United States
Environmental Protection
Agency

Air Pollution Training Institute
MD 20
Environmental Research Center
Research Triangle Park NC 27711

EPA 450/2-82-011
January 1982

Air

EPA

APTI Course 452 Principles and Practice of Air Pollution Control

Student Workbook

United States
Environmental Protection
Agency

Air Pollution Training Institute
MD 20
Environmental Research Center
Research Triangle Park NC 27711

EPA 450/2-82-011
January 1982

Air

APTI Course 452 Principles and Practice of Air Pollution Control

Student Workbook

Technical Content By:

J. E. Maroney
D. S. Beachler
B. M. Ray
D. R. Bullard
G. T. Joseph

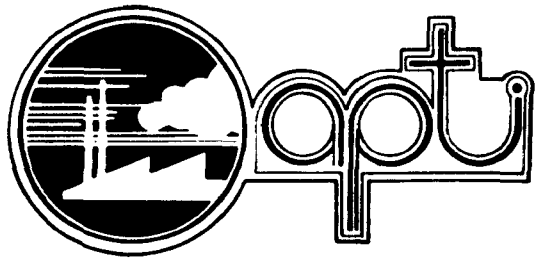
Instructional Design By:

K. M. Leslie

Northrop Services, Inc.
P.O. Box 12313
Research Triangle Park, NC 27709

Under EPA Contract No.
68-02-2374
EPA Project Officer
R. E. Townsend

United States Environmental Protection Agency
Manpower and Technical Information Branch
Office of Air Quality Planning and Standards
Research Triangle Park, NC 27711



Notice

This is not an official policy and standards document. The opinions and selections are those of the authors and not necessarily those of the Environmental Protection Agency. Every attempt has been made to represent the present state of the art as well as subject areas still under evaluation. Any mention of products or organizations does not constitute endorsement by the United States Environmental Protection Agency.

Availability

This document is issued by the Manpower and Technical Information Branch, Control Programs Development Division, Office of Air Quality Planning and Standards, USEPA. It was developed for use in training courses presented by the EPA Air Pollution Training Institute and others receiving contractual or grant support from the Institute. Other organizations are welcome to use the document.

This publication is available, free of charge, to schools or governmental air pollution control agencies intending to conduct a training course on the subject covered. Submit a written request to the Air Pollution Training Institute, USEPA, MD 20, Research Triangle Park, NC 27711.

Others may obtain copies, for a fee, from the National Technical Information Service (NTIS), 5825 Port Royal Road, Springfield, VA 22161.

Sets of slides and films designed for use in the training course of which this publication is a part may be borrowed from the Air Pollution Training Institute upon written request. The slides may be freely copied. Some films may be copied; others must be purchased from the commercial distributor.

Course Description

This training course is a 3½-day lecture course dealing with the principles and practice of air pollution control. The course presents a broad view of all major practical aspects of air pollution control. The lessons include information about pollutants, pollutant sources, effects of pollution, dispersion of pollution, legal authority for air pollution control, measurement and control of emissions, enforcement of regulations, inspections, implementation plans, and other related topics.

This course is taught at an instructional level equivalent to that of advanced undergraduate university study. In the Air Pollution Training Institute curriculum it is a recommended background course for all areas of study. You should have at least a college-level education, and have completed APTI Course SI:422—Air Pollution Control Orientation Course (3rd ed.) or have a minimum of six months of applicable work experience.

How to Use This Workbook

This workbook is to be used during the course offering. It contains a chapter corresponding to each of the eighteen lessons.

Each chapter contains a listing of the lesson goal, the lesson objectives, and any special references that might be helpful to you. Each chapter also contains several pages of black-and-white line-art reproductions of selected lecture slides. These reproductions are intended to generally follow the slide presentations given in the lecture. However, the instructor may on occasion change the order or present new material not included in the workbook. It is recommended, therefore, that you take notes throughout the course and not rely on the graphic reproductions as representing the total course content.

Space for note-taking is provided in each chapter of the workbook.

Table of Contents

Chapter 1

Course Goal and Objectives

Course Goal

The goal of this course is to provide you with basic knowledge of the major practical aspects of air pollution control program development and implementation.

Course Objectives

Upon completion of this course, you should be able to:

- recognize and use appropriately the air pollution control terms used in this course.
- in terms of constitutional, common, statutory, and administrative law, explain how the legal authority for air pollution control is derived and limited.
- relate the legal aspects of air pollution control to the tasks that you perform on the job.
- identify the areas of activity in air pollution control programs and describe their relationship to the development and implementation of programs.
- describe the authority and program elements necessary for State compliance with the Clean Air Act.
- associate air pollution control apparatus and procedures with the types of sources and pollutants to which they are usually applied.
- identify the meteorological and topographic factors that affect dispersion estimates used in program development, and the sources and limitations of related data.
- associate the criteria air pollutants with sampling techniques and reference methods, and recognize procedures used in assembling and applying air quality data.
- recognize the role that other government agencies play in a current comprehensive air pollution control program.
- recognize the health and welfare goals which motivate efforts to improve and/or maintain the quality of the air.

COURSE GOAL

To provide you with basic knowledge of the major practical aspects of air pollution control program development and implementation.

COURSE OBJECTIVES

1. Recognize and use appropriately the air pollution control terms used in this course.
2. In terms of constitutional, common, statutory, and administrative law, explain how the legal authority for air pollution control is derived and limited.
3. Relate the legal aspects of air pollution control to the tasks that a control agency employee performs on the job.
4. Identify the areas of activity in air pollution control programs and describe their relationship to the development and implementation of programs.
5. Describe the authority and program elements necessary for State compliance with the Clean Air Act.
6. Associate air pollution control apparatus and procedures with the types of sources and pollutants to which they are usually applied.
7. Identify the meteorological and topographic factors that affect dispersion estimates used in program development, and the sources and limitations of related data.
8. Associate the criteria air pollutants with sampling techniques and reference methods, and recognize procedures used in assembling and applying air quality data.

9. Recognize the role that other government agencies play in a current comprehensive air pollution control program.

10. Recognize the health and welfare goals which motivate efforts to improve/maintain the quality of the air.

Chapter 2

Air Pollutants and Their Sources

Lesson Goal

To familiarize you with the air pollutants of principal concern, with emphasis on: (1) their names and physical characteristics, (2) their typical sources and concentrations, and (3) methods of specifying and describing their concentrations.

Lesson Objectives

Upon completion of this lesson, you should be able to:

1. name the criteria air pollutants, the hazardous air pollutants, and the principal pollutants regulated under NSPS, and describe their characteristics (e.g., primary vs. secondary, gaseous, particulate, odorless, colorless).
2. name typical sources of the criteria, hazardous, and NSPS-regulated pollutants.
3. use the standard (mass per unit volume of air) and supplemental (ppmv or ppbv) means of stating pollutant concentrations.
4. recognize typical ambient concentration ranges of the criteria, hazardous, and NSPS-regulated pollutants.

AIR POLLUTANTS AND THEIR SOURCES

Ambient Concentration Measurements

Source Emission Measurements

Effects

Control

Source Classification

- mobile vs. stationary
- point, area, or line
- combustion vs. noncombustion
- other

Categories

- Criteria Pollutants
- NSPS-Regulated Pollutants
- Hazardous Pollutants

Criteria Pollutants

Primary

- same form in air as when emitted from source
- particulate or gaseous
- particulate matter, lead, sulfur dioxide, carbon monoxide, oxides of nitrogen

Secondary

- change form after leaving source
- particulate or gaseous
- ozone, sulfates, nitrates

Particulate Matter

- solid or liquid particles
- very small
- remain suspended in air
- bits of dust, soot, smoke, mist
- 0.1 μm to 100 μm

Classifications

- TSP (total suspended particulate) - mass of all particulate matter in given volume of air
- inhalable and respirable particulate matter ($\sim$10μm)
- fine particulate matter ($<$3 μm)

Chemical Characteristics

- inert substances
- acids
- heavy-metal particles
- highly toxic compounds

Typical Sources

Power Plants	Industrial Processes	Miscellaneous

Concentrations

- natural background:
  30-40 $\mu g / m^3$
- severe episodes:
  1,000-3,000 $\mu g / m^3$

Lead (Pb)

- lead-containing particles in the air
- usually solid
- <0.1 μm to 200 μm; most $\sim$1 μm

Chemical Characteristics

- lead salts (often complex)
- lead oxide

Typical Sources

Transportation Vehicles

Incineration

Manufacturing

Mining/Smelting

Concentrations

- natural background: $\sim$0.0006 $\mu g/m^3$
- rural: $\sim$0.1 $\mu g/m^3$
- urban: $\sim$1 $\mu g/m^3$

Particulate Criteria Pollutants (primary)	Gaseous Criteria Pollutants (primary)
• solid or liquid form	• gaseous form
• $\mu g/m^3$	• mg/m^3, $\mu g/m^3$, ppm(v), or ppb(v)
• TSP, lead	• sulfur dioxide, carbon monoxide, oxides of nitrogen

Sulfur Dioxide (SO_2)

- gaseous
- usually measure SO_2, but consider other sulfur oxides in studies and control strategies
- non-flammable / non-explosive
- colorless
- detectable taste / odor at high concentrations
- acids present as droplets / vapor

Chemical Characteristics

- either oxidizing or reducing agent
- easily oxidizes to SO_3, which combines with H_2O to form H_2SO_4

Typical Sources

Combustion Operations	Nonferrous Smelters	Other Industrial Processes

Concentrations

- natural background:

  2 $\mu g/m^3$ (0.7 ppbv)

- severe episode peaks:

  ~3,000 $\mu g/m^3$ (1.05 ppmv)

Carbon Monoxide (CO)

- gaseous
- colorless
- odorless
- tasteless

Chemical Characteristics

- flammable
- strong affinity for O_2-bonding sites of hemoglobin

Typical Sources

Transportation Vehicles

Industrial Processes

Miscellaneous Burning

Stationary Fuel Combustion

Concentrations

- natural background: ~0.05 mg/m³ (44 ppb)
- global average: ~0.12 mg/m³ (100 ppb or 0.1 ppm)
- urban "hot spots": >50 mg/m³ (44 ppm)

Oxides of Nitrogen (NO_x)

- nitrogen dioxide (NO_2), nitric oxide (NO)
- gaseous
- NO — colorless; odorless
- NO_2 — red-brown; pungent odor

Chemical Characteristics

- NO
  - common product of combustion
  - easily oxidized to NO_2
- NO_2
  - quite reactive
  - can combine with H_2O to give HNO_3 droplets/vapor

Typical Sources

Transportation Vehicles	Power Plants	Industrial Processes

Concentrations

- **natural background:**
  $\sim 1\ \mu g/m^3$ (0.6 ppb)
- **peaks:**
  $\geq 750\ \mu g/m^3$ (0.4 ppm)

Criteria Pollutants

Primary	Secondary
• same form in air as when emitted from source	• change form after leaving source
• particulate or gaseous	• particulate or gaseous
• particulate matter, lead, sulfur dioxide, carbon monoxide, oxides of nitrogen	• ozone, sulfates, nitrates

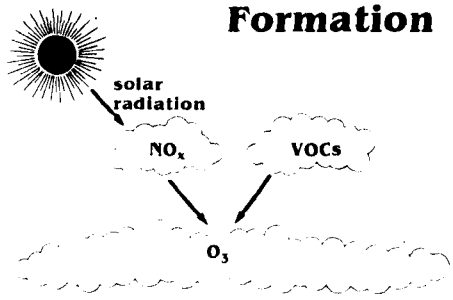
Ozone (O_3)

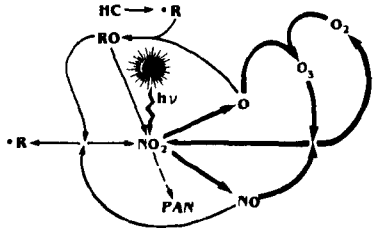
- **photochemical oxidant**
- **gaseous**
- **faintly bluish**
- **distinctive sharp odor**

Chemical Characteristics

- **powerful oxidizing agent**
- **breaks down rapidly**

Formation





Typical Soures of VOCs

Transportation Vehicles

Petroleum Storage / Marketing

Industrial Solvent Use

Chemical Manufacturing

Typical Sources of NO_X

Transportation Vehicles

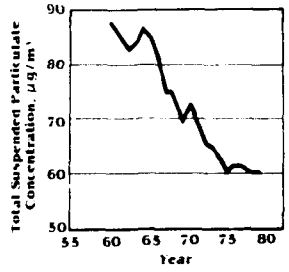
Power Plants

Sulfates and Nitrates

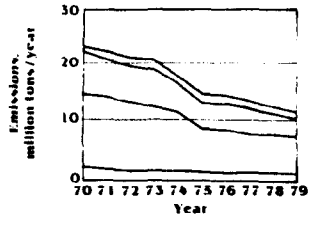
- **not currently criteria pollutants, but contribute to TSP and play *role in acid deposition***
- **mostly fine, solid particles**
- **readily form acids in contact with H_2O**

- formed by oxidation of SO_x, NO_x, and combination with other pollutants
- sources same as for SO_x and NO_x, especially power plants

- **Sulfates**
  $\sim 1\ \mu g/m^3$ to $\sim 20\ \mu g/m^3$ (annual)
  $\sim 0.1\ \mu g/m^3$ (LDL) to $> 80\ \mu g/m^3$ (24-hour)
- **Nitrates**
  $< 1\ \mu g/m^2$ to $\sim 5\ \mu g/m^3$ (annual)
  $0.5\ \mu g/m^2$ to $\sim 10\ \mu g/m^3$ (24-hour)

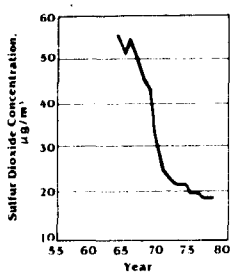


National Trend in Average Particulate Levels, 1960 - 1979

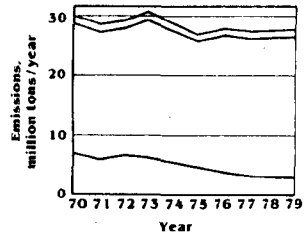


National Trend in Particulate Emissions

Transportation
Fuel Combustion in Stationary Sources
Industrial Processes
Solid Waste and Miscellaneous

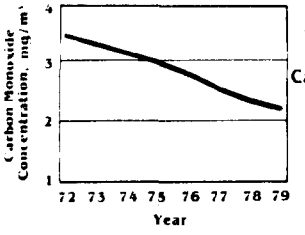


National Trend in Average *Sulfur Dioxide* Levels, 1965 - 1979

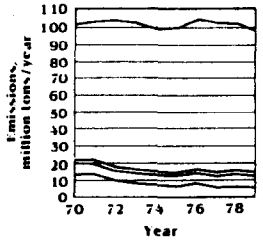


National Trend in Emission of Sulfur Oxides, 1970 - 1979

■ Transportation ■ Fuel Combustion in Stationary Sources
■ Industrial Processes

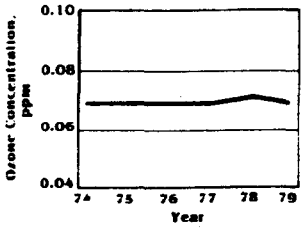


National Trend in Average Carbon Monoxide Levels, 1972 - 1979

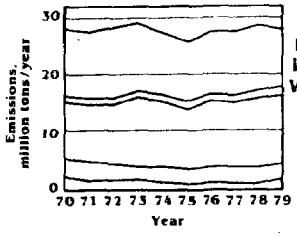


National Trend in Emissions of Carbon Monoxide, 1970 - 1979

■ Transportation ■ Fuel Combustion in Stationary Sources
■ Industrial Processes ■ Solid Waste and Miscellaneous

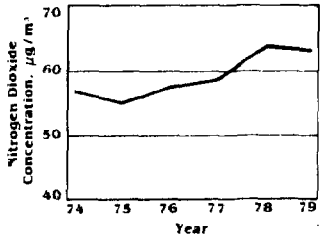


National Trend in Ozone Levels, 1974 - 1979

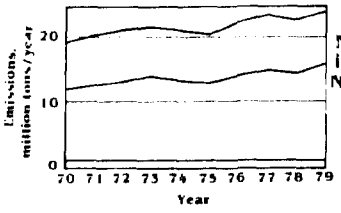


National Trend in Emissions of Volatile Organic Compounds

■ Transportation ■ Fuel Combustion in Stationary Sources
■ Industrial Processes ■ Solid Waste and Miscellaneous
■ Non-Industrial Organic Solvent



National Trend in Average Nitrogen Dioxide Levels, 1975 - 1979



National Trend in Emissions of Nitrogen Oxides, 1970 - 1979

■ Transportation ■ Fuel Combustion in Stationary Sources
■ Industrial Processes

Control Approach for Criteria Pollutants

- standards set for ambient concentrations
  - mass per volume or volume per volume
  - specified averaging time
  - criterion determines if standard violated
- control strategy is mix of emission controls and other measures

NSPS - Regulated Pollutants

- standards specifying emission limits
  - within specific source categories
  - for new sources
  - for major modifications
- operational or performance standards
- require emission control technology considering cost and other factors

- **Criteria Pollutants**
- **Fluorides**
- **Sulfuric Acid Mist**
- **Hydrogen Sulfide**
- **Total Reduced Sulfur**

Fluorides

- various fluorine compounds
- particulate matter and gases
- sources include:
  - aluminum refining plants
  - fertilizer manufacturing
  - plating operation pickling tanks

Sulfuric Acid Mist

- primarily particulate matter
- some gas
- sources include:
  - acid manufacturing
  - pulp and paper mills
  - pickling tanks
  - power plants

Hydrogen Sulfide (H_2S)

- gas
- colorless
- pungent, "rotten egg"-like odor
- very toxic at high concentrations
- converts easily to H_2SO_4 in contact with H_2O
- sources include:
  - petroleum refining
  - pulp and paper mills
  - steel manufacturing

Total Reduced Sulfur (TRS)

- blanket term for sulfur-bearing gaseous compounds
- H_2S, MeSH, DMDS, and DMS
- sources include:
  - pulp and paper mills
  - lime kilns

Hazardous Air Pollutants

- pollutants regulated under NESHAPs
- controlled by limitations on emissions
  - from new sources
  - from existing sources
- cause or contribute to irreversible or incapacitating illness
- importance is in close proximity to source

Asbestos

- small particulate matter (fibers)
- various calcium and magnesium silicates
- sources include:
  - asbestos mining operations
  - textile manufacturing
  - fireproofing materials
  - brake linings
  - building demolition

Beryllium (Be)

- elemental metal
- beryllium silicate
- very light and elastic
- sources include:
  - extraction plants
  - ceramic plants
  - foundries
  - incinerators
  - rocket motor propellant manufacture and stationary test firing

Mercury (Hg)

- elemental metal
- silvery liquid
- cinnabar (HgS)
- sources include:
  - mercury-ore processing
  - sludge drying
  - sludge incineration
  - mercury cell chlor-alkali plants

Vinyl Chloride

- organic compound
- gas
- ethylene dichloride, vinyl chloride, polyvinyl chloride
- source:
  - chemical manufacturing plants

Benzene

- VOC (C_6H_6 ring)
- usually liquid at ambient temperatures
- emitted as vapor/mist mixture
- sources include:
  - chemical manufacturing plants
  - solvent use
  - oil refining

Inorganic Arsenic (As)

- elemental nonferrous metal
- solid at ambient temperatures
- emitted in gaseous arsenic trioxide, which condenses on particulate matter
- sources include:
  - copper- and lead-ore roasting
  - incinerators
  - coal-burning power plants

Radionuclides

- radioactive particles
- unstable atomic nuclei – decompose or disintegrate spontaneously, emitting radiation
- uranium, actinium, thorium
- radioactive character unaffected by chemical change

Radionuclides (continued)

- sources include:
  - nuclear power plants
  - nuclear fuel processing
  - medical facilities
  - laboratories and research facilities
  - mining and milling operations
  - fossil-fuel-fired power plants

Conclusion

- focus on pollutants as substances
- of interest because of their adverse effects on human health or welfare
- no list of air pollutants can be exhaustive and exclusive
  - overlaps and open-endedness are inevitable

Chapter 3

The Effects of Air Pollution

Lesson Goal

To familiarize you with the effects on human health and welfare of the air pollutants of principal concern.

Lesson Objectives

Upon completion of this lesson, you should be able to:

1. define the key terms required for discussion of the effects of air pollutants on receptors.
2. identify the principal human body systems and structures affected by gaseous or particulate air pollutants, and associate health damages with pollutant types.
3. recognize the general types of damage to vegetation and property which can be caused by air pollutants.
4. identify the most important health and welfare effects of the criteria pollutants.

References

1. Heck, Walter C. and Brandt, C. Stafford. 1977. Effects on vegetation: native, crops, forests. Chapter 4 in A. C. Stern, ed., *Air Pollution,* Vol. II. New York: Academic Press.
2. U.S. EPA. See generally the Summary and Conclusions chapter of most recent *Air Quality Criteria for* [Pollutant].
3. Williamson, Samuel J. 1973. *Fundamentals of Air Pollution,* Chapter 2, Some adverse effects, pp. 8-54. Reading, MA: Addison-Wesley.

THE EFFECTS OF AIR POLLUTION

Ambient Air

Pollutant

- a contaminant which can have an adverse effect on public health or welfare

Receptor

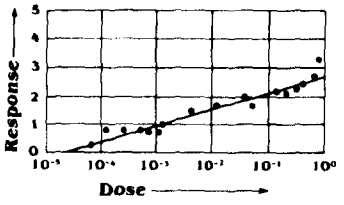
- item or system affected by pollution

Dose

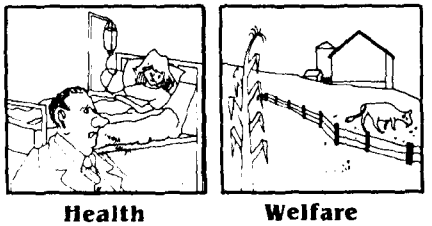
- total amount of pollutant received by receptor

(concentration x exposure time)

Dose-Response Relationship



Types of Effects

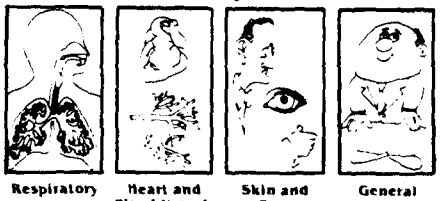


Health Welfare

Methods of Study

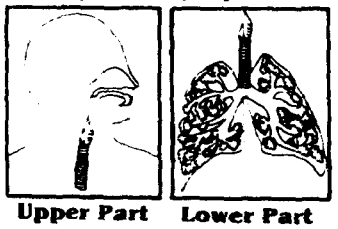
- epidemiology - comparison of concentration statistics with health / welfare statistics
- case studies - study of group(s) exposed to naturally occurring pollutant levels
- laboratory studies - controlled experiments

Systems of the Human Body Affected



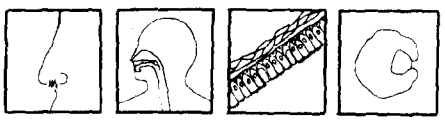
Respiratory | Heart and Blood Vessels | Skin and Eyes | General

Respiratory System



Upper Part Lower Part

Defense and Accumulation Mechanisms



Effects on Respiratory System

- bronchitis
  - acute
  - chronic
- pulmonary emphysema
- lung cancer
- pneumoconiosis

Effects on Heart and Blood Vessels

- indirect effects of lung damage
  - increased load on heart and pulmonary circulation
  - enlargement and weakening of heart and blood vessels
- direct effects
  - inflammation or poisoning of blood, heart, or vessels

Effects on Skin and Eyes

- direct irritation
- allergic and other blood-mediated reactions

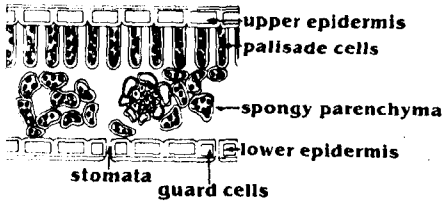
Effects on Body in General

- cancer
  - resulting from transport of pollutants in body
  - resulting from metastasis of lung cancer through lymphatic system

Vegetation Effects

- Target Systems
- Types of Damage

Target Systems



Types of Damage

- acute
- chronic
- adaptive

Abcission

Significance of Vegetation Damage

- visible damage may be *important*
  - ornamental plants
  - wild plants
- *damage may be diagnostic sign*
  - decrease/abnormality of growth of cash crop

Effects of the Criteria Pollutants

- suspended particulate matter
- sulfur dioxide
- carbon monoxide
- ozone
- nitrogen oxides
- hydrocarbons
- lead

Suspended Particulate Matter (TSP)

- physical damage to respiratory system
- *toxic, mutagenic, and carcinogenic damages*
- soiling
- reduction of open-air visibility

Sulfur Dioxide (SO_2)

- alone
  - increased resistance of airway, adding to heart-lung load
  - deterioration of metal and stone
- in synergism with fine particulate matter
  - carried deep into lungs, greatly aggravating other respiratory damages
- other
  - can produce acids and particulate sulfates

Carbon Monoxide (CO)

- directly toxic - ties up sites on hemoglobin molecules, resulting in hypoxia
- effects are usually acute and reversible
- high ambient levels may lead to diminished functioning

Ozone (O_3)

- irritates respiratory system
  - acute
  - chronic
- irritates eyes
- attacks materials
- impairs visibility

Nitrogen Oxides (NO_x)

- apparently are toxic at high levels (rare)
- contribute to bronchitis, pneumonia, and lowered infection resistance
- take part in O_3-producing cycle with hydrocarbons
- produce acids and particulate nitrates

Hydrocarbons (HC)

- take part in O_3-producing cycle
- have little direct health effect at ordinary ambient concentrations
- some may have toxic, mutagenic, or carcinogenic effects

Lead
(Pb)

- must consider routes of entry (to body) other than inhalation
- total lead concentrates in bones and soft tissues
- accumulated lead poisons the blood-forming, nervous, and renal systems
- especially damaging to children

Chapter 4

Air Pollution and the Law: The Clean Air Act

Lesson Goal

To familiarize you with constitutional, common-law, and statutory bases for governmental air pollution control organization and activity; to introduce the elements of the administrative regulatory and adjudicatory process, with its legal bases; and to familiarize you with the purposes and general structure of the Federal Clean Air Act.

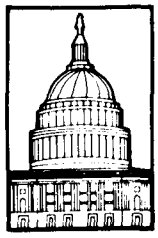
Lesson Objectives

Upon completion of this lesson, you should be able to:

1. describe what is meant by the terms constitutional law, common law, statutory law, administrative law, and enabling legislation, and identify how each influences air pollution control efforts.
2. identify the provisions of the U.S. Constitution which authorize Federal activity in the area of air pollution control.
3. identify the importance of the 4th, 5th, 10th, and 14th amendments to the U.S. Constitution in relation to air pollution programs.
4. recognize the relationship between the U.S. Constitution, Federal laws, State laws, and local laws pertaining to air pollution control.
5. describe the general structure of the Clean Air Act and identify the Federal publication in which the Act can be found.
6. name at least one nonauthoritative current source for information regarding the Act and for regulations implementing it.
7. identify a brief description of its major provisions when given a section number from Title I of the Clean Air Act.

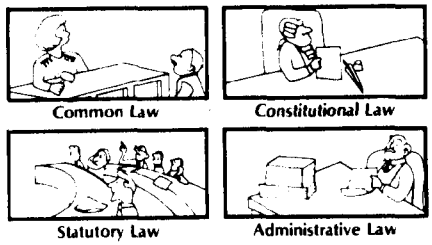
References

1. *Environment Reporter* (staff). 1979. EPA issues memorandum to Regions on post-*Barlow* inspection procedures. *Environ. Rep.* 9:2362-63 (April 20, 1979).
2. Grad, F. P. 1978. *Public Health Law Manual.* 1st ed., rev., 5th printing. Washington, DC: American Public Health Association, Inc., pp. 5-40, 76-107, 122-174 *passim,* 194-221.
3. Office of the Federal Register. 1980. *The Federal Register: What it is and how to use it.* Washington, DC: GPO.
4. Pritchett, C. H. 1971. *The American Constitutional System.* 3rd ed. New York: McGraw-Hill, pp. 1-84, 107-115.
5. Reed, J. C. 1979. Searches by Administrative agencies after *Barlow's* and *Tyler:* Fourth Amendment pitfalls and short-cuts. *Land & Water L. Rev.* 14:207-26.
6. U.S. Senate Comm. on Environment and Public Works. 1977. The Clean Air Act as amended August 1977. Serial No. 95-11. Washington, DC: GPO.
7. Weissberg, L. G. 1978. *Marshall v. Barlow's Inc.:* Are warrantless routine OSHA inspections a violation of the Fourth Amendment? *Environ. Affairs.* 6:423-47.

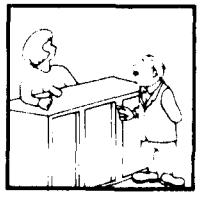


AIR POLLUTION AND THE LAW: The Clean Air Act

LEGAL BASES FOR AIR POLLUTION CONTROL REGULATIONS



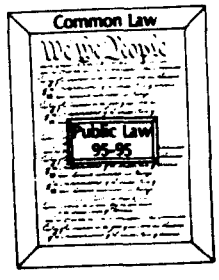
Common Law



- not enacted by legislature
- based on custom, usage
- grows from court rulings, findings, etc.

Significance of Common Law

- general system of principles from which other legal definitions/ideas evolve
- forms "frame" for constitutional and statute law



Common Law Principles Affecting Air Pollution Control

- right of person to use property as desired
- right of person to be secure in person and property
- reconciliation of conflict of rights
- right to sue for nuisance, trespass, or negligence

"Police Power"

- power of sovereign state to make/ enforce laws to protect public safety, health, and welfare
- inherent - accepted as a "given"
- violation is usually a crime

Constitutional Law

- based on provisions of a constitution
- U.S. Constitution
  - written
  - resistant to change

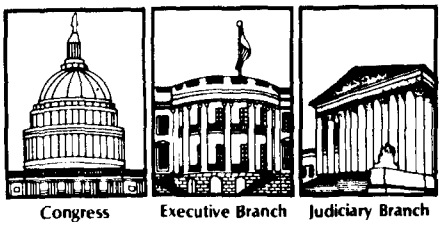
U.S. Constitution

- incorporates separation of powers
- consists of preamble, articles, amendments

Preamble

- gives basic purposes of Constitution
- helps interpret purpose of provisions

"Sneak Preview"



Congress	Executive Branch	Judiciary Branch
• makes the laws	• carries out the laws	• interprets the laws

ARTICLE I - Congress

Congress holds legislative power to:

- provide for the "general Welfare of the United States"
- regulate commerce among states
- make laws necessary to enforce the above powers

ARTICLE II - The Executive

- **power vested in President**
  - **structure of Executive Branch established by law**
  - **President has reorganization powers (subject to approval by Congress)**

ARTICLE III - The Judiciary

- Supreme Court
- other courts established by legislation (Congress)
- power to judge all cases

ARTICLE IV - The States and the Union

ARTICLE V - The Amending Process

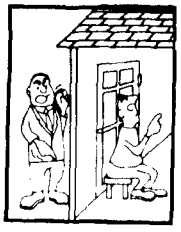
ARTICLE VI - Status of the Constitution (Supremacy Clause)

ARTICLE VII - Ratification

Protection of Rights

- **Bill of Rights - first ten amendments**
- **Fourteenth Amendment**

Fourth Amendment



- protection against unreasonable search and seizure
- probable cause, oath or affirmation, specific descriptions

Relevance to Air Pollution Control Inspections

- must not gain warrantless entry by threat
- agency rules/procedures must clearly set out reasons and methods for routine inspections
- if in doubt, obtain a warrant

Fifth Amendment

- is broad in scope
- protects against
  - double jeopardy
  - self-incrimination
- ensures due process of law
- limits taking of property

Ninth and Tenth Amendments

- ensure that constitutional rights do not abolish common-law rights
- principle of States' rights

Fourteenth Amendment

- creates "U.S. citizenship"
- prevents individual states from violating most Bill of Rights restrictions
- extends "due process" to States

State Constitutions

- framework for States' government and laws
- usually more detailed than U.S. Constitution
- often limit government power more than U.S. Constitution

Constitutional Rights Implementing

- **most constitutional provisions require further interpretation and mechanisms**
- often implemented via specific laws
- often implemented via enabling acts that delegate the power to make rules

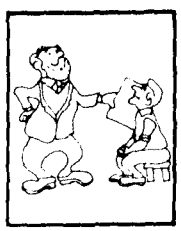
Administrative Law

- authority delegated through enabling legislation
- carried out through agencies, boards, commissions, etc.
  - expertise
  - timeliness

Significance to Air Pollution Control

- **most governmental control activity is through administrative agencies**
  - **national**
  - **state**
  - **local**

Administrative Procedure



- tells regulated parties what to do or not do (but due process rights are protected)
- provides procedural safeguards for rights
- most "informal" rule making governed by Administrative Procedure Act (Title 5, U.S. Code)

Rule Making

- "rules" are generally administrative regulations
- almost all air pollution control requirements come from administrative regulations

- procedural safeguards for due process rights
  - notice to affected parties
  - opportunity to prepare
  - opportunity to present positions
  - fair and properly recorded "hearing"
  - notice of final action

- substantive due process protection
  - certainty - must tell those regulated just what is necessary to avoid penalty
  - reasonableness
  - reasonable classification

Adjudication

- hearings
  - for permits
  - for enforcement - abatement order, administrative penalty
- fairly strict legal requirements
- reviews and appeals always available

Information on Administrative Action

Official Systems

- provide the notice required in rule making and adjudication
- vary in form
  - running record
  - code or compilation

- **Federal Register System**
  - basic means of proposing and promulgating Federal administrative regulations/ decisions
  - daily Federal Register
  - Code of Federal Regulations

- **daily Federal Register**
  - issued every working day
  - contains
    - proposed rules
    - rules and regulations
    - notices
    - proclamations, executive orders, etc.
  - 46 Fed. Reg. 9660 (Jan. 29, 1981)

- **Code of Federal Regulations**
  - annual compilation of all administrative regulations
  - organized by:
    - title
    - chapter subchapter (rarely referred to)
    - part
    - section
  - 40 CFR 50.1 (1980)

Information on Administrative Action

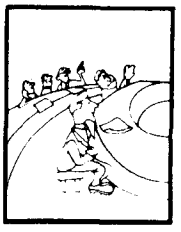
Unofficial Systems - "Services"

- Bureau of National Affairs (BNA)
  - Environment Reporter
  - Air Pollution Control
- Commerce Clearing House (CCH)
  - Pollution Control Guide

Content of Services

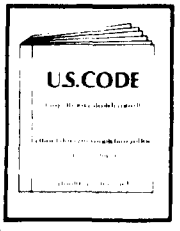
- current news
- Federal law
- Federal regulations
- State laws and regulations
- case reports
- indexes

The Clean Air Act



- statute law
- enabling law

CAA - where to find it



- TITLE 42 - Public Health and Welfare
- Sections 7401-7642
- 42 U.S.C.§§ 7401 et seq.

Other Places to Find CAA

- Statutes at Large
- Congressional publications
- services

CAA - General Organization

TITLE I - Air Pollution Prevention and Control (§101 - 178)

TITLE II - Emission Standards for Moving Sources (§201 - 234)

TITLE III - General (§301 - 327)

CAA - Major Provisions

- will discuss by title, part, and section
- brief discussion - overview

TITLE I (Stationary Sources)
Part A - Air Quality and Emission Limitations

§ 101 - Findings and Purposes
§ 105 - Grants for Support of Programs
§ 107 - Air Quality Control Regions
§ 108 - Air Quality Criteria and Control Techniques
§ 109 - National Ambient Air Quality Standards

TITLE I (Stationary Sources)
Part A - Air Quality and Emission Limitations (continued)

§ 110 - Implementation Plans
§ 111 - Standards of Performance for New Stationary Sources
§ 112 - National Emission Standards for Hazardous Pollutants
§ 113 - Federal Enforcement
§ 114 - Inspections, Monitoring, and Entry

TITLE I (Stationary Sources)

Part B - Ozone Protection §150-159
Part C - Prevention of Significant Deterioration § 160-169A
Part D - Nonattainment Area Plan Requirements § 171-178

TITLE II (Mobile Sources)

§ 201 - 234

TITLE III (General)

§ 303 - Emergency Powers
§ 304 - Citizen Suits
§ 307 - Administrative Proceedings and Judicial Review
§ 323 - National Commission on Air Quality

REVIEW

- **Legal Background**
  - Common Law
  - U.S. Constitution
- ***Administrative Law***
  - *administrative regulations with force of law*
  - *due process rights protected*
  - various sources of information available

REVIEW (continued)

- Clean Air Act
  - Federal statute
  - sets up U.S. air pollution control program
  - delegates administrative powers to EPA
  - primary control responsibility rests with State and local agencies
  - Federal involvement based on General Welfare and Commerce Clauses
  - basic approach is "air quality management"

Chapter 5

Factors Affecting Pollutant Dispersion

Lesson Goal

To familiarize you with (1) the factors that influence the wind, (2) the major meteorological factors of wind and turbulence, and (3) the relationship of stability to turbulence; and the effect of these on pollution dispersion.

Lesson Objectives

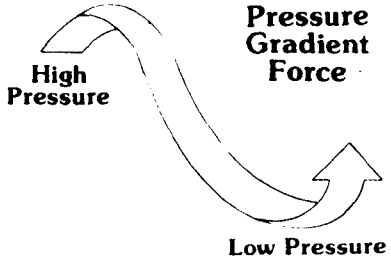
Upon completion of this lesson, you should be able to:

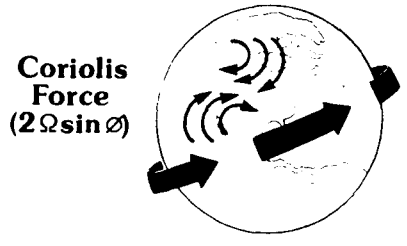
1. identify the four major meteorological factors that affect pollution dispersion.
2. describe the effect of each of the above meteorological factors on the pollution dispersion process.
3. identify three basic types of stability.
4. distinguish between the two types of turbulence and indicate the cause of each.

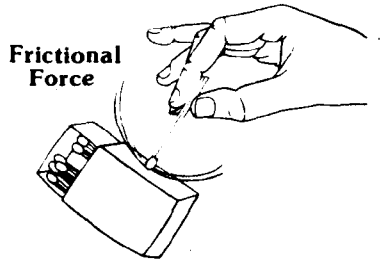
References

1. Byers, H. R. 1956. *General Meteorology*. New York: McGraw-Hill. pp. 511-520.
2. Donn, W. L. 1975. *Meteorology*. New York: McGraw-Hill. pp. 96-117, 160-213, 236-261.

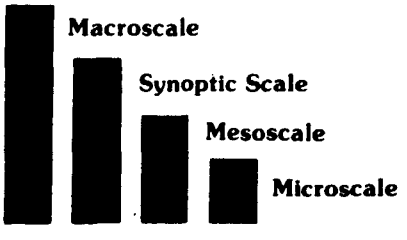
INTRODUCTION TO METEOROLOGY







Meteorological Scales of Motion



Microscale

vertical:
surface → ~100 m $\left(\frac{1}{10}\text{ km}\right)$
horizontal:
1 mm → 2 km

Mesoscale

vertical:
100 m → 2 km
horizontal:
2 km → 200 km

Synoptic Scale

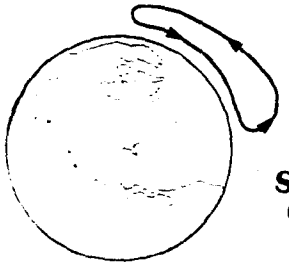
vertical:
200 m $\left(\frac{1}{5}\text{ km}\right)$ → 5 km

horizontal:
200 km → 1000 km

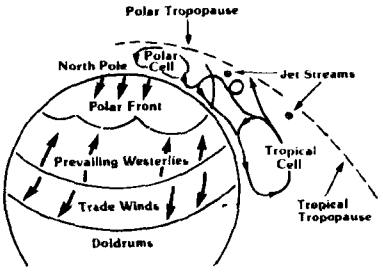
Macroscale

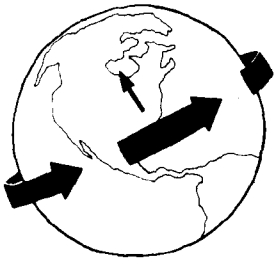
vertical:
300 m $\left(\sim\frac{1}{3}\text{ km}\right)$ → stratosphere

horizontal:
3000 km → planetary

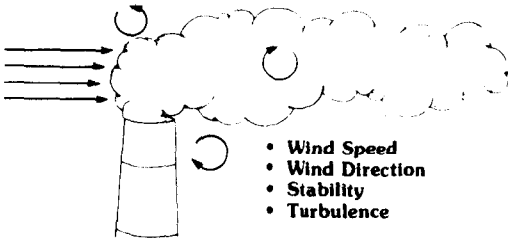


Single Cell





METEOROLOGICAL FACTORS AFFECTING DISPERSION



- Wind Speed
- Wind Direction
- Stability
- Turbulence

Wind Speed

5280' — mile

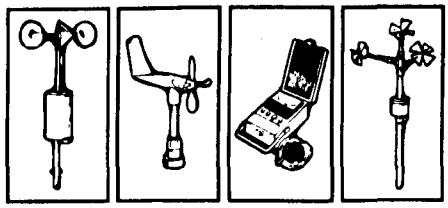
6080' — knot

3300' — kilometer

$c = \frac{1}{u}$ or Concentration = $\frac{1}{\text{Wind Speed}}$

- as wind speed increases, concentration of pollutant decreases proportionally

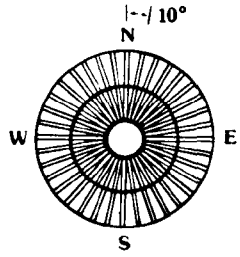
Wind Speed Instruments

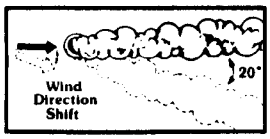


Cup Propeller Hot Wire UVW

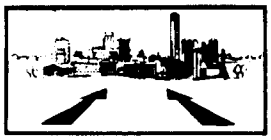
Wind Direction

36 point

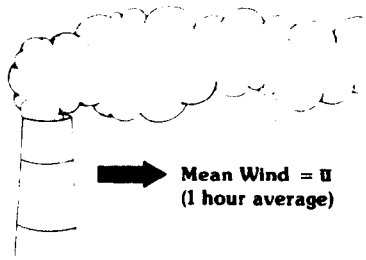




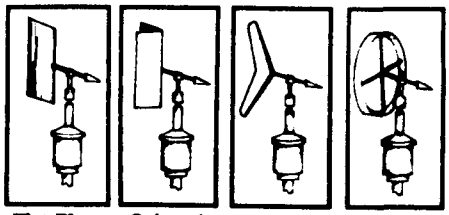
Point Source



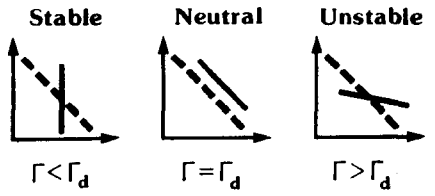
Area Source



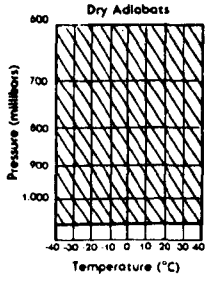
Wind Direction Instruments

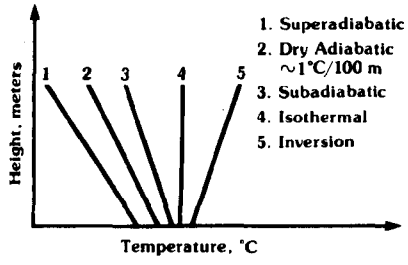


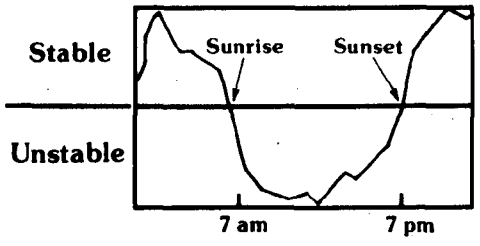
Flat Plate Vane Splayed Vane Airfoil Vane Bivane



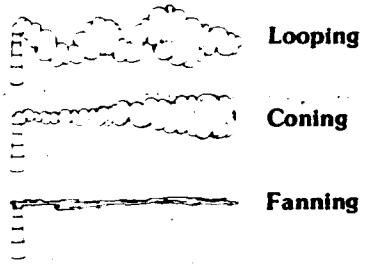
Γ = environmental lapse rate
Γ_d = dry adiabatic lapse rate



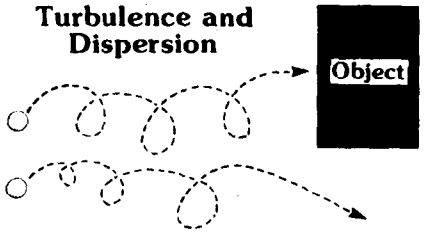




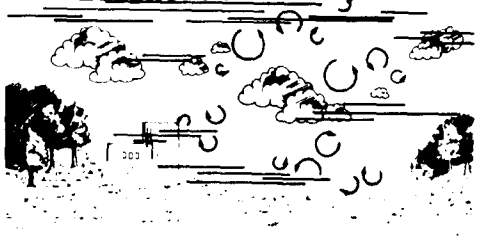
Plume Types



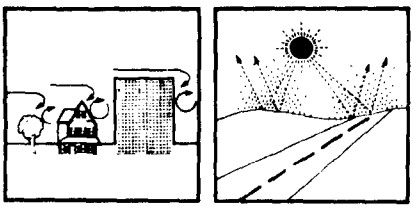
Turbulence and Dispersion



Locations of Turbulence

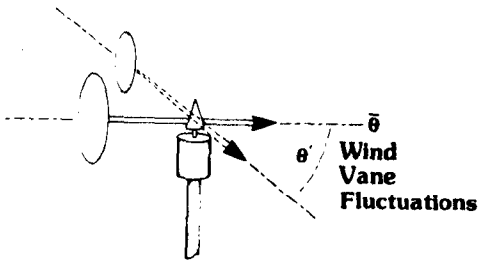


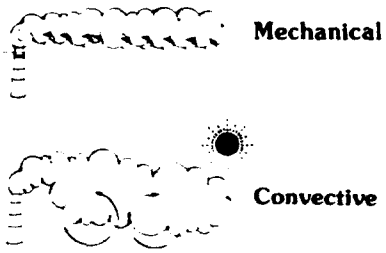
Turbulence

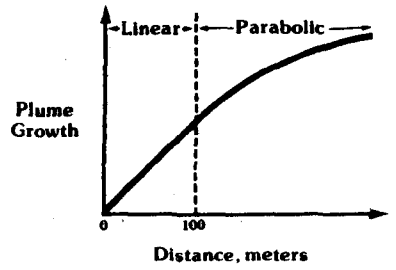


Geometric (Mechanical)

Thermal (Convective)






Linear
Parabolic
Plume Growth
0
100
Distance, meters

Chapter 6

Influence of Topography on Pollutant Dispersion

Lesson Goal

To familiarize you with the types of topography and the resulting influence of each type on pollution.

Lesson Objectives

Upon completion of this lesson, you should be able to:

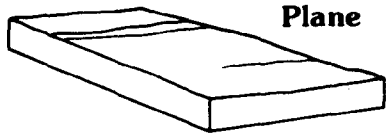
1. identify the four types of topographical shapes.
2. identify the basic effects that topography has on wind.
3. identify dispersion conditions given a specified meteorological situation over a land-water interface.

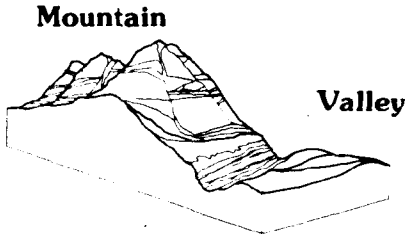
References

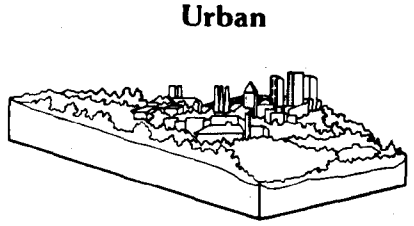
1. Slade, D. H., ed. 1968. *Meteorology and Atomic Energy 1968.* Oak Ridge, Tennessee: U.S. Atomic Energy Commission, Div. of Tech. Information. pp. 24-28.

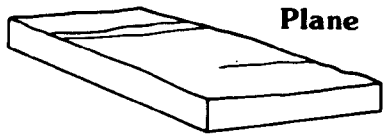
TOPOGRAPHY

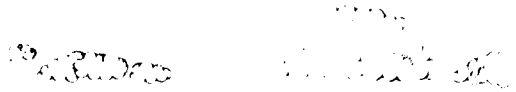
Land = 30% of earth's surface





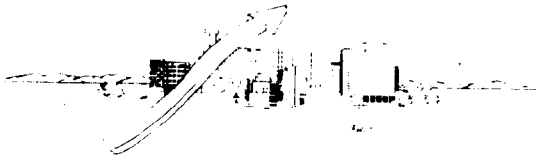






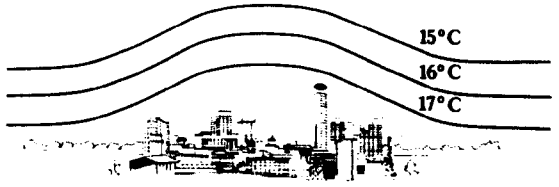
Roughness Factor

Roughness Factor

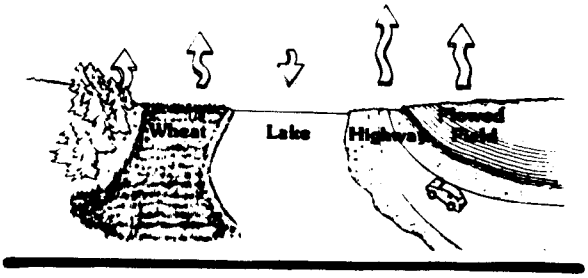


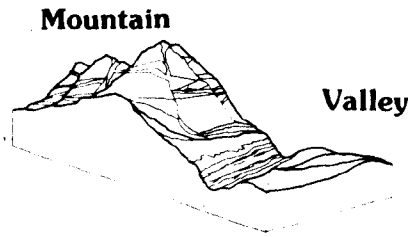
Stability: neutral to unstable

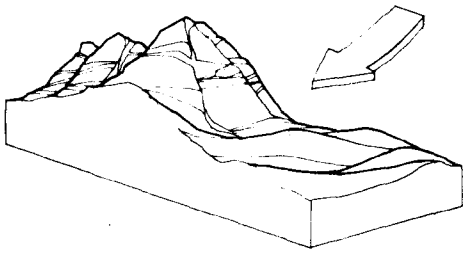
Geometric Effect

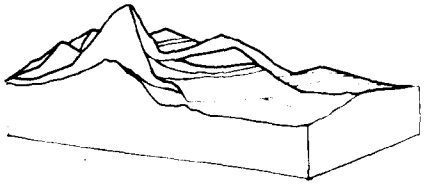


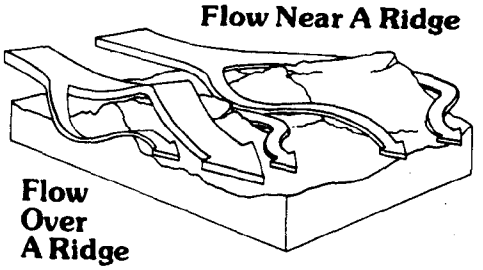
Thermal Effect

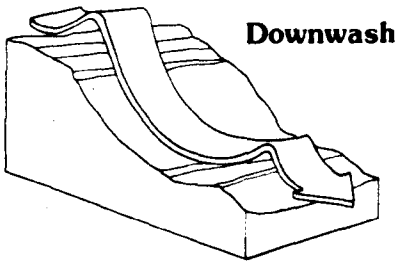


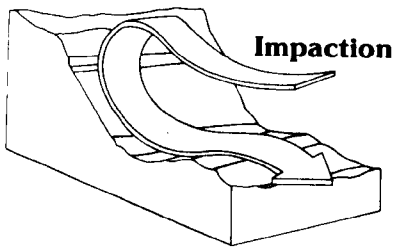

Mountain
Valley



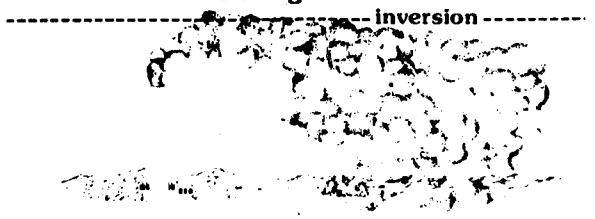


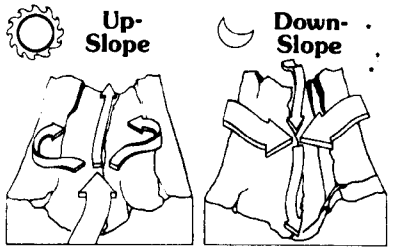

Flow Near A Ridge
Flow
Over
A Ridge

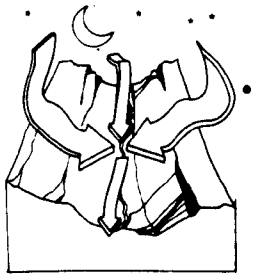

Downwash



Fumigation

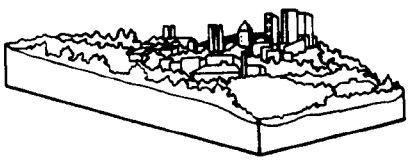






- air cools near surface causing denser air to sink along slopes

Urban



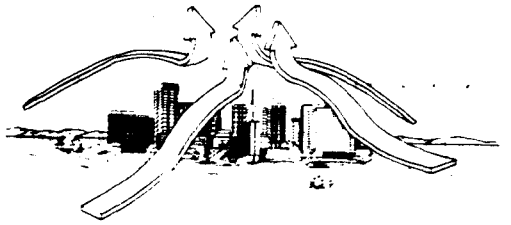
Roughness Factor

Stability: neutral to unstable

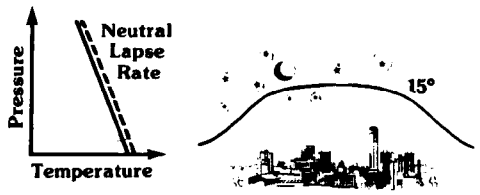
Point Source

Area Source

Geometric Effect

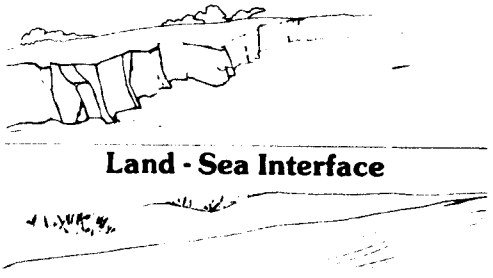


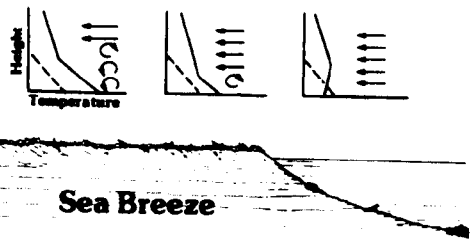
Thermal Effect

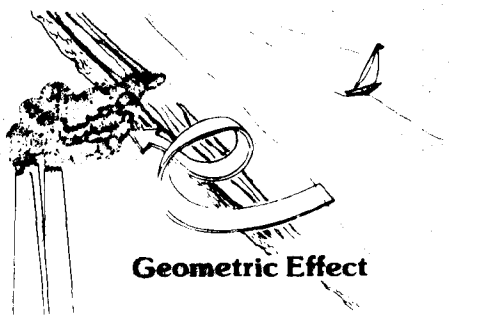


Thermal Effect

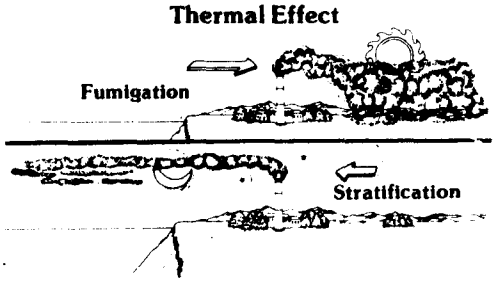
Land







Thermal Effect



Chapter 7

Air Pollution Sources and Source Regulations

Lesson Goal

To familiarize you with the terminology associated with standards and regulations set for stationary sources of air pollutants.

Lesson Objectives

Upon completion of this lesson, you should be able to:

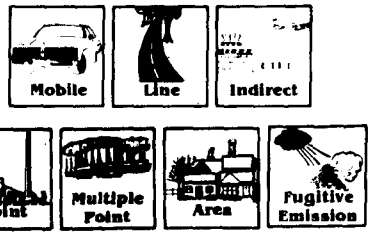
1. recall the terminology used by EPA in identifying sources of air pollution (such as *stationary, mobile, extended area,* and *fugitive emissions).*
2. list at least five types of regulations which deal with stationary sources.
3. define the acronyms BACT, RACT, NSPS, NSR, PSD, LAER, NESHAPs.
4. recognize at least four different types of standards used to regulate stationary sources.

References

1. U.S. Office of the Federal Register. 1981. *Code of Federal Regulations,* Title 40, Protection of Environment, Parts 53-80. Washington, DC: U.S. Government Printing Office.

AIR POLLUTION SOURCES AND SOURCE REGULATIONS

EXAMPLES OF SOURCE TYPES



Mobile Source

- transportation vehicle whose engine burns fossil fuel.

Line Source

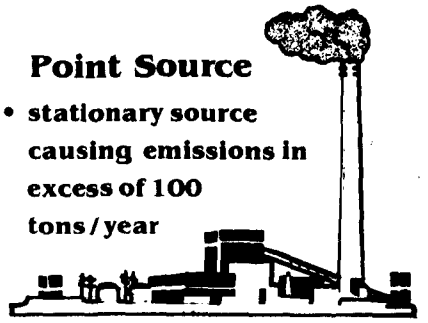
- continuous band where mobile source activity generates emissions

Indirect Source

- airport or federally funded streets and highways

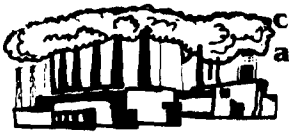
Point Source

- stationary source causing emissions in excess of 100 tons / year



Multiple Point Source

- stationary source having many emission points in a concentrated area



Area Source

- group of residential (or small commercial) installations causing emissions from combustion operations

Fugitive Emissions Source

- source whose emissions are generated by an external force acting on the source

REGULATIONS

Regulations must be:

- understandable
- fair
- enforceable
- attainable

PROGRAM ACRONYMS

SIP—State Implementation Plan

PSD—Prevention of Significant Deterioration

NSR—New Source Review

CONTROL TECHNOLOGY ACRONYMS

NSPS—New Source Performance Standards

BACT—Best Available Control Technology

RACT—Reasonably Available Control Technology

LAER—Lowest Achievable Emission Rate

SCS—Supplemental Control Strategy

NESHAPs—National Emission Standards for Hazardous Air Pollutants

REGULATIONS AFFECTING EXISTING SOURCES

Examples:

- SIP and RACT
- Federal, State and Local Permit Systems

RACT

Reasonably Available Control Technology

- reasonably available technology
- considers cost

REGULATIONS AFFECTING NEW SOURCE CONSTRUCTION

New Source Review (NSR)

- process for reviewing new sources
- source must comply with:
  - NSPS
  - PSD
  - Offset
  - BACT
  - LAER

NSPS

New Source Performance Standards

- promulgated for various source categories
- specify emission limitations
- can be found in CFR

BACT

Best Available Control Technology

- best technology available
- considers cost and energy requirements

PSD

Prevention of Significant Deterioration

- EPA policy applied to new sources in an attainment area

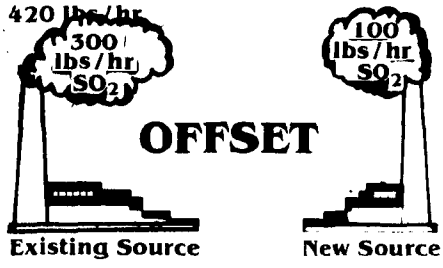
LAER

Lowest Achievable Emission Rate

- control devices to achieve lowest possible emission rate
- required for sources in non-attainment areas

Offset Policy

- required for new sources in non-attainment areas
- "trade-off" of emissions



TYPES OF SPECIFIC REGULATIONS

REGULATIONS SPECIFYING AN EMISSION STANDARD OR AN EMISSION LIMIT

For example:

- 1.2 lbs SO_2 / 10^6 Btu heat input
- 20% opacity

REGULATIONS SPECIFYING TYPES OF FUEL

For example:

- low sulfur coal
- coal / oil / natural gas

REGULATIONS SPECIFYING TYPES OR USE OF PROCESS EQUIPMENT

For example:

- low excess air or staged combustion to reduce NO_x emissions

REGULATIONS SPECIFYING USE OF CONTROL EQUIPMENT AND PERCENTAGE REDUCTION OF EMISSIONS

For example:

- flue gas desulfurization systems on power plants
- vapor recovery systems on petroleum storage tanks

REGULATIONS SPECIFYING THE CONTINUOUS MONITORING OF EMISSIONS AND OF CONTROL EQUIPMENT OPERATION

For example:

- SO_2 monitors on FFFSG's with FGD systems
- measurement of pressure drop across scrubbing system of a fertilizer facility

REGULATORY ENFORCEMENT AUTHORITY

- Section 114 of the Clean Air Act
- State Laws
  - entry, inspection, source testing
  - action during air pollution episodes

REGULATIONS LIMITING NUISANCE OCCURRENCES

For example:

- odor regulations
- dustfall

REGULATIONS DEFINING PROCEDURES FOR CONTROL AND MEASUREMENT OF HAZARDOUS AIR POLLUTANTS

For example:

NESHAPs for polyvinyl chloride reactors
is
.02 g vinyl chloride / kg polyvinyl chloride product

EMISSION STANDARDS FOR SOURCES

- Concentration of Stack Gas (Cs)
- Pollutant Mass Rate (PMR)
- Emission Rate (E)
- Process Weight Rate (E)
- Opacity—out-of-stack
- Opacity—in-stack

Concentration of Stack Gas (C_S)

Can be expressed in:

- ppm
- g/dscm
- gr/dscf

For example:

The NSPS for asphalt concrete plants
is

0.04 gr/dscf ↔ 90 mg/dscm

Pollutant Mass Rate (PMR)

Can be expressed in:

- lb/hr
- g/hr

$$PMR = \text{concentration} \times \text{stack gas volumetric flow rate}$$

$$= \frac{\text{lbs}}{\text{dscf}} \times \frac{\text{dscf}}{\text{hr}}$$

$$= \frac{\text{lbs}}{\text{hr}}$$

For example:

In Illinois the maximum emission rate for organic pollutants is

8 lbs / hr

Emission Rate
(E)

Can be expressed in:

- **lbs / 10^6 Btu heat input**
- **ng / Joule heat input**

$$E = \frac{\text{pollutant mass rate}}{\text{heat input rate}}$$

$$= \frac{\text{lbs/hr}}{10^6 \text{ Btu's/hr}}$$

$$= \frac{\text{lbs}}{10^6 \text{ Btu's}}$$

For example:

The NSPS emission rate for FFFSG is particulate emissions limited to 0.03 lb / 10^6 Btu .

Process Weight Rate
(E)

Can be expressed in:

- **lbs/tons of product**
- **kg/metric tons of product**

For example:

The NSPS for sulfuric acid plants
is
SO_2 emissions limited to 2 kg SO_2/metric ton H_2SO_4 produced.

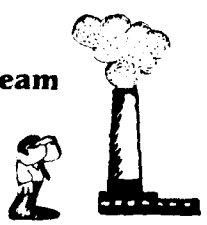
Opacity —out-of-stack

Is expressed in:

- **percent**

For example:

The NSPS for fossil fueled steam generators
is
20%



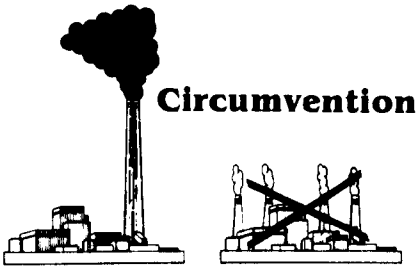
Opacity —in-stack

Is expressed in:

- **percent**

For example:

The California Bay area requirement is 20%.



Circumvention

RELATING SOURCE EMISSIONS TO AMBIENT AIR QUALITY

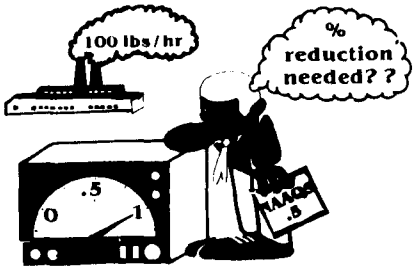
MODELING

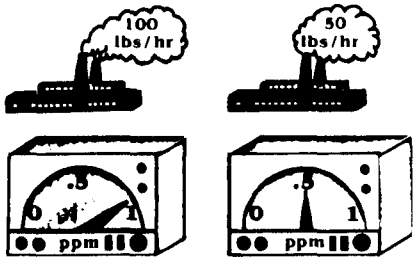
- Gaussian
- Simulation
- Statistical
- Empirical
  - EKMA
  - Rollback

ROLLBACK METHOD

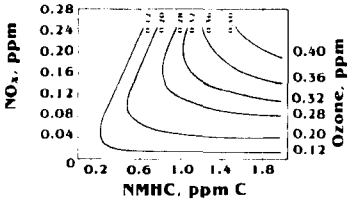
Determines:

- amount of source emissions reduction necessary to improve ambient air quality


100 lbs/hr
%
reduction
needed??
.5
0
1
.8


100
lbs/hr
50
lbs/hr
.5
0
1
ppm
.5
0
1
ppm

EKMA


0.28
0.24
0.20
0.16
0.12
0.08
0.04
0
NOx, ppm
0.40
0.36
0.32
0.28
0.20
0.12
Ozone, ppm
0.2
0.6
1.0
1.4
1.8
NMHC, ppm C

Chapter 8

Measurement of Source Pollutant Emissions

Lesson Goal

To familiarize you with the Federal Reference Methods for source testing and the EPA continuous monitoring program.

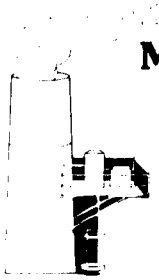
Lesson Objectives

Upon completion of this lesson, you should be able to:

1. recognize the procedures necessary for manual sampling from an exhaust stack of an industrial source.
2. explain the purpose of manuals and continuous monitoring and the uses of data obtained.
3. relate the uses of Reference Methods 1-4 to the other Reference Methods.
4. explain how Reference Methods 5 and 6 are performed.
5. identify the pollutants measured by Reference Methods 5-8.
6. briefly describe Reference Method 9 for plume opacity determination.
7. distinguish between extractive and in situ continuous emission monitoring systems.

References

1. U.S. Office of the Federal Register. 1981, *Code of Federal Regulations,* Title 40, Protection of Environment, Parts 53-80. Washington, DC: U.S. Government Printing Office.



MEASUREMENT OF SOURCE POLLUTANT EMISSIONS

METHODS FOR MEASURING EMISSIONS

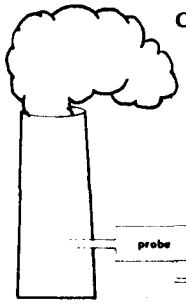
- Manual Sampling
- Visual Emissions Observation
- Continuous Monitoring
  - extractive
  - in-situ
- Remote Sensing

MANUAL SAMPLING

- *extract samples* from various points in stack
- *analyze* samples in *off-site* lab
- procedures described by *reference methods*

VISUAL EMISSION OBSERVATION

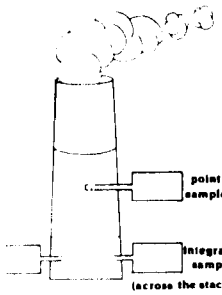
- reads opacity across the plume



CONTINUOUS MONITORING OF SOURCE EMISSIONS

Extractive Method

- *continuously extract* samples from various points in stack
- continuously *analyze* samples *on-site*



CONTINUOUS MONITORING OF SOURCE EMISSIONS

In-situ Method

- *monitor* sits *in stack*
- no sample extraction
- *continuous point or integrated samples*
- *continuous analysis* by monitor

REMOTE SENSING

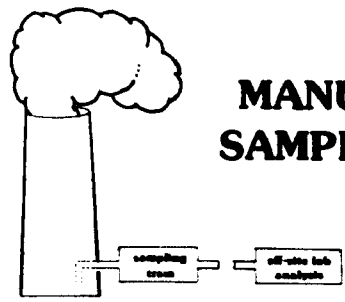
- *monitor* at *ground level* — some distance from stack
- *no* sample *extraction*
- *point or integrated* samples
- *on-site analysis* by the device

USES OF DATA OBTAINED

- Manual Sampling
  - to determine compliance status
- VE Observation
  - to determine compliance status

USES OF DATA OBTAINED (continued)

- Continuous Monitoring
  - to meet NSPS requirements
  - to determine compliance status (Bay Area only)
- Remote Sensing
  - to determine compliance status (possibly in future)



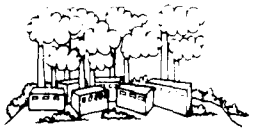
MANUAL SAMPLING

STEPS IN PROCEDURE

- identification of problem
- obtaining entry and cooperation
- conducting pre-survey
- designing experiment
- final preparation
- actual sampling

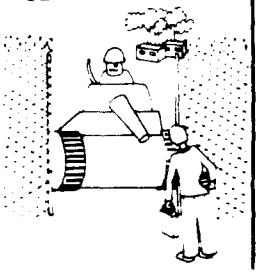
STEPS IN PROCEDURE (continued)

- cleanup after sampling
- handling of sample
- analysis of sample
- reporting results

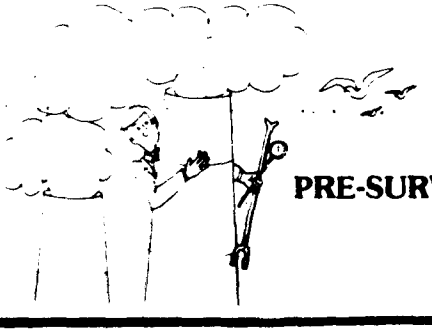


IDENTIFY PROBLEM

OBTAIN ENTRY



AND COOPERATION

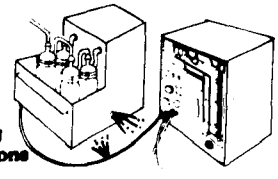


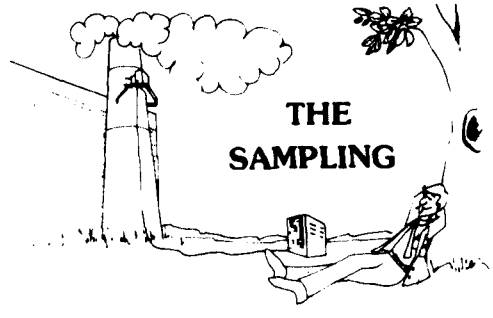
PRE-SURVEY

DESIGN EXPERIMENT

FINAL PREPARATIONS

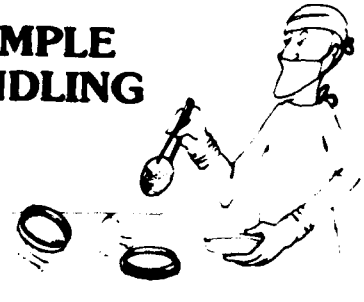
- leak check
- calibration
- correct temperature
- meet regulations
- process operating at normal conditions



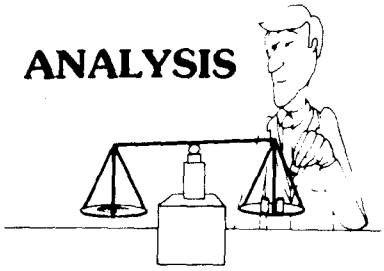


SAMPLE CLEANUP

SAMPLE HANDLING



ANALYSIS



THE REPORT

EPA REFERENCE METHODS

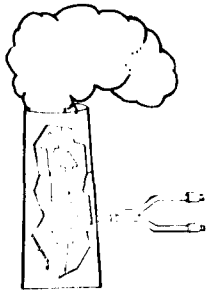
- used for source compliance testing
- describe actual testing procedure
- found in *Code of Federal Regulations*

REFERENCE METHODS 1 THROUGH 4

- used in all other reference methods
- used to determine:
  - number of sampling ports (RM 1)
  - stack gas velocity (RM 2)
  - stack gas molecular weight (RM 3)
  - stack gas moisture content (RM 4)

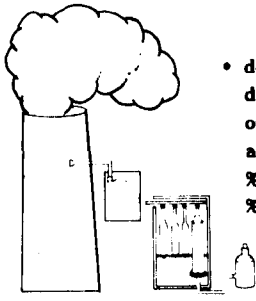
EPA RM 1

- **selection of traverse points**



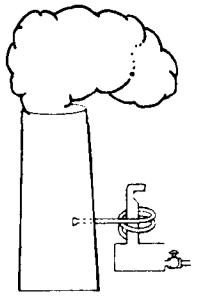
EPA RM 2

- determination of stack gas velocity and volumetric flow rate (using s-type pitot tube)



EPA RM 3

- determination of the dry molecular weight of flue gas (using orsat apparatus measuring % O_2, % CO_2, and % CO)



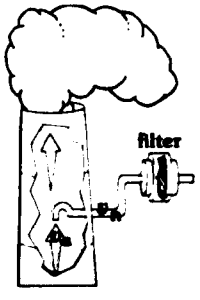
EPA RM 4

- determination of moisture content of stack gas (by condensation method)

REFERENCE METHODS 5 and 6

- describe measurement procedures for particulate matter and SO_2

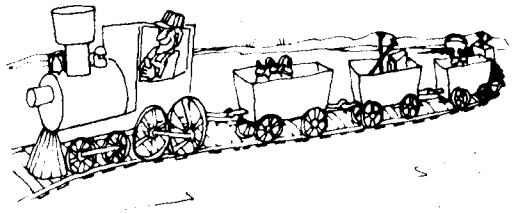
Every state has set emission limits for these two criteria pollutants.

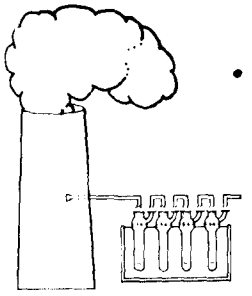


EPA RM 5

- sampling method for particulate matter (isokinetic collection of particles on a filter)

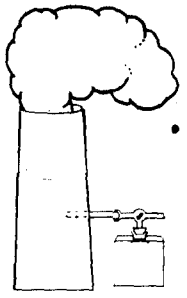
$$v_n = v_s$$





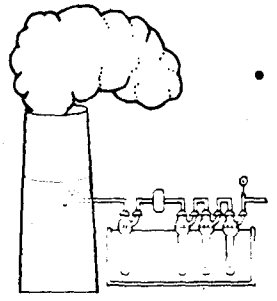
EPA RM 6

- sampling and analytic method for determining SO_2 emissions (barium-thorin titration)



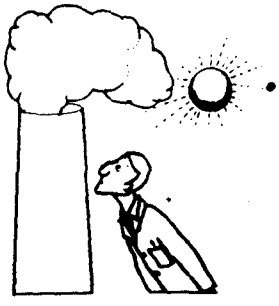
EPA RM 7

- determination of NO_x emissions (colorimetric phenoldisulfonic acid method)



EPA RM 8

- determination of H_2SO_4 mist and SO_2 emissions (intended for H_2SO_4 plants)



EPA RM 9

- determination of stack plume opacity (by visual observation)

Method 10 - Determination of CO

Method 11 - Determination of H_2S

Method 13 and 14 - Determination of Fluorides

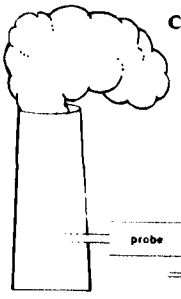
Method 15 - Determination of H_2S, COS, CS_2

Method 16 - Determination of Total Reduced Sulfur

Method 17 - Determination of Particulates (in-stack filtration method)

CONTINUOUS MONITORING OF SOURCE EMISSIONS

- **extractive**
- **in-situ**



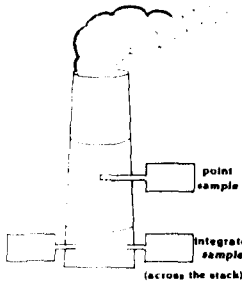
CONTINUOUS MONITORING OF SOURCE EMISSIONS

Extractive Method

- *continuously extract* samples from various points in stack
- continuously *analyze* samples *on-site*

EXTRACTIVE CONTINUOUS MONITORS MEASURE:

- **gaseous emissions**



CONTINUOUS MONITORING OF SOURCE EMISSIONS

In-situ Method

- *monitor* sits *in stack*
- no sample extraction
- *continuous point or integrated samples*
- *continuous analysis* by monitor

IN-SITU CONTINUOUS MONITORS MEASURE:

- **gaseous emissions**
- **opacity**

REMOTE SENSING DEVICES

REMOTE SENSING

- *monitor* at *ground level* — some distance from stack
- no sample extraction
- *point or integrated* samples
- *on-site analysis* by the *device*

REMOTE SENSING DEVICES MEASURE:

- **gaseous emissions**
- **opacity**

- Manual Sampling
  - reference methods
- Visual Emissions Observation
- Continuous Monitoring
  - *extractive*
  - in-situ
- Remote Sensing

Chapter 9

Ambient Air Quality Monitoring

Lesson Goal

To familiarize you with ambient air quality monitoring techniques, considerations, and regulations.

Lesson Objectives

Upon completion of this lesson, you should be able to:

1. list at least six possible objectives of ambient air quality monitoring.
2. describe an ambient air monitoring network including its major subsystems.
3. distinguish between a reference and an equivalent measurement method.
4. describe the reference method or the measurement principle and calibration procedure currently specified by EPA for each criteria pollutant.
5. explain the purpose, findings, and recommendations of the Standing Air Monitoring Work Group (SAMWG).
6. briefly outline the contents of the 40 CFR 58 air monitoring regulations.

References

1. U.S. Environmental Protection Agency (EPA). 1977. *Air Monitoring Strategy for State Implementation Plans*. EPA 450/2-77-010.
2. U.S. Environmental Protection Agency (EPA). *Ambient Air Quality Monitoring, Data Reporting, and Surveillance Provisions*. 40 CFR 58 (July 1980).
3. U.S. Environmental Protection Agency (EPA). *National Primary and Secondary Air Quality Standards*. 40 CFR 50, App. A-G (July 1980).

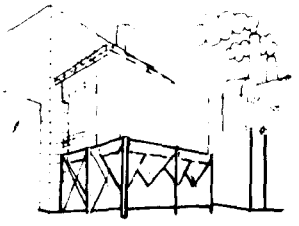
AMBIENT AIR QUALITY MONITORING

AMBIENT AIR QUALITY MONITORING OBJECTIVES

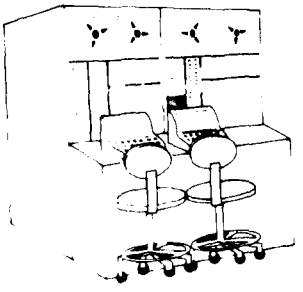
- Determine whether NAAQS have been met
- Evaluate progress toward attainment of NAAQS
- Develop or revise SIPs

- Review impact of new sources

- Establish baseline AQ levels for PSD

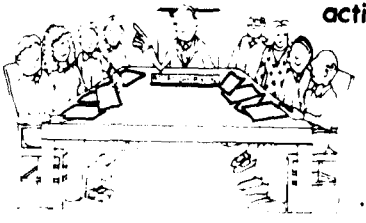


- **Develop control policies**

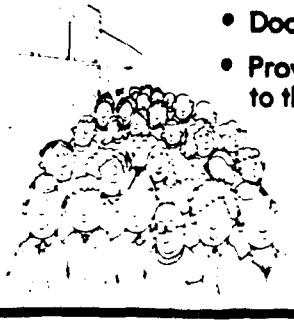


- **Develop models**

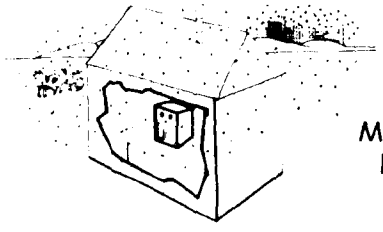
- *Support enforcement actions*



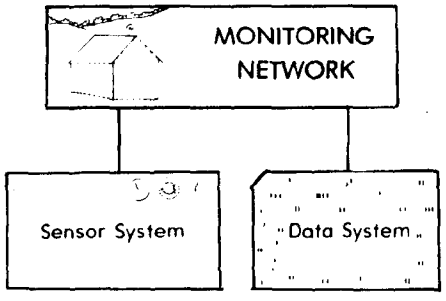
- Document episode and initiate controls

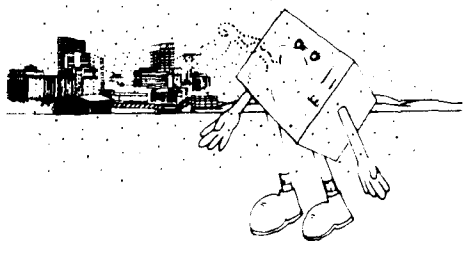


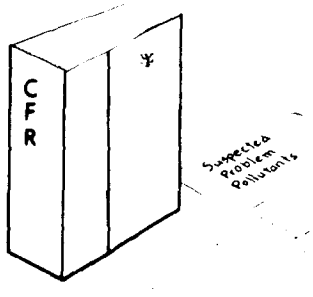
- **Document exposure**
- **Provide information to the public**



AMBIENT
AIR
QUALITY
MONITORING
NETWORK
DESIGN







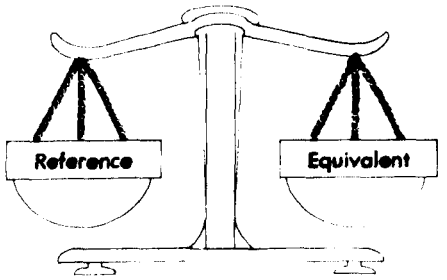
SPECIFICATION OF MONITORING METHODS

State/Local Regulations

- **State/Local Measurement Method**

SIPs

- **EPA Reference or Equivalent Methods**



Both carry the same weight under the law!

EPA Specified Measurement Method

Manual Reference Method

- two part written (cookbook) procedure

Automated Reference Method

- designated instrument which:
  - must use written measurement principle
  - must use written calibration procedure

Reference Methods

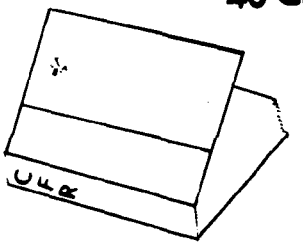
Manual

- only one per pollutant

Automated

- may be many per pollutant

40 CFR 50



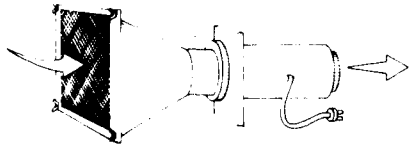
Pollutants and Their Reference Methods

Pollutant	Method	
TSP	Manual	High Volume Sampler
LEAD	Manual	High Volume Sampler with Atomic Absorption Analysis

Pollutant	Method	
SO_2	Manual	Pararosaniline Method
O_3	Automated	MP: Chemiluminescence with Ethylene
		CP: Ultraviolet Photometry
NMHC	Automated	MP: Gas Chromatography with Flame Ionization Detector
		CP: Calibration Gases

Pollutant	Method	
NO_2	Automated	MP: Chemiluminescence with Ozone
		CP: Gas Phase Titration of an NO Standard with Ozone or NO_2 Permeation Device
CO	Automated	MP: Nondispersive Infrared Spectrometry
		CP: Calibration Gases

TOTAL SUSPENDED PARTICULATE MATTER (TSP)



High Volume (Hi-Vol) Sampler

Calculations for TSP Using Hi-Vol Sampler

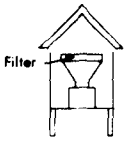
$$TSP = \frac{mass_{final} - mass_{initial}}{\left(\frac{Q_{initial} + Q_{final}}{2}\right) \times \Theta} \times 10^6$$

mass = mass of filter, (g)
Q = flow rate, (m^3/min)
Θ = elapsed sampling time, (min)
10^6 = conversion factor, (g to μg)

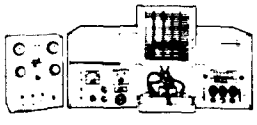
Potential Sources of Error

- nonuniform decreases in flow rate
- artifact formation
- hygroscopic particles

LEAD



HIGH VOLUME SAMPLER



ATOMIC ABSORPTION SPECTROPHOTOMETER

Potential Sources of Error

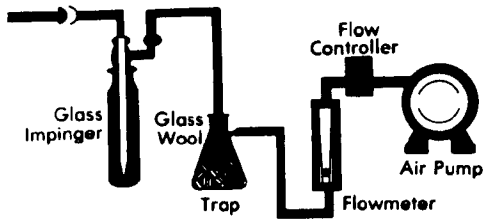
- sampling near roadways
- lead content variation among filters

SULFUR DIOXIDE (SO_2)

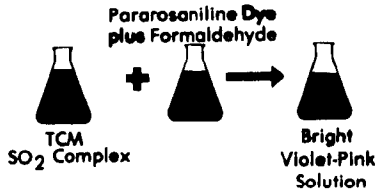
Collection

Reaction

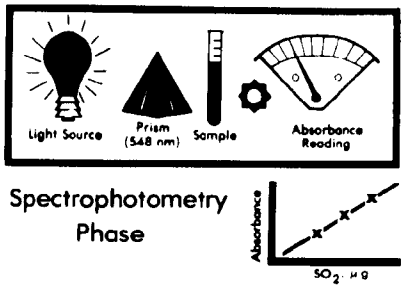
Spectrophotometry



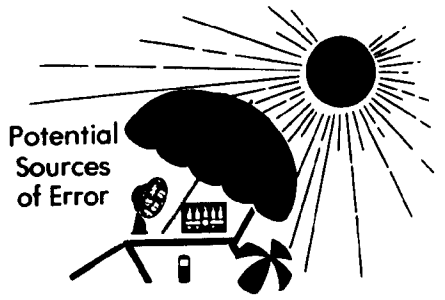
Collection Phase



Reaction Phase



Spectrophotometry
Phase



Potassium
Tetra Chloro Mercurate

K_2HgCl_4

OZONE (O_3)
Automated Method

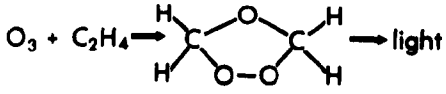
- **Measurement Principle**

MP

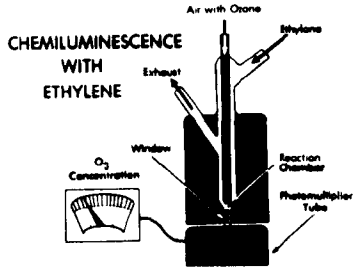
- **Calibration Procedure**

CP

Measurement Principle



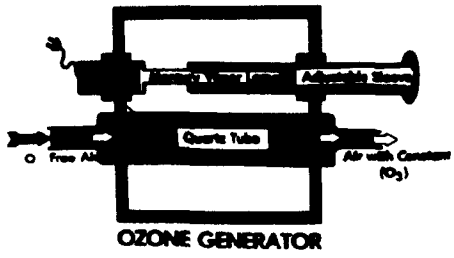
Ozone + Ethylene ⟶ Ozonide ⟶ light
(highly unstable) (420 nm)



Potential Source of Error

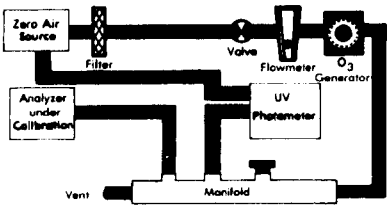
- **H_2O**

Calibration Procedure



OZONE GENERATOR

ULTRAVIOLET (UV)
PHOTOMETRY CALIBRATION



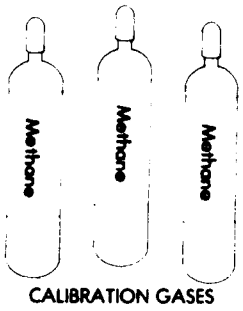
NONMETHANE HYDROCARBONS (NMHC)

Automated Method

- Measurement Principle
  MP
- Calibration Procedure
  CP

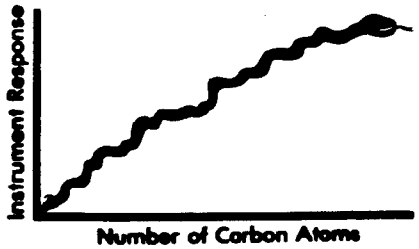
Measurement Principle

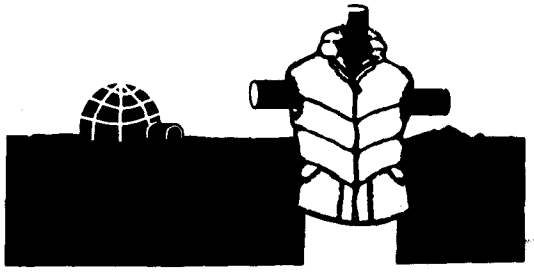
GAS CHROMATOGRAPHY USING FLAME IONIZATION DETECTOR

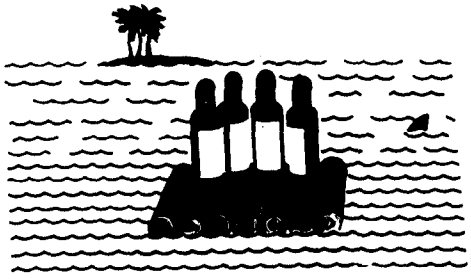


Calibration Procedure

Nonlinear FID Response







NITROGEN DIOXIDE (NO_2)
Automated Method

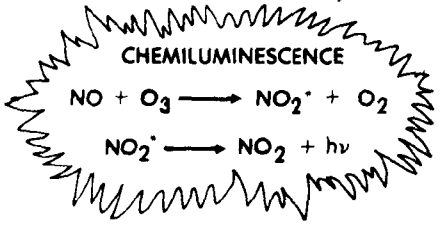
- Measurement Principle

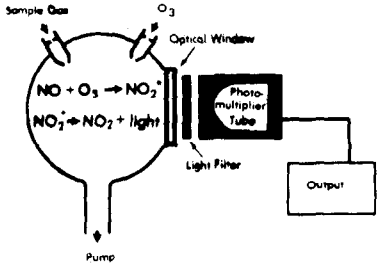
MP

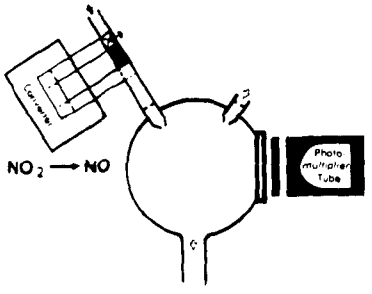
- Calibration Procedures

CP

Measurement Principle







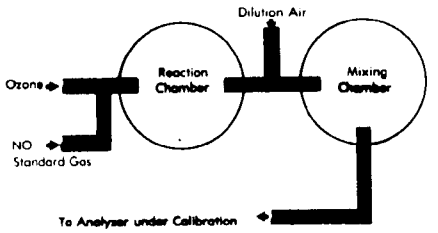
$$[NO_2] = [NO_x] - [NO]$$

Calibration Procedures

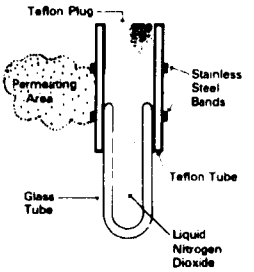
- ALTERNATIVE A: Rapid Gas Phase Titration
- ALTERNATIVE B: NO_2 Permeation System

$$NO + O_3 \longrightarrow NO_2 + O_2$$

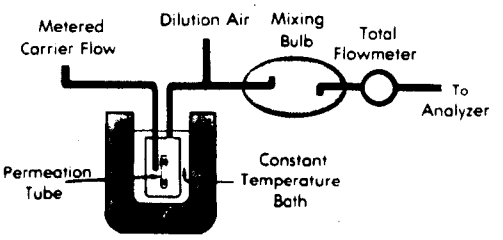
NO_2 GPT CALIBRATION SETUP



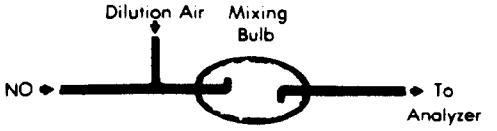
NO_2 PERMEATION TUBE



PERMEATION SYSTEM



NO AND NO_x RESPONSES



Potential Source of Error

- PAN

CARBON MONOXIDE (CO) Automated Method

- Measurement Principle

MP

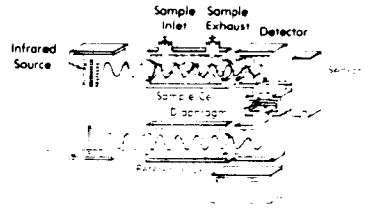
- Calibration Procedure

CP

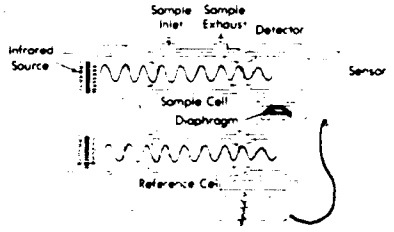
Measurement Principle

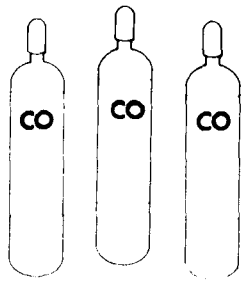
NONDISPERSIVE
INFRARED SPECTROMETRY

NDIR ANALYZER FOR CO



NDIR ANALYZER FOR CO





CALIBRATION GASES

Calibration Procedure

Potential Sources of Error

- CO_2
- H_2O
- Hydrocarbons

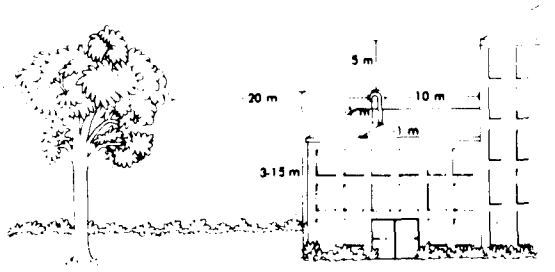
List of Reference/Equivalent Methods

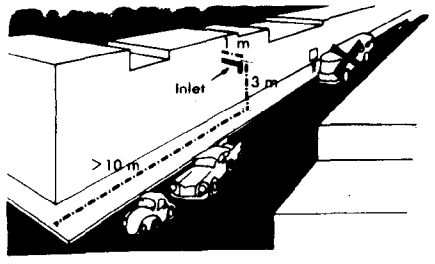
Available from:

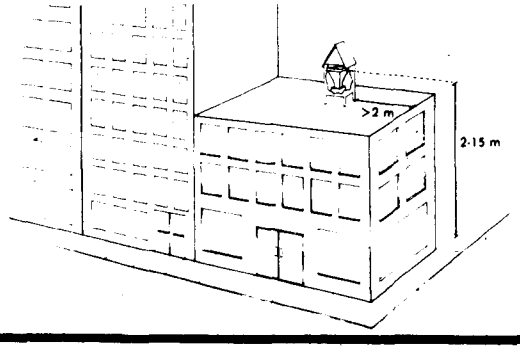
US EPA
Office of Research and Development
EMSL
Research Triangle Park,
North Carolina 27711

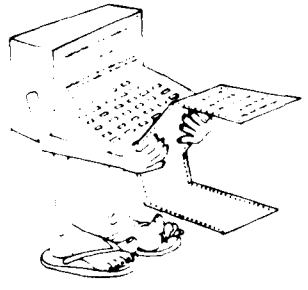
Siting Approach

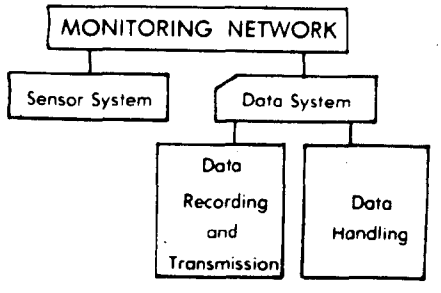
- Define purpose of site
- Assemble site selection information
- Determine general siting area
- Establish final site characteristics


5 m
20 m
10 m
1 m
3-15 m

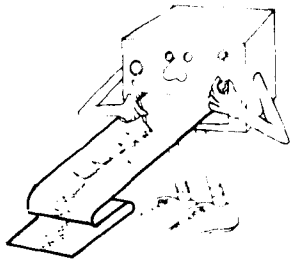

1 m
Inlet
3 m
> 10 m


>2 m
2-15 m

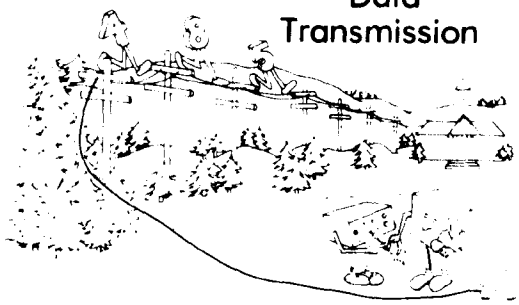



MONITORING NETWORK
Sensor System
Data System
Data Recording and Transmission
Data Handling

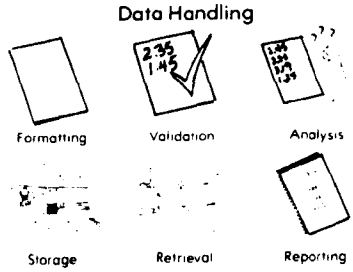
Data Recording



Data Transmission



Data Handling



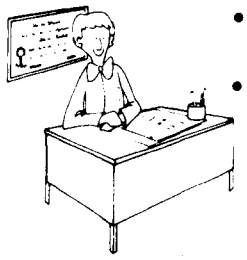
Format

- clear
- understandable
- well documented
- interchangeable

Aerometric and Emissions Reporting System (AEROS)

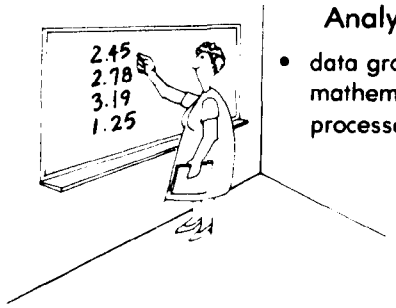
- source data
- emissions data
- air quality data - SAROAD

Validation



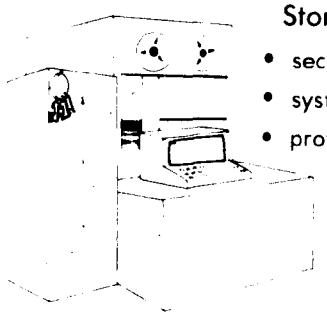
- performed by air pollution professional
- ensures quality

Analysis



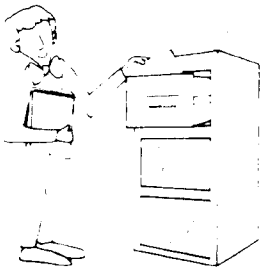
- data grouped or mathematically processed

Storage



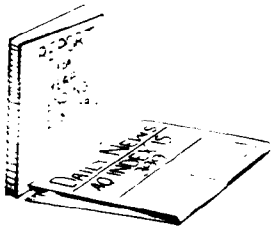
- secure
- systematic
- protective

Retrieval



- easy access for authorized personnel

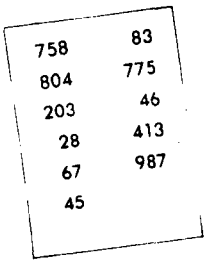
Reporting



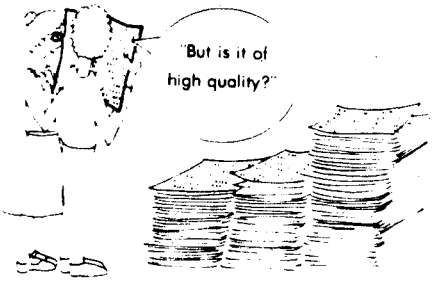
- periodic data reports
- daily public reports

Air Quality Data Handling System (AQDHS-II)

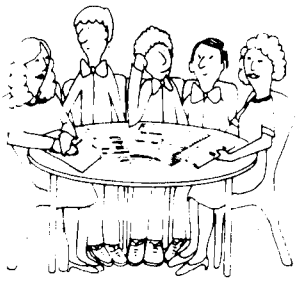
- stores, analyzes, and retrieves air quality data
- prepares EPA-required reports



QUALITY ASSURANCE PROGRAMS



US EPA
Environmental Monitoring Systems Laboratory
Quality Assurance Division
MD-77
Research Triangle Park, North Carolina 27711



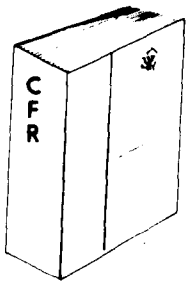
STANDING
AIR
MONITORING
WORK GROUP
(SAMWG)

Major Findings

- inappropriate monitor siting
- questionable data quality
- lack of monitoring activities coordination
- inflexible SIP regulations

SAMWG Recommendations

- Improve data quality by:
  - formal quality assurance programs
  - uniform monitor siting
  - uniform monitoring methodology
- Improve timely submittal of data
- Improve cost effectiveness of monitoring
- Improve monitoring program's responsiveness to data needs



40 CFR 58

40 CFR 58

- air quality monitoring requirements for SIP networks
- quality assurance requirements for PSD networks

Monitoring Stations

SLAMS	State and Local Air Monitoring Stations
NAMS	National Air Monitoring Stations
SPMS	Special Purpose Monitoring Stations

Chapter 10

Control of Particulate Emissions from Stationary Sources

Lesson Goal

To familiarize you with common methods used to control particulate emissions from stationary sources.

Lesson Objectives

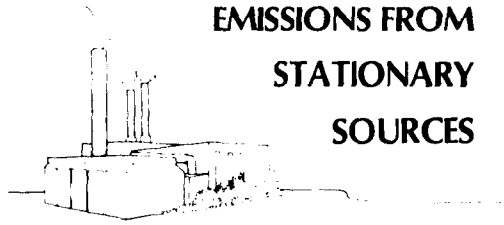
Upon completion of this lesson, you should be able to:

1. distinguish between methods of controlling emissions that require a control device and those which do not require one in the control of pollutant emissions.
2. list the types of devices used to control particulate emissions.
3. discuss the influence of particle size and composition on collection efficiency.
4. recognize the structure of settling chambers and cyclones and briefly describe how they collect particulate matter.
5. recognize the structure of wet collectors used to control particulate matter and briefly describe their operation.
6. recognize the structure of electrostatic precipitators and briefly describe their operation.
7. recognize the structure of fabric filtration systems (baghouses), briefly describe their operation, and list at least three methods of bag cleaning.

References

1. U.S. Environmental Protection Agency (EPA). 1980. *APTI Course 413 Control of Particulate Emissions,* Student Manual. EPA 450/2-80-066.

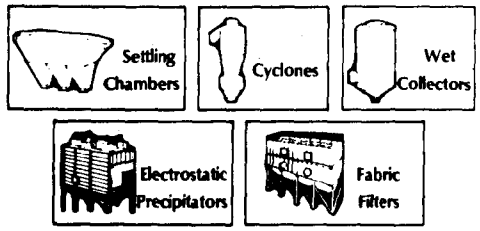
CONTROL OF PARTICULATE EMISSIONS FROM STATIONARY SOURCES



REDUCING PARTICULATE EMISSIONS

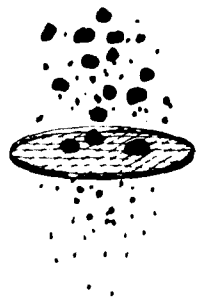
- substituting fuel, process, material, or equipment
- regulating the location of sources
- using control devices

PARTICULATE EMISSIONS CONTROL DEVICES

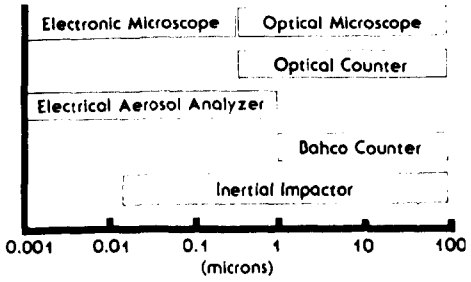


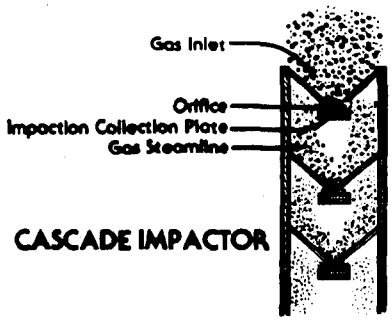
EVALUATING CONTROL DEVICES

- particle sizing

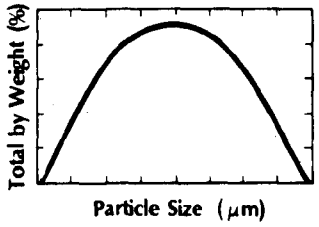


PARTICLE SIZING





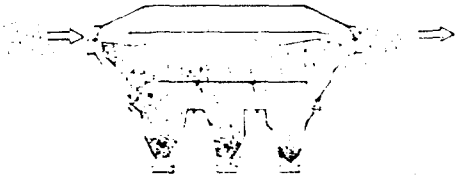
FREQUENCY DISTRIBUTION CURVE



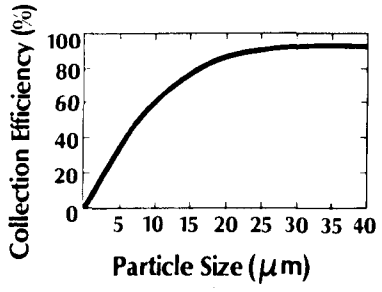
EVALUATING CONTROL DEVICES

- particle sizing
- collection efficiency

COLLECTION EFFICIENCY



high efficiency for large particles
low efficiency for small particles



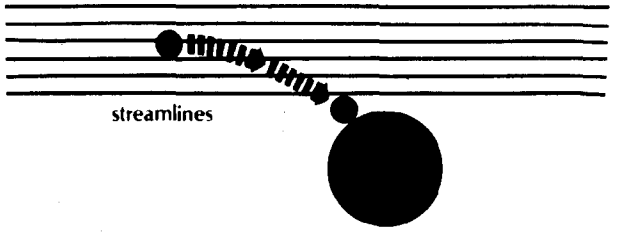
EVALUATING CONTROL DEVICES

- particle sizing
- collection efficiency
- pressure drop
- space requirement
- initial cost
- operating cost

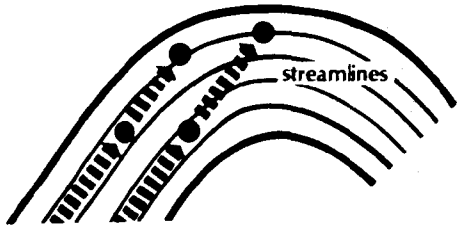
COLLECTION FORCES

- gravity
- centrifugal force
- impaction
- direct interception
- diffusion
- electrostatic attraction

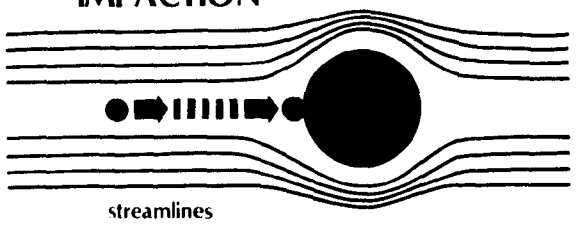
GRAVITY



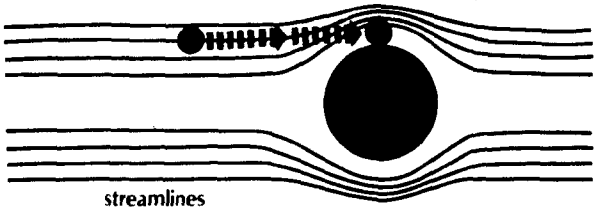
CENTRIFUGAL FORCE



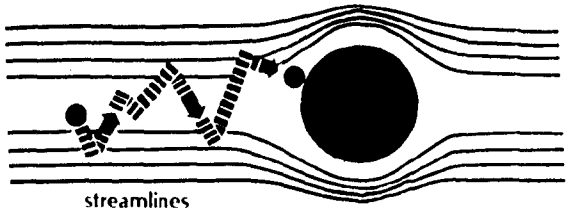
IMPACTION



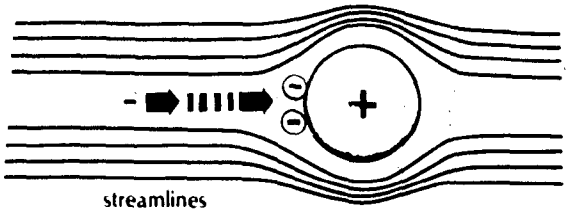
DIRECT INTERCEPTION



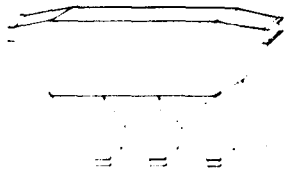
DIFFUSION



ELECTROSTATIC ATTRACTION



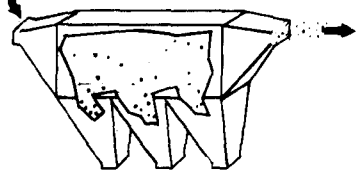
SETTLING CHAMBERS

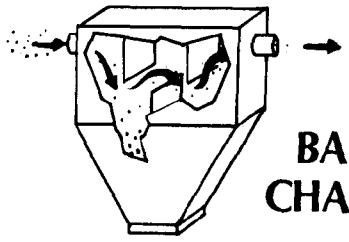


Collection Force

- gravity

SETTLING CHAMBER





BAFFLE CHAMBER

SETTLING CHAMBERS
Advantages

- inexpensive to purchase
- economical to operate

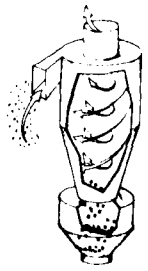
SETTLING CHAMBERS
Disadvantage

- high efficiency limited to particles $> 60 \mu m$

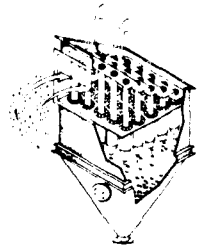
CYCLONES

Collection Forces

- centrifugal force
- gravity



SINGLE CYCLONE



MULTIPLE CYCLONE

CYCLONES
Advantages

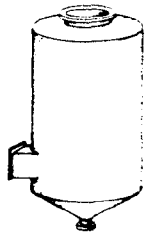
- relatively inexpensive to purchase
- relatively economical to operate

CYCLONES
Disadvantages

Single Cyclone
- high efficiency limited to particles $> 20\mu m$

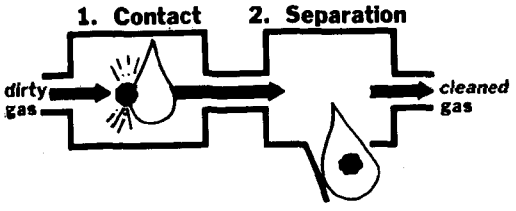
Multiple Cyclone
- high efficiency limited to particles $> 5 - 10\mu m$

WET COLLECTORS
Scrubbers



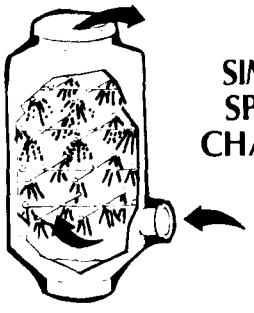
Collection Forces
- impaction
- diffusion
- direct interception

ZONES

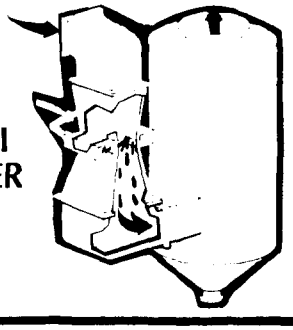


WET COLLECTORS

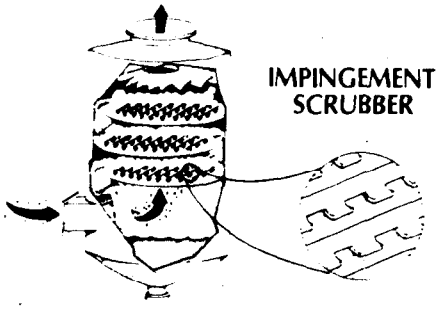
- Spray Towers
- Venturi Scrubbers
- Impingement Plate Scrubbers
- Cyclonic Spray Scrubbers



SIMPLE SPRAY CHAMBER



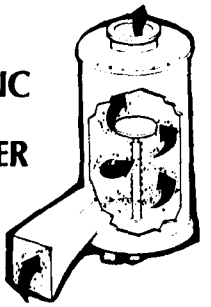
SPRAY VENTURI SCRUBBER



IMPINGEMENT SCRUBBER

DETAIL OF A BAFFLE PLATE

CYCLONIC SPRAY SCRUBBER

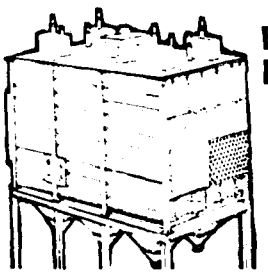


WET COLLECTORS
Advantages

- no secondary dust sources
- small space requirements
- gas collection as well as particle collection
- handles gas streams of high humidity and temperature
- minimal fire and explosion hazard

WET COLLECTORS
Disadvantages

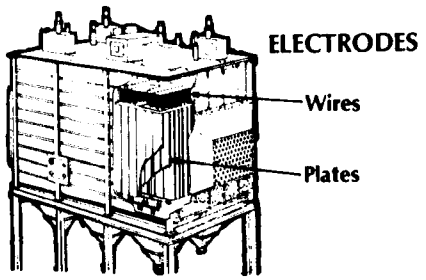
- corrosion problems
- meteorological problems
- high pressure drops and power requirements for increased efficiency
- difficulty of by-product recovery

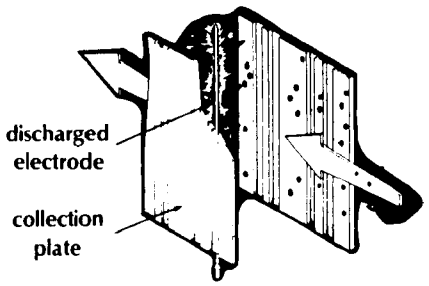


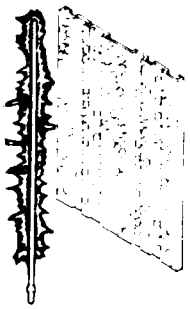
ELECTROSTATIC PRECIPITATORS

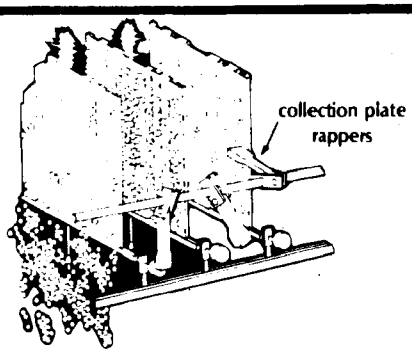
Collection Force

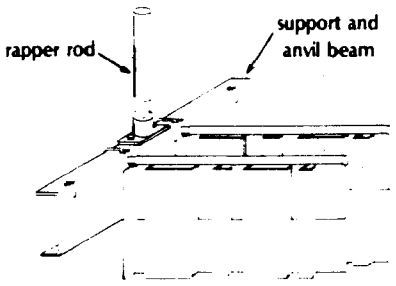
- electrostatic attraction

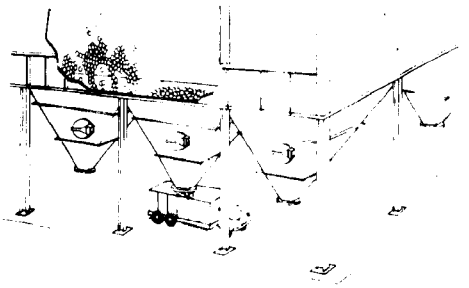

ELECTRODES
Wires
Plates


discharged electrode
collection plate




collection plate rappers


rapper rod
support and anvil beam



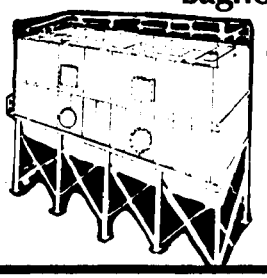
ELECTROSTATIC PRECIPITATORS
Advantages

- can treat large volumes of gas
- high collection efficiency (99%)
- good for high-temperature use
- economical to operate

ELECTROSTATIC PRECIPITATORS
Disadvantages

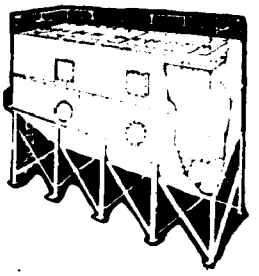
- expensive to purchase
- require a great deal of space
- cannot use around explosive dust

FABRIC FILTERS
Baghouses



Collection Forces

- impaction
- direct interception
- diffusion
- slight electrostatic attraction

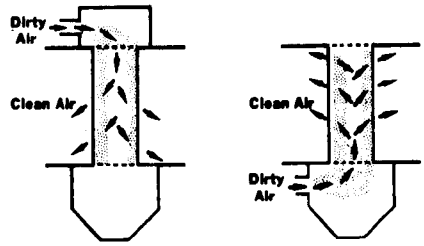


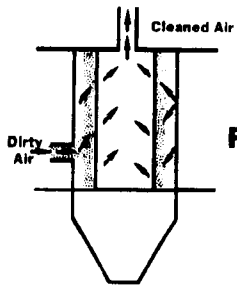
BAGHOUSE

FABRIC FILTER DESIGNS

- Interior Filtration
  - top feed
  - bottom feed
- Exterior Filtration

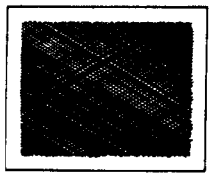
INTERIOR FILTRATION





EXTERIOR FILTRATION

FILTER MATERIAL



- woven

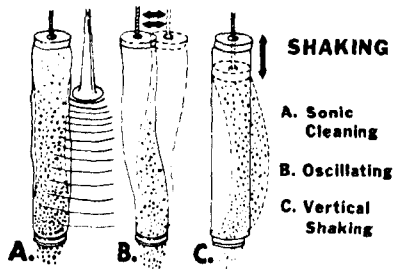
- felt

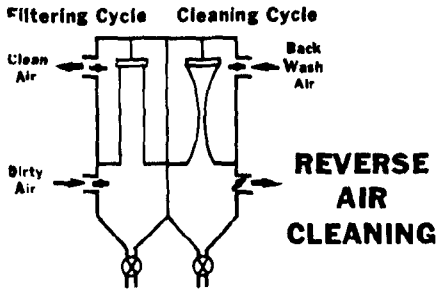
TYPES OF FIBERS

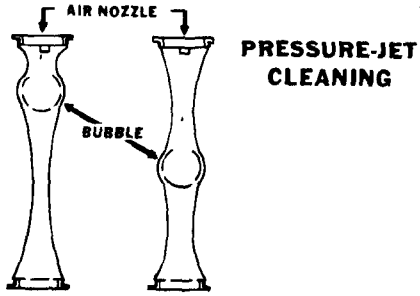
- wool
- cotton
- nylon
- Dacron
- Nomex
- Teflon
- Fiberglas

TYPE OF CLEANING

- Shaking
- Reverse Air Cleaning
- Pressure Jet - Pulse Jet







FABRIC FILTERS
Baghouses

Advantages

- very high collection efficiency
- product collected is dry

FABRIC FILTERS
Baghouses

Disadvantages

- require a great deal of space
- have temperature limitations
- operation and maintenance is expensive

Chapter 11

Control of Gaseous Emissions from Stationary Sources

Lesson Goal

To familiarize you with methods of controlling gaseous emissions.

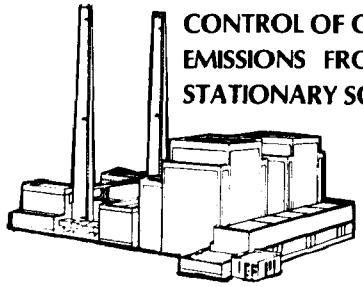
Lesson Objectives

Upon completion of this lesson, you should be able to:

1. distinguish between common control methods for gaseous emissions from combustion sources and those used in process industries.
2. briefly describe absorption, adsorption, condensation, and combustion.
3. define the acronym FGD.
4. name two types of processes for removal of SO_2 from a gas stream.
5. recognize three nonregenerable FGD processes.
6. recognize three regenerable FGD processes.
7. list four combustion modification processes used to reduce NO_x emissions from combustion sources.
8. recognize two flue gas treatment processes used to reduce NO_x emissions from combustion sources.

References

1. U.S. Environmental Protection Agency (EPA). 1981. *APTI Course 415 Control of Gaseous Emissions,* Student Manual. EPA 450/2-81-005.



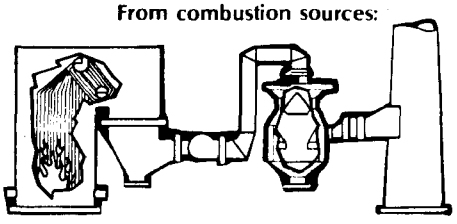
CONTROL OF GASEOUS EMISSIONS FROM STATIONARY SOURCES

Control of gaseous emissions from:

- combustion sources
- process industry sources

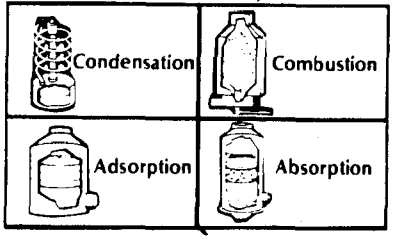
CONTROL OF GASEOUS EMISSIONS

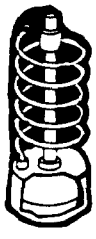
From combustion sources:



CONTROL OF GASEOUS EMISSIONS

From process industry sources:



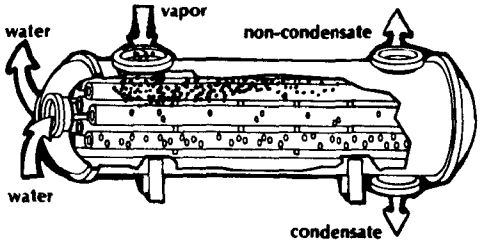


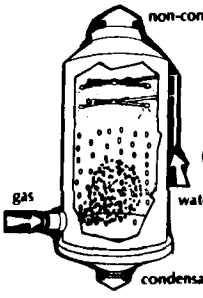
CONDENSATION

TYPES OF CONDENSERS

- Surface Condensers
- Contact Condensers

SHELL-AND-TUBE CONDENSER

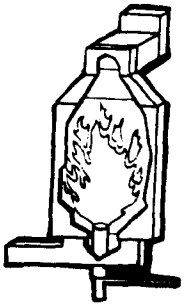




SPRAY TYPE CONTACT CONDENSER

TYPICAL APPLICATIONS

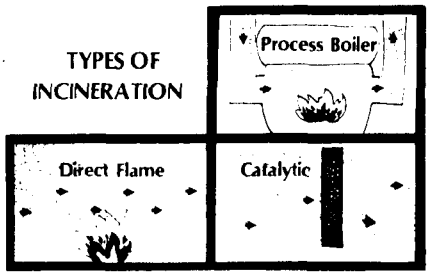
- rendering plants
- vapor degreasing operations
- petrochemical industries



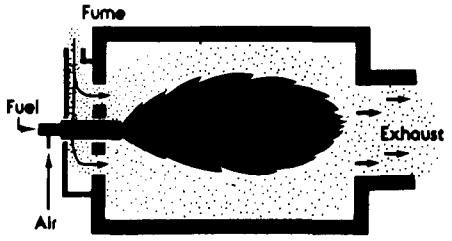
COMBUSTION

- Incineration
- Thermal Oxidation
- Afterburning

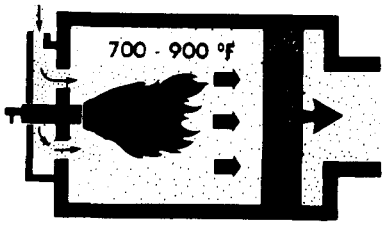
TYPES OF INCINERATION



DIRECT FLAME INCINERATION

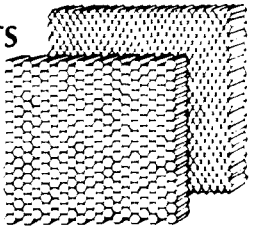


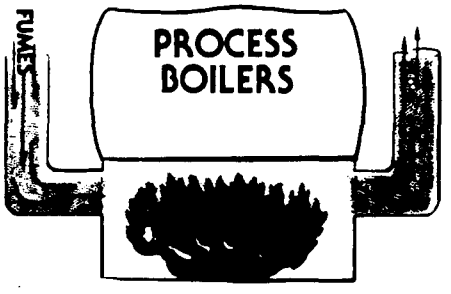
CATALYTIC INCINERATION



TYPICAL CATALYSTS

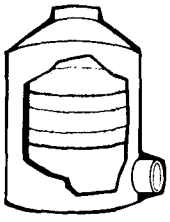
- platinum, palladium
- various shapes



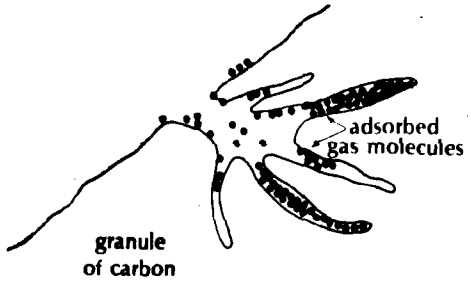


TYPICAL APPLICATIONS

- coating operations
- paint baking ovens
- printing operations
- petroleum refineries

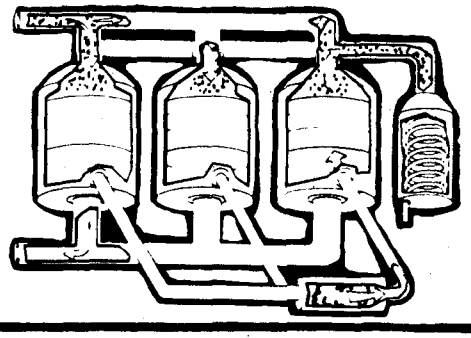


ADSORPTION



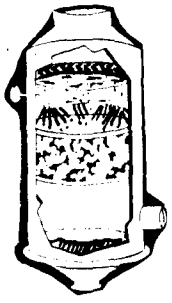
MATERIALS USED FOR ADSORPTION

- activated carbon
- silica gels
- molecular sieves



TYPICAL APPLICATIONS

- coating operations
- dry cleaning operations
- plastic manufacturing
- vapor recovery systems



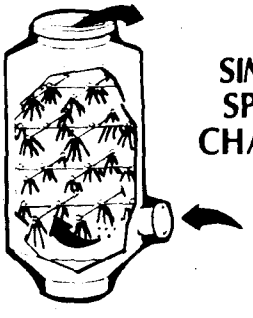
ABSORPTION

FACTORS AFFECTING ABSORPTION

- temperature
- pressure
- solubility
- reaction

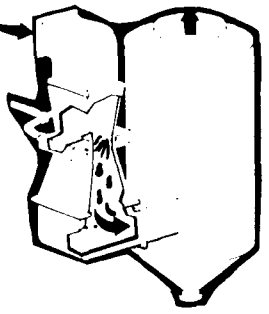
ABSORPTION EQUIPMENT

- Spray Chambers
- Venturi Scrubbers
- Packed Towers
- Cross Flow Scrubbers

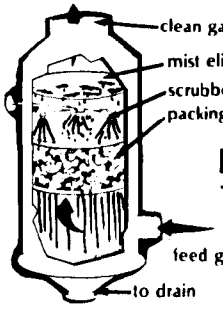


SIMPLE SPRAY CHAMBER

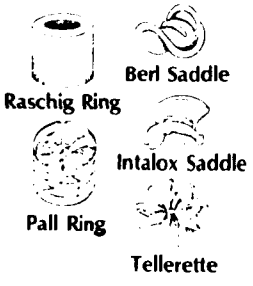
SPRAY VENTURI SCRUBBER



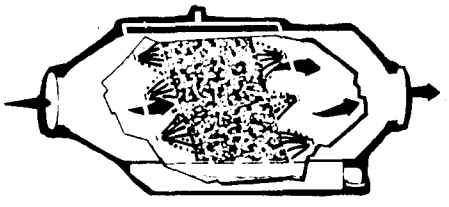
PACKED TOWER



COMMON TOWER PACKING MATERIALS



CROSS FLOW SCRUBBER

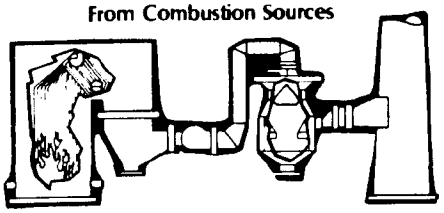


TYPICAL APPLICATIONS

- acid manufacturing
- pickling operations
- Claus Tail Gas operations
- Flue Gas Desulfurization

REDUCTION OF SO_2 EMISSIONS

From Combustion Sources



Flue Gas Desulfurization (FGD)

New Sources after September 1978

- liquid gaseous fuel — 0.8 lb/10^6 Btu
  or 340 ng/J
  and 90% scrubbing

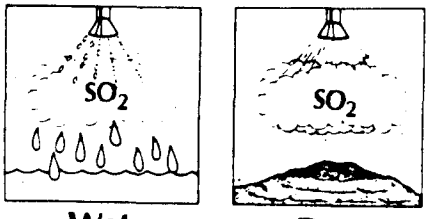
(If below 0.2 lb/10^6 Btu, or 86 ng/J,
then no scrubbing required)

New Sources after September 1978
(continued)

- solid fuel — 1.2 lb/10^6 Btu
  or 520 ng/J
  and 90% scrubbing

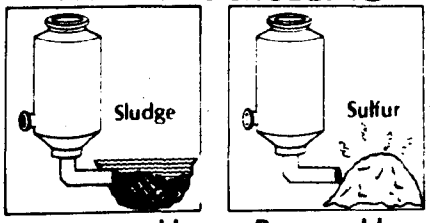
  — 0.6 lb/10^6 Btu
  or 260 ng/J
  and 70% scrubbing

FGD SCRUBBING



Wet Dry

WET FGD SCRUBBING



Nonregenerable Regenerable

TYPICAL FGD SCRUBBER EQUIPMENT

- Spray Chambers
- Venturi Scrubbers
- Packed Towers
- Cross Flow Scrubbers

SO_2 REDUCTIONS

- Wet Scrubbing—at least 90%
- Dry Scrubbing—at least 75-85%

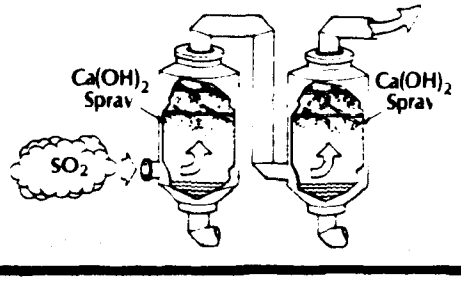
NONREGENERABLE PROCESSES

- Lime Scrubbing
- Limestone Scrubbing
- Double Alkali Scrubbing

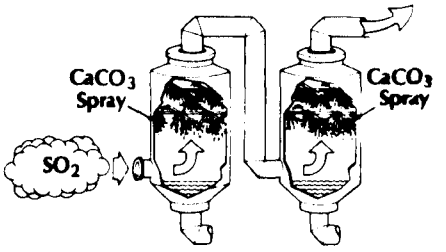
SCRUBBER WASTE DISPOSAL

- Ponding
- Mine Disposal

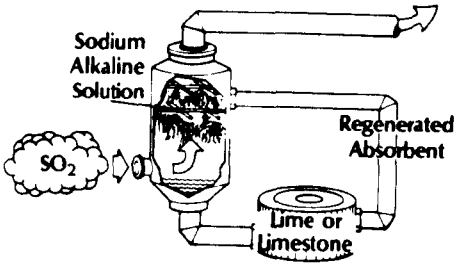
LIME SCRUBBING



LIMESTONE SCRUBBING



DOUBLE ALKALI SCRUBBING



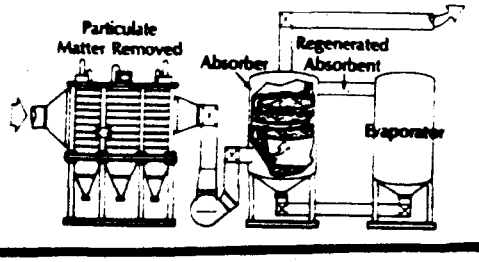
REGENERABLE PROCESSES

- Wellman-Lord/Allied Chemical
- Citrate
- Magnesium Oxide

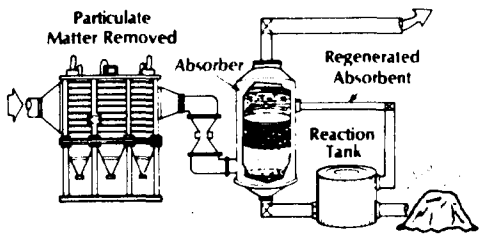
TYPICAL REGENERATION PRODUCTS

- Sulfur
- Sulfuric Acid
- Gypsum Wallboard

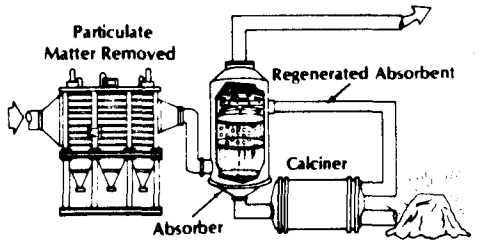
WELLMAN-LORD/ ALLIED CHEMICAL PROCESS

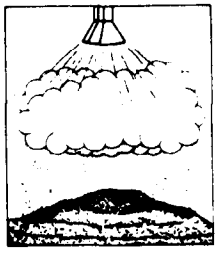


CITRATE PROCESS



MAGNESIUM OXIDE PROCESS



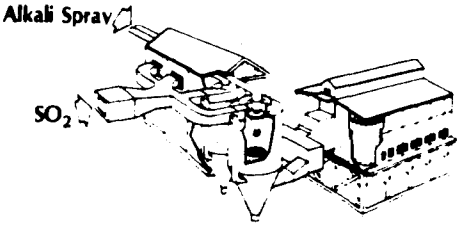


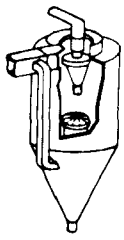
DRY FGD SCRUBBING

TYPICAL DRY PROCESSES

- Spray Dryer with Baghouse/ESP
- Dry Injection
- Alkali and Coal Combustion

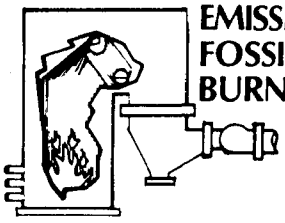
SPRAY DRYER WITH BAGHOUSE





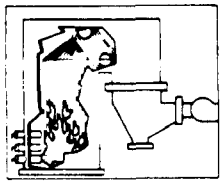
ALKALI SPRAYS

- Sodium Bicarbonate
- Nahcolite
- Lime

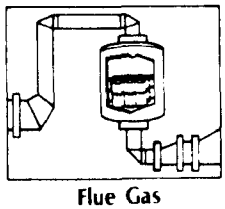


CONTROL OF NO_x EMISSIONS FROM FOSSIL FUEL BURNING SOURCES

METHODS OF REDUCTION



Combustion Modifications



Flue Gas Treatment

- FFFSG rated > 250 × 10^6 Btu/hr

  New Sources after September 1978

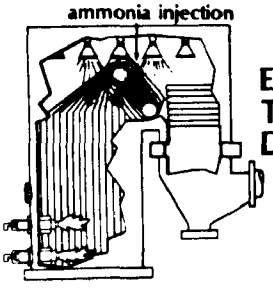
  - gaseous fuel — 0.2 lb/10^6 Btu
  - liquid fuel — 0.3 lb 10^6 Btu
  - subbituminous coal — 0.5 lb 10^6 Btu
  - bituminous anthracite coal, lignite — 0.6 lb 10^6 Btu
  - lignite in slag top furnace — 0.8 lb 10^6 Btu

COMBUSTION MODIFICATIONS

- Low Excess Air
- Staged Combustion
- Flue Gas Recirculation
- Low NO_x Burners

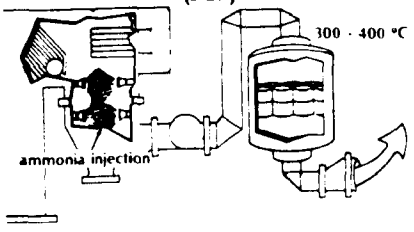
FLUE GAS TREATMENT

- Exxon Thermal De-NO_x
- Selective Catalytic Reduction (SCR)
- UOP Shell Process
- Wet NO_x /SO_x Process



EXXON THERMAL DE-NO_x

SELECTIVE CATALYTIC REDUCTION (SCR)



Chapter 12

Emission Inventories

Lesson Goal

To acquaint you with the concept of emission inventories and their principal uses, their place in control strategy development, and general methods of inventory preparation.

Lesson Objectives

Upon completion of this lesson, you should be able to:

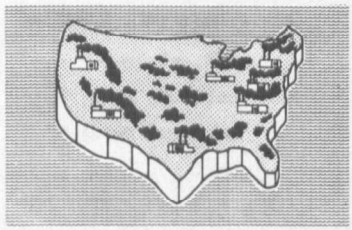
1. define the terms *emission inventory* and *emission factor*.
2. state the uses of emission inventories.
3. identify the role of emission inventories in the development of air pollution control strategies.
4. name the types of sources and classes of pollutants inventoried.

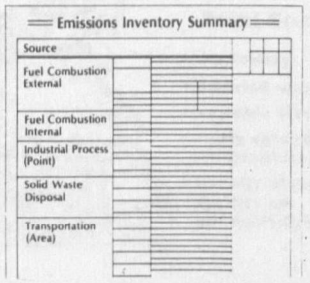
References

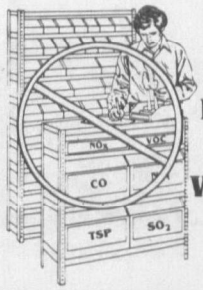
1. Armentrout, David W. 1979. *Development of an Emission Inventory Quality Assurance Program.* Report to EPA by PEDCo Environmental, Inc. EPA 450/4-79-006.
2. DiGasbarro, Philip, and Bornstein, Mark. 1976. *Methodology for Inventorying Hydrocarbons.* Report to EPA by GCA/Technology Division. EPA 600/4-76-013. Material on reactivity indices dated.
3. Hammerle, James R. 1976. Emission Inventory. In *Air Pollution,* 3rd ed., ed. A. C. Stern, Vol. III, pp. 718-84. New York: Academic Press.
4. Stern, A. C., Wohlers, H. C., Boubel, R. W., and Lowry, W. P. 1973. Emission Inventory, Ch. 24 in their *Fundamentals of Air Pollution,* pp. 379-84. New York: Academic Press.
5. U.S. Environmental Protection Agency (EPA). 1974. *Guide for Compiling a Comprehensive Emission Inventory.* 2nd ed. APTD-1135. Partly obsolete due to regulatory and computer system changes, but narrative descriptions of EI methods remain among the clearest in the literature.
6. U.S. Environmental Protection Agency (EPA). 1978. *National Air Pollutant Emission Estimates, 1940-1976.* EPA 450/1-78-003.

7. U.S. Environmental Protection Agency (EPA). 1980a. *National Air Pollutant Emission Estimates, 1970-1978.* EPA 450/4-80-002.
8. U.S. Environmental Protection Agency (EPA). 1980b. *NEDS—National Emissions Data System Information.* EPA 450/4-80-013
9. U.S. Environmental Protection Agency (EPA). 1980c. *Final Emissions Inventory Requirements for 1982 Ozone State Implementation Plans.* EPA 450/4-80-016.
10. U.S. Environmental Protection Agency (EPA). 1980d. *1978 National Emissions Report: National Emissions Data System (NEDS) of the Aerometric and Emissions Reporting System (AEROS).* EPA 450/4-80-029 (microfiche only).
11. U.S. Environmental Protection Agency (EPA). 1981. *Compilation of Air Pollution Emission Factors,* 3rd ed., with Supplements. AP-42.
12. U.S. Environmental Protection Agency (EPA). National Commission on Air Quality (NCAQ). 1981. *Study of the Quality of Emission Inventories: Assessment of Emission Inventory Adequacy for Regulatory Programs.* Report to NCAQ (#22) by Arthur D. Little, Inc. 2 vol. Washington: NCAQ.

EMISSION INVENTORIES





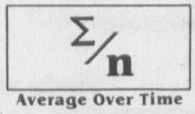


EMISSION INVENTORY

What It's Not

Major Characteristics

Mass / Unit Time



Average Over Time

Controlled and Uncontrolled Sources

Limited Precision

Uses

Research

Control Strategy

Enforcement and Permitting

Ambient Monitoring Planning

Dispersion Modeling

Methods

We'll discuss...

- Levels of Analysis
- Source Inventories
- Pollutant Types
- Quantification of Emissions
- Organization/Presentation of Data
- Uses of Data

Levels of Analysis

- Gross Estimation
- Rapid Survey
- Comprehensive Inventory

Gross Estimation

- applied to U.S. data back to 1940
- based on readily available statistics
- applies crude emission estimates
- uses source categories to which more precise methods are aggregated

Rapid Survey

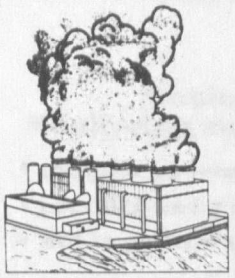
- used from 1966 into 1970's
- individually survey major point sources
- group and estimate other sources

Comprehensive Inventory

- has superseded earlier methods
- survey individual point sources
- collect detailed stack and operating data
- group other sources
- account for temporal and other variation
- need analysis for all but crudest model application

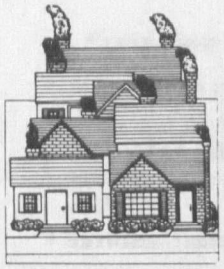
Source Inventories

- Point Sources
- Area Sources
- Line Sources



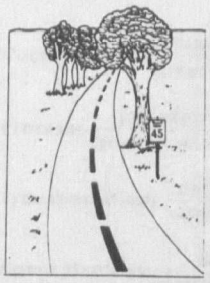
Point Sources

- stationary
- counted one-by-one
- variable size limit
- fairly extended geographical area
- usually plant/facility on connected property



Area Sources

- stationary or mobile
- similar sources scattered over area
- individually too small to count
- very variable in individual emission rates
- random route and rate of travel for mobile sources



Line Sources

- mobile
- major traffic routes
- predictable speed and other factors

Pollutant Types

- Criteria Pollutants
- Hazardous Pollutants
- Other Regulated Pollutants
- Nonregulated Pollutants

Criteria Pollutants

- they must be inventoried / reported because of EPA regulations
- data correlated with ambient concentrations

Hazardous Pollutants

- must be inventoried for control strategy, enforcement purposes
- relation to ambient data is seldom relevant

Other Regulated Pollutants

- data used for enforcement / research applications
- modeling and ambient correlations may or may not be relevant

Nonregulated Pollutants

- data used for research
- pollutants are candidates for regulation
- data is scarce and scattered

Quantification of Emissions

- Source Measurements
- Ambient Monitoring and Modeling
- Emission Factors
- Implications

Source Measurements

- continuous — relatively expensive
  - limited to major point sources
- sampling — short-term measurement
  - projected to longer periods
  - assumes normal operation

Ambient Monitoring and Modeling

- receptor-to-source modeling
- complex and expensive
- not in general use

Emission Factors

- most often used
- estimate of rate at which pollutant released to atmosphere ÷ level of activity
- various units

Combustion: $\frac{\text{pollutant mass rate}}{\text{heat input rate}}$

Process: $\frac{\text{pollutant mass rate}}{\text{item or mass process rate}}$

Transportation: $\frac{\text{pollutant mass rate}}{\text{vehicle miles traveled}}$

Space Heating: $\frac{\text{Btu}}{\text{person·day}} \cdot \frac{\text{lb}}{\text{Btu}} \cdot \text{persons}$

Emission Factors

- most often used
- estimate of rate at which pollutant released to atmosphere ÷ level of activity
- various units
- various characteristics

Emission Factor: constant multiplier representing a function

Emission Estimate: average from study of typical operations

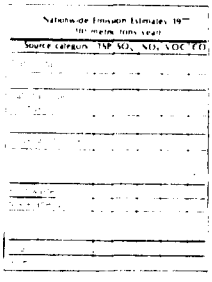
May include seasonal, time of day, etc., adjustments

Implications

- continuous emissions monitoring desirable for large point sources
- projections based on emission testing
- other source emissions estimated from standard emission factors (➡ limit on accuracy)

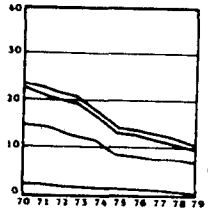
Organization / Presentation of Data

- Tables
- Charts
- Computer Files



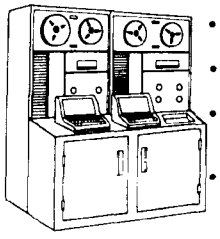
Tables

- most usual form
- organized by source categories, pollutants, or units
- advantages – accessible and flexible
- disadvantages – nonintuitive and overwhelming



Charts

- may be bar / line chart or emission density map
- advantages – intuitive and permits insight into nature of problem
- disadvantages – aggregation, oversimplification, and inflexibility



Computer Files

- used for most EI data storage
- useful for large quantities of data
- allows simple or complex presentation of data
- essential for use of EI data in sophisticated dispersion model

Uses of Data

- Control Strategy Applications
- Enforcement and Permitting Applications
- Other Applications

Control Strategy Applications

- strategy development
- progress tracking

Enforcement and Permitting Applications

- source types, locations
- emissions and other operating data
- compliance status

Other Applications

- monitoring network design
- research
- public information

Legal and Regulatory Requirements

We'll discuss....

- Baseline Emission Inventories
- Projected Inventories
- Reports

Baseline Emission Inventories

- describe "starting point" situation
- are fixed to base year
- cover AQCRs, criteria pollutants
- are comprehensive, accurate, and current

Projected Inventories

- are explicitly treated in nonattainment area plan provisions
- are estimate of future emission inventory
- comprise data base for modeling future air quality

Reports

- annual reports (basic)
- nonattainment area plan reports (additional)

Automatic Data Processing

We'll discuss...

- Organization
- EPA Systems
- Compatible Systems
- Permit and Registration Systems

Organization

- "bookkeeping" — data categorized and stored
- emissions model — data base includes emission factors, other variables

EPA Systems (Part of NADB)

- NEDS — PM, SO_2, NO_x, CO, HC
- HATREMS — other pollutants, including Pb
- SOTDAT — detailed point source testing data
- Others — enforcement and research applications

Compatible Systems

- EIS/PS — Point Sources
- EIS/AS — Area Sources

Both permit easier computation, manipulation, and display of data and submission in NEDS format

Permit and Registration Systems

- handle data for new sources and operating permits
- permit continuous emission file update
- produce reports required by State law, regulations, or policy
- produce EPA-required reports

Summary

- Definition
- Characteristics
- Uses
- Elements
- Special Items

Chapter 13

Enforcement Procedures and Source Inspections

Lesson Goal

To familiarize you with air pollution agencies' enforcement and source inspection procedures.

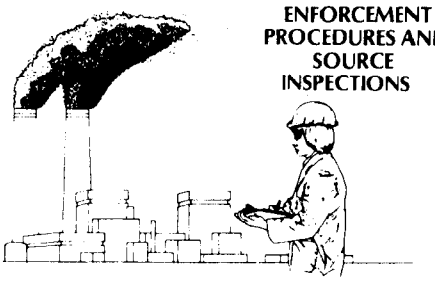
Lesson Objectives

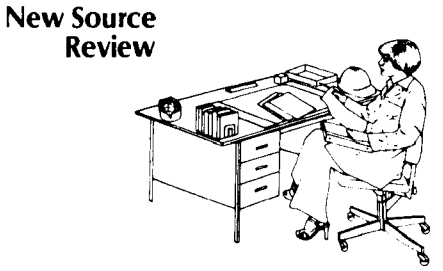
Upon completion of this lesson, you should be able to:

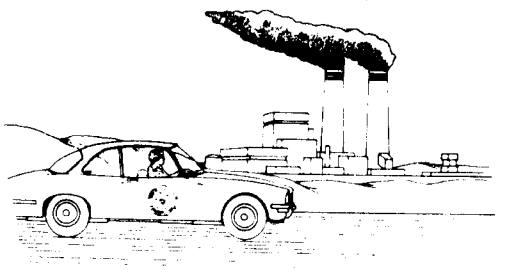
1. briefly describe the new source review procedure in terms of State and local agency responsibility.
2. name three surveillance procedures and explain the role of each.
3. recognize seven steps of a source inspection.
4. briefly describe three types of action for sources not in compliance with air pollution regulations.
5. briefly describe an episode control plan for an air pollution agency.

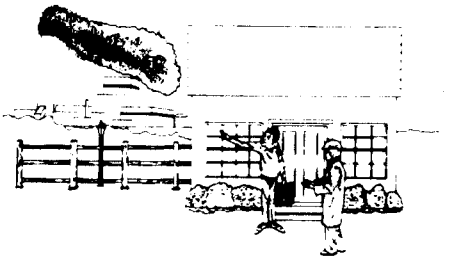
References

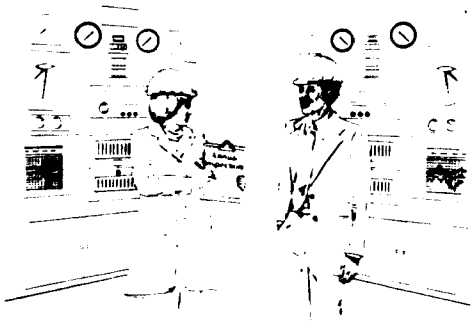
None

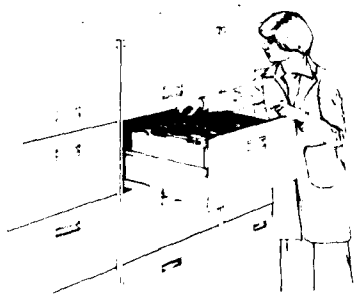

ENFORCEMENT
PROCEDURES AND
SOURCE
INSPECTIONS

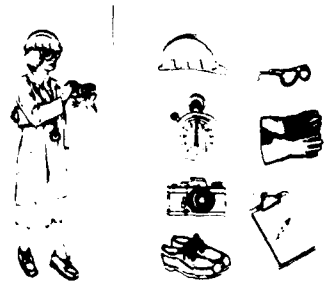

New Source
Review

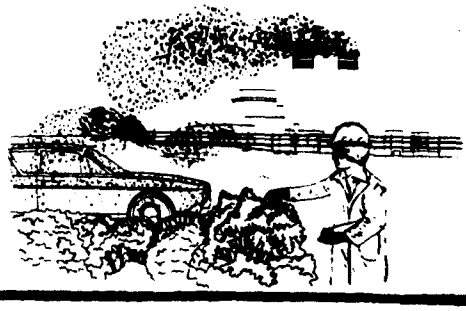


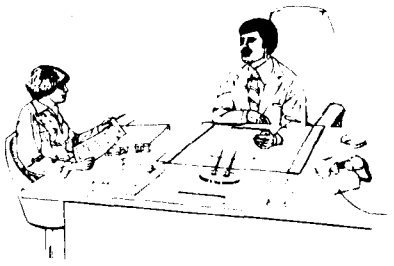


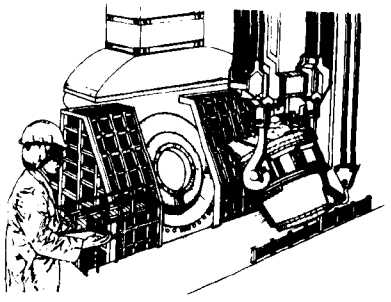


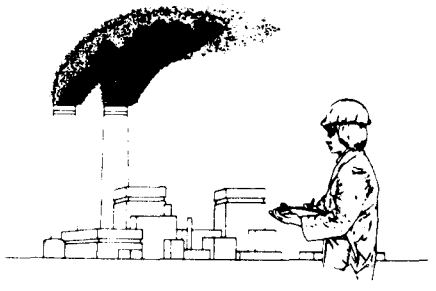


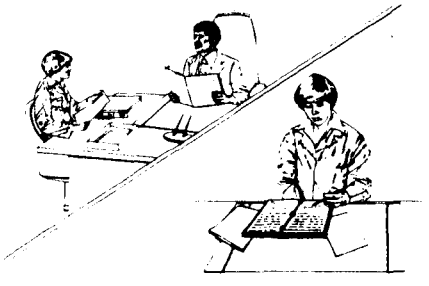


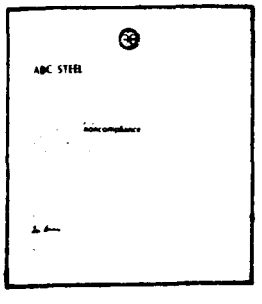


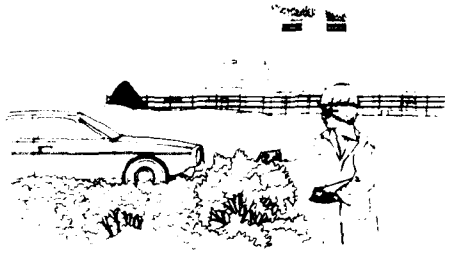


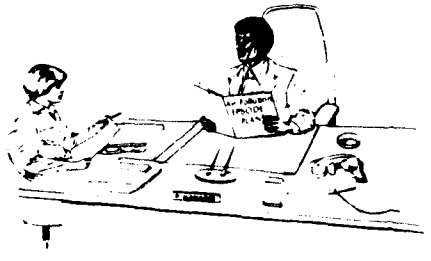







ABC STEEL





Chapter 14

State Implementation Plans—I: Goals and Development

Lesson Goal

To develop, on the basis of the preceding introduction to the legal and regulatory bases of air pollution control programs, your understanding of the specific goals and mechanisms set up by the Clean Air Act (as amended) for developing and revising State Implementation Plans as the principal means of carrying out the air quality management principle.

Lesson Objectives

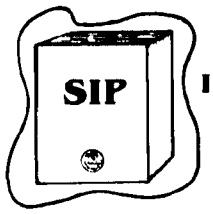
Upon completion of this lesson, you should be able to:

1. describe the concept of Air Resource Management.
2. associate the legal requirements from Section 110 of the Clean Air Act for State Implementation Plans (SIPs) with their corresponding regulatory requirements.
3. recognize essential content features of a State Implementation Plan.
4. identify the steps followed in SIP development—from identification of a problem to promulgation of a State Implementation Plan.

References

1. de Nevers, N. H., Neligan, R. E., and Slater, H. H. 1977. Air Quality Management, Pollution Control Strategies, Modeling and Evaluation. In A. C. Stern, ed. *Air Pollution*. 3rd ed. Vol. V, pp. 4-40. New York: Academic Press.
2. English, A. 1975. State Implementation Plans and air quality enforcement. *Ecol. Law Quarterly* 4:595.
3. Faith, W. L. and Atkisson, A. A. Jr. 1972. *Air Pollution*. 2nd ed. New York: Wiley, pp. 332-351.
4. Heller, A. N., Schueneman, J. J., and Williams, J. D. 1966. The Air Resource Management Concept. *J. Air Pollution Control Association*. 16:307-309.

5. Marchand, L. 1979. The Importance of Clean Air to Canada. *J. Air Pollution Control Association.* 29:104-105.
6. Parish, G. E., 1979. Enforcement and Litigation under the Clean Air Act Amendments of 1977. *Natural Resources Lawyer.* 12:435-489.
7. Schueneman. J. J. 1977. Organization and operation of air pollution control agencies. In A. C. Stern, ed. *Air Pollution.* 3rd ed. Vol V, pp. 109-207 New York: Academic Press.
8. Suess, M. J. and Craxford, S. R., eds. 1976. *Manual on Urban Air Quality Management.* WHO Regional Publications. European Series No. 1. Copenhagen: WHO Reg. Off. for Europe.
9. Weber, E. 1981. Air Pollution Control Strategy in the Federal Republic of Germany. *J. Air Pollution Control Association.* 31:24-30.



STATE IMPLEMENTATION PLANS: Goals and Development

MANAGING THE AIR RESOURCE

- Air Resource Management Concept

Air Resource Management

Systems Approach:

- analysis / description of effects
- determination of air quality standards
- control of emissions
- monitoring / assessment of air quality
- revision of control strategy

Purpose

- control of nature / rate / location of emissions
- explicit conditions for control strategy and its evaluation
- efficient allocation of resources

Implementation

- Air Quality Control Regions (AQCRs)
- Air Quality Criteria and Control Techniques
- National Ambient Air Quality Standards (NAAQS)
- Implementation Plans
- Continuing Monitoring and Cross-Checking

MANAGING THE AIR RESOURCE

- Air Resource Management Concept
- Other Concepts
  - Best Practicable Means Approach
  - Economic Strategies
  - Land Use Control

Best Practicable Means

- emission control standards are based on technological and economic factors
- standards may vary from source to source
- ambient concentrations are disregarded
- this approach is a component of NSPS and NESHAPs

Economic Strategies

- open emission rights market
- computed noncompliance penalties

Land Use Control

- emission density zoning
- green belt/industrial strip planning

AQM Techniques for Conflict Resolution

In theory...

case by case

In practice...

usually applied to disputed ambient standards, technology, etc.

STATE IMPLEMENTATION PLANS
SIP Legal and Regulatory Requirements

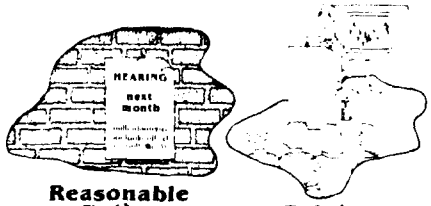
- Legal Requirements
- Regulatory Requirements
- Summary

Legal Requirements

Clean Air Act §110

- is a long, detailed section
- needs detailed regulations on mechanisms for carrying it out

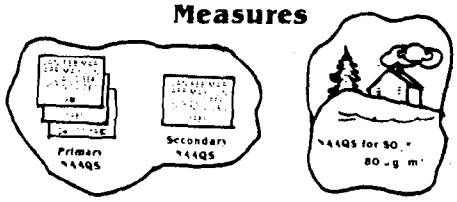
Notice and Hearing



Reasonable Notice

Public Hearings

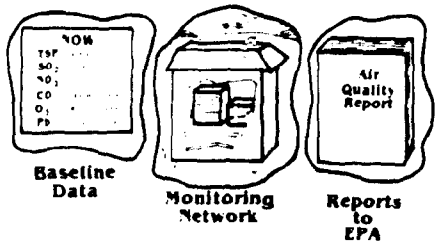
Attainment and Maintenance Measures



Attainment

Maintenance

Air Quality Data



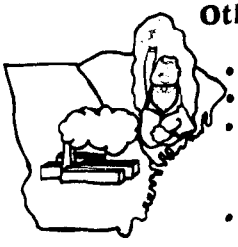
Baseline Data

Monitoring Network

Reports to EPA

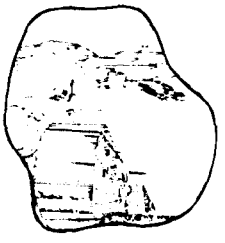
Enforcement Program

Non-Interference with Other States



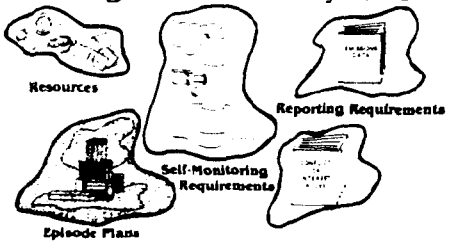
- NAAQS
- PSD
- notification of new sources with interstate impacts
- petition to EPA

New Source Review

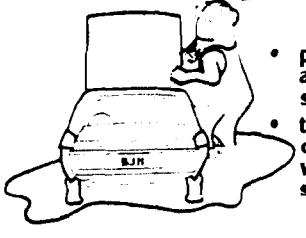


- *is for compliance with* State standards
- interlocks with Federal programs
- relates to §111 review and Federal/State environmental impact review

Binding Commitments by State



Motor Vehicle Inspection and Testing



- periodic - annual, semiannual
- to enforce compliance with standards

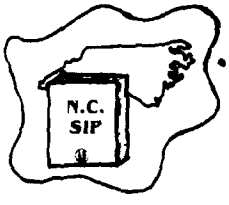
Other Legal Requirements

- revision
- nonattainment and PSD requirements
- permit fee requirements
- ban on EPA requiring indirect source review
- other technical requirements

Regulatory Requirements

- found in 40 CFR Parts 51 and 52

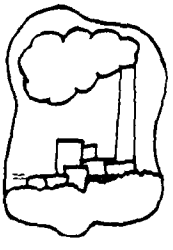
States



- have primary responsibility for developing a SIP and carrying it out

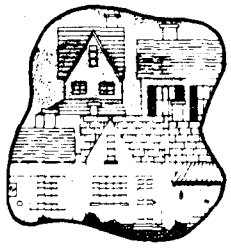
Local Governments

- level of government (other than state) with responsiblity to carry out part of SIP



Point Source
(stationary)

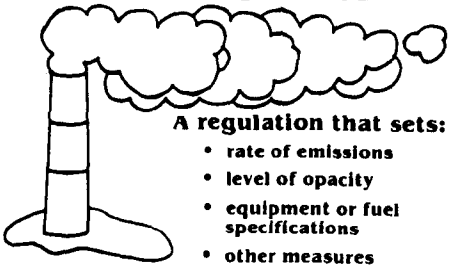
- single major source
- emission control and emission inventory required
- listed in Appendix C of 40 CFR Part 51



Area Source

- a group of small sources

Emission Standard



A regulation that sets:

- rate of emissions
- level of opacity
- equipment or fuel specifications
- other measures

Stipulations

States should not:

- ignore cost or socio-economic impacts of plans
- limit control measures or analysis techniques to those in EPA regulations
- limit controls to only those required to attain NAAQS
- adopt "blanket" controls if standards can be achieved in other ways

Classification of Regions

- used to establish priorities for resource allocation
- based on concentrations of SO_x, TSP, CO, NO_2, and O_3
- consists of Classes I, IA, II, and III

Public Hearings

- required for:
  - basic SIP adoption
  - SIP regulation or compliance schedule revision
  - adoption of transportation control measures

- must be public
- reasonable notice required
- must keep record of proceedings
- certification of hearing to be submitted with plan or revision
- may submit alternate procedures

Submission and Review of SIPs

- must be submitted by the Governor
- must submit within
  a) 9 months after promulgation of primary and secondary standards
  b) 60 days if PSD provisions were inadequate
  c) nonattainment areas
     - January 1, 1979 for 1982 attainment
     - July 1, 1982 for 1987 attainment

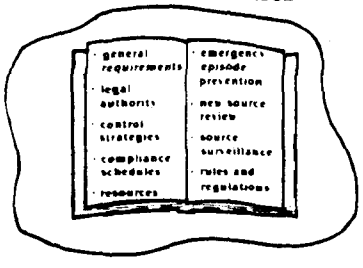
Revisions

- follow requirements of Clean Air Act
- may be at State's option
- require 60-day response or submitted time

Approval by EPA Administrator

- SIP must meet requirements of Clean Air Act
- approval may be in parts
- revisions are not "official" until final approval

Plan Contents



General Requirements

- consideration of alternative strategies encouraged
- attainment dates
  - primary standards—as soon as possible, but within 3 years
  - secondary standards—within a reasonable time
  - nonattainment area plans—December 3, 1982 or December 31, 1987

General Requirements (continued)

- non-interference with NAAQS attainment/maintenance in any other region
- public availability of emission data

Legal Authority

- adopt emission standards, etc.
- enforce law, regulations, and standards
- carry out emergency abatement actions
- prevent construction, modification, or operation of facilities

Legal Authority (continued)

- obtain compliance information, require record keeping, and perform inspections and tests
- require installation of self-monitoring equipment, require reporting of data, and provide data to public
- delegate authority

—authority actually available

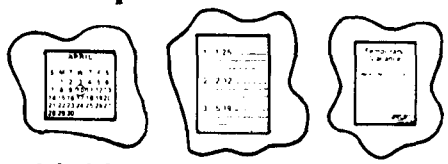
Control Strategies

- purpose
  - attainment/maintenance of NAAQS
- approach
  - development of emission reductions/limitations

Control Strategies
(continued)

- methods
  - region-by-region
  - emission data
  - air quality data
  - emission reductions/ limitations
- demonstration
  - example region
  - modeling

Compliance Schedules



Schedule

Increments of Progress

Variance

Emergency Episode Prevention

- purpose
  - to prevent pollutant concentration from reaching high levels "which could cause significant harm to the health of persons"

Emergency Episode Prevention
(continued)

- requirements
  - at least 2 levels of action
  - public announcement
  - adequate emission control actions
  - forecast data from NWS
  - source inspection
  - communications procedures

New Source Review

- is complementary to regulations for existing sources
- consists of legal and administrative procedures to:
  - determine if proposed construction modification will violate SIP
  - prevent construction modification where necessary
  - require emission etc. data
  - allow for public comment

Source Surveillance

- purpose
  - to determine compliance with control strategy
- approach
  - records and reports
  - periodic source inspection
  - visible emission investigation
  - complaint investigation
  - motor vehicle emission and traffic flow measurements
  - continuous emission monitoring

Resources

- definition
  - people and money required to implement SIP
- contents
  - available resources at time SIP submitted and 1, 3, and 5 years after
  - dollars and people allotted to agencies for each AQCR

Rules and Regulations

- must be actual, enforceable rules
- must require emission reductions, etc. necessary to implement control strategy
- are a large, complex part of any SIP

Legal and Regulatory Requirements

- complexity
- variability
- changeability

SIP DEVELOPMENT AND PROMULGATION PROCESS

- General Information about Process
- Assessment of Problem
- Development of Alternatives
- Proposal of Plan
- Public Hearings
- Submission to EPA
- Approval / Promulgation of Plan
- Revision of Plan

General Information about Process

- variability
  - States have different problems, laws, etc.
  - EPA regions vary in review approach
- guidance
  - regulations (40 CFR 51)
  - manuals
  - letters/memoranda
  - informal responses to inquiries

Assessment of Problem

- assessment can be generated within State/local control agency
  - by data on hand
  - by external forces
- assessment can be generated outside State/local control agency
  - by citizens groups or industry groups
  - to get SIP process started, to get EPA to force SIP action, to get courts to force SIP action or affect sources directly

Assessment of Problem (continued)

- all approaches involve
  - goals
  - basic data and assumptions
  - control strategies
- legal responsibility is on State control agency

Development of Alternatives

- technical considerations
  - degree of control required
  - appropriate control techniques
  - available control techniques
- economic/other considerations
  - cost effectiveness
  - cost-benefit analysis
  - economic availability of control technology
  - social considerations

Proposal of Plan

- purpose
  - to invite public participation
- means
  - State Administrative Procedure Act requirements
  - Federal requirements
  - additional publicity

Public Hearings

- purpose
  - to resolve value questions
- requirements
  - notice of hearing
  - record of proceedings
  - certification of hearing

Submission to EPA

- time
  - NAAQS—9 months after promulgation
  - nonattainment plans (1987 attainment)—July 1, 1982
  - PSD—60 days after EPA finding, or as negotiated
- methods
  - in parts (as completed)
  - as a final, official package

Approval / Promulgation of Plan

- full approval (all parts satisfactory)
  - promulgated in Federal Register (40 CFR 52)
  - is a rare occurrance
- partial approval (portions satisfactory)
  - valid portions promulgated in Federal Register
  - unsatisfactory portions sent back to State for revision or replaced by EPA

Approval / Promulgation of Plan (continued)

- conditional approval (all parts will be satisfactory if certain provisions added)
  - conditional approval announced in Federal Register
  - SIP sent back to State for revision
  - if no timely action EPA substitutes provisions or disapproves

Approval / Promulgation of Plan (continued)

- disapproval (entire plan unsatisfactory)
  - disapproval announced in Federal Register
  - EPA substitute provisions proposed and adopted
  - continuing work with State to obtain SIP to replace EPA provisions

Revision of Plan

- mandatory
  - NAAQS changes/additions
  - nonattainment area plans
  - law suits
- discretionary
  - technology changes
  - availability of other approaches
  - changing patterns of development

Chapter 15

State Implementation Plans—II: Structure and Provisions

Lesson Goal

To familiarize you with the regulatory structure and typical procedural and substantive provisions of SIPs. Emphasis will be on examples of provisions in current SIPs.

Lesson Objectives

Upon completion of this lesson, you should be able to:

1. name the first-level components of a typical State Implementation Plan.
2. state the purposes for which SIP provisions are developed.
3. identify the levels of a typical emergency episode plan; associate control actions with each.
4. define: PSD, nonattainment area plans, BACT, LAER, and RACT; associate these terms with legal requirements for SIPs.
5. describe generally the new source review (NSR) process; recognize differences for PSD and nonattainment area plans.

References

1. Floy, Kent R. 1981. Prevention of Significant Deterioration of Air Quality—The Regulations After *Alabama Power B.C. Env. Aff. L. Rev.* 13.
2. Goldberg, Stephen A. 1980. *Source Planning Under the New PSD Regulations. Environ. Rep.* Monograph No. 29. Washington: BNA.
3. Raffle, Bradley I. 1978. *The New Clean Air Act—Getting Clean and Staying Clean. Environ. Rep.* Monograph No. 26. Washington: BNA.
4. Raffle, Bradley I. 1979. *Prevention of Significant Deterioration and Nonattainment Under the Clean Air Act—A Comprehensive Review. Environ. Rep.* Monograph No. 27. Washington: BNA.
5. Reinwand, Jerry. 1978. The Shaping of National Policy on Prevention of Significant Deterioration. Introduced for the *Record* by Sen. Gravel. 124 *Cong. Rec.* S1139 (daily ed., Feb. 2, 1978). Reprinted at 9 *Environ. Rep.—Curr. Devel.* 1569.

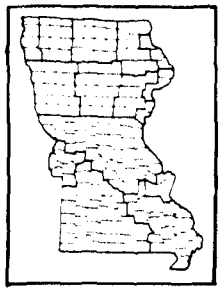
6. U.S. Environmental Protection Agency (EPA). Requirements for preparation, adoption, and submittal of implementation plans. 40 CFR 51 (July 1980).
7. U.S. Environmental Protection Agency (EPA). Approval and promulgation of implementation plans. Subpart A—General Provisions. 40 CFR 50.01—50.24 (July 1980).
8. U.S. Environmental Protection Agency (EPA). Prevention of significant deterioration of air quality. [Basic Federal regulations, amended August 7, 1980.] 40 CFR 52.21 (July 1980).
9. U.S. Environmental Protection Agency (EPA). "Requirements for Preparation, Adoption, and Submittal of Implementation Plans; Approval and Promulgations of Implementation Plans." [PSD and related nonattainment area regulatory changes in response to *Alabama Power v. Costle.*] 45 Fed. Reg. 52676 (August 7, 1980).

STATE IMPLEMENTATION PLANS - II:

Structure and Provisions

SIP STRUCTURE

- **basically the same since 1971**

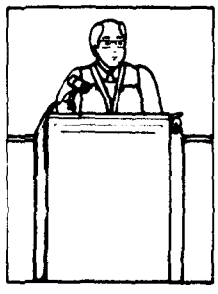


Air Quality Control Regions (AQCRs)

- basic geographical units for detailed control strategy development

AQCRs

- **Purposes**
  - treatment of common problems together
  - classification by priority and attainment status
- **Review / Revision**
  - boundaries - by governor with EPA approval
  - classification - based on air quality data



Legal Authority to Carry Out SIP

Adoption of Regulations

- State Administrative Procedure Act authorizes agency to adopt enforceable regulations
- State law directs agency to adopt regulations

Emission Standards

- regulations in force
- prescribed controls

Emergency Abatement

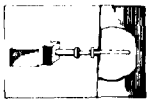
- authority to seek injunctions, etc.
- enforceable contingency plans

Control of Source Construction / Operation

- New Source Review
  - formal procedure
  - authority to prevent construction / modification
- Control of Operation
  - permit system
  - authority to stop operation
  - authority to set compliance schedules

Inspection / Testing / Obtaining Information

- require recordkeeping by sources
  - emissions data
  - process data
- perform inspections
- conduct emissions testing



Emissions Data and Monitoring

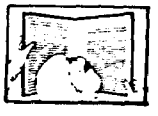
- require installation, maintenance, and use of emission monitoring devices
- require periodic reporting of data
- require reporting of data to public

Enforcement

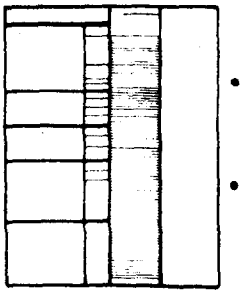
- authority to enforce applicable laws, regulations, and standards
- authority to seek court orders

Other Authority

- motor vehicle inspection and maintenance
- land use measures



SIPs usually contain copies of actual laws, documenting that required authority exists and is in effect.



Emission Inventories

- information base for strategy development and validation
- quantitative description of sources and amounts of emissions

Uses of Emission Inventories

- ambient monitoring network design
- control strategy design
- dispersion modeling input
- control strategy progress evaluation

Requirements for Emission Inventories

- Nonattainment Area Plans
  - comprehensive
  - current
  - complete
- General
  - categorization
  - criteria pollutant coverage
  - units
  - location

Revision of Emission Inventory

- continuing
- periodic

Air Quality Data

- information base for initial or nonattainment area strategy development and evaluation

Existing Data

- baseline for initial or nonattainment area strategy development
  - monitoring network
  - measurements

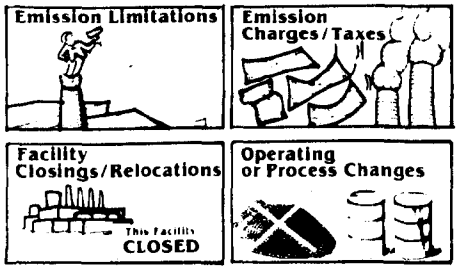
Projected Data

- **data for evaluation of control strategy**
  - **monitoring network**
  - **measurements**

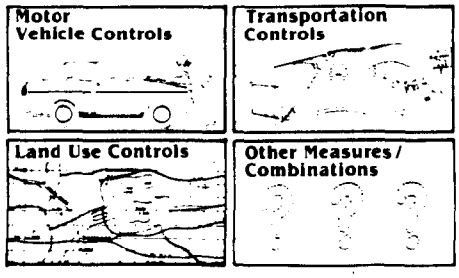
Control Strategy

- **combination of measures to achieve overall emission reductions needed for NAAQS attainment and maintenance**

Possible Measures



Possible Measures

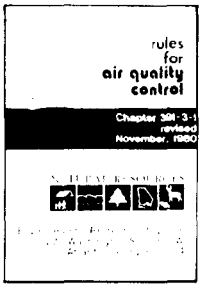


Reduction Estimates

- Methods
  - rollback
  - dispersion modeling
  - simulation modeling, EKMA, etc.
- Allocation
  - to areas
  - to source categories
  - to specific sources

Reduction Estimates

- **Proposed Application**
  - existing and planned sources
  - control technology
  - other reduction methods
- **Result**
  - mix of proposed measures for attainment / maintenance of NAAQS



Emission Control Regulations

- principal means of carrying out most reduction

General Regulations

- are administrative regulations with force of law
- forbid certain actions, require others
- are enforceable against violators

Stationary Source Regulations

- largest and most varied class of regulations
- general
- by source category
- source-specific

In-Use Vehicle Regulations

- inspection and maintenance (I / M)
- retrofit

Fugitive Emissions Regulations

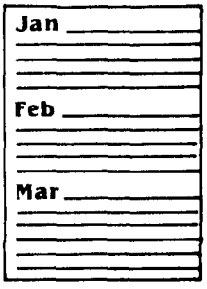
- designed to control road dust, process leaks, process malfunctions, etc.
- regulate equipment and work practice

Open-Burning Regulations

- prohibitions
- time and place restrictions
- special permit systems

Nuisance and Odor Regulations

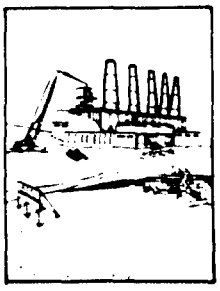
- administrative abatement
- government and private citizen court action



Compliance Schedules

- general — keyed to effective date of control regulations
- source-specific — keyed to special cases and very large source

Incorporated in SIP as detailed source schedules

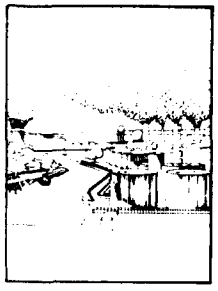


Review of New Sources and Modifications

- authority to prevent construction or operation
- source size criteria
- application and preliminary review process

Review of New Sources and Modifications

- public comment processs
- engineering analysis
- air quality impact analysis
- final permit determination process



Emergency Episode Plans

- for priority I regions

Episode Plan Requirements

- legal - very brief and broad
- regulatory - in §51.16 and Appendix L to Part 51

Basic Episode Plan Features

- levels which could cause significant harm to health of persons (PSI 500)
- two or more levels below significant harm level
- public announcement

Basic Episode Plan Features

- emission control actions for each stage
- acquisition of NWS atmospheric stagnation advisories
- source inspection procedures
- communications procedures

Episode Criteria and Levels

- forecast
- alert (PSI 200)
- warning (PSI 300)
- emergency (PSI 400)

Communications and Enforcement

- effective public notice
- official notice to sources
- inspection
- administrative / court orders
- liaison with other agencies
- notice of episode stage change or termination

Other Features

- disaster powers
- noncriteria pollutant control

Prevention of Significant Deterioration (PSD) Plans

- Pre-1972
- Sierra Club vs Ruckelshaus
- 1974 EPA Regulations
- 1977 Clean Air Act Amendments

Pre-1972

- proposed SIP guidelines
- final SIP guidelines

Sierra Club vs Ruckelshaus

- enjoined immediate approval of any SIP
- required review
- did not define "significant"

D.C. Circuit Court of Appeals upheld District Court findings. Affirmed by Supreme Court.

1974 EPA Regulations

- provisions in place of missing PSD portions of every SIP
- TSP and SO_2 control
- area class system
- BACT for 19 source categories
- impact review by modeling

1977 Clean Air Act Amendments

- formal listing of PSD areas
- increment changes
- mandatory Class I areas
- expansion of source category coverage
- BACT definition
- preconstruction monitoring
- expanded modeling
- Set II pollutants and lead

Current Legal Requirements

- **Purposes**
  - protection of public health / welfare
  - preservation of natural values
  - assurance of economic growth
  - assurance against interstate PSD interference
  - requirement of informed decision making

- **Area Classifications**
  - **mandatory Class I or II**
  - **initial Class II for all others better than secondary NAAQS or unclassifiable**

- Area Redesignations
  - Class I or II restrictions
  - executive / legislative / intergovernmental concurrence
  - notice and public hearing
  - notice to federal land manager
  - EPA review / approval
  - EPA resolution of interstate disputes

- Ceilings and Increments
  - for TSP and SO_2
  - increments - maximum permissible increases in concentration
  - ceilings - concentration in no case to exceed lowest NAAQS
  - special cases

- Notice and Public Participation
  - in redesignation process
  - in source permit process

- Preconstruction Requirements
  - permit
  - permit review / analysis and public hearing
  - demonstration of compliance
  - BACT
  - air quality monitoring

Regulatory Requirements

- Important Terms
  - potential to emit
  - stationary source
  - major stationary source
  - major modification
  - construction

- **Applicability**
  - **geographic - states, areas**
  - **sources - stationary only**
  - **pollutants - criteria, NSPS, NESHAPs**

- **Permit Application**
  - source information - location, operating specs, construction schedule, emission estimates, site/meteorological data
  - impact analyses - NAAQS, increment consumption, general air quality impacts, visibility, soils, vegetation
  - public hearing
  - State and EPA review

Nonattainment Areas

- **primary NAAQs attainment set for 1975**
- **failure of many AQCRs to meet 1975 attainment**
- **EPA regulatory attempts to deal with nonattainment**
- **Clean Air Act Amendments - 1977**

Legal and Regulatory Requirements

- **legal requirements found in CAA Title I, Part D, §§171-178**
- **regulatory requirements found in 40 CFR, Parts 51 and 52**

Major Provisions

- **SIP Revision**

  nonattainment areas to revise SIP to show NAAQS attainment
  - **by 12/31/82, unless impossible for O_3/CO**
  - **by 12/31/87, for O_3/CO**

- **Approval / Disapproval of Submissions**
  - by 7 / 1 / 79 for basic revisions
  - by 7 / 1 / 82 for further measures pertaining to 1987 attainment

- **Plan Provisions**
  - notice / hearing requirements
  - implementation of reasonably available control measures
  - reasonable further progress (RFP)
  - emission inventory
  - emission allowances
  - major source construction / operation permit system

- **Plan Provisions (continued)**
  - resource identification and commitment for implementation
  - emission limits, compliance schedules, etc.
  - intergovernmental consultation and public involvement on effects analysis
  - evidence of legal authority

- **Plans for 1987 Attainment**
  - analysis of alternatives for major source permit
  - schedule for vehicle inspection / maintenance
  - identification of other measures
  - further enforceable measures for 1987 attainment

- **Permit System**
  - major stationary sources or major modifications
  - new source emissions · RFP
  - LAER standard
  - other major sources
  - carrying out of nonattainment SIP

- **Sanctions**
  - Federal grants and projects
  - sewage treatment grants
  - new major source permits

Status

- Initial (1979) Submissions
  - all 51 states with nonattainment areas submitted SIP revisions
  - final approval/disapproval continued into 1981
  - most approvals conditional
  - I/M provisions remain controversial
  - area status subject to continuing update

Status

- Second (1982) Submission for 1987 Attainment
  - due January 1982
  - measures beyond what were RACM in 1979
  - argued impossibility of attainment for certain areas - possible changes in law

Conclusion

- SIP structure and provisions exist to apply AQM approach to the situation in a particular State
- It is a complex area of law, regulation, and technology.

Chapter 16

Control Program History: Effect on Current and Future Patterns

Lesson Goal

To review and emphasize topics covered by category in other lessons by historical exposition of why air pollution control programs have their present form; and to acquaint you with areas of programs that are subject to continuing change, and the directions these changes are likely to take.

Lesson Objectives

Upon completion of this lesson, you should be able to:

1. name the major steps in legislative development leading up to the Clean Air Amendments of 1970.
2. identify the types of air pollution episodes which have influenced program and legal developments.
3. recognize the names of major episodes and associate them with their important characteristics.
4. identify the important policy elements in the Clean Air Amendments of 1970.
5. name the very important policy issues dealt with in the 1977 Amendments which continue to be centers of discussion.

References

1. Ashby, E. and Anderson, M. 1976-77. Studies in environmental protection: the historical roots of the British Clean Air Act, 1956. *Interdisciplinary Sci. Rev.* 1:279-290, 2:9-29 and 2:190-211 (3 articles).
2. Brimblecombe, P. 1976. Attitudes and responses towards air pollution in medieval England. *J. Air Poll. Control Assoc.* 26:941-45.
3. Brimblecombe, P. 1978. Air pollution in industrializing England. *J. Air Poll. Control Assoc.* 28:115-118.
4. Dyck, R. G. 1970. *Evolution of Federal air pollution control policy 1948-1967.* Unpub. diss., Univ. of Pittsburgh.

5. Evelyn, J. 1661. *Fumifugium: or, the inconvenience of the aer, and smoake of London dissipated...* Reprinted 1772. London: B. White.
6. Fromson, J. 1969. A history of Federal air pollution control. *Ohio State Law J.* 30:516-36.
7. Goldsmith, J. R. and Friberg, L. T. 1977. Effects on human health—II. A. Air pollution episodes. in A. C. Stern, ed. *Air pollution.* 3rd ed. Vol. II. New York: Academic press. pp. 469-77.
8. Halliday, E. C. 1961. A historical review of atmospheric pollution. In *Air Pollution.* World Health Organiz. Monograph Series No. 46. Geneva: WHO.
9. Ripley, R. B. 1965. Air pollution and public policy: the Clean Air Act of 1963. Paper pres. to American Univ. Seminar on Economics of Air Pollution, May 5, 1965. Washington: Brookings Institution.
10. Schrenk, H. H., et al., 1949. Air pollution in Donora, Pa.: epidemiology of the unusual smog episode of October 1948. Pub. Health Bull. No. 306 (U.S. Pub. Health Svce.). Washington: GPO.
11. Smith, A. R. 1966. Some aspects of air pollution (3-19). Air pollution and the Alkali Act (22-24). The Clean Air Act in operation (83-87). In his *Air Pollution, a survey...* Monograph No. 22. London: Soc. of Chem. Industry.
12. Stern, A. C. et al., 1973. History of the problem. Chapt. 6 in their *Fundamentals of air pollution.* New York: Academic press, pp. 53-67.
13. U.S. Environmental Protection Agency (EPA). 1971. History of episodes. Appendix B in *Guide for air pollution episode avoidance.* OAP AP-76.
14. U.S. Senate. Public Works Comm. 1963. History of the Federal program. Chapt. III in *A study of pollution—Air.* Staff Report to Senate Comm. on Public Works. Washington: GPO.
15. U.S. Senate. Environment and Public Works Comm. 1975-79. Legislative history of the Clean Air Act Amendments of 1970 [1977]. Cong. Res. Svce. Report. 8 vols. Washington: GPO.

CONTROL PROGRAM HISTORY:
Effect on Current and Future Patterns

Before Federal Involvement

- Chronic, "Nuisance" Problems
- Acute Problems

- England
- sporadic actions
- Alkali Works Regulation Act of 1863

- local ordinances - early 1800s
- major local efforts
- bans and combustion operation rules

- efforts concentrated on abatement of black smoke

Before Federal Involvement

- **Chronic, "Nuisance" Problems**
- **Acute Problems**

Meuse Valley, Belgium
December 1930

- dense fog, no wind, temperature inversion
- SO_2, H_2SO_4, HF, NO_2, CO, CO_2 (concentrations unknown)
- cardiovascular problems, hypotension, alkalosis, sore throat, cough, nausea, vomiting
- 60 to 80 excess deaths; injury to livestock

Donora, Pennsylvania
1948

- fog, temperature inversion, stagnant high pressure
- SO_2, H_2SO_4, other sulfur compounds, O_3, NO_x, organic compounds, smoke (concentrations unknown)
- **coughs, respiratory problems, eye** irritation, nausea, vomiting, cardiovascular problems
- possibly 16 excess deaths

London
December 5-9, 1952

- fog, black smoke, light winds
- SO_2, black suspended particulate matter
- bronchitis, respiratory problems, cardiovascular problems, fever, yellow-black sputum
- 4,000 excess deaths; injury to livestock

New York
1953-1966

- series of episodes; not detected at the time
- all in fall or winter
- usually light wind conditions
- SO_2, suspended particulate matter
- respiratory problems, aggravation of "flu" symptoms, eye irritation, cardiovascular problems
- excess deaths noted
  - 1963, 200-400
  - 1964, 168

Poza Rica, Mexico
1950

- isolated, accidental episode
- one source - sulfur recovery plant
- fog
- H_2S
- almost immediate symptoms - respiratory and central nervous system
- 22 deaths; 320 hospitalizations

Los Angeles
1940s - Present

- series of episodes; "smog" complaints
- summer and fall
- O_3, hydrocarbons, NO_x
- eye irritation, runny nose, "funny" smell, mild breathing problems
- sharp visibility reductions

Growth of U.S. Federal Involvement

- Background
- Early Interest (before 1950)
- Congressional Action (1950-1970)

- police power resides in states
- early control experience was at State/local level
- limitations on extent of Federal power

Early Interest (before 1950)

- largely studies and conferences
- little funding
- noncentralized efforts

Congressional Action (1950-1970)

- Research Funding Proposals
- Air Pollution Control Act - 1955
- Increasing PHS Interest and Experience
- Clean Air Act - 1963
- Motor Vehicle Air Pollution Control Act - 1965
- Air Quality Act - 1967

Air Pollution Control Act of 1955

- "to preserve and protect the primary responsibility and rights of the States and local governments in controlling air pollution"
- HEW assistance to State and local agencies
- 1962 amendment to study motor vehicle exhaust

Increasing PHS Involvement

Clean Air Act of 1963

- basis of current air pollution law
- grants for establishing/expanding programs
- Federal abatement authority - new
- absence of air quality or emission standards

Motor Vehicle Air Pollution Control Act of 1965

Air Quality Act of 1967

- atmospheric areas and air quality control regions
- air quality criteria
- State-set ambient air standards
- implementation plans
- Federal action in case of State failure
- emergency authority

1970 - Present

- Clean Air Amendments of 1970
- Establishment of EPA - 1970
- Implementing the 1970 Amendments
- Proposed Amendments of 1976
- Clean Air Act Amendments of 1977

Clean Air Amendments of 1970

- National Ambient Air Quality Standards (NAAQS)
- Air Quality Control Regions - total coverage
- Implementation Plans
- National Standards of Performance for New Stationary Sources (NSPS)
- National Emission Standards for Hazardous Air Pollutants (NESHAPs)
- National Mobile Source Control Program
- Federal Facility Compliance
- Judicial Review Procedures
- Citizen Suit Provisions

Establishment of EPA - 1970

- Existing National APC Programs in HEW-PHS
- President's Reorganization Plan Number 3 of 1970
- Organizational Principles
  - functional
  - categorical
  - compromises
  - decentralization

Implementing the 1970 Amendments

- Federal-State Interactions
- Problems with 1975 Attainment
- Lawsuits
  - Air Quality Maintenance (AQM)
  - Prevention of Significant Deterioration (PSD)
  - Regulatory Action-Forcing

Proposed Amendments of 1976

- Nonattainment and Offsets
- PSD Controversy
- Lack of Resolution - Failure of Amendments

Clean Air Act Amendments of 1977

- Prevention of Significant Deterioration
- Nonattainment Area Plans
- (Upper Atmosphere) Ozone Protection
- NSPS Expansion
- Enforcement
- New Motor Vehicle Standards
- Penalties and Sanctions
- Miscellaneous (e.g., NCAQ)

Coming Attractions

Regulatory Development and Litigation

- PSD Regulations and Alabama Power
- PSD Set II Regulations
- Visibility Regulations
- Nonattainment Plans and State Suits

Recurring Issues

- PSD and Economic Development
- Transportation Planning
- Federal versus State/Local Authority and Responsibility

The Next Round of CAA Amendments

- When?
- How extensive?
- Progress or reaction? By whose definitions?

Chapter 17

Current Developments in Control Programs

Lesson Goal

To familiarize you with current technical and policy developments in Federal, State and local control programs and to encourage class discussion and exchange of information regarding these developments.

Lesson Objectives

Upon completion of this lesson, you should be able to:

1. name at least two current technical developments that potentially have an effect on control programs.
2. name at least two current policy developments that potentially have an effect on control programs.
3. discuss the effect of the technical developments named in objective #1.
4. discuss the effect of the policy developments named in objective #2.

References

None

Chapter 18

Sources of Information and Professional Development

Lesson Goal

To familiarize you with sources of information that will help you perform your job and with sources of information about job training.

Lesson Objectives

Upon completion of this lesson, you should be able to:

1. identify sources of technical and policy information related to your particular job.
2. identify sources of information about formal academic programs and short-term training programs in the field of air pollution control.
3. name a national professional association for air pollution control personnel.

References

1. *Directory of Governmental Air Pollution Control Agencies as of June 30, 1981.* Pittsburgh: APCA.
2. Colgate, C. Jr., and Broida, P. eds. _____. *National Trade and Professional Association of the United Sates and Canada and Labor Unions.* [latest] ann. ed. Washington: Columbia Books, Inc.
3. Halpin, P. 1977. Literature resources in A. C. Stern, ed. *Air Pollution.* 3rd ed. New York: Academic Press, Vol. II, pp. 611-663.

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
EPA-450/2-82-011		

4. TITLE AND SUBTITLE	5. REPORT DATE
APTI Course 452 Principles and Practice of Air Pollution Control Student Workbook	January 1982 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S)	**8. PERFORMING ORGANIZATION REPORT NO.**
J. E. Maroney, D. S. Beachler, B. M. Ray, D. R. Bullard, G. T. Joseph, K. M. Leslie	
9. PERFORMING ORGANIZATION NAME AND ADDRESS	**10. PROGRAM ELEMENT NO.**
Northrop Services, Inc. P.O. Box 12313 Research Triangle Park, NC 27709	B 18A2C **11. CONTRACT/GRANT NO.** 68-02-2374
12. SPONSORING AGENCY NAME AND ADDRESS	**13. TYPE OF REPORT AND PERIOD COVERED**
U.S. Environmental Protection Agency Manpower and Technical Information Branch Air Pollution Training Institute Research Triangle Park, NC 27711	Student Workbook **14. SPONSORING AGENCY CODE** EPA-OANR-OAQPS

15. SUPPLEMENTARY NOTES

Project Officer for this workbook is R. E. Townsend, EPA-ERC, MD-17, RTP, NC 27711

16. ABSTRACT

This Student Workbook is used in conjunction with Course #452, "Principles and Practice of Air Pollution Control," as designed and presented by the EPA Air Pollution Training Institute (APTI). It supplements the course lecture materials with lesson goals and objectives, literature references, and major slide images for note-taking. Topics covered are:

- Air Pollutants and Their Sources
- Effects of Air Pollution
- Air Pollution and the Law: The Clean Air Act
- Factors Affecting Pollutant Dispersion
- Influence of Topography on Pollutant Dispersion
- Air Pollution Sources and Source Regulations
- Measurement of Source Pollutant Emissions
- Ambient Air Quality Monitoring
- Control of Particulate Emissions from Stationary Sources
- Control of Gaseous Emissions from Stationary Sources
- Emission Inventories
- Enforcement Procedures and Source Inspections
- State Implementation Plans
- Control Program History
- Current Development in Control Programs
- Sources of Information and Professional Development

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Pollution Control Training Manual	Training Course Student Workbook	13 B 5 I 68 A

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)*	21. NO. OF PAGES
Unlimited Available from: National Technical Information Service, 5825 Port Royal Rd., Springfield, VA 22161	Unclassified 20. SECURITY CLASS *(This page)* Unclassified	22. PRICE

EPA Form 2220-1 (9-73)