NATIONAL WEATHER ASSOCIATION
AIR QUALITY REVIEW
(Updated September 2011)

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Link to: Air Quality Awareness

Foreword

The source of this document is primarily the Environmental Protection Agency and the Air Quality Reference Guide for the Houston-Galveston Area, published by the Regional Air Quality Planning Committee of the Houston-Galveston Area Council. Guy Donaldson of the EPA Region VI (214) 665-7242 and Richard Daye of EPA Region VII reviewed the original document.

What is Air Pollution?

Air pollution is the presence of substances, both gases and particles, in the air in amounts that are harmful to the health or comfort of humans or animals, or cause damage to plants or materials. There are natural sources of air pollution, such as volcanic eruptions, forest fires and wind-blown dust and there is air pollution which results from human activities (e.g., industrial processes and motor vehicle use).

Is Air Quality Improving?

The overall answer is yes but not enough yet. In 2006, over 100 million people nationwide lived in counties with pollution levels above the primary standards for six criteria air pollutants. Figure 1 shows that emissions of these pollutants are dropping while the population and consumption of energy continue to increase.

The Clean Air Act and More

Under the federal Clean Air Act (CAA) of 1970, which was significantly amended in 1990, the U. S. Environmental Protection Agency (EPA) is required to study the effects of air pollution on human health and the environment, and establish appropriate ambient, or outdoor, air quality standards. These federal standards are known as the National Ambient Air Quality Standards (NAAQS) and are intended, based on the latest scientific knowledge, to protect public health and welfare. Based on these health and welfare criteria, federal standards have been established for six ambient air pollutants: ozone, particulate matter, carbon monoxide, sulfur dioxide, nitrogen dioxide and lead. These six air pollutants have become known as the criteria pollutants. Table 1 lists the primary standards that are intended to protect public health, as well as the secondary standards that are intended to protect public welfare (e.g., preventing plant, crop, and property damage), for each criteria pollutant. The Clean Air Act also addresses other pollutants, such as air toxics. An area that fails to meet the NAAQS for a pollutant is said to be in nonattainment for that pollutant. Because each urban area has different geographical and meteorological conditions, as well as different emissions sources, different strategies to reduce pollutant levels must be developed for each area. In 2004, a new set of rules, called the Clean Air Rules, was issued by the EPA. According to the EPA, these are a suite of actions that will dramatically improve America's air quality. Three of the rules specifically address the transport of pollution across state borders (the Clean Air Interstate Rule, Clean Air Mercury Rule and Clean Air Nonroad Diesel Rule). These rules provide national tools to achieve significant improvement in air quality and the associated benefits of improved health, longevity and quality of life for all Americans. Taken together, they will make the next 15 years one of the most productive periods of air quality improvement in America's history. Diesel engine manufacturers can already meet the new emission standards on their new engines. As existing engines wear out, they will be replaced by the new, low-emitting engines and eventually all diesels will be low emitters.

The Clean Air Rules of 2004 encompass the following major rules:

Clear Air Interstate Rule NOTE: This rule has been replaced by the Cross-State Air Pollution Rule. See p. 3 for more information.

Mercury Rule

EPA issued the Clean Air Mercury Rule (originally proposed as the Utility Mercury Reductions Rule) on March 15, 2005. This rule will build on the Clean Air Interstate Rule (CAIR) to reduce mercury emissions from coal-fired power plants, the largest remaining domestic source of human-caused mercury emissions. Issuance of the Clean Air Mercury Rule marks the first time EPA has regulated mercury emissions from utilities, and makes the U.S. the first nation in the world to control emissions from this major source of mercury pollution.

On August 9, 2010, the EPA finalized the nation’s first limits on mercury air emissions from existing cement kilns, strengthened the limits for new kilns, and sets emission limits that will reduce acid gases. This final action also limits particle pollution from new and existing kilns, and sets new-kiln limits for particle and smog-forming nitrogen oxides and sulfur dioxide.

When fully implemented in 2013, EPA estimates the annual emissions of mercury will be reduced by 16,600 pounds (92%). EPA estimates that the rules will yield $6.7 billion to $18 billion in health and environmental benefits, with costs estimated at $926 million to $950 million annually in 2013. Another EPA analysis estimates emission reductions and costs will be lower, with costs projected to be $350 million annually.

Nonroad Diesel Rule

The Clean Air Nonroad Diesel Rule will change the way diesel engines function to remove emissions and the way diesel fuel is refined to remove sulfur. The black puff of smoke you see coming from construction and other nonroad diesel equipment will be gone forever. The Rule is one of EPA's Clean Diesel Programs, which together will result in the most dramatic improvement in air quality since the catalytic converter was first introduced a quarter century ago.

Ozone Rules
The Clean Air Ozone Rules (dealing with 8-hour ground-level ozone designation and implementation) designate those areas whose air does not meet the health-based standards for ground-level ozone. The ozone rules classify the seriousness of the problem and require states to submit plans for reducing the levels of ozone in areas where the ozone standards are not met.

Fine Particle Rules
The Clean Air Fine Particle Rules (dealing with $PM_{2.5}$ designations and implementation) designate those areas whose air does not meet the health-based standards for fine-particulate pollution. This requires states to submit plans for reducing the levels of particulate pollution in areas where the fine-particle standards are not met.

(UPDATE) Cross-State Air Pollution Rule (CSAPR) Replaces CAIR
On July 6, 2011, the US Environmental Protection Agency (EPA) finalized the Cross-State Air Pollution Rule (CSAPR). It requires 27 states to significantly improve air quality by reducing power plant emissions that contribute to ozone and/or fine particle pollution in other states. Note that this replaces EPA's 2005 Clean Air Interstate Rule (CAIR).

According to the EPA, the CSAPR should help prevent:

13,000 to 34,000 cases premature mortality

15,000 non-fatal heart attacks

19,000 hospital and emergency department visits

19,000 cases acute bronchitis

420,000 cases upper and lower respiratory symptoms

400,000 cases aggravated asthma

1.8 million days when people miss work or school

The timeline for implementation of the CSAPR is as follows:

Starting January 1, 2012 - SO_2 and annual NO_X reductions

May 1, 2012 - NO_X reductions

By 2014, combined with other final state and EPA actions, reduce power plant SO_2 emissions by 73 percent and NO_X emissions by 54 percent from 2005 levels in the CSAPR region.

To see which 26 states are affected, go to Figure 2.

Health Effects of Air Pollution

Each air pollutant has the potential to cause adverse health effects. These effects depend on the physical and biochemical nature of the pollutant, toxicity of the pollutant, pollutant level, mode and duration of exposure, and individual susceptibility. Generally, higher pollutant levels and longer exposure times have greater effects. Sensitive individuals, or persons with immune or other dysfunctions that reduce their ability to detoxify or excrete pollutants, may experience adverse health effects at lower pollutant levels and following shorter exposures to pollutants than the average person. Exposure to multiple air pollutants generally, but not always, amplifies the effects of individual pollutants and may cause effects different from exposure to the same pollutants individually.

The Air Quality Index (AQI) was established by the EPA in 1999. EPA issued revisions to the AQI to address the new standard on March 12, 2008. This system converts the engineering measurement units from the air monitoring equipment to a common or easily understood index for the general public. It includes colors and ranks the quality of outdoor air. The AQI system can be used for any criteria pollutant. The current AQI can be viewed on EPA's website, http://airnow.gov.

Index Value - Descriptor Color
0-50 Good - Green
51-100 Moderate - Yellow
101-150 Unhealthy for Sensitive Groups - Orange
151-200 Unhealthy - Red
201-300 Very Unhealthy - Purple
300-500 Hazardous - Maroon

Ozone

Description

Ozone is a reactive form of oxygen that is composed of three oxygen atoms (O_3), in contrast to the more common form of oxygen that has two oxygen atoms (O_2). It occurs in two areas of the earth's atmosphere - the stratosphere and the troposphere. Naturally occurring ozone is found in the stratosphere, 6 to 30 miles above the earth's surface, where it plays a positive role in absorbing ultraviolet rays emitted by the sun. Ozone is also found in the troposphere, up to 6 miles above the earth's surface. Exposure to this ground-level ozone in higher concentrations can result in adverse effects to humans, plants and animals. Because ground-level ozone is largely formed from emissions created by human activities, harmful levels of ozone usually occur in urban areas.

Ground-level ozone is not emitted directly into the air, but is formed by a series of complex atmospheric chemical reactions that primarily involve nitrogen oxides (NO_x) and volatile organic compounds (VOCs), which are called precursors, and sunlight. NO_x is produced almost entirely as a byproduct of high-temperature combustion. Common sources of NO_x include automobiles, trucks, construction equipment, marine vessels, incineration, power generation, industrial processes, forest fires, natural gas furnaces and stoves, and fireplaces. The primary non-combustion source of NO_x is the breakdown of nitrogen in the soil by soil microbes. VOCs include many chemicals that vaporize easily, such as those found in gasoline and solvents. VOCs are emitted from:

(1) industrial sources, such as petroleum storage tanks, oil refineries and petrochemical manufacturing plants;
(2) on-road mobile sources, such as automobiles, trucks and motorcycles;
(3) off-road sources, such as airplanes, trains, boats and construction equipment;
(4) area sources, such as gasoline stations, paint, gasoline-powered lawn mowers and printing operations; and
(5) biogenic sources from various trees and plants.

Not all VOCs, however, have equal potential to make ozone. New research indicates the most important issue regarding VOCs are their reactivity. VOCs that are more reactive, such as ethylene and propylene, contribute more to ozone formation than do less reactive VOCs, such as propane and acetone. NO_x is emitted high above the ground in power plant stacks and VOCs are emitted from chemical storage tanks at ground level. They don't mix well since their sources are so far apart. But NO_x and VOCs are created and emitted in the tail pipes of automobiles and thus, their mixing is enhanced.

Ground-level ozone in irritating or harmful concentrations is typically formed during periods of high solar radiation (i.e., no cloud cover), low wind speeds, elevated temperatures and moderate-to-high concentrations of NO_x and VOCs. Varying wind patterns and the time required for ozone to form can result in exceedances of the ozone standard at locations quite remote from the sources of NO_x and VOCs.

Health Effects of Ozone

Exposure to ozone (O_3) can cause or aggravate various respiratory symptoms. These symptoms include decreased lung capacity, exacerbation of asthma, inflammation of lung tissue, and the secretion of mucus in the respiratory passages. These changes can lead to difficulty in breathing, and have been associated with increased hospital admissions and emergency room visits during or a few days after high ozone levels. Exposure to ozone can also impair the body's immune system defenses, making people more susceptible to respiratory infections, including colds, bronchitis and pneumonia. Individuals with asthma or chronic obstructive pulmonary disease (COPD) are especially at risk. Regular or prolonged exposure to ozone may lead to scarring and premature aging of the respiratory system. Scientists have recently documented an increasing trend in the number of diagnosed cases of, and deaths from, asthma. The increasing trend is most pronounced among children living in urban areas. Exposure to ozone, in conjunction with other air pollutants, allergens and/or cigarette smoke, has been documented as a possible contributor to this trend.

A study published in 2002 found that children who play active team sports in areas with high levels of ground level ozone are more likely to develop asthma. Recent epidemiological studies have also suggested that ozone may exacerbate cardiac arrhythmia, and have found a small, but statistically significant, increase in mortality associated with increased ozone levels. Ozone has not been shown to be carcinogenic.

Old Ozone Standard

The old health and welfare NAAQS for ozone (O_3) was 0.12 parts per million (ppm) averaged over one hour. Because of mathematical rounding, an exceedance was considered to have occurred when O_3 levels equal or exceed 0.125 ppm, which equals 125 parts per billion (ppb). The 1-hour ozone standard has been phased out.

New Ozone Standards

In July 1997, the EPA established a new ozone standard. The new standard states that the three-year average of the annual fourth-highest daily eight-hour average concentration, at the same monitor, shall be no greater than 0.08 ppmEPA issued the 8-hour ozone standard in July 1997, based on information demonstrating that the 1-hour standard was inadequate for protecting public health. Scientific information shows that ozone can affect human health at lower levels, and over longer exposure times than one hour.

On March 12, 2008, the EPA established an even more stringent 8-hour ozone standard of .075 ppm. Figure 3 illustrates the areas that fail to attain the new eight-hour standard or which have attained it and now have maintenance plans in place to make sure that they continue to maintain it. Figure 4 illustrates which areas are violate the 8-hour ozone standard based on monitoring data. Figure 5 illustrates which counties are projected to violate the new standard in 2020 based on modeling data.

EPA estimates that the final ozone standards will yield health benefits valued between $2 billion and $19 billion. Those benefits include preventing cases of bronchitis, aggravated asthma, hospital and emergency room visits, nonfatal heart attacks and premature death, among others. EPA's Regulatory Impact analysis shows that benefits are likely to be greater than the cost of implementing the standards. Cost estimates range from $7.6 billion to $8.5 billion.

UPDATE: The EPA is reviewing the 2008 standard and are considering making it even more restrictive. A final decision has not yet been made.

Early Action Compacts (EACs) and the 1-Hour Ozone Standard

- EPA will revoke the 1-hour standard 1 year after the effective date of designating attainment and nonattainment areas for the 8-hour standard.
- To avoid "backsliding," or losing clean air progress towards attaining the 1-hour ozone standard, this rule will require that very specific control measures for the 1-hour standard be included in a state's implementation plan and stay in place until an area

attains the 8-hour standard.
· The discretionary emissions reductions in a state's implementation plan would also remain but could be revised or dropped based on modeling demonstrating that it would be appropriate.
· Phase 2 of the final 8-hour ozone implementation rule will address, among other things, reasonably available control measures, reasonably available control technology, attainment demonstrations and modeling requirements.

Early Action Compacts (EACs) gave certain local areas the flexibility to develop their own approach to meeting the 8 hour ozone standard, provided the communities controlled emissions from local sources earlier than the Clean Air Act would otherwise require.
• Only areas that were already meeting the national 1-hour ozone standard were eligible for this innovative program because EPA wanted to ensure that the communities participating have a proven record of environmental progress.
• The Early Action Compact required areas to meet several milestones to be eligible for a series of 3 deferrals of the effective date of the 8-hour ozone designation. Once an area received a deferral, it had to meet all of their subsequent clean air plan milestones to qualify for a continuation of the deferral.
• In order to qualify for the third and final deferral, States, Tribes or local areas must have submitted to EPA an assessment of their progress toward attainment by June 30, 2006, and must demonstrate attainment with the 8-hout ozone standard by December 31, 2007.
• EACs were signed by representatives of the local communities, State and Tribal air quality officials, and EPA Regional Administrators

The plan was that the 1-hour standard would be revoked for these areas one year after the effective date of their designation as attainment or nonattainment for the 8-hour ozone standard. By April 2008, these areas would be designated attainment if they met all their EAC requirements and have clean 8-hour ozone data by December 31, 2007. They would be designated nonattainment if they do not meet all their EAC requirements, including attainment of the 8-hour ozone standard by December 31, 2007.

The final phase 1 rule that implements the 8-hour ozone standard provides generally that only the portion of the designated area for the 8-hour NAAQS that was designated nonattainment for the 1-hour NAAQS is required to comply with anti-backsliding obligations. The maintenance plans required must demonstrate maintenance only for the area designated nonattainment (or attainment with a maintenance plan specified in the regulations) for the 1-hour NAAQS at the time of designation of the 8-hour NAAQS.

Fourteen areas were listed in 40 CFR Part 81 Subpart C as participating in an Early Action Compact and designated nonattainment with a deferred effective date.

The 1-hour standard will be revoked for these areas one year after the effective date (April 15, 2008) of their designation as attainment or nonattainment for the 8-hour ozone standard. By April 2008, 13 of the areas were designated attainment when they met all of their EAC requirements and had clean 8-hour ozone data by December 31, 2007. The Denver CO Subpart 1 EAC area was designated nonattainment for 8-hour Ozone, effective November 20, 2007 based on air quality data from 2005, 2006 and the first three quarters of 2007.

Federal Control Strategy for Ozone

The Timeline

There is year-to-year variability in ozone attainment problems and this variability is generally considered to be the result of the important role that weather conditions play in ozone formation. During years when there are a high number of sunny days combined with stagnant wind conditions and/or winds that recirculate ozone precursors throughout a region, there can be more exceedances of the standard. If the area is going to attain the federal ozone standard, a control plan must be developed that enables attainment during both favorable and unfavorable weather conditions. The EPA is required to revise the NAAQS for ozone on a set schedule. In addition, new standards including the latest one must be complied with by certain dates.

For the March 12, 2008 issued 8-hour ozone standard of .075 ppm, states had to make recommendations to EPA no later than March 2009 for areas to be designated attainment, nonattainment and unclassifiable. The EPA is now disapproving, approving, promulgating and finding failures to submit for these recommendations. To see the status of these findings, go to:

http://www.epa.gov/air/ozonepollution/actions.html
States must submit State Implementation Plans outlining how they will reduce pollution to meet the standards by a date that EPA will establish in a separate rule. That date will be no later than three years after EPA's final designations.

States are required to meet the standards by deadlines that may vary based on the severity of the problem in the area.

The Exceptional Events Rule (Treatment of Data Influenced by Exceptional Events, March 22, 2007) provides a general schedule for flagging monitored data in the AQS database affected by exceptional events and submitting final documentation to support the claim. The purpose of this rule is to provide states with as much lead time as practical to identify and submit supporting documentation for exceptional events that may affect ozone designations. Exceptional events are events that can affect air quality, are not reasonably controllable or preventable using techniques that tribal, state or local air agencies may implement in order to attain and maintain the National Ambient Air Quality Standards, and are either human caused events that are unlikely to recur in a particular location or naturally occurring events.

On May 13, 2009, the Environmental Protection Agency (EPA) amended the March 2007 Exceptional Events Rule to include specific dates by which states must submit to EPA exceptional event claims that may affect the status of an area under the ozone standards revised in March 2008. The rule amends the existing Exceptional Events rule by providing a revised schedule. The new schedule provides that 2005-2007 data must be flagged in the Agency's AQS database not later than 30 days after this final rule is published in the Federal Register, and that all technical documentation to support exceptional event data status between the years of 2005 and 2007 must be provided to the Agency not later than 30 days after this final rule is published in the Federal Register.

Ozone Computer Modeling

The Clean Air Act (CAA) requires some areas of the country to use one of several EPA approved computer models to analyze regional air pollution reductions. In states like Texas where ozone attainment is a problem, air quality models are used to model precursor pollutant emissions, air movement, chemical reactions, and resultant ozone concentrations. Emissions, source parameters, and meteorological data are fed into the model from thousands of locations on a 3-D grid system that covers the region. Complex equations, based on atmospheric chemical reactions, are used to predict ozone concentrations in each grid for each hour, based on hourly emission rates and wind-flow patterns. The model is run using conditions from representative historical episodes, and the results are compared to ozone levels actually measured at monitoring sites. If the base case modeling results differ substantially from the monitored data, emissions, source characteristics (location, stack parameters, etc.), and meteorological data are investigated and, if justified, corrected to help provide better agreement between the predicted and actual ozone levels. Once a satisfactory agreement between the predicted and actual ozone levels is achieved, meteorological parameters are kept constant and modeled emissions from sources are projected to the area's attainment deadline. Then, the future emissions and/or source parameters are adjusted to evaluate potential control strategies. The photochemical grid modeling, therefore, attempts to predict what the ozone levels would be if various control strategies were implemented, and is helpful in determining the optimum combination of strategies for achieving the federal ozone standard.

Emission Sources: Who Emits VOCs and NO_x?

Emissions inventories are detailed reports of the types and sources of area emissions. These sources of emissions are grouped, for air quality planning purposes, into the following five source categories. Stationary point sources are defined, for emission inventory purposes, as industrial, commercial or institutional plants/operations which emit VOCs of 10 tons per year (TPY) or greater, and/or NO_x or CO emissions of 25 TPY or greater. Owners or operators of such sources are required to annually report the quantity and type of emissions. Refineries, chemical manufacturing facilities, power plants, breweries and bakeries are included in this category. Point sources can emit both VOCs and NO_x, although different types emit different proportions. Area sources emit less than the stationary point source definitions given above, and are not practical to identify individually for emission inventory purposes. The quantity and type of emissions from these sources are estimated using established emission factors and appropriate activity data from the area. For example, emissions from service stations can be estimated based on the number of such facilities in the area and knowledge of the amount of gasoline sold. Print shops, dry cleaners, restaurants, painting operations, degreasing and other solvent-using operations, small building heating, and outdoor burning are a few of the operations included in this category. Area sources generally emit more VOCs than NOx. On-road mobile sources consist of automobiles, trucks, motorcycles and other vehicles that travel on roadways. Computer models estimate emissions from the engines and tailpipes of vehicles, as well as emissions caused by the evaporation of gasoline and other fluids. On-road mobile sources emit both VOCs and NO_x, although different vehicles emit different proportions.

Off-road and non-road mobile sources include emissions from commercial and general aircraft operations, marine vessels, recreational boats, railroad locomotives, and a very broad subcategory that includes everything from engines on construction equipment to lawn mowers, chain saws and leaf blowers. The EPA has passed rules to require new engines for most of the off-road mobile category to meet emission specifications. It will take some time for the effects of these rules to be realized as older engines are retired and new engines are introduced. Biogenic sources of emissions are from plant life in the area, including crops, trees, grass and other vegetation. The quantity and type of emissions from vegetation can be estimated using such tools as satellite imaging and computer modeling. Since biogenic emissions are not anthropogenic, it is not considered practical or desirable to reduce them. While biogenic sources do emit VOCs into the atmosphere that may contribute to ozone formation, they also remove significant amounts of CO_2, SO_2, NO_2, O_3 and particles from the air, and cool the air through shade and transpiration, thus reducing VOC emissions from other sources. Scientists are still refining the techniques to estimate isoprene emissions from trees to ensure that the modeling is correct. In contrast, biogenic emissions of NO_x are generally low, and are mostly associated with agriculture.

Vehicle Emission Standards

Some of the most significant pollution controls established through the Clean Air Act are motor vehicle emission standards. Beginning in the late 1960s, increasingly stringent vehicle emission standards have led to the widespread use of catalytic converters and fuel injection. In December 1999, the EPA announced its newest initiative to further reduce harmful air pollution from vehicles. Known as Tier 2, the new emissions standard is 0.07 grams per mile for NO_x and, for the first time ever, subjects gasoline and diesel sport utility vehicles and light-duty trucks to the same emission standards as automobiles, starting with model year 2004 vehicles. The standard will reduce NO_x emitted from new cars by 77 percent, and NO_x emitted from sport utility vehicles and light-duty trucks by up to 95 percent. In May 2000, the EPA proposed new standards to significantly reduce emissions from heavy-duty diesel engines and vehicles through a phase-in approach. The proposed standards would reduce NO_x from these vehicles by 95 percent and particulate matter by 90 percent. The standards were finalized in December 2000.

Fleet Vehicle Requirements
The Clean Air Act requires that, in severe ozone nonattainment areas like the Houston-Galveston area, a steadily increasing percentage of fleet vehicles meet a set of stricter emission standards. As an example of the effects of the standards, the LEV standard for cars results in 70 percent less VOC emissions and 50 percent less NO_x emissions than conventional 1996 vehicles.

Cleaner Fuels - Gasoline
Since January 1, 1995, reformulated gasoline (RFG), a conventional gasoline blended to burn cleaner and evaporate less, has been sold in nonattainment areas. The use of RFG has resulted in significant reductions in VOCs and, to a lesser extent, NO_x. One of the components of RFG is an oxygenate that helps the gas burn cleaner. In some parts of the country, methyl tertiary butyl ether (MTBE) has been the oxygenate of choice. However, concerns about the role of MTBE in water contamination has led to a decision by the EPA to phase out the use of MTBE, in favor of other oxygenates, such as ethanol. To support the new Tier 2 vehicle standards, the EPA adopted a rule in February 2000 to limit the sulfur content in gasoline. In 2004, refineries and importers were required to meet corporate average gasoline standards of 120-ppm sulfur, with a maximum of 300 ppm. By 2006, refiners will produce gasoline that averages no more than 30-ppm sulfur, with a maximum not to exceed 80 ppm.

Cleaner Fuels - Alternative Fuels
In addition to cleaner burning gasoline and diesel, alternative fuels are another category of cleaner fuels. These fuels are not produced from a traditional petroleum base. Some alternative fuels in light-duty vehicles are compressed natural gas (CNG) and propane (LPG), which are gaseous rather than liquid fuels. Although vehicles using these fuels make up a very small percentage of the total vehicle population, automakers are producing more vehicles that are equipped to run using these fuels. The advantage of using alternative fuels is that they burn cleaner without the use of additives, and produce virtually no particulates. Currently, the majority of vehicles running on these fuels are in government fleets that are under a legislative mandate to run cleaner.

Motor Vehicle Emissions Budget
In states with attainment problems, the state implementation plan (SIP) SIP identifies the level of motor vehicle emissions that an area can produce and still meet air quality standards. This level, known as the motor vehicle emissions budget (MVEB), is intended to apply discipline to local planning. To keep within emissions budgets, MPOs are expected to contribute to the offset of potential emission increases from new road construction with transportation measures that are projected to reduce emissions, such as high-occupancy vehicle (HOV) lanes, grade separations, public transit projects and carpooling incentives. Transportation has a significant affect on air quality.

Transportation Control Measures
The Clean Air Act Amendments of 1990 require regions in nonattainment areas to make

enforceable commitments to implement, maintain and monitor Transportation Control Measures (TCMs). These include HOV lanes, arterial traffic flow improvements, park and ride lots, transit service improvements, bicycle facilities, area wide rideshare programs, computerized transportation management systems and light rail.

Voluntary Mobile Emissions Reduction Program
On October 23, 1997, the EPA adopted a policy to allow credit in the SIP for voluntary mobile emission reduction programs. The intent of the policy is to provide incentives for states, localities and the public to voluntarily reduce air pollution in their communities. Through this policy, the EPA has made it easier for states to obtain SIP credits for voluntary activities, and further encourage innovation and investment in effective programs and actions.

Public/Private Fleet Emission Controls
Under these programs, emission reductions from vehicle fleets will be realized through clean vehicle purchases and retrofits of EPA-approved voluntary retrofit packages.

Highway/Nonroad Demonstration Projects
Ongoing demonstration projects are applying diesel/water emulsion or catalyst after treatment devices to highway diesel engines. These programs seek to expand current demonstration projects to other privately owned vehicle fleets or owner/operators of nonroad equipment.

Locomotive Emission Reductions
In some states, a memorandum of understanding has been signed with railroads to achieve emission reductions through various controls. On March 14, 2008 EPA issued rules to control emissions from locomotives and marine engines.

Commute Solutions
This measure combines both current and future Commute Solutions, regional commute alternatives, such as regional mass transit, vanpooling, teleworking and cash in lieu of paid parking.

Particulate Matter

Description
Particulate matter denotes small particles suspended in air. These particles are exceptionally diverse, and include inorganic salts, acids, metals, water, organic compounds and soot-like material. In 1987, the EPA established a standard for particulate matter that is 10 microns or smaller in diameter (PM_{10}). A micron is approximately equal to 1/100th of the width of a human hair. PM_{10} particles come from (1) combustion, including gasoline- and diesel-fueled cars and trucks, power generation, industrial processes, cigarette smoke, volcanoes and forest fires; (2) road dust; (3) tires; (4) chemical reactions in the atmosphere; (5) soil disturbance from such sources as construction and agriculture; (6) production or degradation of metals, such as chromium and platinum; and (7) various naturally occurring sources, such as pollen, animal dander and insect fecal matter.

Health Effects of Particulates
Epidemiological studies have linked increased levels of particulate matter (PM_{10}) to various health effects. These include an increase in respiratory-related hospital admissions and emergency room visits, asthma, acute respiratory symptoms (i.e., severe chest pain, gasping and aggravated coughing), chronic bronchitis, decreased lung function (which can be experienced as shortness of breath), and work and school absences. Several studies have also linked increased particulate levels to higher death rates from respiratory and cardiovascular diseases. Those most at risk include the elderly, children, asthmatics and adults with pre-existing heart or lung disease. These effects are observed at particulate levels considerably below the current NAAQS for PM_{10}, and are now known to be largely caused by the fine particulate fraction ($PM_{2.5}$). For example, a study published in 2002 concluded that long-term exposure to fine particles in the $PM_{2.5}$ range is associated with increased mortality of people with cardiovascular disease and lung cancer. When drawn into the deepest part of the lungs, these particles tend to stay there, trapped in millions of tiny alveoli, where the impact on lung function is the greatest. Some particulate matter, especially that found in diesel exhaust, has been shown to be carcinogenic.

Old Particulate Matter Standards
In 1987, the EPA established a standard for particulate matter that is 10 microns or smaller in diameter (PM_{10}). A micron is approximately equal to 1/100th of the width of a human hair. The NAAQS for PM_{10} were 150 micrograms per cubic meter of air (µg/m3) averaged over 24 hours, and 50 µg/m^3 averaged over one year. Figure 7 illustrates areas that fail to attain the original PM_{10} standards. In July 1997, the EPA established standards for particulate matter 2.5 microns in diameter ($PM_{2.5}$) or smaller. The standards stated that: (1) the annual mean concentration, averaged over three years, shall not exceed 15 µg/m^3, and (2) the 98th percentile of the 24-hour average concentrations, averaged over three years, shall not exceed 65 µg/m^3.

New Particulate Matter Standards
In September 2006, the EPA issued new standards for fine particles. The 2006 standards tighten the 24-hour fine particle standard from 65 micrograms per cubic meter (µg/m^3) to 35 µg/m^3, and retain the current annual fine particle standard at 15 µg/m^3. EPA has decided to retain the existing 24-hour PM_{10} standard of 150 µg/m^3. Due to a lack of evidence linking health problems to long-term exposure to coarse particle pollution, the Agency has revoked the annual PM_{10} standard. Table 1 reflects the latest PM standards. Figure 7 illustrates areas that fail to attain the new $PM_{2.5}$ standards.

PM2.5 Computer Modeling
$PM_{2.5}$ is also being conducted at both a state and national level as assessment of attainment status and compliance efforts continue.

PM2.5 and Ozone Being Evaluated Together
The interaction of particulate matter and ozone now has the EPA evaluating air quality interaction and regulatory compliance in a different light. Air quality problems may be

tackled by addressing these two pollutants together rather than individually. Figure 8 illustrates areas which are non-attainment for both particulates and ozone.

Carbon Monoxide

Description

Carbon monoxide (CO), a colorless, odorless gas, is emitted during the combustion of gasoline, wood, natural gas and other fuels. Emissions of CO increase significantly from improperly tuned engines. The NAAQS for carbon monoxide is 35 ppm averaged over one hour, and 9 ppm averaged over eight hours (Table 1). Special Note: As of September 27, 2010, all Carbon Monoxide non-attainment areas have been re-designated to maintenance areas.

Health Effects

Carbon monoxide (CO) prevents hemoglobin from carrying oxygen from the lungs to the tissues of the body. Persons with cardiovascular or respiratory disease are particularly susceptible to carbon monoxide because their bodies may be receiving only minimal oxygen ordinarily. Individuals exercising near traffic are also at risk because CO levels can be high near heavy traffic. CO levels inside cars in heavy traffic or at traffic lights may also be high. Chronic exposure to low levels of CO may lead to changes in the heart and brain caused by oxygen deprivation. Increased ambient levels of CO have also been associated with increased hospital admissions for heart arrhythmia and cardiovascular disease. Moderate exposure to CO can cause dizziness, headache and fatigue. At higher concentrations in enclosed spaces, CO can cause unconsciousness and death.

Sulfur Dioxide

Description

Sulfur dioxide (SO_2) is a colorless, odorless gas at low concentrations, but has a pungent odor at higher concentrations. SO_2 is emitted by power plants that burn coal that contains sulfur, petroleum refineries and sulfuric acid plants. Sulfur dioxide can harm vegetation, impair visibility by the formation of sulfates, and contribute to acid rain, in addition to its effects on health. The NAAQS for SO_2 are 0.14 ppm averaged over 24 hours and 0.03 ppm averaged over one year for public health, and 0.50 ppm averaged over three hours for public welfare (Table 1). Figure 9 illustrates areas that fail to attain the SO_2 standards.

Health Effects

The health effects of exposure to sulfur dioxide (SO_2) include a decrease in lung function, irritation of the eyes, tearing, coughing and chest tightness. Urban levels of SO2 have been shown to exacerbate allergies and asthma, and have been associated with increased cardiovascular mortality. Sulfur dioxide contributes to the creation of sulfate particles and sulfuric acid aerosols, both of which have harmful effects at higher concentrations. Exposure to very high levels of SO_2 can result in severe breathing disorders including respiratory paralysis and pulmonary edema.

Nitrogen Dioxide

Description

Nitrogen dioxide (NO_2) is a yellow-brown gas that is part of the family of pollutants referred to as nitrogen oxides (NO_x). Nitrogen oxides are formed almost entirely by high temperature combustion, such as the burning of fuels in power generation plants, industrial boilers, cars, trucks, furnaces and cooking stoves. In agricultural areas, the microbial breakdown of high-nitrogen fertilizers may also contribute to NO_x levels. Particular attention is being paid to this pollutant because of its important role in the formation of ground-level ozone. Reducing NO_x emissions is an important part of the strategy to meet the ozone standards.

There are two NAAQS for NO_2. One is 0.053 ppm averaged over one year (Table 1). There are no non-attainment areas for NO_2 for the one year standard. On January 25, 2010, the EPA promulgated a new one-hour standard of 100 ppb or .100 ppm. It was the first time in 35 years that a new standard for NO_2 had been promulgated. According to the EPA, lower levels of NO_2 will protect millions of Americans from peak short-term exposures, which primarily occur near major roads.

EPA is establishing new monitoring requirements in urban areas that will measure NO_2 levels around major roads and across the community. Monitors must be located near roadways in cities with at least 500,000 residents. Larger cities and areas with major roadways will have additional monitors. Community-wide monitoring will continue in cities with at least 1 million residents.

Working with the states, EPA will site at least 40 monitors in locations to help protect communities that are susceptible and vulnerable to elevated levels of NO_2.

EPA expects to identify or designate areas not meeting the new standard, based on the existing community-wide monitoring network, by January 2012. New monitors must begin operating no later than January 1, 2013. When three years of air quality data are available from the new monitoring network, EPA intends to redesignate areas as appropriate.

For more information, go to: http://www.epa.gov/air/nitrogenoxides

Health Effects

Exposure to nitrogen dioxide (NO_2) can cause lung irritation, a lowered resistance to respiratory infections, exacerbation of allergies, and has been associated with cardiac arrhythmia and vascular changes. Increased ambient levels of NO_2 are associated with increased hospital admissions due to asthma, COPD and heart disease, as well as respiratory mortality. NO_2 contributes to the creation of nitric oxide, peroxyacetyl nitrate, nitrate particles, peroxynitrite radicals and nitric acid aerosols in the atmosphere, all of which have harmful effects at higher concentrations. Some of the health effects correlated with NO_2 may actually be due to one of these other forms of nitrogen. At high levels, exposure to NO_2 can cause pulmonary edema and death. Some forms of nitrogen are mutagenic, causing sudden changes in inheritable genetic matter.

Lead

Description

Lead (Pb) is a toxic metal that was previously used in gasoline and most paints. Lead is emitted into the air by lead battery manufacturing plants, lead battery recovery plants, smelter operations, and the combustion of coal that contains lead. In the United States, lead has been phased out of gasoline, paint and other consumer products because of its undesirable health effects and because lead in gasoline damaged catalytic converters. Levels of lead in the air have since decreased significantly. The NAAQS for lead is 1.5 µg/m3 averaged quarterly (Table 1). Figure 10 illustrates areas that fail to attain the Lead standard.

In 2008, the EPA promulgated a much more restrictive standard of .15 µg/m3. Figure 11 illustrates counties that fail to meet this standard. Implementation plans are being put together to address this air quality problem.

Health Effects

The adverse health effects of lead (Pb) impact virtually every organ system in the body. The nervous system, especially in children, is particularly sensitive to the effects of lead. Exposure of lead to children can have numerous neurological effects, including abnormal neural development, reduced behavioral and cognitive function, and decreased IQ. There is also evidence that lead damages the kidneys and the immune system. Lead has been shown to be carcinogenic in animals.

Air Toxics

Description

Air toxics are defined primarily by their effects. Exposure to air toxics increases a person's risk of developing cancer, immune and neurological damage, and reproductive and endocrine disorders, as well as increases the risk of birth defects in children. Although the term "air toxics" can be used to refer to any hazardous chemical or metal, the term is usually reserved for the 189 chemicals and metals named in Title III of the 1990 Clean Air Act Amendments. These are also known as hazardous air pollutants or HAPs.

Hazardous Air Pollutants (HAPs)

These chemicals and metals include benzene, toluene, vinyl chloride, perchloroethylene, asbestos, arsenic, mercury, chlordane, chromium, 1,3-butadiene, formaldehyde and xylene. Sources of HAPs include industrial processes, motor vehicles, combustion, pesticides, dry cleaners and building materials. The EPA has not established ambient air standards for HAPs, but has established regulations to limit emissions of HAPs from specific major sources. Emissions data supplied by industry for the Toxics Release Inventory (TRI) can be used to help understand the types and levels of air toxics in the area's air. Currently, 654 toxic chemicals and metals are required to be reported as part of the TRI.

Health Effects

Exposure to air toxics, such as benzene, dioxin, toluene, chlordane, formaldehyde, 1,3-butadiene and others, in high concentrations can result in rapid onset of sickness (e.g., nausea, headache, confusion, seizures and severe difficulty in breathing) and death. Most people, however, are exposed to much lower levels of air toxics over an extended period. Many air toxics are neurological poisons and can cause genetic damage. The health effects most commonly associated with air toxics are cancer and various immunological, hormonal, neurological, reproductive, developmental, and respiratory effects.

Because of a growing concern that extremely low levels of some pesticides and chemicals may significantly disrupt endocrine function, the EPA created the Endocrine Disrupters Screening and Testing Advisory Committee (EDSTAC) to study this issue. The health effects of air toxics are often not recognized by patients and physicians because many of the diseases caused by air toxics take years to develop. For example, the latency period following exposure to benzene -known to cause leukemia and aplastic anemia - is 5 to 30 years.

Mercury in the air eventually deposits into water, where it changes into methylmercury, a highly toxic form that builds up in fish. People are primarily exposed to mercury by eating contaminated fish. Because the developing fetus is the most sensitive to the toxic effects of methylmercury, women of childbearing age and children are regarded as the populations of greatest concern.

TABLE 1
National Ambient Air Quality Standards (NAAQS)
(Source: 40 CFR Part 50)

Pollutant	Primary Standard (Public Health)			Secondary Standard (Public Welfare)		
	Level	**Averaging Time**	**Form**	**Level**	**Averaging Time**	**Form**
Ozone	0.12 ppm	1-hour[1]	More than 3 days over 3 years	Same as primary standard		
	0.075 ppm	8-hour	3-year average of annual fourth highest daily minimum	Same as primary standard		
Particulate matter 10 microns or smaller (PM_{10})	150 µg/m^3	24-hour	3-year average of annual 99 percentiles	Same as primary standard		
	Revoked	Annual	N/A			
Particulate matter 2.5 microns or smaller ($PM_{2.5}$)	35 µg/m^3	24-hour	3-year average of 98 percentiles	Same as primary standard		
	15 µg/m^3	Annual	3-year average annual averages			
Carbon Monoxide	35 ppm (40 mg/m^3)	1-hour	More than once per year	No secondary standard		
	9 ppm (10mg/m^3)	8-hour				
Sulfur Dioxide	0.14 ppm	24-hour	More than once per year	0.50 ppm	3-hour	More than once per year
	0.03 ppm	Annual	Not to be exceeded			
	75 ppb	1-hour	3-year average of the 99th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 75 ppb	None		
Nitrogen Dioxide	0.100 ppm	1-hour	3-year average of the annual 98th percentile of the daily maximum 1-hour average concentration	Same as primary standard		
	0.053 ppm (100 µg/m^3)	Annual	Not to be exceeded	0.053 ppm (100 µg/m^3)	Annual	annual arithmetic mean
Lead	.15 µg/m^3	Rolling 3-Month Average	Not to be exceeded	Same as primary standard		

ppm = parts per million
µg/m^3 = micro-grams per cubic meter [1] The 1-hour NAAQS for ozone is being phased out. See ozone section for additional information.

Figure 1: Pollutant Emissions Versus Growth
Source: Environmental Protection Agency

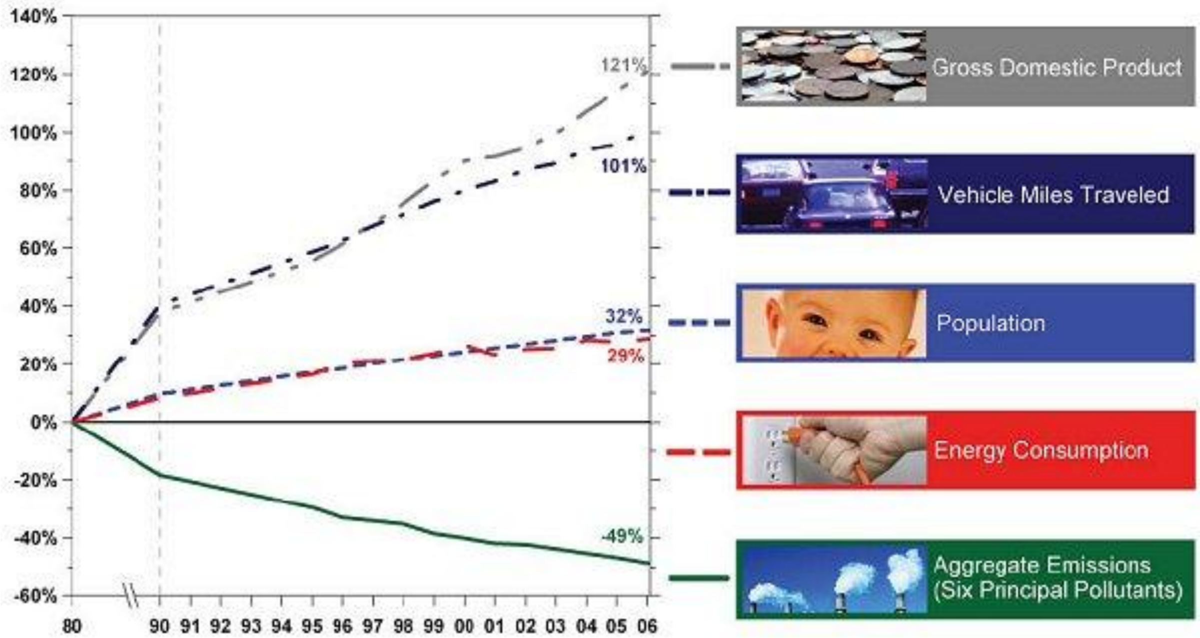

Figure 2: 26 States Affected by Cross-State Air Pollution Rule

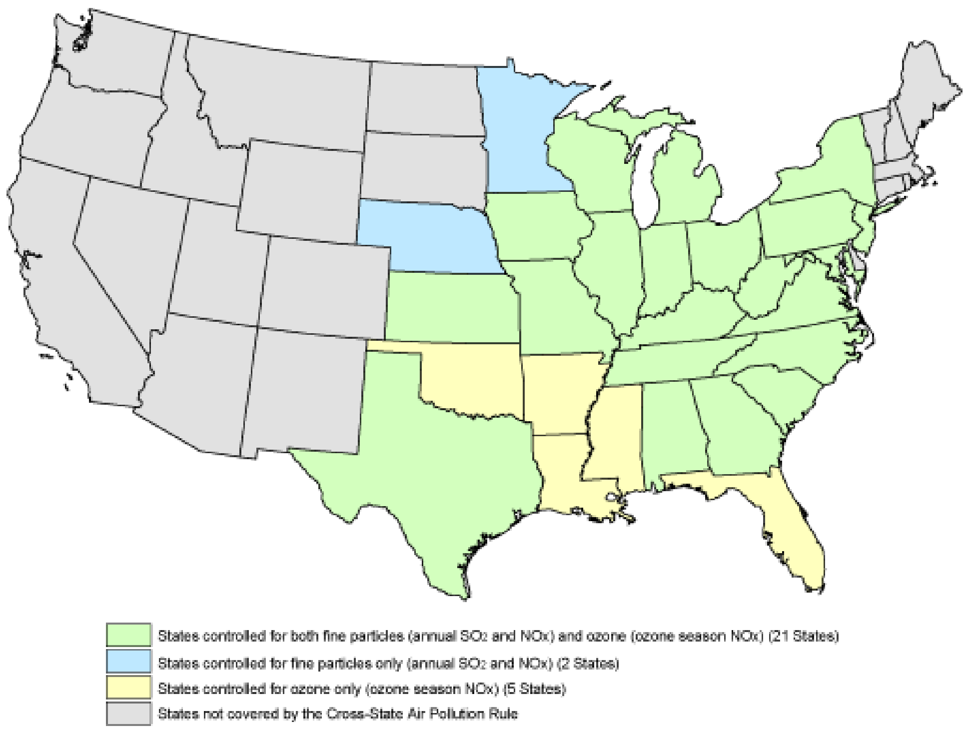

Figure 3: Ozone Nonattainment and Maintenance Areas for .075 ppm 8-Hour Ozone Standard
Source: Environmental Protection Agency

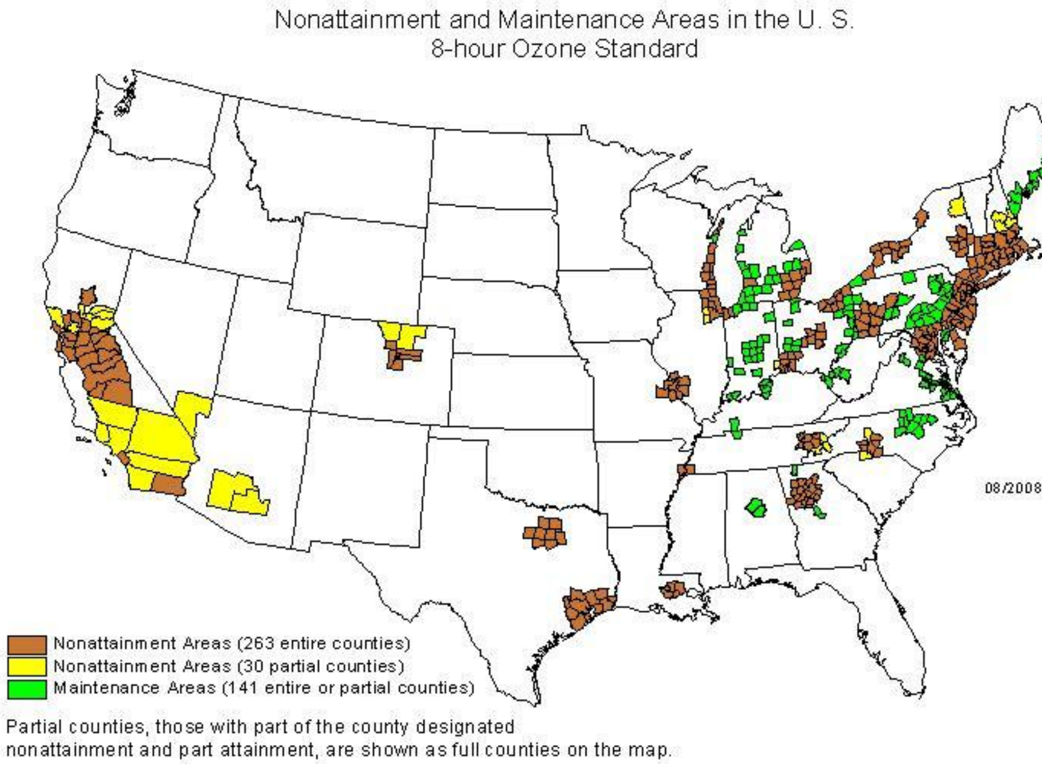

Figure 4: Locations Where Monitors Indicate 8-Hour Ozone Standard Being Violated
Source: Environmental Protection Agency

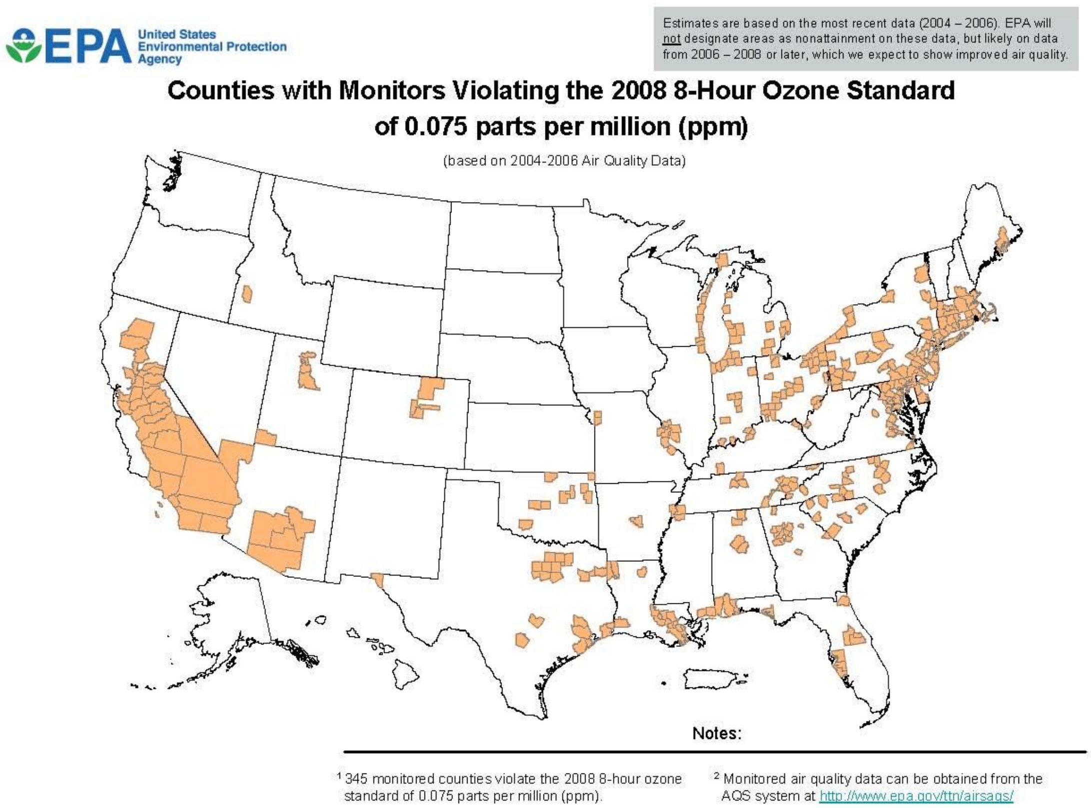

Figure 5: Locations Where Modeling Indicates 8-Hour Ozone Standard Will Be Violated in 2020

Source: Environmental Protection Agency

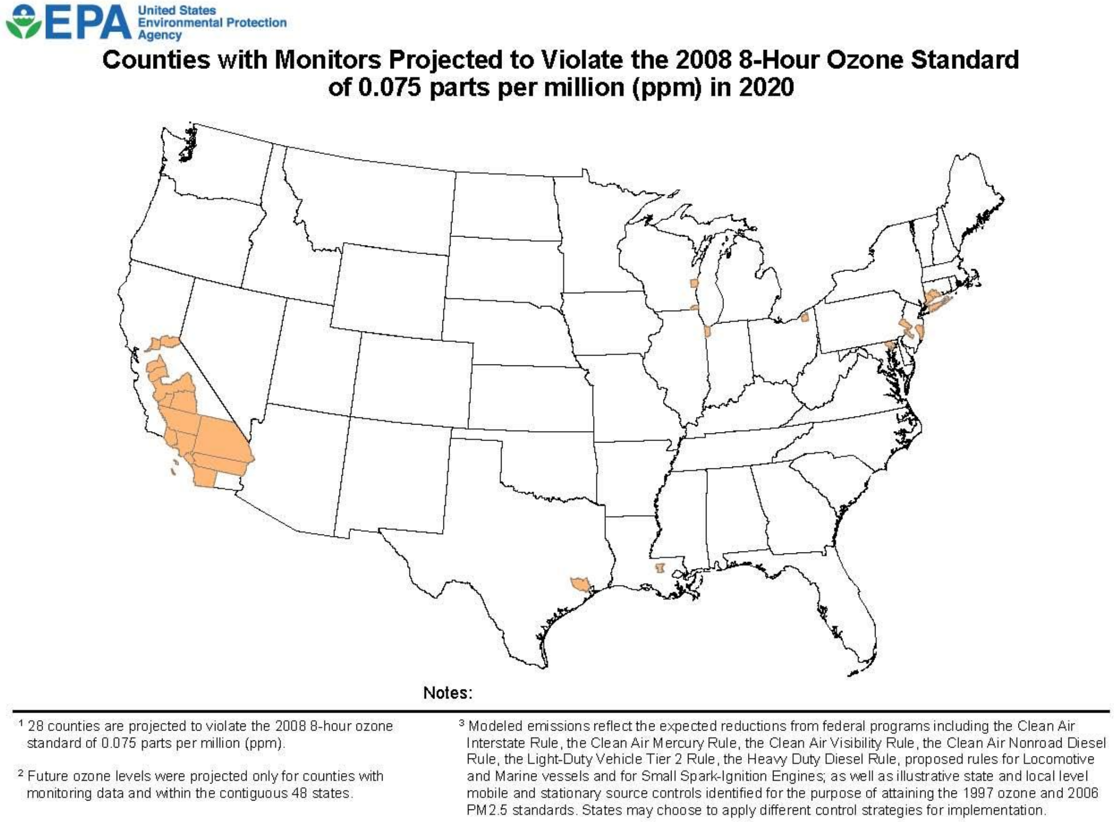

Figure 6: PM10 Attainment Status
Source: Environmental Protection Agency

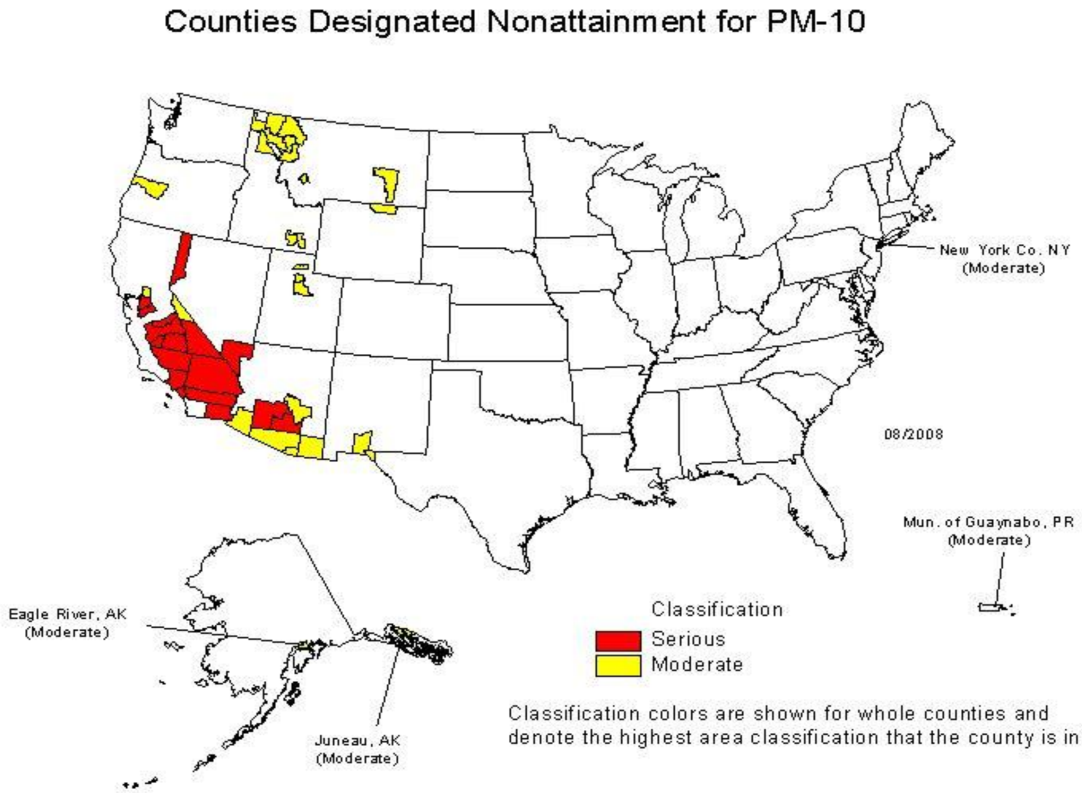

Figure 7: Locations Non-Attainment for 2006 PM2.5 Standard

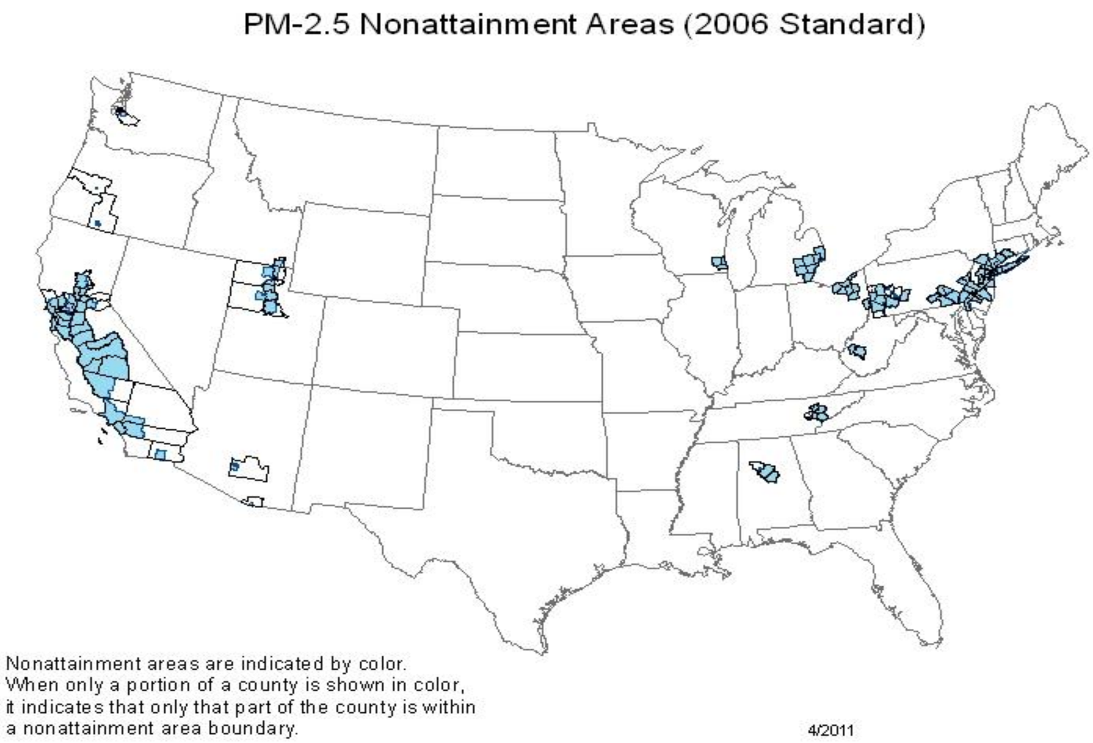

Figure 8: $PM_{2.5}$ and/or 8-Hour Ozone Attainment Status
Source: Environmental Protection Agency

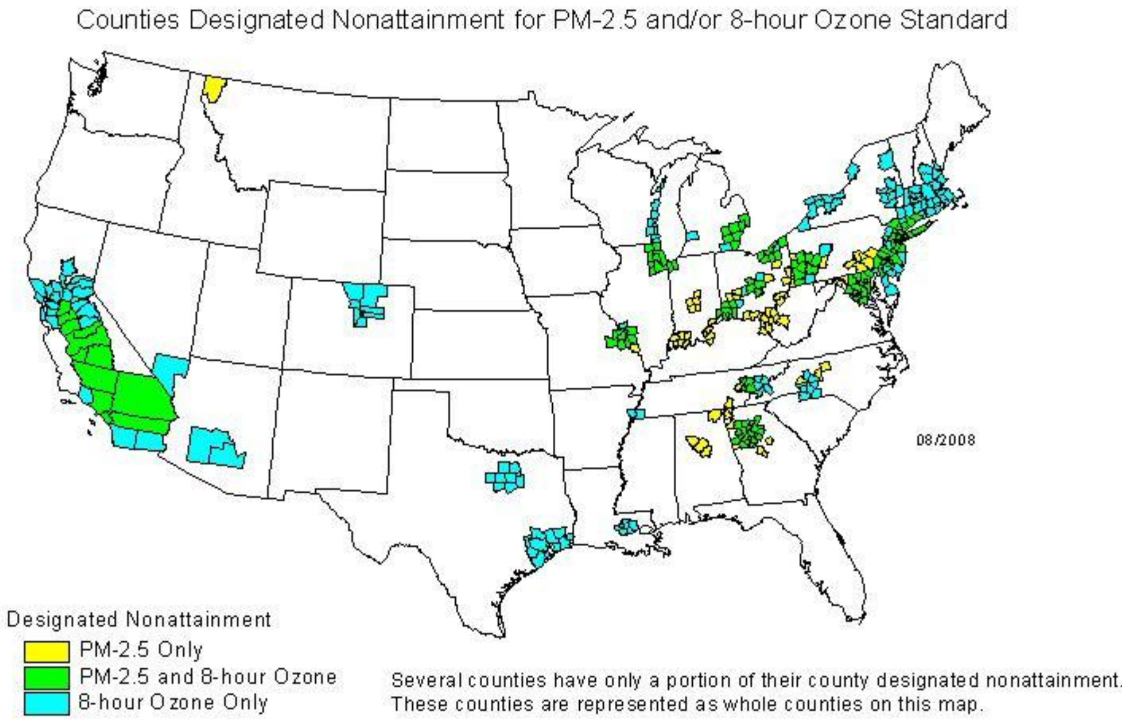

Figure 9: SO_2 Attainment Status
Source: Environmental Protection Agency

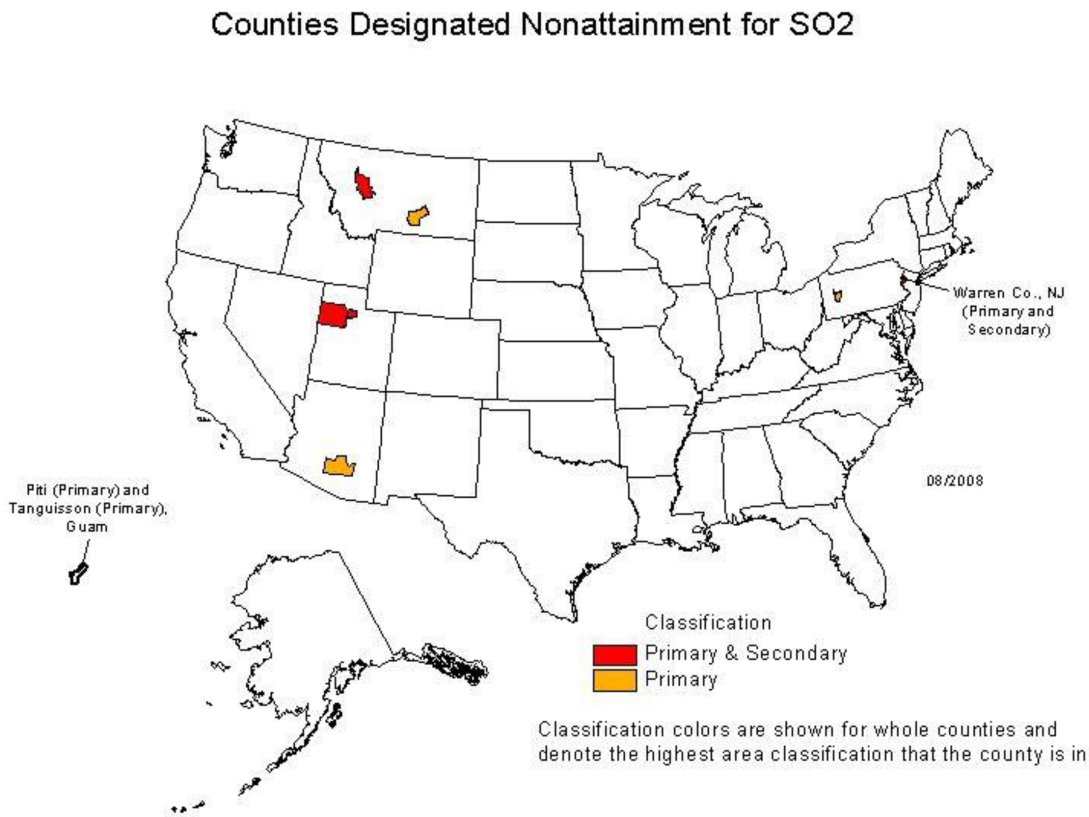

Figure 10: Lead Attainment Status
Source: Environmental Protection Agency

Figure 11: 2008 Lead Standard Attainment Status
Source: Environmental Protection Agency