Air Quality

# 2002 REFERENCE GUIDE

## For the Houston-Galveston Area

# Air Quality Reference Guide for the Houston-Galveston Area

July 2002

The contents of this report reflect the views of the authors who are responsible for the opinions, findings and conclusions presented herein. The contents do not necessarily reflect the views or policies of the Federal Highway Administration, the Federal Transit Administration or the Texas Department of Transportation.

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# Preface

We have prepared the *Air Quality Reference Guide for the Houston-Galveston Area* to provide interested citizens and organizations with accurate and up-to-date information about air pollution in the greater Houston area. We intentionally brought differing perspectives – industry, public health, government, citizens and the environmental community – to the preparation of this guide, and its contents represent the consensus of the group. Consensus was not always easy, but the process gave each of us a more multifaceted appreciation of the complexity of the problems facing the Houston area. We hope that this consensus of differing points of view is shown throughout this document, since working together and coming to a consensus are an integral part of the process to reduce the levels of pollution significantly in our area and within the time frame required. This document, however, is certainly not the final word on air pollution in the Houston area, and will be regularly revised as new information becomes available and as our understanding of the issues improves. We hope that you find this guide useful, and we encourage you to offer suggestions how it might be improved in the next revision.

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# 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. Although there are natural sources of air pollution, such as volcanic eruptions, forest fires and wind-blown dust, significant air pollution is usually the result of human activities (e.g., industrial processes and motor vehicle use).

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.

Ozone, formed by the combination of emitted nitrogen oxides ($NO_{x)}$ and hydrocarbons, also called photochemical smog, is the only criteria pollutant for which the eight-county Houston-Galveston area currently fails to meet the NAAQS. An area that fails to meet the NAAQS for a pollutant is said to be in nonattainment for that pollutant. The eight counties that make up the Houston-Galveston ozone nonattainment area for the one-hour standard are Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery and Waller (Figure 1). The counties comprise the Consolidated Metropolitan Statistical Area (CMSA) for the Houston region.

Other nonattainment areas in Texas include Beaumont-Port Arthur, Dallas-Fort Worth and El Paso. Some U.S. cities, as shown in Table 2, fail to meet more than one of the NAAQS. While the Houston area only fails to meet the NAAQS for ozone, it is designated as a “Severe” ozone nonattainment area under the Clean Air Act classification system. Monitors in the region have recorded some of the highest ozone readings in the nation. 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.

**FIGURE 1: The Eight Counties that Comprise the Houston-Galveston Nonattainment Area for the One-hour Federal Ozone Standard.**

**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 | More than 3 days over 3 years | Same as primary standard | | |
| | 0.08 ppm | 8-hour | 3-year average of annual fourth highest daily maximum | Same as primary standard | | |
| **Particulate Matter 10 microns or smaller ($PM_{10}$)** | 150 $\mu g/m^3$ | 24-hour | 3-year average of annual $99^{th}$ percentiles | Same as primary standard | | |
| | 50 $\mu g/m^3$ | Annual | Not to be exceeded | | | |
| **Particulate Matter 2.5 microns or smaller ($PM_{2.5}$)** | 65 $\mu g/m^3$ | 24-hour | 3-year average of $98^{th}$ percentiles | Same as primary standard | | |
| | 15 $\mu g/m^3$ | Annual | 3-year average of annual averages | | | |
| **Carbon Monoxide** | 35 ppm | 1-hour | More than once per year | No secondary standard | | |
| | 9 ppm | 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 | | | |
| **Nitrogen Dioxide** | 0.053 ppm | Annual | Not to be exceeded | Same as primary standard | | |
| **Lead** | 1.5 $\mu g/m^3$ | Quarterly | Not to be exceeded | Same as primary standard | | |

ppm = parts per million; $\mu g/m^3$ = micro-grams per cubic meter

**TABLE 2: U.S. Cities with a Population Greater than 1 Million in Nonattainment for One or More Criteria Pollutants**
(Source: U.S. EPA, May 21, 2001; www.epa.gov/oar/oaqps/greenbk/ancl3.html)

| City | 1-hr Ozone | Particulate Matter | Carbon Monoxide | Sulfur Dioxide | Nitrogen Dioxide | Lead | Total |
|---|---|---|---|---|---|---|---|
| **Atlanta** | X | | | | | | 1 |
| **Baltimore** | X | | | | | | 1 |
| **Chicago** | X | | | | | | 1 |
| **Cincinnati** | X | | | | | | 1 |
| **Cleveland** | | | | X | | | 1 |
| **Dallas** | X | | | | | | 1 |
| **Denver** | | X | | | | | 1 |
| **Houston** | X | | | | | | 1 |
| **Los Angeles** | X | X | | | | | 2 |
| **Milwaukee** | X | | | | | | 1 |
| **Minneapolis** | | X | | | | | 1 |
| **New York** | X | | X | | | | 2 |
| **Philadelphia** | X | | | | | | 1 |
| **Pittsburgh** | | X | X | X | | | 3 |
| **Phoenix** | | X | | | | | 1 |
| **Sacramento** | X | X | | | | | 2 |
| **St. Louis** | X | | | | | X | 2 |
| **San Diego** | X | | | | | | 1 |
| **San Francisco** | X | | | | | | 1 |
| **Washington D.C.** | X | | | | | | 1 |

X = Nonattainment

## *Criteria Pollutants*

### *Ozone*

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 noncombustion 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.

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.

*Existing Ozone Standard*

The current health and welfare NAAQS for ozone ($O_3$) is 0.12 parts per million (ppm) averaged over one hour. Because of mathematical rounding, an exceedance is considered to have occurred when $O_3$ levels equal or exceed 0.125 ppm, which equals 125 parts per billion (ppb). In 2001, there were 32 days when monitors in the Houston-Galveston area detected $O_3$ higher than the one-hour standard. The Houston-Galveston area is not in attainment for $O_3$.

*New Ozone Standard*

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 ppm. The EPA plans to designate areas that fail to attain the new eight-hour standard following the release of guidance for implementation. This guidance will clarify how the new eight-hour standard will be implemented in the Houston-Galveston eight-county area.

In 2001, there were 48 days when monitors in the Houston-Galveston area detected ozone that exceeded the eight-hour standard. It is expected that the Houston-Galveston area will be designated nonattainment for the eight-hour ozone standard.

*Particulate Matter*

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.

*Existing Particulate Matter Standards*

The current NAAQS for $PM_{10}$ are 150 micrograms per cubic meter of air ($\mu g/m^3$) averaged over 24 hours, and 50 $\mu g/m^3$ averaged over one year (Table 1). In 2001, the maximum concentrations of $PM_{10}$ in the Houston-Galveston area measured 110 $\mu g/m^3$ averaged over 24 hours, and 39 $\mu g/m^3$ as an annual average. The Houston-Galveston area is in attainment for $PM_{10}$ because attainment status is based on three years of data.

*New Particulate Matter Standards*

In July 1997, the EPA established new standards for particulate matter 2.5 microns in diameter ($PM_{2.5}$) or smaller. The new standards state that: (1) the annual mean concentration, averaged over three years, shall not exceed 15 $\mu g/m^3$, and (2) the $98^{th}$ percentile of the 24-hour average concentrations, averaged over three years, shall not exceed 65 $\mu g/m^3$. The EPA plans to designate areas that fail to attain the new $PM_{2.5}$ standards following the release of implementation guidance. In 1997-98, the maximum 24-hour average in the Houston-Galveston area was 53.7 $\mu g/m^3$, and the maximum annual average was 13.8 $\mu g/m^3$. In 1999-2001, the maximum 24-hour average in the Houston-Galveston area was 42.7 $\mu g/m^3$, and the maximum annual average was 15.1 $\mu g/m^3$. This data indicates that the $PM_{2.5}$ standard for the maximum annual average will be difficult for the Houston-Galveston area to attain. However, this incomplete data does not meet EPA standards and, therefore, must be interpreted cautiously.

*Carbon Monoxide*

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. In 1990, on-road mobile sources were responsible for approximately 59 percent of the CO emissions in the Houston-Galveston area, while non-road mobile sources were responsible for 32 percent, stationary point sources for 8 percent, and area sources for 1 percent. The NAAQS for carbon monoxide is 35 ppm averaged over one hour, and 9 ppm averaged over eight hours (Table 1). In 2001, the maximum CO concentration in the Houston-Galveston area measured 7.1 ppm averaged over one hour and 5.0 ppm averaged over eight hours. The Houston-Galveston area is in attainment for CO.

*Sulfur Dioxide*

Sulfur dioxide ($SO_2$) is a colorless, odorless gas at low concentrations, but has a pungent odor at higher concentrations. In Texas, $SO_2$ is emitted primarily 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). In 2001, the maximum $SO_2$ concentration in the Houston-Galveston area

measured 0.045 ppm averaged over 24 hours, 0.004 ppm as the highest annual average, and 0.190 averaged over three hours. The Houston-Galveston area is in attainment for $SO_2$.

*Nitrogen Dioxide*

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. The NAAQS for $NO_2$ is 0.053 ppm averaged over one year (Table 1). In 2001, the maximum annual $NO_2$ concentration in the Houston-Galveston area measured 0.02 ppm. Although the Houston-Galveston region is currently in attainment for $NO_2$, 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 standard.

*Lead*

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 $\mu g/m^3$ averaged quarterly (Table 1). In 1997, the Texas Natural Resource Conservation Commission (TNRCC; known as the Texas Commission on Environmental Quality after Sept. 1, 2002) and the City of Houston phased out ambient monitoring in the eight-county area because all measurements of lead at the four monitoring sites in the Houston-Galveston area were near or below the limit of detection (0.01 $\mu g/m^3$). The Houston-Galveston area is in attainment for lead.

## *Air Toxics*

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 as 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. In 2000, Harris County ranked third out of all of the U.S. counties for toxic air emissions (Table 3).

**TABLE 3: U. S. Counties with the Highest TRI Air Releases in 2000**
(Source: U.S. EPA; www.epa.gov/triexplorer/geography.htm)

| Rank | County/State | Total TRI Air Releases (pounds/year) |
|---|---|---|
| 1 | Toole, Utah | 43,949,589 |
| 2 | Person, N.C. | 28,841,728 |
| 3 | Harris, Texas | 23,987,431 |
| 4 | Armstrong, Pa. | 21,877,931 |
| 5 | Escambia, Fla. | 19,498,144 |
| 6 | Hamblen, Tenn. | 18,842,514 |
| 7 | Adams, Ohio | 18,445,993 |
| 8 | Mobile, Ala. | 18,322,080 |
| 9 | Humphreys, Tenn. | 18,027,918 |
| 10 | Ascension, La. | 17,975,016 |
| . . . | | |
| 39 | Los Angeles, Calif. | 8,216,816 |
| . . . | | |
| 50 | Galveston, Texas | 6,830,194 |
| . . . | | |
| 59 | Brazoria, Texas | 6,156,818 |

For many years, the TNRCC and HRM have been collecting 24-hour average air samples every six days to determine the concentrations of air toxics in the outdoor air. New monitoring methods are currently being developed to allow more frequent and faster determinations of concentrations.

In Texas, the TNRCC has established Effects Screening Levels (ESLs) for many of the air toxics. The ESLs are typically between 1/100th and 1/1,000th of the occupational health standards for the same chemicals and are used by TNRCC staff, mostly during the permitting process for industrial facilities, to evaluate the potential impacts of these chemicals in the outdoor air. The Texas ESLs are not intended to reflect safe concentrations and are to be used only as guidelines. Concentrations of pollutants above their established ESLs trigger a more in-depth review by the TNRCC toxicology and risk assessment staff. Elevated benzene concentrations above the ESLs have occurred in the Houston-Galveston area, as well as several other large cities. However, the area has had sporadic occurrences of other chemicals exceeding 24-hour ESLs, such as 1,3 butadiene in 1998, and carbon tetrachloride and isopentane in 1996.

# What are the 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.

## *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.[1] 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.

[1] McConnell, Rob, Kiros Berhane, Frank Gilliland, Stephanie J. London, Talat Islam, W. James Gauderman, Edward Avol, Helene G. Margolis, John M. Peters. "Asthma in exercising children exposed to ozone: a cohort study." *The Lancet* 359.9304 (2002): 386-391.

## *Particulate Matter*

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.[2] 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.

## *Carbon Monoxide*

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.

[2] Pope, C. Arden, III, Ph.D., Richard T. Burnett, Ph.D., Michael J. Thun, M.D., Eugenia E. Calle, Ph.D., Daniel Krewski, Ph.D., Kazuhiko Ito, Ph.D., George D. Thurston, Sc.D. "Lung Cancer, Cardiopulmonary Mortality, and Long-term Exposure to Fine Particulate Air Pollution." *The Journal of the American Medical Association* 287 (2002): 1132.

## *Sulfur Dioxide*

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 $SO_2$ 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*

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*

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*

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.

# What is the Quality of Houston's Air?

The eight-county Houston-Galveston area currently fails to meet the NAAQS for the criteria pollutant ozone. The majority of area air quality efforts in this region are, therefore, focused on (1) obtaining a better understanding and measuring of the area's ozone levels and its precursors, and (2) identifying and implementing effective ozone reduction control strategies.

## *Air Monitoring*

Concentrations of ozone in outdoor air have been monitored since 1971. There are now 27 air monitoring stations in the Houston-Galveston area (Figure 2), making this the most heavily monitored area in the United States. The City of Houston, the Texas Natural Resource Conservation Commission (TNRCC; known as the Texas Commission on Environmental Quality after Sept. 1, 2002) and Houston Regional Monitoring Corporation (HRM), an industry-funded monitoring network, operate these monitors. Most of the monitoring stations measure the concentrations of the criteria pollutants in the air, as well as air temperature, wind velocity and other meteorological parameters. Some of the monitoring stations also measure the levels of an additional set of selected chemicals, and some measure pollen and mold spores.

Currently, ozone monitors are in only five of the eight counties in the nonattainment area: Brazoria (two stations), Chambers (two stations), Montgomery (one station), Galveston (two stations) and Harris (20 stations). Ozone monitors detected levels over the one-hour standard in all of the counties with monitors in 2001, except in Galveston County. Fort Bend, Liberty and Waller counties do not have any monitors. Aircraft measurements made during the Texas 2000 Air Quality Study (TexAQS 2000) suggest that additional monitors in these areas would provide valuable information for ozone mapping and model verification.

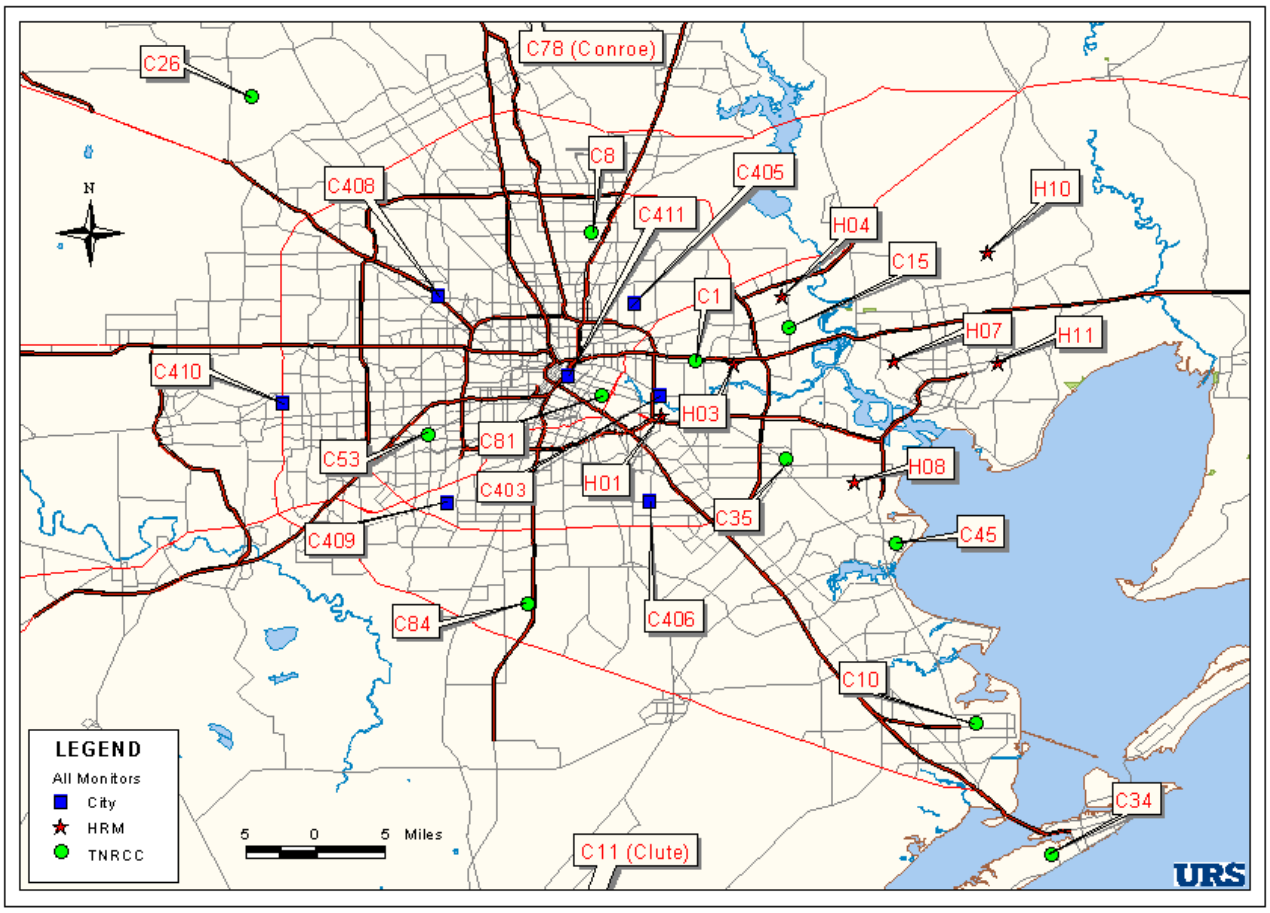



**FIGURE 2: 2002 Ozone Monitoring Sites in the Houston-Galveston Area**
(Source: URS Radian)

*Introduction of $PM_{2.5}$ Monitors to Eight-County Area*

The Houston area is gathering three years of reliable $PM_{2.5}$ data that is required to determine whether or not the area is in compliance with the EPA's $PM_{2.5}$ air quality standards. Thus far, it appears that all 25 of the monitoring sites (Table 4) will be in compliance, however, $PM_{2.5}$ levels at some of the monitors are close to exceeding the three-year annual average standard – 15 µg per cubic meter of air. The 24-hour average standard for $PM_{2.5}$, 65 µg per cubic meter of air, has not been exceeded so far in the Houston area. Detailed $PM_{2.5}$ monitoring results can be viewed at www.tnrcc.state.tx.us/cgi-bin/monops/particulates.

**TABLE 4: Particulate Monitoring Sites**
(Source: TNRCC, Austin, April 2002)

| | | $PM_{2.5}$ | $PM_{2.5}$ | $PM_{10}$ |
|---|---|---|---|---|
| **Name** | **County** | ***continuous*** | ***non-continuous*** | ***non-continuous*** |
| Clute | Brazoria | | S | |
| Fire Station | Galveston | | | S |
| Galveston | Galveston | X | E | X |
| Nessler Pool | Galveston | | S | X |
| League City | Galveston | | S | |
| Aldine | Harris | | E | N |
| Channelview | Harris | S | E | |
| NW Harris | Harris | | | X |
| Lang | Harris | | | S |
| Croquet | Harris | | S | |
| Bayland Park | Harris | | E | |
| Baytown | Harris | | S | |
| Monroe | Harris | | S | S |
| Westhollow | Harris | | | X |
| Pasadena Red Bluff | Harris | | | S |
| Texas Ave | Harris | | S | N |
| HRM Site 1 | Harris | | | X |
| HRM Site 3 | Harris | X | E | X |
| HRM Site 7 | Harris | | | X |
| Mae Drive | Harris | X | | |
| Clinton | Harris | S | S | N |
| Deer Park | Harris | S | E | X |
| Kingwood | Harris | X | | |
| Seabrook | Harris | X | | |
| Conroe Airport | Montgomery | S | E | |

***Abbreviations:***

N - NAMS Network (National Air Monitoring Stations)

S - SLAMS Network (State or Local) Air Monitoring Stations

X - Special Purpose

E - Speciated Sampler

## *Our Ozone Nonattainment Status*

The federal standard for ozone is a one-hour average concentration of 0.12 parts per million (ppm). To meet the standard, this one-hour average concentration cannot be exceeded at any one monitor in the area on more than three days over a three-year period. An area will comply with the attainment of the one-hour ozone standard when the fourth highest ozone level is 0.12 ppm or lower at the monitor with the highest ozone levels. Currently, 56 areas in the United States, including the Houston-Galveston area, are listed as being in nonattainment of the one-hour ozone standard. Although the highest number of days above the standard at any one monitor in the Houston-Galveston area has been declining since 1987 (Figure 3), this area will need aggressive reductions in air emissions to reach the average of one per year needed for compliance.

Under the federal Clean Air Act Amendments (CAAA) of 1990, ozone nonattainment areas are classified based on the highest ozone levels experienced during the three-year periods, 1987-1989 or 1988-1990. The five classifications are Marginal, Moderate, Serious, Severe and Extreme. Each classification has different pollution control requirements and different deadlines to attain the ozone standard. Areas with higher ozone levels are given more time to attain the standard, but must also implement more stringent pollution controls.

The Houston-Galveston-Brazoria nonattainment area, which includes Harris County and the seven surrounding counties, is classified as a Severe-17 nonattainment area, based on its highest ozone levels during 1987-89. In addition to the Houston-Galveston-Brazoria area, other Severe-17 nonattainment areas include the California Southeast Desert, New York-New Jersey-Long Island, Chicago-Gary-Lake County and Milwaukee-Racine. The Clean Air Act Amendments gave these areas 17 years to meet the one-hour ozone standard, and, therefore, they have a one-hour ozone attainment deadline of 2007. Although there are five nonattainment areas classified as Severe-17, the Houston-Galveston-Brazoria area has the highest ozone levels. The Los Angeles nonattainment area is the only area classified as Extreme, based on its highest ozone levels for 1987-89.

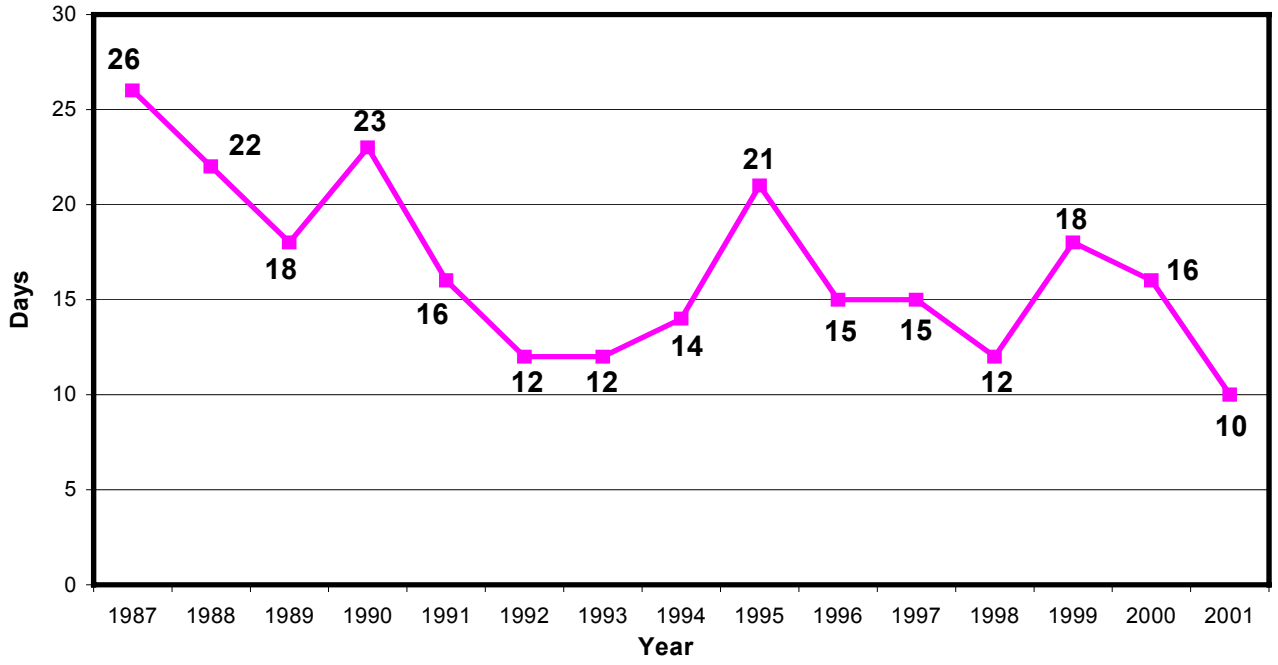



**FIGURE 3: Maximum Number of Days that Any Single Monitor in the Houston-Galveston Area Exceeded the 1-Hour Ozone Standard**
(Source: Houston Regional Monitoring, TNRCC, City of Houston and U.S. EPA, 2002)

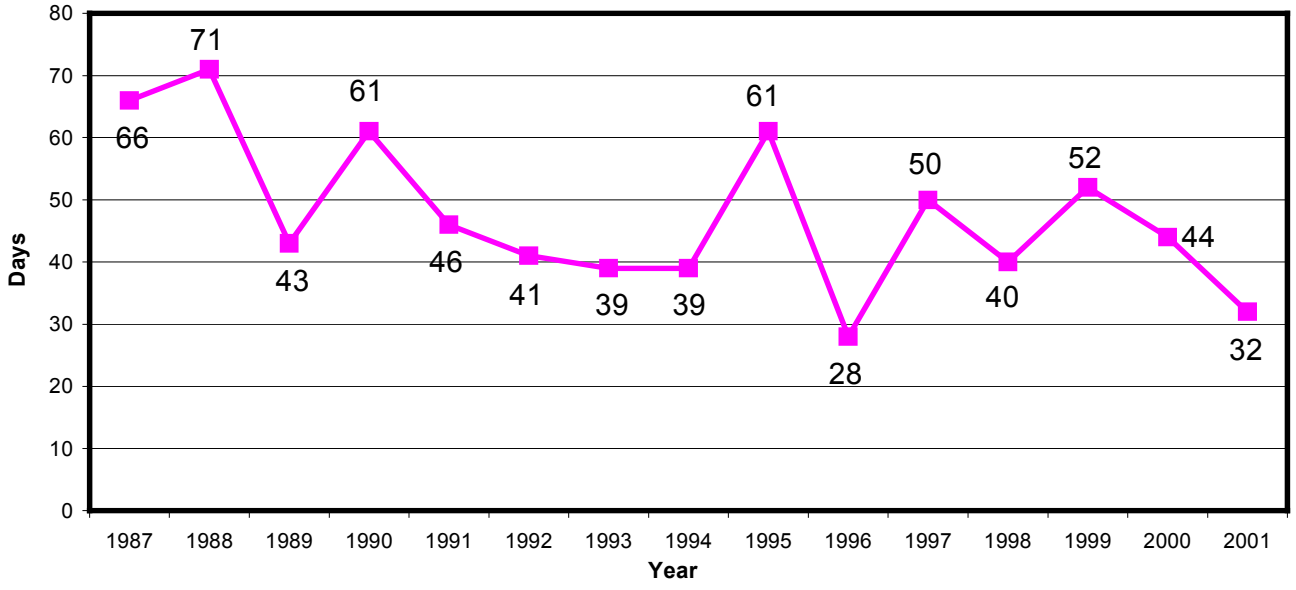



**FIGURE 4: Number of Days When at Least One Monitor Exceeded the 1-Hour Ozone Standard**

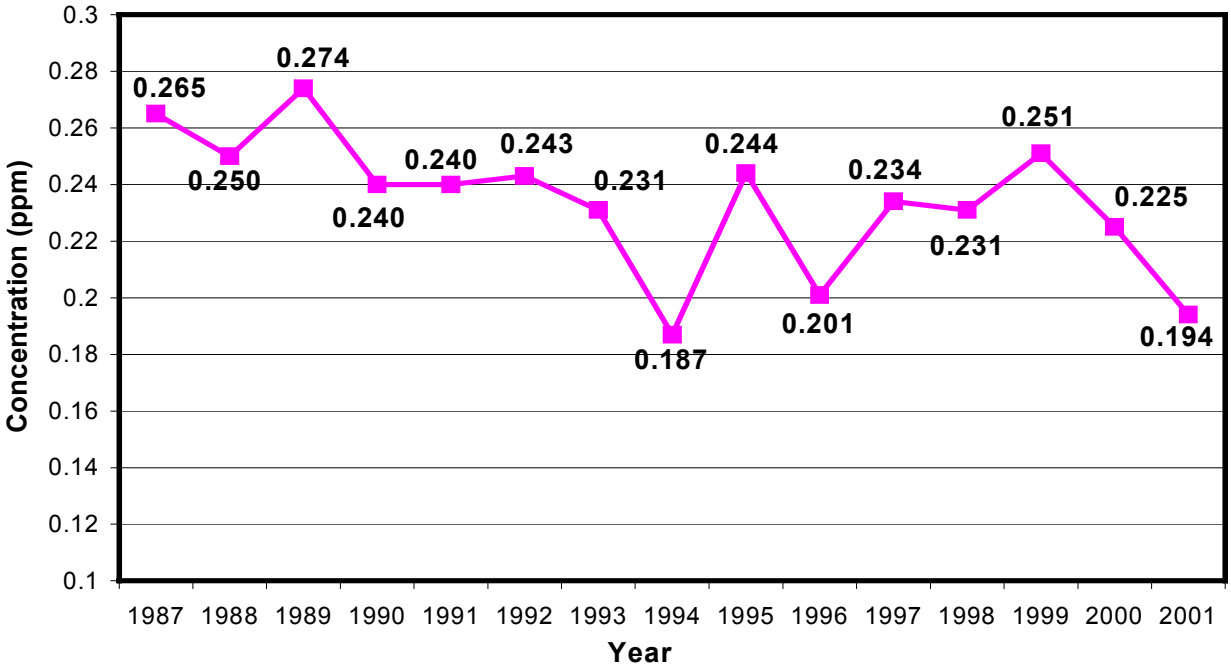



**FIGURE 5: Maximum 1-Hour Ozone Concentration**
(Source: Houston Regional Monitoring, TNRCC, City of Houston and U.S. EPA, 2002)

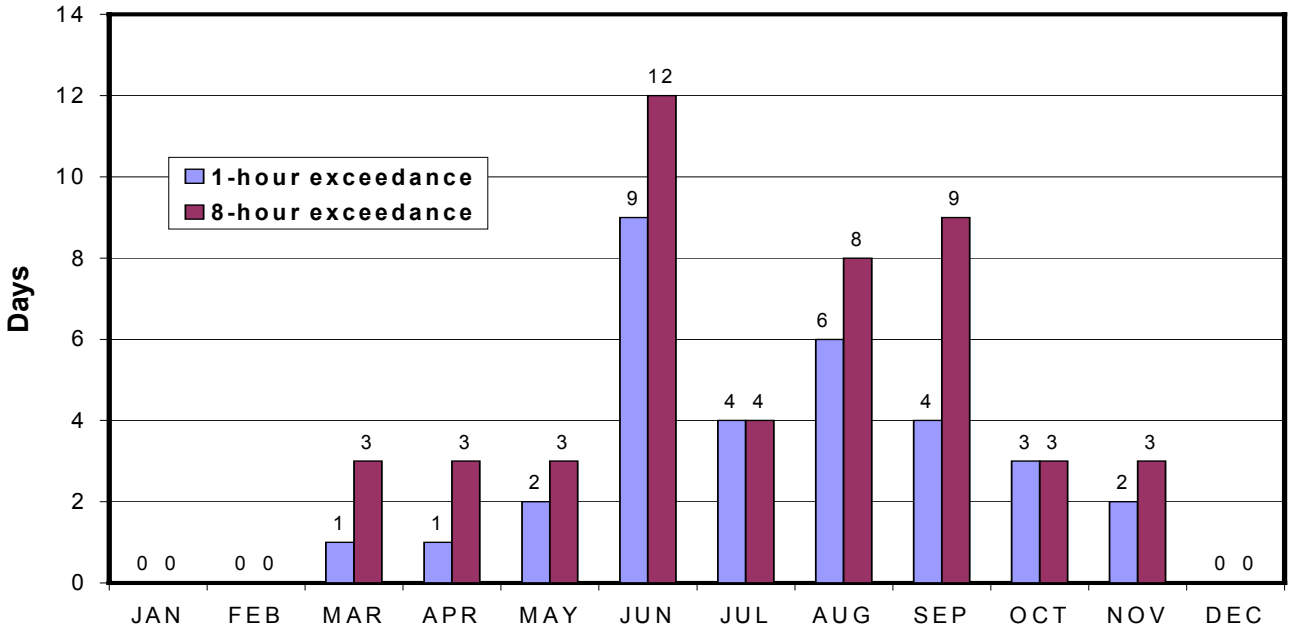



**FIGURE 6: 2001 Ozone Exceedance Days by Month**

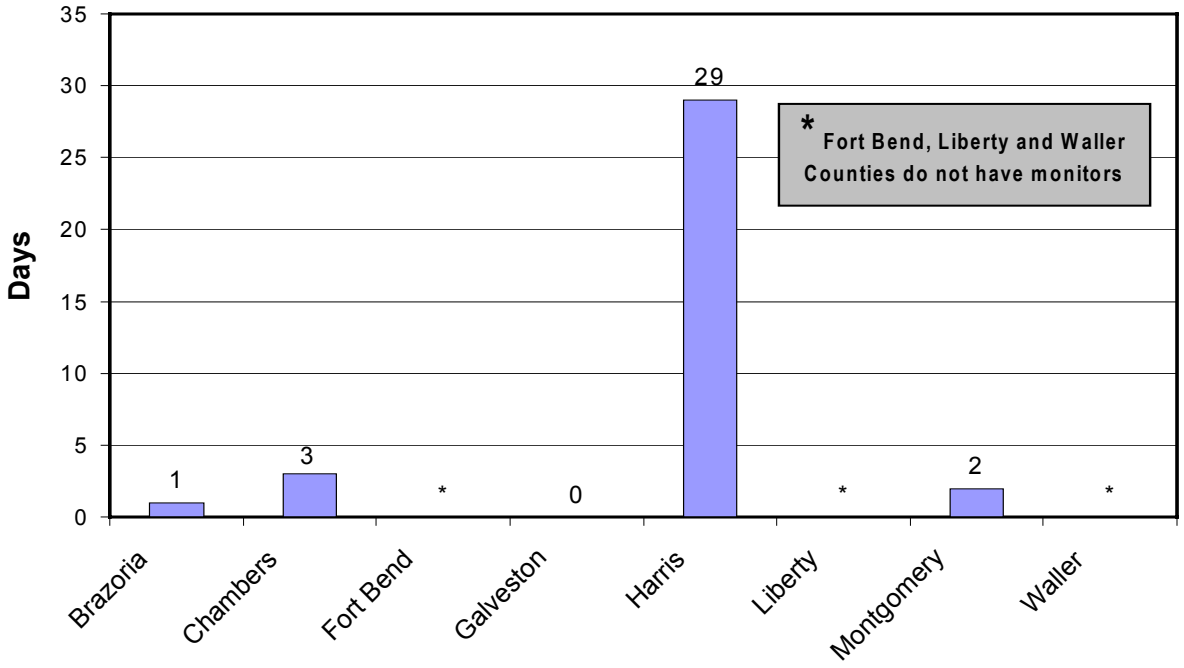



**FIGURE 7: 2001 Ozone Exceedance Days by County**

The long-term (15-20 year) downward trend in ozone is generally considered to be the result of the efforts that have been made to reduce emissions from various sources of VOCs, such as industry, cars and trucks, and small businesses. The Houston-Galveston area has implemented many new controls on emissions since 1990, in an attempt to reduce ambient levels of VOCs in the area. The TNRCC issued a report in May 1997 resulting from its study of ambient monitoring data for VOCs and certain air toxics from 1987-1995. It concluded that the average ambient VOC concentrations have been reduced by more than 50 percent in, and the average ambient levels of benzene, toluene and xylene have been reduced by 50 percent or more.

As shown in Figures 3 through 5, since 1991, there has been little progress toward the ozone standard, which has been frustrating to both policy makers and regional stakeholders. However, it is important to note that ozone levels have not increased, despite strong economic activity and population growth.

There has been a tremendous amount of scientific investigation regarding why monitored ozone levels have not continued to decline and a number of possible explanations continue to be investigated, including:

- The region has become $NO_x$ limited (i.e., VOC reductions are no longer effective);
- The region is not focused on highly reactive VOC reductions (i.e., olefins);
- The region has not made sufficient $NO_x$ reductions (i.e., deeper reduction are needed); and
- The emission estimates may be incorrect (i.e., ineffective control programs, under reporting and/or inaccurate characterization of emissions, etc.).

As you can also see in Figures 3 through 5, there can be a significant amount of year-to-year variability in ozone levels. In one year the ozone levels can be lower than the general trend, but will then increase above the general trend the next year. This year-to-year 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 the region, the eight-county area sees higher ozone levels and more exceedances of the one-hour 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. Figure 6 shows 2001 ozone exceedance days by month, and Figure 7 shows 2001 exceedance days by county.

## *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. The TNRCC is currently using the comprehensive air quality model with extensions (CAMx) to model precursor pollutant emissions, air movement, chemical reactions, and resultant ozone concentrations. Emissions 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 and meteorological data are

investigated and, if justified, modified 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 (2007). Then, the future emissions 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 $NO_x$.

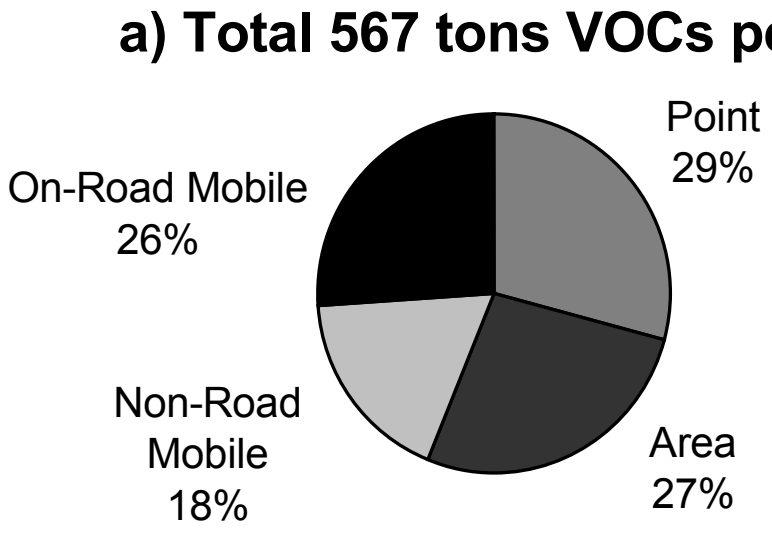
**On-road mobile sources** consist of automobiles, trucks, motorcycles and other vehicles that travel on roadways in the eight-county nonattainment area. The Houston-Galveston Area Council (H-GAC) estimates the quantity and type of emissions from such sources using the latest computer models available from the EPA. These 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. Most engines in this category have few or no emission controls and are considered high emitters of VOCs and $NO_x$ on a unit basis, although different types emit different proportions.

**Biogenic sources** of emissions are from plant life in the area, including crops, trees, grass and other vegetation. TNRCC estimates the quantity and type of emissions from vegetation 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.

Figure 8 shows man-made (excluding biogenic) emissions of VOCs and $NO_x$, with VOC and $NO_x$ emissions allocated to source categories, according to the 1999 Periodic Emission Inventory. Although the 1999 Periodic Emission Inventory is the most recent report of regional emissions of both VOCs and $NO_x$, emissions inventories are regularly updated when new information becomes available. The inventories used for the 2000 ozone modeling will be somewhat different than those shown in Figure 8. Figure 9 shows the 1999 emissions of VOCs and $NO_x$ in each of the eight nonattainment counties. It also shows 2000 population numbers for each county.



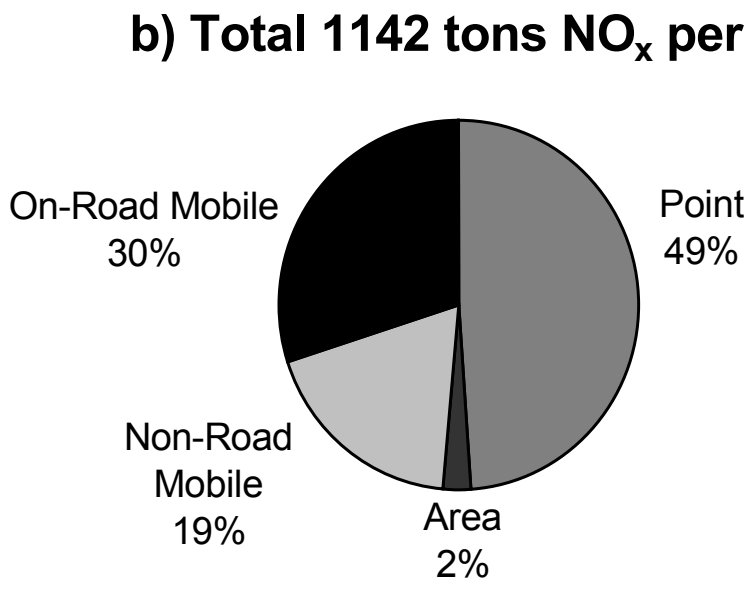




**FIGURE 8: Man-made Emissions by Source Category in the Houston-Galveston Area for (a) VOCs and (b) $NO_x$**
(Source: 1999 Periodic Emissions Inventory, TNRCC)

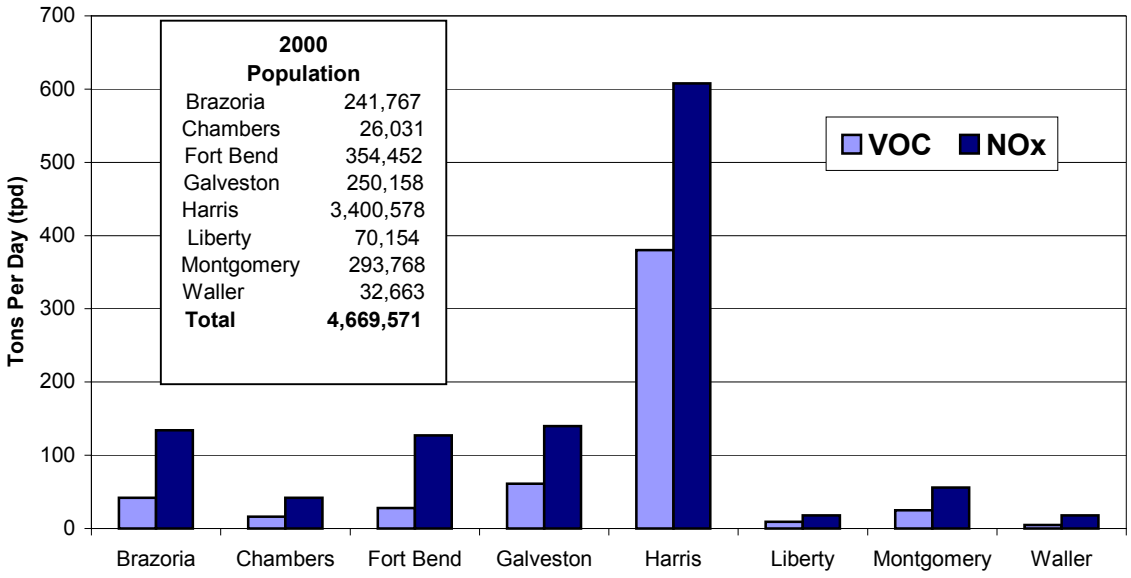



**FIGURE 9: Man-made Emissions of VOCs and $NO_x$ by County**
(Source: 1999 Periodic Emissions Inventory, TNRCC and the Texas State Data Center)

# What are We Doing to Clean Up the Air?

## *The State Implementation Plan for the Houston-Galveston Area*

EPA regulations require states with areas failing to attain one or more of the NAAQS to prepare and execute a State Implementation Plan (SIP). This dynamic plan is a blueprint of how the state will demonstrate attainment of the federal air quality standards in a nonattainment area. It is intended for a SIP to be revised regularly, as new information becomes available, and as required by the Clean Air Act (CAA). The original ozone SIP for the Houston-Galveston area was submitted in 1973 and has, subsequently, been revised many times. The Texas SIP documents are available at www.tnrcc.state.tx.us/oprd/sips/index.html.

From 1973 to the late 1990s, emission control strategies focused on the reduction of VOCs from industrial sources. In 1998, the EPA and the Texas Natural Resource Conservation Commission (TNRCC; known as the Texas Commission on Environmental Quality after Sept. 1, 2002) determined that reductions above and beyond those of VOCs would be necessary. Furthermore, photochemical modeling indicated that $NO_x$ emissions from point, area and mobile sources would need to be reduced by 65 percent to 85 percent to demonstrate attainment. Therefore, the May 1998 SIP revision lists various options for reducing $NO_x$ and VOC emissions.

However, in its evaluation of the May 1998 SIP revision for the Houston-Galveston area, the EPA determined that the SIP was incomplete, since it did not list sufficient specific control measures to bring the area into attainment. In the SIP revision of 1999, the TNRCC conducted additional modeling per the EPA's request to include specific control measures. The EPA analyzed the November 1999 SIP and determined that there was a gap of 118 tons per day (tpd) between the reductions in the plan and those needed for attainment. The EPA required the immediate submittal of further control measures and commitments.

In December 2000, the TNRCC submitted its ozone attainment demonstration SIP revision for the Houston-Galveston area to meet its commitments and reduce the shortfall in the SIP. For the first time, the agency was forced to adopt strategies that influenced behavior because no additional technologically based strategies were available. In September 2001, a follow-up "clean-up" SIP was adopted by the TNRCC at the request of the EPA. On October 21, 2001, the EPA approved both the December 2000 and September 2001 SIP revisions as an attainment demonstration. Table 5 summarizes the control strategies adopted in the two revisions. The revisions also include enforceable commitments to enhance the science and close

the shortfall of 56 tpd. Figures 10 and 11 show modeled future emissions in 2007 with and without the regulations in the SIP (measures to fill the 56 tpd gap shortfall are not included).

There will be two major revisions to the SIP in 2002 and 2004. These revisions will consider the results of new research and modeling obtained from the Texas Air Quality Study 2000, specifically the affects of highly reactive VOC emissions on ozone formation. Additionally, new technologies and innovative ideas are being studied as potential future control measures to further reduce VOC and $NO_x$ emissions. The TNRCC anticipates that the new measures and scientific enhancements incorporated into the 2002 and 2004 revisions of the SIP will fulfill its commitment to obtain the additional emission reductions necessary to close the shortfall and demonstrate attainment.

## TABLE 5: Houston-Galveston Area (HGA) State Implementation Plan (SIP) Control Strategies (see also Appendix G)

| Control Strategy | Brief Description | Affected Area | $NO_x$ Reductions (tons per day) |
|---|---|---|---|
| Point Source $NO_x$ Controls | • Requires a wide variety of minor and major stationary sources to meet new requirements, in order to reduce $NO_x$ emissions by 90 percent<br>• Begins April 1, 2003, and is phased in through April 1, 2007 | 8 HGA Counties | 586 |
| Vehicle Inspection/ Maintenance Program | • Requires emissions testing of all gasoline-powered vehicles 2-24 years old, with testing beginning on the vehicles' 2nd anniversary<br>• 1995 and older vehicles will be tested with a treadmill-like machine<br>• 1996 and newer vehicles will be tested with a computer that plugs into the vehicles' computer<br>• All vehicles registered, and primarily operated, in Harris County beginning May 1, 2002<br>• All vehicles registered, and primarily operated, in Brazoria, Fort Bend, Galveston and Montgomery counties beginning May 1, 2003<br>• All vehicles registered, and primarily operated, in Liberty, Waller and Chambers counties beginning May 1, 2004 (option to develop an alternate plan) | 8 HGA Counties | 36.20 |
| Voluntary Mobile Emission Reductions | • Includes numerous projects identified by the Houston-Galveston Area Council, such as a smoking vehicle program, bus fare promotions, alternative fuel programs and vehicle scrappage | 8 HGA Counties | 23.00 |
| Speed Limit Reduction | • All roadways with a current posted speed limit above 55 mph in the eight-county area are restricted to 55 mph<br>• Includes tollways, but HOV lanes are exempt<br>• Begins May 1, 2002 | 8 HGA Counties | 12.33 |
| Cleaner Diesel Fuel | • Improved diesel fuel for all on-highway and off-highway sales in East and Central Texas by April 1, 2005 | East/Central Texas | 6.67 |
| Airport Reductions | • Agreed orders signed with Continental and Southwest Airlines<br>• MOA signed with the City of Houston<br>• Phased in through Dec. 31, 2005 | | 5.09 |
| Commercial Lawn Operating Restriction (applies to local governments) | • Restricts the use of small commercial gasoline equipment between 6 a.m. and noon, beginning April 1, 2005<br>• Only applies April 1 through Oct. 31 each year<br>• Applies in Harris, Fort Bend, Brazoria, Galveston and Montgomery counties<br>• Commercial operators are exempt from the rule in the case of certain emergencies, or if they can develop a plan to lower emissions that receives the approval of the commission and the EPA | 8 HGA Counties | 4.60 (equivalent) |
| California Spark-Ignition Engines | • Requires manufacturers to ensure that certain off-highway gasoline engines are certified to California standards<br>• Begins May 1, 2004 | Statewide | 2.80 |

| | | | |
|---|---|---|---|
| Transportation Control Measures | • Includes numerous projects identified by the Houston-Galveston Area Council, such traffic signalization, bicycle/pedestrian projects, intersection improvements, and park and ride lots | 8 HGA Counties | 1.06 |
| Stationary Diesel Engine | • Operators and owners of stationary engines must meet operating restrictions and emission specifications<br>• Begins April 1, 2004 | 8 HGA Counties | 1.00 |
| Gas-fired Heaters, Small Boilers and Process Heaters | • New natural gas-fired heaters, small boilers and process heaters with a maximum rate capacity of up to 2.0 MM Btu/hr will be sold and installed statewide<br>• Begins July 1, 2002 | Statewide | .50 |
| VOC Controls | • Implement additional control technology requirements for batch processes, bakeries and offset lithographic printers to reduce VOC emissions | 8 HGA Counties | 0.00 |
| Emissions Banking and Trading | • Create an overall $NO_x$ Trading Program for the Houston-Galveston area<br>• Additional modifications address the generation of emissions reduction credits made to the existing statewide program | 8 HGA Counties for the emissions cap | 0.00 |

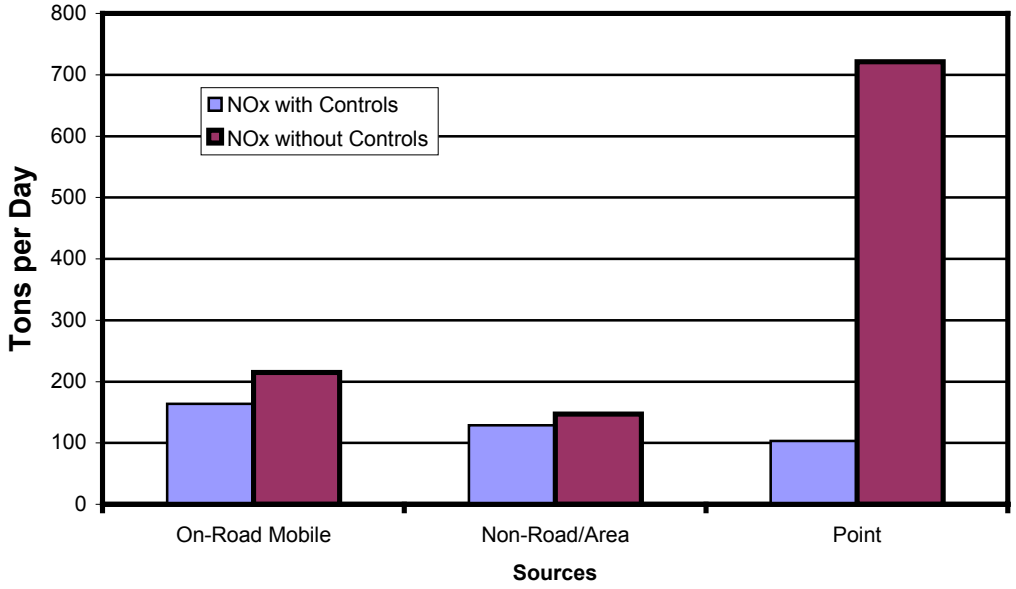



**FIGURE 10: 2007 Total $NO_x$ Tons per Day, With and Without Controls**
(Source: TNRCC September 26, 2001 Adopted Attainment Demonstration SIP)

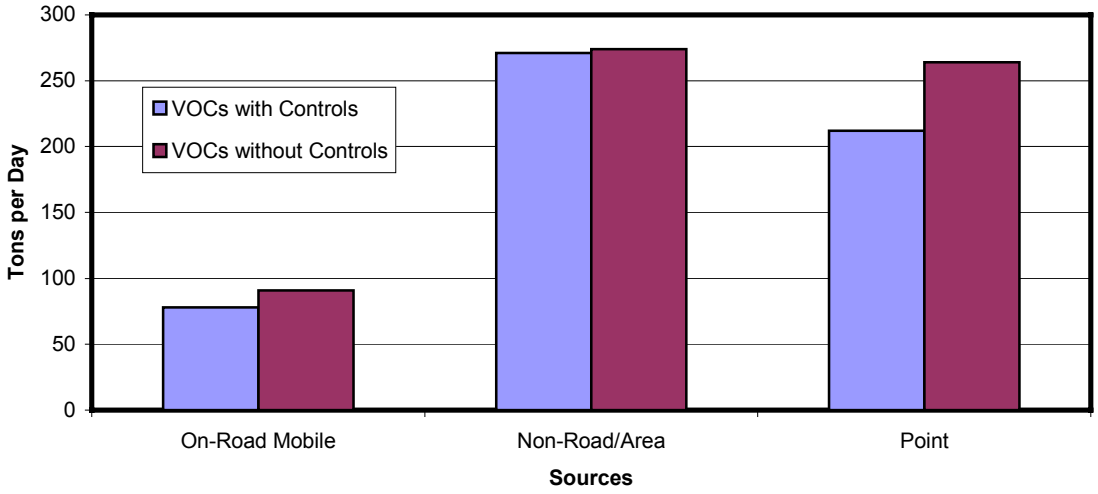



**FIGURE 11: 2007 Total VOCs Tons per Day, With and Without Controls**
(Source: TNRCC December 6, 2000 Adopted Attainment Demonstration SIP)

## *Federal Control Strategies*

### *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 the only gasoline available for sale in the nonattainment area. The use of RFG has resulted in significant reductions in VOCs and, to a lesser extent, $NO_x$ in this region. One of the components of RFG is an oxygenate that helps the gas burn cleaner. In the Houston area, 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 recent decision by the EPA to phase out the use of MTBE, in favor of other oxygenates, such as ethanol.

Beginning in January 2000, more stringent RFG standards (Phase II RFG) replaced RFG in the Houston-Galveston nonattainment area. Phase II RFG will remove an additional 41,000 tons of smog-forming pollutants in RFG areas, the equivalent of eliminating emissions from 16 million cars nationwide, from the air. Compared to conventional gasoline, Phase II RFG will cut the release of VOCs by 27 percent and $NO_x$ emissions by 7 percent.

To support the new Tier 2 vehicle standards, the EPA adopted a rule in February 2000 to limit the sulfur content in gasoline. Beginning in 2004, refineries and importers will be 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 - Diesel Fuel*

Since October 1, 1994, federal law has allowed a maximum of 500-ppm sulfur diesel fuel for use in on-road vehicles. California diesel fuel allows the same 500 ppm, but requires low aromatics (10 percent aromatics maximum, compared to 25 percent to 35 percent aromatics in typical on-road diesel). While the federal low-sulfur diesel fuel has had only minimal impacts on $NO_x$ reductions, it has resulted in larger reductions in sulfur and particulates.

In May 2000, the EPA proposed rules to limit sulfur in diesel fuel. Reduced sulfur content is required to allow advanced pollution control technologies, particulate traps and catalytic treatments to be effective in diesel vehicles. Reduced sulfur content has also been shown to extend engine life and reduce maintenance costs. Low-sulfur diesel is projected to reduce particulates by 10 percent to 20 percent, and $NO_x$ by 7 percent to 10 percent.

*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. The most commonly used alternative fuels in light-duty vehicles in this area 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.

## *State Strategies*

The TNRCC has adopted numerous VOC and $NO_x$ controls designed to reduce emissions. These controls are expected to reduce ozone levels significantly in the Houston-Galveston nonattainment area, as well as in other nonattainment areas and near-nonattainment areas across the state.

### *Emission Reductions by Grandfathered Facilities*

With the Texas Clean Air Act (TCAA) revision of 1971 came a new air permit requirement for stationary sources. Beginning in 1971, before a new facility is constructed, an air permit has to be obtained from the TNRCC and the new facility has to use the "best available control technology" (BACT) to control air emissions. For facilities that were already in existence in 1971, air permits are not required until the facility is later modified.

A "modification" to an existing facility is a change to the facility that results in a significant increase in air emissions. Under the Texas Clean Air Act, if an existing facility has never been modified, there is no requirement to obtain a permit and/or meet BACT. These unmodified existing facilities are referred to as grandfathered facilities. In 2001, the 77$^{th}$ Legislature passed House Bill 2912, requiring grandfathered facilities to obtain an air permit, applying a ten-year-old BACT. These requirements will not only reduce emissions in the Houston-Galveston area, but emissions will decrease across Texas.

### *Texas Emission Reduction Program*

The 77$^{th}$ Legislature passed Senate Bill 5, that instructed the TNRCC to remove the Construction Activity Restriction and the Accelerated Purchase of Tier II/III Diesel Equipment Rule from the SIP. The bill also created the Texas Emission Reduction Plan (TERP), designed to provide economic incentives for improving air quality throughout the state. The program provides incentives, rebates and grants for various types of clean air projects, such as improvements to on-road diesel and non-road diesel emissions, infrastructure development programs, qualifying fuel projects, demonstration projects, energy efficiency programs and new technology programs.

The grant programs, which are administered by the TNRCC, include the purchase or lease of new non-road equipment, replacement of on-road and non-road diesel vehicles, retrofits and add-ons of on-road and non-road diesel engines and vehicles, demonstration projects, use of

qualifying fuel, and infrastructure projects. These projects (excluding demonstration projects) are subject to a $13,000/ton of $NO_x$ maximum cost effectiveness threshold.

Funding for TERP is estimated at $133 million per year. The funding breakdown is as follows: 72 percent for diesel reduction programs, not more than 3 percent for infrastructure projects, not more than 15 percent for on-road diesel purchases; 10 percent for light-duty purchases and lease incentives; 7.5 percent for energy efficiency programs; 7.5 percent for new technology and research (TCET); 3 percent for administration. Of the bill's money, 72 percent is to be administered by the TNRCC and 10 percent will be set aside for non-regional projects that don't meet the localized allocation scheme.

Although a portion of the funding has been challenged, the agency anticipates that the Texas Legislature will provide the contested portion of funding. The first request for projects period closed on November 21, 2001, and resulted in five funded projects in the Houston area (www.tnrcc.state.tx.us/oprd/sips/rfp1sum1.pdf). The second application period ended on March 29, 2002, and grant plans are being evaluated. The next request for projects is scheduled for the fall of 2002.

*Motor Vehicle Emissions Budget*

The 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. On-road mobile vehicles contribute 30 percent of the area's $NO_x$ emissions and 26 percent of the VOC emissions. Examples of on-road measures chosen by the region and incorporated into the SIP for emission reductions include the Transportation Control Measures (TCMs) and the Voluntary Mobile Emission Reduction Program (VMEP). Although few local programs currently address emissions from off-road mobile transportation sources, such as planes, trains, ships and construction equipment, these sources are significant contributors to area pollution, and controls for these sources are included in the December 2000 SIP.

*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). H-GAC and the transportation project-implementing agencies have committed to a number of TCMs for on-road mobile source emissions. These include HOV lanes, arterial traffic flow improvements, park and ride lots, transit service improvements, bicycle facilities, areawide rideshare programs, computerized transportation management systems and light rail.

Such measures are projected to contribute about 1.06 tons per day of $NO_x$ reductions and 2.13 tons per day of VOC reductions in 2007.

*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.

The Houston-Galveston area is required to reduce emissions by 23 tpd $NO_x$ in the December 2000 SIP through the following VMEPs:

*Scrappage*

This measure intends to scrap 7,200 light-duty vehicles by 2007 from fleet turnover.

*Smoking Vehicle Program*

The Texas Smoking Vehicle Program is a citizen outreach strategy designed to encourage the proper maintenance and repair of cars, trucks and buses with excessive emissions, and promote public awareness regarding the harmful emissions and air pollution caused by these vehicles. The program allows citizens to anonymously report motor vehicles that have been observed emitting exhaust smoke for more than 10 consecutive seconds. The owners of these smoking vehicles will be notified and encouraged to voluntarily repair their vehicles. Smoking vehicles can be reported by calling 1-800-453-SMOG, sending a fax to 512-239-2050, sending an e-mail to smog@tnrcc.state.tx.us, or by using the online reporting form at www.smokingvehicle.org.

*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*

A memorandum of understanding has been signed with Union Pacific, Burlington Northern and Santa Fe Railroads to achieve emission reductions through various controls.

*Commercial Marine*

Memorandums of agreement have been signed with Texas Waterway Operators and Texas Department of Transportation for emission reductions through various controls.

*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.

*Regional Computerized Traffic Signal System (RCTSS)*

This measure is a compilation of individual initiatives to reduce vehicle congestion on surface streets through signal timing.

*Cool Cities*

The existing tree canopy coverage in our region will be used to calculate the economic and environmental benefits that trees provide in terms of pollution mitigation and cooling costs.

*Smart Growth*

This measure encourages green development through increased population density and mixed-land use initiatives to reduce number, frequency and length of trips.

*Local Government Emission Reduction Programs*

Under this measure, cities, counties and/or other public organizations will develop multi-component emission reduction strategies targeting on- and off-road mobile sources, as well as stationary sources.

*AERCO Pilot Project*

Emission reduction credits will be generated from retrofitted mobile sources. Emission benefits generated by this measure will be comprised of a compilation of expected trades of emission reduction credits.

*Transportation Conformity*

The regional transportation system, which includes freeways, surface roads, HOV lanes and buses must contribute to improving air quality. It is the responsibility of H-GAC, serving as the area Metropolitan Planning Organization (MPO) for the region, acting through its Transportation Policy Council (TPC), and working with an interagency conformity consultation committee, to ensure that regional transportation does not increase regional $NO_x$ and VOC emissions. Since the area is in nonattainment, the MPO must demonstrate that the Metropolitan Transportation Plan (MTP), a 20-year long-range transportation plan, and the Transportation Improvement Program (TIP), a three-year implementation plan, conform to the air pollution reduction goals laid out in the SIP. To conform, the eight-county nonattainment area cannot have an increase in on-road mobile source-generated VOC or $NO_x$ emissions from those shown in the 1990 emissions inventory, even if the area experiences significant increases in vehicle miles traveled. In other words, the area must not exceed the MVEB established in the SIP. The area must also show that transportation emissions continue to decline throughout the long-range transportation planning time, and that the area is meeting the SIP commitments it has made.

*Transportation Conformity Lapse Situations*

To receive federal approval, a new or revised MTP or TIP must show how much pollution will be added to, or subtracted from, the region. Whenever a change is made to an MTP or TIP in a nonattainment area, federal rules state that the revisions must adhere to the region's air quality plan. Conformity lapses occur as a result of a failure to implement SIP control measures or a failure to demonstrate conformity within the required timeframe. A conformity

lapse allows only those transportation projects that are exempt from federal air quality conformity requirements to proceed. Exempt projects may include safety, maintenance and TCMs approved in SIPs. A lapsed area cannot increase roadway capacity until it demonstrates conformity. Although the Houston-Galveston area has previously been in a lapse, it is currently in conformity.

## *Local Initiatives*

In addition to controls considered for inclusion in the next SIP revision, the following efforts have been initiated at the local level.

### *Regional Air Quality Planning Committee*

The Regional Air Quality Planning Committee (RAQPC) was created in 1991 to advise the H-GAC Board of Directors and Transportation Policy Council on issues relating to air quality. RAQPC is comprised of 26 representatives of local government; environmental, public health and citizen groups; and business and industry from all eight counties in the nonattainment area. The committee conducts monthly meetings, which are open to the public.

### *Principles for Cleaner Air*

In January 1999, the H-GAC Board of Directors, Harris County, the City of Houston, and area business and environmental leaders (www.cleanairaction.org/education/principles/orgs.html) endorsed nine principles, developed through the RAQPC Executive Committee, that address regional air quality. The Principles for Cleaner Air (Appendix C) continue to provide a framework for developing a regional consensus on air pollution reduction measures, and endorsement of the Principles represents a willingness of diverse interest groups to work together for cleaner air.

### *Mission Clean Air*

Mission Clean Air is an incentive-based campaign designed for businesses, industries and local governments to lead the challenge of improving air quality and reducing vehicle miles traveled. H-GAC administers Mission Clean Air programs – Commute Solutions, Clean Cities/Clean Vehicles and the Area Emission Reduction Credit Organization (AERCO). This

targeted campaign offers a variety of options, including tax incentives, federal and state grants opportunities, technical assistance, recognition through public relations, and other benefits. Participants can earn the designation as Clean Air Leaders and become part of a regional public recognition and marketing campaign.

*Commute Solutions*

Commute Solutions is a voluntary trip-reduction program that strives to reduce vehicle trips and/or vehicle miles traveled (VMT) throughout the eight-county Houston-Galveston Transportation Management Area (TMA). This program is designed to reduce traffic congestion, and improve mobility and air quality.

Commute Solutions is a partnership of H-GAC, the Metropolitan Transit Authority (METRO) and other transit agencies, the Texas Department of Transportation (TxDOT), and the region's Transportation Management Organizations (TMOs), including the Bay Area Transportation Partnership, Central Houston "Downtown in Motion," North Houston Association and TREK (The Uptown Galleria and Greenway Plaza areas). The purpose of this partnership is to provide a one-stop approach and unified marketing theme for alternative commute programs in the Houston-Galveston region for both commuters and businesses. Commute Solutions promotes vanpooling, carpooling, transit, telecommuting, and other transportation-related options and services by providing incentives and services to commuters directly.

Commute Solutions uses five fundamental transportation strategies to help meet the region's alternative transportation needs:

- move more people in fewer vehicles;
- use transportation that does not contribute to congestion and pollution;
- reduce the number of people commuting during rush hours;
- reduce the number of single occupant vehicles; and
- eliminate altogether the need to commute to work.

All Commute Solutions trips will count toward the area's overall trip-reduction goal. Documenting trip reduction with H-GAC is an important part of the area's long-term approach to ozone attainment because eliminating vehicle trips and/or VMT reduces emissions of both VOCs and $NO_x$, unlike many transportation-related emission reduction measures that reduce one while increasing the other.

*Public Transportation Systems*

Many of the transportation control measures identified in the Clean Air Act are transit-oriented and are within METRO's current and planned transit service and capital programs. METRO serves approximately 1,281 square miles (in Harris County, and small portions of Fort Bend and Waller counties) out of the 8,800 square miles in the eight-county nonattainment area. Services include more than 1,400 buses, along with several other alternative transportation strategies such as RideShare, park and ride lots, HOV lanes and a carpool/vanpool program. METRO is also currently constructing a light rail line down Houston's Main Street corridor to expand mobility options within the area.

In addition to METRO, three other transit systems operate within the region. Island Transit serves the City of Galveston; Brazos Transit System serves Montgomery and Liberty counties with commuter buses and vanpools; and Connect Transportation, part of The Gulf Coast Center, provides on-demand service for Brazoria and Galveston counties.

*Regional Bicycle and Pedestrian Program*

The 1996 Bicycle and Pedestrian Plan ensures the continued, orderly development of bicycle and pedestrian facilities in the Houston-Galveston TMA. In addition to this plan, H-GAC and the Bicycle and Pedestrian subcommittee are preparing goals, objectives and action steps to guide the development of the Bicycle and Pedestrian Plan Policy. The purpose of this plan policy is to establish a comprehensive strategy for replacing enough vehicle trips during the next 25 years to make significant impact on congestion, air pollution and overall quality of life. It is also consistent with federal goals to double the current percentage of total trips made by bicycling and walking, and reduce the number of bicyclists and pedestrians killed or injured in traffic accidents.

The current long-range transportation plan calls for the construction of 391 miles of on-and-off road facilities at a cost of approximately $86 million. The majority of these facilities are within the city of Houston, although Baytown, Texas City and Tomball have also received funds for bikeway projects. Once completed, over 500 miles of bicycle and pedestrian facilities (not including sidewalks) will be linked in a comprehensive, cohesive network.

*Clean Cities/Clean Vehicles Program*

The Clean Cities/Clean Vehicles Program is a locally based government/industry partnership to expand the use of cleaner fuels and vehicles. Stakeholders represent local, state and federal agencies, and businesses that are committed to the use of cleaner engines and fuels.

Clean Cities/Clean Vehicles is a fuel neutral program and can provide development assistance through the U.S. Department of Transportation's Congestion Mitigation/Air Quality (CMAQ) funds, in addition to several other funding sources. Funds are available to local and state governmental entities and private companies that reside within the Houston-Galveston area's eight-county nonattainment boundary for the purchase and/or conversion of vehicles to operate on cleaner fuel, and the purchase or upgrade of fueling infrastructure.

*Area Emission Reduction Credit Organization*

The mission of the Houston-Galveston Area Emission Reduction Credit Organization (AERCO) is to promote the coexistence of improved air quality and economic development through the effective management of emission credits and allowances in the Houston-Galveston nonattainment area. The Houston-Galveston AERCO is actively seeking to assist in the process of creating, documenting and certifying emission reduction credits and allowances.

The Houston-Galveston AERCO will buy Emission Reduction Credits (ERCs), Mobile Emission Reduction Credits (MERCs), Discrete Emission Reduction Credits (DERCs), and Mobile Discrete Emission Reduction Credits (MDERCs). AERCO will also accept donations equivalent to credits when employers implement clean air programs. Donated credits may be eligible for a federal income tax deduction.

Emission offsets are required for new sources, major industrial modifications and compliance with required emission reductions. All credits and allowances are certified with the TNRCC's Emissions Banking and Trading Program.

*The Clean Air Action Program*

The federally funded Clean Air Action Program is a public outreach effort by the Houston-Galveston Area Council. Its goal is to assist the region in attaining compliance with federal air quality standards by reducing ground-level ozone pollution. It is designed to complement and support existing air quality and related transportation outreach efforts throughout the eight-county area. The program works with representatives from the U.S. EPA

and the TNRCC, local governments, business and industry, chambers of commerce, environmental and health organizations, transportation agencies, public interest groups and schools.

The Clean Air Action program uses the "Principles for Cleaner Air," educates the public on the health hazards of exposures to high levels of ozone smog, and encourages voluntary actions to reduce vehicle emissions. Program elements include media and public service programs, public affairs programming, an ongoing public relations campaign, and participation in special events throughout the region. The largest incentives to encourage significant emission reductions have been the August "Clean Air Month" promotion, during which all METRO bus fares were subsidized by 50 percent, and METRO's Clean Air U.Pass, which offers free bus passes for the entire fall semester to area college and vocational school students.

### *Houston-Galveston-Brazoria Ozone Alert System*

#### *Ozone Watches and Warnings*

The ozone watch/warning system for the Houston-Galveston-Brazoria ozone nonattainment area operates as a collaboration of public, private and not-for-profit groups to connect resources and use available technology to improve public notification of air quality status, especially ground-level ozone. Ozone watches are issued by the TNRCC and broadcast through the Ozone Alert system when weather conditions are predicted to be conducive to the formation of excessive levels of ozone.

Ozone levels are measured at the regional network of 27 ozone monitors that are connected to one central computer operated by the TNRCC in Austin. When any of these monitors detects ozone above the federal health standard for outdoor air, the TNRCC computer sends a notice to the Harris County Office of Emergency Management (HCOEM) server. The HCOEM server then sends emails and pager ozone warnings to those who have signed up to be notified. Anyone can sign up at www2.hcoem.org/Ozone_2001/pick_station.asp. Additional ozone warnings are issued when additional monitors detect ozone over the federal health standard. No "all clear" will be issued after ozone levels drop, which typically happens after sunset.

*Ozone Warning – Levels*

Ozone warnings indicating the level of air pollution and recommended actions to take are a feature of the Ozone Alert system. The system uses the Air Quality Index (AQI) established by the EPA in 1999. This system includes colors and ranks the quality of outdoor air. Although the AQI system can be used on any criteria pollutant, in the Houston area, the system is used almost exclusively for one-hour ozone levels.

*U.S. EPA Air Quality Index*

| **Index Value** | **Descriptor** | **Color** | **1 Hr. Ozone ppb** |
|---|---|---|---|
| 0-50 | Good | Green | --- |
| 51-100 | Moderate | Yellow | --- |
| 101-150 | Unhealthy for Sensitive Groups | Orange | 125-164 |
| 151-200 | Unhealthy | Red | 165-204 |
| 201-300 | Very Unhealthy | Purple | 205-404 |
| 300-500 | Hazardous | Maroon | 405-604 |

When any of the monitors detects ozone in the "unhealthy" (level red) or "very unhealthy" (level purple) ranges, the TNRCC notifies the National Weather Service (NWS), which generates an ozone warning message for immediate broadcast. This is sent to all media outlets. It is also available to other users who have access to the NWS information and is posted on the NWS Web page. The warning is re-issued if the ozone warning is upgraded from level red to level purple. When the initial NWS ozone warning (level red or level purple) is issued, it is broadcast on the weather radio in both Galveston and Houston with a tone alert. If the ozone warning is upgraded from level red to level purple, a new message is generated and broadcast on the weather radio with a tone alert. The City of Houston has developed guidance for schools on recommended outdoor activities for the various ozone warning levels (Appendix H).

*Clean Air Partnership*

The City of Houston, Harris County and the Greater Houston Partnership formed the Clean Air Partnership to serve as a voice of unified leadership on clean air issues in the region. The group, comprised of local leaders, with representation from the environmental community, health profession and civic organizations, also coordinates and communicates various efforts underway by each partner to optimize the effectiveness of these efforts.

*City of Houston Clean Air Initiatives*

In January 2000, the City of Houston began the process of identifying its own internal $NO_x$ emissions sources and methods to reduce them. This collaborative effort resulted in the Emissions Reductions Plan (ERP) in July 2000 with a goal to reduce the City's internal $NO_x$ emissions by 75 percent (Appendix E).

The City of Houston identified several ways to reduce or eliminate its $NO_x$ emissions, which focused on cleaner operation of City vehicles and equipment, and reducing employee commuting. The City initiated a Diesel Field Demonstration Project, with the use of CMAQ funds provided through H-GAC, to seek technologies to reduce emissions from its existing fleet. In the process, the City found a discrepancy in some manufacturer's claims and actual reductions in $NO_x$ emissions from diesel fuels.

The EPA recognized the need for a regulatory process to verify emissions reductions from fuel additives and retrofit technologies. The City of Houston also received a $500,000 TNRCC grant from the new Texas Emissions Reduction Plan (TERP) program for the retrofit of 33 off-road ditch excavators.

The City of Houston convened a work group, with wide area representation, which compiled a list of recommendations for City actions to reduce fine particulate emissions. Appendix D contains this list.

The City is now in the process of conducting additional testing of emissions control devices and retrofitting City-owned diesel engines. Upcoming projects include a buying consortium for cleaner, low-sulfur diesel fuel – four years ahead of federal mandates, a partnership with the University of Houston to build a diesel emissions laboratory, and development of a hybrid diesel/electric garbage truck – the first of its kind in the nation. The City of Houston is poised to lead the region toward clean air attainment by building on its past accomplishments.

*Greater Houston Partnership/Business Coalition for Clean Air*

The Business Coalition for Clean Air (BCCA) is a project of the Greater Houston Partnership. It endeavors to bring together business interests in the eight-county nonattainment area to explore effective, feasible strategies to attain the ozone standard while maintaining the economic vitality of the region. The BCCA conducts technical and economic studies, provides information on air quality issues, and engages local, state, and national elected officials on environmental policy issues.

*Houston Environmental Foresight Program*

Houston Environmental Foresight is a non-governmental, consensus-based program convened by the Houston Advanced Research Center (HARC) to develop recommendations that address high priority regional environmental issues, including air pollution. Additional information can found at www.harc.edu/4site/.

## *Research Initiatives*

*Assessment of the Health Benefits of Improving Air Quality in Houston*

The City of Houston commissioned researchers from Sonoma Technology, Inc., California State University and the University of California, Irvine, to address the potential health and economic benefits of reducing area air pollution. The overall purpose of the Sonoma Study was "to provide information that will assist decision-makers in setting priorities for emissions reductions based on the relative health benefits of different emission control strategies." Major findings included:

- Total annual economic benefits associated with improved health if the area were in compliance with the one-hour ozone and $PM_{2.5}$ NAAQS in 2007 would be $2.9 billion to $3.1 billion.
- The health benefits of lower exposure to fine particles outweighed the benefits of reduced ozone exposure significantly.

The authors noted that numbers used in the study were very conservative, and that a number of effects could not be analyzed because of a lack of sufficient data and/or health studies meeting their inclusion criteria. The study was unable, for example, to evaluate mortality in children and adults less than 30 years old, the health costs of air pollution-induced cancer or the direct health effects of hazardous air pollutants.

*Local Exposure and Health Effects Research*

Currently several projects and programs are of particular interest to the study of air pollution and health in the Houston-Galveston area. The Mickey Leland National Urban Air Toxics Research Center (NUATRC), located in the Texas Medical Center, and the Health Effects Institute has funded a three-city study examining personal exposure to selected VOCs, fine airborne particles and other compounds. Called the RIOPA (Relationship of Indoor, Outdoor and

Personal Air) study, its objective is to determine the impact of outdoor sources on indoor and personal air concentrations of the compounds mentioned above in at least 100 non-smoker households in Houston, Elizabeth, N.J., and Los Angeles.

The Houston component of this national study was conducted by researchers at the University of Texas School of Public Health (UTSPH). The study has been completed and the investigators are currently analyzing and publishing the results. RIOPA provides the largest database available on residential indoor/outdoor concentrations and personal exposures to a broad range of air pollutants in Texas. It is also the only study, to date, in the United States that has monitored indoor, outdoor and personal air concentrations of this broad range of air pollutants.

NUATRC is also funding a study on the effects of other compounds on asthma in children. The study will investigate whether certain air toxics such as aldehydes and ketones play a role in the exacerbation of asthma in middle school children in the Aldine school district. Subjects will wear personal air monitors for 24 hours a day for 10 consecutive days to measure personal exposure to the specified air toxics. These concentrations will be compared to indoor, outdoor and fixed ambient site monitors. The main health endpoints that will be evaluated include lung function and use of medication. This study is being carried out by a team of researchers from the University of Texas School of Public Health, Texas Children's Hospital and Baylor College of Medicine.

In addition, several health-based programs are underway to better characterize and treat children with asthma, a significant health problem in urban areas. Baylor College of Medicine is currently conducting a randomized clinical trial that targets Houston inner-city children (5-14 years old), utilizing an educational multimedia interactive computer program to create customized asthma management plans.[3] Baylor College of Medicine has also recently been designated one of 19 clinical research centers for asthma in the United States.

The Houston Independent School District participates in a school-based asthma intervention program, *Partners in School Asthma Management*, that is funded by the National Institutes of Health. The University of Texas Medical Branch in Galveston operates a home-based intervention program for children with asthma. The City of Houston Department of Health and Human Services, with funding from the Texas Department of Health, implemented an Asthma Surveillance Project in 2000. This school-based project focuses on incorporating a

[3] Tortolero SR, Bartholomew LK, Tyrrell S, et al. "Environmental Allergens and Irritants in Schools: A focus on asthma." J School Health 2002; 72(1):33-38.

baseline survey on breathing problems into the kindergarten enrollment process at 10-12 area schools to allow the creation of a central database to study the prevalence of children with breathing problems in Houston. The project will also educate students, school nurses and others about effective interventions to reduce asthmatic symptoms in children, including taking appropriate action on days with poor air quality.

Notwithstanding the studies and programs described above, relatively few population-based studies have examined health effects in area residents in relation to air pollution. The estimates used in the Sonoma Study were based on measurements done in other urban areas, and the review recommended that epidemiological studies be done in this area. Epidemiological studies are needed to collect extensive data on all pollutants, and carefully control confounders, such as weather, smoking and socioeconomic status.

*The Texas 2000 Air Quality Study (TexAQS 2000)*

Researchers from government laboratories, universities and industry have completed the data collection for a major field study of air quality in southeast Texas, with a focus on the Houston-Galveston area. As part of the study, gas-phase and particle-phase pollutants were quantified, and meteorological measurements were collected from aircraft and at numerous ground locations.

The goal of the research is to provide a better understanding of the basic chemical, meteorological and atmospheric transport processes that determine ozone and fine particle distributions, and develop new scientific understanding that will assist policy-makers in devising optimal ozone and PM management strategies. Initial results suggest that highly reactive VOCs act as a catalyst in the ozone formation process and, therefore, should be targeted in the TNRCC's emission reduction strategies. For more information, visit www.utexas.edu/research/ceer/texaqs.

*Houston PM SuperSite (Gulf Coast Aerosol Research and Characterization) Program*

The U.S. EPA has awarded $3.65 million to a consortium of universities, led by The University of Texas at Austin, to study PM in the Houston region. The 16-month study began data collection in August 2000, and was closely coordinated with the TexAQS 2000. The program is part of the EPA's Particulate Matter SuperSite Program. The program goal is to collect air quality data in five distinct geographic areas of the United States to improve the understanding of the sources and fates of fine particulate matter, and the impact of particles on human health. This program will also evaluate emerging technologies to quantify ambient PM

concentrations. In the Houston area, air samples were obtained at three core sites and 20 peripheral sites. Topics studied included the chemical makeup of PM, its sources and formation, variations by time of day and season, how it is transported, and how it affects lung tissue. For more information, visit www.utexas.edu/research/ceer/texaqs/supersite.

*Citygreen Urban Ecosystem Analysis*

This study, with funding from the U.S. Department of Agriculture Forest Service and private funding from local Houston sources, was concluded in December 2000. Using American Forests Citygreen® software, satellite images over a 27 year period, low-level digital imagery and field plots, researchers established the economic impact of the area's urban forest on air pollution mitigation, storm water runoff and energy conservation. For more information, or to review Houston's Urban Ecosystem Analysis (UEA), as well as analyses of other urban areas, visit www.americanforests.org, then highlight "urban ecosystem analysis."

*Task Force for Ozone Reduction Strategies*

The Task Force for Ozone Reduction Strategies (TFORS) allows an opportunity for a variety of stakeholders to provide input during the SIP development process by giving them access to the best science available in modeling the formation of ozone. Stakeholders include representatives of citizen groups, industry, local government, environmental groups, academics and regulatory agencies. TFORS advises the Air Quality Modeling (AQM) group at the University of Houston's main campus on its air quality modeling program. The final result will be a series of science-based/model-tested recommendations to the TNRCC on how the Houston-Galveston area can reduce ozone at the lowest cost to society. For more information about TFORS, visit www.eih.uh.edu/air/tfors.

*Texas Environmental Research Consortium*

Chartered on February 18, 2002, the Texas Environmental Research Consortium (TERC) seeks to develop environmental research capabilities within Texas, while utilizing national experts. The TERC's goals include implementing an air quality research agenda that augments the TNRCC's research efforts, and improving the understanding of ozone science and modeling.

With assistance from the Science Advisory Committee, Science Synthesis Committee, Consortium Advisory Council and Research Management Organization, the TERC Board of Directors will guide the consortium to support sound air quality policies in Texas.

*Urban Heat Island (see Appendix F)*

The Heat Island Group of Lawrence Berkeley National Laboratory (LBNL) has undertaken a detailed modeling study to assess the potential benefits of increased surface reflectivity and urban vegetation in the Houston area. Meteorological modeling conducted for the Houston region, to date, has shown that heat island mitigation measures could have a cooling effect that is sufficient to reduce ozone in the region. However, modeling these measures also reveals uncertainties due to difficulties with required modeling regimes. The heat island measures included in this modeling increased the region's tree canopy and changed the reflectivity of roofing and paved surfaces within available technology boundaries and aggressive market penetration rates. The TNRCC intends to identify existing urban heat island measures and develop additional programs.

## What Can I Do to Improve Air Quality?

Daily activities, such as driving, refueling, lawn mowing, painting, and the use of pesticides and high-nitrogen fertilizers, contribute VOCs, $NO_x$ and other pollutants to the air we breathe. Frequently, the products we buy (carpeting, furniture, paints, etc.) and the services we use (dry cleaning, lawn care, etc.) also add contaminants to our air. With a population of more than 4 million in the region, these individual activities and products together create a significant portion of our air pollution. Each of us can contribute to air quality improvement by making minor changes in our daily living patterns.

We can change our driving habits and learn to limit activities that produce VOCs and $NO_x$ whenever possible. We can become knowledgeable consumers, purchasing and following directions carefully when using products that can pollute the air. Such changes also reduce, sometimes substantially, our own exposure to these pollutants. We can become well-informed citizens. We can attend programs and meetings about improving air quality and ask questions or offer our ideas on the topics. We can pay attention to pending decisions by local, state and national regulatory agencies concerning air quality, and write or call representatives with our evaluations of these issues.

When each of us becomes involved in making environmental decisions and supporting programs that effectively reduce air pollution, we will make progress towards improving the air quality for all of us. Some of the ways you can help improve air quality include:

**Reduce Use of Solvents.** Oil-based paints, paint removers, caulk, cleaning solvents and other materials that contain VOCs contribute relatively large quantities of VOCs to the air. Read product labels to know what you are buying and, whenever possible, request, purchase and use water-based materials.

**Reduce Use of Energy.** Power generation to cool and light our homes is a large source of area $NO_x$ emissions. Turn off lights not in use, use energy-efficient light bulbs and appliances, and use as little air conditioning as is reasonable and comfortable. Weather strip, caulk and insulate homes and businesses.

**Keep Vehicles in Good Repair.** If you drive, make certain your vehicle pollutes as little as possible by keeping it in good repair. One fouled spark plug can result in 75 times the normal VOC emissions, and a faulty oxygen sensor can increase VOC emissions by four times and CO emissions by 12 times. Driving a malfunctioning car, truck or van can

increase the levels of benzene and other pollutants inside the vehicle by as much as 30 times. Yearly tuneups, routine oil changes and optimum tire pressure not only reduce emissions of VOCs, $NO_x$ and other pollutants, but increase fuel economy, protect your investment and save money.

One good way to check if your vehicle is running properly is to have its emissions tested. The new Inspection and Maintenance Program, called Air Check Texas, is more costly and may take more time, but is also more thorough. It deserves our patient support when we get our cars tested, to help improve the air quality in our region.

**Drive for better fuel economy and fewer emissions.** Poor trip planning and bad driving habits can significantly increase vehicle emissions and personal exposure to VOCs and $NO_x$. Avoiding rush-hour traffic can help eliminate stop-and-go traffic and reduce idling, both of which significantly increase vehicle emissions.

In addition, avoid situations that encourage idling, such as drive-throughs, whenever possible. Rapid acceleration, either from a stop or through a yellow light, should be avoided, as should tailgating, which increases levels of pollutants within the interior of your vehicle. Air conditioning in cars increases gasoline consumption (and resultant pollution) by approximately 15 percent and should be used only when necessary.

**Use Alternative Commuting Options.** There are many different ways to commute that significantly reduce traffic congestion and your exposure to pollution. These options include carpooling, vanpooling, public transit, cycling, walking, teleworking and compressed work schedules. Consider which choices are available to you.

**Use Vapor-Recovery Systems when Refueling.** All service stations in the area, except those with lower volumes of patrons, have now installed vapor-recovery systems to capture gasoline vapors that escape during refueling. Some systems are obvious to the motorist because of the bellows on the nozzle, and others are less obvious vacuum-assisted systems. Use of either system significantly reduces the escape (90 percent or more) of chemicals that form ozone and toxic gasoline fumes into the air, and reduces your own exposure. Never top off your tank because this increases emissions considerably.

**Select Low Emission Vehicles.** In the past few years, innovative changes have been made in the design and manufacture of cars and trucks to reduce emissions. Although

diesel engines have been recommended for better fuel economy, they produce higher levels of harmful fine particle emissions.

To assist the consumer, the EPA has certified a number of vehicles as low emission vehicles (LEV). The EPA also has more stringent standards for ultra low emission vehicles (ULEV), super ultra low emission vehicles (SULEV), inherently low emission vehicles (ILEV) and zero emission vehicles (ZEV). When replacing currently owned vehicles, you can become informed about fuel efficiency and emissions of new vehicles by visiting the Green Car Guide on the EPA Web site (www.epa.gov/greenvehicles).

**Reduce Unnecessary Trips.** Combining trips and reducing miles driven will reduce the total emissions of air contaminants. Additionally, vehicles have higher emissions during the first few minutes of operation than they have once they are warmed up. By planning ahead, you may be able to combine trips and minimize your number of "cold starts," thus reducing the peak VOCs, $NO_x$ and other pollutants from your car at start up.

**Reduce Emissions from Off-Road Sources.** Gasoline engines on lawn mowers, leaf blowers, chain saws, boats and other equipment have minimal emission controls and are significant polluters. An older gas-powered lawn mower operated for one hour emits the same amount of VOCs as a new car driven 340 miles; a chain saw operated two hours produces VOCs equivalent to driving 3,000 miles. Buy and use nonpolluting electric or manual equipment, whenever possible, to reduce VOCs and $NO_x$. Choose a landscaping service that uses newer or nonpolluting equipment, and, if they do not, encourage them to switch.

**Postpone Polluting Activities on High Ozone Days.** On days that are forecast to be high ozone days, postpone unnecessary trips, refueling vehicles, painting, spraying pesticides, and using gasoline-powered lawn mowers, leaf blowers and other small gasoline engines. With a little thought, you may be able to add to this list and develop habits that will minimize your contribution to our air pollution and the illnesses caused by pollution.

## What Happens if We Don't Improve Air Quality?

The consequences of failure to reach attainment by 2007, or failure to meet any other emission reduction milestones, are severe. Residents and businesses in the eight-county area will continue to experience the adverse health effects of ozone. Furthermore, the region may experience the loss of federal transportation funding, severe restrictions on growth of existing and new industry in the area, and the imposition of a Federal Implementation Plan (FIP) in lieu of state or local controls.

EPA actions are explicitly described in the Clean Air Act Amendments. Failure to meet any deadline starts a "sanctions clock" that gives the region 18 months to resolve the failure before the EPA must impose an "offset sanction." The offset sanction would increase the emissions offset ratio, which is required to obtain a permit for a new emissions source, from the current 1.3:1 to 2.0:1. After 24 months without resolution, the EPA is required to remove federal transportation funds from the affected region. Continued unresolved failures result in the development of a FIP for the region by the EPA.

Failure to demonstrate conformity of the long-range transportation plan with the SIP can lead to earlier impacts on the region than the SIP sanctions. Transportation projects will be halted if they are not part of a conforming long-range transportation plan. Unless projects are exempted from conformity (as are certain highway safety and transit projects), design and construction may not begin without a conformity finding. If the EPA notifies a region of failed conformity, new projects cannot be added to the plan or the TIP after 120 days.

## How Much Does Air Pollution Cost?

Air pollution is costly for our society. These costs include expenses for increased health care and property damage, as well as less tangible costs, such as decreased property values and diminished quality of life. Some of these costs are paid directly by individuals or businesses, and some are paid indirectly through insurance and decreased productivity.

Reduction of air pollution also costs our society. These costs include expenditures for installation, operation, maintenance, monitoring and record-keeping of emission control systems. Some of these expenditures are paid directly by individuals or businesses and some are paid indirectly through increased costs of consumer products and loss of business opportunities. Some of these expenditures may be offset by the recovery of wasted product or by the creation of business and job opportunities in the development and implementation of air pollution control systems.

The total costs incurred by our society as a result of air pollution are very difficult to measure. Though some studies have attempted to quantify the health costs of air pollution in the Houston-Galveston area, comprehensive studies of both the costs and benefits of regulations in this region have not yet been done. On a national level, attempts have been made in recent years to estimate the cost of specific new emission control regulations and the benefits those regulations will produce. Such estimates, if accurate, may help our society make balanced decisions in our future efforts to improve air quality.

# Conclusion

Houston-Galveston area businesses and individuals have made significant reductions in air emissions over the past quarter century and the area has seen reductions in ozone levels and other pollutants. Through that 25-year experience, much has been learned about air quality within the Houston-Galveston area, but much still remains to be learned and achieved to meet this region's air quality goals. As we continue efforts to improve air quality, there will sometimes be a need to make difficult public policy decisions. We hope that this *Air Quality Reference Guide* will provide citizens with the background necessary to better understand the issues involved in such decision-making.

# Appendix A: Resources & Information

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|---|---|
| American Lung Association | www.lungusa.org<br>800-LUNG-USA (586-4872) |
| American Lung Association of Texas<br>Houston and Southeast Region | www.texaslung.org<br>713-629-1600 |
| Air & Waste Management Association,<br>Gulf Coast Chapter | www.awma.org<br>713-260-0441 |
| American Meteorological Society, Houston Chapter | www.ametsoc.org/AMS<br>281-337-5074 |
| Austin County<br>County Judge<br>Emergency Coordinator<br>General Information | www.austincounty.com<br>979-865-5911 ext. 101<br>979-865-5911 ext. 148<br>979-830-0789 |
| BikeHouston, Inc.<br>(formerly Houston Area Bicyclist Alliance) | www.bikehouston.org<br>713-729-9333 |
| Brazoria County<br>County Judge<br>Emergency Management<br>Environmental Health | www.brazoria-county.com<br>979-864-1200<br>979-864-1201<br>979-864-1600 |
| Chambers County<br>County Judge<br>Environmental Health<br>Environmental Protection Department | www.co.chambers.tx.us<br>409-267-8295<br>409-267-8392<br>409-267-8424 |
| Citizens' Environmental Coalition | www.cechouston.org<br>713-524-4ECO (4232) |
| Colorado County<br>County Judge<br>Health Department | www.rtis.com/reg/colorado-cty<br>979-732-2604<br>979-732-2435 or 979-732-3662 |
| Environmental Defense<br>Texas | www.environemtnaldefense.org<br>(512) 478-5161 |
| Fort Bend County<br>County Judge<br>Office of Emergency Management<br>Environmental Health<br>Health Department<br>Switchboard<br>Vehicle Maintenance Department | www.co.fort-bend.tx.us<br>281-341-8608<br>281-309-5002<br>281-342-7469<br>281-342-7469<br>281-342-3411<br>281-341-4792 |
| Fort Bend Family Health Center | 713-342-1746 |
| Galveston County<br>County Judge<br>Environmental Health Department<br>Health Department (Switchboard)<br>Pollution Control Department<br>Recycling Department | www.co.galveston.tx.us<br>409-766-2244<br>409-938-2411<br>409-938-7221<br>409-938-2251<br>409-766-2122 |

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|---|---|
| Galveston-Houston Association for Smog Prevention (GHASP) | www.ghasp.org<br>713-528-3779 |
| Galveston-UTMB | |
| Pediatric Clinic | 409-747-9345 |
| Adult Clinic | 409-747-8950<br>409-772-7063 |
| Greater Houston Partnership | www.houston.org<br>713-844-3600 |
| Business Coalition for Clean Air (BCCA) | 713-844-3629 |
| Gulf Coast Institute | www.livablehouston.org<br>713-523-5757 |
| Harris County | www.co.harris.tx.us |
| Switchboard | 713-755-5000 |
| County Judge | 713-755-4000 |
| Environmental Health | 713-439-6270 or 713-439-6260 |
| Health Services | 713-439-6000 |
| Office of Emergency Management | www.hcoem.org |
| Parks Planning Department | 713-956-3024 |
| Public Health and Environmental Services | 713-439-6000 |
| Pollution Control | 713-920-2831 |
| Harris County Hospital District | |
| Ben Taub Hospital | 713-793-2000 |
| LBJ | 713-526-4243 |
| Medical Clinic | 713-793-3145 |
| Houston Advanced Research Center (HARC) | www.harc.edu |
| Mitchell Center for Sustainable Development | 281-363-7913 |
| Houston Environmental Foresight | 281-364-4008 |
| Houston Bicycle Club, Inc. | www.hbc.stevens.com<br>713-782-0885 |
| Houston Chronicle | www.chron.com<br>713-220-7171 |
| Houston, City of | www.ci.houston.tx.us |
| Mayor | mayor@cityofhouston.net |
| Bureau of Air Quality Control | 713-640-4200 |
| Citizens' Assistance Office | 713-247-1888 |
| Department of Health and Human Services | 713-794-9320 |
| Parks & Recreation Department | 713-845-1000 |
| Public Works & Engineering Department | 713-837-7560 |
| Houston Bikeway Program | www.houstonbikeways.org<br>713-837-0003 |

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|---|---|
| Houston-Galveston Area Council | www.hgac.cog.tx.us/transportation<br>713-627-3200 |
| Clean Air Action Program | www.cleanairaction.org<br>713-993-2438 |
| Clean Cities/Clean Vehicles Program | www.houston-cleancities.org<br>713-993-4582 |
| Commute Solutions | www.commutesolutions.org<br>713-993-4521 or 1-888-606-RIDE |
| Mission Clean Air | www.missioncleanair.org<br>713-993-4537 |
| Area Emission Reduction Credit Organization (AERCO) | www.hgac.cog.tx.us/intro/introaerco.html<br>713-993-4537 |
| Regional Air Quality Planning Committee (RAQPC) | www.hgac.cog.tx.us/transportation/comm_raq.html<br>713-993-4537 |
| Regional Transportation Plan / Corridor Studies | www.2025plan.org<br>713-993-4502 |
| Houston Regional Monitoring Corporation<br>713-914-6612 | www.hrm.radian.com |
| League of Women Voters of Houston | www.lwvhouston.org<br>713-784-2923 |
| Liberty County | www.naco.org/counties/counties/county.cfm?id=48291 |
| County Judge | 936-336-4600 |
| General Information | 936-336-4558 |
| Matagorda County | www.naco.org/counties/counties/county.cfm?id=48321 |
| County Judge | 979-244-7680 |
| Environmental Health Department | 979-244-2717 |
| Metropolitan Transit Authority (METRO) | www.ridemetro.org<br>713-635-4000 or 1-888-606-RIDE |
| Environmental Planning | 713-635-4000 |
| Montgomery County | www.naco.org/counties/counties/county.cfm?id=48339 |
| County Judge | 936-539-7812 |
| Environmental and Consumer Health Department | 936-539-7839 |
| Switchboard | 936-756-0571 |
| Montgomery County-UTMB | |
| Family Practice | 936-525-2800 |
| Mothers for Clean Air | www.mothersforcleanair.org<br>713-526-0110 |
| Natural Resources Defense Council | www.nrdc.org<br>212-727-2700 |
| Rice Design Alliance | www.rda.rice.edu<br>713-348-4876 |
| Rice University | www.rice.edu<br>713-348-0000 |
| Sierra Club Houston Regional Group | http://texas.sierraclub.org/houston<br>713-895-9309 |
| Sierra Club – Lone Star Chapter | http://lonestar.sierraclub.org/houston |
| Clean Air Program Director | 512-477-1729 |

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|---|---|
| STAPPA / ALAPCO | www.cleanairworld.org |
| (State and Territorial Air Pollution Program Administrators / Association of Local Air Pollution Control Officials) | 202-624-7864 |
| Texas, State of | www.texas.gov<br>512-463-2000 or 800-843-5789 |
| Governor's Office | www.governor.state.tx.us |
| Lieutenant Governor | 800-441-0373 |
| Senate | www.senate.state.tx.us |
| Health & Human Services Committee | 512-463-0390 |
| House of Representatives | www.house.state.tx.us |
| Environmental Regulation | 512-463-0770 |
| Transportation | 512-463-018 |
| Texas Children's Asthma, Allergy Clinic | 832-824-1319 |
| Texas Children's Hospital, Junior League Clinic | 832-824-3013 |
| Texas Department of Public Safety | www.txdps.state.tx.us<br>512-424-2000 |
| Governor's Division of Emergency Management | www.txdps.state.tx.us/dem<br>512 424-2432 |
| AirCheckTexas | www.aircheckтexas.org |
| Vehicle Inspection & Maintenance (I/M) Program | 512-424-2138 |
| DPS Regional Office, Houston | 713-957-6120 |
| DPS Regional Office, N. Houston-Rosslyn | 281-272-1150 |
| Texas Department of Health, Houston | www.tdh.state.tx.us<br>713-767-3000 |
| Texas Department of Transportation, Houston | www.dot.state.tx.us<br>713-802-5000; 800-558-9368 |
| Texas Natural Resource Conservation Commission (known as the Texas Commission on Environmental Quality after Sept. 1, 2002) | www.tnrcc.state.tx.us<br>512-239-1000 |
| Agency Communications | 512-239-0010 |
| Publications | www.tnrcc.state.tx.us/admin/topdoc/index.html |
| TNRCC Library | 512-239-0020 |
| Office of Environmental Policy, Analysis, Assessment | www.tnrcc.state.tx.us/homepgs/oepaa.html<br>512-239-5109 |
| State Implementation Plans (SIP) | www.tnrcc.state.tx.us/oprd/sips/index.html<br>512-239-1970 |
| Texas Emission Reduction Plan (TERP) | www.tnrcc.state.tx.us/oprd/sips/terp.html<br>512-239-2583 |
| Motorist's Choice Vehicle Emission Testing Program | www.tnrcc.state.tx.us/air/ms/motoristchoice.html<br>512-239-1457 |
| Smoking Vehicle Hotline | www.smokingvehicle.org<br>800-453-SMOG (7664) |
| Office of Compliance and Enforcement | |
| Monitoring Operations – Ozone Information | www.tnrcc.state.tx.us/air/monops/index.html |
| Small Business and Environmental Assistance | www.tnrcc.state.tx.us/homepgs/ed.html#3<br>800-447-2827 |
| Pollution Prevention | www.tnrcc.state.tx.us/exec/sbea/p2tech.html |
| Clean Texas Program | www.cleantexas.org<br>512-239-3766 |
| Texas Clean Air Roundtable | www.cleantexasair.org |
| Region 12 – Houston | 713-767-3500 |

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|---|---|
| University of Houston | www.uh.edu |
| Central Campus | 713-743-2255 |
| Clear Lake | www.cl.uh.edu |
| | 281-283-7600 |
| Environmental Institute of Houston | www.eih.uh.edu |
| | 281-283-3950 |
| University of Texas Pediatric Allergy Clinic | 713-704-0753 |
| U. S. Environmental Protection Agency | www.epa.gov |
| Public Information Center | 800-887-6063 |
| Office of Air Quality Planning & Standards | www.epa.gov/oar/oaqps |
| | 919-541-5616 |
| AirNow (National Air Quality Information) | www.epa.gov/airnow |
| | AIRNOW@epa.gov |
| Air Risk Information Support Center (Air RISC) | www.epa.gov/ttn/atw/hapindex.html |
| Air RISC Hotline | 919-541-0888 |
| U. S. Environmental Protection Agency – Region 6 | www.epa.gov/region6/index.htm |
| South Central (Dallas) | 214-665-6444 |
| Environmental Emergencies | 1-866-EPASPILL (372-7745) |
| South Central (Houston) | 281-983-2100 |
| Walker County | |
| County Judge | 936-436-4910 |
| Natural Resources Conservation Service | 936-291-1901 |
| Waller County | www.naco.org/counties/counties/county.cfm?id=48473 |
| County Judge | 979-826-4441 |
| Emergency Management | 979-826-2242 |
| Health Department | 979-826-7670 |
| Wharton County | www.naco.org/counties/counties/county.cfm?id=48481 |
| County Judge | 979-532-2381 |
| Office of Emergency Management | 979-532-1123 |
| Health Department | 409-543-7414 |

**SUBJECT MATTER**

Air Chemistry
- EPA Office of Air & Radiation: www.epa.gov/oar
- Airsite (U. North Carolina and U. Leeds, UK): http://airsite.unc.edu

Air Quality
- EPA Office of Air Quality Planning and Standards: www.epa.gov/oar/oaqps ; www.epa.gov/airnow
- EPA Office of Air & Radiation: www.epa.gov/oar
- TNRCC Office of Air Quality: www.tnrcc.state.tx.us
- H-GAC Air Quality Section: www.hgac.cog.tx.us/air
- California Air Resources Board: www.arb.ca.gov
- Ozone Transport Assessment Group /OTAG: www.capita.wustl.edu/OTAG

Air Toxics
- EPA Office of Air Quality Planning and Standards: www.epa.gov/oar/oaqps
- Environmental Defense: www.scorecard.org
- GHASP: www.ghasp.org/publications.html

Alternative Fuels/Vehicles

Houston Clean Cities: www.houston-cleancities.org
Rocky Mountain Institute: www.rmi.org
HyperCar Inc.: www.hypercar.com
TNRCC Texas Clean Fleets Program: www.tnrcc.state.tx./air/ms/tcfprgm.htm
CALSTART: www.calstart.com
Electric Vehicle Association of Greater Washington, DC: www.evadc.org
Fuel Cells 2000: www.fuelcells.org
DOE Alternative Fuels Data Center: www.afdc.nrel.gov

Community Information Sources

Clean Air Action: www.cleanairaction.org
Citizens' Environmental Coalition: www.cechouston.org
Environmental Defense: www.environmentaldefense.org
Galveston-Houston Association for Smog Prevention: www.ghasp.org
Gulf Coast Institute: www.gulfcoastideas.org
Houston Dept. of Health & Human Services: www.ci.houston.tx.us/health.htm
Mothers for Clean Air: www.mothersforcleanair.org
Natural Resources Defense Council: www.nrdc.org
State and Territorial Air Pollution Program Administrators (STAPPA) & Association of Local Air Pollution Control Officials (ALAPCO): www.cleanairworld.org

Current Monitoring Data

TNRCC Office of Compliance and Enforcement – Monitoring Operations: www.tnrcc.state.tx.us/air/monops/index.html

Emissions Inventory

EPA Office of Air Quality Planning and Standards: www.epa.gov/oar/oaqps
TNRCC Office of Environmental Policy, Analysis, and Assessment: www.tnrcc.state.tx.us/air/aqp/pollsource.html

Environmental Law/ The Clean Air Act

EPA Office of Air Quality Planning and Standards: www.epa.gov/oar/oaqps

Health Effects of Pollution

EPA Office of Air Quality Planning and Standards: www.epa.gov/oar/oaqps

Heat Island Effects

Lawerence Berkeley National Lab Heat Island Group: www.eetd.lbl.gov/HeatIsland/
American Forests: www.americanforests.org
U.S. National Assessment: Potential for Climate Variability & Change: www.nacc.usgcrp.gov

International Agencies

The United Nations (Development Programme): www.undp.org/indexalt.html
The World Health Organization (Guidelines for Air Quality): www.who.org/peh/air/airindex.htm

Pollution Prevention

EPA Pollution Prevention Clearinghouse: www.epa.gov/opptintr/library/libppic.htm
EPA Enviro-sense: www.es.epa.gov/
TNRCC Pollution Prevention: www.tnrcc.state.tx.us/exec/sbea/p2tech.html

Public Transportation

American Public Transit Association: www.apta.com/sites/transus/transus.htm
Federal Railroad Administration: www.fra.dot.gov
Federal Transit Administration: www.fta.dot.gov

Regional Transportation Planning

H-GAC Transportation Planning: www.hgac.cog.tx.us/transportation ; www.2025plan.org

Urban Sprawl

HARC Center for Sustainable Development: www.harc.edu/mitchellcenter

# Appendix B: Air Quality Abbreviations and Terms

| | |
|---|---|
| AERCO | Area Emission Reduction Credit Organizations |
| AQI | Air Quality Index |
| BACT | Best Available Control Technology |
| BAP | Bureau of Air Policy |
| BAQC | Bureau of Air Quality Control |
| BART | Best Available Retrofit Technology |
| BCCA | Business Coalition for Clean Air |
| CAA | Clean Air Act of 1970 |
| CAAA | Clean Air Act Amendments of 1990 |
| CARE | Clean Air Responsibility Enterprise |
| CMAQ | Congestion Mitigation/Air Quality funds under ISTEA and TEA21 |
| CMSA | Consolidated Metropolitan Statistical Area *(the Houston-Galveston-Brazoria CMSA consists of the Houston PMSA [Chambers, Fort Bend, Harris, Liberty, Montgomery and Waller Counties], the Galveston-Texas City PMSA [Galveston County], and the Brazoria PMSA [Brazoria County])* |
| CNG | Compressed Natural Gas |
| CO | Carbon Monoxide |
| $CO_2$ | Carbon Dioxide |
| COAST | Coastal Oxidant Assessment for Southeast Texas |
| COG | Council of Governments |
| COPD | Chronic Obstructive Pulmonary Disease |
| DERC | Discrete Emission Reduction Credit |
| EPA | Environmental Protection Agency |
| ERC | Emission Reduction Credit |
| ERP | Emissions Reductions Plan |
| ESL | Effects Screening Level |
| ETR | Employer Trip Reduction |
| FCFF | Federal Clean Fuel Fleet |
| FTA | Federal Transit Administration (*formerly UMTA – Urban Mass Transit Administration)* |
| GHP | Greater Houston Partnership |
| GHRCP | Greater Houston Regional Clean Cities Program |
| GIS | Geographic Information Systems |
| HAP | Hazardous Air Pollutant |
| HC | Hydrocarbons |
| HCOEM | Harris County Office of Emergency Management |
| HGA | Houston-Galveston Area |
| H-GAC | Houston-Galveston Area Council |
| HIRI | Heat Island Reduction Initiative |
| HOV | High-Occupancy Vehicle |
| HRM | Houston Regional Monitoring Corporation |
| ILEV | Inherently Low Emission Vehicle |
| I/M | Inspection/Maintenance program *(for vehicle emission controls)* |
| ISTEA | Intermodal Surface Transportation Efficiency Act of 1991 |
| LEV | Low Emission Vehicle |
| LNG | Liquefied Natural Gas |
| LPG | Liquefied Propane Gas |
| MACT | Maximum Achievable Control Technology |
| MDERC | Mobile Discrete Emission Reduction Credit |
| MERC | Mobile Emission Reduction Credit |
| METRO | Metropolitan Transit Authority of Harris County |
| MOA | Memorandum of Agreement |
| MPO | Metropolitan Planning Organization |
| MTBE | Methyl Tertiary Butyl Ether |

| | |
|---|---|
| MTP | Metropolitan Transportation Plan |
| µg | Microgram or $10^{-6}$ gram |
| NAAQS | National Ambient Air Quality Standards |
| NAMS | National Air Monitoring Station |
| NESHAPs | National Emission Standards for Hazardous Air Pollutants |
| NLEV | National Low Emission Vehicle |
| $NO_2$ | Nitrogen Dioxide |
| $NO_x$ | Nitrogen Oxide |
| NWS | National Weather Service |
| $O_2$ | Molecular Oxygen |
| $O_3$ | Ozone |
| OTAG | Ozone Transport Assessment Group |
| Pb | Lead |
| $PM_{2.5}$ | Particulate Matter less than 2.5 microns in size |
| $PM_{10}$ | Particulate Matter less than 10 microns in size |
| PMSA | Primary Metropolitan Statistical Area |
| PMT | Personal Miles Traveled |
| PPB | Parts per Billion |
| PPM | Parts per Million |
| RACT | Reasonably Available Control Technology |
| RAQPC | Regional Air Quality Planning Committee |
| RCAP | Regional Commute Alternatives Program |
| RFG | Reformulated Gasoline |
| SIP | State Implementation Plan *(plan detailing pollution controls for achieving attainment status required of TNRCC by the U.S. EPA through the CAA of 1970 and 1977)* |
| SLAMS | State or Local Air Monitoring Station |
| $SO_2$ | Sulfur Dioxide |
| SOCMI | Synthetic Organic Chemical Manufacturing Industry |
| SOV | Single Occupant Vehicle |
| SULEV | Super Ultra Low Emission Vehicle |
| SUV | Sport Utility Vehicle |
| TAFF | Texas Alternative Fuel Fleet Program |
| TCAA | Texas Clean Air Act |
| TCEQ | Texas Commission on Environmental Quality *(formerly known as the Texas Natural Resource Conservation Commission*) |
| TCMs | Transportation Control Measures |
| TCP | Transportation Control Plan (*as envisioned by EPA to reduce mobile source emissions enough to meet the NAAQS)* |
| TDM | Transportation Demand Management |
| TEA21 | Transportation Equity Act for the 21st Century *(replaces ISTEA)* |
| TERP | Texas Emissions Reduction Plan |
| TIP | Transportation Improvement Program |
| TMA | Transportation Management Area |
| TMO | Transportation Management Organization |
| TNRCC | Texas Natural Resource Conservation Commission *(known as the Texas Commission on Environmental Quality after Sept. 1, 2002)* |
| TPC | Transportation Policy Council |
| TPD | Tons per Day |
| TPY | Tons per Year |
| TxAQS 2000 | Texas 2000 Air Quality Study |
| TxDOT | Texas Department of Transportation *(formerly known as the Texas Highway Department)* |
| ULEV | Ultra Low Emission Vehicle |
| USDOT | United States Department of Transportation |
| VMEP | Voluntary Mobile Emission reduction Program |
| VOC | Volatile Organic Compound |
| ZEV | Zero Emission Vehicle |

# Appendix C: The Principles for Cleaner Air

The following principles should guide the creation of a strategy enabling the region to reach attainment of the ozone standard. A collaborative process involving the various stakeholders in the region should be utilized to forge air quality solutions from this point forward.

- Contributions to ozone non-attainment come from every segment of the region. Consequently, every person, government entity and all businesses of the region, including mobile sources, off-road construction equipment, permitted or grandfathered point sources, should do their part to reduce nitrogen oxides ($NO_x$) and volatile organic compound (VOC) emissions.

- Control strategies should be implemented as expeditiously as practicable to realize health benefits and prevent imposition of sanctions upon the region.

- The ozone standard should be attained at the lowest economic and social costs considering effects on lifestyle to the citizens of the region.

- Local flexibility should be preserved to the greatest extent possible.

- Some emission control strategies are best implemented at the national level, such as those on automobiles and consumer goods, and, hence, should be accelerated if they contribute to attainment at lower costs and less adverse impacts than other controls.

- Control strategy options considered should include all technically feasible ones prioritized by their relative benefit to cost characteristics.

- Economic incentives should be explored as part of the area's attainment approach.

- All reasonable efforts should be made to avoid State Implementation Plan (SIP) disapproval by EPA. If ozone attainment cannot be reached by reducing ozone precursors to the maximum technically feasible and cost-efficient extent, other options to obtain SIP approval will be explored.

- Encourage TNRCC to undertake a comprehensive air quality research strategy to provide additional scientific information necessary for design of ozone control programs that can be reasonably expected to reduce ozone formation and public exposure to ozone.

The public health of area residents, the vibrancy of the region's economy, and continued transportation improvements are only assured if a sound, acceptable ozone compliance plan is developed and implemented.

# Appendix D: The City of Houston Mayor's Short-Term Fine Particulate List of Recommendations for City Actions

**Mayor's Short-Term Fine Particulate Work Group List of Recommendations for City Actions**

1. Require on-road diesel in lieu of off-road diesel in City contracts.
2. Conduct Selective Catalytic Reduction diesel catalyst demonstrations.
3. Conduct other diesel catalyst demonstrations.
4. Conduct diesel fuel (including water emulsion) demonstrations.
5. Include opacity check in truck safety inspection program.
6. Establish clean-burning vehicle and equipment preference (including fine particulates).
7. Enhance traffic signalization program to reduce fine particulates.
8. Increase enforcement of materials transport controls (open truck bed covers).
9. Require construction dust control and construction unpaved staging/transition controls.
10. Develop and implement airport ground service equipment reduction options (including fine particulates reductions).
11. Initiate taxi incentives/controls/opacity tests to encourage low particulate emitting vehicles.
12. Assess air quality impacts (fine particulates) of speed hump devices.
13. Assess air quality impacts (fine particulates) of fireworks shows.
14. Support Texas 2000 Air Quality Study.
15. Enhance clean air public education and information (including fine particulates).*

* Indicates Work Group recommendation for all participating organizations and groups.

# Appendix E: City of Houston Emissions Reductions Plan

**City of Houston Emission Reduction Plan**

Executive Order 1-45 led to the creation of the Mayor's Clean Air Team. The team consisted of Air Quality Liaisons from each city department as well as other department and private sector stakeholders. The team collectively used an eight-step process, which resulted in the creation of the City of Houston's Emissions Reduction Plan and subsequent supporting guidelines.

1. Identify sources and quantify amounts of emissions.
2. Define the emissions reductions target goal.
3. Document and quantify previous emissions reductions.
4. Identify citywide emissions reductions controls and establish timelines for their implementation.
5. Identify needed department emissions reductions controls and establish a timeline for implementation.
6. Adopt citywide and departmental emissions reductions controls sufficient to meet the target goal.
7. Implement the adopted emissions controls.
8. Monitor the actual emissions reductions versus the estimated emissions reductions and make adjustments to ensure achievement of the target goal.

In order to achieve optimal success and reach the target of 75 percent $NO_x$ emission reductions, a set of eight citywide (seven operational and one construction) and five departmental controls were designed and evaluated.

Cost/benefit analyses of the respective controls were completed and the controls were then ranked in order from most cost effective to least cost effective. Based on this ranking, it was required to use all eight citywide controls and three of the five departmental controls to reach the target.

The plan consists primarily of the following controls:

1. Continue existing policy of requiring new purchases of clean vehicles and equipment.
2. Purchase very low sulfur gasoline and diesel fuel starting in Fiscal Year 2002.
3. Conduct field demonstrations of diesel catalysts in Fiscal Year 2001 and retrofit the city's diesel fleet with the successful catalysts, starting in Fiscal Year 2002.
4. Retrofit the city's stationary emission sources (i.e. boilers, generators) starting in Fiscal Year 2002.
5. Expand Employee Commute Options (bus passes and van/car pools) citywide starting in Fiscal Year 2002.
6. Require city contractors to meet the same emissions reduction requirements as city operations with the major costs starting in Fiscal year 2003.

At the heart of the plans' controls is the Diesel Field Demonstration Project. The city was awarded $671,057.00 in grants in April 2000 for this project. It is important to note that if the field demonstration does not validate a retrofit emission control system capable of achieving 75 percent $NO_x$ reductions, the entire city plan will need to be reassessed and revised. The project will consist of field demonstrations using diesel catalysts on various vehicles and equipment from the summer of 2000 through the spring of 2001. The successful outcome of these demonstrations will allow the city to retrofit that part of its 2,700-item inventory of on-road and off-road diesel equipment for which new clean replacements are not purchased. The results of the project will also assist city contractors in meeting the city's contractual requirements for clean vehicles and equipment on all city contracts starting in July 2002.

| **Implementation Phases** | | | |
|---|---|---|---|
| **Phases** | **Citywide Actions** | **Department Actions** | **Schedule (M/Y)** |
| Pre-Implementation | | | |
| | Plan Development | | 01/00-06/00 |
| | Plan Adoption | | 07/00-08/00 |
| Implementation | | | |
| One: Existing actions, field demonstrations and new clean vehicles & equipment | Control 1: Clean Vehicles & Equipment | Control 1: Reduce VMT and hours used | 05/00-06/03 |
| | Control 2: Restrict Idling | Control 2: Compressed Work Week | |
| | Conduct diesel field demonstrations | Control 3: Global Positioning System | |
| | | Control 4: Reduce fleet and equipment | |
| Two: Reformulated fuels and diesel retrofits; expand employee commute options | Control 3: Expand free bus passes | | 07/01-06/03 |
| | Control 4: Use very low sulfur gas & diesel | | |
| | Control 5: Install diesel retrofits | | |
| | Control 6: Implement generator/boiler combustion controls | | |
| | Control 7: Subsidize car/van pools | | |
| Three: Expand contractor requirements | Control 8: Construction and O&M Contracts | | 07/02-06/03 |
| Post Implementation | Monitor, Review, Assess | | 07/03-10/03 |

# Appendix F: Urban Heat Island Effects

Meteorologists have known for almost fifty years that cities are 6 to 8 degrees hotter than the surrounding countryside. Figure F1 shows a sketch of this phenomenon, the "heat island effect," which results from the replacement of trees and vegetation with buildings, parking lots, and roadways as a result of urban growth. Trees block solar radiation and cool the surrounding area by evapotranspiration – using heat to evaporate water from leaves. When trees are cut and vegetation is cleared for development, this effect is lost. When the sun beats down on buildings covered with dark non-reflective roofing materials, most of the heat goes inside and increases the demand for air conditioning. In addition, dark-colored pavement absorbs heat and releases it only slowly at night.

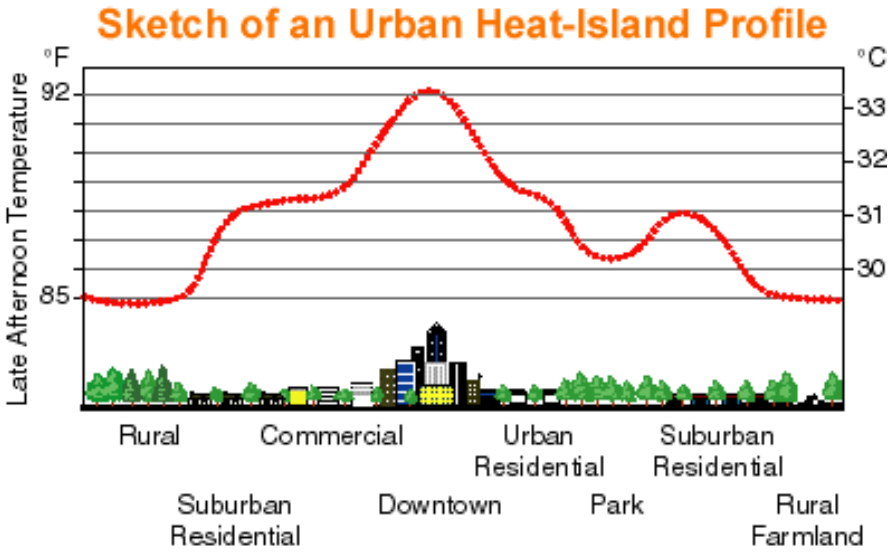


**FIGURE F1: The Temperature Profile of an Urban Heat Island**
(Source: http://eetd.lbl.gov/HeatIsland/)

Increased use of energy for air conditioning leads to higher $NO_x$ emissions and results in a higher rate of ozone formation during the summer months. Heat can also be viewed as a type of pollution because it exacerbates health problems such as heat stress and asthma. In the hot summer months, hot air plumes can even increase the amount of precipitation that falls on the city and change local weather patterns.

Experience in Atlanta, Salt Lake City, Baton Rouge and other urban areas suggests that a combination of three long-term mitigation measures can reduce urban heat island effects: (1) planting shade trees in strategic locations, (2) replacing dark roofs with reflective, lighter roofs or

planting roof gardens, and (3) using lighter, more reflective surfaces for pavement. Strategic planting of trees not only cools the city, but can also decrease storm water runoff and erosion and decrease urban noise. Replacing dark roofs with highly reflective roofs can keep buildings cooler and save money through reduced energy use. Increasing the albedo (reflectivity) of the surrounding area by installing reflective pavement adds to the overall decrease in ambient air temperature.

At the Lawrence Berkeley National Laboratory, recent simulations have shown that reducing summer temperature for the Los Angeles area by 6 degrees F would result in an overall smog reduction of about 12 percent. In Los Angeles, for example, for every degree Fahrenheit the temperature rises above 70 degrees, the incidence of smog increases by 3 percent. The EPA is working with state air quality offices to develop a method that could potentially allow states to include heat island reduction strategies into their air quality plans as a control measure for ozone reduction.

Meteorological modeling conducted for the Houston region has shown that heat island mitigation measures could have a cooling effect that is sufficient to reduce ozone in the region. However, modeling these measures also reveals uncertainties due to difficulties with required modeling regimes. The heat island measures included in this modeling increased the region's tree canopy and changed the reflectivity of roofing and paved surfaces within available technology boundaries and aggressive market penetration rates. The Texas Natural Resource Conservation Commission (TNRCC; known as the Texas Commission on Environmental Quality after Sept. 1, 2002) intends to identify existing urban heat island measures, and develop additional programs and strategies for the Houston-Galveston area.

# Appendix G: Houston-Galveston Area's Attainment Demonstration Control Measures

| Short Title | Rule Description | Area Affected |
|---|---|---|
| Emission Banking and Trading | • Creates overall $NO_x$ emissions cap.<br>• Implement emissions banking and trading program for flexibility in complying with the cap.<br>• Modifies the existing banking and trading program statewide to make it compatible with the allowance cap program in the Houston area.<br>• Includes mobile source trading. | • Houston-Galveston eight-county area.<br>• Statewide for emissions banking and trading modifications. |
| HGA Post-1999 ROP/Attainment Demonstration SIP | Speed Limit Reduction<br>• The speed limit on all roadways with a maximum speed limit above 55 mph.<br>• Starts May 1, 2002. | • Houston-Galveston eight-county area. |
| HGA Post-1999 ROP/Attainment Demonstration SIP | Transportation Control Measures<br>• SIP control strategy (no rules required).<br>• Numerous projects have been identified by the Houston-Galveston Area Council for inclusion in the SIP, such as traffic signalization and bicycle/pedestrian projects. | • Houston-Galveston eight-county area. |
| Inspection and Maintenance | • Requires Acceleration Simulation Mode or equivalent testing, as well as On-Board Diagnostics testing.<br>• Begins May 1, 2002, for Harris County.<br>• Begins May 1, 2003, for Brazoria, Fort Bend, Galveston and Montgomery counties.<br>• Begins May 1, 2004, for Chambers, Liberty and Waller counties. | • Houston-Galveston eight-county area. |
| Construction Equipment Operating Restriction | • Establishes a restriction on the use of heavy-duty diesel construction equipment from 6 a.m. – noon, starting April 2005.<br>• Only applies during Daylight Savings Time each year (first weekend in April through the last weekend in October).<br>• Exempts wet concrete operations and emergency operations. | • Houston-Galveston eight-county area. |

| | | |
|---|---|---|
| | • Also provides an exemption from the rule if an alternative plan is submitted assuring equivalent emission reductions. | |
| Accelerated Purchase of Tier 2 / Tier 3 Diesel Equipment | • Requires the early retirement of older equipment and purchase of newer, clean, off-highway diesel equipment.<br>• Phased-in implementation beginning in December 2004.<br>• Also provides an exemption from the rule if an alternative plan is submitted assuring equivalent emission reductions. | • Houston-Galveston eight-county area. |
| Cleaner Diesel Fuel | • By May 1, 2002, the fuel will have improved aromatics and centane for all on-highway sales statewide and for all on and off-highway sales in East/Central Texas.<br>• By May 1, 2004, sulfur will be reduced to 30 parts per million (ppm) in East/Central Texas for on- and off-road fuel.<br>• By May 1, 2006, all on-highway fuel statewide will go to 15 ppm (equivalent to the proposed federal rule), and off-highway fuel will go to 15 ppm in East/Central Texas. | • Statewide for on-highway fuel.<br>• East/Central Texas for on and off-highway fuel. |
| Airport Ground Support Equipment | • Requires ground support equipment fleets to reduce emissions by 90 percent by 2005.<br>• Phased-in implementation – 20 percent, 50 percent and 90 percent in 2003, 2004 and 2005, respectively.<br>• Allows for the implementation of alternative emission reduction measures that produce equivalent $NO_x$ reductions. | • Hobby, Bush Intercontinental and Ellington Airports. |
| Low Sulfur Gasoline | • Requires a low sulfur gasoline (15 ppm).<br>• Enhances emissions performance of newer cars.<br>• Begins May 1, 2004. | • East/Central Texas. |
| California Spark-Ignition Engines | • Requires manufacturers to ensure that all affected large spark-ignition (LSI) engines are certified under California LSI standards.<br>• Begins May 1, 2004.<br>• Exempts agriculture and construction equipment less than 175 hp, recreational equipment, stationary engines, marine vessels, and equipment on tracks. | • Statewide. |

| | | |
|---|---|---|
| Point Source $NO_x$ Controls | • Requires a wide variety of minor and major stationary sources to meet new emission specifications and other requirements in order to reduce $NO_x$ emissions.<br>• Total $NO_x$ reductions required from these sources is 90 percent.<br>• Requires sources with a design capacity to emit 10 tons per year or greater emissions to participate in the Emissions Banking and Trading Program. | • Houston-Galveston eight-county area. |
| Residential and Commercial Air Conditioners | • Requires new units to reduce ozone by at least 70 percent and retain a minimum ozone reduction efficiency of 50 percent for 15 years.<br>• Begins January 1, 2002. | • East/Central Texas. |
| Diesel Emulsion | • Requires retail on-highway diesel fuel sales for heavy-duty vehicles over 26,000 pounds to be diesel emulsion fuels.<br>• Requires off-highway diesel equipment over 175 hp to use diesel emulsion fuels.<br>• Begins May 1, 2004. | • Houston-Galveston eight-county area. |
| $NO_x$ Reduction Systems | • Requires a reduction system for locally registered (Houston-Galveston eight counties) on-highway, pre-1997 diesel trucks over 26,000 pounds by May 1, 2004.<br>• Requires a reduction system for all off-highway diesel equipment over 175 hp by May 1, 2004.<br>• Requires a reduction system for all locally registered on-highway heavy-duty, pre-1997, gasoline-powered trucks over 26,000 pounds by May 1, 2004. | • Houston-Galveston eight-county area. |
| Vehicle Idling Restrictions | • Limits idling for all vehicles over 14,000 pounds to five consecutive minutes.<br>• Begins April 1, 2001.<br>• Only applies from April 1 – Oct. 31 each year. | • Houston-Galveston eight-county area. |
| Lawn Service Equipment Operating Restrictions | • Restricts the use of small gasoline equipment between 6 a.m. – noon, starting in 2005.<br>• Only applies April 1– Oct. 1 each year. | • Houston-Galveston eight-county area. |

# Appendix H: Ozone Pollution and Physical Activities

## I. INTRODUCTION

This document is intended to provide information and guidance on ozone air pollution and its impact on school activities. Superintendents, as well as other appropriate staff (e.g., principals, teachers, nurses, and coaches) are encouraged to use this document as a tool in making decisions regarding outdoor activities during periods of high ozone pollution.

For further information regarding health recommendations and physical activity restrictions, please call _____, director of student medical services, tel_____. For information regarding air quality compliance issues, please call the (ISD) Environmental Health and Safety (EHS) office at _____.

## II. BACKGROUND

The Houston region (including Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery and Waller counties) exceeds federal health-based standards for ground level ozone. Ground-level ozone is different from atmospheric ozone (the kind referred to when discussing "holes in the ozone layer") in that it pollutes the air we breathe. Ozone is a main ingredient of smog. It is harmful because it irritates the airways and makes it harder to breathe. Older adults and children who spend a lot of time outdoors during the day and people with breathing problems such as asthma and allergies are particularly vulnerable to ozone's effects. Research into health effects of air pollution has led the U. S. Environmental Protection Agency to identify children as particularly sensitive to outdoor air pollution. For this reason, it is important that school faculty, staff and administrators are aware of changes in air quality, and that they consider air quality when planning and conducting outdoor activities involving children.

Air quality values are indicated by the U.S. Environmental Protection Agency's (EPA) nationally Air Quality Index or AQI. The values listed in the table below describe the severity of ozone pollution.

**U.S. EPA Air Quality Index**

| Index Value | Descriptor | Color | 1hr Ozone ppb |
|---|---|---|---|
| 0 – 50 | Good | Green | -- |
| 51 – 100 | Moderate | Yellow | -- |
| *101 – 150* | *Unhealthy for Sensitive Groups* | *Orange* | *125-164* |
| *151 – 200* | *Unhealthy* | *Red* | *165-204* |
| *201 – 300* | *Very Unhealthy* | *Purple* | *205-404* |
| *301 – 500* | *Hazardous* | *Maroon* | *405-604* |

A network of outdoor air monitors continually operates to detect pollutant levels in the Houston Area. You can view the network on the Internet on the State Environmental Agency's* Web site at www.tnrcc.state.tx.us/cgi-bin/monops/select_curlev?region12_cur.gif and locate the monitors

nearest to your campus. When ozone levels exceed federal standards, an air pollution warning is automatically generated and distributed via email to system subscribers. You can subscribe to receive ozone warnings through the Internet by visiting www.hcoem.org and clicking on "subscribe to ozone alerts." Warnings are also broadcast on message-activated National Weather Service radios.

When the TNRCC meteorological team predicts that atmospheric conditions are favorable for the production of high levels of ozone, an Ozone Watch is issued. Normally the TNRCC team makes its prediction by 3 p.m. each day for the next day's Ozone Watch. Occasionally, the TNRCC team will be unable to make its prediction until 9 a.m. on the day for which an Ozone Watch is called. Distribution methods for ozone watches are the same as those for ozone warnings.

This bulletin suggests guidelines to help schools protect children from the effects of outdoor air pollution. For further information regarding air quality, visit the Clean Air Action Web site at www.cleanairaction.org, or call the City of Houston Department of Health and Human Services Bureau of Air Policy at (713) 794-9384.

## III. RECOMMENDED RESTRICTION OF PHYSICAL ACTIVITIES

The following limits on activity for each type of episode are recommended:

A. Level Orange (Unhealthy for Sensitive Groups)

1. Susceptible individuals, primarily children with heart or respiratory disease such as asthma or allergies should minimize outdoor activity.

2. Healthy individuals with noticeable health effects associated with existing conditions should minimize outdoor activity.

B. Level Red (Unhealthy)

1. All children should discontinue prolonged, vigorous exercise outdoors lasting longer than one hour.

2. Susceptible individuals, primarily children with heart or respiratory disease such as asthma or allergies should avoid outdoor activity and remain indoors in air-conditioned spaces.

3. Outdoor activities that should be avoided include, but are not limited to calisthenics, basketball, baseball, running, soccer, football, tennis, swimming and water polo.

C. Level Purple (Very Unhealthy)

1. All children should discontinue vigorous outdoor activities, regardless of duration, and they should remain indoors in air-conditioned spaces.
2. All outdoor physical education classes, sports practices and athletic competitions should be rescheduled.

## IV. SITE ADMINISTRATOR RESPONSIBILITIES

(Refer also to the district/campus plan for safety)

A. Regular School Program

1. Alert faculty and staff and all other site users (e.g., _____) when ozone warnings are issued. The administrator should include information on the severity level (orange, red, or purple) in the alert. The location of the monitor(s) which are reporting exceedances as well as the levels reported from the nearest monitors may also be included for activity planning purposes.

2. Observe appropriate physical activity restrictions represented in Section III.

3. Students and staff with special health problems should follow any additional precautions recommended in writing by their individual physician. This information must be recorded on the student/employee health card.

4. School site administrators may wish to notify parents of high air pollution levels.

5. If an ozone exceedance is expected, but has not yet occurred at the time an outdoor activity is scheduled to begin, that event may begin as scheduled. When an ozone watch is in effect, outdoor activities scheduled for the afternoon should be rescheduled for the morning.

B. Interscholastic Athletic Program

1. Observe appropriate physical activity restrictions represented in Section III.

2. If an ozone exceedance is expected, but has not yet occurred at the time an interscholastic game or event is scheduled to begin, that event may begin as scheduled.

3. If an interscholastic game or event is scheduled to begin and a warning is in effect, the event should be canceled, delayed or rescheduled. The school should communicate with the interscholastic athletics office to coordinate cancellation or rescheduling of the game or event.

## V. POSTING OZONE WATCH/WARNING SIGNS

Ozone Watch/Warning signs may be posted at all entrances and exits following notification of a predicted air pollution episode. Announcements over the public address system may be used in conjunction with the posting of signs to notify students and staff of the predicted advisory or pollution episode. The attached signs ("Andy Airedale" Series) may be reproduced for use at individual sites.

* Effective Sept. 1, 2002, the Texas Natural Resource Conservation Commission (TNRCC) is changing the agency's name to the Texas Commission on Environmental Quality (TCEQ).

# Additional Resources


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