EVE 402/502
Air Pollution Generation and Control

Chapter #2
Federal Legislation and
Regulatory Trends

Introduction

- Air pollution regulation has (basically) been enacted in order to protect human health
  - England took baby steps back in the 13th century
  - First efforts in the US didn't take place until the 1940s
  - Major developments took place between 1955 and 1970
    - Lots of trial and error
  - Significant changes in the 90s

Methods to Determine Health Effects Caused by Air Contaminants

- Adverse effects of air contaminants are studied by three primary methods:

1. Epidemiological Studies of Human Populations
   - Study effects to humans and other animals that have occurred (evidence-based medicine)
   - Typically study effects of contaminants at low concentrations during extended periods of time
   - Complicating factors due to co-existence of multiple contaminants

2. Laboratory Studies of Humans that are Exposed to Known Air Contaminants

- Study human response to exposure of individual components (exercise, concentrations of specific contaminants, degree of sensitivity)
- Laboratory measurements are more specific and sensitive than field measurements
- Short duration of intensive experiments
- Study humans before, during, and after exposure

3. Laboratory Studies of Animals and Plants that are Exposed to Known Air Contaminants

- Study animals and plants before, during, and after exposure
- Greater flexibility with respect to contaminant type, concentration and duration of exposure
- Difficult to extrapolate results from animals and plants to humans
- Difficult to extrapolate results from short-term high-concentration exposure to long-term low-concentration effects

Air Quality Laws and Regulations

- Typically air quality laws are mandated by the federal government in the form of the Clean Air Act (1963), and its amendments in 1970, 1977, and 1990. These laws are then interpreted to develop regulations such as the National Ambient Air Quality Standards (NAAQS), New Source Performance Standards (NSPS), and, National Emission Standards of Hazardous Air Pollutants (NESHAP).

The regulations are based on considerations such as type of contaminant, concentration of contaminant, mass emission rate of contaminant, averaging time, cost and/or availability of air quality control technology.

Clean Air Act Amendments of 1970

- Goal: Clean air by July 1975
- Established United States Environmental Protection Agency (USEPA)
- Provided funds to support research programs at the state and regional level
- Established National Ambient Air Quality Standards (NAAQS)

CAAA of 1970

- Development of State Implementation Plans (SIPs)
- Required Reasonably Available Control Technology (RACT) for certain existing sources
- Established New Source Performance Standards (NSPS) for certain new, modified, or reconstructed sources

CAAA of 1970

- Enforcement of National Emission Standards for Hazardous Air Pollutants (NESHAPs)
  - From 1973 to 1984, the number of hazardous air pollutants (HAPs) increased from 3 to 8
  - NESHAPs limit emissions of materials that may cause an increase in fatalities or serious, irreversible, or incapacitating illness

- Requirement of Best Available Control Technology (BACT) that is determined on a case-by-case basis considering economic, environmental, and energy constraints (RACT < NSPS < BACT < MACT (Maximum Achievable Control Technology)
- Establish air quality monitoring requirements
- Establish fines and criminal penalties
- Establish standards for aircraft
- Establish more strict automobile emission standards

Clean Air Act Amendments of 1977

- States must submit revised SIPs
- Classification of areas with respect to NAAQS
- Establish policy pertaining to non-attainment areas

- Expansion of the concept of Prevention of Significant Deterioration (PSD)
  - If an area meets the NAAQS, how much worse will it be allowed to get?
- New major facilities must apply to BACT standards
- Establish Good Engineering Practice (GEP) for stack height

Clean Air Act Amendments of 1990

Urban Air Quality: Ambient air quality regulations pertaining to O_3, CO, and PM_{10} were strengthened

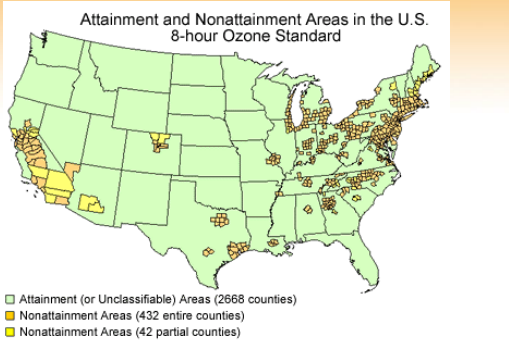
There were 96 cities that failed existing O_3 standards and were ranked from marginal to extreme. New control strategies included upgraded inspection and maintenance programs for automobiles, vapor recovery systems, transportation controls to reduce the amount of vehicle miles driven in an urban area, and stricter controls for stationary sources

Carbon monoxide standards were not met in 41 cities and those cities were ranked from moderate to serious. Possible control strategies included initiating or upgrading inspection and maintenance programs for vehicles and transportation controls.

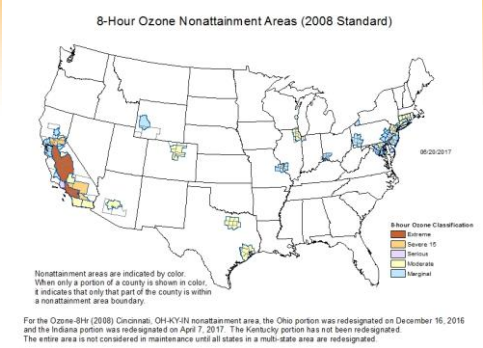
Particulate:The 72 cities that did not meet the PM_{10} standard needed to implement RACT and other types of control strategies.

A history of federal O_3 regulation in the US

Year	Primary/ Secondary	Indicator	Averaging Time	Level	Form
1971	Primary and secondary	Total photochem. oxidants	1 hr	0.08 ppm	Not to be exceeded more than one hour per year
1979	Primary and secondary	O_3	1 hr	0.12 ppm	The wording is complicated...however, it's basically the same as above
1997	Primary and secondary	O_3	8 hr	0.08 ppm	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
2008	Primary and secondary	O_3	8 hr	0.075 ppm	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
2015	Primary and secondary	O_3	8 hr	0.070 ppm	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years

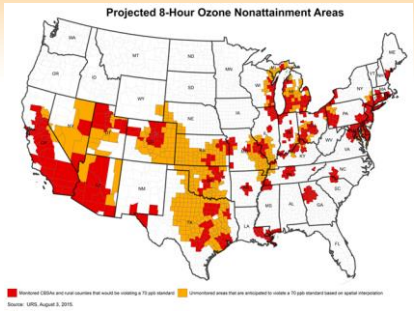


https://archive.epa.gov/ozonedesignations/web/html/nonattaingreen.html



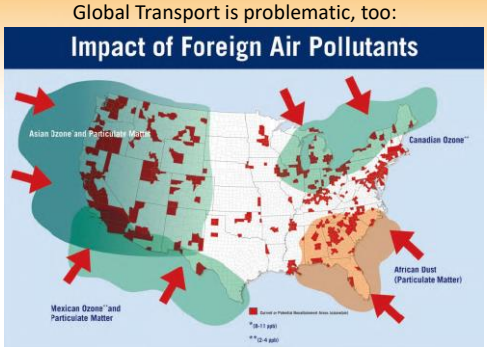
https://www3.epa.gov/airquality/greenbook/map8hr_2008.html

Anticipated impact of 2015 O_3 revision:

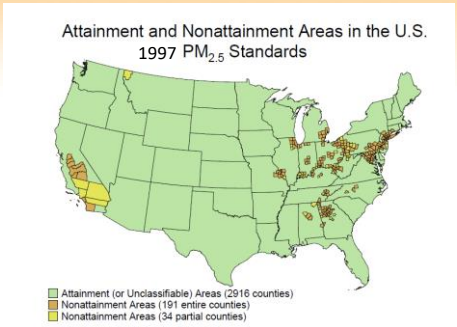


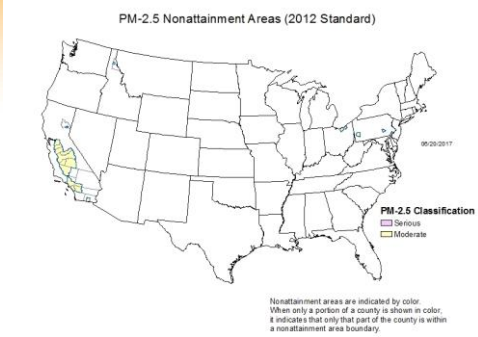
https://www.uschamber.com/issue-brief/ozone-national-ambient-air-quality-standards

Global Transport is problematic, too:

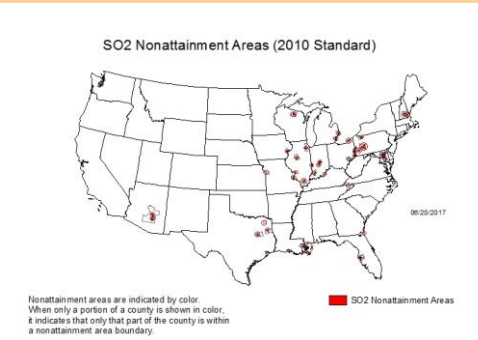


https://www.uschamber.com/issue-brief/ozone-national-ambient-air-quality-standards

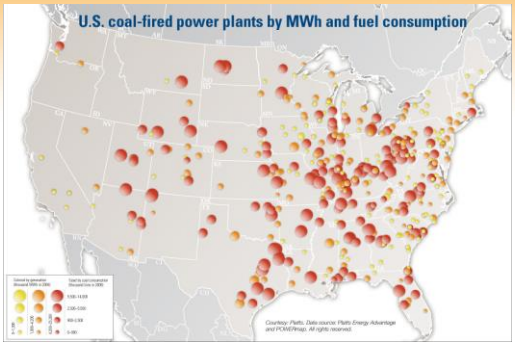




https://www3.epa.gov/airquality/greenbook/mappm25_2012.html



https://www3.epa.gov/airquality/greenbook/mapso2_2010.html



Red: highest output plants
Largest circles: highest coal consumption plants

CAAA, 1990

Permits: USEPA's ability to enforce standards was enhanced by requiring that a facility obtain a five year operating permit for the entire facility. Also facilities were required to pay permit fees that reimburse state agencies for costs incurred to operate the permit program.

Motor Vehicles: Allowable emissions of hydrocarbons, carbon monoxide, and nitrogen oxides were reduced for 1994 vehicles. Also, emission standards needed to be met for longer time periods. Emphasis was also placed on the use of reformulated gasoline to reduce the aromatic content of gasoline used in heavily polluted urban environments. Oxygenated fuels (e.g., alcohol blended fuels) were also to be sold during the winter in cities with elevated carbon monoxide concentrations.

Hazardous Air Pollutants (HAPs):

Emissions of 187 hazardous air pollutants (e.g., carcinogens, mutagens, and reproductive toxins) were to be reduced within 10 years. The list of HAPs is revised with time. The list of toxic materials were to be published by EPA within one year of the passage of the 1990 CAAA. MACT requirements are to be developed for specific source categories.

Acid Deposition: A market-based system was implemented to reduce the amount of sulfur dioxide emitted into the atmosphere from utility power plants. The amount of nitrogen oxides emitted from utility power plants was reduced by implementing performance-based standards.

Ozone Depletion: Restrictions pertaining to chloro-fluoro-carbons (CFCs) will be more strict than previously defined by the Montreal Protocol. Production of carbon tetrachloride and methyl chloride will be phased out by 2000, methyl chloroform will be phased out by 2002, and CFC production will be phased out by 2030. Use of CFCs in "nonessential" applications will be prohibited after November 1992. Warning labels are also required on all containers and products that contain CFCs and other ozone-depleting materials.

Enforcement: EPA can assess penalties up to $200,000 and require that violations be corrected without filing a court case. "Field citations" can also be issued up to $5000/day by EPA inspectors. Recipients of penalties and citations are entitled to an administrative hearing if they disagree with EPA's findings. Violations of environmental emergency orders can be as high as $25,000/day.

Also, premeditative release of hazardous air pollutants that place a person in imminent danger can result in 15 years in jail and a fine up to $1M. Negligent releases are punishable by up to one year in jail and a fine.

$10,000 can be awarded to citizens who provide information leading to criminal convictions or civil penalties associated with the Clean Air Act of 1990.

Titles of the Clean Air Act of 1990

Title I	Provision for attainment and maintenance of NAAQS	Title VII	Provisions relating to enforcement
Title II	Provisions relating to mobile sources	Title VIII	Miscellaneous provisions
Title III	Hazardous air pollutants	Title IX	Clean air research
Title IV	Acid deposition control	Title X	Disadvantaged business concerns
Title V	Permits	Title XI	Job displacement provisions
Title VI	Stratospheric ozone protection		

National Ambient Air Quality Standards (NAAQS)[a]

Carbon Monoxide (CO)

Primary Standards*	9 ppm for 8 hour[b] 35 ppm for 1 hour[b]
Secondary Standards	N/A

Limits carboxyhemoglobin concentration in blood.

[a]Values given for 25°C and 760 mm Hg
*Aggravation of cardiovascular disease
[b]Not to be exceeded more than once per year

http://www.epa.gov/air/criteria.html

Effects Associated with Exposure to Carbon Monoxide

Concentration	Exposure	Effects
80-97 mg/m^3 17-21 mg/m^3	1 hr 8 hr	Sensitive subjects have reduced exercise capacity
115 mg/m^3	8 hr	Dizziness and headaches
97-241 mg/m^3		Impairment of maximum sustained exercise in healthy human subjects

Lead (Pb)

Primary Standard*	0.15 μg/m^3 for 3 months
Secondary Standard	Same as primary

*Increased concentration of Pb in blood

Increased exposure to Pb causes impairment of porphyrin metabolism (synthesis of hemoglobin), learning disabilities, and seizures.

Nitrogen Dioxide (NO_2)

Primary Standards*	100 ppb for 1 hour[a] 53 ppb (annual mean)
Secondary Standard	53 ppb (annual mean)

NO_2 also contributes to the formation of photochemical oxidants

*Risk of acute and chronic respiratory disease
[a]98th percentile, averaged over 3 years

Effects Associated with Exposure to Nitrogen Dioxide

Concentration	Exposure	Effects
150-188 µg/m^3	Over several years	Increases incident of acute respiratory disease in children and their parents
207 µg/m^3	8 hr	Reduction in ventilatory function for asthmatics

Ozone (O_3)

Primary Standard* 0.070 ppm_v for 8 hour[a]

Secondary Standard Same as primary

*Eye irritation and respiratory function impairment

[a]Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years

Effects Associated with Exposure to Photochemical Oxidants

Concentration	Exposure	Effects
98 µg/m^3	4 hr	Vegetation damage
255 µg/m^3	Daily maximum	Subjects with respiratory disease are impaired

Particulate Matter with diameter < 10 µm (PM_{10})

Primary Standard*	150 µg/m^3 for 24-hr[a]
Secondary Standard	Same as primary

*Reduction in ventilatory function

[a]Not to be exceeded more than once per year on average over 3 years

Particulate Matter with diameter < 2.5 µm ($PM_{2.5}$)

Primary Standard	12 µg/m^3 annual mean[a]
Secondary Standard	15 µg/m^3 annual mean[a]
Primary and Secondary	35 µg/m^3 24-hr[b]

1997-2002: Review of $PM_{2.5}$ health effects
2012-2017: Attainment of $PM_{2.5}$ standards should be achieved

[a]Annual mean, averaged over 3 years
[b]98th percentile, averaged over 3 years

Effects Associated with PM Exposure

Concentration	Effects
60-180 µg/m^3 TSP with SO_2 and relative humidity (RH) effects	Corrosion of steel and zinc plates
150 µg/m^3 TSP (RH<70%)	Visibility reduced to ~ 5 miles
100-130 µg/m^3 TSP with SO_2 > 0.05 ppm_v	Increased incidence of respiratory disease
750 µg/m^3 TSP with SO_2 > 0.27 ppm_v	Excessive deaths

Sulfur Dioxide (SO_2)

Primary Standard*	75 ppb for 1-hr[a]
Secondary Standard	0.5 ppm for 3-hr[b]

*Aggravation of chronic lung disease and increased risk of acute and chronic respiratory illness

[a]99th percentile of 1-hour daily maximum concentrations, averaged over 3 years

[b]Not to be exceeded more than once per year

Effects Associated with SO_2 Exposure

Concentration	Effects
105-236 µg/m^3	Annual mean exposure to 185 µg/m^3 smoke is associated with increased occurrence of respiratory symptoms and lung disease
288-497 µg/m^3 (24 hr mean)	Associated with increased rate of hospitalization of sensitive population groups (elderly)
785 µg/m^3	Tree damage