Chapter 1: Ozone and Major Control Programs

Ozone Formation and Effects

Ground-level ozone pollution is common in many parts of the United States. While ozone levels in urban areas can be high because of concentrated local sources of ozone-forming pollutants, ozone levels in both urban and rural areas are affected by regional transport—the movement of ozone and/or its precursors by the wind. Because of transport, ozone levels can also be elevated in rural areas with few local emission sources.

EPA revised its national air quality standards for ozone in 1997, establishing an 8-hour standard to better protect public health. The 8-hour standard is 0.08 parts per million (ppm). An area meets the standard if the 3-year average of the annual fourth highest daily maximum 8-hour average concentration is less than or equal to 0.08 ppm.

In April 2004, EPA designated 126 areas in the United States as nonattainment for the 8-hour ozone standard,

About Ground-Level Ozone

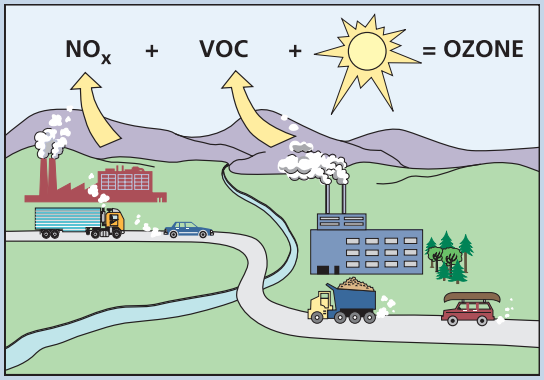
Location & Formation: Beneficial ozone occurs naturally in Earth's upper atmosphere (the stratosphere), where it shields the planet from the sun's harmful ultraviolet rays. At ground level, harmful ozone pollution forms when emissions of NO_X and VOCs react in sunlight. Because ground-level ozone is highest when sunlight is most intense, the warm summer months (May 1 to September 30) are generally referred to as the "ozone season."

Health Effects: Ozone can aggravate respiratory diseases, such as asthma, emphysema, and bronchitis, and can reduce the respiratory system's ability to fight off bacterial infections. Even healthy people can have symptoms related to ozone exposure. Over time, ozone reduces lung function. And recent research suggests that acute exposure to ozone likely contributes to premature death.

Transport: Wind can affect both the location and concentration of ozone pollution. NO_X and VOC emissions can travel hundreds of miles on air currents, forming ozone far from the original emission sources. Ozone also can travel long distances, affecting areas far downwind. High winds tend to disperse pollutants and can dilute ozone concentrations. Light winds, on the other hand, allow pollution levels to build up and become more concentrated.

Ecological Impacts: Ground-level ozone damages vegetation and ecosystems, leading to reduced agricultural crop and commercial forest yields, and increased plant susceptibility to diseases, pests, and other stresses, such as harsh weather. Ozone also damages the foliage of trees and other plants, adversely affecting the landscape of cities and national parks, forests, and recreation areas.

To learn more about ozone and its health impacts, please visit the AIRNow Web site at <www.airnow.gov>. For information on the health and ecological effects of ozone, go to <http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=114523>. For more about the relationship between emissions and ozone formation, visit <www.epa.gov/airtrends>.



based on ozone levels from 2001-2003 (see Figure 1). The vast majority of these are in the East (404 counties or partial counties) and are home to more than one-third of all Americans.

Reducing Ozone Pollution: Major Control Programs for NO_X and VOCs

The majority of NO_X and VOC emissions in the eastern United States come from three types of sources: mobile sources, industrial processes, and the electric power industry. Mobile sources and the electric power industry were responsible for 78 percent of annual NO_X emissions in 2004 (see Figure 2). That same year, 99 percent of VOC emissions came from industrial processes (including solvents) and mobile sources. Emissions from natural sources, such as trees, may comprise a significant portion of total VOC emissions, especially during the ozone season. Figure 2 does not include these emissions.

EPA has developed more than a dozen control programs since 1990 to reduce ozone by decreasing emissions of NO_X and VOCs (see Table 1). These programs complement state and local efforts to improve ozone air quality and meet national standards.

Figure 1: 8-hour Ozone Nonattainment Areas

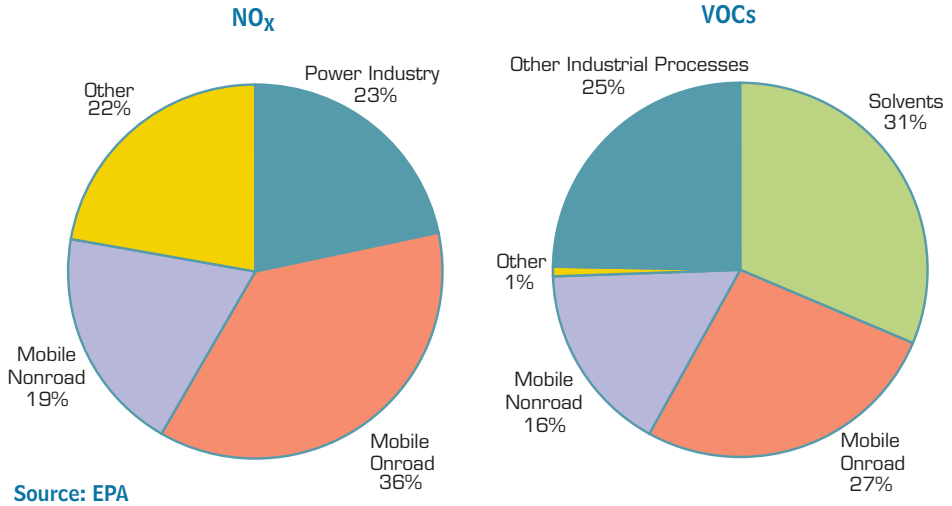
Nonattainment areas

Source: EPA

Notes:

- Map includes partial counties.
- Nonattainment areas as of of April 2004

Figure 2: Sources of NO_X and VOC Annual Emissions in the Eastern United States, 2004

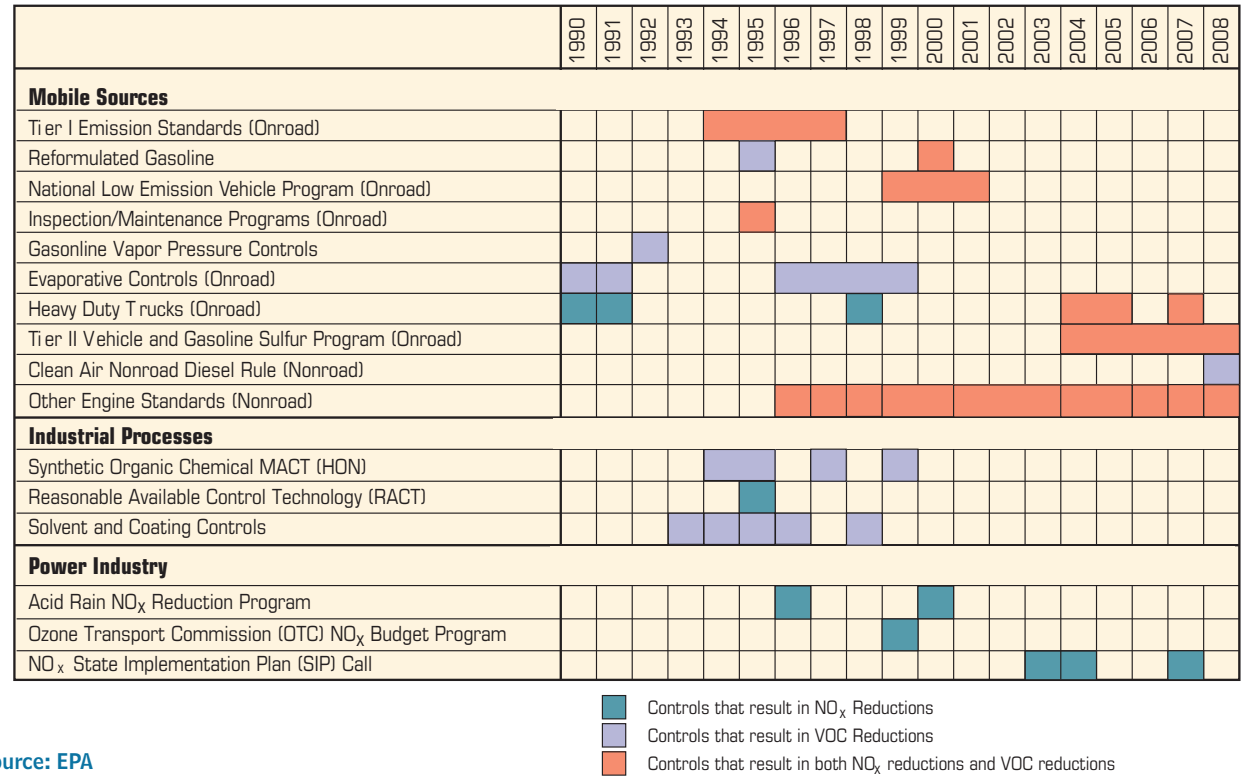


Source: EPA

Notes:

- Emissions are from the following states: Minnesota, Iowa, Missouri, Arkansas, Louisiana, Wisconsin, Illinois, Tennessee, Mississippi, Michigan, Indiana, Kentucky, Alabama, Florida, Georgia, South Carolina, North Carolina, Virginia, West Virginia, Ohio, Pennsylvania, Delaware, Maryland, District of Columbia, New Jersey, Connecticut, Rhode Island, Massachusetts, New Hampshire, New York, Vermont, and Maine.
- The Other category for NO_X emissions includes some industrial boilers and smaller sources such as residential fuel combustion.
- Emissions are projected from EPA's preliminary 2002 National Emissions Inventory (NEI).

Table 1:
Major EPA NOx and VOC Emission Control Programs since 1990



Source: EPA

Notes:

- **Years highlighted indicate implementation or compliance dates.**
- **Early reductions occur prior to compliance date.**
- **In many cases, engine standards are phased in over multiple model years. In some cases the time periods overlap.**
- **For fuel standards, year indicates when the fuel was made available.**

Mobile Sources

Emission control programs established for mobile sources in the 1990s include regulations for new vehicles and for fuels. Benefits from vehicle engine standards increase modestly each year as older, more-polluting vehicles are replaced with newer, cleaner models. In time, these programs yield substantial emission reductions. Benefits from fuel programs generally begin as soon as a new fuel is available.

As Table 1 shows, many of the mobile source controls required since the mid-1990s apply to onroad vehicles, such as cars and trucks. EPA also has established programs to reduce emissions from nonroad mobile sources, including the Clean Air Nonroad Diesel Rule of 2004. This rule includes new engine standards that will reduce NO_X emissions and particle pollution by 90 percent from nonroad diesel engines used to power equipment such as backhoes, tractors, material heavy forklifts, and airport service vehicles. The rule's particle pollution controls will also yield VOC reductions.

Industrial Processes

Large VOC reductions from industrial processes during the 1990s primarily resulted from solvent controls. These emission reductions typically occur where and when the solvent is used, such as during commercial and residential painting. In some cases, states are required to adopt Reasonably Available Control Technology (RACT) for major industrial sources of NO_X and VOCs. Implemented in the late 1990s, RACT is expected to achieve an average of 30 to 50 percent

NO_X reduction per major NO_X emission source. EPA's New Source Review Program (not shown in Table 1) requires new industrial facilities or existing facilities making major modifications to install Best Available Control Technology to limit emissions.

In addition, EPA's rule that controls hazardous air pollutants (commonly referred to as the "HON") is expected to reduce emissions of VOCs generated by the synthetic organic chemical manufacturing industry and several other processes by 1 million tons per year from 1999 levels.

The Power Industry

The power industry is one of the largest emitters of NO_X in the United States. Power industry emission sources include large electric generating units and some large industrial boilers and turbines. There are three major control programs that affect the power industry: EPA's Acid Rain Program, the Ozone Transport Commission's NO_X Budget Program, and EPA's NO_X SIP Call.

The Acid Rain NO_X Reduction Program

Congress established the Acid Rain Program as part of the Clean Air Act Amendments of 1990. This national program reduces sulfur dioxide (SO_2) and NO_X emissions from coal-fired electric generating units greater than 25 megawatts (MW). The Acid Rain Program's NO_X Reduction Program is not a cap and trade program. Instead, affected sources must meet certain NO_X emission rates established for different coal-fired boiler types (emission rates are the amount of NO_X emitted per unit of heat input). Companies can develop emissions averaging plans that provide compliance flexibility. The program began in 1996 for the largest NO_X emitters among coal-fired electric generating units; a second phase to reduce NO_X emissions from the remaining coal-fired generating units began in 2000.

The OTC NO_X Reduction Programs

The Ozone Transport Commission (OTC) was established under the Clean Air Act to help reduce summertime ground-level ozone in the Northeast and mid-Atlantic regions. In 1995, the OTC required existing stationary sources to reduce NO_X emissions to meet RACT limits. From 1999 to 2002, most of the states in the OTC region implemented the OTC NO_X Budget Program. This program achieved reductions in NO_X from fossil fuel-fired electric generating units and large industrial boilers and turbines through an ozone season (May 1 through September 30) cap and trade program. The second phase of the OTC NO_X Budget Program was slated to begin on May 1, 2003, but was superseded by EPA's NO_X SIP Call. The OTC states include: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, and Washington, D.C.[1]

The NO_X SIP Call

In 1995, EPA and the Environmental Council of the States formed the Ozone Transport Assessment Group to begin addressing the problem of ozone transport in the eastern United States. In 1998, based on the group's

What Is Cap and Trade?

Cap and trade is a policy tool for reducing emissions from a group of sources over a broad geographic region.

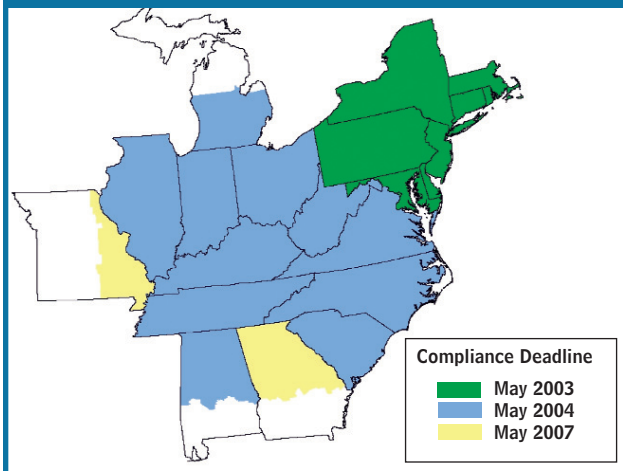
This approach first sets an overall cap, or maximum amount of emissions per compliance period, for all sources under the program. Authorizations to emit, known as emission allowances, are then allocated to affected sources. The total number of allowances allocated cannot exceed the cap.

Under an emissions cap and trade program, sources have flexibility to choose how to meet the emission reduction requirements. A source may either limit emissions to meet the number of allowances it receives each compliance period, or it may purchase additional allowances. Sources with emissions below their limits may sell excess allowances or save ("bank") them for future use.

Sources must accurately measure and routinely report all emissions to guarantee that the overall emissions cap is achieved. Rigorous emissions monitoring ensures credibility of trading programs. For more on emissions cap and trade programs, visit <www.epa.gov/airmarkets>.

[1] Maine, Vermont, and Virginia did not join the OTC trading program. New Hampshire is not subject to requirements of the NO_X SIP Call.

Figure 3: NO_X SIP Call Region, Program Implementation



Source: EPA

findings and other technical analyses, EPA issued a regulation to reduce the regional transport of ground-level ozone. This rule, commonly called the NO_X SIP Call, requires states to reduce ozone season NO_X emissions that contribute to ozone nonattainment in other states.

Compliance with the NO_X SIP Call was scheduled to begin in 2003. The OTC states adopted the original compliance date of May 1, 2003, in transitioning to the NO_X SIP Call. In states outside the OTC region, however, litigation delayed the initial deadline until May 31, 2004. For those states, the first compliance period (2004) was for a shorter-than-normal ozone season (see Figure 3). In addition, litigation delayed the start date for portions of Georgia and Missouri until 2007. EPA has proposed to stay the NO_X SIP Call requirements for Georgia while it responds to a petition to reconsider Georgia's inclusion in the NO_X SIP Call.

The NO_X SIP Call did not mandate which sources must reduce emissions; rather, it required states to meet an overall emissions budget and gave them flexibility to develop control strategies to meet that budget. All affected states chose to meet their NO_X SIP Call requirements by participating in the NO_X Budget Trading Program (NBP).

The NO_X Budget Trading Program

More than 2,500 units were affected under the NBP in 2004. These include electric generating units, which are large boilers, turbines, and combined cycle units used to generate electricity for sale. As shown in Figure 4, electric generating units constitute more than 85 percent of all regulated units. The program also applies to large industrial units that produce electricity and/or steam, primarily for internal use. Examples of these units are boilers and turbines at heavy manufacturing facilities, such as paper mills, petroleum refineries, and iron and steel production facilities. These units also can include steam plants at institutional settings, such as large uni-

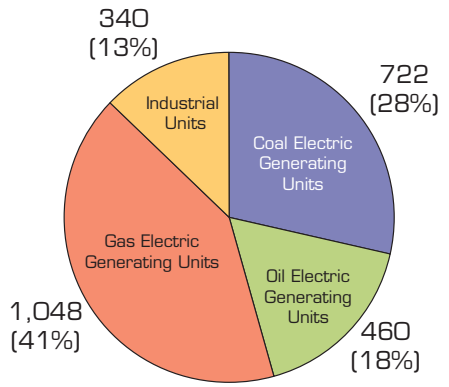
Key Components of the NO_X Budget Trading Program

- The NBP is a cap and trade program for electric generating units and large industrial boilers and turbines.
- The emissions budget sets a cap on emissions at a level chosen to help states meet their air quality goals.
- The NO_X emissions market allows sources to trade (buy and sell) allowances throughout the year.
- At the end of every ozone season, each source must surrender sufficient allowances (each allowance represents one ton of emissions) to cover its ozone season NO_X emissions. This process is called annual reconciliation.
- If a source does not have enough allowances to cover its emissions, EPA will automatically deduct allowances from the following year's allocation at a 3:1 ratio.
- If a source has excess allowances because it reduced emissions beyond required levels, it can sell the unused allowances or "bank" (i.e., save) them for use in a future ozone season.
- To accurately monitor emissions, sources use continuous emissions monitoring systems (CEMS) or other approved monitoring methods under EPA's stringent monitoring requirements (40 CFR Part 75).

versities. Some states have included other types of units, such as petroleum refinery process heaters and cement kilns.

Two criteria are part of determining whether a unit is affected under the NBP: the unit must be fossil fuel-fired and must meet specific size thresholds. For electric generating units, the program generally applies to any unit connected to a generator with a nameplate capacity (the power output in MW that the machine is designed to produce) greater than 25 MW. Some OTC states, however, include units connected to generators with at least 15 MW capacity. For industrial units, the NBP applies to units with a maximum design heat input capacity greater than 250 million British thermal units per hour (mmBtu per hr).

Figure 4:
Number of Units in the NO_X Budget Trading Program by Type, 2004



Source: EPA

Note: Total affected units in 2004 = 2,570

State Trading Budgets, Allowance Allocations, and Compliance Supplement Pool (CSP) Allowances

EPA provided broad discretion to states as to how they could allocate allowances from their trading budget to affected sources. One option was to allocate allowances based on each source's share of statewide ozone season heat input (i.e., fuel use). Another option was based on each source's share of ozone season output (e.g., generation) to reward sources that generate more energy with less fuel input. States could also set-aside allowances for new sources or as incentives for energy efficiency and renewable energy programs.

In addition to their NO_X budgets, states received additional allowances to distribute from the Compliance Supplement Pool (CSP). EPA created the CSP allowances to address concerns that initial efforts to comply with the NO_X emissions cap could have too many primary electric generating units out of operation at the same time to install pollution control retrofits, which could have adversely affected electricity supply reliability. The CSP allowances help states to phase-in compliance during the first two years of the trading program and allow sources to limit units out of service at critical times during the year. States were allowed to distribute their CSP allowances based on early reductions in NO_X emissions, on the basis of demonstrated need, or on some combination of the two methods.

The CSP allocation was a one-time, up-front allocation. For the states that began to comply with the NO_X SIP Call in 2003 (states that had been a part of the OTC trading program), all CSP allowances were distributed as vintage year 2003 allowances and replaced existing banked OTC allowances. The non-OTC states distributed CSP allowances as vintage year 2004 allowances. The vintage is the first year an allowance can be used for compliance (i.e., deducted to cover emissions). For example, almost all 2004 vintage allowances may be used for compliance beginning in 2004, or for any year thereafter. The only exception is the 2004 CSP allowances, which may only be used for compliance through the 2005 ozone season.