ONAL INVENTORY OF SOURCES AND EMISSIONS: NICKEL - 1968

NMENTAL PROTECTION AGENCY
f Air and Water Programs
Quality Planning and Standards
ngle Park, North Carolina 27711

APTD-69

NATIONAL INVENTORY OF SOURCES AND EMISSIONS: NICKEL - 1968

by

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Publication No. APTD-69

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This was an industry oriented study and the authors express their appreciation to the many companies and individuals in the nickel industry for their contributions.

We wish to express our gratitude for the assistance of the various societies and associations, and to many branches of the Federal and State Governments.

Our express thanks to Mr. C. V. Spangler, Project Officer, National Air Pollution Control Administration, for his helpful guidance.

PREFACE

This report was prepared by W. E. Davis & Associates pursuant to Contract No. CPA 22-69-131 with the U. S. Public Health Service, U. S. Department of Health, Education, and Welfare, National Air Pollution Control Administration.

The inventory of atmospheric emissions has been prepared to provide reliable information regarding the nature, magnitude, and extent of the emissions of nickel in the United States for the year 1968.

Background information concerning the basic characteristics of the nickel industry has been assembled and included. Process descriptions are given, but they are brief, and are limited to the areas that are closely related to existing or potential atmospheric losses of the pollutant.

Due to the limitation of time and funds allotted for the study, the plan was to personally contact about twenty percent of the companies in each major emissions source group to obtain the required information. It was known that published data concerning emissions of the pollutant was virtually non-existent, and contacts with industry ascertained that atmospheric emissions were not a matter of record.

The nickel emissions and emissions factors presented are based on information obtained from the only production company in the United States, and from reprocessing companies that handled about sixty percent of the nickel consumed in 1968. The companies visited were responsive and provided estimates of their emissions. Nickel emissions and emissions factors are considered to be reasonably accurate.

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SUMMARY

The flow of nickel in the United States has been traced and charted for the year 1968. Consumption for the year was reported to be 159,306 tons and domestic production to be 29,215 tons including the production from both primary and secondary sources. Imports, *mostly from* Canada, totaled 147,950 short tons.

Emissions to the atmosphere during the year were 6,475 short tons. About 83 percent of the emissions were due to the burning of heavy fuel oil and coal.

Estimates of emissions for mining, metallurgical processing, and reprocessing operations are based on data obtained by personal contact with processing and reprocessing companies, and are considered to be reasonably accurate. Further effort is recommended to confirm the accuracy of the emissions from the burning of residual fuel oil and coal.

SOURCES OF NICKEL

Nickel is a light gray, tough, ductile and partially magnetic metal that belongs to the iron-cobalt family. It melts at 1452 C and has an atomic weight of 58.69. Next to chromium, it is considered the most important steel alloying metal.

Nickel is widely distributed over the face of the earth, but there are relatively few workable deposits. It occurs in the earth's crust at about 0.016 percent, and in the world's reserves the concentration in the ore ranges from 0.4 to 5.0 percent.

Nickel deposits fall into three general classifications - nickel - copper sulfides, nickel silicates, and nickel laterites. About half of the world's production at present is from large Canadian deposits of the sulfides of nickel, copper and iron; chiefly pentalandite, chalcopyrite, and pyrrhotite. These ores also contain varying quantities of cobalt, gold, silver, selenium, tellurium, and platinum group metals.

The largest known deposits of nickel silicate ores are in New Caledonia, but there are commercially significant deposits in South America, Indonesia and the United States. Ore in the United States contains about 1.2 percent nickel.

There is only one operating nickel mine in the United States which is located near Riddle, Oregon.

MATERIAL FLOW
NICKEL

MATERIAL FLOW CHART - 1968

(Short Tons)

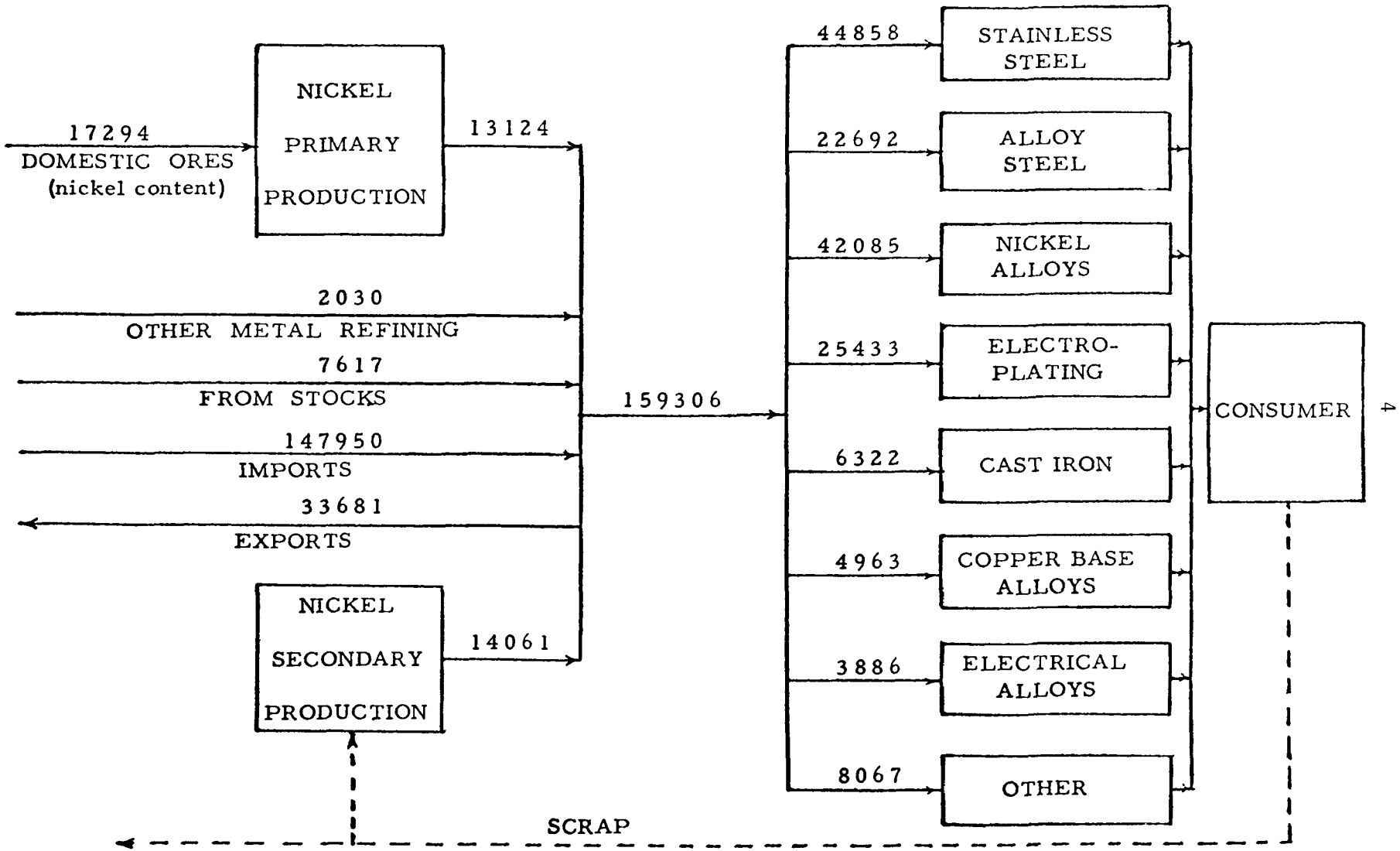

Figure III

MINING AND PROCESSING

Nickel produced in the United States during 1968 was about 18 percent of the nickel consumed and half of the production was from secondary sources derived from reprocessing nickel-base, copper-base, and aluminum-base scrap.

Domestic primary production was from domestic nickel ore and as a by-product of other metal refining. All domestic ore was mined at one location near Riddle, Oregon.

NICKEL PRODUCTION IN UNITED STATES [1]/

1 9 6 8

Nickel Produced	Short Tons
Domestic Ore	13,124
By Product	2,030
Secondary	14,061

1- Bureau of Mines Minerals Yearbook - 1968

NICKEL IMPORTS AND EXPORTS

During 1968 nickel imports totaled 165,986 tons gross weight (147,950 short tons - nickel content), consisting chiefly of unwrought metal, slurry, ferronickel, oxide, and oxide sinter. About 90 percent of the unwrought metal was imported from Canada, and 9 percent from Norway. The imported slurry was about 91 percent from Canada and 9 percent from the Republic of South Africa. Ferronickel was 83 percent from New Caledonia. Oxide and oxide sinter was 99.9 percent from Canada. [1]/

Exports of nickel and nickel alloy products during 1968 were 33,681 short tons, including 16,762 tons waste and scrap, 6,498 tons unwrought metal and 3,340 tons in catalysts. [2]/ The balance of the exports were plates, sheets, strip, bars, rods, shapes, anodes, wire, powder, foil, tubes, etc.

NICKEL STOCKS

Industry stocks at the beginning of 1968 were 31,007 short tons, and at the end of the year the total was 26,534 short tons. During the same period Government nickel stocks decreased 3,144 short tons due to deliveries made on contracts that existed prior

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1-2- Bureau of Mines Minerals Yearbook - 1968

to 1968. [1]/ During 1968, 7,617 short tons of nickel from stocks went to reprocessing.

REPROCESSING

The apparent consumption of nickel in the United States during 1968 has been reported at 159,306 short tons. [2]/

STAINLESS STEEL

For many years the largest use of nickel in the United States has been in stainless steel; about 28 percent of the total use during 1968 was for this purpose. Stainless steel is used in many industries because of its corrosion resistance, attractive appearance, and it does not require periodic repainting. The commercial and industrial applications for stainless steel are numerous; including, components for automobiles, aircraft, textile equipment, food processing equipment, chemical industry equipment, general industrial equipment, pulp and paper equipment, metal working equipment, electrical machinery, appliances, and other equally important items.

The construction industry is the largest single market for stainless at present, and it appears likely that this market will continue to expand rapidly.

1-2- Bureau of Mines Minerals Yearbook - 1968

In the United States the use of nickel in stainless steel during 1968 was 44, 858 short tons.[1]/

ALLOY STEEL

Nickel is used in steel to help make it tough. It is used in automobiles, trucks, heavy construction equipment, agriculture equipment, mining equipment, etc. - principally in gears and engine parts. The steel for these applications generally contains 0.40 to 4.25 percent nickel, and as speeds increase or the size of equipment becomes larger, the nickel content will likely be increased. In aircraft, aerospace, and hydrospace applications, the alloy steel contains up to 18 percent nickel. In submarine hulls there is a considerable usage of HY-80 armor plate steel (2.75 Ni).

Electric generating equipment is another important application from the standpoint of tonnage. Steels containing 2 to 4 percent nickel are used currently, but the trend is toward larger turbines and generators which will require richer nickel-bearing steels.

In the United States during 1968, the consumption of nickel in alloy steel, other than stainless steel, was 22,692 short tons or about 14 percent of the nickel used during the year.

1- Bureau of Mines Minerals Yearbook - 1968

NICKEL ALLOYS

For many years, the second largest use of nickel in the United States has been in nickel alloys; including, sand and investment castings, monel alloy, nickel-silvers, electrical alloys, and electrical resistance alloys.

Castings containing nickel are the heat resistant castings used chiefly in the petroleum, chemical and automotive industries; the corrosion resistant castings used in the petroleum and chemical industries; the alloy steel castings for agriculture, mining and construction equipment; gray iron castings used in the automotive industry; ductile iron castings for agricultural and metal working equipment; cast brasses and bronzes for marine and process industry equipment.

Monel alloys contain more than 50 percent nickel, and one of the largest fields of application for these alloys is chemical processing equipment handling fluorides. Other applications are for equipment used in steam power plants, and in the salt and potash industries.

The nickel content in the family of copper-nickel-zinc alloys (known as the nickel-silvers) likely averages about 15 percent. Applications for these alloys include thousands of small items; such as zipper fasteners, cigarette lighters, silver-plated flatware, contact springs, electron tube pins, etc.

Electrical alloys are used in electron tubes and cathode ray tubes as glass-to-metal sealing alloys.

Electrical resistance alloys are used for resistance heating applications, thermostats, thermocouples, and thermopiles.

During the past ten years 23 percent of the nickel used in the United States was in nickel alloys, and in 1968 the consumption for that prupose was 42,085 short tons or about 26 percent. [1]/

1- Bureau of Mines Minerals Yearbook - 1968

ELECTROPLATING

In this report on nickel the term electroplating is used to cover all types of plating operations; including, electroplating, chemical plating, electroforming, nickel cladding, sprayed coatings, and vapor deposited coatings.

Nickel plating is used extensively in the United States for plating automobile parts and consumer products; such as, appliances, furniture, utensils, etc. About 50 percent of the nickel consumed in plating is for automotive use, and 25 percent for consumer products. It is used principally for decorative applications; however, corrosion protection, wear, and impact resistance are important considerations that are also taken into account by those specifying materials and finishes.

During the past ten years, 14 percent of the nickel used in the United States was for plating. In 1968 the consumption for that purpose was 25,433 short tons or about 16 percent of the nickel used that year. 1/

1- Bureau of Mines Minerals Yearbook - 1968

COPPER-BASE ALLOYS

Alloys containing less nickel than copper are referred to as cupronickels. The high copper types containing 90 percent copper/10 percent nickel and 70 percent copper/30 percent nickel are widely used for components of condensers, heat exchangers, and other heat transfer equipment in power plants, and applications where the media are water and steam. These alloys are resistant to general corrosion; have good anti-fouling characteristics; retain useful strength at temperatures up to about 700 F; are easily formed and welded; and are reasonable in cost.

Another type of cupronickel alloy containing about 45 percent nickel also has an established reputation. The principal applications are thermocouples, thermopiles, and resistors. For these uses the alloy is usually produced in the form of wire, flattened wire, and ribbon.

In the United States, nickel used for copper-base alloys during 1968 was 4,963 short tons. [1]/

1- Bureau of Mines Minerals Yearbook - 1968

OTHER

Catalysts

Nickel catalysts are used in essential industries producing hydrogenated vegetable oils, hydrogen, ammonia, petrochemicals, synthetic fibers, plastisols, and also in general hydrotreating processes in the refining industry.

Coinage

The use of nickel in coinage in the United States jumped dramatically in 1965 when cupronickel cladded coins were introduced for dimes and quarters. During 1968, the use for this purpose was about 1000 short tons.

Batteries

The nickel-cadmium battery has come into use in the United States since World War II, and has been used for diesel locomotives, buses and other heavy machinery, as well as for rechargeable flashlights, electric shavers, etc. It is also used for numerous military and space applications. The advantages include - long life, simple maintenance, maximum current delivery with minimum voltage drop, quick charging, and the ability to operate effectively over a wide temperature range, but its price is considerably higher than for a comparable lead-acid battery.

In 1968, nickel used in batteries is estimated to be 600 short tons based on information received from manufacturers.

E M I S S I O N S

NICKEL EMISSIONS

Several statements in this report indicate that the companies visited during this study were responsive and provided estimates of nickel emissions even though there were no emissions records available. In one instance the estimate was based on test data but in all other cases the determination of nickel emissions was the result of material balance studies.

Some information was obtained regarding the chemical nature of emissions. At one processing location the emissions were referred to as fine ore and at another they were described as nickel oxide. All of the reprocessing companies indicated their nickel emissions were in the oxide form.

Information was obtained concerning the chemical nature of emissions due to the use of nickel in gasoline. Industry reports that extensive studies have shown the combustion of the hydrocarbon soluble nickel compounds used as additives in gasoline results in the formation of inert inorganic nickel salts; such as the oxides and sulfates. No further reactions of these salts after emission were detected. The only company known to use nickel in gasoline has stated they will phase out the use of nickel in their products by early 1970.

No data was available regarding the chemical nature of emissions

resulting from the burning of residual oil.

Even though industry furnished no data regarding the particle size of nickel emissions, there is information available stating that when burning residual oil, eighty five percent of the particulates are less than one micron. [1]/ It is also reported that the particle size of metal fume is 0.1 to 1 micron. [2]/ Based on this information it is assumed that particle size of nickel oxide emissions is 0.1 to 1 microns.

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1 - Allen, G. L.; F. H. Viets; and L. C. McCabe - 1952 Control of Metallurgical and Mineral Dusts and Fumes in Los Angeles County, California. Bureau of Mines Information Circular 7627.

2 - Danielson, John A.; Editor: Air Pollution Engineering Manual; U. S. Dept. of Health, Education, and Welfare; Public Health Service: 1967.

NICKEL EMISSIONS BY SOURCE - 1968

SOURCE CATEGORY	SOURCE GROUP	SHORT TONS	
MINING AND METALLURGICAL PROCESSING			248
	Mining & Smelting	248	
REPROCESSING			834
	Stainless Steel	442	
	Alloy Steel	147	
	Nickel Alloys	53	
	Cast Iron	79	
	Copper Base Alloys	6	
	Electrical Alloys	5	
	Other	102	
CONSUMPTIVE USES			5095
	Oil	4970	
	Gasoline	25	
	Coal	100	
	TOTAL		6177

Nickel emissions during processing and use are based on particulate control indicated as follows:

Mining and Smelting - Wet scrubbers, bag filters, and electrostatic precipitators.

Stainless Steel - Fifty percent of plants controlled with bag filters.

Alloy Steel - Fifty percent of plants controlled with bag filters.

Nickel Alloys - All plants controlled with bag filters.

Cast Iron - Uncontrolled.

Copper Base Alloys - All plants controlled with bag filters.

Electrical Alloys - All plants controlled with bag filters.

Oil Burning - Uncontrolled.

Gasoline - Uncontrolled.

Coal Burning - Seventy five percent particulate control.

NICKEL EMISSIONS BY STATES
(Short Tons)
1968

State	Reprocessing	Consumptive Uses	Total
New York	46	1005	1051
Pennsylvania	275	370	645
Massachusetts	0	573	573
New Jersey	0	539	539
California	0	444	444
Florida	0	332	332
Connecticut	18	242	260
Illinois	29	214	243
Ohio	86	54	140
Indiana	33	101	134
Maryland	29	84	113
Virginia	0	105	105
All Other States	80	1032	1112
Undistributed			486
	TOTAL		6177

NICKEL EMISSIONS FACTORS

MINING AND PROCESSING	C	17 lb/ton of nickel processed
REPROCESSING		
Stainless Steel	C	10 lb/ton of nickel charged
Alloy Steel	C	10 lb/ton of nickel charged
Nickel Alloys	C	2 lb/ton of nickel charged
Cast Iron	NC	20 lb/ton of nickel charged
Copper Base Alloys	C	2 lb/ton of nickel charged
Electrical Alloys	C	2 lb/ton of nickel charged
Production of Iron and Steel	C	0.0015 lb/ton of iron & steel
CONSUMPTIVE USES		
Burning Residual Oil	NC	0.017 lb/bbl of oil
Burning Coal	C	0.0026 lb/ton of coal

C - Controlled

NC - Not Controlled

MINING

and

METALLURGICAL PROCESSING

The entire domestic production of nickel ore is from a single open-pit mine located in Douglas County, Oregon. The ore containing about 1.4 percent nickel is dug from the mountain, largely without blasting, and trammed down about two thousand feet to the smelter. It is then melted in electric furnaces, and poured into reaction ladles where reduction is accomplished by adding crushed ferrosilicon to the molten ferronickel.

The ore is dug from 40 foot minimum width benches, spaced at 20 foot vertical intervals, and moved to screens where it is classified before it is sent to the tramway surge pile. Efforts to blend the ore into a uniform feed to the melting furnaces begin at the mine and continue throughout all the subsequent operations.

During 1968, the domestic production of nickel ore was 1,217,906 dry short tons which contained 17,294 tons of nickel. Production at the smelter was 25,835 tons of ferronickel, containing 13,124 tons of nickel. [1]/

Secondary Nickel Alloy Smelters are also an important factor in the

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1- Bureau of Mines Minerals Yearbook - 1968

industry. They utilize scrap and prepare a nickel base alloy specification metal with residual elements held to stipulated limits. This product is sold principally to alloy steel mills for use as a nickel alloying addition to their production heats.

The secondary smelters also produce a nickel alloy or shot product produced to exact specification for foundry use.

During 1968, the nickel emissions to the atmosphere from sources of mining and metallurgical processing are estimated at 248 short tons, based on an emissions factor of 17 pounds per ton of nickel produced.

REPROCESSING

The principal use of nickel is as an alloying element. When alloyed with other metals, nickel imparts strength, toughness, hardness, and ductility together with resistance to oxidation and corrosion. It is used extensively in the production of ferroalloys, and the largest single application is in the manufacture of stainless steels.

In the melting and alloying of stainless and heat resisting steels, other steel alloys, nickel alloys, copper-base alloys, electrical resistance alloys, and cast iron, nickel is lost to the atmosphere in the form of nickel oxide or as a complex oxide combined with other alloying elements; therefore, from the standpoint of atmospheric emissions, it is important to determine the total amount of nickel that is melted during alloying.

In the manufacture of alloy steels a considerable amount of alloy steel scrap is used in the melt along with primary materials. Published data does not show amount of nickel contained in this scrap. Information is available showing the amount of stainless and heat resisting steels produced, and the percentage of nickel contained therein.

STAINLESS & HEAT RESISTING STEELS

The production of stainless and heat resisting steels is reported annually by the American Iron and Steel Institute according to type number, and for 1968 the reported data is summarized as follows:

Type Number	Production (short tons)	Nickel Content (percent)	Nickel Content (short tons)
200 Series	38,290	4.50	1,725
300 Series	932,138	9.30	86,500
400 & 500 Series	459,508	negligible	-
	Total		88,225

During 1968 nickel emissions to the atmosphere resulting from the production of stainless and heat resisting steels are estimated at 442 short tons based on an emissions factor of 10 pounds per ton of nickel charged to the melt. The emissions factor used is the average of the factors estimated by the manufacturers contacted during the study.

ALLOY STEEL

In order to estimate the amount of nickel in the alloy steel produced during 1968, published data for 1967 has been used. Alloy steel production during 1967 (other than stainless) is reported by

the American Iron and Steel Institute according to category as follows:

CATEGORY	SHORT TONS
Nickel	34,452
Nickel-Chromium	90,997
Nickel-Moly	383,132
Ni-Chrome-Moly-Van	159,330
Ni-Chrome-Moly	1,420,588
Other Alloy not containing nickel or silicon	9,251,177
Total	11,339,676

Primary nickel consumed in alloy steel in 1967 was 23,661 short tons; [1]/ an average nickel content of 1.13 percent. Scrap consumed in alloy steel in 1967 was 3,005,000 short tons. [2]/ Since nickel alloy steels are about 18.5 percent of all alloy steel, then alloy scrap should average about 18.5 percent nickel alloy. On this basis 558,000 short tons of nickel alloy scrap (1.13 percent nickel content) would contain 6300 short tons of nickel. Assuming the same use during 1968, the 6300 short tons of nickel in scrap added to the 22,692 short tons of primary nickel used in 1968 would result in a total of 28,992 short tons of nickel in the alloy

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1-2- Bureau of Mines Minerals Yearbook - 1967.

steel melt during 1968.

Nickel emissions to the atmosphere resulting from the production of alloy steels are estimated for 1968 on the basis of an emissions factor of 10 pounds per ton of nickel charged to the melt. Total emissions for alloy steels are estimated at 147 short tons.

NICKEL ALLOYS - CAST IRON

COPPER BASE ALLOYS - ELECTRICAL ALLOYS

Accurate information concerning the total tonnage of scrap used in nickel alloys, cast iron, copper-base alloys and electrical resistance alloys is not available; therefore it is assumed that 25 percent scrap is added to the melt.

Emissions factors and emissions for 1968 are listed as follows:

	Emissions Factor lbs/ton of nickel charged	Emissions (short tons)
Nickel Alloys	2	53
Cast Iron	20	79
Copper-Base Alloys	2	6
Electrical Resistance Alloys	2	5

ELECTROPLATING

The process of electroplating with nickel consists of setting up the article to be coated as the cathode in an electrolytic bath. The electrolyte is a solution of the metal to be deposited and the anode is metallic nickel. When an electric current is passed through the electrolyte, ions from the electrolyte are deposited at the cathode, and an equivalent amount of nickel is disolved at the anode.

From the standpoint of emissions to the atmosphere, most of the electroplating processes are of little interest because the emissions are of negligible volume. Generally, air pollution control equipment is not required for any of the processes except for chrome plating.

The people in the plating industry that were contacted during this study reported that their emissions to the atmosphere are negligible.

OTHER

Batteries

In the process of producing nickel-cadmium batteries of the sintered-plate type, more nickel is used than cadmium. The grids of both positive and negative plates consist of sintered carbonyl nickel powder and the active material of the positive plate, when charged, is nickel oxide.

Each plate of the core assembly has as its foundation a screen of nickel-wire mesh which is converted into a sheet as nickel powder is deposited in its meshes by a sintering process. It is the active material electrochemically deposited within the pores of the sheets that distinguishes between positive and negative plates.

Battery manufacturers contacted during this study report nickel emissions to the atmosphere at an average of 8 pounds per ton of nickel processed.

Nickel emissions to the atmosphere during 1968 are estimated at 2.4 tons.

Catalysts

Manufacturers of catalysts contacted during this study stated that their atmospheric emissions of nickel are negligible.

Nickel Plated Scrap

Steel production during the past ten years has varied from about 93 million tons in 1959 to 131 million tons in 1968; an average of 115 million tons per year. During the same period, nickel used in plating has varied from about 16 thousand tons in 1959 to 25 thousand tons in 1968; an average of 20 thousand tons per year. (Table I)

Based on the assumption that 75 percent of the nickel plating was on iron and steel, the ratio of nickel to steel in scrap steel is about 0.26 pounds of nickel per ton of steel.

The 38.5 million tons of steel scrap purchased by the steel industry in 1968 [1] is estimated to contain 5000 tons of nickel.

Nickel emissions to the atmosphere during the making of steel (other than alloy steel) are estimated at 100 tons or 0.0015 pounds of nickel per ton of steel produced.

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1 - Metal Statistics 1969; American Metal Market Company, New York, New York.

T A B L E I

NICKEL USED IN PLATING - STEEL PRODUCTION
(Short tons - Thousands)

YEAR	NICKEL USED IN PLATING	STEEL PRODUCTION
1959	16	93,446
1960	17	99,282
1961	17	98,014
1962	19	98,328
1963	20	109,261
1964	21	127,076
1965	21	131,462
1966	16	134,070
1967	28	126,920
1968	25	131,098
	200	1,148,957

Metal Statistics - 1969; The American Metal Market Co.;
New York, New York

CONSUMPTIVE USES

Alloys that contain nickel are used in many instances because they are corrosion resistant. This is the principal reason that they are used extensively in the pulp and paper, petroleum, and chemical industries. In order to increase the useful life of the equipment and reduce maintenance costs, they are used for piping and equipment that is in contact with corrosive liquids. Nickel losses do occur during use, but mostly they are of such a nature that they would not result in emissions to the atmosphere.

There are other instances where nickel alloys are used because they are heat resistant. One such application is in jet engines, and in this case, the losses that occur undoubtably become atmospheric emissions; however, these losses are considered negligible.

Oil

Many crude oils contain trace amounts of a number of metals, [1]/ including nickel, which is present in higher concentrations than many other metals. The concentrations of nickel can range from nearly zero to over 100 ppm (Tables II & III). The higher concentrations of nickel often are detected in asphaltic crude oils.

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1 - Ball, J. S., W. J Wenger, C. A. Horr, and A. T. Myers. Metal Content of Twenty-Four Petroleums; J. Chem. & Eng. Data; v. 5; No. 4; Oct. 1960.

Even though nickel is found in most crude oil, it is generally agreed that there is no nickel in motor fuel unless it is intentionally used as an additive. Refineries report that during the refining process, the nickel in the crude remains with the heavy ends; in road oil, asphalt and heavy fuels.

In the United States the demand for petroleum products, during 1968, was 4,901,789,000 bbls.; including - residual fuel oil at 668,239,000 bbls., asphalt at 141,151,000 bbls., road oil at 7,080,000 bbls. (Table IV) Using the nickel content of the crude as 10 ppm average, the crude contained approximately 7,350 tons of nickel. After refining, about 95 percent of the nickel remained in the residual fuel oil, the asphalt, and the road oil. The residual fuel oil then contained 5,710 tons of nickel.

The residual fuel oil used in the United States during 1968, exclusive of use in vessels, was 581.9 million bbls. This oil, containing about 4,970 tons of nickel, was used by industrials, electric-utility companies, railroads, oil companies, the military, as well as for heating. (Table V)

Based on negligible particulate control[1], emissions to the atmosphere during 1968 are estimated at 4,970 tons of nickel.

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1 - Control Techniques for Particulate Air Pollutants; NAPCA Pub. No. AP - 51; U.S. Dept. of Health, Education and Welfare.

Gasoline

It has been suggested that the use of nickel in gasoline may explain the presence of nickel in the soil at sites near dense traffic. [1] During this study, all the major oil companies were contacted regarding their use of nickel, and all but one have reported no nickel was used during 1968.

Coal

A study has been made regarding emissions from coal fired power plants and emissions of nickel particulate have been recorded. Nickel concentrations found in fly ash samples, taken after fly ash collection, ranged from 0.58 to 3.0 grains per scf x 10^{-4}. [2]

Based on 300,000,000 tons of coal consumed by power plants in 1968, 75 percent particulate control [3], nickel concentration of 0.58 grains per scf x 10^{-4}, and 160 scf per pound of coal, the nickel emissions were 100 tons.

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1 - Lagerwerff, J. V. and A. W. Specht; Contamination of Roadside Soil and Vegetation with Cadmium, Nickel, Lead and Zinc: U.S. Soils Laboratory, Beltsville, Md.

2 - Cuffe, Stanley T. & Gerstle, Richard W.; Emissions from Coal Fired Power Plants; A Comprehensive Summary; Public Health Service Publication No. 999-AP-35.

3 - Control Techniques for Particulate Air Pollutants; NAPCA Pub. No. AP-51; U.S. Dept. of Health, Education, and Welfare.

T A B L E II

NICKEL CONTENT OF DOMESTIC CRUDE OILS

CRUDE	NICKEL CONTENT - ppm
West Texas Sour	4.3
West Texas Intermediate	1.4
Texas-Oklahoma Panhandle	3.0
East Texas	1.7
Louisiana Ostrica	2.1
West Kansas	6.3
Wyoming Sweet	2.7
Wyoming Sour	6.1
California L. A. Basin	64.0
California S.J.V. Blend	53.0
Alaska North Slope	11.3

T A B L E III

NICKEL CONTENT OF IMPORTED CRUDE OILS

CRUDE	NICKEL CONTENT - ppm
Cabinda	11.6
Gamba	1.0
Hassi Messaoud	0.3
Serir	4.0
El Alamein	4.8
El Morgan	28.0
Kirkuk	11.0
Basrah Zubair	3.1
Souedie	22.2
Agha Jari	10.1
Gach Saran	29.5
Arabian Export	3.2
Kuwait Export	6.0
Safaniya Khafji	11.0
Murban	0.8
Zakum	0.3
Minas	2.3
Seria	0.5
Orito	12.9
Tigre	10.0
Tia Juana	28.0
Britamoil	7.7
Inter Provincial PL Mix	1.8
Saskatchewan	28.9

T A B L E IV

SUPPLY AND DEMAND OF ALL OILS IN THE UNITED STATES

Supply	Thousands of Barrels
Domestic Production	3,879,353
Imports	1,042,746
Total New Supply - -	4,922,099
Domestic Demand	
Gasoline	1,956,000
Jet Fuel	349,378
Ethane	55,152
Liquefied Gases	330,589
Kerosine	102,934
Distillate Fuel Oil	874,539
Residual Fuel Oil	668,239
Petrochemical Feedstocks	92,936
Special Napthas	27,007
Lubricants	48,467
Wax	4,360
Coke	76,319
Asphalt	141,151
Road Oil	7,080
Still Gas	149,796
Miscellaneous Products	17,842
Total Demand	4,901,789

Mineral Industry Surveys; U. S. Department of Interior; Bureau of Mines; Crude petroleum, petroleum products and Natural gas liquids - 1968

TABLE V

SHIPMENTS OF RESIDUAL FUEL OIL IN THE UNITED STATES - 1968

USE		MILLION BARRELS
Heating		174.3
Industrial		175.0
Electric Utilities		185.0
Military & Other		47.6
		581.9
STATE		
New York		116.4
Massachusetts		67.8
New Jersey		62.6
California		51.8
Pennsylvania		42.4
Florida		38.6
Connecticut		28.1
Illinois		24.1
Virginia		12.0
Indiana		11.4
Washington		10.0
OTHER STATES		
	Pacific-Mountain	25.5
	North Central	23.6
	Southern	48.3
	Northeast	19.3
		581.9

Mineral Industry Surveys; Shipments of Fuel Oil & Kerosine in 1968; U. S. Dept. of Interior, U. S. Bureau of Mines, Sept. 17, 1969.

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15. Supplementary Notes

16. Abstracts

The inventory of atmospheric emissions has been prepared to provide reliable information regarding the nature, magnitude, and extent of the emissions of nickel in the United States for the year 1968. Background information concerning the basic characteristics of the nickel industry has been assembled and included. Process descriptions are given, but they are brief, and are limited to the areas that are closely related to existing or potential atmospheric losses of the pollutnat. The nickel emissions and emissions factors presented are based on information obtained from the only production company in the United States, and from reprocessing companies that handled about sixty percent of the nickel consumed in 1968. The companies visited were responsive and provided estimates of their emissions. Nickel emissions and emissions factors are considered to be reasonably accurate.

17. Key Words and Document Analysis. 17a. Descriptors

Inventory
Atmospheric emissions
Emissions
Nickel
Nickel industry
Pollutant
Nickel emissions
Nickel emission factors

17b. Identifiers/Open-Ended Terms

17c. COSATI Field/Group 13B

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