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Air Quality Regulation in the United States

A complicated system yields laudable results

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A complex network of federal and state environmental regulations has developed over the years to protect our environment, and these regulations are typically structured to address pollutants affecting soil, water, or air. Notwithstanding the notably complicated regulations found in soil and water regulatory programs such as the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA, more commonly known as "Superfund") or the federal Clean Water Act (CWA), air quality regulation is the hands-down winner in statutory and regulatory complexity. The federal Clean Air Act (CAA) alone has been referred to as the most complicated statute in history. The statutory complexity is compounded by the thousands of pages of federal regulations and the overlapping statutes and regulations adopted by each individual state.

The federal CAA is the principal air quality legislation in the United States, employing three strategies for protecting air quality. First, individual states are given the duty to monitor ambient air, i.e., "outdoor air" as opposed to air inside buildings, for compliance with federal air quality standards and to take actions to improve air quality where necessary. Second, pollutants from mobile sources, e.g., cars, trucks, construction equipment, and lawn mowers, are controlled by requiring manufacturers to meet national emissions standards. Third, discrete sources of pollution from individual facilities such as factories, power plants, and landfills are regulated to ensure that emissions will not degrade air quality in the local area around the facility or contribute to degradation of the ambient air quality anywhere. The U.S. Environmental Protection Agency (EPA) is primarily responsible for implementing the provisions of the CAA.

Protecting the Ambient Air

Ambient air quality in the United States is required to meet National Ambient Air Quality Standards (NAAQS, commonly pronounced "naks") that are the keystone of the U.S. air quality program. The CAA defines "primary" standards, which are set at levels to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly, with an adequate margin of safety. The CAA also sets "secondary" standards, which are set at levels to protect public welfare, including protection against visibility impairment and damage to animals, crops, vegetation, and buildings. The CAA requires periodic review of the science upon which the NAAQS are based and the NAAQS themselves. Since the ambient air can be polluted by emissions from every type of source, the regulatory scheme is very inclusive.

The CAA identifies NAAQS for six "criteria" air pollutants that have been found to be detrimental to human health and to be pervasive across the country. These six NAAQS pollutants are sulfur dioxide, particulate matter, nitrogen dioxide, lead, carbon monoxide, and ozone. The levels of these six pollutants in the ambient air must be below the primary NAAQS for each pollutant. Each state is

required to demonstrate that every part of the state meets the NAAQS for each of these six pollutants.

There are a number of observed health effects resulting from exposure to excessive levels of the six NAAQS air pollutants. For example, ozone damages lung tissue, reduces lung function, and sensitizes the lungs to other irritants. Elevated carbon monoxide levels can cause impairment of visual perception, manual dexterity, learning ability, and performance of complex tasks. Nitrogen dioxide can irritate the lungs, cause bronchitis and pneumonia, and lower resistance to respiratory infections. High concentrations of sulfur dioxide affect breathing and may aggravate existing respiratory and cardiovascular diseases. Sulfur dioxide is also a primary contributor to acid deposition, or acid rain, which causes acidification of lakes and streams and can damage trees, crops, historic buildings, and statues. Sulfur compounds in the air also contribute to visibility impairment in large parts of the country, especially noticeable in national parks. The health effects from excessive exposure to lead are seizures, mental retardation, and/or behavioral disorders.

The basis for particulate matter health effects requires some explanation in that the health concerns arise simply from the size of the pollutant. Particulate matter is a complex mixture of extremely small particles and liquid droplets and may consist of acids, organic chemicals, metals, and soil or dust particles. Health effects from particulate matter exposure include breathing and respiratory symptoms, aggravation of existing respiratory and cardiovascular disease, alterations in the body's defense systems against foreign materials, damage to lung tissue, carcinogenesis, and premature death. Particulate matter also is a major cause of visibility impairment in the United States. Similar to the ozone standard, the particulate matter NAAQS has been tightened in recent years to control much smaller particles, which are a greater health concern because finer particles can penetrate deeper into the lungs. The previous "PM10" standard, meaning a standard for particles with a diameter of 10 micrometers or less, was changed to the current "PM2.5" or "fine particle" standard. For reference, 2.5 micrometers is approximately one-thirtieth the diameter of a human hair, and several thousand particles could fit on the period at the end of this sentence.

To protect against these health and public welfare effects, numerical NAAQS standards are set and are defined in terms of parts per million (ppm). One ppm denotes one particle of a substance for every 999,999 other particles; e.g., one drop of ink in a 40-gallon drum of water, or one second per 280 hours (11 days, 16 hours). Some of the NAAQS have short-term and long-term concentration levels. The short-term standards address acute health effects resulting from exposure to short-duration, higher concentrations of a contaminant, whereas the long-term standards are intended to protect against chronic health effects caused by long-term exposure to lower levels of a contaminant. For example, sulfur dioxide has a short-term, 24-hour standard of 0.14 ppm and a long-term annual standard of 0.030 ppm. This means that the ambient air is healthy when the long-term annual average levels of sulfur dioxide remain under the annual limit and when there are short excursions of higher levels of sulfur dioxide (up to the short-term 24-hour exposure limit).

A geographic area is in "attainment" of the NAAQS for any one of the six criteria pollutants where the concentration of that pollutant in the ambient air is below the regulatory standard, and an area is in "nonattainment" for a NAAQS pollutant where the concentration level is above the standard. An area can be simultaneously in attainment for one pollutant while in nonattainment for another. When an area is found to be in nonattainment of the NAAQS, the CAA establishes deadlines for the state to correct the air quality problems. The CAA also provides for sanctions if the area fails to return to attainment by the deadline. These sanctions include curtailing federal highway dollars, withholding grants for highway development, requiring new facilities (i.e., new sources of emissions) to purchase air emission offset credits at a rate of two to one, and having the federal government take control of the area's air quality programs. These sanctions have the twofold purpose of preventing increases in air pollutants (e.g., by not building highways, thereby limiting the increase in car pollution and dissuading new businesses from locating in the area) and encouraging the area to take affirmative actions to improve its own air quality problems (i.e., to avoid sanctions that would hurt its economy). There is also a third classification of "unclassifiable," which is reserved for areas of the country that

cannot be classified on the basis of available information.

As noted, pollutants entering the ambient air can come from many stationary and mobile sources related to human activities (called "anthropogenic sources") and from natural sources. The most complicated of the pollutants is ozone because it is a "reactive" pollutant, meaning that it forms by a chemical reaction in the air. Although it occurs naturally in the stratosphere to provide a protective layer high above the earth, at ground level it is the prime ingredient of smog. Ozone is directly emitted by few sources, but instead forms when nitrogen oxides and volatile organic compounds (VOCs) combine in the presence of sunlight in hot summer months. Nitrogen oxides are a product of combustion and so are emitted wherever fuels are burned. Motor vehicles, power plants, manufacturing plants, aircraft, fireplaces, barbecue grills, and a host of other combustion sources produce nitrogen oxides. Volatile organic compounds, as the name implies, are organic compounds that readily evaporate into the air under normal atmospheric conditions and are likewise emitted from a variety of sources. Typical VOCs are alde-hydes, ketones, hydrocarbons, etc., and VOC sources include motor vehicles, chemical plants, refineries, factories, consumer and commercial products, and other industrial sources. Interestingly, trees are an important biological source of VOCs (e.g., terpene from pine trees, a major component of resin used to make turpentine) and significantly contribute to ozone formation in certain parts of the country.

Other NAAQS pollutants are more readily identifiable to specific sources. Most of the carbon monoxide pollution in the air comes from mobile sources. In fact, 77 percent of the nationwide carbon monoxide emissions are from the transportation sector, with the largest contribution coming from highway motor vehicles. Other major sources of carbon monoxide are wood-burning stoves, incinerators, and industrial facilities. Ambient levels of sulfur dioxide result largely from stationary sources such as coal and oil combustion, steel mills, refineries, pulp and paper mills, and nonferrous smelters. Other sources of sulfur dioxide include diesel engines and natural sources, e.g., volcanic eruptions.

Particulate matter encompasses a broad assortment of pollutants emitted by many different types of sources. Dust, dirt, soot, smoke, and liquid droplets directly emitted into the air by sources such as factories, power plants, cars, construction activity, fires, and natural windblown dust all cause increased particulate matter levels in the ambient air. Particles formed in the atmosphere by condensation or the transformation of emitted gases such as sulfur dioxide and VOCs also are considered particulate matter. In contrast to the broad array of particulate matter sources, lead is emitted by a more limited number of sources. Lead gasoline additives, nonferrous smelters, and battery plants are the most significant contributors to atmospheric lead emissions.

States are in the best position to identify and regulate the myriad of sources that generate air pollutants and, pursuant to the CAA, are the primary governmental entities responsible for developing plans to restore air quality in nonattainment areas. For example, many areas of the country struggle with controlling ozone, which, as noted above, is a pollutant formed by a chemical reaction between nitrogen oxides and VOCs in the presence of sunlight. Therefore, if an area has an ozone problem, the state, working with local officials, must first determine the sources of the nitrogen oxides and VOC emissions and then develop a strategy for controlling the components of the ozone reaction. Although sunlight is also a component of the ozone reaction, so far there have been no efforts to regulate sunlight.

The mechanism identified under the CAA for the states to use in developing a plan is the State Implementation Plan (SIP). The SIP is a state's road map for reducing emissions and taking other steps as necessary to return air quality to compliance with the NAAQS. As required under the CAA, the SIP contains emission limitations, provisions for gathering air quality data, and enforcement provisions; addresses interstate and international transport of pollutants; provides for adequate staffing and funding of the regulatory authority; and includes a number of other requirements for assuring that each nonattainment area will return to attainment status. SIPs must be approved by the

EPA and must be reviewed frequently and modified to ensure the state is on track to achieve air quality standards.

In addition to the air regulatory programs required under the federal CAA, the states also have air quality programs independent of federal requirements. State programs identify facilities required to obtain environmental registrations or permits, detail the administrative procedures for obtaining authorization, and provide for public involvement in the permitting process. The states also develop regulations to address issues unique to the state, e.g., protecting environmentally sensitive areas or natural resources.

Protecting the Air from Mobile Sources

"Mobile" air emission sources include everything from on-road passenger vehicles and heavy-duty trucks to off-road construction equipment, lawn mowers, and small gardening equipment. CAA fuel economy and emission standards apply to vehicle and equipment manufacturers. To provide uniform national emission standards, the CAA provides the EPA with the almost exclusive authority to regulate mobile sources. It is "almost" exclusive because California has a special exception to regulate mobile sources in the state since air pollution was more severe in California when the CAA was passed, and the state already had its own mobile source programs in place. All other states must adopt either the EPA's standards or California's standards but cannot otherwise adopt different standards for mobile sources.

The inability of non-California states to regulate mobile sources can be a major obstacle in the ozone SIP attainment planning process because, in many areas, most nitrogen oxide emissions come from mobile sources. For example, in the Dallas-Fort Worth area (DFW), over 70 percent of the nitrogen oxide emissions are from on-road and off-road mobile sources. Therefore, when attempting to craft a SIP to return the DFW area to attainment, the state of Texas is only able to squeeze emission reductions from about 30 percent of the nitrogen oxide sources. Texas has the limited ability to lower speed limits and therefore marginally raise fuel economy and lower emissions, but the state otherwise has little ability to impact mobile source emissions. Instead, for the other 70 percent of the nitrogen oxide emissions in the DFW area, Texas, like other states with major metropolitan areas, must first wait for manufacturers to begin producing new, lower-emission vehicles and equipment in compliance with federal timelines. However, even after new models are available, no significant reduction in emission levels will occur until the various existing fleets of cars, trucks, construction equipment, lawn mowers, and leaf blowers are replaced, which could take many years.

Protecting the Air from Individual Point Sources of Emissions

The CAA and the states regulate individual facilities that emit pollutants. Commonly referred to as "point sources" of pollution, individual facilities are required to demonstrate compliance with various CAA and state standards based on the type of facility and the level and nature of emissions. The primary mechanism for ensuring compliance is the permitting system.

Virtually every facility that emits a pollutant into the air requires some level of authorization, either federal, state, or both. Very small sources, often referred to as "de minimis" sources, e.g., a power saw or a space heater, are typically exempted from permitting because the impact on health and the environment is small. Minor sources of emissions, e.g., a concrete batch plant or an automotive paint and body shop, often are not regulated directly under the federal permitting system but do require permits from the state. Finally, major sources of air pollution, e.g., a large power plant or chemical plant, are subject to state and federal permitting requirements. The federal regulations define the sources that are "major" and therefore require federal review and authorization.

New sources of emissions also are required to apply Best Available Control Technology (BACT). This is somewhat of an amorphous requirement in that BACT is a moving target that changes with

advances in technology. When applying for a permit, the applicant is required to survey the current emission control technology for the type of facility being permitted and then use the best technology currently available for controlling emissions. The EPA maintains a database of permits and technologies to help both applicants and regulators determine BACT at any point in time.

Certain types of emission sources have been found to contribute significantly to ambient air pollution and the CAA goes beyond the permitting system and mandates the use of specific control technology. The EPA has identified over 60 of these types of sources, which are required to meet minimum technology and emission control practices termed "New Source Performance Standards" (NSPS). Requirements under an NSPS may consist of emission limitations, equipment design specifications, work practices, or operational standards.

Federal and state regulatory programs also can control emissions from individual emission sources through blanket regulations applicable to categories of sources. One of the most well-known and successful programs is the Acid Rain Program that reduced sulfur dioxide emissions from power plants across the country. A recently adopted federal program, the Clean Air Interstate Rule (CAIR), will have a similar effect by further curtailing sulfur dioxide emissions and nitrogen oxide emissions to help the entire eastern half of the United States reach attainment of the ozone and PM_{2.5} NAAQS.

A Simple Concept—But a Monstrous Program

An elaborate regulatory network has developed in this country to protect and improve air quality. Essentially every type of air contaminant and emission source has been evaluated to determine its impact on air quality and possible need for regulation. Even impacts of de minimis sources often are accounted for by a state in its inventory of emission sources, although the source itself might not otherwise require regulation. The regulatory network is intended to protect every member of society, even those most sensitive to air contaminants, and to protect the public welfare. To ensure this program is working, environmental regulatory agencies stay busy enforcing air quality regulations, not only in high-profile cases that make the news, but also against operators of small emission sources who surprisingly often have no clue they are even regulated.

The preceding discussion enormously simplifies the detail of the regulatory programs, and this article has not attempted to address many other important air quality provisions. For example, one important new program adopted by the EPA last year is the Clean Air Mercury Rule (CAMR), whereby the United States became the first country in the world to regulate mercury emissions from power plants. Programs such as the Title V Operating Permit program, National Emission Standards for Hazardous Air Pollutants (NESHAPs), Regional Haze, Strato-spheric Ozone Protection, the Acid Rain Program, and other programs identify and address specific air pollution concerns. New rules are constantly being added by both the EPA and the states and existing regulations are revised and updated routinely to ensure the regulations stay current.

Air Quality Progress and Global Warming

So, with all of the regulatory activity, has the air quality improved since the CAA was enacted in 1970? According to the EPA, there have been significant improvements in air quality. The EPA has tracked the emissions of NAAQS pollutants from all sources since 1970 and, as of 2005, the following progress had been made: carbon monoxide reduced by 55 percent; sulfur dioxide reduced by 52 percent; nitrogen oxides reduced by 30 percent; volatile organic compounds reduced by 53 percent; and lead reduced by over 98 percent. Particulate matter also has been reduced; while there are no emissions data from 1970 for the new PM_{2.5} standard, the EPA has tracked PM₁₀ emissions since 1970 and, as of 2005, those emissions had been reduced by at least 70 percent. The EPA has measured a 28 percent reduction in ozone levels from 1980 to 2005. The EPA projects that these levels will be reduced even further over the next decade as new air quality programs are implemented across the country.

Finally, as if the air regulations are not complicated enough, the issue of climate change is now on center stage in scientific, political, and policy arenas. In the spring of this year, the Supreme Court weighed in by deciding the much-watched case of *Massachusetts v. EPA*, No. 05-1120 (slip op. April 2, 2007). The case concerned the state of Massachusetts's petition to the EPA to regulate carbon dioxide from mobile sources based on the state's claim that it would suffer harm from global warming. The Court ruled that carbon dioxide is an air pollutant as that term is defined in the CAA and the EPA, therefore, has the ability to regulate carbon dioxide and other greenhouse gases if, as provided by the CAA, such gases cause or contribute to air pollution that may reasonably be anticipated to endanger public health or welfare. The EPA must now determine whether greenhouse gas emissions from motor vehicles meet this threshold standard of the CAA.

In addition to the EPA's consideration of the greenhouse gas issue, there are several bills in Congress addressing climate change. It is therefore likely that new statutory or regulatory provisions addressing climate change will soon emerge. Regardless of whatever policy decisions are finally made by Congress or the EPA, the two things to count on are that air regulations will become even more complicated and air quality in the United States will continue to improve.

Has air quality improved since enactment of the CAA? The EPA has noted the following reductions in air contaminants since 1970:

Carbon monoxide: 55%
Sulfur dioxide: 52%
Nitrogen oxides: 30%
Volatile organic compounds: 53%
Lead: 98%
Particulate matter (PM10):* 70%
Ozone:** 28%

EPA projects that these levels will be reduced even further over the next decade as new air quality programs are implemented across the country.

*** There are no emissions data from 1970 for the new PM2.5 standard.**

**** Ozone reductions are measured from 1980.**

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