Appendix C: Key Pollutants

Appendix C: Key Pollutants

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Appendix C: Key Pollutants

C1 Summary

The EPA has identified six pollutants, termed "criteria pollutants," that cause or contribute to air pollution and could endanger the public health or welfare. These pollutants are addressed by the key statutes and regulations identified above, including the *National Environmental Policy Act of 1969 (NEPA)* (Reference 30), Council on Environmental Quality regulations (Reference 9), the *Clean Air Act (CAA) as amended* (Reference 5), and the General Conformity Rule (Reference 7). The six criteria pollutants are:

- Ozone (O_3),
- Carbon monoxide (CO),
- Particulates (PM-10),
- Sulfur dioxide (SO_2),
- Nitrogen dioxide (NO_2), and
- Lead (Pb).

The EPA established numerical air quality standards under the *CAA* for these criteria pollutants that are to be applied uniformly throughout the U.S. These standards are termed the National Ambient Air Quality Standards (NAAQS). A region's air quality is determined by comparing ambient air pollution levels with the appropriate NAAQS for each criteria pollutant. An area, or air quality control region, that violates the NAAQS for a particular pollutant anywhere within the region is designated as being in "nonattainment" for that pollutant (e.g., an area may be designated as nonattainment for ozone and carbon monoxide). Most major urban areas with heavy industrialization have levels of certain pollutants that exceed the NAAQS. The NAAQS for ozone is most commonly exceeded; roughly 100 areas are designated as nonattainment for ozone.

The *1990 CAA Amendments* established a new classification of nonattainment areas for ozone, carbon monoxide, and particulates on the basis of the severity of present pollution levels (e.g., moderate and serious for carbon monoxide). Based on the classification, deadlines for achieving attainment were set. Table C-1 lists the averaging periods and primary standards for the criteria pollutants. Primary standards define the air quality required to prevent any adverse impact on human health.

In addition to national standards for these pollutants, some states and local air districts have established air quality standards that are stricter than the NAAQS. States and local standards should be verified early in the air quality assessment process by contacting the appropriate agencies. Appendix J addresses State Indirect Source Review (ISR) regulations.

The criteria pollutants are discussed below, including the impact of aviation sources on pollutant levels.

Table C-1: National Ambient Air Quality Standards (NAAQS)

(as of November 15, 1990)

Pollutant	Averaging Period	Standard[1]
Ozone (O_3)	1-hour average	0.120 ppm (235 $\mu g/m^3$)
Carbon Monoxide (CO)	8-hour average	9 ppm (10 mg^3)
	1-hour average	35 ppm (40 mg^3)
Particulate Matter (PM-10)	24-hour average	150 $\mu g/m^3$
	annual arithmetic mean	50 $\mu g/m^3$
Sulfur Dioxide (SO_2)	24-hour average	365 $\mu g/m^3$
	annual arithmetic mean	0.03 ppm (80 $\mu g/m^3$)
Nitrogen Dioxide (NO_2)	annual arithmetic mean	0.053 ppm (100 $\mu g/m^3$)
Lead (Pb)	annual arithmetic mean	1.5 $\mu g/m^3$

C1.1 Ozone (O_3)

Ozone (O_3), commonly referred to as "smog," is formed in the atmosphere rather than being directly emitted from sources. Ozone forms as a result of volatile organic compounds (VOCs) and oxides of nitrogen (NO_x) reacting in the presence of sunlight in the atmosphere. Ozone levels thus are highest in warm-weather months. VOCs and NO_x are termed "ozone precursors" and their emissions are regulated in order to control the creation of ozone.

VOCs are created when fuels or organic waste materials are burned. Examples of significant VOC emission sources at airports and air bases are aircraft, ground support equipment, and ground access vehicles. VOC emissions from these sources are highest during low power settings such as aircraft and vehicle idle. Other emission sources include aerosol sprays, dry cleaning operations, paints, and solvents. Most hydrocarbons are presumed to be VOCs in the regulatory context, unless otherwise specified by the EPA. In the emission inventory calculations presented in this document, VOC emissions are not calculated directly, but instead are estimated from calculated hydrocarbon emissions. See the VOC definition in the Glossary for the conversion factors to apply to total hydrocarbon emissions to convert them to VOC emissions.

Two types of nitrogen oxides are emitted into the atmosphere in significant quantities: nitric oxide (NO) and nitrogen dioxide (NO_2). NO is formed during high-temperature combustion processes when nitrogen and oxygen react in the presence of air. NO_2 is formed when NO reacts with atmospheric oxygen (O_2), and is regulated separately as a criteria pollutant (see discussion below). When both chemical compounds are emitted, they are referred to collectively as total oxides of nitrogen (NO_x). Significant NO_x sources at airports and air bases are aircraft and

[1] Refers to primary standards, which define the air quality required to prevent any adverse impact on human health.

gasoline-powered ground access vehicles. The significant NO_x-producing modes of aircraft operation are takeoff and climbout. Other emission sources include boilers and electric power plants.

Ozone damages lung tissue, reduces lung function, and sensitizes the lungs to other irritants. Scientific evidence indicates that ambient levels of ozone not only affect people with impaired respiratory systems (e.g., asthmatics), but also healthy adults and children. Ozone may produce adverse health effects such as chest discomfort, coughing, nausea, respiratory tract and eye irritation, and decreased pulmonary functions.

C1.2 Carbon Monoxide (CO)

Carbon monoxide (CO) is an odorless, colorless, and poisonous gas. Most CO is formed as a result of incomplete combustion of organic materials used as fuel (e.g., gasoline, coal, wood). The most significant sources of emissions at airports and air bases are aircraft and ground access vehicles. CO emissions from these sources are highest during incomplete combustion, during idling and low speed mobile source operations, such as aircraft taxi and vehicle idle, which are the most prevalent CO emission sources commonly found at airports and air bases. Other examples of CO sources at airports and air bases are ground support equipment and combustion stationary sources.

CO enters the bloodstream and reduces oxygen delivery to the body's organs and tissues. Its most serious effects occur at high concentrations, and therefore it tends to be a localized problem. CO may produce adverse health effects such as headaches, work capacity impairment, learning ability impairment, dizziness, weakness, nausea, vomiting, loss of muscular control, increasing and decreasing respiratory rates, collapse, unconsciousness, or death. The health threat from CO is most serious for those who suffer from cardiovascular disease. Healthy individuals also can be affected, but only at higher concentrations.

C1.3 Particulates (PM-10)

Particulate matter includes solid and liquid material suspended in the atmosphere. Particulates form as a result of incomplete combustion. Particulate emission rates are somewhat higher at low power rates than at high power rates since combustion efficiency improves at higher engine power. Most particulate material is not inhaled because of its large size. PM-10, fine particles less than 10 micrometers in diameter, are likely to be responsible for adverse health effects. They are not easily filtered from the air by the body and subsequently are inhaled into the lungs. Therefore, in 1987, the EPA replaced the earlier total suspended particulate (TSP) standard with a standard for PM-10. Examples of PM-10 include dust, fog, and fumes. The level of PM-10 in the atmosphere is largely affected by wind and rainfall conditions. Aircraft are the primary source of PM-10 emissions at airports and air bases. Other airport and air base PM-10 sources include ground access vehicles, industrial operations, construction vehicles, and construction activities.

PM-10 may produce adverse health effects including effects on breathing and respiratory symptoms, aggravation of existing respiratory and cardiovascular disease, alterations in the body's defense systems against foreign materials, damage to lung tissue, carcinogenesis, and premature mortality. The elderly, children, individuals with chronic obstructive pulmonary or cardiovascular disease, influenza, and asthma are most likely to be sensitive to the effects of fine particulate matter.

C1.4 Sulfur Dioxide (SO_2)

Sulfur oxides (SO_x) are gases produced from industrial processes (e.g., the burning of sulfur-containing fuels such as coal and oil). Emissions of SO_x depend entirely on the sulfur content of the fuel. Approximately 95 percent of sulfur oxides are sulfur dioxide (SO_2). SO_2 is a relatively stable, colorless gas with a strong suffocating odor. Very little SO_2 is emitted from any aviation source.

Exposure to high concentrations of SO_2 may produce adverse health effects such as throat and lung irritations, swelling and accumulation of fluid in the throat and lungs, nasal bleeding, and aggravation of existing respiratory and cardiovascular disease. People most sensitive to SO_2 include asthmatics, individuals with cardiovascular disease or chronic lung disease (e.g., bronchitis, emphysema), children, and the elderly. In addition, SO_2 and nitrogen oxides are the major precursors for acid rain.

C1.5 Nitrogen Dioxide (NO_2)

Nitrogen dioxide (NO_2) is a poisonous, reddish-brown to dark brown gas with an irritating odor. As discussed above in the context of ozone, NO_2 forms when nitric oxide (NO) reacts with atmospheric oxygen (O_2). Most sources of NO_2 are man-made sources; the primary source of NO_2 is high-temperature combustion. Significant sources of NO_2 at airports and air bases are boilers, aircraft operations, and vehicle operations. NO_2 emissions from these sources are highest during high-temperature combustion, such as aircraft takeoff mode.

NO_2 may produce adverse health effects such as nose and throat irritations, coughing, choking, headaches, nausea, stomach or chest pains, and lung inflammations (e.g., bronchitis, pneumonia). The effects of short-term exposure are still unclear, but continued or frequent exposure to concentrations higher than those normally found in the ambient air may cause increased incidence of acute respiratory disease in children.

C1.6 Lead (Pb)

Lead (Pb) is a heavy metal solid that is bluish-white to silvery gray in color. Lead occurs in the atmosphere as lead oxide aerosol or lead dust. Historically a significant source of lead in the air at airports and air bases was ground access vehicles operating on leaded gasoline. The amount of lead emissions from vehicles has decreased, however, due to the significant Federal controls on leaded gasoline and the resultant increase in the use of unleaded gasoline in catalyst-equipped cars. Currently, the chief (but typically insignificant) source of this pollutant at airports and air bases is the combustion of leaded aviation gasoline in piston-engine aircraft.

In the body, lead accumulates in blood, bone, and soft tissue. Because it is not readily excreted, lead also affects the kidneys, liver, nervous system, and blood-forming organs. Lead may produce adverse health effects such as fatigue, sleep disturbance, headache, aching bones and muscles, constipation, abdominal pains, decreased appetite, and permanent nervous system damage. High levels of exposure to lead may lead to seizures, coma, or death. Fetuses, infants, and children are especially susceptible to low doses of lead.