Appendix A

Emissions Inventory

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Appendix A: EMISSIONS INVENTORY

Introduction

This Appendix discusses the District's emissions inventory (EI) in detail. It describes the federal requirements pertaining to emissions inventories for State Implementation Plan (SIP) submittals. Summaries of the emission inventories used in the PM10 Plan can be found in Chapter 3. The detailed emissions inventory is found in the reference documentation.

Emission inventories are lists of all known pollutant sources for a specific area. It estimates the amount of a specific pollutant that is emitted into the air over a defined time period. It is important to recognize that the emissions inventory is not a direct measure of air quality. The emissions inventory does not explain how long pollutants stay in the air, how they react in the atmosphere to form other substances, or how far they travel. Nevertheless, an accurate inventory is critical to the success of the air quality modeling used to demonstrate attainment of the standards.

The federal Clean Air Act section 172(c)(3) requires all plan submittals to include a comprehensive, accurate, and current inventory of actual emissions from all sources of the relevant pollutant(s). The inventory that meets these qualifications is selected as the base year inventory. All other inventories used in the PM10 Plan rely on the base year inventory to forecast and backcast other years. The year 1999 was selected as the base year for the PM10 Plan because it has the most complete emissions inventory currently available. The base year EI used in this PM10 Plan uses the most recent data available; therefore, it differs from the published 1999 inventories for earlier plans.

The base year and subsequent year emission inventories describe summer and winter seasons, and average annual emissions for directly emitted PM10 and PM10 precursors. Seasonal inventories are provided to account for the differences in emissions occurring during the times of year when the SJVAB exceeds the 24-hour PM10 standard. Summer is defined as May through October and Winter is defined as November through April.

The emissions inventory for 2002 is the basis of an important PM10 planning requirement. As a consequence of failure to attain the PM10 standard by the CAA deadline, the PM10 Plan is required to demonstrate at least five percent per year reductions in PM10 or PM10 precursors based on the most recent emissions inventory. The District must calculate progress toward this milestone from the date of such submission until attainment. In this case, the *2003 PM10 Plan* was due December 31, 2002. Therefore, the 2002 inventory was used as the baseline to calculate the quantitative milestones required for 2005, 2008 and the attainment year 2010.

The emissions inventory is divided into source categories and subcategories. The main source categories are stationary sources (both point and aggregated), area-wide sources, on-road mobile sources, and off-road mobile sources. These source

categories are described in greater detail in the next section. Source categories provide a convenient way to organize the emissions inventory and to determine the significance of particular sources.

The inventory for the PM10 Plan will be incorporated into the SIP. Inventories will also be updated during reasonable further progress reports that are required every three years until attainment. The emissions inventory is continuously being updated and improved. Chapter 8, 'Ongoing Activities,' identifies emissions inventory improvements that the District plans to address in the near future.

EMISSIONS INVENTORY DETAILS

Determining emissions generally involves the use of emission factors. The EPA describes an emission factor as a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. These factors are usually expressed as the weight of pollutant divided by a unit weight, volume, distance, or duration of the activity emitting the pollutant (e.g., grams of particulate emitted per gallon of fuel burned). Such factors facilitate estimation of emissions from various sources of air pollution. In most cases, these factors are simply the averages of all available data of acceptable quality, and are generally assumed to be representative of long-term averages for all facilities in the source category (i.e., a population average).
The general equation for emission estimation is:

$$E = A \times EF \times (1-ER/100)$$

where:

E = emissions,
A = activity rate,
EF = emission factor, and
ER= overall emission reduction efficiency, %.

The extent of completeness and detail of the emissions information is determined by the information available from published references. Emissions from some processes are better documented than others. For example, several emission factors may be listed for the production of one substance: one factor for each of a number of steps in the production process such as neutralization, drying, distillation, and other operations. However, because of less extensive information, only one emission factor may be given for production facility releases for another substance, though emissions are probably produced during several intermediate steps. There may be more than one emission factor for the production of a certain substance because differing production processes may exist, or because different control devices may be used.

It is important to realize that emissions inventories are only estimates, since it is highly impractical to directly measure and compile emissions on a continuous basis from a multitude of sources. Methods such as surveys and sampling are used to overcome

this limitation. Actual emission measurements can be taken on a sample of devices to determine an average emission rate. Source tests at stationary emission sources provide a snapshot of emission rates that can then be applied over time. Field measurements of fugitive dust emissions taken at sources such as construction sites can be used to determine an average emission rate under a variety of conditions. Generally, emission factors developed using a large number of measurements are more accurate than those relying on fewer measurements. The EPA has developed a comprehensive source for emission factors known as the "Compilation of Air Pollutant Emission Factors," or commonly referred to as "AP42." The ARB also compiles California- specific emission factors for many sources. The District is responsible for selecting emission factors for stationary sources and some area-wide sources.

Once an emission factor is determined, the next step is to determine the population (number of sources) and extent of each source. Population data is collected directly and indirectly. For example, vehicle registration data are gathered by the state. Stationary sources must obtain a permit from the District; therefore populations of permitted equipment are directly obtained and are reasonably accurate. The number of fireplaces is not reported and must be estimated indirectly using housing statistics and surveys. Each source category has its own methodology.

The next step is to determine an activity rate. Activity data is reported in hours of operation, gallons of fuel used, miles traveled, and other units. Stationary sources of emissions permitted by the District are required to report actual emissions to ensure that they remain below their emission limits. This provides detailed activity data that is used in the emissions inventory. Often, a survey is carried out to determine usage rates. For example, people are asked to report how much wood they burn in their fireplaces and the type of wood burning devices they use, or vehicle miles traveled is estimated with the aid of traffic counts, travel surveys, and transportation models.

A variety of measurement units are applied to emission-producing activities. For example, when estimating emission factors for engines, data such as horsepower, hours of operation, or gallons of fuel used may be used to determine emissions. Population or miles driven may be used as units for other sources to determine emission factors for water heaters or vehicles, respectively. The emission estimates for most point sources (specific facilities) are generally more reliable than the estimates based on studies because emission estimates from point sources are usually generated from the use of source tests, and the emission factors for that source are generated from this test. Furthermore, facility operators can inform the District of their actual production figures or fuel burned, which eliminates the need for the District to estimate this type of data.

Emissions inventories are never considered to be entirely complete at any one given time. These inventories can always be improved with the use of better emission factors and activity data. The District, in cooperation with the ARB, is committed to continually updating the emissions inventory as research studies, emission factor updates, and other information become available. When emissions data change dramatically, the

District is committed to revising the inventory and to ensuring that any impact is reflected in the control strategy and the attainment demonstration.

The PM10 Plan also includes an emissions inventory of PM10 precursors. Precursors are those compounds that are emitted into the atmosphere as a gas and form PM10 through a variety of chemical processes. Since the amount of secondary material formed is dependent on atmospheric conditions and the presence of other reactive compounds, the amount of secondary particulates cannot be directly calculated for an emissions inventory. However, with the use of an atmospheric model, the precursor emissions inventory can be used to estimate particulate formation under the conditions experienced in the SJVAB. This is the same method used for ozone, which is a product of atmospheric processes involving VOC and NOx. Precursors examined for the PM10 Plan are VOC, NOx, ammonia (NH3), and SOx. Of these precursors only NOx appears to make a significant contribution to the attainment strategy. However, because of uncertainty in the precursor modeling, the District and ARB have developed inventories for each precursor. This is the first attempt by ARB to produce an NH3 inventory for the SJVAB. The inventory is prepared differently than the precursor pollutants inventory. Ammonia emission estimates have a large amount of uncertainty and the District has committed to its improvement.

Stationary Sources

Stationary source emissions are classified as an emission source that is fixed in place rather than movable (e.g., stack, engine, large water heater, etc.). Primary processes that produce air pollution are fuel combustion; industrial processes; petroleum production and marketing; waste disposal and cleaning and surface coatings. The specific sources associated with these processes are listed within the following source categories:

1. Fuel Combustion: This category contains emissions produced by stationary fossil fuel combustion equipment such as boilers and engines. Emissions in this category are produced by the following sources:
    a. Petroleum Refining: Fuel-burning equipment located at refineries;
    b. Food and Agricultural Processing: Orchard heaters; agricultural irrigation pumps; fuel-burning equipment located at food processing plants;
    c. Oil and Gas Production: Stationary internal combustion engines, boilers, heaters, turbines, and steam generators at facilities engaged in the extraction and processing of petroleum products for shipment, using fuels such as natural gas, distillate oil, and liquefied petroleum gas;
    d. Electric Utilities: Diesel and natural gas turbines used to generate electricity;
    e. Cogeneration: Cogeneration is the simultaneous production of electricity, heating and cooling in a single thermodynamic process.

Equipment used in cogeneration includes turbines and reciprocating engines.

f. Manufacturing/Industrial: The same type of equipment as listed under Oil and Gas Production, but used in industrial and manufacturing activities;
g. Services and Commerce: Fuel combustion equipment including commercial space and water heaters; and
h. Other: Unspecified fuel combustion processes.

2. Industrial Processes: This category produces VOC and NOx emissions from the following sources:
   a. Mineral Processes: Crushed rock and other mineral processing;
   b. Food and Agriculture: Sugar beet processing, wine fermentation, wine and brandy aging, bakeries, spice manufacturing,
   c. Chemical: Fiberglass operations, synthetic rubber and plastics manufacturing and miscellaneous chemical processes;
   d. Metal Processes: Secondary metal production;
   e. Glass and Related Products: Glass manufacturing; and
   f. Other: Unspecified industrial processes.

3. Petroleum Production and Marketing: This category includes emissions resulting from the handling of petroleum liquids and gases at extraction, processing, transport, and marketing facilities. Because this category includes emissions related to the handling of petroleum products, and does not include combustion sources, it is comprised entirely of VOC emissions. Emissions in this category are produced by the following sources:
   a. Oil and Gas Production: Valves, fittings, compressor seals, flanges, storage tanks, crude oil sumps and pits, and oil production tanks;
   b. Petroleum Marketing: Petroleum storage tanks, loading of marine vessels and tank cars/trucks with crude oil, natural gas transmission losses, underground gasoline tanks, and vehicle refueling; and
   c. Petroleum Refining: Valves, fittings, storage tanks and loading racks at refining facilities.

4. Waste Disposal: This category contains emissions from the following sources:
   a. Landfills: Decomposition of waste material at landfill sites;
   b. Incineration: Incinerators and flares burning process gas; and
   c. Other: Unspecified volatile organic waste.

5. Cleaning and Surface Coatings: This category contains VOC emissions from the following sources located at businesses:
   a. Dry Cleaning: Petroleum and other dry cleaning solvents;
   b. Degreasing: Petroleum and synthetic solvents used to clean parts and materials at industrial and commercial facilities;

c. Printing: Inks, solvents, and cleaning agents;
d. Other Surface Coating: Paints, thinners, and cleaning agents for auto painting, solvent vats used in manufacturing, coatings used for aircraft parts, solvent used for adhesives and sealants, industrial coatings for plastics, paper, marine vessels, and wood furniture;
e. Industrial Solvent Use: Organic cleaning agents and solvents used in industrial processes such as the fabrication of plastic products and surface coating operations;
f. Adhesives and Sealants: Organic emissions from the use of adhesives and sealants, used mainly for wood, wood-related and packaging activities; and
g. Other: Unspecified cleaning and surface coatings emissions.

Sources of air pollution in the stationary source inventory are tracked as point sources or aggregated-point sources. Point sources are those facilities that emit pollutants in quantities sufficient to require individual tracking of their emissions (generally over 10 tons per year) and include processing, manufacturing, and industrial operations.

Aggregated-point sources are point sources that emit less than 10 tons per year of any one pollutant. There are far too many of these to keep track of individually, but when added together they can represent a large quantity of air pollution. Examples of these sources include gas stations, water heaters, and space heating. Emissions from these types of sources are calculated on a broader scale of estimation, and not on an individual basis. For example, emissions from gas stations are generally calculated by the amount of gasoline sold in each county, with an emission factor based on 1000 gallons sold.

Area-wide Sources

Area-wide sources include source categories that are associated with human activity and the emissions that take place over a wide geographic area. Area-wide sources dominate the PM10 inventory as a directly emitted source category. Fugitive dust sources of PM10 (e.g., paved roads, unpaved roads, and agricultural operations) are examples of area-wide sources. In addition, paints, cooking, construction, and consumer products are also considered area-wide sources. The following is a more descriptive list of the types of sources categories found under area-wide sources:

1. Miscellaneous Processes: The emissions in this category are produced by the f ollowing sources:
    a. Unplanned Fires: Auto/structural fires;
    b. Residential Fuel Combustion: fuel oil, propane, natural gas, and wood, etc. used in homes;
    c. Farming Operations: Dust from land preparation and harvesting operations; cattle feedlot dust; organic emissions from animal husbandry;

   d. Construction and Demolition: Dust from construction of buildings and roads;
   e. Entrained Road Dust – Paved: Dust entrained by vehicular travel on paved roads;
   f. Entrained Road Dust – Unpaved: Dust entrained by vehicular travel on unpaved farm roads, unpaved non-farm roads, private unpaved roads and unpaved traffic areas;
   g. Fugitive Windblown Dust: Dust caused by wind blowing across exposed agricultural land;
   h. Cooking: Particulate and organic emissions from the preparation of food for human consumption at eating establishments; and
   i. Other: Other unspecified processes.

2. Solvent Use: This inventory category consists of evaporative emissions from consumer products, architectural coatings, pesticides and asphalt paving. Emissions in this category are produced by the following sources:
   a. Architectural Coating: Oil and water based paints and thinners used to paint commercial and residential buildings and other structures;
   b. Asphalt Paving: Cutback asphalt, emulsified asphalt, hot-mix asphalt, and road oils; asphalt roofing;
   c. Consumer Products: Antiperspirants and deodorants, air fresheners, automotive windshield wiper fluids, bathroom cleaners, consumer engine cleaners, barbecue lighter fluid, aerosol insect repellents and other consumer products; and
   d. Pesticide Application: Synthetic and non-synthetic pesticides used for agricultural and non-agricultural purposes
3. Waste Burning: This category includes various activities that burn waste materials. Waste Burning sources contribute emissions from the following sources:
   a. Agricultural Debris: Field crop residue and pruning;
   b. Range Management: Range vegetation and chaparral;
   c. Forest Management: Forest vegetation; and
   d. Other: Weed abatement, non-agricultural open burning and fire fighter training.

Methods used to estimate emissions for area-wide sources are similar to aggregated-point sources, but area-wide source emissions are frequently more difficult to estimate. The same techniques used in estimating point source emissions are often used, but with less reliability. For example, it is difficult to determine the number of residential fireplaces as well as the amount of wood burned in fireplaces within the District. Although there are methods to estimate this, the quality of data is not as reliable or accurate as that of point sources and point source tests. The estimates are based on total activity during a season and they do not provide much information about typical use, daily activity, or exact location of the source.

Mobile Sources

The mobile source inventory includes emissions from vehicles and mobile equipment powered by piston and turbine engines. Mobile sources are grouped as on-road vehicles (e.g., cars and trucks), and other mobile sources (e.g., tractors, construction equipment, and lawn and garden equipment).

Mobile source emissions (VOC, NOx, SOx, CO, NH3, and PM10) result from fuel combustion and fuel evaporation. For example, evaporative emissions from automobile fuel tanks are a source of VOC emissions. During the day, increasing temperatures cause gasoline in tanks and fuel systems to expand, displacing vapors (which are mostly VOC) into the atmosphere unless they are contained by an on-board vapor recovery system. Mobile source emissions categories are as follows:

1. On-Road Motor Vehicles: This category includes light-duty passenger vehicles (automobiles), light-duty trucks (pick-up trucks), medium-duty trucks, heavy-duty trucks (dominated by diesel trucks), motorcycles, heavy-duty buses and motor homes. The on-road motor vehicle emissions inventory was developed for the District by the California Air Resources Board (ARB).

2. Other Mobile sources: This group includes ships, boats, airplanes, trains, residential utility equipment, and construction equipment that do not produce emissions on roads and highways. It includes the following types of sources:

a. Aircraft - Government: Military aircraft;
b. Aircraft - Other: Commercial and general aviation; crop dusters;
c. Mobile Equipment: Farm equipment and construction equipment not included in the utility equipment category; commercial and industrial equipment (e.g. forklifts); mining equipment; transport refrigeration units; logging equipment; oil drilling and workover rigs; and airport ground support equipment;
d. Off-Road Vehicles: Four-wheel drive passenger vehicles, off-road motorcycles; ATVs; snowmobiles;
e. Ships: Commercial shipping and recreational boats;
f. Trains: The District is traversed by several major railway lines linking the area with the Sacramento and Bay Areas, and the Southeast Desert;
g. Utility Equipment: Small utility engines driving chain saws, lawn mowers, leaf blowers, and portable compressors and generators; and
h. Fuel Storage and Handling: Organic emissions from gas cans.

The PM10 Plan uses ARB's mobile source emissions inventory model EMFAC2002 version 2. 2 (April 2003) to calculate on-road mobile source emissions. The ARB developed EMFAC in lieu of the EPA's motor vehicle emissions model MOBILE. The benefit of the ARB's model is that statewide motor vehicle emission control programs are included in the emission estimates.

The off-road emissions inventory is developed with emission estimates from ARB's OFFROAD model. Other mobile categories, such as locomotives and aircraft, are estimated using emission factors developed by the EPA.

Natural Sources

In addition to man-made air pollution, there are natural sources of emissions, also known as biogenic sources (organic emissions from plants) geogenic sources (such as petroleum seeps) and wildfires. These natural sources emit significant quantities of pollutants. For example, certain types of vegetation emit large amounts of isoprene, terpenes, and other organic compounds that are VOC. Emission rates depend upon plant species, season, biomass density, time of day, local temperature, and other factors.

The biogenic inventory for the San Joaquin Valley has been the subject of recent research and refinements. The biogenic VOC emissions inventory is estimated at 379.37 tons per day for the District. Seasonal or annual estimates have not been prepared using this updated methodology, but it provides a sense of the magnitude of biogenic emissions during the summer.

Growth and Control Factors

Projecting quantities of pollution in future years is traditionally accomplished by assuming that PM10, NOx, SOx, NH_3, and VOC emissions are directly related to activity and control levels. If an activity level increases, it is generally assumed that emissions will similarly increase. Activity levels are represented by indicators such as population, housing, employment, oil and gas production, and vehicle miles traveled. These indicators are referred to as "surrogates". The ratio of the projected surrogate for each year to the actual 1999 level of activity is referred to as its growth factor. Growth factors are multiplied by 1999 emissions to project future year's emissions. A growth factor of less than one indicates a decline in an activity (declining emissions) over the planning period, while a growth factor of more than one indicates an increase in activity (increasing emissions).

Using the best data available, the ARB and the District compiled growth factor estimates for the years 1970 through 2030 for each group of sources and in each of the eight counties within the District. Although using growth factors is a standard method for projecting emissions, their use cannot account for all activities that might occur in an area during a given time frame. However, growth factors tend to be more accurate when applied to the SJVAB as a whole. For example, one facility might gain in market share while another loses its market share even though production increases at both facilities. While the overall growth factor is correct, each facility had very different growth rates. A report showing the growth factors that were used is located in a reference document.

The ARB estimates the on-road mobile source emissions growth for each class of vehicle, based on information obtained from the Transportation Planning Agencies (TPAs) located within the District, and Caltrans. Also, enhanced inspection and maintenance programs for motor vehicles and other motor vehicle control programs are factored into the mobile source projections included in this PM10 Plan. These data collectively represent the best available estimates on a county-by-county basis of future activity levels for mobile sources within the District.

After the baseline emissions inventory is multiplied by a growth factor, it is then multiplied by a control factor. A control factor is a weighted average that represents the level of controls of one or more rules, regulations, and/or programs, for a group of sources. This control factor takes into account information other than control levels as stated in a rule or program. Rule penetration, compliance rates, public awareness, participation, and other agency's rules that affect the air quality are all considered in determining a control factor. Control factors need to be updated on a continuing basis as the production levels, industry types and size, programs, public awareness, base year inventories, and other conditions change over time. Control factor estimates for the years 1970-2030 were compiled by the District and ARB and can be found in a reference document.

FUTURE YEAR INVENTORIES

Detailed Annual, Summer, and Winter inventories for the 2002, 2005, 2008, and 2010 inventories are available in a reference document to this Plan. At the end of Chapter 3, there is a series of summary tables that show the annual emissions of a year followed by that year's seasonal emissions. The summary tables include 2002, 2005, 2008 and 2010 emissions.

AVERAGE ANNUAL, SEASONAL, PLANNING, AND MODELING INVENTORIES

An annual average inventory represents the emissions on an average day during a year, by taking the total annual emissions in tons and dividing them by 365 days.

One of the necessary inputs to air quality modeling is an emissions inventory with temporally and spatially resolved emissions estimates. For stationary, area-wide and other mobile sources, the annual average emissions are adjusted to account for monthly and weekly variations. A modeling inventory is developed for a weekday and weekend day in the year and months needed (e.g. August 2000). The reason for this method is to more closely approximate the actual emissions that occurred during an episode.

For example, some businesses have certain months that are busier than others. These busy months will have more emissions than slower months. An example of this type of operation is a tomato processing plant, which has more emissions during harvest time

than any other time during the year. Data on normal operating schedules (hours per day, days per week, and weeks per year) are collected as a part of routine point source inventory procedures. During special studies, actual daily or hourly emissions are gathered for large sources. Spatially, the geographic location of each facility is used to place its emissions in the modeling domain.

Other source categories can vary seasonally as well as over the week. For example, use of recreational boats is much higher in the summer than in the winter and higher on weekends than weekdays. Similarly, fireplaces are used in the winter with almost no use in the summer months.

On-road motor vehicle emissions are estimated by EMFAC. EMFAC is used to produce emission estimates for each day of each episode by county. County average hourly temperatures, weighted by gridded VMT, are input to EMFAC. The Direct Travel Impact Model (DTIM) is then used to estimate gridded on-road motor vehicle emissions. DTIM uses digitized roadway segments (links) and traffic analysis zone activity centroids to spatially allocate emissions for travel and trip ends.

Biogenic organic emissions are developed using a Geographic Information System (GIS)-based model, called BEIGIS. BEIGIS uses California-specific input databases with a minimum spatial resolution of 1 square kilometer (km) and an hourly temporal resolution. BEIGIS builds the inventory from the bottom up for natural, urban and agricultural plant species. Emission rates depend upon plant species, light intensity, biomass density, temperature, and other factors. Biogenic inventories are developed hourly for specific days.

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