, C-16382, C-27556, C-28017, C-33338, D-08275, D-08812, D-09240, D-27096, D-36503, F-13451, F-34948, G-00177, G-00375, G-00873, G-03283, G-03287, G-05002, G-05025, G-05475, G-05697, G-05780, G-06028, G-06177, G-06704, G-06814, G-07551, G-07892, G-08411, G-08566, G-08683, G-09253, G-09408, G-09486, G-09493, G-09535, G-11580, G-13154, G-14492, G-16810, G-18046, G-18501, G-19159, G-19304, G-20287, G-20687, G-22637, G-23768, G-23876, G-23926, G-24081, G-24428, G-25328, G-26260, G-26310, G-26915, G-27961, G-28011, G-29129, G-29256, G-29286, G-29493, G-29815, G-29816, G-29825, G-29958, G-30009, G-30181, G-30334, G-30355, G-30672, G-30686, G-31040, G-31351, G-31584, G-31899, G-31962, G-32041, G-32216, G-32613, G-32624, G-32625, G-32696, G-32737, G-32738, G-33202, G-33372, G-33864, G-33903, G-34066, G-34175, G-34436, G-34837, G-34841, G-34902, G-34947, G-35021, G-35174, G-35211, G-35217, G-35377, G-35387, G-35559, G-36152, G-36283, G-36740, G-36932, G-36934, G-37023, G-37040, G-37540, G-37731, G-37788, G-37933, G-37941, G-37964, G-38579, G-39095, G-39406, G-39621, G-39867, G-40021, G-40022, G-40057, G-40295, G-40492, G-40532, G-40697, G-41695, G-41731, G-41872, G-42098, G-42661, G-42698, G-42716, G-42757, G-42759, G-42884, G-43196, G-44294, G-44746, G-45273, H-01523, H-18481, H-18520, H-32736, H-33922, H-35209, H-35234, H-40368, H-42945, K-03007, K-11746, K-16808, L-00311, L-36877

USSR A-28210, A-39152, B-13982, B-15208, B-19725, B-21719, B-22492, B-31390, B-33157, B-34313, B-35478, C-06881, C-06894, C-08130, C-08145, C-17771, C-19857, C-20945, C-25979, C-29595, C-44995, D-00261, D-05260, D-08438, D-10554, D-10634, D-25089, D-26387, D-34008, D-44996, E-10215, E-24166, E-29699, E-29910, E-40157, E-44999, F-06648, F-13635, F-13943, F-15493, F-17161, F-27348, F-34607, F-36524, F-39522, G-04251, G-08949, G-09484, G-09486, G-09493, G-15731, G-26720, G-41695, H-19620, H-28448, I-22128, K-02580, K-08803, K-09259, K-11746, K-22223, K-41682, L-02635, L-08196, L-16200

UTAH E-45050, H-39690, L-39640

V

VALLEYS A-19684, A-41889, A-41890, C-42137, D-41887, D-41888, G-41895, H-10318, H-41891, H-41892, H-41893

VANADIUM D-00017, D-00974, D-03526, D-05551, D-11028, G-03086, G-05475, G-21070, H-07742

VANADIUM COMPOUNDS A-05067, A-06351, A-26645, A-36846, B-03337, B-26243, C-25222, C-30360, C-31304, C-32892, C-38682, C-38778, C-41016, C-42360, C-44210, C-44995, D-03526, D-04938, D-04996, D-05167, D-05551, D-11028, D-17340, D-21015, D-22290, D-23388, D-24351, D-27174, D-27188, D-28326, D-28629, D-29191, D-30493, D-31325, D-35861, D-35940, D-36486, D-37191, D-37202, D-37264, D-42122, D-42367, D-43316, D-44059, D-44580, D-44996, E-29910, F-03799, F-39522, G-05475, G-23167, G-32608, G-32735, G-35041, G-38580, G-38869, G-40068, G-44364, G-44696, H-07742, H-23435, H-36991, I-31377, K-41682

VAPOR PRESSURE B-20735, B-34846, E-00834, E-24109, F-03525, F-06648, F-17161, J-22358

VAPOR RECOVERY SYSTEMS B-05300, B-16053, B-20844, B-25033, N-09780

VAPORS A-26191, B-31390, B-35018, B-35352, B-41544, B-44660, C-05977, C-06072, C-09333, C-23596, C-27556, F-08207, F-10599, G-07162, G-08949, G-27490, G-29588, G-36093, G-41067

VARNISHES G-03654, J-30696

VEGETABLES A-14135, A-32748, C-00125, D-05573, F-13461, G-05541, G-17214, G-31528, G-39406, G-41895, H-07742, H-08884, H-09448, H-12647, H-14489, H-14786, H-17215, H-17217, H-17218, H-17220, H-17978, H-20062, H-24947, H-25878, H-27352, H-27489, H-28379, H-30921, H-33364, H-33922, H-35410, H-35880, H-36611, H-37926, H-37977, H-39287, H-40540, H-41891, H-41892, H-44071, J-21749

VEHICLES A-00962, A-01565, A-01868, A-03278, A-03280, A-04460, A-05171, A-08039, A-08972, A-09210, A-09355, A-09393, A-09686, A-12624, A-14461, A-15295, A-15599, A-16156, A-17304, A-17325, A-17778, A-19598, A-20545, A-22579, A-22976, A-23250, A-23280, A-23316, A-23561, A-23620, A-23789, A-24156, A-24829, A-24996, A-26100, A-26134, A-26552, A-26645, A-26763, A-27180, A-27272, A-27458, A-27595, A-27943, A-28560, A-29096, A-29127, A-29661, A-29782, A-29786, A-30414, A-30604, A-30759, A-30976, A-31085, A-31133, A-31136, A-31313, A-31315, A-31323, A-31395, A-31596, A-32035, A-32447, A-32492, A-32621, A-33087, A-33169, A-33350, A-33365, A-33378, A-33667, A-33710, A-33822, A-33965, A-34018, A-34040, A-34350, A-34442, A-34774, A-35078, A-35123, A-35353, A-35477, A-35481, A-35484, A-35919, A-35953, A-36080, A-36082, A-36083, A-36084, A-36664, A-37176, A-37372, A-38522, A-38543, A-38891, A-39603, A-39609, A-39754, A-40314, A-40677, A-41035, A-41145, A-41654, A-42080, A-42679, A-43346, A-43966, A-44227, A-45136, B-00015, B-00063, B-05214, B-09231, B-17906, B-18053, B-20844, B-22414, B-23697, B-24182, B-24184, B-25096, B-25301, B-25894, B-28108, B-28377, B-28730, B-29656, B-29898, B-30154, B-30633, B-30944, B-30950, B-31221, B-31314, B-31341, B-31364, B-31496, B-31519, B-31604, B-31819, B-31825, B-31985, B-32355, B-32822, B-33366, B-33386, B-33388, B-33403, B-33542, B-33550, B-33657, B-34035, B-34381, B-34457, B-34536, B-35018, B-35223, B-35476, B-35535, B-36144, B-36523, B-36721, B-37195, B-37234, B-37275, B-37468, B-37619, B-37845, B-38287, B-39275, B-39404, B-41112, B-44283, B-44660, B-44750, C-06112, C-06643, C-18302, C-21948, C-24617, C-26467, C-30290, C-30593, C-32058, C-32829, C-43587, C-44479, D-00969, D-00985, D-01315, D-03410, D-03441, D-03526, D-04646, D-04938, D-05260, D-08275, D-08438, D-08568, D-08591, D-08812, D-08821, D-09240, D-09726, D-10554, D-10595, D-11028, D-12099, D-15610, D-16539, D-16576, D-16684, D-16791, D-17058, D-19433, D-24162, D-24414, D-24952, D-25055, D-25635, D-25881, D-26287, D-26535, D-27187, D-27188, D-27191, D-27257, D-27672, D-27675, D-27831, D-28178, D-28326, D-28528, D-28634, D-28635, D-28650, D-29515, D-29655, D-29744, D-29814, D-30860, D-31014, D-31669, D-31775, D-32055, D-32350, D-32883, D-32912, D-32945, D-33114, D-34008, D-34933, D-35940, D-36009, D-36449, D-36503, D-36909, D-37288, D-37366, D-37394, D-39081, D-39535, D-39914, D-39988, D-40118, D-41033, D-41664, D-43693, D-43962, D-44330, E-01821, E-23743, E-27116, E-30073, E-30676, E-31895, E-37953, E-38666, E-44813, F-00058, F-08207, F-14995, G-00076, G-00148, G-00375, G-00597, G-00708, G-03287, G-05002, G-08411, G-10856, G-11468, G-19940, G-20704, G-21423, G-27253, G-27291, G-29129, G-29789, G-30156, G-30328, G-30355, G-30671, G-30672, G-31319, G-31517, G-31528, G-31899, G-32484, G-32905, G-33165, G-33497, G-33607, G-33778, G-33910, G-34059, G-34406, G-35118, G-35811, G-36354, G-37942, G-37964, G-39095, G-40485, H-16655, H-17182, H-17216, H-17218, H-17225, H-21794, H-25374, H-25878, H-26276, H-28529, H-30424, H-33364, H-36611, H-39409, J-26765, J-30329, J-30696, J-38624, K-03007, K-09259, K-24107, K-30069, L-00311, L-02635, L-03536, L-07952, L-09009, L-17472,

L-23608, L-23610, L-24214, L-24757, L-25288, L-30152, L-30908, L-31957, L-32462, L-32789, L-32865, L-33844, L-35151, L-36030, L-37423, L-37521, L-37717, L-41703, L-42873, L-44325, M-33904, N-04052, N-04212, N-04649, N-08273, N-09780, N-20548
VENTILATION A-15769, A-30414, A-33169, A-34774, A-36083, A-39367, B-09798, B-25033, B-35540, B-41544, B-44283, B-44341, B-44660, C-38165, C-42775, D-33114, D-36562, D-43962, D-44996, E-30676, E-44813, G-03654, G-04196, G-04251, G-08566, G-34895, G-34951, G-37229
VENTILATION (PULMONARY) G-00902
VENTURI SCRUBBERS B-03125, B-22520, B-30124, B-32248, B-42131, B-43515, D-05260, G-00177
VETERINARY MEDICINE G-23715
VIRGINIA A-35676, C-01249, E-05713
VIRUSES C-33055, G-41097
VISIBILITY A-16766, A-32621, A-34018, A-35123, B-28377, B-30633, B-32938, B-33994, B-42829, D-00005, D-05573, D-07198, D-35407, E-30863, E-35264, E-38666, G-27291
VISIBLE RADIATION H-11157
VOLATILITY A-02636, A-06220, A-26100, A-26925, A-31085, A-34774, A-35050, A-36535, A-36664, A-37312, A-39610, A-40455, A-41738, A-44682, B-19637, B-20735, B-27503, B-31341, B-33542, B-33550, B-35688, B-44470, C-30635, C-33178, C-41825, C-42139, C-43737, F-03525, J-22358
VOLCANOES A-35788, D-23864, D-37288, G-39095
VOLTAGE B-07606, B-32760, B-37750, C-25979, C-26145, C-32474
VOLTMETERS C-42312

## W

WASHINGTON (STATE) G-00375, I-00305, K-11746
WASHINGTON D C D-01355, D-16839, E-05713
WASHOUT D-21015, D-31325, D-44996, E-03841, E-05713, E-10215, E-24166, E-29688, E-30676, E-32158, H-28289, I-00305
WATER A-03280, A-25417, A-26454, A-32035, A-41889, A-45092, B-29058, B-32036, B-35018, B-40411, C-26955, C-28755, D-25635, F-03525, F-06648, F-14138, F-15493, F-36067, G-05002, G-10434, G-35811, H-09448, H-14786, H-17217
WATER POLLUTION A-03280, A-24080, A-30674, A-32035, A-33293, A-34647, A-35398, A-40314, A-41889, A-41945, B-27824, B-30124, B-35342, C-30635, C-33042, C-33055, C-35396, C-38670, C-44210, D-35407, D-37369, D-38110, D-41887, D-41979, D-42120, E-33225, F-35378, F-35379, F-36076, G-29816, G-30671, G-31528, G-35811, G-36283, G-37788, G-39095, G-42757, H-24667, H-27489, H-32291, H-32736, H-34830, H-34831, I-00305, L-23608, L-23610, L-24214, L-28349, L-29421, L-29888, L-34033, N-28803
WEATHER MODIFICATION A-23620, A-29096, A-35078, D-21684, E-19058, E-24570, E-29445, E-31895, E-36714, E-40157, E-44999, G-38616
WEST AND GAEKE METHOD C-00855, C-32476, C-38755, D-02133, F-37213, K-08420
WEST VIRGINIA G-44696
WET CYCLONES A-20652, B-43515
WETTING B-37750, C-32975, E-32158
WHEAT A-36032, H-17220, H-27489, H-32335
WIND ROSE D-05623
WINDS A-29787, A-30513, A-39367, A-40583, B-28730, B-44283, C-02164, C-21948, C-23646, C-26848, C-27829, C-40724, D-00005, D-03410, D-03441, D-04996, D-05623, D-07198, D-08502, D-08568, D-08821, D-09240, D-10634, D-12099, D-15789, D-16791, D-16839, D-17340, D-23864, D-24414, D-26387, D-26535, D-27187, D-27672, D-28629, D-28650, D-29655, D-29814, D-30410, D-33114, D-35489, D-35725, D-36009, D-36449, D-36474, D-36806, D-37026, D-37366, D-37369, D-37394, D-39081, D-39988, D-40584, D-42122, D-42247, D-43962, D-44059, D-44996, E-01821, E-05713, E-12777, E-21182, E-27116, E-30073, E-37953, E-38118, E-44813, E-45050, G-29129, G-44087, H-32224, H-33985, H-35827, L-08196, L-23562, L-35922, N-04212, N-11871
WOOD A-39462, C-08130, C-23096, F-27752, G-31040
WOOLS B-08562, B-09798, B-26532

## X

X-RAYS B-27371, C-11042, C-29810, C-32534, C-33055, C-34407, C-35494, C-36588, C-36698, C-37175, C-38778, C-40407, C-40631, C-40724, C-41016, C-42437, C-43448, C-43763, C-44479, N-28803
XYLENES A-36541, A-43966, B-01851, B-22414, B-29414, C-38670, D-06788

## Y

YOKOHAMA B-28730, D-15175, D-25881, D-26044, D-27187, D-29385, D-29814, D-29918, D-31014, D-32727, D-32883, D-32912, D-36486, D-36820, G-07423, G-30671, G-33165, H-21018

## Z

ZINC A-06220, A-09686, A-29787, A-34788, A-34916, A-34921, A-39462, A-42676, A-43271, B-00107, B-03125, B-03754, B-09798, B-17525, B-21324, B-32248, B-32319, B-32760, B-35296, B-35303, B-37750, B-40709, C-06045, C-10528, C-11042, C-15734, C-19857, D-00017, D-00974, D-03526, D-05551, D-11202, D-20191, D-26054, D-30892, F-06648, F-13534, G-00662, G-03086, G-09253, G-10434, H-07742, H-08884, I-06355, I-06357, J-30696, N-04649
ZINC COMPOUNDS A-03982, A-05067, A-06351, A-12751, A-12823, A-18297, A-22370, A-24285, A-26441, A-26454, A-29539, A-29572, A-29787, A-30414, A-31632, A-33822, A-35168, A-35224, A-35957, A-36846, A-37190, A-41889, A-41890, A-45072, B-09798, B-10558, B-24553, B-25470, B-26532, B-30229, B-32260, B-33157, B-34071, B-35035, B-35296, B-35303, B-37750, B-40709, B-43515, B-43937, B-44742, C-05787, C-08145, C-09333, C-09888, C-10528, C-11042, C-19313, C-19501, C-22975, C-25015, C-25535, C-25793, C-25979, C-27075, C-28126, C-30113, C-30635, C-30707, C-31933, C-32476, C-32718, C-34407, C-36703, C-38682, C-38778, C-39136, C-39516, C-41825, C-41908, C-41968, C-42020, C-42084, C-42139, C-42312, C-42360, C-42928, C-43448, C-43720, C-44210, C-44995, D-03526, D-04996, D-05167, D-05551, D-05623, D-09432, D-17340, D-23388, D-23971, D-27174, D-27188, D-27648, D-27831, D-27880, D-28653, D-29191, D-30892, D-31325, D-35010, D-36288, D-37288, D-37320, D-37518, D-39535, D-41033, D-41888, D-42122, D-42367, D-43316, D-43468, D-44234, D-44580, D-44996, E-12777, E-44813, F-13635, F-13839, F-14510, F-16595, F-34297, F-35378, F-36067, F-39522, F-43436, F-44164, G-01797, G-07162, G-23801, G-24716, G-30181, G-32218, G-35041, G-38580, G-38721, G-39179, G-40688, G-41894, G-41895, G-44053, G-44696, H-07742, H-08884, H-11452, H-14489, H-21794, H-22926, H-23258, H-23435, H-27489, H-28379, H-30921, H-31010, H-31801, H-32224, H-32322, H-32335, H-32338, H-32736, H-34831, H-35880, H-36265, H-36991, H-37977, H-38332, H-39287, H-39690, H-41733, H-41891, H-41893, H-42250, H-42336, H-43279, K-14443, K-44310, L-00311, L-17472, L-33844, L-34980, L-39640, L-44325, N-04649
ZIRCONIUM F-10599