BASE YEAR 2008 EMISSION INVENTORY

SOURCE CATEGORY METHODOLOGIES

Bay Area Air Quality Management District

939 Ellis Street
San Francisco, California 94109

EMISSION INVENTORY

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BASE YEAR 2008

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

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SECTION 1

INTRODUCTION

INTRODUCTION TO THE EMISSION INVENTORY METHODOLOGY DOCUMENT

BACKGROUND

The purpose of this methodology document is to enable the reader to understand how emission estimates were developed for each category. It is hoped that this Introduction will provide the background needed to successfully utilize the information presented in any methodology.

GENERAL METHODOLOGY INFORMATION

An emission inventory consists of emission estimates for a variety of sources and operations. These are clustered into groups of similar sources or operations called categories. Examples are: (1) refinery valves and flanges, (2) plastic products manufacturing, (3) domestic natural gas used for space heating and (4) passenger car engines with catalytic converters. A methodology may be written for a single category or a group of them.

The wide range of source and operation types that the emission categories represent fall into two classes, **Anthropogenic Sources** and **Biogenic (Natural) Sources**:

Anthropogenic emission sources are produced from human activity and can be divided between **stationary** and **mobile sources**. **Stationary sources** can be further divided between **point** and **area sources**. Some emission categories may consist only of **point** or of **area sources;** however, other categories may consist of both **point** and **area sources**. It is important to recognize that emission values presented by the District are estimates only, based on available data and engineering judgment.

Point sources are those that are identified on an individual basis such as refineries and manufacturing plants. The district maintains a computer data base with detailed information on operations and emissions characteristics for about 7,000 facilities, with approximately 25,000 different sources, throughout the Bay Area. Data on the activity, seasonal variations, and hours of operation are collected at the process level from each facility. Parameters that affect the quantities of emissions are updated regularly. The emissions from general processes, such as combustion, are computed using generalized or specific emission factors. These emission factors are periodically reviewed and updated.

Area sources are stationary sources that are individually small, but that collectively make a large contribution to the inventory. Some examples of area sources are commercial cooking, fireplaces and woodstoves, dry cleaners, architectural coatings, etc. Many area sources do not require permits from the District, such as residential heating and a wide range of consumer products such as paints, solvents, and cleaners. Some facilities considered to be area sources, such as gas stations and dry cleaners, do require a permit from the District. Emission estimates for area sources may come from the District's database, be calculated by the California Air Resources Board (CARB) using

statewide data, or be calculated based on surrogate variables such as population. Temporal data, such as weekly, monthly and yearly variations, are collected and updated when needed.

Mobile sources include both on-road motor vehicles and off-road sources. Examples of on-road vehicles include automobiles, trucks and buses. Estimates of on-road motor vehicle emissions take into account the number of vehicles and fleet mix (vehicle type, model year, and accumulated mileage), miles traveled, ambient temperatures, vehicle speeds, and vehicle emission factors. These emission factors are developed from comprehensive CARB testing programs. Off-road mobile sources include aircraft, boats, ships, trains, farm, construction equipment, lawn and garden equipment, etc. Various methodologies are used for compilation of emissions from these mobile sources. Emission factors and methodologies for off-road mobile sources are calculated from information provided by CARB and EPA.

Biogenic emissions occur from natural sources such as plants and trees. Vegetation emits large amounts of isoprene, monoterpenes, and other organic compounds that are ozone precursors. Emission rates depend upon species, season, biomass, time of day, local temperature, moisture and other factors. CARB estimates these biogenic emissions which, in 2008, amounted to 105 tons per day of reactive organic emissions.

METHODOLOGY DETAILS

Each methodology consists of a text with an example below that illustrates the text format and content.

EXAMPLE OF A METHODOLOGY FORMAT

Emission Inventory
Category # --- (or Category #'s ---, ---, ---)

Methodology Title

EMISSIONS

Introduction: May contain information that can help put the category in perspective, with regard, e.g., to the previous emission inventory. It can detail information on the splitting of categories, other unusual features, etc.

Methodologies: May contain specific methodology details, references on emission factors and emission data (PONSCO and GHG, where applicable).

Monthly Variation: Contains monthly information, or refers to it.

County Distribution: Contains county information, or refers to it.

TRENDS

History: Describes how trend data for the category/categories covered by this methodology were developed.

Growth: Describes how trend data for the category/categories covered by this methodology were developed.

Control: Describes rules regulating criteria pollutants for the category/categories covered by this methodology.

By: --- ------
Date: --- ------
Base Year ----

EIC: --- ------

PAGE NUMBERS

The page numbers are ordered as follows:
[section number].[subsection number].[1*]-[page number]

* 1 for methodology

examples: 5.2.1-2 page 2 of methodologies for landfills (section 5, subsection 2)

The acronym "PONSCO" may appear in the methodology document. It refers to emissions of total particulate, total organics, nitrogen oxides (NO_X), sulfur dioxide (SO_2) and carbon monoxide (CO), in that order.

There may be references to "reactive organics". Reactive organics are photochemically reactive organic compounds. They react rapidly with oxides of nitrogen in the presence of sunlight to produce "photochemical smog", including its major component, ozone. For each category, the fraction of reactive organics may vary from zero to all of the total organic emissions. It is calculated by excluding the non-reactive organic compounds listed in Table 1.

TABLE 1

ORGANIC COMPOUNDS CONSIDERED NON-REACTIVE

1. Methane
2. Ethane
3. Acetone
4. Perchloroethylene (tetrachloroethylene)
5. Methylene chloride
6. 1,1,1-trichloroethane
7. 1,1,2-trichlorotrifluoroethane (CFC-113)
8. Trichlorofluoromethane (CFC-11)
9. Dichlorodifluoromethane (CFC-12)
10. Dichlorotetrafluoroethane (CFC-114)
11. Chlorodifluoromethane (CFC-22)
12. Chloropentafluoroethane (CFC-115)
13. 2-chloro-1,1,1,2-tetrafluoroethane (HCFC-124)
14. pentafluoroethane (HFC-125)
15. 1,1,2,2-tetrafluoroethane (HFC-134)
16. 1,1,1-trifluoroethane (HFC-143a)
17. 1,1-difluoroethane (HFC-152a)
18. Trifluoromethane (CFC-23)
19. Perfluorocarbons.

Note that carbon monoxide, carbon dioxide, carbonic acid, metallic carbide or carbonates, and ammonium carbonate are not classified as organic compounds.

Greenhouse Gases

Certain categories (i.e. Combustion, Landfill, Cement, etc.) may also emit Greenhouse gases (GHG's). Table 2 lists the GHG's with corresponding global warming potentials (GWP's). The Global Warming Potential for a particular greenhouse gas has been defined as the ratio of heat trapped by one unit mass of the greenhouse gas to that of one unit mass of Carbon dioxide (CO_2) over a specified time period. For example, CO_2 has a GWP equal to 1.

TABLE 2

GHG		GWP
Formula	**Common Name**	
CO_2	Carbon Dioxide	1
CH_4	Methane	21
N_2O	Nitrous Oxide	310
HCFC-22	Chlorodifluoromethane	1,500
HCFC-123	Dichlorotrifluoroethane	90
HCFC-124	Chlorotetrafluoroethane	470
HCFC-142b	Chlorodifluoroethane	1,800
HFC-23	Trifluoromethane	11,700
HFC-32	Difluoromethane	650
HFC-125	Pentafluoroethane	2,800
HFC-134a	Tetrafluoroethane	1,300
HFC-143a	Trifluoroethane	3,800
HFC-152a	Difluoroethane	140
HFC-227ea	Heptafluoropropane	2,900
HFC-236fa	Hexafluoropropane	6,300
HFC-43-10-mee	Decafluoropentane	1,300
PFC-14	Tetrafluoromethane	6,500
PFC-116	Hexafluoroethane	9,200
PFC-218	Perfluoropropane	7,000
PFC-318	Octafluorocyclobutane	8,700
PFC-3-1-10	Decafluorobutane	7,000
PFC-5-1-14	Perfluorohexane	7,400
SF_6	Sulfur Hexafluoride	23,900

Note:

The CO_2 emission from some activities (i.e. landfills, wine/beer fermentation, landfill gas combustion, digester gas combustion, etc.) is considered to be biogenic. The District's Regulation 3-240 defines Biogenic Carbon Dioxide as "Carbon dioxide emissions resulting from materials that are derived from living cells, excluding fossil fuels, limestone and other materials that have been transformed by geological processes. Biogenic carbon dioxide originates from carbon (released in the form of emissions) that is present in materials that include, but are not limited to, wood, paper, vegetable oils, animal fat, and food, animal and yard waste."

SECTION 2

PETROLEUM REFINING FACILITIES

EMISSION INVENTORY

CATEGORIES #10-#16

REFINERY EMISSIONS
Basic Refining Processes (10)
Wastewater Collection & Separation Systems (11)
Wastewater Treatment Facilities (12)
Cooling Towers (13)
Vacuum Producing Systems (14)
Flares and Blowdown Systems (15)
Other Refining Processes (16)

EMISSIONS

Introduction

Petroleum refining involves changing crude oil into useful petroleum products such as fuel gas, lube oil, and grease. A vast array of equipment and processes are used to refine crude oil, and the emissions that are generated from them make up the petroleum refining emissions categories. Emissions reported here are from general refining processes and devices. They do not include emissions from refinery fugitives, storage, and combustion devices (other than flares and blow down systems) which are accounted in other categories of the emission inventory.

Category 10 includes main refining processes that involve chemical reactions, such as but not limited to cracking, polymerization, and reforming. Significant amounts of nitrogen oxide (NOx), sulfur oxide (SOx), carbon monoxide (CO), and particulate (PM) emissions are produced during catalytic cracking and coking operations.

Category 11 includes all permitted refinery oil/water separation equipment and fugitive emissions from process drains. This category also contains units such as clarifiers and dissolved air flotation systems.

Category 12 accounts for emissions from treatment of wastewater at oil refineries.

Category 13 contains emissions from cooling systems. Emissions from cooling towers consist of fugitive VOC's and dissolved gases (such as hydrogen sulfide and ammonia) which are leaked through heat exchangers into cooling water. The contaminants are then vaporized into the atmosphere at the cooling tower.

Category 14 includes emissions from vacuum producing systems. Vacuum systems are used primarily to distill heavy crude residues which cannot be distilled at atmospheric pressure.

Category 15 accounts for all refinery process gas (combustion) emissions from flares and blow down systems. Refinery flares can emit large quantities of organics, sulfur dioxide and carbon monoxide as well as greenhouse gases.

Category 16 includes emissions from all other refinery processes not covered in category 15. Emissions of organic compounds and greenhouse gases from storage tanks, sulfur recovery units, and combustion processes are shown in sections 6.1.1, 3.4.1, and 7.10.1 respectively. The processes in this category include distillation, hydrogen manufacturing

plants, fuel blending. Coke loading and storage facilities account for most of the particulate emissions in this category.

Methodologies

Emissions for these categories are obtained from point source data in the District's record keeping system (Data Bank). Emissions are updated annually, on a source-by-source basis, using the following inputs:

1. Process material throughputs as reported by the refineries (this data is routinely updated)

2. Emissions factors (these may be source specific as reported by refineries or general factors, i.e. from the EPA)

3. Emissions control factors (device-specific or general - these may be supplied by refineries also)

Emission information from numerous sources is grouped into the above mentioned categories. EPA's AP-42, Chapter 5 contains description of petroleum refining processes and emission factors. Criteria pollutants and greenhouse gas emissions, including carbon dioxide (CO_2), methane (CH4), and nitrous oxide (N2O), are produced during refining processes. Since refinery emissions are part of point sources, criteria pollutants as well as greenhouse gas data are obtained from the refinery plant as part of the Bay Area Air District permit renewal process.

The county fraction and monthly/daily factors are calculated based on data obtained from the Data Bank.

TRENDS

History

Historic emissions have generally varied with refinery throughputs. Past base year historical emissions include interchangeable emission reduction credit (IERC). IERC banking emissions are now inventoried separately under categories 298-301. Also, flare source emissions from categories 298 and 299 are now accounted for in category 15. Beginning in December 2003, flare emission monitoring control was implemented for all refineries in the Bay Area. Flare emissions are based upon these monitoring data.

Growth

Projected growth for all refinery related categories was taken from the California Energy Commission report on California's Petroleum Infrastructure (2007) that predicted California refiners expand distillation capacity to increase at a rate of approximately one percent per year. California refiners have recently added and will continue to add more process units to produce reformulated gasoline. However, no large increases in emissions are expected.

Future flare emissions are difficult to predict, since they are predicated on emergencies and the nature of emergencies which are unknown and unpredictable. However, with the recent passage of refinery flare monitoring and flare minimization plan requirements,

flare emissions are expected to remain constant as long as there are no large upset in refinery processes that would warrant increase in flaring activities.

Control

Refinery emissions are regulated by the District. Regulation 6, 7, 8, and 9 regulate Particulate Matter, Odorous Substances, Organic Compounds, and Inorganic Gaseous Pollutants respectably.

Regulation 12, Rule 11 and 12 pertain to flare monitoring and flare minimization plan at Petroleum Refineries. The rule does not mandate reductions. District staff has found that because refiners have looked more closely both at monitoring and the feasibility of flaring reductions, flaring activities at the five Bay Area refineries have dropped dramatically over the past years. The result has been a significant emission reduction that cannot be directly attributed to this rule, but has and will ultimately be reflected in the emissions.

By: Tan Dinh
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Base Year: 2008

EMISSION INVENTORY

CATEGORIES #17-19

REFINERY FUGITIVE EMISSIONS

EMISSIONS

Introduction

Categories 17, 18, and 19 contain refinery fugitive emissions from sealed equipment. These emissions are treated as point sources and are unique to each refinery. Emissions occur from process equipment whenever components such as valves, flanges, pumps, compressors, and pressure relief valves (PRVs) leak due to seal failure. These emissions generally occur randomly and are difficult to predict.

Valve and flange leaks account for the bulk of total fugitive emissions while pressure relief valves account for the smallest amount of total fugitive emissions.

Methodologies

The petroleum refineries are periodically surveyed for the number of mechanical components utilized in an oil refining process. These components include valves, PRVs, pumps, and compressor seals. Individual types of components are summed up and emissions are calculated based on throughputs and specific emission factors.

Emission information from numerous sources is grouped into the above mentioned categories. EPA's AP-42, Chapter 5 contains description of petroleum refining processes and emission factors. Criteria pollutant, mainly total organic compounds, and greenhouse gas emissions, including carbon dioxide (CO_2), methane (CH4), and nitrous oxide (N2O) are produced during refining processes. Since refinery emissions are part of point sources, criteria pollutants as well as greenhouse gas data are obtained from the refinery plant as part of the Bay Area Air District annual permit renewal process.

The county, month, and day factors are obtained from information collected in the District’s data bank. Information such as plant's location, seasonal usage, and days per week of operation are also stored in the data bank.

TRENDS

History

Historical changes in fugitive emissions in the Bay Area have been due to installation of newer process units that supplement rather than replace old process units.

Growth

It is expected that fugitive emissions will not increase significantly in future after new units are built to produce reformulated gasoline.

Control

The District adopted control regulations in 1980 for valves and flanges, pump and compressor seals and PRVs. This marked the first step in the control of fugitive emissions. Control for valves vary widely, gas PRVs are 95% controlled, while heavy liquid valves have negligible control. Most common and significant emission sources are the light liquid service valves, and they are controlled by 65 to 72%.

In 1997 and 1998, the District combined the three previous regulations 8-18, 8-25, and 8-28, into a single regulation, Equipment Leaks, # 8-18. Regulation 8-25 was deleted. Regulation 8-28 was changed to focus on episodic emissions from the normal operation of pressure relief valves.

During this change the leak standard for only the pressure relief valves was reduced from 10,000 parts per million (ppm) to 500 ppm of total organic compounds. In addition, applicability of the new Regulation 8-18 was broadened to include all leaking equipment, not just valves, flanges, and other equipment specifically listed in the earlier regulation. The following table summarizes the limits.

			Limit Standards (ppm)			
Cat #	*Sources*	*Regulation*	*Pre-'93*	*1/1/93*	*1/1/97*	*1/7/98*
17	Valves & Flanges	8-18	10,000	500	100	100
18	Pump & Comp. Seals	8-25	10,000	1,000	500	500
19	PRV's	8-28	10,000	10,000	10,000	500

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EMISSION INVENTORY

CATEGORY # 20

REFINERY PROCESS VESSEL DEPRESSURIZATION

EMISSIONS

Introduction

Emissions for this category are generated from depressurization of process vessels at petroleum refineries. Generally a standard procedure requires repeated purging of the process vessel with inert gasses to reduce the concentration of organic vapors to below 300 PPM, before venting a vessel to the atmosphere.

Methodology

These emissions are from point sources data reported annually. The District updates the data each year on a source-by-source basis using as input:

1. Process material throughputs as reported annually by the refineries.
2. Emissions factors (these may be source specific factors reported by the companies through source test results or applicable general factors, i.e. from the EPA).
3. Emissions control factors (device-specific or general - these may be supplied by the companies also).

Greenhouse gas emission factors are also provided by the individual refineries and/or taken from EPA. Emissions for greenhouse gases including CO2, CH4, and N2O are reported by the refinery during the District's annual permit renewal process.

The county, month, and day factors are obtained from the data bank's information on each plant's location, seasonal usage, and days per week of operation.

TRENDS

History

Emissions for category 20 have been relatively insignificant for last few years, at less than 5 pounds per day for the entire region.

Growth

Projected growth for this category is based on the throughput of marine operations.

Control

The District adopted Regulation 8, Rule 10 on July 20, 1983. Overall control afforded by this rule is estimated to be 95%.

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SECTION 3

CHEMICAL MANUFACTURING FACILITIES

EMISSION INVENTORY

CATEGORY # 23

COATINGS AND INKS MANUFACTURING

EMISSIONS

Introduction

Organic solvent evaporation from the manufacture of coatings and inks is reported in this category. Coatings manufacturer is a facility that mixes, blends, or compounds paints, varnishes, lacquers, enamels, shellac, or sealers from raw materials. Ink manufacturer is a facility that mixes, blends or compounds printing inks from raw materials. Printing inks consist of pigments, which produce the desired colors, binders which lock the pigment to the substrate, and solvents, usually organic compounds that dissolve the pigments and binders. A majority of the emissions come from mixing and cleaning operations. Throughput information of each source is reported by the facilities and is stored in the District's Data Bank system.

Methodology

Organic emissions are calculated by using data on the reported throughput, the specific materials (i.e. density, percent VOC in coatings, etc.) as supplied by the companies through the District "S" and "G" forms. The District updates the data each year on a source-by-source basis using as input:

1. Process material throughputs as reported annually by the chemical manufacturing companies.

2. Emissions factors (these may be source specific factors reported by the companies through source test results or applicable general factors, i.e. from the EPA).

3. Emissions control factors (device-specific or general - these may be supplied by the companies also).

The county, month, and day factors are obtained from the data bank's information on each plant's location, seasonal usage, and days per week of operation.

Monthly Variation

Monthly distribution was estimated based on major coatings and inks manufacturer's reported quarterly percent throughput. An attempt was made to weight-average into monthly factor, with March through August being the high season and November and December being the lowest.

County Distribution

The county location of each company as reported in the Data Bank is used to distribute emissions into each county.

TRENDS

History

Emissions have been generally increasing due to increasing demand on coatings and inks, which has been about 4 to 8 percent per year in the 1980's. District Regulation 8, Rule 35, pertaining to emissions control from mixing operations at coating and ink facilities was adopted in May 1984. Since the adoption of the regulation, there have been significant changes in the manufacturing process. It was estimated there was a 55% emission reduction due to the implementation of the regulation.

Growth

Projections to year 2030 was based on growth profile of ARB's Manufacturing in the Printing Industry, and is expected to grow at a only 1-2 percent per year in the next few years.

Control

Regulation 8, Rule 35 was amended effective January 1993, eliminating the exemptions from small users, requiring lids on all portable and stationary mixing vats, and other cleaning provisions. Control effectiveness of the amended regulation has resulted in an 84% emission reduction since 1993.

By: Tan Dinh
Date: December 2010
Base Year: 2008

EMISSION INVENTORY

CATEGORY # 24

RESINS MANUFACTURING

EMISSIONS

Introduction

Emissions reported in this category are from operations performed at resin manufacturing facilities. Resin is a semi-solid, water insoluble organic material with little or no tendency to crystallize under standard temperature and atmospheric conditions. Resins are the basic components of plastics and other surface coating formulations. Equipment used in the operations and manufacturing of resins include resin reactor vessels and thinning/blending tanks. The manufacturing of resins produces mostly organic emissions.

Methodology

Organic emissions are calculated based on throughput data, material description (i.e. density, percent VOC in coatings, etc.) as reported by the companies via the Bay Area Air District's "S" and "G" air permit forms. The District obtain each year, as necessary, updates for the data during the permit renewal process. The data is gathered on a source-by-source basis using the following criteria as input:

1. Process material throughputs as reported annually by the chemical manufacturing companies.

2. Emissions factors (these may be source specific factors reported by the companies through source test results or applicable general factors, i.e. from the EPA).

3. Emissions control factors (device-specific or general - these may be supplied by the companies also).

In addition to criteria pollutants, greenhouse gases are also produced in the manufacturing of resins. The emissions factors are supplied by the plants and/or taken from EPA.

The monthly distribution is estimated based on data from the company's reported quarterly seasonal percent throughput. The county location of each company as reported in the District's record keeping system (Data Bank) is used to distribute emissions into each county.

TRENDS

History

Emissions have increased due to increasing demand from related industries, such as plastics and coating manufacturers. District Regulation 8, Rule 36, limiting emissions from resin manufacturing operations was adopted in June 1984.

Growth

Projections to year 2030 were based on growth profile of ARB's Chemical Manufacturing which is expected to grow at about 2-3 percent per year for the next few years.

Control

It is estimated that the District achieved a 52% reduction in organic emissions due to the implementation of Regulation 8, Rule 36.

By: Tan Dinh
Date: December 2010
Base Year: 2008

EMISSION INVENTORY

CATEGORY # 25

PHARMACEUTICALS & COSMETICS

EMISSIONS

Introduction

Emissions in this category are from the pharmaceuticals and cosmetics industry. Pharmaceuticals manufacturing plants are those producing or blending chemicals for use in pharmaceutical products. These consist of the manufacture, packaging, and sales of chemicals used as medication for humans and animals. Sources of emissions at pharmaceutical plants may come from batch process equipment, such as reactors, distillation units, extractors, centrifuges, filters, crystallizers, dryers, and storage and transfer.

Several different products are manufactured at Cosmetics products facilities. Organic chemicals are used as raw materials and solvents; such as ethanol, acetone, isopropanol, etc. are used. Solvent is recovered where convenient, and as a means of cost effectiveness. Emissions from these operations are almost entirely non-methane organic solvents.

There is a wide variety of products manufactured from these two industries, which may also include non-pharmaceuticals for preventive medicine and health-enhancement, medicated and non-medicated cosmetics, and food additives.

Methodology

The amount of solvent usage from the pharmaceutical manufacturers was estimated based on the U.S. Dept. of Commerce "Current Industrial Reports", and the "Census of Manufacturers". It was assumed solvent usage from the cosmetics industry was included from this estimate. Using one dollar per gallon of alcohol, the dollar estimate was converted to gallons. This amount was projected for Bay Area use with an annual growth rate of 2.6 % from 1993. It was assumed this is the total solvent usage by the pharmaceutical and cosmetics industries. The average solvent density was assumed to be 6.6 lbs./gal.

The District data bank reported point sources from several pharmaceutical companies. Throughput and other data information of each source are reported by the facilities. Emissions are calculated by using these data through the District "S" and "G" forms.

It is assumed there are also a number of other smaller pharmaceutical and cosmetics manufacturers, known as area sources, not included in the District data bank system. Subtracting the total solvent usage estimate from the point source usage yields an area

source solvent usage. An uncontrolled emission factor of 330 lbs./1000 gallons is based on a 5% loss of the usage.

District Regulation 8, Rule 24, limiting organic compounds emissions from various pharmaceutical and cosmetics manufacturing operation took effect in July 1984 with an estimated 42% overall control.

Monthly Variation

Monthly distribution was assumed to be uniform.

County Distribution

The ratio of each County's population was used to distribute emission into counties.

TRENDS

History

Emissions through the years were estimated by using the estimated solvent usage by the industry.

Growth

Emissions through the year 2030 are projected according to estimated growth prediction of pharmaceutical and cosmetic products industry. Approximately 0.8% per year of growth is expected in the next few years.

Control

Efforts are being made to streamline and standardize rules and regulations. Any subsequent refinement in Regulation 8, Rule 24 due to this streamlining should not have any effect on the controls, and therefore the controls for this rule will remain at 42%.

By: Tan Dinh
Date: December 2010
Base Year: 2008

EMISSION INVENTORY

CATEGORIES #21, #22, #26, #27

ALL OTHER CHEMICAL PLANT EMISSIONS
Sulfur and Sulfuric Acid Manufacturing Facilities (#21, #22)
All Other Chemical Plants Point Source Emissions (#26)
Fugitive Emissions at Chemical Plants (#27)

EMISSIONS

Introduction

Category 21 contains emissions from sulfur recovery units and sulfur storage at refineries and chemical plants. Category 22 contains emissions from sulfuric acid storage tanks at refineries and chemical plants. The emissions of concern from these categories are sulfur dioxide. Abatement devices to treat sulfur recovery units' tail gas and sulfur dioxide scrubbers at sulfuric acid manufacturing plants have significantly reduced the amount of sulfur dioxide emitted. The emissions data shows that without the District's controls, 150 tons per day of sulfur dioxide would have been emitted in to the atmosphere instead of approximately 3 tons per day.

Category 26 contains all other chemical plant point source emissions. Some of these sources include acid manufacturing plants, kiln burners, and specialty chemicals manufacturing plants. Emissions caused by the combustion of fuels at chemical plants are not accounted for in this category.

Category 27 contains fugitive emissions at chemical plants. Components such as valves, flanges, pumps, compressors, and pressure relief valves (PRVs) are potential sources that can leak due to seal failure. These emissions generally occur randomly and are difficult to predict. In addition, these emissions may be intermittent and vary in intensity over time. According to EPA report (EPA-625/10-84-004, Dec. 1984) 35% of the total emissions at the chemical manufacturing facilities are emitted as fugitive emissions.

Methodologies

These categories contain both point and area source emissions from chemical plants in the District. Most of the emissions (point sources) from chemical plants are accounted for through our permitting processes, however, Category 27 fugitive emissions (area sources) are not. Fugitive emissions for Category 27 were taken as 35% of the total organic emissions at the chemical manufacturing facilities (Categories 21 through 26) within the District. The number of equipment components was used as throughput.

Emissions for Categories 21, 22, and 26 were obtained from point source data only, as contained in the District's data bank. The District updates the data each year on a source-by-source basis using as input:

1. Process material throughputs as reported annually by the chemical manufacturing companies.

2. Emissions factors (these may be source specific factors reported by the companies through source test results or applicable general factors, i.e. from the EPA).

3. Emissions control factors (device-specific or general - these may be supplied by the companies also).

Criteria pollutants and greenhouse gas emissions, including carbon dioxide (CO_2), methane (CH4), and nitrous oxide (N2O), are produced in the chemical plant processes. Since these emissions are part of point sources, criteria pollutants as well as greenhouse gas data are obtained from the plant as part of the Bay Area Air District permit renewal process.

Monthly Variation and County Distribution

The county, month, and day factors are obtained from the data bank's information on each plant's location, seasonal usage, and days per week of operation.

TRENDS

History

In general, emissions increase as throughputs increase. In addition to usage changes, new installations also increase the emissions. Overall emissions for these categories did not significantly increase in last eight years.

Growth

The projected growths in these categories are taken from expected growth in manufacturing employment over the region to the year 2030. The employment data was obtained from the Association of Bay Area Government's (ABAG) 2009 "Projections" reports.

Control

The District adopted Regulation 8, Rule 22 on March 5, 1980. The control afforded by this rule is estimated to be 60%, with rule effectiveness at 98% for an overall control rate of 59%. This rule only affects fugitive emissions at chemical manufacturing facilities.

Regulation 9 also controls non-organic emissions from many of the manufacturing plants in these categories. For example, the District amended Regulation 9, Rule 1 in 1983, 1992, and 1995 for sulfur dioxide limits at sulfur recovery systems and sulfuric acid plants. Regulation 9 also sets limits on hydrogen sulfide, nitrogen oxides, and carbon monoxide emissions.

By: Tan Dinh
Date: December 2010
Base Year: 2008

SECTION 4

OTHER INDUSTRIAL AND COMMERCIAL PROCESSES

EMISSION INVENTORY

CATEGORIES # 28 & 935

LARGE AND SMALL BAKERIES

EMISSIONS

Introduction

Emissions from these categories are from large commercial bakeries as well as smaller bakeries. Bread is produced either by sponge-dough process, brews (or liquid sponges) process, or straight-dough process. Commercial bakeries more often use the sponge-dough process, where ingredients are initially mixed, bread dough fermented from 3 to 5 hours, and then baked in ovens at about 450 °F. Bakery products such as sweet rolls, crackers, pretzels, cakes, cookies, doughnuts, biscuits, etc. are either leavened by yeast or by baking powder. Yeast metabolizes the sugars and starches in the dough during fermentation process. The end product of this chemical reaction is primarily carbon dioxide and ethanol (TOG).

The major criteria pollutant emitted from bread baking is primarily ethanol, which is a by-product of the leavening process. Emissions of combustion products from the burning of fuel in the ovens stacks are not considered in this category. Carbon dioxide (CO_2) is calculated from the combustion of the ethanol from the bread in an abatement device such as an afterburner. The abatement devices are used on the larger (point source) ovens. There is no CO_2 emission data from the fermentation process available at this time.

Methodologies

Throughput information from large bakeries are reported and stored in the District's Data Bank system. Source tests, which are conducted at various times, provide the data for criteria pollutant emission factors. (During the rulemaking process in the late 1980's, fifteen ovens from six large bakeries in the Bay Area were source tested by the District. Ethanol (TOG) emissions ranged from 0.3 to 7.0 pounds per thousand pounds bread produced, depending on the oven size, operating temperature, and type of product.) As mentioned above, CO_2 emissions are estimated from the combustion of ethanol from the bread in an abatement device. Emissions from these larger bakeries are called point sources (Category #28).

There are numerous smaller bakeries in the Bay Area, which are not in the Data Bank system. These bakeries use smaller ovens. Source test results showed an emission factor of 5.4 pounds ethanol per ton of bread produced. Emissions from these smaller bakeries are called area sources (Category #935).

Throughput data for small bakeries was based on a survey regarding the large bakeries. Small bakeries showed an approximately 37% share of the total bread market. The 2008

average daily throughput from smaller bakeries was calculated to be about 84,233 tons/year. TOG emissions from small bakeries were 1,246 pounds/day (0.62 ton per day).

Small Bakeries (Area Sources):

TOG Emission = throughput X emission factor

TOG Emission = 84,233 tons bread/yr. X 5.4 lbs./ton bread / 365 days/year
= 1,246 lbs./day, or 0.62 ton/day
(uncontrolled organic emission)

Monthly Variation

For large bakeries, monthly distribution was based on each company's reported quarterly seasonal percent throughput data. For small bakeries (area sources), monthly distribution was based on a 1990 production of a large bakery, which is assumed to be typical.

County Distribution

The county locations and associated emissions of each of the large bakeries were used to distribute countywide emissions. For small bakeries, the number of employees in the large bakeries was subtracted from the total number of employees in each county's bakeries. This data was found in the U.S Census Department's 2007 County Business Patterns.

TRENDS

History

Historical emissions were estimated using actual throughputs and the Association of Bay Area Government's (ABAG's) 2009 Manufacturing and Wholesale Employment growth profile. District Regulation 8, Rule 42 set standards for new and modified bakery ovens on large commercial bakeries effective January of 1989.

Growth

Emissions projections to 2030 were also based on ABAG's 2009 Manufacturing and Wholesale Employment growth profile.

Control

District Regulation 8, Rule 42 was amended requiring control equipment for existing ovens, which commenced operation prior to January 1989. This became effective

beginning January 1992. Currently, there is an estimated 77% overall control (for large bakeries) on TOG emissions because of this rule.

By: Stuart Schultz
Date: January 2011
Base Year 2008

EIC Code: 42041260120000

EMISSION INVENTORY

CATEGORIES # 29, 1710, & 1711

OTHER INDUSTRIAL/COMMERCIAL PROCESSES, COOKING CHARBROILING, DEEP FAT FRYING, AND UNSPECIFIED (GRIDDLES)

EMISSIONS

Introduction

This category includes particulate and volatile organic compound (VOC) emissions from the preparation of food for human consumption at eating establishments. Carbon dioxide (CO_2), a greenhouse gas, is also emitted from cooking process in these three categories. Restaurant equipment that contributes to these emissions includes charbroilers (Category 29), deep fat fryers (Category 1710) and griddles (Category 1711). Charbroilers can either be conveyorized or under-fire; both types generally use natural gas, however, under-fire charbroilers may use solid fuels, such as charcoal or wood. Deep-fat fryers may be either gas-fired or electric to heat the cooking oil used to cook the food. Griddles use an exposed metal plate, heated by either gas or electricity, to cook the food.

These categories do not include the products of combustion emissions from fuel usage (i.e. natural gas or solid fuels) at these establishments. Those emissions can be found in Categories 307, 1590, or 312.

Methodology

The District estimated the number of restaurants in operation in the Bay Area with assistance from each county's health department. Each county health department provided the number of restaurants permitted within their jurisdiction. The District refined the number of restaurants by eliminating the ones not open to the public, gone out of business, or those that are less likely to cook, such as delicatessens and ice cream parlors. In 2008, it was estimated there were 15,500 restaurants within the District's borders.

The District used a 1997 South Coast Air Quality Management District (SCAQMD) report, "Staff Recommendations Regarding Controlling Emissions from Restaurant Operations", to estimate the number of charbroilers, deep fat fryers, and griddles used in the Bay Area. The SCAQMD report surveyed the type of equipment that was used in restaurant cooking operations in their district boundaries. This report found approximately 33% of the restaurants operate under-fired charbroilers, 4% operate chain-driven charbroilers, 62% operate deep fat fryers, and 52% operate griddles. Based on these percentages, the District estimates approximately 5,115 restaurants operate under-fired charbroilers, 620 operate chain-driven charbroilers, 9,610 operate deep fat fryers, and 8,060 operate griddles.

The average amount of food cooked on each type of appliance was developed for the California Air Resources Board by the Public Research Institute. Table 1 of the attachments lists the estimated amount of food (meat or fries) cooked per restaurant in a given year. Emission factors, developed by the University of California at Riverside and the University of Minnesota, were used to quantify the emissions each type of food cooked on charbroilers, deep fat fryers, and griddles. Total District throughputs for each type of food for each device were calculated by multiplying the amount of food cooked by the number of restaurants with that particular cooking device. Emissions were calculated by multiplying the emission factor by the throughput. The emission factors, throughputs and emissions of TOG, PM, and CO_2 by type of appliance are found in Tables 2, 3 and 4 of the attachments.[1] Table 5 lists the TOG, PM, Condensable Vapor, and CO_2 emissions for each category.

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Monthly Variation

Monthly distribution was estimated based on seasonal variation of each establishment, which is a higher sale during summer months due to longer daylight hours and warmer weather.

County Distribution

The number of eating establishments in each county was based on data provided by each of the Bay Area's county health department. The District refined these numbers of restaurants by eliminating the ones not open to the public, gone out of business, or those that were less likely to cook.

TRENDS

History

Emissions back to 1996 were estimated based on historical number of eating establishments in the Bay Area as reported in the "Taxable Sales in California (Sales & Use Tax) publications. Prior to 1996 the emissions were based on ABAG's 2009 Total Population growth profile.

Growth

Projections to year 2030 were based on ABAG's 2009 Total Population growth profile.

[1] Note TOG is considered all reactive for these three categories. In this case TOG equals ROG. The PM emissions are particulate matter less than 10 microns in size (PM_{10}) since it is assumed all particles larger than 10 microns are captured before the outside exhaust. A portion of these PM_{10} emissions are in the form of condensable vapors. Condensable are vapors in the gaseous form at entry into the ventilation hood, but may condense into particulate form (i.e. liquid or solid state) in the duct works, as it exits the exhaust fan, or in the atmosphere. The particulate emissions calculated here include condensable vapors; however, because these vapors behave as gases, they cannot be removed through mechanical infiltration.

Control

On December 7, 2007, the District adopted Regulation 6, Rule 8, Commercial Cooking Equipment, to reduce particulate and VOC emissions from commercial cooking equipment. Effective January 1, 2009, chain-driven charbroilers that cook at least 400 pounds of beef per week are required to operate with a certified catalytic oxidizer. Effective January 1, 2010, any newly installed under-fired charbroiler that has a grill surface area of at least 10 square feet and cooks at least 800 pounds of beef per week will be required to install a control device to reduce PM_{10} emissions to no more than 1 pound of PM_{10} per 1000 pounds of beef cooked. Effective January 1, 2013, any existing restaurant having an under-fired charbroiler that has a grill surface area of at least 10 square feet and cooks at least 800 pounds of beef per week will be required to install a control device to reduce PM_{10} emissions by the same amount.

By: Stuart Schultz
Date: January 2011
Base Year 2008

EIC Code: 69068060000000 (Category 29)
69068260000000 (Category 1710)
69068460000000 (Category 1711)

Table 1--Estimated Amount of Food Cooked Per Year Per Restaurant (1000 lbs/yr) in the BAAQMD[1]

Type of Food	Category 29 Conveyorized Broiler (1000 lbs/year)	Category 29 Under-Fired Broiler (1000 lbs/year)	Category 1710 Deep Fat Fryer (1000 lbs/year)	Category 1711 Griddle (Unspecified) (1000 lbs/year)
Hamburger	41.486	14.049	14.271	18.838
Steak	12.281	9.363	9.436	8.633
Poultry w/Skin	7.651	7.485	18.955	4.574
Poultry w/o Skin	13.842	9.311	10.804	5.768
Pork	2.997	7.699	3.045	5.810
Seafood	6.179	7.416	8.252	4.791
Fries	0.000	0.000	14.248	0.000
Total	84.436	55.323	79.010	48.415

[1] Study conducted by the Public Research Institute (PRI)

Throughput, Emission Factor, & Emissions Calculations

Table 2--Under-Fired Broiler (CAT29)

Composite EF Calculation

Type of Food	Emission Factors (lbs/1000 lbs food cooked)				Throughput[3]	PM Emissions[1]		Condensable Vapors[2]		TOG Emissions[4]		CO_2 Emissions	
	PM[1]	Condensable Vapors[2]	TOG[4]	CO_2	(1000 lbs/year)	(tons/yr)	(tons/day)	(tons/yr)	(tons/day)	(tons/yr)	(tons/day)	(tons/yr)	(tons/day)
Hamburger	9.5	19	3.94	750	71,860.635	341.338	0.935	682.676	1.870	141.565	0.388	26,948	73.829
Steak	9.5	19	3.94	750	47,891.745	227.486	0.623	454.972	1.246	94.347	0.258	17,959	49.204
Poultry w/Skin	2	9.5	1.82	475	38,285.775	38.286	0.105	181.857	0.498	34.840	0.095	9,093	24.912
Poultry w/o Skin	2	9.5	1.82	475	47,625.765	47.626	0.130	226.222	0.620	43.339	0.119	11,311	30.989
Pork	2	9.5	1.82	475	39,380.385	39.380	0.108	187.057	0.512	35.836	0.098	9,353	25.624
Seafood	3.3	0	0.38	475	37,932.840	62.589	0.171	0.000	0.000	7.207	0.020	9,009	24.682
Total	5.348	12.247	2.524	591.377	282,977.145	756.705	2.073	1,732.784	4.747	357.135	0.978	83,673	229.241

[1] emissions considered to be all PM-10 or lower; all particulates > 10 microns assumed to be captured before outside exhaust

[2] Condensable Vapors considered PM-10, or lower, emissions

[3] It is assumed ther are 5,115 under-fired broilers in the BAAQMD in 2008

[4] The term ROG & VOC are used interchangeably; ROG factor = 1, so ROG = TOG

Table 2--Chain-Driven Broiler (CAT29)

Composite EF Calculation

Type of Food	Emission Factors (lbs/1000 lbs food cooked)			Throughput[3]	PM Emissions[1]		TOG Emissions[2]		CO_2 Emissions	
	PM[1]	TOG[2]	(Lbs/1000 lbs. Cooked	(1000 lbs/year)	(tons/yr)	(tons/day)	(tons/yr)	(tons/day)	(tons/yr)	(tons/day)
Hamburger	7.42	2.27	750	25,721.320	95.426	0.261	29.194	0.080	9,645	26.426
Steak	7.42	2.27	750	7,614.220	28.249	0.077	8.642	0.024	2,855	7.823
Poultry w/Skin	1.56	1.05	475	4,743.620	3.705	0.010	2.487	0.007	1,127	3.087
Poultry w/o Skin	1.56	1.05	475	8,582.040	6.703	0.018	4.499	0.012	2,038	5.584
Pork	1.56	1.05	475	1,858.140	1.451	0.004	0.974	0.003	441	1.209
Seafood	2.58	0.22	475	3,830.980	4.937	0.014	0.419	0.001	910	2.493
Total	5.367	1.766	650.114	52,350.320	140.471	0.385	46.216	0.127	17,017	46.621

[1] emissions considered to be all PM-10 or lower; all particulates > 10 microns assumed to be captured before outside exhaust. Emission Factor already has Condensable Vapors calculated in; EF's for poultry, pork, & seafood was modified based on data ratios from underfired broilers.

[2] The term ROG & VOC are used interchangeably; ROG factor = 1, so ROG = TOG

[3] It is assumed ther are 620 chain-driven broilers in the BAAQMD in 2008.

Total throughput (under-fired & chain-driven broilers), 1000 lbs/yr: **335,327.465**

Composite PM-10 emission factor for broilers, lbs/1000 lb food cooked, including Condensable Vapors from both Chain-Driven & Under-Fired Broilers: **15.6859**

CompositeTOG emission factor for broilers, lbs/1000 lb food cooked: (assume a ROG Factor of 1) **2.4057**

Composite CO_2 emission factor for broilers, lbs/1000 lb food cooked: **600.5465**

Table 3--Deep Fat Fryer (CAT1710)

Type of Food	Emission Factors (lbs/1000 lbs food cooked)				Throughput[4]	PM-10 Emissions[1]		Condensable Vapors[2]		TOG (ROG) Emissions[4]		CO_2 Emissions	
	PM[1]	Condensable Vapors[2]	TOG[3]	CO_2 Emission Factor	(1000 lbs/year)	(tons/yr)	(tons/day)	(tons/yr)	(tons/day)	(tons/yr)	(tons/day)	(tons/yr)	(tons/day)
Hamburger	0.1	3	0	47	137,143.157	6.857	0.019	205.715	0.564	0.000	0.000	3,223	8.830
Steak	0.1	3	0	47	90,679.191	4.534	0.012	136.019	0.373	0.000	0.000	2,131	5.838
Poultry w/Skin	0.1	3	0.12	47	182,157.934	9.108	0.025	273.237	0.749	10.929	0.030	4,281	11.728
Poultry w/o Skin	0.1	3	0.12	47	103,821.827	5.191	0.014	155.733	0.427	6.229	0.017	2,440	6.684
Pork	0.1	3	0.12	47	29,258.606	1.463	0.004	43.888	0.120	1.756	0.005	688	1.884
Seafood	0.1	3	0.14	47	79,300.567	3.965	0.011	118.951	0.326	5.551	0.015	1,864	5.106
fries	0.1	3	0.21	47	136,923.280	6.846	0.019	205.385	0.563	14.377	0.039	3,218	8.816
Total	0.100	3.000	0.1023	47.000	759,284.562	37.964	0.104	1,138.927	3.120	38.842	0.106	17,843	48.885

[1] emissions considered to be all PM-10 or lower; all particulates > 10 microns assumed to be captured before outside exhaust

[2] Condensable Vapors considered PM-10, or lower, emissions

[3] The term ROG & VOC are used interchangeably; ROG factor = 1, so ROG = TOG

[4] It is assumed ther are 9,610 deep fat fryers in the BAAQMD in 2008

Total throughput, 1000 lbs/yr: **759,284.562**

Composite PM-10 emission factor for deep-fat fryers, lbs/1000 lb food cooked, including Condensable Vapors from deep-fat fryers: **3.100**

Composite TOG emission factor for deep-fat fryers, lbs/1000 lb food cooked: **0.102**

Composite CO_2 emission factor for deep fat fryers, lbs/1000 lb food cooked: **47.000**

Table 4--Flat Top Griddles (Unspecified) (CAT 1711)

Type of Food	Emission Factors (lbs/1000 lbs food cooked)				Throughput[4]	PM Emissions[1]		Condensable Vapors[2]		TOG (ROG) Emissions[3]		CO_2 Emissions	
	PM[1]	Condensable Vapors[2]	TOG[3]	CO_2	(1000 lbs/year)	(tons/yr)	(tons/day)	(tons/yr)	(tons/day)	(tons/yr)	(tons/day)	(tons/yr)	(tons/day)
Hamburger	1.3	6	0.07	174	151,834.602	98.692	0.270	455.504	1.248	5.314	0.015	13,210	36.191
Steak	1.3	6	0.07	174	69,582.302	45.228	0.124	208.747	0.572	2.435	0.007	6,054	16.585
Poultry w/Skin	1.3	6	0.4	174	36,869.986	23.965	0.066	110.610	0.303	7.374	0.020	3,208	8.788
Poultry w/o Skin	1.3	6	0.4	174	46,492.982	30.220	0.083	139.479	0.382	9.299	0.025	4,045	11.082
Pork	1.3	6	0.4	174	46,828.278	30.438	0.083	140.485	0.385	9.366	0.026	4,074	11.162
Seafood	1.3	6	0.4	174	38,617.717	25.102	0.069	115.853	0.317	7.724	0.021	3,360	9.205
Total	1.300	6.000	0.2128	174.000	390,225.867	253.647	0.695	1,170.678	3.207	41.511	0.114	33,950	93.013

[1] emissions considered to be all PM-10 or lower; all particulates > 10 microns assumed to be captured before outside exhaust

[2] Condensable Vapors considered PM-10, or lower, emissions

[3] The term ROG & VOC are used interchangeably; ROG factor = 1, so ROG = TOG

[4] It is assumed ther are 8,060 flat to griddles in the BAAQMD in 2008

Total throughput, 1000 lbs/yr: **390,225.867**

Composite PM-10 emission factor for flat top griddles, lbs/1000 lb food cooked, including Condensable Vapors from deep-fat fryers: **7.300**

CompositeTOG emission factor for flat top griddles, lbs/1000 lb food cooked: **0.2128**

Composite CO_2 emission factor for flat top griddles, lbs/1000 lb food cooked: **174.000**

Table 5--Total Emissions

Category Number	Cooking Device	Emissions (tons/day)				
		PM-10	Condensable Vapors (CV)	PM-10 & CV	TOG (ROG)[2]	CO_2
29	Under-Fired Broiler	2.073	4.747	6.821	0.978	229.241
29	Chain-Driven Broiler[1]	0.385		0.385	0.127	46.621
1710	Deep Fat Fryer	0.104	3.120	3.224	0.106	48.885
1711	Griddles (Unspecified)	0.695	3.207	3.902	0.114	93.013
	Total	3.257	11.075	14.332	1.325	417.761

[1] PM-10 emissions include CV emissions

[2] ROG Factor = 1, so ROG = TOG

EMISSION INVENTORY

CATEGORY # 31

WINERIES - FERMENTATION

EMISSIONS

Introduction

This category accounts for the ethanol emissions resulting from the fermentation of grapes at wineries located in the Bay Area. During the fermentation process, sugar in the grape juice reacts with yeast to form ethanol (alcohol) and carbon dioxide (CO_2) gas. Ethanol is emitted into the atmosphere through evaporation. The amount of ethanol formation is dependent on tank design, length of fermentation period, fermentation temperature, and volume and sugar content of fermenting juice. Sugar content is measured as degrees Brix (grams sugar/100 ml. juice).

Methodology

Wine production in the Bay Area was estimated based on ARB's methodology and Wine Institute's Grape Crush report. Ethanol emission factors from the two types of wine (White and Red) were derived by the ARB from a computer model developed by Williams and Boulton. The ethanol emission factors per thousand gallons of wine produced for white wine, rose wine, and red wine are listed below:

- White wine: 2.5 lbs.
- Rose and Red wine: 6.2 lbs.

Using an estimated production of wine as: 41.5% white and 58.5% red wine, a composite emission factor of 4.7 lbs. per thousand gallon of wine produced was derived.

The carbon dioxide (CO_2) emission factor was derived from the chemical equation.

$$C_6H_{12}O_6 + \text{yeast} \rightarrow 2C_2H_5OH + 2CO_2$$

Assume that fifty percent of CO_2 emissions escaped to atmosphere during fermentation process, the CO_2 emission factor of 157.41 lbs. per thousands of gallons of wine was estimated. District's Regulations 3, adopted on May 21, 2008, defined the carbon dioxide (CO_2) emissions from wine fermentation processes was biogenic carbon dioxide emissions.

The total emissions for this category are determined by multiplying the emission factor and the wine production. This methodology is presently based on ARB's methodology (Section 5.1).

Year	Annual Average Emissions (Tons/day)	
	TOG	**CO_2**
2005	0.49	16.30
2008	**0.40**	**13.26**
2010	0.40	13.32
2015	0.40	13.47
2020	0.41	13.61

Monthly Variation

The ethanol emissions associated with wine fermentation occurs during the grape crushing season, which generally runs from mid-August through October.

County Distribution

County distribution was based on the amount of wine production in each county. Alameda, Contra Costa, Napa, Santa Clara, Solano, and Sonoma Counties were assumed to produce wine.

TRENDS

History

For emission inventory before 1982 Base Year, the throughput was obtained from the Wine Institute located in San Francisco. Since 1982 Base Year, the throughput has been obtained from the "Final Grape Crush Report" published by the California Department of Food and Agriculture. Although phylloxera bugs attack vine rootstock, the wine production in vineyards increased at moderate rate in 1996. ARB revised Winery methodology in September 2004 to reflect current wine production in California.

Growth

Past and future projection of emissions was based on the food manufacturing industries taken from ABAG's 2009 Projections report.

By: Michael Nguyen
Date: February, 2011
Base Year 2008

EIC: 42041260120000 (Cat#31)

EMISSION INVENTORY

CATEGORY # 32

WINERIES/BREWERIES - AGING

EMISSIONS

Introduction

This category consists of both area and point sources. The area source accounts for the ethanol emissions from aging of brandy. Brandy is produced from a distillation process, separating ethanol and other volatile substances from fermented juices. The brandy is then aged for a period of two to ten years. During the aging process, usually, in 50-gallon oak barrels, there is a considerable amount of ethanol emissions released from the barrels into the atmosphere. The point source portion accounts for organic emissions from brewery sources contained in the District's Data Bank.

Methodology

California Wine Institute reported that 44,487,000 gallons of Brandy were in storage in 1992. San Joaquin Valley District estimated 4,561,546 gallons of brandy in 2007. The 57,380 barrels of Brandy in Bay Area was estimated based upon the above reported data.

An emission factor for a 50-gallon Brandy barrel was derived by the Wine Institute. The assumption being: brandy is 120 proof (60% alcohol) on the average; and alcohol is lost during aging at a rate of 2.5% per year per barrel. This resulted in an emission factor of 4.96 lbs. ethanol per barrel of Brandy.

Emissions calculations from the aging of brandy consist of multiplying the emission factor with the amount of brandy barrels in storage in the District. The methodology is presently based on ARB's methodology (Section 5-2).

Emissions from point sources are calculated from operating data (throughput, emission factors, control factors, if any, etc.) submitted for each equipment as part of the permit process. This operating data is updated upon renewal of the permit.

Monthly Variation

Brandy is aged for a period of years, during which emissions are released 365 days per year and 24 hours per day.

County Distribution

County distribution is based on the number of 50-gallon brandy barrels in each county. Napa, Santa Clara, Solano, and Sonoma counties are assumed to produce or to store the 50-gallon brandy barrels.

TRENDS

History

From 1970 to 1987, estimated emissions were based on the summary report of the number of alcoholic production facilities in California published by U.S. Department of Census. The number of alcoholic production facilities had been reduced in Santa Clara County due to increasing new electronic manufacturers and housing development. However, grape production has increased since 1988; therefore, emissions were estimated to be at constant level during 1988-1990. In 1993, grape crush was down approximately 7 % from the 1992 crush, and 7 % less than the record-large 1982 crush of 3,115,531 tons. Emissions from 1993 to 1998 are assumed to be constant at the 1993 production level.

Growth

Future projection of emissions was based on the food manufacturing industries taken from ABAG's 2009 Projections report.

By: Michael Nguyen
Date: February, 2011
Base Year 2008

EIC Code: 42041260120000 (Cat#32)

EMISSION INVENTORY

CATEGORY # 33

OTHER FOOD & AGRICULTURAL PROCESSING

EMISSIONS

Introduction

The category includes emissions from processing plants of miscellaneous food and agricultural products for human or animal consumption such as: coffee and cocoa bean roasting; grain feed milling/packaging; spice/flavoring handling; sugar refinery; onion, garlic, corn, and pet food processing.

Methodology

This category consists only of point sources that are contained in the District Data Bank system. Individual companies report information on plant equipment, operating data, and source throughput. This information is updated upon permit renewal in the District's Data Bank. Criteria pollutant emissions calculated by using throughput data of the specific materials, emission factors based on various test data and publications, operating times, batch cycle variables, and control equipment reduction factors.

Carbon dioxide (CO_2) emissions are produced during the fermentation process of beer production and in the combustion of organic emissions from coffee and cocoa beans in abatement devices, such as an afterburner. The CO_2 emissions emitted from beer production is considered biogenic.

Monthly Variation

Monthly distribution was estimated to be the same throughout the year due to the variety of processing facilities.

County Distribution

The county location of each company as reported in the Data Bank is used to distribute emissions into each county.

TRENDS

History

The historical growth profile was based on a combination of prior emissions data (back to 1987) and the Association of Bay Area Government's (ABAG's) 2009 Manufacturing & Wholesale Employment data.

Growth

Projections of emissions to 2030 were based on ABAG's 2009 Manufacturing & Wholesale Employment data.

Control

Emissions through the years were estimated by using agricultural production data in the District. In 1963-1964 there was at least 50% reduction of particulate emissions from equipment such as coffee roaster and food dryers brought about by the District's Regulation 6 on visible emissions from the Ringlemann 2 standard. In 1970 there was at least an additional 25% reduction in particulates from the Ringlemann 1 standard. Currently, there is an estimated 98% overall control of particulates from this category.

By: Stuart Schultz
Date: January 2011
Base Year 2008

EIC Code: 42041860000000

EMISSION INVENTORY

CATEGORY # 34

METALLURGICAL

EMISSIONS

Introduction

Emissions associated with the production of ferrous and non-ferrous metals occur during the melting process performed in the various types of furnaces such as electric arc, cupola, crucible, and reverberatory. Point sources are defined as the various metallurgical furnaces and associated equipment, which are subject to District regulations and the permit system. Included may be some exempt sources for which permits are not required.

Methodology

This category contains emissions from point sources only. Emissions from point sources are calculated from operating data submitted for each equipment as part of the permit approval process. Parameters and variables include throughput, emission factors, operating times, batch cycle variables, and stack parameters. For control equipment, the weight percent reduction factors for each pollutant account for emission reduction. Throughput is updated upon permit renewal. The emissions for the point sources are contained in the permit data bank and the summation of the emissions provides the emissions for the category.

Monthly Variation

Monthly variation of emissions is assumed to vary in similar proportion to variation in manufacture and coating of miscellaneous metal parts.

County Distribution

The data bank system contains information on the county location of each processing plant; hence, emissions are distributed to the counties accordingly.

TRENDS

History

The historical growth profile was based on a combination of prior emissions data (back to 1987) and the Association of Bay Area Government's (ABAG's) 2009 Manufacturing Employment growth profile.

Growth

Projections of emissions to 2030 were based on ABAG's 2009 Manufacturing & Wholesale Employment growth profile.

Control

In 1963-1970, the particulate emissions were reduced due to the control imposed by Ringlemann requirements from Regulation 6. Additional particulate emissions reductions were caused from the shutdown of metallurgical manufacturing facilities. Currently, there is an estimated 97% overall control of particulates from this category.

By: Stuart Schultz
Date: January 2011
Base Year 2008

EIC Code: 44044070000000

EMISSION INVENTORY

CATEGORY # 35

WOOD PRODUCTS MANUFACTURING

EMISSIONS

Introduction

Emissions from this category include generation of small wood waste particles (sawdust) from woodworking operations such as sawing, planing, lathing, and sanding. Industries engaged on these operations include manufacturers of plywood, particleboard, hard board, and furniture.

Methodology

This category contains emissions from both point and area sources. Wood waste generated as particulate matter is removed from the wood working operations mainly for housekeeping purposes, by either a cyclone or a baghouse. The Data Bank contains throughput information submitted by individual plant by sources. Emissions are then calculated by using specific emission factors for a particular source operation supplied by the company. The point sources account for the majority of emissions from this category. It was estimated that area sources account for 20% of the total emissions from this category.

Monthly Variation

The emissions over the 12 months were estimated based on the throughput data from each plant.

County Distribution

Emissions are distributed to the counties based on the location of the processing plant. The District's data bank contains the information on plant location.

TRENDS

History

The historical growth profile was based on a combination of prior emissions data (back to 1990) and the Association of Bay Area Government's (ABAG's) 2009 Manufacturing Employment growth profile.

Growth

Projections of emissions to 2030 were based on ABAG's 2009 Manufacturing and Wholesale Employment growth profile.

By: Stuart Schultz
Date: January 2011
Base Year 2008

EIC Code: 45099502300000

EMISSION INVENTORY

CATEGORIES # 36, 1747, 1748, 1749, 1750

CEMENT MANUFACTURING (CAT. #36)
CEMENT PLANT COMBUSTION, COKE (CAT. # 1747)
CEMENT PLANT COMBUSTION, COAL (CAT. # 1748)
CEMENT PLANT COMBUSTION, NATURAL GAS (CAT. # 1749)
CEMENT PLANT COMBUSTION, OTHER (DIESEL) (CAT. # 1750)

EMISSIONS

Introduction

The primary criteria pollutant emission from cement manufacturing is particulate matter. Particulate matter at cement plants are generated during quarrying, crushing, grinding, blending, drying, transfer process, and storage of cement. The largest single source of emissions is the kiln. The cement industry generally uses mechanical collectors, electric precipitators, or baghouses to control emissions. The most desirable method of disposing of the dust collected by an emission control system is injection into kiln burning zone for inclusion in the clinker.

Various fuels are used in the kiln for the cement manufacturing process. These fuels include coke, coal, natural gas, and diesel. The emissions from these fuels are the five criteria pollutants, namely PM, organics, NO_x, SO_x, and CO.

Carbon Dioxide (CO_2), a greenhouse gas (GHG), is also produced during the cement manufacturing process. Carbon Dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) are the GHG's emitted during the combustion of the fuels.

Methodology

These categories contain criteria pollutant and GHG emissions from point sources only. Emissions were individually calculated for each source operation in the District's Data Bank System. Emissions are calculated by multiplying the specific emission factor for a particular source operation by the throughput. These data are supplied by the permitted facility. The summation of these emissions provides the emissions for these categories.

The CO_2 emission factor used in the cement manufacturing process was obtained from the California Climate Action Registry's Cement reporting Protocol. The combustion sources (coke, coal, natural gas. and diesel) GHG emission factors for CO_2, CH_4, and N_2O were obtained from the Department of Energy (EIA) and the California Energy Commission (CEC).

Monthly Variation

Monthly and daily production rates follow permitted data supplied by the major cement manufacturer.

County Distribution

Emissions are distributed to the county based on the location of the processing plant. The District's data bank contains the information on plant location.

TRENDS

History

The historical growth profile for Category 36 was based on a combination of prior cement kiln throughput data (back to 1987) and the Association of Bay Area Government's (ABAG's) 2009 Construction Employment growth profile. The historical growth profile for Categories 1747 - 1750 was based on a combination of prior fuel throughput data (back to 1999) and the Association of Bay Area Government's (ABAG's) 2009 Construction Employment growth profile.

Growth

Projections of emissions to 2030 in all categories were based on ABAG's 2009 Construction Employment growth profile.

Control

In Category 36, particulate emissions were reduced due to the control imposed by Ringlemann requirements from Regulation 6. Particulates are also controlled from Categories 1747 – 1750. Currently, there is greater than 99% overall control of particulates from these categories.

By: Stuart Schultz
Date: February 2011
Base Year 2008

EMISSION INVENTORY

CATEGORY #37

CONTAMINATED SOIL AERATION

EMISSIONS

Introduction

Category 37 accounts for organic emissions from contaminated soil aeration events. Contaminated soil aeration occurs when soil containing organic compounds is excavated and allowed to vent into the open air. These events include underground gasoline tank removal, soil excavation during pipeline leak repairs, and removal of other organic and petroleum chemical spills.

Methodology

The District requires a written report for any soil aeration activity. These reports were evaluated to determine a generalized emission factor for each event as well as to estimate the total number of excavations.

Regulation 8, Rule 40 allows up to 150 pounds per day of organic compound emissions per aeration event. The organic compound emissions factor was calculated assuming the aeration site starts emitting at 120 pounds per day, with emissions halving every ten days, and with emissions set at zero at the 90th day. Two tank removals or replacements are also assumed to occur per aeration event. On average, about 250 excavation events take place annually in the Bay Area.

County Distribution

The county activity distribution is based on an average number of aeration events in each county in the District.

Monthly Variation

The monthly factors are assumed to be uniform. More aeration events are assumed to start during weekdays than during weekends.

TRENDS

History

State regulations governing the construction standards of gasoline holding tanks required many stations to replace their existing tanks. In our Source Inventory of 1987, the District had 152 excavation events reported. In 1990, this number had grown to 1254. The number of excavations remained above 1100 per year through the mid 1990s.

Growth

Much of the increase since 1987 had been due to the Porter and Cologne Act regulated by the State Water Resources Control Board and California Regional Water Quality Control

Boards. Parts of these underground tank regulations govern the replacement of underground storage tanks.

The California Code of Regulations, Title 23, Division 3, Chapter 16 stated that by December 22, 1998, all underground storage tanks containing hazardous substances, other than those containing motor vehicle fuels, need to be retrofitted with secondary containment. By the same date, motor vehicle fuel tanks made of steel needed to be retrofitted with secondary containment or be provided with both interior lining and exterior cathodic protection.

The number of excavation events remained at close to the 1990 rate through 1998 and declined afterwards.

Control

The District adopted Regulation 8, Rule 40 on February 15, 1989. The overall control afforded by this rule is 81%. This rule applies for soil aeration events only. Air stripping and soil excavation events are inventoried in category 937, under Regulation 8, Rule 47.

Rule 40 sets the rate of uncontrolled aeration in addition to describing an acceptable soil aeration procedure. For an uncontrolled aeration, an operator may not aerate the soil at above certain rate per day; however, the soil aeration may be extended over many days. This does not reduce the total emissions from an aeration event.

By: Sukarn Claire
Date: January 2011
Base Year: 2008

EIC: 69999500000000

EMISSION INVENTORY

CATEGORY # 937

AIR STRIPPING AND SOIL VAPOR EXTRACTION

EMISSIONS

Introduction

This category accounts for the emissions from air stripping and soil vapor extraction processes. Soil and groundwater contamination are the result of leaking underground storage tanks, accidental spills and landfill leachate. Air stripping process is commonly used for contaminated groundwater remediation. Contaminated groundwater is pumped into the air-stripping tower. A blower generally exhausts the effluent air stream from the stripping column. The contaminated air stream is routed to an air pollution control device (i.e., carbon adsorbers). Soil vapor extraction is one of the techniques to extract volatile organic compounds (VOC) from contaminated soil through the use of a vacuum system. Fresh air is injected into the subsurface at locations around the contaminated area. The contaminated air is withdrawn under vacuum from extraction wells. This contaminated air is then vented directly to a VOC treatment system such as carbon adsorbers, thermal incinerators, catalytic incinerators, and condensers prior to being released to the atmosphere.

Methodology

This category contains emissions from point sources only. Point source emissions are calculated from each equipment's operating data submitted as part of the permit approval process. The Data Bank contains throughput information submitted by individual plants by sources. Emissions are then calculated by using specific emission factors for a particular source operation supplied by the company. If no specific factor is available, a generalized factor developed by district staff engineer will be use to determine emissions.

Monthly Variation

The data bank contains percentage of throughput data for each of the four 3-month seasonal periods: (December - February, March - May, June - August, September - November).

County Distribution

The data bank system contains information on the county location of each processing plant; hence, emissions are distributed to the counties accordingly.

TRENDS

History

The historical growth profile was based on a combination of prior emissions data (back to 1996) and the Association of Bay Area Government's (ABAG's) 2009 Manufacturing Employment growth profile.

Growth

Future projections of emissions to 2030 are based on ABAG's 2009 Manufacturing Employment growth profile.

Control

The District adopted Regulation 8, Rule 47 on December 20, 1989. This rule requires all facilities to control emissions by at least 90%; however, based on emissions data, the overall control efficiency is estimated at 96%.

By: Stuart Schultz
Date: January 2011
Base Year 2008

EMISSION INVENTORY

CATEGORY # 38

ASPHALTIC CONCRETE PLANTS

EMISSIONS

Introduction

Asphaltic concrete paving is a mixture of well graded, high quality aggregate and liquid asphaltic cement which is heated and mixed in measured quantities to produce bituminous pavement material.

Methodology

All asphaltic concrete plants operating in the Bay Area are in the District's data bank system and considered point sources. The Data Bank contains throughput information submitted by individual asphaltic concrete plants by sources. Emissions are then calculated by using specific emission factors for a particular source operation supplied by the company. If no specific factor is available, a generalized factor developed by district staff engineer will be use to determine emissions.

Monthly Variation

Monthly distribution was estimated to have the highest activity during the months of June through November. Lesser activity occurred during the remainder of the year with the least activity occurring during the months of January through March.

County Distribution

The data bank system contains information on the county location of each processing plant; hence, emissions are distributed to the counties accordingly.

TRENDS

History

The historical growth profile was based on a combination of prior emissions data (back to 1987) and the Association of Bay Area Government's (ABAG's) 2009 Construction Employment growth profile.

Growth

Projections of emissions to 2030 were based on ABAG's 2009 Construction Employment growth profile.

Control

In 1961-1962, there was a large reduction of particulate due to the control imposed by the District's Ringlemann 2 requirements. In 1971-1972, there was a further reduction of particulates caused by the District's adoption of the more stringent Ringlemann 1 requirements. Currently, there is an estimated greater than 99% overall control of particulates from this category.

By: Stuart Schultz
Date: January 2011
Base Year 2008

EMISSION INVENTORY

CATEGORY # 39

CONCRETE BATCHING

EMISSIONS

Introduction

This category accounts for dust emissions from concrete batching plants. Concrete batching is composed of water, cement, sand, gravel and crushed stone. Concrete batching is prepared either at a building construction site or for the manufacture of concrete products such as pipes and prefabricated construction parts. Fugitive sources of emissions include the loading and unloading of cement, handling of sand and the mixing of cement, sand, and aggregate.

Methodology

This category contains emissions from point and area sources. For point sources, the data bank contains throughput information submitted by individual concrete batching plants by sources. Emissions are then calculated by using specific emission factors for a particular source operation supplied by the company.

Cement production for California in 2008 was estimated at 11,281,310 short tons. This was calculated by taking the U.S. production, as provided by the Department of Conservation, Bureau of Mines, and multiplying that figure by the California fraction of the U.S. total. Total 2008 concrete production in California (using mixing ratios found in AP-42, page 11.12-7) was estimated at 92,473,832 tons/yr. and allocated throughout California by means of population. The Bay Area's concrete production from both point and area sources was estimated at 17,153,896 tons/yr. The 2008 area source throughput of 5,704,720 tons/year was calculated by subtracting the total concrete production throughput from the point source throughput.

The emission factors used for area source concrete batching, based on Truck Mix Operations (found in AP-42's Mineral Products Industry section), include total process emissions, wind erosion estimates from sand and aggregate storage piles, and vehicular travel estimates from unpaved roads. The composite emission factor was estimated at 0.16 lbs/ton of concrete produced. Emissions from area sources were calculated by multiplying this emission factor to the estimated area source concrete production throughput.

Monthly Variation

Monthly variation was estimated and used to distribute emissions over the 12 months. Greatest activity occurs during the months of June – September. The slowest activity occurs during the months of December – March.

County Distribution

For point sources, the data bank system contains information on the county location of each processing plant; hence, emissions are distributed to the counties accordingly. Emissions from area sources were distributed to counties by the construction employment estimates from each county.

TRENDS

Growth

The historical growth profile was based on a combination of prior emissions data (back to 1987) and the Association of Bay Area Government's (ABAG's) 2009 Construction Employment growth profile.

Growth

Projections of emissions to 2030 were based on ABAG's 2009 Construction Employment growth profile.

By: Stuart Schultz
Date: January 2011
Base Year 2008

EIC Code: 43043070180000

EMISSION INVENTORY

CATEGORY # 40

GLASS AND RELATED PRODUCTS MANUFACTURING

EMISSIONS

Introduction

The main pollutant emitted by glass manufacturing plant is particulates in the form of dust. Particulates result from volatilization of materials in the melt that combine with gases and form condensates. Emissions from the forming and finishing phase depend upon the type of glass being manufactured. Emissions for glass and related product manufacturing can be categorized by three production phases: raw materials handling, glass melting and refining, and forming and finishing. The raw materials handling phase is the major fugitive dust emissions. The emissions are generated at each of the material transfer points. The emissions from forming and finishing phase are solid particles of glass and related products. (NO_x emissions are the result of electric furnace operation.)

Methodology

Emissions for this category were obtained from point source data only. The Data Bank contains throughput information submitted by the plants by sources. Emissions are then calculated by using specific emission factors for a particular source operation supplied by the company. The summation of these emissions provides the emissions for the category. Emissions from storage of organic liquids or combustion of fuels at glass and related product manufacturing facilities are accounted for in other categories.

Monthly Variation

The data bank contains percentage of throughput data for each of the four 3-month seasonal periods: (December - February, March - May, June - August, September - November).

County Distribution

The data bank system contains information on the county location of each processing plant; hence, emissions are distributed to the counties accordingly.

TRENDS

History

The historical growth profile was based on a combination of prior emissions data (back to 1987) and the Association of Bay Area Government's (ABAG's) 2009 Manufacturing Employment growth profile.

Growth

Projections of emissions to 2030 were based on ABAG's 2009 Manufacturing Employment growth profile.

Control

In 1963, there was at least 50% reduction of particulate emissions from equipment brought about by the District's Regulation 6 on visible emissions from the Ringlemann 2 standard. In 1970 there was at least an additional 25% reduction in particulates from the Ringlemann 1 standard. Currently, there is an approximate 74% overall control of particulates from this category.

By: Stuart Schultz
Date: January 2011
Base Year 2008

EMISSION INVENTORY

CATEGORY # 41

STONE, SAND, AND GRAVEL

EMISSIONS

Introduction

This category accounts for dust emissions generated from stone, sand, and gravel processing (i.e. crushing, quarrying, screening, handling, etc.). Fugitive sources include the transfer of stone, sand, and gravel, truck loading, mixer loading, vehicle traffic, and wind erosion from sand.

Methodology

Emissions for this category were obtained from point source data only. These data originated with throughput information supplied by the quarry plants stored in the District's Data Bank. Emissions were calculated using specific emission factors submitted by the plant for a particular source operation.

Monthly Variation

The data bank contains percentage of throughput data for each of the four 3-month seasonal periods: (December - February, March - May, June - August, September - November).

County Distribution

The data bank system contains information on the county location of each processing plant; hence, emissions are distributed to the counties accordingly.

TRENDS

History

The historical growth profile was based on a combination of prior emissions data (back to 1987) and the Association of Bay Area Government's (ABAG's) 2009 Construction Employment growth profile.

Growth

Projections of emissions to 2030 were also based on ABAG's 2009 Construction Employment growth profile.

Control

In 1963, there was at least 50% reduction of particulate emissions from equipment brought about by the District's Regulation 6 on visible emissions from the Ringlemann 2 standard. In 1970 there was at least an additional 25% reduction in particulates from the Ringlemann 1 standard. Currently, there is an approximate 82% overall control of particulates from this category.

By: Stuart Schultz
Date: January 2011
Base Year 2008

EMISSION INVENTORY

CATEGORY # 42

SAND (ABRASIVE) BLASTING

EMISSIONS

Introduction

Abrasive blasting (of which sandblasting is a part) is the use of abrasive materials to clean or prepare a surface, such as metal or masonry. Sand is the most commonly used abrasive material. Other abrasives include coal and smelter slags, glass beads, aluminum oxide, steel shot, walnut shells, garnet, etc. Industries that use abrasive blasting include ship building and repair, aircraft manufacturing, fabricated metal manufacturing, oil and gas extraction industries, aluminum and other nonferrous production and processing industries, etc.

There are three types of propelling methods used for abrasive blasting:

1. Dry System where compressed air is used to propel the abrasive using either a suction or pressure type process.
2. A wet system where air or water pressure are used to propel an abrasive slurry to the target surface.
3. Centrifugal Wheel System where centrifugal and inertial forces are used to propel abrasive materials.

In many applications, the abrasive materials can be reused. However, once the abrasive's particle size gets smaller, its stripping efficiency drops and has to be replaced. On the other hand, sand is commonly used for abrasive operations where recycling is not feasible, such as unconfined sand blasting operations.

Methodology

The District's Data Bank system contains information on companies with abrasive blasting operations in the Bay Area. These sources are considered point sources. Sand is the most commonly used abrasive material, however there are other abrasive materials used in the Bay Area, such as steel shot, glass beads and aluminum oxide. For emission calculation purposes, it is assumed sand is used in both point and area sources. The other abrasive materials' usages were in the point sources.

Throughput Calculations

The 2008 sand throughput was estimated from the U. S. Geological Survey's (USGS) Mineral Commodity Survey. According to this survey, abrasive sand consumed 3% of the industrial sand production; and California received

approximately 6.4% of the total sand produced. The BAAQMD's[1] percentage of California's total abrasive sand throughput was approximately 14.5%. This was estimated by using the ratio of the number of employees associated with abrasive blasting (by NAICS) in the District versus California. The following industries were used for this calculation:

- Ship building and repair (NAICS 3366)
- Aircraft manufacturing industry (NAICS 336411)
- Steel product manufacturing industry (NAICS 3312)
- Aluminum production and processing industry (NAICS 3313)
- Nonferrous production and processing industry (NAICS 3314)
- Fabricated metal product manufacturing industry (NAICS 332)
- Oil and gas extraction industry (NAICS 211)

Using these figures, the 2008 estimated total sand throughput in the Bay Area is as follows:

2008 Sand usage in the United States (from the USGS's 2008 Salient U.S. Silica Statistics: 30,484,383 tons/year

2008 Bay Area sand usage for abrasive purposes:

30,484,383 tons/yr X 0.03 (for abrasive purposes) X 0.064 (to Calif.) X 0.145 (BAAQMD portion) = 8,506 tons/year

Subtracting out the point source (permitted) sand throughput of 2,924 tons/year to get the area source throughput yields:

8,506 tons/yr – 2,924 tons/yr = 5,582 tons/year

Emission Calculation

U.S. EPA (1998) recommended particulate emission factors for sand blasting were used for emission calculations. They are as follows:

PM 54 lbs/ton
PM_{10} 26 lbs/ton

The 2008 Area Source Sand Blasting emissions for total particulates (PM) in the BAAQMD are as follows:

PM = (5,582 tons/year X 54 lbs/ton) / 2000 lbs/ton = **150.7 tons/year (or 0.413 ton/day)**
PM_{10} = (5,582 tons/year X 26 lbs/ton) / 2000 lbs/ton = 72.6 **tons/year (or 0.199 ton/day)**

The 2008 point source total particulate emission for this category was **0.061 ton/day.**

[1] For Solano County, assume 73% within BAAQMD's jurisdiction; for Sonoma County assume 87% within BAAQMD's jurisdiction.

The 2008 point and area source total particulate emission was 0.061 ton/day + 0.413 ton/day = **0.474 ton/day**

Monthly Variation

The monthly variation of emission was estimated to be approximately three times the amount during the period of April through October as opposed to the rest of the year.

County Distribution

For point sources, the data bank system contains information on the county location of each processing plant; hence, emissions are distributed to the counties accordingly. Emissions from area sources were distributed to counties by the total employment estimates from those industries listed above by NAICS.

TRENDS

History

The historical growth profile (back to 1987) was based on a combination of prior emissions data from the District and sand production data from the USGS. Prior to 1987, the historical growth profile was based on the Association of Bay Area Government's (ABAG's) 2009 Manufacturing Employment growth profile.

Growth

Projections of emissions to 2030 were based on ABAG's 2009 Manufacturing Employment growth profile.

Control

Larger abrasive blasting operations are subject to the District's Regulation 6, Particulate Matter and Visible Emissions, which places limitations on emission rates, concentration, visible emission and opacity. Pollution control devices for abrasive blasting operations include dust filters/collectors or baghouses, etc. Controls can range up to 99% or higher.

Unconfined and temporary abrasive blasting operations are subject to District Regulation 12, Rule 4, Miscellaneous Standards of Performance, Sandblasting. This rule establishes opacity and abrasives standards.

By: Stuart Schultz
Date: January 2011
Base Year 2008
EIC Code: 43042870000000

EMISSION INVENTORY

CATEGORY # 43
SEMICONDUCTOR MANUFACTURING

CATEGORY # 1891
SEMICONDUCTOR MANUFACTURING – HALOGENATED GASES

EMISSIONS

Introduction

These categories include organic and greenhouse gas (GHG) emissions from semiconductor manufacturing plants and other related integrated circuits manufacturing. Semiconductor manufacturing processes include blank wafer production, semiconductor fabrication, and assembly and packaging. (The following description of the semiconductor manufacturing processes was taken from the BAAQMD's Permit Handbook, Section 7, Chapter 4.)

Blank Wafer Production

1. Silicon Crystal Growth:

   Molten silicon is introduced into a mold with a seed crystal of silicon. As the molten silicon cools, it crystallizes around the seed to "grow" a single crystalline ingot. Crystal growth is not in itself a source of air emissions and is not subject to permit requirements. Miscellaneous cleaning operations may result in organic or inorganic emissions. Organic cleaning operations may be exempt in accordance with Regulation 2-1-118. Abatement of organic or inorganic emissions may be required if emissions exceed the current best available control technology (BACT) trigger level.

2. Wafer Manufacturing:

   The cooled silicon ingot is shaped and sliced into round wafers, which are mechanically polished ("lapped"). These steps are subject to the particulate emission limits of Regulation 6 if particulate emissions are produced and vented outside of the facility. Mechanical shaping, slicing and polishing may be exempt from permit requirements in accordance with Regulation 2-1-121.1 or 2-1-125.1.2.

   After polishing, wafers are etched in a chemical bath to remove surface imperfections. Depending on the type and concentration of etchants used, mists and aerosols may be produced. Finally, each wafer is polished to a smooth finish. The etching operations may be exempt from permitting requirements by

Regulation 2-1-127.4, if the toxic risk provisions of Regulation 2-1-316 are satisfied.

If adhesives are used to fix wafers in position during polishing, the use of adhesives may be subject to VOC limits and other requirements in Regulation 8, Rule 51. The application of adhesives may be exempt from permit requirements in accordance with Regulation 2-1-119.2, if the toxic risk provisions of Regulation 2-1-316 are satisfied. Miscellaneous cleaning operations may result in organic or inorganic emissions. Organic cleaning operations may be exempt in accordance with Regulation 2-1-118. Abatement of organic or inorganic emissions may be required if emissions exceed the current best available control technology (BACT) trigger level.

Semiconductor Manufacturing

The processes used to form ICs on the wafer include:

- Oxidation, where an inert layer of silicon dioxide is formed on the wafer by exposing the wafer to a heated oxygen environment.

- Photoresist application, exposure and development, where solvent-based, light-sensitive resin solutions are uniformly applied to the wafer and then processed to leave a pattern of cured photoresist on the wafer which corresponds to the circuit image, while removing the non-image coating. Photoresist applicators may also apply non-light sensitive coatings (spin-on-glass, anti-reflective coatings) and solvents (edge bead remover, hexamethyldisilazane (HMDS)).

- Etching, where reactive gases or liquids are used to remove the silicon dioxide layer from the wafer surface where it is not protected by cured photoresist, thereby exposing the underlying silicon for further processing; liquid etching is classified as a wet chemical station, as described below.

- Photoresist stripping, where cured photoresist is removed from the wafer after it has allowed selective wafer surface processing; stripping solutions may be organic or inorganic depending on the composition of the underlying wafer surface, and therefore may be classified as either solvent stations or a wet chemical stations, as described below.

- Doping (diffusion, ion implant), where the wafer is exposed to impurities that penetrate into the exposed silicon patterns to selectively modify the electrical conductivity of the silicon, thereby producing electronic components and circuits.

- Layering (epitaxial growth, metallization films, chemical vapor deposition), where a doped wafer is covered with a uniform layer of

silicon (to form a base for additional circuit layers) or metal (to form a conductive connection between the circuit layers and the external IC package).

Other processes include:

- Chemical mechanical polishing (CMP), where wafer surfaces are polished to maintain wafer flatness during processing.

- Solvent stations, where wafers or tools are cleaned by immersion in a solvent liquid or vapor or by being sprayed with a solvent liquid.

- Wet chemical stations, where wafers or tools are cleaned or etched by immersion in an inorganic solution or by being sprayed with such a solution.

- Wipe cleaning, where tools and work surfaces are cleaned in place or at a dedicated station.

Assembly and Packaging

This is where wafers are cut into individual integrated circuits, which then are mounted into a package for assembly on a printed circuit board.

Methodology

Category #43

This category contains point sources only where information on equipment, operating data, and throughput of each source are reported by individual semiconductor manufacturing plants and are stored in the District's Data Bank. Organic emissions and GHG's are calculated by using the throughput data of specific materials reported and emission factors that are based on various test data and publication. These information are updated upon permit renewal.

Category #1891

This category estimates the halogenated (fluorinated) gas emissions in those facilities found in Category #43. These emissions are considered as area sources. The halogenated gas emissions were estimated using data from the 2004 California Air Resources Boards "Documentation of California's Greenhouse Gas Inventory" (Sector: Industrial: Manufacturing: Electric & Electronic Equipment: Semiconductors & Related Products). From the State level, the Bay Area emissions were calculated using the number of employees data found in the 2005 County Business Patterns for the Semiconductor and Related Device Manufacturing (Industry Code 334413). Growth to a

particular base year was based on data from Category 43 and the Association of Bay Area Governments' (ABAG's) 2009 Information Employment growth profile.

Halogenated gas emissions are considered total organic gas (TOG) emissions, with no reactive organic gas (ROG) component. They are also considered GHG's with a range of global warming potential (GWP) values. The GWP value used for calculation purposes was 6500.

Monthly Variation

Emissions for both categories were assumed to be uniform for each month of the year.

County Distribution

Category #43

The county location of each company as reported in the Data Bank was used to distribute emissions into each county.

Category # 1891

The number of employees in each applicable Bay Area county, as found in the 2007 County Business Patterns for the Semiconductor and Related Device Manufacturing, was used to determine the county fraction. A particular county's "county fraction" was multiplied by the total emission to obtain that county's emission.

TRENDS

History

Category 43

There are no emissions reported prior to 1975 since semiconductor industries existed only after this year. In 1984, emissions were calculated to be about 5 tons/day from a District report on "Emissions from Semiconductor Plants in Santa Clara County". From 1975 - 1984, the growth profile was assumed to grow linearly. From 1987 – 2005, the growth profile was based on emissions as provide in the District's Data Bank. (The growth profile was interpolated between the years 1984 – 1987.)

Category 1891

From 1984 – 2004, the growth profile was based on ABAG's 2009 Information Employment growth profile. From 1975 - 1984, the growth profile was assumed to grow linearly.

Growth

For both categories, projections to year 2030 were based on ABAG's 2009 Information Employment growth profile.

Control

Category 43

District Regulation 8, Rule 30, adopted in July 1983, set operating standards in solvent cleaning stations at semiconductor manufacturing facilities. An amendment to the regulation effective in November 1988 further set standards for the negative photoresist operations. October 1998 set requirements for solvent spray and solvent vapor units and fab area wipe cleaning operations. Additionally, there were further amendments to negative photoresist operations. Currently, it is estimated emissions are reduced by an overall control of approximately 85% due to this regulation.

By: Stuart Schultz
Date: February 2011
Base Year 2008

EIC: 29999580000000 (Category 1891)

EMISSION INVENTORY

CATEGORY # 44

FLEXIBLE & RIGID DISCS MANUFACTURING

EMISSIONS

Introduction

This category includes volatile organic compound emissions from computer discs manufacturing plants. Manufactured discs are flat, circular plastic film contained in a non-rigid envelope (flexible), or a non-flexible plate (rigid), with a magnetic coating on which digital information can be stored. Manufacturing processes include coating, mixing operations, coating line, and polishing. Organic solvents are used in these operations and emissions from volatile organic compounds are reported in this category. Throughput information of each source is reported by individual companies and is stored in the District's Data Bank System.

Methodology

Information on equipment, operating data, and throughput of each source are reported by individual manufacturing plants and are stored in the District's Data Bank. Emissions are calculated by using the throughput data of specific materials reported and emission factors that are based on various test data and publication. These information are updated upon permit renewal.

Monthly Variation

Monthly distribution was estimated based on each company's reported quarterly seasonal percentage throughput data.

County Distribution

The county location of each company as reported in the Data Bank is used to distribute emissions into each county.

TRENDS

History

The historical growth profile was based on a combination of prior emissions data (back to 1990) and the Association of Bay Area Government’s (ABAG’s) 2009 Information Employment growth profile.

Growth

Projections to year 2030 were based on the ABAG’s 2009 Information Employment growth profile.

Control

District Regulation 8, Rule 38 pertaining to disc coating, polishing and coating mixing operations requirements became effective in January 1987. Currently, the estimated overall control from this rule is approximately 81%.

By: Stuart Schultz
Date: January 2011
Base Year 2008

EMISSION INVENTORY

CATEGORY # 45

FIBERGLASS PRODUCTS MANUFACTURING

EMISSIONS

Introduction

Emissions from this category are from fiberglass products manufacturing plants. Organic compounds are used for the production or rework of product by mixing, pouring, hand laying-up, impregnating, injecting, forming, spraying, and/or curing unsaturated polyester materials with fiberglass, fillers or any other reinforcement materials and associated clean-up. The evaporation of these organic compounds, are considered as emissions from this category.

Methodology

This category contains emissions from point sources only. Information on equipment, operating data, and throughput of each source are reported by individual manufacturing plants and are stored in the District's Data Bank. Emissions are calculated by using the throughput data of specific materials reported and emission factors that are based on various test data and publication. This information is updated upon permit renewal.

Monthly Variation

Monthly distribution was estimated based on each company's reported quarterly seasonal percent throughput data.

County Distribution

The county location of each company as reported in the Data Bank is used to distribute emissions into each county.

TRENDS

History

The historical growth profile was based on a combination of prior emissions data (back to 1990) and the Association of Bay Area Government’s (ABAG’s) 2009 Manufacturing Employment growth profile.

Growth

Projections to year 2030 were also based on the ABAG’s 2009 Manufacturing Employment growth profile.

Control

District Regulation 8, Rule 50 effective June 1991 has set standards requirements in polyester resin operations. Currently, it is estimated the overall control of the rule is approximate 87%.

By: Stuart Schultz
Date: January 2011
Base Year 2008

EMISSION INVENTORY

CATEGORY # 46

RUBBER PRODUCTS MANUFACTURING

EMISSIONS

Introduction

Emissions from this category are from rubber fabrication industry, including vulcanizing, where raw rubber is compounded by additives and formed into desired shape and cured at required temperature. In the forming steps, large amounts of organic solvent are often used and therefore included in the emissions in this category.

Methodology

Throughput information of each source is reported by individual companies and stored in the District's Data Bank System. These Point Source emissions are calculated by using data from a particular source operation and emission factors based on tests and other data publication. If no specific factor is available, a generalized factor is used developed by district staff engineer. Total rubber products production was estimated based on U. S. Department of Commerce "Current Industrial Report on Rubber Products". In 2008, it was estimated 15,958 tons were used by area sources not otherwise reported, or part of the District Data Bank system.

The organics emission factor was estimated based on AP-42, for emulsion styrene-butadiene copolymer production. Emulsion latex polymerization is done in batch process, hence smaller usage than emulsion crumb polymerization. An emission factor of 7.54 lbs./ton was derived.

Calculation: (Area Sources):

Emissions = 15,958 tons/yr x 7.54 lbs./ton / 2000 lbs./ton / 365 days/yr
= 0.16 ton organics/day

Monthly Variation

Monthly distribution was estimated based on cyclic production of rubber products industry, and is reported by each company's quarterly percent throughput.

County Distribution

The number of employees within the Rubber Product Manufacturing sector (SIC No. 3262) taken from the 2007 County Business Patterns was used to distribute emissions into the Bay Area counties.

TRENDS

History

The historical growth profile was based on a combination of prior emissions data (back to 1990) and ARB's Rubber Manufacturing Industry growth profile.

Growth

Projections to year 2030 were also based on the Association of Bay Area Government's 2009 Manufacturing Employment growth profile.

By: Stuart Schultz
Date: January 2011
Base Year 2008

EIC Code: 41040250620000

EMISSION INVENTORY

CATEGORY # 47

PLASTICS PRODUCTS MANUFACTURING

EMISSIONS

Introduction

Emissions from this category are from plastics products manufacturing plants. Various products are manufactured from plastics, including usage in protective coatings, molding and casting, laminating, adhesives, treatment of textiles, paper and leather, electrical wire and parts, bottles, and others.

Synthetic resins are the materials from which the synthetic plastics are made. Thermosetting resin is molded under heat and pressure and then cooled. Should it be reheated, it will not soften. The thermoplastic resin is also molded under heat and pressure, but must be chilled in order to harden so that it may retain its molded shape. If reheated, it will soften again, and may be shaped anew. The chief raw materials in producing synthetic resins include urea, formaldehyde, phenol, phthalic anhydride, glycerin, acetone, methanol, phenol, and other compounds. During miscellaneous processes such as molding, extrusion, mixing, reacting, curing, drying, and storage, volatile organics from the raw materials, solvent, or other liquid are emitted and considered in this category.

Methodology

This category contains emissions from point sources only. Information on equipment, operating data, and throughput of each source are reported by individual manufacturing plants and are stored in the District's Data Bank. Emissions are calculated by using the throughput data of specific materials reported and emission factors that are based on various test data and publication. This information is updated upon permit renewal.

Monthly Variation

Monthly distribution was estimated based on each company's reported quarterly seasonal percent throughput data.

County Distribution

The county location of each company as reported in the Data Bank is used to distribute emissions into each county.

TRENDS

History

The historical growth profile was based on a combination of prior emissions data (back to 1987) and the Association of Bay Area Government's (ABAG's) 2009 Manufacturing Employment growth profile.

Growth

Projections to year 2030 were based on ABAG's 2009 Manufacturing Employment growth profile.

Control

District Regulation 8, Rule 52, effective June 1, 2000, has set standards requirements for polystyrene, polypropylene, and polyethylene foam product manufacturing operations. Prior to the passage of this rule, sources were subject to the Miscellaneous Operations rule (Regulation 8, Rule 2). Currently, it is estimated the overall control due to these rules is approximately 76%.

By: Stuart Schultz
Date: January 2011
Base Year 2008

EMISSION INVENTORY

CATEGORY #48

OIL PRODUCTION

EMISSIONS

Introduction

Emission sources associated with oil production include waste pits, well blowouts, gas/liquid separation, heater treaters, control valves, pressure relief valves, spills, pipe fittings, pump seals and compressor seals. During oil production, pollutants of concern are volatile organic compounds (VOCs), methane (CH_4), hydrogen sulfide (H_2S) and hazardous air pollutants (HAPs). Category 48 accounts for fugitive organic emissions including methane from oil production fields in the San Francisco Bay Area.

Methodology

Throughput/activity information for oil production in each Bay Area county was obtained from the California Department of Conservation's Division of Oil, Gas and Geothermal Resources (DOGGR). This category represents the area source emissions. The District also permits certain units at oil production facilities. These units are account as point sources. Emissions are calculated using a composite emission factors. The composite emission factors were developed based on information on various processes in oil production from the Environmental Protection Agency's document AP-42. Emission Factors in pounds per barrel of oil processed (lb/Barrel) are shown below.

Category	Total Organics (TOG)	Methane (CH_4)
48	1.63	0.326

County Distribution

The county activity is based on amount of oil produced in each Bay Area county in accordance with data from the California Department of Conservation.

Monthly Variation

Monthly and daily factors are assumed to be uniform.

TRENDS

History

Since late 1980s, California oil production has been declining. Oil production in the nine Bay Area counties peaked in the mid-1980s and has dropped steadily since. The number of producing oil wells in the nine bay counties has dropped from 87 in 1986 to about 40 in 2000s. Historical emissions for this category have varied with oil production activity.

Growth

According to the California Energy Commission, future California oil production, although uncertain, is expected to decline at a small annual rate during the next 20 years. Statistical extrapolation from historical data produces a very broad range, varying between a 7 percent decline to 1 percent increase. California oil production is responsive to prevailing oil prices. If economically feasible, enhanced oil recovery techniques can be used to extract oil from fields that have been nearly depleted using conventional methods. According to the "Oil & Gas Supervisor", oil production in the Bay Area could actually increase despite the decrease in number of operating oil wells.

Control

The District adopted Regulation 8, Rule 37 on March 20, 1985 to control the amount of emissions at natural gas and crude oil production facilities. This rule has a control of 80% on reactive organic compounds, with a rule effectiveness of 90% reached by 1989.

By: Sukarn Claire
Date: January 2011
Base Year: 2008

EIC: 31030216000000

EMISSION INVENTORY

CATEGORY #49

GAS PRODUCTION

EMISSIONS

Introduction

Fugitive emissions at natural gas production fields occur from process equipment whenever components in the liquid or gas stream leak. There are several potential sources of leaks, such as valves, flanges, pumps, compressors, and pressure relief valves (PRVs). These emissions occur randomly and are difficult to predict. During gas production, pollutants of concern are volatile organic compounds (VOCs), methane (CH_4), hydrogen sulfide (H_2S) and hazardous air pollutants (HAPs). Category 49 accounts for fugitive organic emissions including methane (CH_4) from gas production fields in the San Francisco Bay Area.

Methodology

Gas production activity/throughput information for the Bay Area counties was obtained from the California Department of Conservation's Division of Oil, Gas, and Geothermal Resources (DOGGR) report. This category represents the area source emissions. The District also permits certain units at gas production facilities. These units are accounted as point sources. Emissions are calculated using composite emission factors. The composite emission factors were developed based on information on various processes in gas production from the U. S. Environmental Protection Agency's document AP-42. Emission factors in pounds per 1000 cubic feet of gas processed (lb/1000 ft^3 or lb/MCF) are shown below.

Category	Total Organics (TOG)	Methane (CH_4)
49	0.134	0.107

County Distribution

The county activity is based on amount of gas produced in each Bay Area county in accordance with the California Department of Conservation.

Monthly Variation

Monthly and daily factors are assumed to be uniform.

TRENDS

History

Emission trends have followed the gas production activity trend. Natural gas production in California has been on the increase in recent years. Past years emissions were determined by using actual gas production rate data for each one of the District's nine counties taken from the Department of Conservation's report.

Growth

Demand for natural in California and the nation has been growing at approximately 1.5% per year and is expected to remain at that level. Gas use is up due to its competitive price and environmental attractiveness. Natural gas production in the district is expected to grow approximately 1.5% per year.

Control

The Bay Area Air District adopted Regulation 8, Rule 37 on March 20, 1985 to control the amount of emissions at natural gas and crude oil production facilities. This rule has a control of 80% on reactive organic compounds, with a rule effectiveness of 90% reached by 1989.

By: Sukarn Claire
Date: January 2011
Base Year: 2008

EIC: 31099501000000

EMISSION INVENTORY

CATEGORY # 54

OTHER INDUSTRIAL/COMMERCIAL

EMISSIONS

Introduction

This category accounts for process emissions from other miscellaneous industrial and commercial plants (i.e. ceramic processing, mixing, grinding and packaging of mineral base products, gypsum wallboard manufacturing, oyster shell processing machines, metal shops, etc.) not accounted for through other District rules.

Methodology

This category consists only of point sources that are contained in the District Data Bank system. Individual companies report information on plant equipment, operating data, and source throughput. This information is updated upon permit renewal in the District's Data Bank. Criteria pollutant emissions calculated by using throughput data of the specific materials, emission factors, and control equipment reduction factors (if applicable). The emissions factor may specific for a particular source operation supplied by the company. If no specific factor is available, a generalized factor developed by a District staff engineer will be used to determine the emissions.

All seven of the greenhouse gases, namely carbon dioxide (CO_2), biogenic CO_2, methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFC's), perfluorocarbons (PFC's), and sulfur hexafluoride (SF_6), are also calculated in the applicable sources.

Monthly Variation

The data bank contains throughput data for each of the four 3-month seasonal periods (December - February, March - May, June - August, September - November).

County Distribution

The data bank system contains information on the county location of each processing plant; hence, emissions are distributed to the counties accordingly.

TRENDS

History

The historical growth profile was based on a combination of prior emissions data (back to 1987) and the Association of Bay Area Government's (ABAG's) 2009 Manufacturing & Wholesale Employment growth profile.

Growth

Future projections of emissions to 2030 are based on ABAG's 2009 Manufacturing & Wholesale Employment growth profile.

By: Stuart Schultz
Date: February 2011
Base Year 2008

EIC Code: 49599500000000

SECTION 5

WASTE MANAGEMENT

EMISSION INVENTORY

CATEGORY # 50

PUBLICLY OWNED TREATMENT WORK

EMISSIONS

Introduction

A typical POTW facility collection system will contain a lift station, trenches, junction boxes and manholes. Wastewater streams normally are introduced into the POTW collection system through individual or area drains, which can be open to the atmosphere or sealed to prevent wastewater contact with the atmosphere. Emissions are emitted from wastewater collection, treatment, and storage systems through volatilization of organic compounds at the liquid surface.

Methodology

This category contains organic emissions from point sources only. The emissions in this category are from municipal wastewater treatment plants. All plants operating in the District are in the Data Bank System. The Data Bank contains throughput information submitted by individual plants by sources. Emissions are then calculated by using specific emission factors and control factors, if any, for a particular source operation supplied by the company. Methane (CH_4) and nitrous oxide (N_2O), both greenhouse gases, are also calculated at POTW's.

Monthly Variation

The data bank contains percentage of throughput data for each of the four 3-month seasonal periods: (December - February, March - May, June - August, September - November).

County Distribution

The county location of each processing plant as reported in the databank is used to distribute emissions into each county.

TRENDS

History

The historical growth profile was based on a combination of prior emissions data (back to 1990) and the Association of Bay Area Government's (ABAG's) 2009 Total Population data.

Growth

Projections to year 2030 were also based on ABAG's 2009 Total Population growth profile.

By: Stuart Schultz
Date: February 2011
Base Year 2008

EMISSION INVENTORY

CATEGORIES # 1157, 1158, 1686, & 1687

OTHER INDUSTRIAL/COMMERCIAL - PROCESSES/FACILITIES WASTE MANAGEMENT - LANDFILLS, FUGITIVE POINT & AREA, LANDFILL, FLARES, & LANDFILL, INTERNAL COMBUSTION ENGINES

EMISSIONS

Introduction

These four categories account for emissions from landfills in the Bay Area. Categories 1157 and 1158 account for organic and greenhouse gas (GHG) emissions (Biogenic CO_2, CH_4, and N_2O) from point and area source landfills, respectively. Category 1157 (Point Source Landfills) also has particulate emissions from activities such as vehicle traffic on unpaved roads, bulldozing, scraping, etc. Categories 1686 and 1687 account for point source criteria pollutant (particulate, organic, NO_x, SO_x, and CO) and GHG emissions (Biogenic CO_2, CH_4, and N_2O) from the combustion of landfill gases from flares and internal combustion engines (ICE), respectively, at landfills. Landfill gas may also be combusted in ICE's outside landfills; however, they are covered in Categories 303 (Reciprocating Engines—Gas Fuels) and 305 (Turbines—Gas Fuels).

Landfill gas production rates and compositions vary greatly, even within a single landfill. There are no comprehensive data leading to the development of generalized emission factors for the Bay Area. Biodegradation takes place over an extended period of time, therefore, waste generated in prior years must be considered for emissions calculations. It is assumed it takes 15 years for maximum biodegradation to take place. However, biodegradation occurs, to a lesser extent, 35 years and beyond. (For emission calculation purposes in Categories 1157 and 1158, 40 years for biodegradation was used.) Prior to the mid-1960's, it was assumed that 60% of the waste was buried in landfills and 40% of the waste was burned on-site. After that it was assumed the burned waste was diverted to the landfills.

Methodology

Point Sources

It is assumed all active landfills within the District are permitted sources. Inactive landfills less than 30 years old and have greater than one million tons of refuse in place are also considered permitted. These permitted landfills are considered to be point sources; their throughput and emission information has been inventoried in the District's database since the early 1980's. Although most point source landfills have collection systems associated with them, there are several landfills that do no have a collection system.

Landfills with Collection Systems

For those landfills with active collection systems, it is assumed that 25% escapes as fugitive landfill gas 75% of the gases are captured and are either destroyed by flaring or burned in an internal combustion engine (ICE) or turbine. Those captured gases that are flared or burned in an ICE or turbine are accounted for and reported to the California Air Resources Board (CARB) under our combustion "C" sources. The following are a list of source codes associated with the criteria pollutant and GHG emissions from landfills with collection systems:

1. G7145511

   The throughput associated with this source code represents the amount of landfill gas collected for a particular year. The District uses the throughput and emission factor data to calculate the fugitive methane and GHG emissions from this source based on the following assumptions:

   - The landfill gas collection system captures 75% of the total amount of landfill gas generated at the site (AP-42, Chapter 2.4); the remaining 25% of landfill gas is assumed to be fugitive emissions.

   - Landfill gas, on average, contains 55% methane (CH_4), 40% carbon dioxide (CO_2), with the remaining 5% nitrogen, oxygen, non-methane organic compounds, etc.

   - In accordance with the Intergovernmental Panel on Climate Change (IPCC) and EPA GHG inventory procedures, 10% of the CH_4 fugitive landfill gas is oxidized into CO_2. The N_2O emission factor was provided by CARB in their Documentation of California's Greenhouse Gas Inventory (Category: Managed waste Disposal Sites, Sector: Industrial: Landfills, not specified).

   - Constants used in the emission factor calculations are as follows:
     The standard molar volume of gases is 387.006 scf/lb-mole.
     The molecular weight of CH_4 is 16.043 lbs/lb-mole.
     The molecular weight of CO_2 is 44.010 lbs/lb-mole.

   - The CO_2 emissions from this source are considered to be biogenic.

2. Combustion Sources Using Landfill Gas

   The assumed 75% landfill gases captured are combusted in the "C" sources by flaring or used as fuel in turbines or IC engines. A 99% destruction efficiency of TOG is assumed for flaring operations; a 97% destruction efficiency of TOG is assumed when landfill gas is burned in an internal combustion engine. A slightly higher TOG destruction efficiency, 99% or more, is achieved in turbines. Particulate, NO_x, SO_x, and CO emissions are also considered as products of combustion.

Greenhouse gases (CO_2, CH_4, and N_2O) emissions are also calculated from these combustion sources. The CH_4 and CO_2 emission factors were based from both EPA AP-42 and District sources. The N_2O emission factor was based on California Energy Commission data. The CO_2 emissions emitted from these combustion sources are considered to be biogenic.

3. G7145580

   This source code represents the fugitive ROG emissions with throughput given as the amount of refuse as tons-in-place. There are no methane or GHG emissions associated with this source.

4. G7145540

   This source code represents fugitive ROG emissions from the on-site handling of contaminated soils. This soil is usually contaminated from gasoline or diesel, and the units associated with this material code are in tons/yr. There are no methane or GHG emissions associated with this source.

5. G7145466

   This source code represents particulate PM_{10} emissions from landfill activity that includes vehicle traffic on unpaved roads, bulldozing, scraping and dumping activities, wind erosion from land cover, etc. Throughput is based on tons of incoming waste for a particular year.

<u>Landfills without Collection Systems</u>

For those few landfills without collection systems, the following is the source code associated with this type of landfill:

1. G7159580

   The throughput from this source code represents the total tons in place of refuse. The District uses the throughput and emission factor data to calculate the fugitive organic and GHG emissions from this type of landfill based on the following assumptions:

   - The landfill gas generation rate (LGR) of methane is dependent upon the age of landfill, moisture content, type of refuse, etc. and will vary from landfill to landfill.

   - The landfill gas composition for these types of landfills is approximately 50% CH_4 and 50% CO_2. (There is additionally a small amount of ROG, but for calculation purposes assume the equal percentage split.)

- The constants used in emission factor calculations are the same as those used for Source Code G7145511.

- In accordance with the Intergovernmental Panel on Climate Change (IPCC) and EPA GHG inventory procedures, 10% of the CH_4 fugitive landfill gas is oxidized into CO_2. The N_2O emission factor was provided by CARB in their Documentation of California's Greenhouse Gas Inventory.

- The CO_2 emissions from this source are considered to be biogenic.

Area Sources

Area sources consist of inactive landfills that had less than 1 million ton of refuse in place. These landfills were closed many years ago and data is very limited. In 1999, it was estimated area source throughputs comprised 10% of the total waste in place. In future years, this value will decrease linearly because of less contribution from these area sources. In 2008, it was estimated area source throughputs comprised 7.75% of the total waste in place. The assumptions used estimate criteria pollutant (organics) and GHG (CO_2, CH_4, and N_2O) emissions listed below:

- The LGR of methane for these closed landfills was 0.030 mcf/year – ton-in-place.

- The landfill gas composition for area source landfills is similar to point source landfills without collection systems, namely 50% CH_4 and 50% CO_2. (There is additionally a small amount of ROG, but for calculation purposes assume the equal percentage split.)

- The constants used in emission factor calculations are the same as those used for Source Code G7145511.

- The ROG factor for area source landfills is the same as for point source landfills at 0.0089.

- In accordance with the Intergovernmental Panel on Climate Change (IPCC) and EPA GHG inventory procedures, 10% of the CH_4 fugitive landfill gas is oxidized into CO_2. The N_2O emission factor was provided by CARB in their Documentation of California's Greenhouse Gas Inventory.

- The CO_2 emissions from this source are considered to be biogenic.

Monthly Variation

Estimated daily emissions are assumed to be uniform for all months of the year. This is due to burial/insulation of the refuse that reduces impact of ambient temperature changes, allowing somewhat uniform biodegradation throughout the year.

County Distribution

Point Source Categories (Cat. Nos. 1157, 1686, and 1687)

The data bank system contains information on the county location of each landfill; hence, emissions are distributed to the counties accordingly. It is assumed San Francisco County has had no landfills within their boundaries; therefore, their refuse is transported to the other counties.

Area Source Category (Cat. No. 1158)

The county fractions were based in the number of closed landfills (not accounted for by the District) in the in each county. This data was obtained from the Solid Waste Information System (SWIS) at CalRecycle's website (http://www.calrecycle.ca.gov).

TRENDS

History & Growth

Category Nos. 1157 and 1158's historical and projected growth factors were based on the following:

- Association of Bay Area Government's (ABAG's) 2009 Population growth profile,
- Percentage of cumulative waste generation attributed to point or area source,
- Per capita waste generation, and
- Overall collection efficiency of the landfill gas.

As mentioned previously, prior to the mid-1960's, it was assumed 60% of the waste was buried in landfills (point source) and 40% of the waste was burned on-site, as in backyard incinerators. By 1999, it was assumed that 90% of the cumulative waste generation was attributed to point sources, and the remaining 10% was attributed to area sources. By 2030, it is assumed the point source percentage will increase linearly to 97.75% and the area source percentage will decrease linearly to 2.25%

Since the State of California passed a mandate (Assembly Bill 939) that required a reduction in waste generation, per capita waste generation in the District has decreased. Until 1990, this factor was approximately 1.32 tons/person/year; in 2008, it had decreased to 0.79 tons/person/yr. By 2030, it is assumed the per capita waste generation in the District will decrease linearly to 0.70 tons/person/year.

In addition to what was previously mentioned, Categories Nos. 1686 and 1687 historical and projected growth factors were based on the following:

Prior to 1984 (the year Reg. 8, Rule 34 was passed), it was assumed all landfill gases were emitted as fugitive emissions. By 1996, the overall collection efficiency at landfills was assumed to be 75%, with 25% of the landfill gases emitted as fugitive emissions. Between those two years, the collection efficiencies were interpolated.

Control

Currently, Regulation 8, Rule 34 (Solid Waste Disposal Sites) requires that certain landfills process landfill gases through a gas collection and emission control system such that:

1. There are no leaks that exceed 1000 PPM by volume measured as methane at any component or connector of the landfill gas collection system; and
2. The collected gases are process in an enclosed ground type flare with a TOG destruction efficiency of at least 98% by weight; or
3. The collected gases are processed in an energy recovery device or emission control system that reduces the amount of TOG by at 97% by weight.

By: Stuart Schultz
Date: February 2011
Base Year 2008

EIC Code: 12012202420000

SOURCE INVENTORY

CATEGORY # 52

LAND FARMING

EMISSIONS

Introduction

Land farming is a process in which waste (biosolids), primarily from dried sewage sludge, is deposited and spread on rural, open lands. Greenhouse gas emissions, namely methane (CH_4), and nitrous oxide (N_2O) were also calculated for this category.

Methodology

Emissions for this category are calculated by multiplying the annual activity (throughput) value for a particular year by the emission factor in question.

The annual activity (throughput) for this category was obtained from the March 2009 report "Bay Area Biosolids Management: Challenges, Opportunities, and Policies." The amount of biosolids generated in in the Bay Area in 2007 was estimated to be 158,000 dry tons. Approximately 19% of that amount, or 30,020 dry tons, was "land applied" for Land Farming purposes. The Association of Bay Area Governments' (ABAG's) 2009 Total Population growth profile was used to obtain the 2008 throughput value of 30,223 dry tons/year.

The emission factor for reactive organic gases (ROG) was obtained from the California Integrated Waste Management Board Contractor's Report to the Board, "Emissions Testing of Volatile Organic Compounds from Greenwaste Composting at the Modesto Compost Facility in the Sab Joaquin Valley", October 2007. The ROG emission factor for greenwaste /food scrap composting ranged from 1.3 – 2.6 lbs./ton composted. A mid-point value of 1.95 lbs./ton was used.

A ROG factor of 0.8689 was used to calculate the total organic gas (TOG) emission factor. This ROG factor was obtained from data compiled by the San Joaquin Valley Air Pollution Control District for greenwaste composting. The TOG emissions factor of 2.24 lbs./ton was calculated by dividing the ROG emission factor by the ROG factor. The CH_4 emission factor of 0.29 lbs./ton was calculated by subtracting the TOG emission factor by the ROG emission factor.

The N_2O emission factor of 1.1997 lbs./ton was obtained from the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories, Chapter 4, Biological Treatment of Solid Waste.

Monthly Variation

For monthly variation, the emissions are distributed evenly throughout the year.

County Distribution

Data attributing the throughput activity to the various Bay Area counties was obtained from the March 2009 report "Bay Area Biosolids Management: Challenges, Opportunities, and Policies."

TRENDS

History

Until the early 1990's, land farming consisted of wastes more from the industrial sector. Most of these industrial wastes are now transported outside the District to be spread on the land. Prior to 1990, the growth was based on the ABAG's 2009 Manufacturing Employment growth profile. Between 1990 and 1993 growth was interpolated.

Growth

Emissions after 1993 are assumed to grow at a rate similar to the population as provided by ABAG's 2009 Population growth profile.

By: Stuart Schultz
Date: February 2011
Base Year 2008

EIC Code: 19999502600000

EMISSION INVENTORY

CATEGORY # 53

OTHER INDUSTRIAL/COMMERCIAL - PROCESSES/FACILITIES
WASTE MANAGEMENT - OTHER

EMISSIONS

Introduction

This category accounts for emissions from other industrial and commercial - waste management facilities. Emissions from this category were obtained from point source data only, as contained in the District's Data Bank.

Methodology

This category contains emissions from point sources only. The Data Bank contains throughput information submitted by individual plants by sources. Emissions are then calculated by using specific emission factors and control factors, if any, for a particular source operation supplied by the company.

Monthly Variation

The data band contains percentage of throughput data for each of the four 3-month seasonal periods: (December - February, March - May, June - August, September - November).

County Distribution

The data bank system contains information on the county location of each processing plant; hence, emissions are distributed to the counties accordingly.

TRENDS

History

The historical growth profile was based on a combination of prior emissions data (back to 2005) and the Association of Bay Area Government's (ABAG's) 2009 Manufacturing Employment growth profile.

Growth

Projections to year 2030 were also based on ABAG's 2009 Manufacturing Employment growth profile.

By: Stuart Schultz
Date: February 2011
Base Year 2008

EMISSION INVENTORY

CATEGORY # 1709

COMPOSTING OPERATIONS

EMISSIONS

Introduction

Composting is a biological process where organic materials, such as leaves, grasses, etc., are decomposed by microorganisms to create a nutrient-rich, soil-like material. Composting most often takes place in aerobic conditions, however, under certain conditions, composting can occur under anaerobic conditions. These conditions include compost pile structure and density, particle size, low oxygen supply, moisture content, low oxygen supply, etc. Methane emissions increase under anaerobic conditions. Therefore, proper monitoring and management are very important to maintain aerobic conditions for efficient composting operation.

The composting process includes the following steps:

- Feedstock Preparation,
- Composting,
- Curing,
- Screening, and
- Storage.

In the feedstock preparation step, the composted organic materials are screened and, if required, processed in a grinder to achieve the best composting conditions. This mixture is then placed in rows or piles where the decomposition process begins. The initial phase of composting, lasting for about one month, is very active and generates temperatures high enough to kill weed seeds and pathogens. After this "active" phase, the material is cured at a slower rate and temperature. During this phase, the moisture content is reduced and a more stable product is produced. Once the compost is cured, the material is screened to produce the desired product and then stored prior to final distribution and use.

Methodology

In 2008, there were approximately 30 composting facilities[1] in the Bay Area. Ten (10) of these facilities are permitted by the District and considered point sources. The point sources contain annual activity (throughput) information for each applicable source that

[1] The composting operations that involve mushroom farming were not included in this count. The 2006 IPCC Guidelines for National greenhouse Gas Inventories does not assign mushroom farm media preparation to the waste sector for emission inventory development. It falls under the Industrial Processes and Product Use, Food and Beverage Industry, or Agriculture, Forestry, and Other Land Use, manure Management, Poultry (3A2i).

is stored in the District's Data Bank. Reactive organic (ROG) emissions are then calculated by using emission factors (generalized or specific) and control factors, if any, for a particular source operation supplied by the company. Some related compositing activity (i.e. chipping and grinding, transporting activities, etc.) are also permitted and particulate emissions are calculated.

The other approximate 20 facilities are considered area sources where annual throughput, criteria pollutant emission factors (TOG and ROG), and control activity (if any) are estimated. The TOG and ROG emissions are calculated by multiplying the throughput by the emission factor and, if applicable, the control factor.

Greenhouse Gas (GHG) emission, namely methane (CH_4) and nitrous oxide (N_2O), are also associated with composting activity. The CH_4 and N_2O emissions are calculated similarly to the criteria pollutant emissions mentioned above.

The throughput and emissions factors (TOG, ROG, and GHG) estimates were developed based on the following:

Throughput Data

For those composting facilities not permitted by the District (area sources), throughput data was provided by industry and CalRecycle officials or using CalRecycle's Solid Waste Information System's (SWIS's) database. The throughput information provided in the SWIS database represents maximum allowable throughputs. The actual throughput was estimated to be 60% of the SWIS database value.

The units for throughput information should be in tons per year, however, they may appear in other units, such as cubic yards per year (yd^3/yr), cubic yards per day (yd^3/day), tons per day, etc. For those throughputs that required a conversion factor to tons, the following bulk density values were used:

Greenwaste – 3.54 yd^3/ton
Mixed (greenwaste mixed with food, manure, etc.) – 2.24 yd^3/ton

The above conversion factors were taken from the California Integrated Management Board (CIWMB) Report, "Third Assessment of California's Compost and Mulch Producing Infrastructure", May 2009.

For throughputs that were in a volume per day format, it was assumed most facilities operated 260 days per year. However, for some facilities, this value may vary slightly.

Emission Factors

The Reactive Organic Gas (ROG) emission factors used for emission calculation purposes are listed below:

Greenwaste – 0.85 lb/ton
Greenwaste/Food Scrap (assume as mixed) – 1.95 lbs/ton

The emission factors above were cited in the October 2007 CIWMB study, "Emission Testing of VOC from Greenwaste Composting at the Modesto Compost Facility in the San Joaquin Valley." The mid-point value for each of the emission factors was used.

Total Organic Gas (TOG) emission factors were calculated by dividing the ROG emission factors by a ROG factor. A ROG factor, obtained from data compiled by the San Joaquin Valley Air Pollution Control District (SJVAPCD), of 0.8689 was used. The TOG emission factors used for emission calculation purposes are listed below:

Greenwaste – 0.98 lb/ton
Greenwaste/Food Scrap (assume as mixed) – 2.24 lbs/ton

Methane (CH_4) emission factors were assumed to be the difference between the TOG and ROG emission factors. The CH_4 emission factors used for emission calculation purposes are listed below:

Greenwaste – 0.13 lb/ton
Greenwaste/Food Scrap (assume as mixed) – 0.29 lbs/ton

The Nitrous Oxide (N_2O) emission factors varied from 0.12 to 1.1997 lbs/ton and were obtained from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 4, Biological Treatment of Solid Waste. The N_2O emission factors used for emission calculation purposes are listed below:

Greenwaste – 0.12 lb/ton
Greenwaste, including food – 0.6599 lb/ton
Mixed (greenwaste, manure, etc.) – 1.1997 lbs/ton

Emission Calculation

The TOG, ROG, CH_4, and N_2O annual emissions for an area source facility were calculated by multiplying the estimated throughput by the respective pollutant emission factor.

Monthly Variation

The emissions are assumed to be distributed evenly throughout the year.

County Distribution

The county distribution was based on the location and TOG emission data as found in data mentioned above.

TRENDS

History

It was assumed composting in the Bay Area began in the mid-1980's (1985 was used as the starting point). There was limited information in prior years, so it was assumed

throughput activity exhibited a linear decrease from 2005 back to 1985. From 2005 – 2008, the growth was based on the Association of Bay Area Government's (ABAG's) 2009 Total Population growth profile.

Growth

Projections to year 2030 were based on the ABAG's 2009 Total Population growth profile.

Control

Currently, there is no District rule regulating emissions from compost facilities. There are several facilities in the Bay Area with in-vessel composting where it is assumed there is an overall VOC control efficiency of 90%.

By: Stuart Schultz
Date: February 2011
Base Year 2008

EIC Code: 19917002600000

SECTION 6

PETROLEUM PRODUCTS EVAPORATION AND LEAKAGE

EMISSION INVENTORY

CATEGORIES #55-#58, #84-#85, #940

STORAGE TANKS

EMISSIONS

Introduction

Tanks are used at petroleum refineries to store raw materials, intermediate products, finished products, and wastes. There are numerous intermediate products in a refinery including liquefied petroleum gas, gasoline, kerosene, diesels, and fuel oils. The waste products include wastewater, spent acids, and oily sludge.

Categories 55-58 contain emissions from refineries tanks, and categories 84-85 account for emissions from tanks at other sites. Category 940 accounts for emissions from cleaning of all storage tanks.

Storage tanks at bulk plants and gasoline stations are inventoried in sections 6.4 and 6.9, respectively.

Methodologies

The categories for storage tanks contain emissions from both point and area sources. Tank emissions are calculated using equations and emission factors from U.S. EPA's Compilation of Air Pollutant Emisssion Factors, AP-42, Volume I: Station Point and Area Sources. The primary criteria pollutant emitted from storage tanks include hydrocarbon vapors or volatile organic compounds (VOCs).

The predominant types of storage tanks found in a refinery include:

- Fix roof tanks
- External floating roof tanks
- Internal floating roof tanks
- Conservation tanks, pressure tanks, and others

The types of tank along with the following parameters (given below) are used to calculate emissions.

- Tank diameter
- Paint factor
- Tank height
- Vapor space
- Temperature change
- Tank volume
- Throughput
- Stored material
- Factors specific to stored material

Point source emissions are obtained from the District's data bank system. The data bank contains information submitted by the individual refinery by tank sources. Area Source emissions are derived based on an estimated ratio between area and point source throughputs via tank type.

Monthly Variation and County Distribution

The county, month, and day factors are obtained from the data bank's information for each category.

TRENDS

History

Historical emissions have varied with refinery throughputs.

Growth

Projected growth for all refinery related categories was taken from the California Energy Commission report on California's Petroleum Infrastructure (2007) that predicted California refiners expand distillation capacity to increase at a rate of approximately one percent per year. California refiners have recently added and will continue to add more process units to produce reformulated gasoline. However, no large increases in emissions are expected.

Control

Regulation 8 Rule 5 controls emissions from the storage of organic liquids. Control efficiencies are estimated to range from 17% to 96%, depending on the type of tank, percentage of sources with true vapor pressures above 0.5 psi, and average true vapor pressure of the corresponding category. The following table show the control and rule efficiencies. (Sources with true vapor pressure greater than 0.5 psi are affected by this rule.)

Cat #	*type of tank/category*	*% less than 0.5 psi*	*average true vapor pres.,psi*	*% control efficiency*	*% rule effectiveness*
55	cone roof	87	1	17	97
56	ext. floating roof	24	4	65	98
57	int. floating roof	30	3	60	100
58	other refinery	33	>>20	96	99
84	cone roof	62	3	32	98
85	other non-refinery	46	8	65	65
940	tank cleaning	--	--	88	98

By: Tan Dinh
Date: December 2010
Base Year: 2008

EMISSION INVENTORY

CATEGORIES #60, #86-#91 & #795-#800

REFINERY & MARINE LOADING OPERATIONS
Other Refinery Loading Operations (60)
Marine Vessel Lightering (86-87)
Marine Vessel Ballasting (88-90)
Marine Vessel Cleaning & Gas Venting (91)
Refinery Tanker / Barge Loading (795-798)
Non-Refinery Tanker / Barge Loading (799-802)

EMISSIONS

Introduction

Category 60 includes all refinery loading operations other than tanker and barge loading. This category accounts for emissions mostly from loading racks and railroad/truck tank car loading.

The following categories include evaporation emissions due to handling of all organic products at marine loading facilities.

Categories 86 and 87 account for evaporation emissions due to the transfer of cargo (organic materials) from larger ships to smaller ships and barges. Lightering is necessary because large ships are unable to navigate the shallow waters of the San Francisco Bay. Since the mid-2000's, there has been little or no lightering activity in the San Francisco Bay.

Categories 88-90 account for evaporation emissions due to ballasting crude oil, gasoline, and other materials, respectively. Ballasting is the process of pumping seawater into petroleum holding tanks to make a vessel more stable. When water is pumped into a tank, the contaminated vapor in the tank is displaced into the atmosphere.

Emissions from ballasting are declining because few vessels now calling on Bay Area ports ballast into cargo tanks. Older vessels are being phased out of service in response to the Oil Pollution Act of 1990. Modern vessels have segregated ballast tanks that are used only for ballast water. There are no organic emissions emitted during ballast operations with segregated ballast tanks.

Category 91 accounts for emissions from gas venting. When a tank vessel unloads its product, organic vapors are left in the compartments. Frequently, vessels vent these vapors to the atmosphere for safety reasons.

Categories 795-798 account for all evaporative emissions from loading/unloading of gasoline, crude oil and other organic products from marine vessels at the oil refineries. Categories 799-802 account for evaporative emissions from loading/unloading of gasoline and crude oil from all non-refinery operations.

Methodologies

Area Sources:

For Categories 86 and 87, the refineries within the District were surveyed to obtain the throughputs (in 1000 gallons) transferred for a given year. The monthly variations and county distributions were also obtained from these surveys. Emission factors were

obtained from ARB's Emission Inventory Procedural Manual. Since 2005, there has been no lightering activity in the San Francisco Bay.

For Categories 88-90, the amount of material transferred was estimated from data found in the U.S. Army Corps of Engineers' 2008 Waterborne Commerce of the United States, Part 4--Waterways and Harbors-Pacific Coast, Alaska and Hawaii. The emission factors, ballasting amounts for the different fuels, etc. were obtained from California Air Resources Board's Methodology Document on Marine Petroleum Unloading (October 1997).

For Category 91, the following assumptions were made:

1. The average tanker delivering crude oil to the Bay Area has a deadweight tonnage of 120,000 tons. This represents a tanker volume of approximately 32.4 million gallons, assuming a density of 7.4 lbs./gal.

2. In 2008, it was estimated a total of 6,867,568 million gallons of crude was unloaded in Bay Area ports. Assuming the above tanker volume, this represents approximately 212 tanker visits.

3. Purging is not done that often at Bay Area ports. In the report, Oil Tanker Purging & Gas Freeing (December 1999), it was estimated purging occurred in connection with 35 – 50 arrivals per year. In 2004, it was estimated there were 12 venting operations per year. Since 2004, most ship operators perform their venting operations outside the District boundaries.

4. The emission factor used in purging applications is the same one developed for ballasting operations for crude oil (0.9 lb. VOC/1000 gal). Although ballasting and purging are different operations, they involve displacement of vapors remaining in the tank after cargo discharge.

Point Sources:

Categories 60 and 795-802 contain point sources permitted by the District. The District updates the data each year on a source-by-source basis using as input:

1. Process material throughputs as reported by the companies.

2. Emissions factors (these may be source specific factors reported by the companies or source test results or general factors, from the AP-42).

3. Emission control factors (device-specific or general).

Monthly Variation

For the point source categories (Cats. 60, 795-802), the monthly distribution was estimated based on each company's reported quarterly seasonal throughput data. For the area source categories (Cats. 88-91), the monthly distribution was assumed to be uniform throughout the year.

County Distribution

For the point source categories, the county location of each company, as reported in the Data Bank, is used to distribute emissions into each county. For the area source categories, the county distribution was based on the throughputs of products unloaded at the various Bay Area ports, as reported in the U.S. Army Corps of Engineers' 2008

Waterborne Commerce of the United States, Part 4--Waterways and Harbors-Pacific Coast, Alaska and Hawaii.

TRENDS

History

Prior years' growth factors for these categories were based on historical data (i.e. from the U.S. Army Corps of Engineers' Waterborne Commerce reports, the District's databank, etc.) and energy reports.

Growth

The projected growth for the Ballasting categories (Cat. 86-90), the Marine Vessel Cleaning & Gas Venting category (Cat. 91), and the Non-Refinery Tanker/Barge Loading categories (Cat. 799-802) were based on fuels report from the California Energy Commission. Projected growth for all refinery related categories was taken from the California Energy Commission report on California's Petroleum Infrastructure (2007) that predicted California refiners expand distillation capacity to increase at a rate of approximately one percent per year. The introduction of reformulated gasoline with lower vapor pressure will help in reducing evaporation emissions.

Control

- Categories 86 - 87:

  Regulation 8-46 (Marine Vessel to Marine Vessel Loading) became effective on July 1, 1991. The overall control efficiency is estimated to be 95%.

- Categories 88, 89, and 91

  On December 7, 2005, District Regulation 8, Rule 44 (Marine Tank Vessel Operations) was amended to extend organic compound control requirements to ballasting (Categories 88 and 89), gas freeing, tank washing, and purging activities (Category 91) from venting tank emissions to the atmosphere. This amendment controls organic emissions from loading operations of gasoline, gasoline blended stock, aviation gas, JP4 jet fuel, crude oil and other liquids with a flash point below 100 °F. (Since diesel, residual, and distillate fuel oils have flash points above 100 °F, these fuels from Category 90 were excluded from control requirements. The adoption of this amendment will control organic emissions by 95%.

- Categories 795 - 802:

  District Regulation 8-44 (Marine Vessel Loading Terminals) became effective July 1, 1991. The overall control efficiency is estimated to be 96%.

By: Tan Dinh/Stuart Schultz
Date: December 2010
Base Year: 2008

EIC Codes:
33037016000000 (Cats. 86, 87)
33037216000000 (Cat. 88)
33037211000000 (Cats. 89, 90)
49999500100000 (Cat. 91)
33036616000000 (Cat. 799)
33036611000000 (Cat. 800)
33036816000000 (Cat. 801)
33036811000000 (Cat. 802)

EMISSION INVENTORY

CATEGORIES # 61, # 868

NATURAL GAS DISTRIBUTION
-POWER PLANT FUEL USE
-OTHER FUEL USE

EMISSIONS

Introduction

Emissions associated with the transmission of natural gas are mostly fugitive organic emissions that occur due to the leaks in pipeline. Components such as valves, flanges, pumps, compressors, and pressure relief valves (PRVs) are the potential leak sources.

Category 61 and 868 account for fugitive organic emissions including methane (CH_4) from natural gas distribution system in the San Francisco Bay Area. Emissions from Pacific Gas and Electric's (PG&E's) pipeline system that distributes natural gas for its own use are covered in Category #61. Emissions from PG&E's pipeline system that distributes natural gas to residential, commercial and industrial customers are covered in Category #868.

Methodology

Fugitive emissions occur from leaks in the pipeline distribution system. Prior to 1990, an emission factor of 0.7% by volume of gas distributed was used. This factor was based on the South Coast Air Quality Management District report "Estimated Fugitive Emissions from Natural Gas Transmission for Calendar Year 1979", July, 1980. Since 1990, an emission factor of 0.2% has been used for both distribution systems: PG&E's own usage (Category #61) and PG&E's customers (Category #868). This emission factor is based on the 1990 PG&E report titled “Unaccounted-For Gas Project”. Emission Factors in pounds per thousand cubic feet of gas (lb/MCF) are shown below.

Categories	Total Organics (TOG)	Methane (CH_4)
61, 868	88.0	85.4

County Distribution

County distributions for Category #61 and #868 are based on natural gas usage data obtained from the California Energy Commission (CEC), PG&E, and City of Palo Alto.

Temporal Variation

The daily, weekly and monthly emission rates are considered to be uniform.

TRENDS

History

In general, emissions increase as activity increases and emissions decrease as activity decreases. In recent years, emissions for category #868 have been increasing, while emissions for category #61 have been on the decrease due to PG&E's divestments in power plants.

For Base Year 1983, all natural gas distribution losses were handled as a single category which had been designated as Category #43. The category has been subsequently split into two categories (#61 and #868) since Base Year 1987.

Growth

For Category #61, it was assumed that annual emissions would tend to follow two components: services industry employment and population by county in the District. As such, a hybrid growth profile was developed based on 50% of the appropriate county services industry employment value and 50% of the appropriate county population value in combination with CEC's natural gas data.

For Category #868, it was assumed that annual emissions would tend to follow: manufacturing industry employment and population by county in the District in combination with CEC's natural gas consumption forecasts. As such, a hybrid growth profile was developed based on 50% of the appropriate county manufacturing industry employment value and 50% of the appropriate county population value in combination with CEC's natural gas data.

The employment and population data was obtained from the Association of Bay Area Government's (ABAG's) 2009 "Projections" reports.

By: S. Claire
Date: January 2011
Base Year: 2008

EIC: 33031801100000

EMISSION INVENTORY

CATEGORIES # 62 - 63

BULK PLANTS - STORAGE TANKS

EMISSIONS

Introduction

These categories account for the organic emissions from the storage of organic liquids in tanks at bulk plant and terminals. The emissions are due to breathing and working losses. Breathing loss is the expulsion of vapor from tank due to vapor expansion and contraction of the liquid in the tanks. Working loss occurs when vapor is displaced during tank loading operations and when air drawn into the tank during unloading operations.

Methodologies

These categories contain point source emissions. Emissions were determined by the District's data bank system. These data originated with tank information (i.e. vapor pressure, tank color, size, throughput, etc.) supplied by the plants and stored in the District's data bank system. Throughput is updated upon permit renewal. The organic liquid storage emission factors were obtained from AP-42.

Monthly Variation

The data bank contains percentage of throughput data for each seasonal quarter: (December - February, March - May, June - August, September - October) provided by companies holding District permits.

County Distribution

Emissions distributed into counties were based on actual locations of the plants in the Bay Area.

TRENDS

History

Historical data was based on past years gasoline consumption in the Bay Area. The estimated gasoline consumption was obtained from California Taxable Gasoline Sales.

Growth

The reported year-to-year variation in emissions is due to changes in either the volume of materials put through the storage tank, or in the composition of the organic liquids stored. Projections are based on future gasoline consumption in the Bay Area.

Control

Emissions were reduced due to the effect of Regulation 8 Rule 5, amended on October 18, 2006. This rule requires reducing emissions of organic liquid loaded from loading operations at terminals and bulk plants.

On April 15, 2009, the District amended the Regulation 8, Rule 39 (Gasoline Bulk Plants). The amendments include a requirement to minimize the release of organic compounds during maintenance and repair operations, and a reduction in the allowable backpressure in new vapor recovery system piping.

By: Michael Nguyen
Date: February, 2011
Base Year 2008

EIC: 33038211000000 (Cat#62)
33038411000000 (Cat#63)

EMISSION INVENTORY

CATEGORY # 938

OTHER NON-GASOLINE TERMINALS AND BULK PLANTS STORAGE

EMISSIONS

Introduction

This category accounts for the organic emissions from the storage of organic liquids (non-gasoline) in tanks at bulk plant and terminals. The emissions are due to breathing and working losses. Breathing loss is the expulsion of vapor from tank due to vapor expansion and contraction of the liquid in the tanks. Working loss occurs when vapor is displaced during tank loading operations and when air drawn into the tank during unloading operations.

Methodology

This category contains point source emissions. The data originated with tank information (i.e. vapor pressure, tank color, size, throughput, etc.) supplied by the plants. Throughput is updated upon permit renewal. Throughput is updated upon permit renewal. The organic liquids (non-gasoline) emission factors were obtained from AP-42.

Monthly Variation

The data bank contains percentage of throughput data for each seasonal quarter: (December - February, March - May, June - August, September - October).

County Distribution

Emissions distributed into counties were based on locations of the plants in the Bay Area.

TRENDS

History

Historical data was based on past years gasoline consumption obtained from California Taxable Gasoline Sales in the Bay Area. Prior to 1999 Base Year source inventory, this category had been included from storage tank at bulk plants and terminals categories.

Growth

The reported year-to-year variation in emissions is due to changes in either the volume of materials put through the storage tank, or in the composition of the organic liquids stored. There is no data available to project emissions for this category. Therefore, projected emissions are assumed to grow at the rate of 0.5% per year.

Control

Emissions were reduced due to the effect of Regulation 8 Rule 6, amended in March 1982 The amended rules require reducing emissions of organic liquid loaded from loading operations at terminals and bulk plants.

By: Michael Nguyen
Date: February, 2011
Base Year 2008

EIC: 49999500100000 (Cat#938)

EMISSION INVENTORY

CATEGORIES # 64, 898

TRUCK LOADING
BULK PLANTS AND TERMINALS

EMISSIONS

Introduction

Fuels are delivered by tank trucks from the fuel terminals to service stations, commercial accounts and local bulk storage plants. Loading losses are primary source of evaporative emission from truck loading. Loading losses occur as organic vapors in the empty tank are displaced to atmosphere by the liquid being loaded into the tanks. These categories account for the organic emissions associate with transfer of gasoline to trucks from racks at terminals and bulk plants.

Methodologies

These categories contain point source emissions. Emissions were determined by the District's Data Bank System. These data originated with information supplied by the plants and stored in the District's Data Bank System. Throughput is updated upon permit renewal. The organic liquid storage emission factors were obtained from AP-42.

Monthly Variation

The Data Bank contains percentage of throughput data for each seasonal quarter: (December - February, March - May, June - August, September - October).

County Distribution

Emissions distributed into the nine counties were based on the actual locations of the plants in the Bay Area.

TRENDS

History

Historical emission data was based on past years Bay Area gasoline consumption. The estimated gasoline consumption was obtained from California Taxable Gasoline Sales, Board of Equalization.

Growth

Projections are based on future gasoline consumption in the Bay Area.

Control

Truck loading emissions were reduced due to the effect of Regulation 8 Rule 39, adopted on October 7, 1987 and Regulation 8 Rule 33, adopted on November 30, 1983. Regulation 8 Rule 33 requires to reduce emissions of precursor organic compounds from gasoline transfer operations at gasoline bulk terminals and delivery vehicles (Cat # 898). Regulation 8 Rule 39 requires to reduce emissions of precursor organic compounds from gasoline transfer operations at gasoline bulk plants and delivery vehicles (Cat # 64).

On April 15, 2009, the District amended the Regulation 8, Rule 33 (Gasoline Bulk Terminals) and Regulation 8, Rule 39 (Gasoline Bulk Plants). The amendments include a requirement to minimize the release of organic compounds during maintenance and repair operations, and a reduction in the allowable backpressure in new vapor recovery system piping.

By: Michael Nguyen
Date: February, 2011
Base Year 2008

EIC: 33099511000000 (Cat#64, #898)

EMISSION INVENTORY

CATEGORIES # 1600-1602

GASOLINE TRUCK TRANSPORT

EMISSIONS

Introduction

Gasoline truck transit losses are similar in many ways to breathing losses associated with petroleum storage. The gasoline is transferred by tank trucks from refineries and bulk plants for delivery to end user outlets. Emissions depend on the vapor tightness of the tank, the pressure relief valve settings, the pressure in the tank at the start of the trip, the vapor pressure of fuel being transported, and the degree of fuel vapor saturation of space in the tank.

Methodology

This category accounts for the organic emissions occurring in transit while transporting fuel by tank trucks. Emissions from gasoline cargo tanks include the fugitive emissions and emissions from maintenance. The emission points are from pressure-related fugitive (Cat#1600, Cargo Tank) emissions from the cargo tank fittings and valves, vapor hoses (Cat#1601, Loading-Return Vapor Hoses) after loading into the underground tank, and wetted wall emissions from the product (Cat#1602, Loading-Main Hoses).

- Pressure-related fugitive (Cat#1600, Cargo Tank) emissions are volatile organic vapors leaking from fittings, valves and other connecting points in the vapor collection system on a cargo tank. Pressure inside the cargo tank is caused by solar and reflective heat gains. Due to these heat gains, vapors inside the cargo tank expand and exert pressure to the tank walls, fittings and valves.

- Emissions from the vapor hose (Cat#1601, Loading-Return Vapor Hoses) are a result of vapors trapped inside the hose after product delivery to the underground tank. Some vapors condense inside the hose. When the hose is disconnected from the underground tank and truck fittings, the vapors and condensed vapor inside the hose are emitted into the ambient air.

- Emissions from the product hoses (Cat#1602, Loading-Main Hoses) are a result of residual product clinging to the walls of the hoses. Residual liquid, inside the hose, vaporizes into the ambient air resulting in emissions.

This methodology is presently based on ARB's methodology (Section 4.11). ARB estimated TOG emission factors as following:

- Pressure-Related (Cat#1600) Losses: 0.588 lbs per 1000 gallons,

- Vapor Hose (Cat#1601) Losses: 0.024 lbs per 1000 gallons, and
- Product Hose (Cat#1602) Losses: 0.133 lbs per 1000 gallons.

The estimates of gasoline consumption in the Bay Area were provided by Caltrans Transportation Planning Support Information System (TPSIS). These estimates were made by adjustments of Gasoline Dispensing Facility sales, total taxable gasoline sales (exclude aviation) from CA Board of Equalization, population, number of registered vehicles, and the number of driver's licensee. The throughput for this category is apportioned based upon throughput and TPSIS's estimated gasoline consumption. The total emissions are determined by multiplying the emission factor and the throughput.

Monthly Variation

Monthly variation of emissions was based on the monthly California taxable sales data from the Board of Equalization.

County Distribution

Emissions distributed into the nine counties were based on Caltrans Transportation Planning Support Information System's breakdown.

TRENDS

History

Prior to 1999 Base Year, taxable gasoline sales for California obtained from the Board of Equalization were assumed to distribute to all gasoline filling stations.

Growth

Gasoline consumption in 2007 reached record levels. However, the gasoline consumption decreased slightly during the economic recession in 2008 - 2010. Projections are based on future gasoline consumption in the Bay Area. Projections are based on future gasoline consumption in the Bay Area.

By: Michael Nguyen
Date: February, 2011
Base Year 2008

EIC: 33039511000000 (Cat#1600)
33039611000000 (Cat#1601)
33039711000000 (Cat#1602)

EMISSION INVENTORY

CATEGORY # 66

FILLING STATIONS - SPILLAGE

EMISSIONS

Introduction

Gasoline spillage occurs during filling such as prefill and postfill nozzle drip and overflow from the vehicle's fuel tank at service stations. The amount of spillage loss can depend on the service station business characteristics and nozzle types (conventional nozzle or vapor recovery nozzle).

Methodology

This category accounts for evaporative emissions resulting from spillage at vehicle filling stations. The estimates of gasoline consumption in the Bay Area were provided by Transportation Planning Support Information System, Caltrans. These estimates were made by adjustments of Gasoline Dispensing Facility sales, total taxable gasoline sales (exclude aviation) from CA Board of Equalization, population, number of registered vehicles, and the number of drivers' licenses. TOG emission factor was taken from AP-42. The TOG emissions are determined by multiplying the emission factor and the throughput.

Monthly Variation

The monthly variation of emissions was based on monthly California taxable sales data from the Board of Equalization.

County Distribution

Emissions distributed into the nine counties were based on Caltrans Transportation Planning Support Information System's breakdown.

TRENDS

History

Historical emissions were based on past years Bay Area gasoline consumption. Prior to 1990 Base Year, taxable gasoline sales for California obtained from the Board of Equalization were assumed to distribute to all gasoline filling stations in California. ARB estimated that Bay Area consumed 20.01% of this state total. The emissions for this category were determined according to this estimated throughput.

Growth

Gasoline consumption in 2007 reached record levels. However, the gasoline consumption decreased slightly during the economic recession in 2008 - 2010. Projections are based on future gasoline consumption in the Bay Area.

Control

Emissions were reduced due to the improvement of vapor recovery nozzle in Phase II Gasoline Dispensing Facilities. Regulation 8 rule 7 does not specify emission reduction for this category. However, the improvement of the vapor recovery nozzles reduces spillage at vehicle filling services stations.

By: Michael Nguyen
Date: February, 2011
Base Year 2008

EIC Code: 42041260120000 (Cat#66)

EMISSION INVENTORY

CATEGORIES # 67 - 74

FILLING STATIONS - STORAGE TANKS

EMISSIONS

Introduction

Emissions from gasoline dispensing facilities (GDF) are generated when gasoline vapors in the underground storage tank are displaced to the atmosphere by the gasoline being loaded into the tank. The emissions are due to breathing (vapor expansion and contraction of liquid in the tank) and working (from filling and emptying the tanks). Breathing losses occur as a result of dinural temperature and pressure variations. Working losses occur as fueling from underground storage tanks, fresh air is entered into the tank through the vent. Because this entering air is not at equilibrium with the liquid in the tank, evaporation of liquid occurs. Most gasoline dispensing facilities (GDF) in the Bay Area were equipped with Phase I and/or Phase II vapor recovery systems. Phase I vapor recovery system employs a dual hose that recovers gasoline vapor back to the tank truck during the filling of underground tanks. The integral part of Phase II vapor recover system is the vapor recovery nozzle and hose that efficiently collect the displaced vapors.

Methodologies

These categories account for organic emissions associated with the storage of fuel at gasoline service stations (or GDF). The estimates of gasoline consumption in the Bay Area were provided by Caltrans' Transportation Planning Support Information System (TPSIS). These estimates were made by adjustments of Gasoline Dispensing Facility (GDF) sales, total taxable gasoline sales from California Board of Equalization, population, number of registered vehicles, and the number of drivers' licenses. The throughput for each type of GDF was estimated based on the information contained in the District's data bank.

The 2008 gasoline consumption in the Bay Area was 7,714 thousand gallons per day. Emission factors were taken from AP-42, Section 4.4. The total emissions for area source categories are determined by multiplying the emission factor, control factor and throughput.

Monthly variation

Monthly variation of emissions was based on gasoline usage data for California. The monthly Bay area gasoline usage was estimated from Board of Equalization Taxable Gasoline Sales monthly report.

County Distribution

Emissions distributed into the nine counties were based on Caltrans' Transportation Planning Support Information System's breakdown.

TRENDS

History

Emissions for these categories had been reduced due to Phase I and II vapor balance system requirements since 1975. Prior to 1990 Base Year, taxable gasoline sales for California obtained from the Board of Equalization were assumed to distribute to all gasoline filling stations in the California. ARB estimated that Bay Area consumed 20.01% of this state total. The emissions for this category were determined according to this estimated throughput.

Growth

Gasoline consumption in 2007 reached record levels. However, the gasoline consumption decreased slightly during the economic recession in 2008 - 2010. Projections are based on future gasoline consumption in the Bay Area.

Control

Emissions were reduced due to the effect of Regulation 8, Rule 7, Phase II requirements and the following actions:

- In July 1976, California Health & Safety Code required CARB certified 90% Phase II gasoline dispensing facilities.
- In August 1978, CARB amended Phase II GDF to 95% efficiency.
- In July 1986, CARB issued "Rectification Orders".
- In October 1990, District adopted pressure-vacuum valve requirements for GDF.
- In January 1992 , Re-formulated Gasoline, Phase I , and
- In January 1999, Re-formulated Gasoline, Phase II.

In March 2000, California Air Resources Board (CARB) adopted a series of new Enhanced Vapor Recovery (EVR) amendments to its gas station vapor recovery regulations (Phase I and Phase II). In addition, CARB adopted new standards:

- to make vapor recovery system compatible with on-board vapor recovery (ORVR) systems on motor vehicles,
- to reduce gasoline spillage, liquid retain in the nozzles, and
- to pressure-related fugitive emissions.

The adopted amendments also include mandatory In-Station-Diagnostics (ISD), which are requiring electronic monitoring of vapor recovery system operation and performance. The table below summarizes the EVR implementation schedule.

Control Type	Effective Date	Certification Requirement Date
Phase I Vapor Recovery	4/1/2001	4/1/2001
Phase II Vapor Recovery	4/1/2003	4/1/2003
ORVR Compatibility	4/1/2001	4/1/2003
Liquid Retention • Initial limit: 350 mls/1000 gallons • Final limit: 100 mls/1000 gallons	 4/1/2001 4/1/2001	 4/1/2001 4/1/2003
Spillage and Dripless Nozzles	4/1/2001	4/1/2004
In-Station Diagnostics • >1,800,000 gal/year • >160,000 gal/year	 4/1/2003 4/1/2004	 4/1/2003 4/1/2004

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EIC: 33037611000000 (Cat#67)
33037611000000 (Cat#68)
33037611000000 (Cat#69)
33037611000000 (Cat#70)
33037411000000 (Cat#71)
33037411000000 (Cat#72)
33037411000000 (Cat#73)
33037411000000 (Cat#74)

EMISSION INVENTORY

CATEGORIES # 75 - 78

FILLING STATIONS - FILLING VEHICLE TANKS

EMISSIONS

Introduction

Motor vehicle refueling emissions come from vapors displaced from the automobile tank at gasoline dispensing facilities. The quantity of evaporative emissions depends on gasoline temperature, automobile tank temperature, gasoline RVP and dispensing rate. The control technique for vehicle refueling emissions is Phase II vapor recovery system. The Phase II is equipped with a rubber boot to collect and the route the vapors through the nozzle into a coaxial vapor-liquid hose and to the dispenser and into storage tank.

Methodologies

These categories account for organic emissions at vehicle filling stations during refueling operations. The estimates of gasoline consumption in the Bay Area were provided by Transportation Planning Support Information System (TPSIS), Caltrans'. These estimates were made by adjustments of Gasoline Dispensing Facility (GDF) sales, total taxable gasoline sales from California Board of Equalization, population, number of registered vehicles, and the number of driver's licensee. The throughput for each type of GDF was estimated based on the information contained in the District's data bank. There are 2,548 GDF in operation in the Bay Area.

The 2008 gasoline consumption in the Bay Area was 7,714 thousand gallons per day. Emission factors were taken from AP-42, Section 4.4. The total emissions for area source categories are determined by multiplying the emission factor, control factor and throughput.

Monthly variation

Monthly variation of emissions was based on gasoline usage data for California by months. The monthly Bay Area gasoline usage was estimated from Board of Equalization Taxable Gasoline Sales monthly report.

County Distribution

Emissions distributed into the nine counties were based on Caltrans Transportation Planning Support Information System's breakdown.

TRENDS

History

Emissions for these categories had been reduced due to Phase II vapor balance system requirements since 1976. Prior to 1990 Base Year, taxable gasoline sales for California obtained from the Board of Equalization were assumed to distribute to all gasoline filling stations in the California. ARB estimated that Bay Area consumed 20.01% of this state total. The emissions for this category were determined according to this estimated throughput.

Growth

Gasoline consumption in 2007 reached record levels. However, the gasoline consumption decreased slightly during the economic recession in 2008 - 2010. Projections are based on future gasoline consumption in the Bay Area. Projected emissions from 2000 to 2030 are expected to increase at the rate of 0.25% per year.

Control

Emissions were reduced due to the effect of Regulation 8, Rule 7, Phase II requirements and the following actions:

- In July 1976, California Health & Safety Code required CARB certified 90% Phase II gasoline dispensing facilities.
- In August 1978, CARB amended Phase II GDF to 95% efficiency.
- In July 1986, CARB issued "Rectification Orders".
- In October 1990, District adopted pressure-vacuum valve requirements for GDF.
- In January 1992 , Re-formulated Gasoline, Phase I , and
- In January 1999, Re-formulated Gasoline, Phase II.

In March 2000, California Air Resources Board (CARB) adopted a series of new Enhanced Vapor Recovery (EVR) amendments to its gas station vapor recovery regulations (Phase I and Phase II). In addition, CARB adopted new standards:

- to make vapor recovery system compatible with on-board vapor recovery (ORVR) systems on motor vehicles,
- to reduce gasoline spillage, liquid retain in the nozzles, and
- to pressure-related fugitive emissions.

The adopted amendments also include mandatory In-Station-Diagnostics (ISD), which are requiring electronic monitoring of vapor recovery system operation and performance.

The table below summarizes the EVR implementation schedule.

Control Type	Effective Date	Certification Requirement Date
Phase I Vapor Recovery	4/1/2001	4/1/2001
Phase II Vapor Recovery	4/1/2003	4/1/2003
ORVR Compatibility	4/1/2001	4/1/2003
Liquid Retention • Initial limit: 350 mls/1000 gallons • Final limit: 100 mls/1000 gallons	 4/1/2001 4/1/2001	 4/1/2001 4/1/2003
Spillage and Dripless Nozzles	4/1/2001	4/1/2004
In-Station Diagnostics • >1,800,000 gal/year • >160,000 gal/year	 4/1/2003 4/1/2004	 4/1/2003 4/1/2004

By: Michael Nguyen
Date: February, 2011
Base Year 2008

EIC: 33037811000000 (Cat#75)
33037811000000 (Cat#76)
33037811000000 (Cat#77)
33037811000000 (Cat#78)

EMISSION INVENTORY

CATEGORY # 1197

FILLING STATIONS - SPILLAGE/EXCESS EMISSIONS

Introduction

This category accounts for excess emissions from gasoline dispensing nozzles at gasoline service stations. The excess emissions are comprised of spitback, pseudo-spillage, low air to liquid ratio, pressure-related fugitive emissions, idle-nozzle emissions occurring after a refueling using Emco Wheaton A4001 nozzles and "whoosh" emissions. Spitback, pseudo-spillage, low air to liquid ratio, and pressure-related fugitives excess emissions apply only to Phase II vapor recovery systems using "bootless" nozzles. Idle nozzle emissions apply to refueling events using Emco Wheato n A4001 balance-type nozzles. "Whoosh" emissions are from all vehicle fuel tanks. In 1995, 352 gasoline service stations were equipped with vacuum-assist Phase II vapor recovery systems utilizing bootless nozzles. The bootless nozzle design typically, but not always, uses a coaxial spout design. Product flows through the inner tube, while a vacuum pump draws the vapors through the outer portion of the coaxial spout. The primary marketing advantage of the bootless nozzle is that it does not require the bellows necessary on balance-type nozzles. The recovered vapors are then sent back to underground storage tank under a slight pressure. Because of excess dispensing rates, and certain design issues, the initial bootless nozzles were more prone to spitback and spillage.

Excess emissions

- Spitback Spillage: Spitback is the forcible ejection of gasoline from the fillpipe, upon activation of the nozzle's primary shutoff mechanism, at the end of a fueling event. When gasoline dispensing rate is greater than ten gallons per minute (10 gpm), the nozzle's primary shutoff mechanism fails to adequately cease dispensing. Normally the bellows on a balance-type nozzle redirects spitback into the motor vehicle's fillpipe. In the case of bootless nozzles, liquid gasoline leaves the fillpipe and spills on both the vehicle and ground. Two of the "bootless" vacuum-assist Phase II systems were certified at dispensing rates over 10 gpm, the Gilbarco VaporVac (13.0 gpm) and the Hasstech (12.0 gpm). In addition, based on confusion within the industry, many of the Dresser/Wayne WayneVac bootless systems were also installed and operated at dispensing rates well in excess of 10 gpm.

- Pseudo-Spillage: Pseudo spillage in bootless nozzle is from the liquid gasoline retained in the (a) product side of the nozzle, (b) vapor passage of the nozzle, (c) primary shutoff chamber of the nozzle, and (d) vapor passage of the coaxial hose. This liquid is on the atmosphere side of any check valves and it either evaporates between refueling events, or is spilled as the next customer attempt to insert the nozzle into the fillpipe.

  Balance type nozzles are required to possess a mechanism that prevents the nozzle from dispensing gasoline unless the bellows is compressed. This device prevents

prefueling spillage caused by inadvertently depressing the nozzle trigger prior to insertion into the vehicle fillpipe. Many of the bootless nozzles will "spit" gasoline if the trigger is depressed.

It is important that a nozzle be securely latched onto the lip of the fillpipe to prevent the nozzle from falling out during a refueling event. Commonly used bootless nozzles use a spout spring to serve this function. This specific spring, however, does not make a secure connection to the fillpipe in most vehicles. Since the nozzles used do not possess an attitude shutoff design, if the nozzle falls out of the fillpipe, it will continue to dispense gasoline until it hits the ground and in some instances will continue to dispense gasoline until the nozzle or dispenser is deactivated.

- Low Air to Liquid (A/L) Ratio: Excess emissions caused by low collection efficiencies due to inadequate air to liquid (A/L) ratios occur at bootless nozzles systems. The BAAQMD's testing of over 1,200 refueling gasoline service stations equipped with the WayneVac vacuum assist systems showed an average A/L of 0.77. Low A/L ratios reduce the ability of the system to adequately collect vapors from the vehicle fuel tank. Assuming a linear relationship between A/L and collection efficiency, and collection efficiency of 96% at A/L of 1.00, the collection efficiency at 0.77 A/L can be calculated as 96% x 0.77 = 73.9%. Therefore, the excess emission factor is:

  (8.4 lbs/1000 gal)(96% -73.9%) = 1.85 lbs/1000 gal

- Pressure-Related Fugitives: Many of the defects causing the low A/L ratio at the bootless nozzle system that allows ambient air to be ingested into the underground storage tanks. This air evaporates liquid gasoline, creating an increase in the storage tank headspace pressure. Excess headspace pressure in the storage tank results in excess pressure-related fugitive emissions.

- Idle Nozzle Emissions: BAAQMD source test data shows that the Emco Wheaton A4001 nozzles emit more than other balance system nozzles. The vapor check valve in the Emco Wheaton A4001 nozzle is located between the hose and the dispenser, instead of being an integral part of the nozzle. Therefore, a portion of the condensed gasoline left in the hose after each refueling event evaporates and is emitted via the nozzle. Due to thermal considerations, emissions are greatest during the summer months.

- Whoosh Emissions: "Whoosh" emissions are the emissions released when the gasoline cap on the vehicle tank is removed for fueling.

Table I shows the 1995, 2000, 2003 and 2008 estimated emissions along with 1995 gasoline throughput and emission factors used for each category.

Table I - Estimated 1995, 2000, 2003 and 2008 Excess Emissions

Cause of Excess emissions	**1995 Throughput (1000gallons /day)**	**1995 TOG Emission Factor (lbs/1000 gal)**	**1995 Emissions (tons/day)**	**2000 Emissions (tons/day)**	**2003 Emissions (tons/day)**	**2008 Emissions (tons/day)**
1. Spitback Spillage [a]	160	19.7	1.58	0.00	0.00	0.00
2. Pseudo-Spillage [b]	3,194	0.75	1.20	0.31	0.06	0.06
3. Low Air to Liquid (A/L) Ratios [c]	1,597	1.85	1.48	0.39	0.07	0.07
4. Pressure-Related Fugitives [d]	3,194	3.97	6.34	5.25	3.17	1.04
5. Idle-Nozzle Emissions Occurring after refueling [e]	1,675	1.60	1.34	0.45	0.07	0.06
6. "Whoosh" Emissions [f]	7,986	0.66	2.64	1.76	1.21	0.43
Annual Average			**14.60**	**8.15**	**4.59**	**1.66**

Total gasoline consumption in the Bay Area was obtained from Caltrans. The 1995 calendar year gasoline consumption was 2,915,034 thousand gallons, or 7,986 thousand gallons per day.

Assumptions:

This category accounts for only the excess emissions resulting from the use of bootless nozzles at gasoline dispensing facilities (GDF), idle-nozzle emissions occurring after refueling, and "Whoosh" emissions.

a Forty percent of the daily gasoline was pumped through bootless nozzles. Five percent of the vehicles were subjected to the excess spitback spillage. Therefore,

Throughput = (7,986 thousand gallons)(40%)(5%)
= 160 thousand gallons

The emission factor for excess spitback caused by high dispensing rates was estimated to be 19.7 lbs/1,000 gallons based on bootless nozzle tests conducted by District Source Test Engineers.

b All bootless nozzles were subjected to this loss; therefore, throughput is 40% of the gasoline consumption.

The emission factor for Pseudo-spillage was estimated to be 0.75 lbs/1000 gallons based on bootless nozzle tests conducted by District Source Test Engineers.

c Fifty percent of bootless nozzles were equipped with the WayneVac system which showed low A/L ratios.

Throughput = (7,986 thousand gallons)(40%)(50%)
= 1,597 thousand gallons

Emission factor for Low Air to Liquid Ratios was obtained from the results of several bootless nozzle tests conducted by District Source Test Engineers.

d All bootless nozzles were subjected to this loss; therefore, throughput is 40% of the gasoline consumption.

The emission factor for Pressure-Related Fugitives was estimated to be 3.97 lbs/1000 gallons based on the results of several tests conducted by District Source Test Engineers.

e 20.97% of the nozzles in the Bay Area is Emco Wheaton (EW) A4001 nozzles having excess idle-nozzle emissions. Therefore,

Throughput = (7,986 thousand gallons)(20.97%)
= 1,675 thousand gallons

The refueling uncontrolled emission factor is 8.4 lbs/1000 gallons. Since 95% is controlled, 5% emissions are already accounted for in other categories. The excess idle nozzle emission factor is based on the assumption that EW 4001 nozzles emit 20% greater emissions than other nozzles, as stated in Toxics Committee of California Air Pollution Control Officers Association (CAPCOA), December 1997 report. Therefore, the EW 4001 idle nozzle emission factor is:

Emission Factor = (8.4 lbs/1000 gallons)(95%)(20%)
= 1.60 lbs/1000 gallons

f Emission factors for "whoosh" emissions were obtained from "Gasoline Service Station Industrywide Risk Assessment Guidelines" prepared by the Toxics Committee of the California Air Pollution Control Officers Association (CAPCOA), December 1997. This throughput for "whoosh" emissions applies to total gasoline consumption in the Bay Area. It must be noted that several designs of Onboard Refueling Vapor Recovery (ORVR) vehicles greatly reduce the emissions from this category.

Steps taken to Control Excess Emissions

Spitback Spillage

Because the US EPA requirement to limit dispensing rates (10 gallons per minute or less), effective July 1, 1996 all of the excess emissions due to spitback emissions have been eliminated. Aggressive enforcement, including measuring dispensing rates, will ensure compliance.

Pseudo-Spillage

Bay Area AQMD developed an inspection procedure, GDF-IP-04, to quantify these emissions on a per nozzle basis and limit pseudo-spillage to 3 drops per minute. Regulation 8, Rule 7 was amended to limit pseudo-spillage on all new installations. It is estimated that 95 percent of these excess emissions will be reduced by 2003.

Low Air to Liquid (A/L) Ratios

The emissions caused by low A/L occur both as reduced collection efficiency during the refueling event and increased pressure-related emissions caused by air ingestion through leaks in nozzles not being used during the refueling activity. The Bay Area has worked closely with CARB to have one dispenser manufacturer require retrofitting systems which had liquid traps in the vapor piping to eliminate this problem. All new and rebuilt nozzles are also now equipped with the improved spouts. The Bay Area AQMD also imposed an Abatement Order on Shell, the company which has the largest population of bootless systems. As a result, A/L tests are being conducted quarterly and equipment checks, including the "Bag Test" developed by the Bay Area AQMD are required to be conducted monthly. It is estimated that 95 percent of these excess emissions will be reduced by 2003.

Pressure-Related Fugitives

The Bay Area developed two additional inspection procedures:

- a simple visual inspection procedure for both the affected industry and local inspectors to detect vapor leaks in the Phase I equipment, and
- an inspection procedure to determine compliance with the pressure integrity performance specification (0.38 CFH @ 2.0 inches water column) for drop tube based overfill protection.

These changes improve the performance of Phase I equipment in service stations, and maintain the integrity of the systems between tests. It is estimated that 50 percent of these excess emissions will be reduced by 2003.

California Air Resources Board (CARB) adopted a series of new Enhanced Vapor Recovery (EVR) amendments to its gas station vapor recovery regulations (Phase I and Phase II) in March 2000. The adopted amendments also include mandatory In-Station-Diagnostics (ISD), which are requiring electronic monitoring of vapor recovery system operation and performance. The certification requirement of In-Station-Diagnostics is expected to be fully implemented by April 2004. However, emission reductions will be gradual and take longer. The pressure-related fugitive emissions will be reduced 80 percent by 2006.

Idle Nozzle Emissions

A revision to Regulation 8, Rule 7 disallowed the use of balance nozzles without an integral vapor valve (i.e. the Emco-Wheaton A4001 nozzles). It is estimated that 95 percent of these excess emissions will be reduced by 2003.

Whoosh Emissions

Some onboard refueling vapor recovery (ORVR) systems in post 2000 cars have a design which minimizes the pressure-related vehicle tank headspace losses when the fill cap is removed. It is estimated that 80 percent of these excess emissions will be reduced by 2006.

ARB Actions

In March 2000, California Air Resources Board (CARB) adopted a series of new Enhanced Vapor Recovery (EVR) amendments to its gas station vapor recovery regulations (Phase I and Phase II). In addition, CARB adopted new standards:

- to make vapor recovery system compatible with on-board vapor recovery (ORVR) systems on motor vehicles,
- to reduce gasoline spillage, liquid retain in the nozzles, and
- to pressure-related fugitive emissions.

The adopted amendments also include mandatory In-Station-Diagnostics (ISD), which are requiring electronic monitoring of vapor recovery system operation and performance. The table II below summarizes the EVR implementation schedule.

Table II - EVR implementation schedule

Control Type	Effective Date	Certification Requirement Date
Phase I Vapor Recovery	4/1/2001	4/1/2001
Phase II Vapor Recovery	4/1/2003	4/1/2003
ORVR Compatibility	4/1/2001	4/1/2003
Liquid Retention • Initial limit: 350 mls/1000 gallons • Final limit: 100 mls/1000 gallons	 4/1/2001 4/1/2001	 4/1/2001 4/1/2003
Spillage and Dripless Nozzles	4/1/2001	4/1/2004
In-Station Diagnostics • >1,800,000 gal/year • >160,000 gal/year	 4/1/2003 4/1/2004	 4/1/2003 4/1/2004

Monitoring of vapor recovery system operation and performance per CARB's mandatory In-Station-Diagnostics, pressure-related fugitive emissions will be further reduced by 2003 and beyond.

By: Michael Nguyen
Date: February, 2011
Base Year 2008

EIC: 33038011000000

EMISSION INVENTORY

CATEGORY # 1434

PORTABLE FUEL CONTAINER SPILLAGE

EMISSIONS

Introduction

Portable fuel containers or "Gas cans", and gas can spouts are used to refuel off-road engines and equipment (i.e. lawnmowers, chainsaws, motorcycles, etc.). Portable fuel containers are made of either plastic or metal in variety shapes and sizes ranging form one to more than six gallons capacity. Portable fuel containers are designed for transportation, storing and dispensing fuel. The California Air Resource Board (CARB) regulates all portable fuel containers manufactured for sale and use in 2000. The regulations are intended to reduce refueling emissions from equipment and engines in the off-road categories that are predominantly refueled with portable fuel containers. The Mobile Source Control Division (MSCD) of CARB conducted surveys to establish the number of statewide portable fuel container population in 1998. These surveys show that there are 9,878,706 portable fuel container units statewide. The data also indicate that 94% of portable fuel containers are used in residential households, and 6% for commercial use. Therefore, the effect of the statewide regulations on commercial users (i.e., tree trimming services, landscape maintenance professionals, automobile tow services, etc.) would be insignificant. Using total container population and an average useful life of 5 years suggested by several manufacturers, ARB estimates the total sales of all portable fuel containers statewide.

Methodology

This category accounts for evaporative emissions resulting in spillage from refueling, transport and storage of the portable fuel containers. These portable containers contribute emissions by:

- permeation of vapors through walls in containers made from plastic;
- escaping fumes while fuel is being poured into equipment;
- spillage and/or over-filling as fuel is being poured into equipment;
- spillage and evaporation through secondary vent holes; and
- evaporation through inadequately capped spouts.

The MSCD survey indicated that 1,975,741 units of residential and commercial portable fuel container were sold in 1998. Assumed 20 percent of these units are sold in the Bay Area. This figure was derived from Bay Area household population compared to statewide data. CARB has grouped the various sizes of portable fuel containers into three categories as shown in Table 1.

Table 1 – 1998 Statewide Residential and Commercial Sales Data

Container Sizes (gallons)	Annual Unit Statewide Sales
1 - 1.5	773,930
2 - 2.5	704,137
5 – 6	497,674
Total	1,975,741

The 2000 statewide uncontrolled ROG emissions from portable fuel containers are 50.3 tons per day statewide. The Bay Area contributes an estimated 19.5% or 9.8 tons per day, uncontrolled ROG emissions. Table 2 shows the 2000, 2005, and 2010 estimated Portable Fuel Container ROG emissions in the Bay Area.

Table 2 – Bay Area Portable Fuel Container ROG Emissions in 2000, 2005, and 2010

Year	**ROG Emissions** (Tons/Day)
2000	9.80
2005	6.66
2010	3.83

CARB estimates 35.7 tons of uncontrolled ROG emissions per day statewide from portable fuel containers in 2005.

Monthly Variation

Monthly variation of emissions was based on the monthly California taxable gasoline data from the Board of Equalization.

County Distribution

County household population from ABAG's 2009 Projections was used to distribute emissions for each county.

TRENDS

History

Historical data (portable fuel container sales) were not available. Therefore, emissions were based on past years Bay Area household population.

Growth

ARB projected ROG emissions from portable fuel containers are listed in the data section.

Control

On September 11, 2000, CARB regulated all portable fuel containers manufactured for sale and use in California. This regulation required all portable containers and spouts to have an automatic shut-off feature to prevent overfilling of power equipment fuel tanks. The spouts should also have an automatic closing feature so the can would be sealed when not in use. This gas can regulation prevented spills during equipment fueling and evaporation during fuel storage. CARB estimated an overall reduction of 3 tons per day (approximately 30 percent compared to previous estimates) in ROG emissions if this regulation was fully implemented by 2005.

By: Michael Nguyen
Date: February, 2011
Base Year 2008

EIC: 89089511000041 (Cat#1434)

EMISSION INVENTORY

CATEGORIES # 79 - 80

AIRCRAFT FUELING

EMISSIONS

Introduction

Emissions from these categories occur during refueling (including spillage) of general aviation, commercial, and military aircraft with aviation gasoline or jet fuel. Over-the-wing and single point pressure fueling are two systems used by airports for refueling aircraft. The over-the-wing is similar to a service station without a vapor recovery system. Single point pressure systems use pressure and a closed connection to refuel aircraft. The gasoline vapors in the aircraft tank are vented into the atmosphere through vents on the wings. Other sources of emissions for these categories are also from working and breathing of the underground storage tank during refueling.

Methodologies

The amount of aviation and jet fuel usage from San Jose International Airport and Oakland International Airport were obtained from the airport's Monthly Activity Report. The fuel usage at the other airports were determined by apportioning the Oakland Airport usage with the number of operations. The uncontrolled emission factors of gasoline service station are used for refueling with gasoline over-the-wing. The emission factors are chosen based on EPA, AP-42 publication and engineering judgment. Total organic emissions for aircraft refueling categories are determined by multiplying the emission factor and estimated throughput.

Monthly Variation

Monthly variations of emissions are based on the monthly traffic counts at the San Jose International Airport.

County Distribution

Emissions were distributed into the nine counties based on aircraft operations activity at each airport in each county.

TRENDS

History

Historical emission data was based on the aircraft operations at San Jose International Airport. These categories were created to account for the organic emissions at filling stations during aircraft refueling of aviation and jet fuel since 1987 Base Year emission inventory.

Growth

Projections to 2030 are based on the estimates of the number of operations and revenue passenger miles as predicted by the airlines industries.

By: Michael Nguyen
Date: February, 2011
Base Year 2008

EIC: 49999500100000 (Cat#79-80)

EMISSION INVENTORY

CATEGORIES # 81 - 83

SHIP AND BOAT FUELING

EMISSIONS

Introduction

Emissions from these categories occur during the fueling of ships, tugboats, ferry boats, fishing boats, and recreational boats, including spillage and from the working and breathing emissions of storage tanks. Emissions result from vapor displacement to the atmosphere.

Methodology

Fuel usage from Ships and Tugboats were estimated based on the number of ships data provided by the San Francisco Marine Exchange (see also Ships Categories). It was assumed that about 30 % of the fuel used by ships and tugboats were pumped in the Bay Area. Emission factors for gasoline station are used to calculate emissions.

Fuel usage from Ferry boats were obtained from the major ferry and cruise operators in the Bay - i.e. the Golden Gate Bridge District (Ferry Division), Blue and Gold, and Red and White Fleet (see also Ferry Boats Category). Of the total registered boats, it was assumed that 75% were used for fishing activities. It was assumed further that an average of 4 hours was used per trip. Fuel rate was estimated at 5.24 gal per hour for an average engine size of 140 HP engine at 80% power load. Fuel usage was estimated based on this for the Fishing boats category. (see also Fishing Boats Categories).

For recreational boats, the amount of fuel usage was estimated based on a KVB Study on gasoline use tax, the number of boats per DMV registration.

Total organics emissions are determined by multiplying the estimated fuel usage in each of the category activity and the emission factor.

Monthly Variation

Emissions from the Recreational Boats Fueling category were distributed into the nine counties based on KVB's report on "Inventory of Emissions from Boating Sources in California." Monthly emissions variations for the ships, ferry, and fishing boats fueling were estimated partly based on the ferry boats schedule and with the highest usage in the summer months.

County Distribution

Emissions from recreational boat fueling category distributed into the nine counties are based on the number of boat registration in each county. County distribution are based on actual port location for Ferry, Ships and Tugboats

TRENDS

History

These categories were created to account for the organic emissions at filling stations during ship and boat refueling since 1987 Base Year emission inventory.

Growth

Projections are based on population growth for the Bay Area taken from the ABAG's 2009 Projections report.

By: Michael Nguyen
Date: February, 2011
Base Year 2008

EIC: 49999500100000 (Cat#81-83)

EMISSION INVENTORY

CATEGORY # 939

OTHER FUELING

EMISSIONS

Introduction

Emissions from these categories occur during the refueling of alternative fuels used in recreational vehicles, small tanks for barbecues, stoves for mobile homes, camping, balloon flights, and space heaters in rural areas, other internal combustion engines, and other industrial machines sources.

Methodologies

The ARB estimated alternative fuel usage as 8% by on-road vehicles, 10% by other internal combustion engines, 8% by farm equipment, and 74% by residential/commercial sources. About 18% of the total state usage, or approximately 92,736 thousand gallons (propane), came from the Bay Area.

The emission factor used was based on fuel tests by the Western Propane Gas Association which showed an average of about 0.263 grams of total hydrocarbon per liter of fuel. This converts to about 2.193 lbs. of total organics per thousand gallons of fuel.

Monthly Variation

Since activities on this category are heavily during recreational use, monthly variation was estimated similar to the recreational boats category, with the highest usage during the summer months.

County Distribution

Emissions were distributed into the nine counties based on population of each county.

TRENDS

History

These categories were created to account for the organic emissions at other fueling stations other than motor vehicles, recreational boats, ferry boats, and fishing boats since 1987 Base Year emission inventory.

Growth

Projections are based on population growth for the Bay Area was taken from ABAG's 2009 Projections report.

By: Michael Nguyen
Date: February, 2011
Base Year 2008

EIC: 49999500100000 (Cat#939)

EMISSION INVENTORY

CATEGORY #92

STERILIZERS

EMISSIONS

Introduction

Ethylene Oxide is used extensively at large medical facilities in equipment sterilizers as well as in fumigators for the food industry. Ethylene Oxide is widely used due to its ability to kill microbes in difficult to reach places. Category 92 accounts for organic emissions from medical sterilizers in the Bay Area.

Methodology

Point Source:

This category contains point source emission data reported to the District's permitting department. The District updates the data each year on a source-by-source basis using as input:

1. Process material throughputs as reported by the companies

2. Emissions factors (these may be source specific factors reported by the companies through source test results or applicable general factors, i.e. from the EPA)

3. Emissions control factors (device-specific or general - these may supplied by companies also)

The county, month, and day factors are obtained from the data bank's information on each plant's location, seasonal usage, and days per week of operation.

Area Source:

The area source emissions account for non-permitted ethylene oxide emission sources. In 1987, about 206,000 pounds of ethylene oxide was estimated as area source emissions. Because most of these sources are now permitted sources due to Regulation 11 Rule 9, the amount of area source emissions is estimated to have dropped to 1050 pounds of sterilizer gas. Emission factor used for ethylene oxide is one. Therefore, all of the ethylene oxide used is emitted as organic emissions.

The point source emissions at present are less than 0.01 tons/day of reactive organics.

TRENDS

History

Actual emissions from the District’s permitted sources were used for historical years.

Growth

Growth of ethylene oxide use in sterilizers is estimated to follow population growth. The population data used for growth profiles was obtained from the Association of Bay Area Government's (ABAG's) 2009 "Projections" and the California Statistical Abstracts.

Control

Ethylene Oxide is suspected of increasing the risk of stomach cancer and leukemia in humans. Because of this risk, the District adopted Regulation 11, Rule 9 on November 1, 1989. Note that this Rule is under Reg. 11, "Hazardous Pollutants".

By: Sukarn Claire
Date: January 2011
Base Year: 2008

EIC: 69999500000000

EMISSION INVENTORY

CATEGORY # 95 - 97

ASPHALT PAVING

EMISSIONS

Introduction

Road Oils (Slow-cure Liquid Asphalt), Hot Mix Asphalt, and Emulsified Asphalt, Categories 95 –97, respectively, account for the organic emissions from asphalt paving materials during and after the paving of roads, streets, and parking lots in the Bay Area.

Rapid-cure Liquid Asphalt (Rapid-cure Cutback Asphalt) is no longer used in the Bay Area. Rapid-cure Liquid Asphalt was formerly Category 94.

Medium-cure Liquid Asphalt (Medium-cure Cutback Asphalt) may be used in the Bay Area provided the atmospheric temperature does not exceed 50^{0}F for 24 hours after application (per BAAQMD Regulation 8, Rule 15, Sections 302 and 112.) This restriction greatly limits the application of this type asphalt; therefore, the organic emissions from Medium-cure Liquid Asphalt are considered negligible.

Slow-cure Liquid Asphalt (Slow-cure Cutback Asphalt) may also be used in the Bay Area with restrictions (per BAAQMD Regulation 8, Rule 15, Section 304). Slow-cure Liquid Asphalt is synonymous with "Road Oils" (Category 95).

Methodology

The organic emission from asphalt paving operations in the Bay Area was based on ARB's methodology for emission calculations (Attachment C: Asphalt Paving and Roofing, from STI's Area Source Emissions Updates, March 2003). In 2008, the Energy Information Administration (EIA) Office of Oil and Gas reported 13,703,000 barrels of asphalt were used in California for paving and roofing purposes. Of that amount, it was assumed 80% (10,962,400 barrels) of the asphalt was used for road paving and 20% (2,740,600 barrels) was used for roofing. (To calculate asphalt usage in tons per year it was assumed an asphalt density of 8 lbs/gal and a barrel equivalent to 42 gals.) Additionally, the statewide asphalt use for paving applications was estimated as follows:

- Hot-mix: 88%
- Emulsified: 9%
- Road Oils: 2%
- Cutback: <1%

(Note: It is assumed some districts, including the BAAQMD, do not use Rapid-cure Cutback Asphalt.) County throughputs can be apportioned from the state's total using the miles of paved roads in each of the counties. This data was acquired from the States' Teale Data Center. The organic emission factors used for hot-mix, emulsified, and road

oils were 0.04, 17.9, and 2.19 lb/ton of asphalt applied, respectively. (Note—the initial emission factor used for road oils was 88 lbs./ton. This was an EPA recommended value; however, regulatory controls reduced this value to the level stated above.) The total emissions for area source categories are determined by multiplying the emission factor, throughput, and rule effectiveness factor, if applicable.

Monthly Variation

Monthly variation of emissions is based on estimates of construction activities in a year.

County Distribution

County activity was based on miles of paved roads in each county as acquired from the Teale Data Center.

TRENDS

History

Since the early 1980's, the Asphalt Institute has done the reporting of asphalt sales and road oils. The historical growth profile was based on a combination of prior emissions calculations and the Association of Bay Area Government's (ABAG's) 2009 Transportation and Utility Employment growth profile.

Growth

Future projections of emissions to 2030 are also based on ABAG's 2009 Transportation, Communication, and Utility Employment growth profile.

Control

Due to Rule 8-15, there is no longer any usage of Rapid-cure Cutback Asphalt in the Bay Area by 1982. The emissions from Slow-cure Liquid asphalt (Road Oils) category were reduced by approximately 75% in 1988 and 97.5% in 1989. Similarly, emissions from using emulsified asphalt were reduced by 49% in 1988 and 55.3% in 1989.

By: Stuart Schultz
Date: January 2011
Base Year 2008

EIC Code: 54056204000000 (Cat. 95)
54056404000000 (Cat. 96)
54056604000000 (Cat. 97)

EMISSION INVENTORY

CATEGORY # 1618

ASPHALT ROOFING

EMISSIONS

Introduction

Asphalt is used to adhere, repair, and/or create a smooth finish over manufactured roofing materials (i.e. cap sheets, felt sheets and flashing squares) on commercial and industrial buildings and multiple unit dwellings. This category estimates organic emissions from roofing operations; however, it does not include the manufacture of roofing materials, nor does it cover emissions from fuel combustion.

The organic emission from asphalt roofing operations in the Bay Area was based on ARB's methodology for emission calculations (Attachment C: Asphalt Paving and Roofing, from STI's Area Source Emissions Updates, March 2003).

Methodology

In 2008, the Energy Information Administration (EIA) Office of Oil and Gas reported 13,703,000 barrels of asphalt were used in California for paving and roofing purposes. Of that amount, it was assumed 80% (10,962,400 barrels) of the asphalt was used for road paving and 20% (2,740,600 barrels) was used for roofing. Individual county throughputs can be apportioned from construction activity that was provided to ARB. (For the Bay Area, the fractional total to the state was approximately 0.2564.) The 2008 throughput for the BAAQMD was 702,746 bbls/yr (or 123,079 tons/yr, assuming density of asphalt at 8.34 lb/gal). Applying the AP-42 organic emission factor of 6.2 lb/ton of roofing material, the 2008 BAAQMD asphalt roofing emissions, in tons per day, is as follows:

> 702,746 bbl/yr. *X* 42 gal/bbl *X* 8.34 lb/gal (density factor) *X* 1 ton/2000 lb *X* 1 yr/365 days *X* 6.2 lb/ton (emission factor) *X* 1 ton/2000 lb = 1.05 tons/day

Monthly Variation

According to ARB, asphalt roofing activity occurs uniformly throughout the year.

County Distribution

As mentioned previously, county throughputs can be apportioned from construction activity that was provided to ARB

TRENDS

History

The historical growth profile was based on a combination prior emissions data (2000) provided by ARB and ABAG's 2009 Construction Employment Growth Profile.

Growth

Projected emissions to 2030 for both categories were based on ABAG's 2009 Construction Employment Growth Profile.

By: Stuart Schultz
Date: January 2011
Base Year 2008

EIC Code: 54059004000000

EMISSION INVENTORY

CATEGORIES # 1241, 1243, & 1245

SOLVENT CLEANING OPERATIONS

EMISSIONS

Introduction

The categories reported here are organic emissions resulting from the uses of solvent in Cold Cleaning, Vapor Degreasing, and Other Hand Wiping operations. Category 1241 consists of point and area source emissions from Cold Cleaning operations; Category 1243 consists only of point source emissions from Vapor Degreasing operations; and Category 1245 consists of both point and area source emissions from Other Hand Wiping activities. Category 1243 also has greenhouse gas (GHG) emissions from perfluorocarbon usage in the vapor degreasers.

Cold Cleaners

The two basic types of cold cleaners are maintenance cleaners and manufacturing cleaners. The maintenance cold cleaners are usually simpler, less expensive and smaller. They are designed principally for automotive and general plant maintenance cleaning. Solvents used in maintenance cleaners are mainly aliphatic petroleum solvents such as mineral spirits and Stoddard solvents.

Manufacturing cold cleaners usually perform a higher quality of cleaning than maintenance cleaners and are therefore more specialized. Manufacturing cold cleaning is generally used in metalworking production. A wide variety of solvents are used in this type of cold cleaner. Manufacturing cold cleaners are fewer in number than maintenance cleaners, but tend to emit more solvent per unit because of the larger size and workload.

Cold cleaning operations include spraying, brushing, flushing and immersion. The designs for material handling in cold cleaning systems are generally divided into manual and batch loaded conveyorized systems. Manual loading is used for the simple, small-scale cleaning operations while batch loaded conveyorized systems are used for the more complex, larger-scale cleaning operations.

Vapor Degreasers

Vapor degreasers clean through the condensation of hot solvent vapor on colder parts. Solvent vapors condense on the parts to be cleaned until the temperature of the parts approaches the boiling point of the solvent. The condensing solvent dissolves the oils and provides the washing action. There are two types of vapor degreasers, open top and conveyorized. Open top degreasers are batch loaded (cleaning only one load at a time)

and are normally located near the work that is to be cleaned. Conveyorized solvent degreasers generally are located at central cleaning stations, which require transport of parts for cleaning.

A typical vapor degreaser is a tank designed to produce and contain solvent vapor. At least one section of the tank is equipped with a heating element that uses steam, electricity, or fuel combustion to boil the solvent. As the solvent boils, dense solvent vapors displace the air within the equipment. Condenser coils located on the sidewalls of the degreaser control the upper level of this pure vapor. These coils (which are supplied with a coolant such as water) are generally located around the inner surface of the degreaser and must be placed below the top edge of the degreaser. This is to protect the solvent vapor zone from disturbance caused by air movement around the equipment.

The distance from the top of the vapor zone to the top of the degreaser tank is called the freeboard and is generally established by the location of the condenser coils. The freeboard is 50% – 60% of the width of the degreaser for solvents with higher boiling points (perchloroethylene, trichloroethylene, and 1,1,1-trichloroethane). The freeboard is at least 75% of the width of the degreaser for solvents with lower boiling points (trichlorotrifluoroethane and ethylene chloride).

Most degreasers are equipped with a water separator. The condensed solvent and moisture are collected in a trough below the condenser coils and directed to the water separator. The water separator is a simple container, which allows the water to separate and decant from the system while the solvent flows from the bottom of the chamber back into the vapor degreaser.

Hand Wiping

Hand wiping, or wipe cleaning, includes solvent cleaning done by hand or by means of equipment other than cold cleaners or vapor degreasers. Emissions from hand wiping activities are widespread and occur from solvent usage in manufacturing and maintenance activities. Manufacturing usage refers to any activity (other than in cold cleaners or vapor degreasers) where solvent is used to clean products during the manufacturing process. This includes final wipe cleaning prior to packaging and shipping. Maintenance usage refers to any activity (other than in cold cleaners or vapor degreasers) where solvent is used to clean machinery, tools or other equipment not incorporated into the product. To illustrate this, hand wiping may involve wipe-cleaning a small electronic component with alcohol or large manufacturing equipment with a solvent.

Methodologies

Cold Cleaners

Emissions from the Cold Cleaning Category (Cat. 1241) were estimated using the District's July 1998 "Staff Report on Solvent Cleaning Operations for Regulation 8, Rule 16." In this report, the 1996 cold cleaning emissions were estimated with the assumption

that this represented approximately 65% of the total emissions from solvent cleaning operations (including conveyorized). The remaining 35% of the total emissions came from vapor degreasers. A particular base year's emissions from cold cleaners were based on these 1996 figures and adjusted using growth factors and control factors (discussed under Growth Profile and Control sections).

Cold cleaning and vapor degreasing operations consist of both point and area source emissions. Point sources are covered under the District's permit system. Emissions are calculated by using solvent throughput of each source reported by companies in the District's Data Bank system. Emission factors were based on solvent composition. Cold cleaning area source emissions were calculated by subtracting their respective total emissions from their respective point source emissions. As mentioned previously, the total emissions from cold cleaning and vapor degreasing operations were estimated from the District's staff report.

Vapor Degreasers

According to District Permit personnel, all vapor degreasers operating within the District can be considered to be point sources. Therefore, organic and GHG emissions are calculated by using specific emission factors (based on solvent composition) and control factors, if any, for a particular source operation supplied by the company. If no specific factor is available, a generalized factor developed by district staff engineer will be used to determine emissions. The company also reports solvent throughput of each source.

Other Hand Wiping

The total District hand wiping emissions were based on the 1996 California Air Resources Board's (CARB) report on "Solvent Cleaning/Degreasing Source Category Emission Inventory". One aspect of this report dealt with hand wiping emissions in each air basin within California for 1993. A particular base year's emissions from hand wiping were based on this 1993 value and adjusted using a growth and control factor (discussed under the Growth Profile and Control sections).

Additionally, there are hand wiping emissions that can be found in other District categories (both point and area sources). Since these sources are subject to various other rules (i.e. graphic printing operations, polyester resin operations, various industrial/commercial coatings rules, etc.), the emissions will remain in these specific categories. To prevent "double-counting", the organic emissions from these categories will be subtracted from the growth adjusted CARB total hand wiping value. This new emission value is known as Other (or remaining) Hand Wiping emissions.

Listed below are the categories that contain hand wiping emissions to be subtracted from the total value:

Category	Description
23	Coatings and Ink (point source)
24	Resins (point source)
45	Fiberglass Products Manufacturing (point source)
108	Gravure Printing (point source)
109	Flexographic Printing (point source)
110	Letterpress Printing (point source)
112	Lithographic Printing (point and area sources)
115	Silkscreen Printing (point and area sources)
116	Small In-house Printing (point and area sources)
253, 257, 259, 261, 263, 265, 267	Various Industrial/Commercial Coatings (point and
269, 271, 273, 275, 277, 279, 281	area sources)
282	Other Organics Evaporation (point source)

As mentioned previously, this value is subtracted from growth adjusted CARB total hand wiping estimate to obtain the Other (or remaining) Hand Wiping emissions for Category 1245.

Other Hand Wiping emissions consist of both point source and area source emissions. Point source emissions are covered under the District's permit system. Area source emissions were estimated by subtracting the Other (or remaining) Hand Wiping emissions from the point source emissions.

Monthly Variation

The monthly distribution was estimated based on the point source's weighted average of reported quarterly seasonal percent throughput data.

County Distribution

For point sources, the data bank system contains information on the county location of each facility; hence, emissions are distributed to the counties accordingly. For area sources, emissions distributed into the nine Bay Area counties are based on the county fractions as determined from CARB's report on "Solvent Cleaning/Degreasing Source Category Emission Inventory".

TRENDS

History

The growth profiles for the Cold Cleaning, Vapor Degreasing, and Other Hand Wiping categories all followed the Association of Bay Area Government's (ABAG) 2009 Manufacturing Employment profile for the years prior to 1993. Between the years 1993 – 2008, the growth profiles were modified to reflect the estimated emissions (point and area source) calculated for those years.

Growth

The growth profile for Cold Cleaning (Cat. 1241) and Other Hand Wiping (Cat. 1245) operations after 2008 was also based on ABAG's 2009 Manufacturing Employment profile. For Vapor Degreasers (Cat. 1243), a decrease in solvent usage from the mid-1990's has been observed. Using this trend, a conservative estimate of 1.0%/year decrease in throughput activity was assumed after 2010.

Control

District Regulation 8, Rule 16 (for Solvent Cleaning Operations) set operating and equipment standards for cold cleaners and vapor degreasers. In Reg. 8, Rule 16, hand wiping activity was only subject to the Monitoring and Records section. (However, hand wiping may be subjected to other Regulation 8 rules.) Originally adopted in 1979, there have been several amendments to this rule, with the latest being October 2002. It is estimated the current overall control efficiency for cold cleaners is approximately 68%. For vapor degreasers, the overall control efficiency is currently estimated at 81%.

An amendment to Regulation 8, Rule 4 (adopted October 16, 2002 and effective June 1, 2003) placed VOC limits on solvent usage in surface preparation (hand wiping) activities to 50 g/l unless controlled to an approved abatement device with an overall control efficiency of at least 85%. (There was a limited exemption which delayed these surface preparation standards in production machinery until June 1, 2004.)

By: Stuart Schultz
Date: January 2011
Base Year 2008

EIC Codes: 22020481060000 (Cat. 1241)
22020681060000 (Cat. 1243)
22020881060000 (Cat. 1245)

EMISSION INVENTORY

CATEGORIES # 105 - 107

DRY CLEANERS

EMISSIONS

Introduction

In the dry cleaning process, washing is conducted by agitating the fabric in a solvent bath. The next step is extraction where excess solvent is removed by centrifugal force. In the final step, drying is conducted by tumbling the fabric in a stream of warm air to vaporize and remove the solvent from the fabric. When the washing and extraction steps are performed in one machine and drying in a second machine, it is referred to as a transfer operation. When one machine performs all three steps, it is referred to as a dry-to-dry operation. Coin-operated dry cleaning machines, which are directly available for use by the consumer, typically involve dry-to-dry operations. These dry cleaning facilities emit organic emissions resulting from the use of solvent in cleaning process. The organic emissions may either be reactive (i.e. Stoddard solvent) or nob-reactive (i.e. perchloroethylene). The amount of emission depends on the equipment type, amount of cleaning performed and operating practices. Dry cleaning equipment includes washers, dryers, solvent stills, muck cookers, still residues, and filter muck storage areas. Emissions may also come from leaks from pipes, flanges and pumps.

The most common dry cleaning synthetic solvent in use today is perchloroethylene, or PERC, a non-flammable, but expensive material (Category # 105). The other cleaning solvents used are the non-halogenated petroleum solvents (Category # 107). These include both reactive solvents (i.e. Stoddard Solvent, DF-2000, etc.) and non-reactive solvents (i.e. siloxane). Other than PERC, currently there are no other halogenated solvents (Category #106) used in the District.

Methodologies

Most of the dry cleaning facilities in the Bay Area are covered under the District's Permit system. Emissions are calculated by using solvent throughput information of each source reported by individual companies in the District's Data Bank system, called point sources. Emission factors used were based on tests and other data publication. Those small numbers of dry cleaning facilities not covered under the District's Permit system are considered area sources. For Categories 105 and 107, area source emissions are assumed to be 10% of the point source emissions.

Monthly Variation

Monthly distribution was estimated based on each facility's reported quarterly seasonal percent throughput data.

County Distribution

The county location of each facility reported in the Data Bank is used to distribute emissions into each county.

TRENDS

History

Prior years' emissions were estimated using the Association of Bay Area Governments' (ABAG's) 2009 Population growth profile. This growth profile was modified to reflect the emissions data between the years 1987 – 2008.

Growth

Over the past years, PERC usage has decreased significantly. This decrease is the result of several factors, one being its toxicity. Dry cleaners have been switching to other cleaners, such as non-halogenated hydrocarbon solvents. In March 2008, amendments to District Regulation 11, Rule 16 (Rule 11-16) phases out all PERC usage in dry cleaning operations by 2023. The cumulative PERC reduction (listed below) was used in developing the growth profile for Category 105 that represents this phase out:

Year	% Reduction for that Year	% Cumulative Reduction
2008	18.57%	18.57%
2009	18.57%	37.14%
2010	18.57%	55.71%
2011	1.43%	57.14%
2012	4.90%	62.04%
2013	3.88%	65.91%
2014	8.16%	74.08%
2015	6.73%	80.81%
2016	8.98%	89.79%
2017	4.90%	94.69%
2018	1.43%	96.12%
2019	1.63%	97.75%
2020	0.82%	98.57%
2021	0.41%	98.98%
2022	0.20%	99.18%
2023	0.82%	100.00%

Because of the phase out of PERC, usage of non-halogenated petroleum solvents (Category #107) will increase. It was estimated the 2015 and 2020 TOG emissions (point & area) were 0.68 ton/day and 0.70 ton/day, respectively.

Control

The District originally adopted District Regulation 8, Rule 27 (Rule 8-27), for Synthetic Solvent Dry Cleaning Operations as an ozone control measure in May 1980. This rule was amended in March 1982, November 1984, and September 1990 with additional operating requirements. In 1994, the District adopted Regulation 11, Rule 16 (Rule 11-16) to incorporate new regulatory standards adopted at the state and federal levels. Rule 11-16, with its new solvent standards and control requirements, replaced Rule 8-27. Rule 8-27 was retained as part of the District's regulations for State Implementation Plan (SIP) considerations, however, in March 2009 was deleted.

District Rule 11-16 (Perchloroethylene and Synthetic Solvent Dry Cleaning Operations), passed in December 1994 required more stringent requirements on controls, monitoring, ventilation, secondary controls, and certain prohibition of usage of certain machines. In March 2009, Rule 11-16 was amended to incorporate into the District rule a state law phase out schedule that would eliminate the use of Perchloroethylene in dry cleaning by January 1, 2023.

District Regulation 8, Rule 17 (Rule 8-17), adopted in May 1980, set operating and emission control requirements to dry cleaning operations using petroleum solvents. In March 1985 and September 1990, this rule was amended to reflect additional control and operating requirements. Some of the newer alternative technologies currently available include some non-halogenated photochemical organic compounds (POC) and non-photochemical organic compounds (NPOC). To reflect the expanded applicability of this rule and update the equipment standards and control requirements, Rule 8-17 was amended again in March 2009. The title of this rule was also changed from "Petroleum Solvent Dry Cleaning Operations" to "Non-halogenated Dry Cleaning Operations".

By: Stuart Schultz
Date: December 2010
Base Year 2008

EIC Code: 21020033000000 (Cat. 105)
21020081020000 (Cat. 106)
21020081500000 (Cat. 107)

EMISSION INVENTORY

CATEGORIES # 108 - 110, 112, 115, 116

PRINTING: GRAVURE, FLEXOGRAPHIC, LETTERPRESS, LITHOGRAPHIC, SILKSCREEN AND SMALL IN-HOUSE PRINTING

EMISSIONS

Introduction

Emissions from these categories are from graphic arts printing operations. The graphic arts printing operation uses a variety of inks, materials, coatings, fountain solutions, blanket washes, makeup solvent, solubilizers, and clean-up materials. Organic compounds are contained in these products and are emitted into the atmosphere during the printing operations.

Graphic arts printing consist of five primary types of printing operations: Gravure, Flexographic, Letterpress, Lithographic, and Screen. Of the five types of operations, only four major types of printing processes are involved: gravure, letterpress, lithographic, and screen (flexographic printing is simply a modified form of letterpress). These printing processes are briefly described below.

1. Gravure Printing (Cat # 108) – a type of printing operation whereby ink is transferred from a plated minute etched well to a substrate that is supported by an impression roller. Ink excess is removed by a doctor blade;
2. Flexographic Printing (Cat # 109) – a printing operation that utilizes a "rolling technique" to apply words, designs, and pictures to the substrate. The image carrier is made of either a rubber elastomer or a similarly related elastomeric material;
3. Letterpress Printing (Cat # 110) - a printing operation whereby ink is transferred to the paper via an image surface. The image area is raised relative to the non-image area;
4. Lithographic Printing (Cat # 112) – a printing operation whereby printing of image and non-image areas are carried out on the same plane;
5. Screen Printing (Cat # 115) – a printing operation whereby printing ink passes to a web or a fabric from which a refined form of stencil is applied.

In this emission inventory, the District also accounts for small in housing printing emissions (Cat 116). Small in house emissions is comprised of various small in house operations that may the use intaglio, ink jet, and xerographic prints in their printing processes.

Methodologies

Regulated Sources: Emissions from large graphic arts printing facilities in the Bay Area are regulated under Regulation 8, Rule 20 and permit data for these facilities are stored in the District's permit system called “point sources”. Under this system, throughput data of regulated graphic arts facilities is tracked and recorded in the District's Data Bank system. The stored data along with emission factors derived from publication sources or through actual field tests provide the information used to calculate emissions of the facilities.

Unregulated Sources: Emissions from small, unpermitted printing facilities are estimated based on data gathered through the U. S. Department of Commerce’s publication titled, "Printing Ink Manufacturing: 2002". Throughput data is taken from this publication and used to estimate the emissions from unregulated sources. A growth factor based on U. S. shipment of paper production and population data of the Bay Area population was used to estimate future printing emissions.

In addition to organic emissions from printing operations, adjustments were made to include emissions from cleaning solvents such as fountain solutions, preparation, and cleanup solutions. These solutions are used to clean and prepare equipment and materials for printing jobs. The sum of the calculated emissions from permitted facilities and unpermitted facilities provides an overall estimated value of emissions for Bay Area graphic arts printing sources.

Monthly Variation

The quarterly seasonal percent throughput data from reported companies was used to estimate the monthly variation in an area.

County Distribution

County location of each company as reported in the Data Bank was used to distribute emissions for each county.

TRENDS

History

Historical emissions were estimated based on ARB's Manufacturing-Printing growth profile.

Growth

Projections to year 2030 were based on a modified growth profile of ARB's Manufacturing, Printing industry in the Bay Area.

Control

The Bay Area's graphic arts printing industry are regulated under Regulation 8, Rule 20. This rule 20 was adopted in 1980, amended in 1984, 1985, 1989, 1993, 1995, 1997, 1999, and 2008. The Rule requires low solvent usage on inks and coatings, volatile organic compound limits of products and fountain solution and/or requirements on approved emission control system, and compliance schedules. The rule has resulted in reduced emissions for most of these categories.

By: Tan Dinh
Date: December 2010
Base Year: 2008

EIC Code: 240-260-8400-0000 (Cat 108)
240-262-8400-0000 (Cat 109)
240-266-8400-0000 (Cat 110)
240-264-8000-0000 (Cat 112)
240-268-8400-0000 (Cat 115)
240-995-8000-0000 (Cat 116)

EMISSION INVENTORY

CATEGORIES # 117, 118

ADHESIVES AND SEALANTS

EMISSIONS

Introduction

Emissions reported in these categories are fugitive organic emissions resulting from the usage of adhesives and sealants. Adhesives and sealants are primarily used in wood, wood-related, and packaging activities. The emissions reported in these categories include emissions resulting from both industrial and consumer usage of adhesives and sealants.

Adhesives and sealants are generally categorized and distinguished by source types. Most adhesives and sealants are either of a water-based type or of a solvent-based type. Adhesives and sealants can also be found, although in a smaller quantity, in the form of hot melts (100% solids), radicured, powders, and reactive types.

Raw materials primarily used in the production of adhesive and sealants are rubber, starch, animal glues, bitumen, and synthetic resins. Other materials of smaller quantity that can be found in adhesive and sealant formulations include phenolic resins, formaldehyde, polyolefins, polyvinyl acetate, acrylics, polyvinyl chloride, polyesters, polyvinyl alcohol, and solvents, including hexane, heptane, xylene, toluene, methylene chloride, and 1,1,1-trichloroethane.

Methodologies

Permitted Facilities

Companies utilizing large amounts of adhesives/sealants are monitored and regulated by the District's permit system. Throughput of adhesive and sealant usage for each permitted facility are tracked and recorded in the District's Data Bank system. Some of the industries affected under the District's permit system for the usage of adhesives and sealants include large wood production manufacturers, wood related construction companies, and packaging companies. Emissions are calculated based on throughput data and emission factors. Emission factors used in the calculation are either derived from field tests and/or obtained from publications. If no specific factor is available, a generalized factor is used in the calculation.

Non-Permitted Facilities

Emissions from adhesive and sealant used in non-permitted industries are estimated based on a geographical area. These emissions are termed "area source" emissions. Non-permitted industries includes construction sites, small

industrial companies, transportation facilities, dental and medical buildings, electric and electronics facilities, and other miscellaneous sites.

Data used to estimate area sources are based on "The Rauch Guide to the U.S. Adhesives and Sealants Industry, 2000-02 Edition". Adjustments were made for 2008 using both the construction growth for each county in the Bay Area and the Rauch Guide's projection. Emission factors used in the calculation of these area sources were taken from ARB's report titled "Adhesives and Sealants". The emission factors used in the calculations were 1,230 lbs. of VOC per ton of solvent-borne adhesives/sealants and 90 lbs. of VOC per ton of water-borne adhesives/sealants.

Monthly Variation

Monthly distribution was estimated based on each company's reported quarterly seasonal percent throughput data.

County Distribution

The county location of each company as reported in the Data Bank was used to distribute emissions for each county.

TRENDS

History

Emissions through the years were estimated based on ARB's growth data on the construction industry.

Growth

Projections to year 2030 were based on the same growth profile of ARB's construction industry in the Bay Area.

Control

District Regulation 8 Rule 51 set limitation standards on adhesive products effective January 1995 and assumed to have 60% control effectiveness.

By: Tan Dinh
Date: December 2010
Base Year: 2008

EIC Code: 250-292-8202-0000 (Cat 117)
250-292-8250-0000 (Cat 118)

EMISSION INVENTORY

CATEGORIES #1010-1012, 1014-1016, 1019-1023, 1026-1028, 1030-1032, 1035, 1039, 1042-1045, 1048-1049, 1052-1056, 1059-1061, 1063-1065, 1068, 1072, 1075, 1275, 1277, 1279, 1281, 1629-1633, 1635-1639, 1888-1890

STRUCTURES COATING: SOLVENT BASE; WATER BASE; THINNING, ADDITIVES, AND CLEANUP SOLVENTS

EMISSIONS

Methodology

The California Air Resources Board (CARB) has conducted surveys of architectural coatings marketed in California every four or five years, with the first one in 1976, and the latest one in 2005. These surveys assist both CARB and local districts track organic emissions from architectural coatings. The "2005 Architectural Coatings Survey" contains 2004 data from which this report is based upon.

The categories include organic gas emissions resulting from the application of architectural coatings and associated use of additives, thinning and cleanup solvents. Architectural coatings include a variety of coatings, for example: (1) paints - flats, and non-flats, (2) clears - lacquers, varnishes, and sealers, (3) stains, (4) industrial maintenance coatings, (5) specialty coatings, etc. These coatings are used on various structures, including bridges, buildings, streets, and roofs. Emissions occur from evaporation of the organic solvents during application and air drying of the coatings. To estimate organic solvent emissions, the quantity of various types of coatings and the associated solvent content in each coating should be known. Additives are used in water-base coatings; thinning solvents are used in solvent-base coatings; cleanup solvents are used in both water-base and solvent-base coatings. There are many types of coatings and each coating formulation has its own specific amount of solvent. Each type of coating is assigned a category number.

The Bay Area fraction of the California architectural coating sales can be apportioned to its counties using population. The 2004 BAAQMD architectural coating sales (water and solvent based) was calculated by multiplying the total 2004 California architectural coating sales by the ratio of the District versus Statewide population figures. The District used the Association of Bay Area Government's (ABAG's) 2009 Households growth profile to estimate the 2008 throughputs for these various coatings used in the Bay Area.

Estimated 2004 Bay Area architectural coatings throughputs (sales) were broken down into the various coating categories along with associated emission factors. They are shown in Table 1 for solvent based coatings and Table 2 for water based coatings. Organic emissions from the use of clean-up and thinning solvents have been revised and a new category (Additives) has been added. Previously, thinning and cleanup solvent usage ratios were based on the assumption of one pint per gallon of solvent-based coatings. Currently, the ratios are as follows: 0.0597 gallon of thinning solvent per gallon of solvent based coatng; 0.0044 gallon additives per gall water based coating; and, 0.0160 gallon cleanup solvent per gallon solvent and water based coatings. Estimates of

thinning, additives and cleanup solvent usage and their associated emission factors were shown in Table 3.

Monthly Variation

Monthly variation in emissions was made in proportion to the average monthly sales of coatings reported in the U.S. Department of Commerce of Paint and Allied Products.

County distribution

Estimated Bay Area coatings emissions were distributed proportionally to the population in each county.

TRENDS

History

The historical growth profiles were based on a combination prior emissions data (some back to the mid-1980's) and the CARB's growth factors.

Growth

The projected emissions to 2030 for all categories were based on the ABAG's 2009 Households growth profile..

Controls

Regulation 8, Rule 3 was adopted by BAAQMD on March 1, 1978, and limits the volatile organic content of products sold for "application to stationary structures and their appurtenances, including houses, buildings, bridges, tanks, railings, streets and highways." A lawsuit was filed which overturned a 1990 amendment; final elements of this lawsuit were settled in 1998. Also in 1998, an amendment incorporated provisions that would allow low solids architectural coatings to be sold and used within the BAAQMD. In November 2001, the District an amendment provided a further reduction in VOC to 19 of the architectural coatings. In July 2009, the District again passed amendments to its Architectural Coating Rule that further limit the amount of VOC allowed in certain architectural coatings. These amendments will result in a VOC reduction of 3.98 tons/day in 2011 and 1.65 tons/day in 2012.

By: Stuart Schultz
Date: December 2010
Base Year 2008

TABLE 1

2004 CONSUMPTION OF SOLVENT BASED STRUCTURAL COATINGS IN THE BAY AREA

Category Number	EIC Code	Type of Coating	2004 Usage (gal/yr)	2004 VOC (ROG) Emission Factors (grams/liter)
1010	52052091590000	Flats	768	329
1011	52052091610000	Non-Flats, High Gloss	7,669	372
1012	52052091600000	Non-Flats, Low & Medium Gloss	15,373	373
1014	52052091530000	Non-Flats, Quick Dry Enamels	134,138	389
1015	52052091410000	Varnish, Clear & Semi-Transparent	146,838	455
1016	52052091570000	Lacquers	176,392	312
1019	52052091310000	Stains, Clear & Semi-Transparent	275,030	356
1020	52052091360000	Stains, Opaque	3,880	288
1021	52052091770000	Wood Preservatives	30,890	327
1022	52052091050000	Primers, Sealers, & Undercoats	42,390	361
1023	52052091060000	Quick Dry Primers, Sealers, & Undercoats	41,446	405
1026	52052091720000	Industrial Maintenance	267,608	222
1027	52052091760000	Traffic Marking	61,948	96
1028	52052091130000	Waterproofing Sealers	36,716	268
1030	52052091650000	Concrete Curing Compounds	8,232	225
1031	52052091740000	Roof Coatings	8,081	229
1032	52052091660000	Dry Fog Coatings	35,192	320
1035	52052091730000	Metallic Pigmented Coatings	82,384	424
1039	52052091700000	Form Release Compounds	53,538	242
1042	52052091000000	Other Coatings	130,898	414
1275	52052091640000	Bituminous Roof	25,152	250
1277	52052091690000	Floor	13,386	238
1629	52052091090000	Bituminous Roof Primer	11,279	340
1630	52052091220000	Faux Finishing	833	390
1631	52052091260000	Rust Preventative	377,038	375
1632	52052091080000	Specialty Primer, Sealer, & Undercoat	288,241	343
1633	52052091180000	Waterproofing Concrete/Masonry Sealers	179,684	205
		TOTAL	2,455,024	

TABLE 2

2004 CONSUMPTION OF WATER BASED STRUCTURAL COATINGS IN THE BAY AREA

Category Number	EIC Code	Type of Coatings	2004 Usage (gal/yr)	2004 VOC (ROG) Emission Factors (grams/liter)
1043	52052092590000	Flats	7,008,032	32
1044	52052092610000	Non-Flats, High Gloss	332,969	58
1045	52052092600000	Non-Flats, Low & Medium Gloss	6,021,245	49
1048	52052092410000	Varnish, Clear & Semi-Transparent	52,527	92
1049	52052092570000	Lacquers	66,527	63
1052	52052092310000	Stains, Clear & Semi-Transparent	75,785	70
1053	52052092360000	Stains, Opaque	176,209	39
1054	52052092770000	Wood Preservatives	1,807	42
1055	52052092050000	Primer, Sealer, & Undercoats	1,914,028	47
1056	52052092060000	Quick Dry Primer, Sealer, & Undercoats	5,520	10
1059	52052092720000	Industrial Maintenance	134,466	79
1060	52052092760000	Traffic Marking	354,547	61
1061	52052092130000	Waterproofing Sealers	247,646	55
1063	52052092650000	Concrete Curing Compounds	141,022	37
1064	52052092740000	Roof Coatings	256,527	18
1065	52052092660000	Dry Fog Coatings	35,847	60
1068	52052092730000	Metallic Pigmented Coatings	25,006	28
1072	52052092230000	Form Release Compounds	7,327	32
1075	52052092000000	Other Coatings	639,551	14
1279	52052092640000	Bituminous Roof	250,260	2
1281	52052092690000	Floor	219,814	40
1635	52052092090000	Bituminous Roof Primer	1,528	71
1636	52052092220000	Faux Finishing	56,307	95
1637	52052092260000	Rust Preventative	17,085	87
1638	52052092080000	Specialty Primer, Sealer, & Undercoat	89,700	42
1639	52052092180000	Waterproofing Concrete/Masonry Sealers	179,245	52
		TOTAL	18,310,527	

TABLE 3

2004 CONSUMPTION OF ADDITIVES, THINNING AND CLEANUP SOLVENTS[1] IN THE BAY AREA

Category Number	EIC Code	Type of Coating	2004 Usage (gal/yr)	2004 VOC (ROG) Emission Factors (grams/liter solvent)
1888	52052283020000	Thinning (for Solvent Based Coatings)	143,908	709
1889	52052283100000	Additives (for Water Based Coatings)	78,330	110
1890	52052283500000	Cleanup (for Solvent & Water Based Coatings)	323,404	709

[1] Solvent/Additive Usage Ratios are as follows: 0.0597 gal. thinning solvent/gal. of solvent based coating; 0.0044 gal. additive/gal. water based coating; 0.0160 gal. cleanup solvent/gal. solvent & water based coating.

EMISSION INVENTORY

CATEGORIES # 252-253, 256-281

OTHER ORGANIC COMPOUNDS EVAPORATION INDUSTRIAL/COMMERCIAL COATINGS

EMISSIONS

Introduction

The following categories contain the inventory of organic gas emissions that result from the use of industrial coatings, special product coatings, and thinning and clean-up solvents:

- Can and Coil (P)
- Wood Furniture & Cabinet (P/A)
- Paper Coating (P/A)
- Fabric & Film (P/A)
- Plastic Parts & Product (P/A)
- Magnet Wire (P/A)
- Large Appliance & Metal Furniture (P/A)
- Misc. Metal Parts & Small Appliance (P/A)
- Flat Wood Paneling (P)
- Motor Vehicle Assembly Plants (P/A)
- Auto Refinishing (P)
- Marine Coating (P/A)
- Aerospace Assembly (P)
- Other Coatings (P/A)

Note: The categories with a "P" in parenthesis represent point source categories only. The categories with a "P/A" in parenthesis represent both point and area source categories.

These categories are composed of many types of coatings such as enamels, lacquers, varnishes, etc. Organic emissions occur from the evaporation of organic solvents, which result from the application and drying of coatings. In order to calculate emissions, the amount of coatings, the solvent fraction of the coatings, and the amount of thinning and cleanup solvent, should be known. The efficiency of control equipment, such as afterburners, condensers, and the amount of solvent recycled are all useful variables in determining emissions.

Perflouorocarbons (PFC's) may also be used in association with the "Others Coating" point source group. For the most part, they are used in the technology industry. PFC's are non-reactive organic compound that are also greenhouse gases GHG).

Methodologies

For all permitted plant sites, the yearly renewal of permits provides updated industrial usage of coatings and the effects of changes to control equipment. Organic and GHG (if applicable) emissions are calculated for each piece of equipment. All large equipment and control equipment are registered, unless exempt. For each category a coatings-usage balance is made between the coatings reported in the permit data bank and the coatings-usage estimated for the

category. Coatings' usage not shown in the permit data bank is included in these categories and distributed as emissions from area sources. The area source emission factor and throughput for each relevant category are contained in the Data Bank. For each category, there are many differing formulations used; hence, a single composite emission factor is determined for each industrial category. Sources of industrial coatings-shipments are conducted nationally by the U.S. Department of Commerce. An approximation of latest available coating shipments (throughput) for the Bay Area can be estimated by applying the ratio of population for the Bay Area to the national population. This total District throughput value is subtracted from the corresponding point source throughput value to obtain a particular category's area source throughput. Organic emissions are calculated by multiplying the solvent throughput by emission factor and control factor (if any). The exceptions to this method of area source calculations are as follows:

- For Wood Furniture and Cabinet Coating Categories (Cat. 256-257), estimating the coating usage per facility and determining the number of facilities from the latest County Business Pattern Count was used in determining the area source emissions.

- For Magnetic Wire Coatings Categories (Cat. 264-265), the District's total throughput was based on the ratio of the number of Bay Area employees versus national employees for this particular industry. The area source throughputs and emissions are calculated similarly to the primary method (as listed above).

- For Auto Refinishing Coating Categories (Cat. 274-275), area source emissions were based on data contained in the California Air Resources Board's (CARB) 2002 Suggested Control Measure (SCM).

- For Paper, Fabric and Film Coatings Categories (Cat. 258-261) and Misc. Metal Parts and Small Appliance Category (Cat. 268-269), it was assumed the area source emissions consisted of 10% of the point source emissions.

Monthly Variation

Monthly variation in emissions was made proportional to the monthly sales of coatings are reported by the U.S. Department of Commerce in their Current Industrial reports, Paint, Varnish and Lacquer, M28F Series.

County Distribution

Solvent emissions for the Bay Area were apportioned into counties by one of the methods listed below for each industrial coatings category:

1. The county location of each company as reported in the District's permit data bank,
2. Employee (for a given industry) population distribution,
3. Establishment (for a given industry) population distribution, or
4. Total population distribution

TRENDS

History

Prior years' emissions for these various categories were estimated using modified Association of Bay Area Governments (ABAG) 2009 growth profiles. Depending on the category, the growth profiles were based either on ABAG's 2009 Manufacturing Employment or Service Employment. Modification was done to represent actual emissions data, primarily between the years 1993 – 2005 (although in some instances, actual emissions data went back to 1987).

Growth

The projected growth in emissions to the year 2030 for these various categories is based on projected forecasts in growth developed by ABAG. As mentioned previously, depending on the category, the growth profiles were based either on ABAG's 2009 Manufacturing Employment, Service Employment or 2009 Total Population.

Control

The control factor is an estimate of reduction of solvent emissions, which takes into account the various strategies used to comply with regulations that are designed to gain an overall reduction of emissions in a particular category. The control factor reflects the proportion of solvent emissions remaining as a result of Regulation 8 and the various rules. The rule effectiveness accounts for the amount of emissions achieved by compliance with the rule. Additional dates and changes in rule effectiveness are incorporated into the calculation as additional amendments are passed or compliance with the rule progresses.

By: Stuart Schultz
Date: December 2010
Base Year 2008

EIC Codes: 23022890000000 (Cat. 252), 23024083000000 (Cat. 253)
23023290000000 (Cat. 256), 23024083000000 (Cat. 257)
23022290000000 (Cat. 258), 23024083000000 (Cat. 259)
23022490000000 (Cat. 260), 23024083000000 (Cat. 261)
23023690000000 (Cat. 262), 23024083000000 (Cat. 263)
23099590000000 (Cat. 264), 23024083000000 (Cat. 265)
23022690000000 (Cat. 266), 23024083000000 (Cat. 267)
23023090000000 (Cat. 268), 23024083000000 (Cat. 269)
23099590000000 (Cat. 270), 23024083000000 (Cat. 271)
23099590000000 (Cat. 272), 23024083000000 (Cat. 273)
23021890000000 (Cat. 274), 23024083000000 (Cat. 275)
23022090000000 (Cat. 276), 23024083000000 (Cat. 277)
23023890000000 (Cat. 278), 23024083000000 (Cat. 279)
23099590000000 (Cat. 280), 23024083000000 (Cat. 281)

EMISSION INVENTORY

CATEGORY # 282

OTHER ORGANIC COMPOUNDS EVAPORATION
OTHER ORGANIC EVAPORATION

EMISSIONS

Introduction

This category contains various types of equipment identified in the permit data bank as not defined in the many other categories and therefore designated as "other" equipment. Emissions from this category are from various sources and different industrial processes. The emissions for these point sources are contained in the permit data bank.

Methodology

This category contains emissions from point sources only. Point source emissions are calculated from a facility's equipment operating data submitted as part of the permit approval process. The Data Bank contains throughput information from sources submitted by individual plants. Emissions are then calculated by using specific emission factors for a particular source operation supplied by the company. If no specific factor is available, a generalized factor developed by district staff engineer will be use to determine emissions.

Monthly Variation

The data bank contains throughput data for each month provided by companies holding District permits.

County Distribution

Emissions distributed into counties were based on actual locations of the plants in the Bay Area.

TRENDS

History

The historical growth profile was based on a combination of prior emissions data (from 1996 to 2008) and the California Air Resources Board Manufacturing Employment growth profile.

Growth

Future projections of emissions to 2030 are based on the Association of Bay Area Government's (ABAG's) 2009 Manufacturing Employment growth profile.

Control

Sources in this category may be subject to Regulation 8, Rule 4 (General Solvent & Surface Coating Operations). The purpose of this Rule is to "limit emissions of volatile organic compounds from the use of solvents and surface coatings in any operation other than those specified by other Rules of the Regulation 8." Originally passed in 1980, this rule has been amended several times—the latest being in 2002 regarding surface preparation standards.

By: Stuart Schultz
Date: December 2010
Base Year 2008

EIC Code: 49999500100000

SECTION 7

STATIONARY COMBUSTION OF FUELS

EMISSION INVENTORY

CATEGORIES #283, 284, 285

FUEL COMBUSTION - DOMESTIC NATURAL GAS
- SPACE HEATING
- WATER HEATING
- COOKING

EMISSIONS

Introduction

These categories estimate criteria pollutant (particulate, organic, NO_x, SO_x, and CO) and GHG emissions (CO_2, CH_4, and N_2O) resulting from the combustion of natural gas in the residential sector. Natural gas consists of a high percentage of methane (generally above 85 percent) and varying amounts of ethane, propane, butane, and inert gases. The combustion of natural gas in the residential sector is broken down into three categories: Space Heating, Water Heating, and Cooking. Categories 283, 284, and 285 account for area source emissions from Space Heating, Water Heating, and Cooking, respectively.

Design of residential boilers and furnaces generally resemble firetube type boilers with flue gas traveling through several channels or tubes with water or air circulated outside the channels or tubes.

Methodologies

Total natural gas usage for these categories was obtained from the California Energy Commission (CEC), the Pacific Gas and Electric Company (PG&E), and the city of Palo Alto. This total natural gas usage was broken down into three categories based on information from CEC and PG&E, and is shown below.

Residential Natural Gas Usage by Category

Category	Category	Percent
283	Space Heating	57.3 %
284	Water Heating	38.5 %
285	Cooking	4.2 %

Emission factor information for natural gas combustion was obtained from the U.S. Environmental Protection Agency's (EPA's) document AP-42, the U.S. Department of Energy's (DOE's) Energy Information Administration (EIA) and the California Energy Commission (CEC).

The natural gas combustion emission factors for these categories, in pounds per million cubic feet (Lb/MMCF) are shown below.

Category	PART	ORG	NOX	SO_2	CO	CO_2	CH_4	N_2O
All	7.6	11	94	0.6	40	120000	2.3	2.2

County Distribution

Natural gas information provided by CEC and PG&E includes residential, commercial, and industrial usage for the Bay Area nine counties by month. Information on Palo Alto's natural gas usage was obtained separately from the City of Palo Alto and was used together with Santa Clara County natural gas usage values. This was done because the city obtained gas from a supplier other than PG&E. Solano and Sonoma Counties are partially in the San Francisco Bay Area Air District, so data were used for the cities that are in the District. For Solano County, data used were for Benicia, Fairfield, Suisun and Vallejo; for Sonoma County, data used were for Cotati, Petaluma, Rohnert Park, Santa Rosa, Sebastopol and Sonoma.

Temporal Variation

Space Heating:

Daily Activity: The maximum activity occurs in the early daylight hours and in the evening hours, with average activity during the day and low activity at night.

Weekly Activity Code: The activity is uniform seven days a week.

Monthly Activity: The monthly activity was based on monthly residential natural gas sales from the California Energy Commission. Activity occurs from November to June, with the highest months being December through April.

Water Heating:

Daily Activity: The maximum activity occurs in the early daylight hours and in the evening hours, with average activity during the day and low activity at night.

Weekly Activity: The activity is uniform seven days a week.

Monthly Activity: The monthly activity is assumed to be uniform throughout the year.

Cooking:

Daily Activity: The activity occurs during meal time hours.

Weekly Activity: The activity is uniform seven days a week.

Monthly Activity: The monthly activity is assumed to be uniform throughout the year.

EMISSION TRENDS

History

Historical emission trends are based on natural gas usage in the San Francisco Bay Area.

Growth

Emission growth projections are based on household population growth. Household population data was obtained from two sources, the Association of Bay Area Government's (ABAG's) 2009 "Projections" reports and the California Statistical Abstracts.

Control

The District adopted Regulation 9; Rule 6 on April 1, 1992 to control the amount of NOx emissions from natural gas fired water heaters. This rule has a control of 46% with a rule effectiveness of 94% reached by the year 2002.

By: Sukarn Claire
Date: January 2011
Base Year: 2008

EIC: 61060601100000, 61060801100000, 61061001100000

EMISSION INVENTORY

CATEGORIES #286 & 287

FUEL COMBUSTION - STATIONARY SOURCES

DOMESTIC - LIQUID PETROLEUM GAS (LPG)
DOMESTIC - DISTILLATE OIL

EMISSIONS

Introduction

This category contains emissions from domestic fuel combustion of LPG and distillate oil.

Methodology

Emissions estimates from domestic LPG and distillate oil combustion are based on the "BTU equivalent - natural gas approach". This approach follows an ARB methodology as given in a document titled, "Methods for Assessing Area Source Emissions in California", Section 5-3. The approach is based upon, namely:

1. Number of housing units heated by LPG and distillate oil as provided by the 2000 Department of Finance's Census of Population and Housing.

2. Bay Area natural gas fuel usage as provided by Pacific Gas and Electric Company.

3. Natural gas usage conversion to average BTUs per household.

4 Estimation of LPG and distillate oil usage based on average BTUs per household.

5. Calculation of LPG and distillate oil emissions.

6. Greenhouse gas emission factors are obtained from the U.S. Department of Energy's (DOE's), Energy Information Administration (EIA).

Monthly Variation

The monthly variation for LPG and distillate oil was based on data provided by PG&E Customer Accounting Department. This data details domestic natural gas usage by number of customers (dwelling units) in each county. For all counties except Solano and Sonoma, data sets reflecting the entire counties were used in the calculation. For Solano and Sonoma Counties that are both partially in the District, only data for cities within the

District were used. For Solano County, data sets used were for Benicia, Fairfield, Suisun and Vallejo. For Sonoma County, data sets used were for Cotati, Petaluma, Rohnert Park, Santa Rosa, Sebastopol and Sonoma.

County Distribution

County distribution of emissions was based on the Department of Commerce's 2000 Census of Population and Housing for California. In that report, the number of homes using LPG and fuel oil as a heating medium were used in the estimate of county distribution.

TRENDS

Growth

For Category 286 (Fuel Combustion, Stationary Sources, Domestic LPG), an assumption was made that annual emissions, over the years, would tend to follow household population data. Population data used in the projection was based on the Association of Bay Area Government's (ABAG's) 2009 "Projections" report. For Category 287 (Fuel Combustion, Stationary Sources, Domestic Distillate Oil), the growth was assumed to be diminished as the fuel would eventually be phased out in favor of natural gas. A 2% reduction per year was chosen, starting in 1992.

By: Tan Dinh
Date: December 2010
Base Year: 2008

EIC Code: 610-995-0120-0000 (Cat 286, 287)

EMISSION INVENTORY

CATEGORIES #288, #289

FUEL COMBUSTION - STATIONARY SOURCES
DOMESTIC SOLID FUEL - WOOD
Woodstoves (#288), Fireplaces (#289)

EMISSIONS

Introduction

This methodology is used to estimate the criteria pollutant emissions from residential wood combustion, namely from fireplace and woodstove. Fireplaces are the most common wood burning device in a home. They are used primarily for supplemental heating and for aesthetic appeal. Fireplace combustion is characterized by high air-to-fuel ratios and burn rates. Traditional masonry fireplaces typically contain large open fireboxes without combustion air controls and are not highly efficient heating devices. A net heat loss may occur in a residence if colder, outside air is drawn in to replace the inside air used for combustion and lost through the chimney draft. There are also prefabricated (metal) fireplaces which are slightly higher in energy efficiency than masonry fireplaces. Fireplace inserts that fit into the fireplace can increase the heating efficiency by either radiating the heat into the house or venting heated air into the house by air circulating around the insert with the help of a fan.

Woodstoves are used primarily as domestic space heaters and have enclosed fireboxes and dampers to reduce air-to-fuel ratios and burn rates. Since they are stand alone heating devices, the greater surface area radiates more heat than a fireplace.

The emissions from residential fireplaces and woodstoves are highly variable, depending on the amount of wood burned and the types of woodstoves and fireplaces being used for burning wood. Many assumptions were made with the realization that any variations in one or more of these variables would substantially change the calculations.

Methodologies

The emission estimates for woodstoves and fireplaces were derived from BAAQMD's wood burning survey performed between winter of 2005 and spring of 2006. This survey was performed by True North Research. Data collected from this survey includes wood burning activities via frequency, fuel type, and quantity for the Bay Area nine counties. A compilation and analysis of this data was performed by Dr. David Fairley, BAAQMD's statistician, in a report entitled "Revised Estimates of Wood Burning in the San Francisco Bay Area Based on Telephone Survey Data". Statistical estimation methods were used in this report to derive the annual and seasonal amount of wood burned by county. Throughputs were also derived based on data obtained from the survey. A density of 5 lbs per unit of log was assumed in the calculation. Wood stove

and fire place emission factors were based on data obtained from ARB and EIIP volume IV. Composite emission factors were calculated for wood stove criteria pollutants based on an average of conventional and EPA phase II wood stove emission factors. The number of conventional versus EPA phase II wood stoves were derived based on a statistical analysis from the 05-06' winter survey.

In addition to criteria pollutant emission, greenhouse gases for wood smoke are also reported in the emission inventory. Wood smoke carbon dioxide emissions are considered to be biogenic emissions. Biogenic Carbon Dioxide (Bio-CO_2) emissions are a subset of total CO_2 emissions which are emitted from materials that are derived from living cells, excluding fossil fuels, limestone and other materials that have been transformed by geological processes. Bio-CO_2 originates from carbon that is present in materials such as wood, paper, vegetable oils and food, animal, and yard waste. Wood smoke greenhouse gas emission factors are obtained from the Department of Energy's (DOE's), Energy Information Administration (EIA).

Monthly Variation

The monthly variation for wood burning in woodstoves and fireplaces was also derived from Bay Area's 2005-2006 telephone survey on wood burning. Monthly variation was estimated based on sample weights assigned from the data analysis. The estimates were appropriately adjusted for county population.

County Distribution

There were wide county differences in the amounts of wood burned. For fireplaces, the more urban counties – Alameda, San Francisco and San Mateo – tend to have lower amounts burned per household than counties in more rural parts such as Sonoma and Napa counties. However, because of the large populations, Alameda, Contra Costa and Santa Clara were estimated to contain the largest quantity of logs burned per area. For wood stoves, Sonoma, Marin and Napa have the largest household number of logs burned per household but, again because of population, the largest number of logs burned in wood stoves per area was found in Contra Costa and Santa Clara counties.

TRENDS

Growth

Future projections of emissions are based on household growth in the Bay Area from 2009 "Projections" report published by ABAG.

CONTROL

Control of residential wood combustion currently falls under EPA's Standards of Performance for New Stationary Sources (NSPS) for residential wood heater (stoves). (This is adopted by reference in the District Regulation 10.) The NSPS required that new residential heaters manufactured on or after July 1, 1988, or sold on or after July 1, 1990 be certified to meet particulate emission standards of 5.5 grams per hour for

catalytic wood heaters and 8.8 grams per hour for non-catalytic wood heaters. These are known as Phase I stoves. More restrictive particulate emission standards were set for stoves manufactured on or after July 1, 1990 or sold after July 1, 1992. For catalytic wood heaters this was 4.1 grams per hour and for non-catalytic wood heater this was 7.5 grams per hour. These are known as Phase II stoves. Although EPA has only set emission limits for particulate matter, emission of reactive organic compounds and carbon monoxide are expected to be limited as well.

Natural gas fireplaces, pellet fueled wood stoves, and EPA-certified woodstoves and fireplaces are increasing in popularity every year. Particulate emissions from these heating devices are insignificant. Some cities and counties in the Bay Area have (or are looking at) enacting new ordinances restricting new wood stove and fireplaces to these low particulate emitting heating devices.

In July 2008, the District enacted a rule (Regulation 6, Rule 3) to control emissions from wood-burning devices. This rule limits emissions of particulate matter (PM) and visible emissions (VE) from wood-burning devices, including any wood-burning device, pellet-fueled wood heater or any indoor permanently-installed device burning any solid fuel for aesthetic or space-heating purposes which includes fireplaces. The rule will help to reduce PM emissions from the burning of wood in woodstoves and fireplaces.

By:	Tan Dinh
Date:	December 2010
Base Year:	2008
EIC Code:	610-600-0230-0000 (Cat 288) 610-602-0230-0000 (Cat 289)

EMISSION INVENTORY

CATEGORIES #290, 291, 292

FUEL COMBUSTION - STATIONARY SOURCES - COGENERATION
- BOILERS
- TURBINES
- RECIPROCATING ENGINES

EMISSIONS

Introduction

These stationary combustion categories (290, 291 and 292) account for criteria pollutant (particulate, organic, NO_x, SO_x, and CO) and greenhouse gas emissions (CO_2, CH_4, and N_2O) from boilers, turbines, and reciprocating engines at cogeneration plants in the San Francisco Bay Area. Cogeneration plants are located at many sites in the Bay Area, including oil, chemical and food processing companies, municipal utility companies, hospitals, and military bases etc.

Cogeneration plant is a power station that simultaneously generates both electricity and useful heat by utilizing one primary fuel.

Modern, highly efficient power plants use the gas turbine Combined Cycle (CC). The combined-cycle gas turbine power plant consists of one or more gas turbines equipped with heat recovery steam generators to capture heat from the gas turbine exhaust. Steam produced in the heat recovery steam generators powers a steam turbine generator to produce additional electric power. Use of the otherwise wasted heat in the turbine exhaust gas results in high thermal efficiency compared to other combustion based technologies. Combined-cycle plants currently entering service can convert about 50 percent of the chemical energy of natural gas into electricity. Additional efficiency can be gained in combined heat and power (CHP) applications (cogeneration), by bleeding steam from the steam generator, steam turbine or turbine exhaust to serve direct thermal loads, such as food and chemical processing.

Methodology

Emissions for these categories were obtained from point source data only, as contained in the District's data bank. The District updates the data each year on a source-by-source basis using as input:

1. Process material throughputs as reported by the plants

2. Emissions factors (these may be source specific factors reported by the plants through source test results or applicable general factors, i.e. from the U.S. Environmental Protection Agency (EPA)

3. Emissions control factors (device-specific or general - these may be supplied by the plants also)

Information on these specific cogeneration sources allowed them to be identified as boilers, turbines or reciprocating engines. Some of these sources may be of the "dual fuel" type, i.e., they are able to combust either gaseous or liquid fuel. EPA's document AP-42 contains emissions information on these types of sources.

The fuel specific greenhouse gas emission coefficients for these categories were obtained from the U.S. Department of Energy's (DOE's) Energy Information Administration (EIA), the U.S. Environmental Protection Agency's (EPA's) document AP-42, and the California Energy Commission (CEC).

County Distribution

The Bay Area Air District's point source database contains county distribution information for each facility based on its location.

Monthly Variation

Monthly variation of emissions is based on the company reported quarterly throughput/ activity data.

TRENDS

Historical

Historical emissions have varied with fuel usage activity. Prior to Base Year 1987, these three categories were grouped as one category.

Growth

For Category #290 (boilers), it was assumed that annual emissions, over the years, would tend to follow two components: retail trade industry employment and services industry employment. As such, the annual variation ratio value was developed as a hybrid, based on 50% of the retail trade industry employment value and 50% of the services industry employment value.

For Category #291 (turbines), it was assumed that annual emissions, over the years, would tend to follow two components: manufacturing industry employment and population within the District jurisdiction. As such, the annual variation ratio value was developed as a hybrid, based on 50% of the manufacturing industry employment value and 50% of the population value.

For Category #292 (reciprocating engines), it was assumed that emissions over the future years would tend to follow population growth.

The employment and population data used were obtained from two sources, the Association of Bay Area Government's (ABAG's) 2009 "Projections" reports and the California Statistical Abstracts.

Control

District Regulation 9, Rules 8 and 9 control NOx and SOx emissions from the internal combustion of fuels in engines and turbines, respectively.

By: Sukarn Claire
Date: January 2011
Base Year: 2008

EMISSION INVENTORY

CATEGORIES #293 - #294

FUEL COMBUSTION - STATIONARY SOURCES - POWER PLANTS
-GAS FIRED BOILERS
-OIL FIRED BOILERS

EMISSIONS

Introduction

Categories 293 and 294 estimate criteria pollutant (particulate, organic, NO_x, SO_x, and CO) and greenhouse gas emissions (CO_2, CH_4, and N_2O) from gas and oil fired boilers at the steam turbine power plants in the San Francisco Bay Area. All of the large steam turbine/boiler type electric power plants are located in San Francisco and Contra Costa counties.

A power generation plant which converts heat energy of fuel combustion into electrical energy by utilizing a steam turbine and alternator, is known as a steam turbine power plant. Steam is produced in the boiler by combusting fuel. The steam is then expanded in the turbine to spin the steam turbine. The steam turbine drives the alternator which converts mechanical energy of the turbine into electrical energy.

Emissions from the gas and oil fired turbines at power plants are contained in Categories 1595 and 297.

Methodology

Emissions for these categories were obtained from point source data only, as found in the District's data bank. Some of the boilers are of the "dual fuel" type, i.e.; they can either use natural gas (N.G.) or fuel oil. Presently only natural gas is used at the steam turbine/boiler type power plants.

The Nitrogen Oxide (NO_x) emission rates for the large steam power plants in the Bay Area have decreased over the years (from emission rate of about 0.15 lb. / MM BTU in 1990 to about 0.057 lb/ MM BTU in 2002).

The District updates the data each year on a source-by-source basis using as input:

1. Process material throughputs as reported by the power plants (this data is routinely updated)

2. Emissions factors (these may be source specific as reported by the facility or general factors, i.e. from the Environmental Protection Agency (EPA)

3. Emission control factors (device-specific or general - these may be supplied by the power plants also)

Information on the specific sources allowed them to be identified as gas fired or oil fired boilers. Many of these sources may be of the "dual fuel" type, i.e., they are able to combust either gaseous or liquid fuel. EPA's document AP-42 contains emissions information on these types of sources.

The fuel specific greenhouse gas emission coefficients for these categories were obtained from the U.S. Department of Energy's (DOE's) Energy Information Administration (EIA), the U.S. Environmental Protection Agency's (EPA's) document AP-42, and the California Energy Commission (CEC).

County Distribution

The District point source database contains county distribution information for each facility based on its location.

Monthly Variation

Monthly variation of emissions is based on company reported quarterly throughput/activity data.

TRENDS

Historical

NO_x emissions from 1980 through 2002 were based on actual fuel usage data provided by power plants operating in the Bay Area. Emissions over the years have fluctuated by a factor of about 2.5 based on external factors, such as amount of rainfall and the availability of low cost hydroelectric power during that year. The NO_x emissions have varied from over 30 tons/day to as low as 10 tons/day.

The fuel oil usage at the power plants has been decreasing over the years. Since 1996, electric utility power plants have been prohibited from burning fuel oil by District Regulation 9, Rule 11, except for emergency situations.

Growth

Emission projections were made by District staff, by using the California Energy Commission's (CEC) 2003 fuel usage forecasts for the Bay Area as a guide. The Bay Area boiler/steam turbine type power plant NO_x emissions have decreased from historical (e.g., 1994) levels of over 30 ton/day to about 1 ton/day in 2007. This is due to shutting down of the older inefficient boilers and the stringent Best Available Retrofit Control (BARCT) requirements of Regulation 9-11 for existing utility power plants (0.057 Lb/MMBTU or 48 ppm in 2003, 0.018 lb/MMBTU or 15 ppm in 2005) and the Best Available Control (BACT) requirements of Regulation 2-2 for new power plants (0.0089

lb/MMBTU or 7.5 ppm). NO_x emission concentrations are given in ppm by volume, dry basis at 15% O_2.

Control

As noted above, District Regulation 9-11 and 2-2 control NO_x and CO emissions from fuel combustion in boilers at electric power plants in the Bay Area.

By: Sukarn Claire
Date: January 2011
Base Year: 2008

EMISSION INVENTORY

CATEGORY #297, 1595, 1596 and 1597

FUEL COMBUSTION - STATIONARY SOURCES - POWER PLANTS
OIL FIRED TURBINES
GAS FIRED TURBINES
POWER TRANSMISSION/DISTRIBUTION
POWER IMPORTS

EMISSIONS

Introduction

Categories 297 and 1595 account for criteria pollutant (particulate, organic, NO_x, SO_x, and CO) and greenhouse gas emissions (CO_2, CH_4, and N_2O) from oil and gas fired turbines at the electric power plants in the San Francisco Bay Area.

Modern, highly efficient power plants use the gas turbine Combined Cycle (CC). A combined-cycle gas turbine power plant consists of one or more gas turbines equipped with heat recovery steam generators to capture heat from the gas turbine exhaust. Steam produced in the heat recovery steam generators powers a steam turbine generator to produce additional electric power. Use of the otherwise wasted heat in the turbine exhaust gas results in high thermal efficiency compared to other combustion based technologies. Combined-cycle plants currently entering service can convert about 50 percent of the chemical energy of natural gas into electricity. Additional efficiency can be gained in combined heat and power (CHP) applications (cogeneration), by bleeding steam from the steam generator, steam turbine or turbine exhaust to serve direct thermal loads, such as food and chemical processing.

Category 1596 contains estimates of fugitive emissions of Sulfur Hexafluoride (SF_6) from power transmission and distribution system in the Bay Area. SF_6 is an inorganic very potent greenhouse gas. SF_6 is used in the electrical industry as a gaseous dielectric medium for high-voltage circuit breakers, switchgear, and other electrical equipment. SF_6 gas has a much higher dielectric strength than air or dry nitrogen that makes it possible to significantly reduce the size of electrical gear.

Indirect greenhouse gas emission estimates from electricity imports to the Bay Area are accounted for in Category 1597.

Emissions from gas and oil fired steam turbine/boiler type electric power plants are covered in Categories 293 and 294.

Methodology

Emissions for Categories 297 and 1595 were obtained from point source data only, as found in the Air District's data bank.

The District updates the data each year on a source-by-source basis using as input:

1. Process material throughputs as reported by the power plants (this data is routinely updated)

2. Emissions factors (these may be source specific as reported by the facility or general factors, i.e. from the Environmental Protection Agency (EPA)

3. Emission control factors (device-specific or general - these may be supplied by the power plants also)

Emissions originate from turbines at various power plants and other facilities in the Bay Area. Many of these turbines are of the "dual fuel" type, i.e., they are able to combust either natural gas or fuel oil. Specific information on these sources allowed them to be identified as either gas or oil fired sources. The EPA's document AP-42 contains this information on dual fuel combustion turbines and engines.

The fuel specific greenhouse gas (GHG) emission coefficients for these categories were obtained from the U.S. Department of Energy's (DOE's) Energy Information Administration (EIA), the U.S. Environmental Protection Agency's (EPA's) document AP-42, and the California Energy Commission (CEC).

The SF_6 emissions for Category 1596 were based on PG&E's Service Area total fugitive SF_6 emissions. The SF_6 emissions were apportioned to the Bay Area based on the Bay Area population as compared to total PG&E Service Area population.

Indirect GHG emissions from electricity imported to the Bay Area (Category 1597) were estimated based on total power consumption to power generated locally in the Bay Area. It is estimated that about one fourth to one third of electricity used in the Bay Area is imported from sources outside of the Bay Area. Emission factors (lb/MWh) used in calculations were in accordance with the California Climate Action Registry.

County Distribution

The District point source database contains county distribution information for each facility for Category 297 and 1595. County distribution for Category 1596 and 1597 is based on population and power consumption, respectively.

Monthly Variation

Monthly variation of emissions is based on company reported quarterly throughput data for C297 and C1595. Uniform activity is assumed for C1596 and C1597.

TRENDS

History

Category 297 emissions prior to 1987 were derived from Base Year 1983 trend values. Historical emissions have varied with fuel usage activity. Emission projections for base

years prior to 1996 were developed from natural gas and fuel oil usage estimates provided to the District by PG&E.

Growth

Category 297 emissions projections for this base year were developed based on the electric power generation forecast by the California Energy Commission (CEC). In the long term, fuel oil usage is projected to be small.

Category 1595 emission projections were developed based on the electric power generation fuel usage forecast by the California Energy Commission (CEC). Emissions for this category are expected to grow due to new power plants being built and increase in power consumption.

Category 1596 emissions are not expected to grow so much as utilities have enrolled in voluntary SF_6 emission reduction programs.

Category 1597 emissions are expected to grow in accordance with CEC's power consumption projections.

Control

The Bay Area Air District Regulation 9, Rule 9 controls NOx and CO emissions from fuel combustion in gas turbines.

By: Sukarn Claire
Date: January 2011
Base Year: 2008

EMISSION INVENTORY

CATEGORIES #298, 299, 300, 301

FUEL COMBUSTION - STATIONARY SOURCES
OIL REFINERIES - EXTERNAL COMBUSTION
REFINERY MAKE GAS (298)
NATURAL GAS AND OTHER GASES (299)
LIQUID FUEL (300)
SOLID FUEL (301)

EMISSIONS

Introduction

These categories contain emissions from oil refinery external combustion sources.

Methodologies

Emissions for these categories were obtained from point source data as found in the District's Data Bank System. Each year, the District collects and records the data from individual refinery plants via a permitting process. The data is recorded using the following as inputs:

1. Process material throughputs (as reported by the plants, this data is routinely updated)

2. Emissions factors (these may be source specific as reported by the plants or general factors, i.e. from the EPA)

3. Emissions control factors (device-specific or general - these may be supplied by the plants also)

Emission information from numerous sources is grouped into the above mentioned categories. EPA's AP-42, Chapter 5 contains description of petroleum refining processes and emission factors. Criteria pollutants and greenhouse gas emissions, including carbon dioxide (CO_2), methane (CH4), and nitrous oxide (N2O), are produced during refining processes. Since refinery emissions are part of point sources, criteria pollutants as well as greenhouse gas data are obtained from the refinery plant as part of the Bay Area Air District permit renewal process.

The county, month, and day factors were derived based on information gather from a plant’s location, seasonal usage, and daily operation as found in the District’ Databank System.

TRENDS

Historical

Emissions prior to 1987 were derived from Base Year 1983 trend values. Past base year historical emissions include interchangeable emission reduction credits (IERC) which were part of category 10. IERC banking emissions are now inventoried under categories 298-300. Also, flare source emissions from categories 298 and 299 are now accounted for in category 15.

Growth

Projected growth for all refinery related categories was taken from the California Energy Commission report on California's Petroleum Infrastructure (2007) that predicted California refiners expand distillation capacity to increase at a rate of approximately one percent per year. California refiners have recently added and will continue to add more process units to produce reformulated gasoline. However, no large increases in emissions are expected from these units.

Control

Regulation 9-10 controls emissions of NOx due to external combustion. Significant reduction in NOx emissions was observed between the period from year 2000 to 2004 for refinery external combustion operations as a result of this rule.

By: Tan Dinh
Date: December 2010
Base Year: 2008

EMISSION INVENTORY

CATEGORIES # 302, 303, 304

FUEL COMBUSTION - STATIONARY SOURCES
RECIPROCATING ENGINES
- GASOLINE
- GAS FUEL
- LIQUID FUEL

EMISSIONS

Introduction

Categories 302, 303, and 304 estimate criteria pollutant (particulate, organic, NO_x, SO_x, and CO) and greenhouse gas emissions (CO_2, CH_4, and N_2O) from reciprocating engines in the San Francisco Bay Area. Category #302 contains reciprocating engines for firewater pumps and standby generators at the oil refineries. Category 303 contains mostly internal combustion engines/electric generators at various companies and utility districts. Category 304 accounts for emissions mostly from diesel fuel engines. Most of the sources in this category are emergency or standby electric generators.

Methodology

Emissions for categories 302 and 303 were obtained from point sources only. Emissions for category 304 were obtained from both point and area sources. The total engine population and emission estimates are based on ARB's 2003 report, Stationary Non-Agricultural Diesel Engines. The area source portion accounts for emissions from engines those are not included in the District's point source inventory. The District's permit requirement for engines was lowered to 50 horse powers or more. As a result, number of engines in the point source inventory is expected to increase with a corresponding decrease in the area source inventory.

The District updates the emissions data each year using as input:

1. Process material throughputs as reported by the facility

2. Emissions factors (these may be source specific as reported by the facility or general factors, i.e. from the Environmental Protection Agency (EPA)

3. Emissions control factors (device-specific or general - these may be supplied by the facility also)

Information on the specific reciprocating engine sources allowed them to be identified as using gasoline, gas fuel or liquid fuel. The EPA's document AP-42 contains this information on various fuel combusting reciprocating engines.

The fuel specific greenhouse gas emission coefficients for these categories were obtained from the U.S. Department of Energy's (DOE's) Energy Information Administration

(EIA), the U.S. Environmental Protection Agency's (EPA's) document AP-42, and the California Energy Commission (CEC).

County Distribution

The District's point source database contains county distribution information for each facility/source based on its location.

Monthly Variation

Monthly variation of emissions is based on company reported quarterly throughput or activity data.

TRENDS

History

For Category 302, emissions have been extremely low and constant over the past years. Emissions for Categories 303 and 304 have generally varied with fuel usage activity in the San Francisco Bay Area.

Growth

Emissions for Category 302 are assumed to stay fairly constant in future years. For Category 303, it was assumed that annual emissions would tend to follow and be influenced by two components: manufacturing industry employment and population. As such, a growth profile was developed, based on 33.3% of the manufacturing industry employment value and 66.7% of the population value within the District. It is assumed that annual emissions from Category 304 would tend to follow and be influenced in roughly equal amounts by two components: manufacturing industry employment and population. As such, a growth profile was developed, based on 50% of the manufacturing industry employment value and 50% of the population value within the District. Projected emissions include expected benefits from ARB's Air Toxic Control Measure (ATCM). Growth profile data was obtained from two sources, the Association of Bay Area Government's (ABAG's) 2009 "Projections" reports and the California Statistical Abstracts.

Control

The Air District's Regulation 9, Rule 8 controls NOx and SOx emissions of fuel combustion in reciprocating engines.

By: Sukarn Claire
Date: January 2011
Base Year: 2008

EIC: 05004012000000 (Cat. 304)

EMISSION INVENTORY

CATEGORY #1598

FUEL COMBUSTION - STATIONARY SOURCES
RECIPROCATING ENGINES
EMERGENCY DIESEL GENERATORS

EMISSIONS

Introduction

Category 1598 and 304 contain emissions from diesel engines used in emergency/standby electric generators. Category 1598 was added to account for additional emissions generated due to the increased use of emergency generators during the electric power shortage crisis in California (2001-2002). Category 304 contains emissions from normal usage of standby generators. These emissions from Category 304 are not covered here.

Methodology

Emissions due to increased emergency generator usage were estimated to be negligible during the electric power shortage crisis in California (2001-2002) and emissions are not expected to grow in the near future.

The District collects fuel usage data each year on a source-by-source basis from facilities operating in the Bay Area. Emissions are calculated using fuel usage data and emission factors in the database. Emission and control factors used are either source specific as reported by the plants or general factors, i.e., from the Environmental Protection Agency (EPA); the U.S. Department of Energy's (DOE's) Energy Information Administration (EIA); California Energy Commission (CEC) etc.

TRENDS

History (New category)

Growth

An electric energy crisis in California appears to be over. Emissions from increased usage of standby generators did not appear to materialize as estimated previously.

Control

Regulation 9 controls emissions of NOx and SOx of combustion.

By: Sukarn Claire
Date: January 2011
Base Year: 2008

EIC: 09904012000000

EMISSION INVENTORY

CATEGORIES #305 - 306

FUEL COMBUSTION - STATIONARY SOURCES - TURBINES

-GAS FUEL

-LIQUID FUEL

EMISSIONS

Introduction

Categories 305 and 306 account for criteria pollutant (particulate, organic, NO_x, SO_x, and CO) and greenhouse gas emissions (CO_2, CH_4, and N_2O) from fuel combustion in turbine engines in the San Francisco Bay Area. Category 305 accounts for emission from gas fired turbines and Category 306 from oil fired turbines, respectively.

A combustion turbine is a rotary engine that extracts energy from a flow of combustion gases. It has an upstream compressor coupled to a downstream turbine, and a combustion chamber in-between. The products of the combustion are forced into the turbine section. There, the high velocity and volume of the gas flow is directed through a nozzle over the turbine's blades, spinning the turbine which powers the compressor and drives their mechanical output.

Methodologies

Emissions for these categories were obtained from point source data as found in the District's Data Bank System. Each year, the District collects and records the data from individual plants via a permitting process. The data is entered and recorded as follows:

1. Process material throughput/activity (as reported by the plants, this data is routinely updated)

2. Emission factors (these may be source specific as reported by the plants or general factors, i.e. from the EPA)

3. Emission control factors (device-specific or general - these may be supplied by the power plants also)

Specific information on these sources allowed them to be identified as either gas or liquid fuel fired turbines. The EPA's document AP-42 contains this information on various fuel combusting turbines and engines.

The fuel specific greenhouse gas emission coefficients for these categories were obtained from the U.S. Department of Energy’s (DOE’s) Energy Information Administration

(EIA), the U.S. Environmental Protection Agency's (EPA's) document AP-42, and the California Energy Commission (CEC).

County Distribution

The District's point source database contains county distribution information for each facility/source based on its location.

Monthly Variation

Monthly variation of emissions is based on company reported quarterly throughput or activity data.

TRENDS

History

For category #306, it was felt that historical emission trends tend to follow population data. As such, the annual variation ratio value for each year was based on the appropriate population value.

Growth

For Category #305, it appeared that sources at oil refineries made the greatest contribution to emissions. Therefore, the emission growth profile for this category is developed in the same manner as the oil refinery external combustion categories. CEC projects about 1 percent growth per year.

Growth profile for Category #306 is assumed to follow population growth. The population data was obtained from the Association of Bay Area Government's (ABAG's) 2009 projection reports.

Control

The Air District's Regulation 9, Rule 9 controls NOx and SOx emissions from fuel combustion in stationary turbines.

By: Sukarn Claire
Date: January 2011
Base Year: 2008

EMISSION INVENTORY

CATEGORY #307, #1590, #1591, #968

FUEL COMBUSTION - STATIONARY SOURCES - NATURAL GAS

OTHER EXTERNAL COMBUSTION, POINT SOURCES

OTHER EXTERNAL COMBUSTION, AREA SOURCES- INDUSTRIAL

OTHER EXTERNAL COMBUSTION, AREA SOURCES- COMMERCIAL

GLASS MELTING FURNACES

EMISSIONS

Introduction

Categories 307, 968, 1590, and 1591 account for criteria pollutant (particulate, organic, NO_x, SO_x, and CO) and greenhouse gas emissions (CO_2, CH_4, and N_2O) from natural gas combustion sources.

Categories 307, 1590, and 1591 estimate emissions from sources, such as industrial/commercial/institutional water and steam boilers, furnaces, space heaters, process heaters, pre heaters, ovens and after burners etc.

Category 968 accounts for emissions from the natural gas fired glass melting furnaces at glass manufacturing plants in the Bay Area.

Methodologies

Point source:

Emissions for Categories 307 and 968 were obtained from point source data only as found in the District's data bank. The District updates the data each year on a source-by-source basis using as input:

1. Process material throughputs as reported by the plants.

2. Emissions factors (these may be source specific as reported by the plants or general factors, i.e. from the EPA).

3. Emissions control factors (device-specific or general - these may be supplied by the plants also).

Information on these specific sources allowed them to be identified as boilers, heaters, and furnaces etc. EPA's document AP-42 contains combustion related emissions information on these sources.

The fuel specific greenhouse gas emission coefficients for these categories were obtained from the U.S. Department of Energy's (DOE's) Energy Information Administration (EIA), the U.S. Environmental Protection Agency's (EPA's) document AP-42, and the California Energy Commission (CEC).

Area source:

Emissions for categories 1590 and 1591 were obtained from the area sources only. Categories 1590 and 1591 contain emissions from industrial and commercial sources, respectively. The area source natural gas usage estimates were developed by obtaining the total point source usage, and then subtracting it from the corresponding combined values for commercial, institutional and industrial natural gas total usage (point + area) in the District, provided by the California Energy Commission (CEC) or PG&E. The computation to develop area source natural gas usage was as follows:

CEC or PG&E's Total natural gas usage values	-	District Data Bank's Point source usage values	=	Area source natural gas usage values

Emission factor information for natural gas combustion was obtained from the U.S. Environmental Protection Agency's (EPA's) document AP-42, the U.S. Department of Energy's (DOE's) Energy Information Administration (EIA) and the California Energy Commission (CEC).

The area source natural gas combustion emission factors in pounds per million cubic feet (Lb/MMCF) are shown below.

CATEGORY	PART	ORG	NOX	SO_2	CO	CO_2	CH_4	N_2O
1590, 1591	7.6	11	98	0.6	42	120000	2.3	2.2

County Distribution

Categories 307 and 968: The District's point source database contains county distribution information for each facility based on its location.

Categories 1590 and 1591: County distribution is based on natural gas usage in each of the Bay Area County.

Monthly Variation

For point sources monthly variation of emissions is based on company reported quarterly throughput data. Area source monthly variation is based on average fuel usage by month.

TRENDS

History

Glass Melting Furnaces, Category 968 was added to the emissions inventory system for base year 1990 after adoption of Regulation 9, Rule 12. Prior to base year 1990, emissions from Glass Melting Furnaces were accounted for in Category 307. For base year 2002, Category 307 was further split into point sources (C307) and area sources (C1590). For base year 2008, Category 1590 was split into Industrial (C1590) and Commercial (C1591) sources.

Prior to base year 1987, category 307 was grouped as four categories: #86, 97, 99 and 111. This change to a single category for all area sources was made due to unavailability of separate natural gas usage data for each category.

Growth

Growth projections for Category 307, 1590 and 1591 are based on the California Energy Commission's natural gas demand forecasts.

For category 968, it was assumed that annual emissions would tend to follow and be influenced by manufacturing industry employment.

The data used in developing growth profile was obtained from the Association of Bay Area Government's (ABAG's) 2009 "Projections" reports.

Control

District's Regulation 9 controls emissions of NOx and CO from combustion.

By: Sukarn Claire
Date: January 2011
Base Year: 2008

EIC: 06099501100000 (Cat. 1590)

EMISSION INVENTORY

CATEGORIES #308, 309, 310, 311, 312

FUEL COMBUSTION - STATIONARY SOURCES

OTHER EXTERNAL COMBUSTION

LPG, DISTILLATE OIL, RESIDUAL OIL, COKE & COAL, OTHER FUELS

EMISSIONS

Introduction

These categories account for criteria pollutant (particulate, organic, NO_x, SO_x, and CO) and greenhouse gas emissions (CO_2, CH_4, and N_2O) from external combustion of fuels other than natural gas at industrial facilties in the San Francisco Bay Area. Categories 308, 309, 310, 311, and 312 estimate emissions from external combustion of fuels such as liquefied petroleum gas (LPG), distillate oil, residual oil, coke & coal and other fuels, respectively.

Methodologies

Emissions for these categories were obtained from point source data only, as contained in the District's data bank. The District updates the data each year on a source-by-source basis using as input:

1. Process material throughputs as reported by the plants utilizing these fuels for external fuel combustion

2. Emissions factors (these may be source specific factors reported by the plants through source test results or applicable general factors, i.e. from the EPA)

3. Emissions control factors (device-specific or general - these may supplied by the plants also)

Information on these specific sources allowed them to be identified as using fuels such as liquefied petroleum gas (LPG), distillate oil, residual oil, coke & coal and other fuels. Environmental Protection Agency’s document AP-42 contains external combustion emission information on these types of sources.

The fuel specific greenhouse gas emission coefficients for these categories were obtained from the U.S. Department of Energy’s (DOE’s) Energy Information Administration (EIA), the U.S. Environmental Protection Agency’s (EPA’s) document AP-42, and the California Energy Commission (CEC).

The county, month, and day factors are obtained from the data bank's information on each plant's location, seasonal usage, and days per week of operation.

TRENDS

History

Emissions prior to 1987 were derived from Base Year 1983 trend values. Category 309 had been grouped as four categories before Base Year 1987 and Category 311 had been grouped as two categories. The historical trend values for categories 309 and 311 were summed, respectively, to build the historical emissions data.

Growth

For Categories 308 and 309, it was felt that annual emissions, over the years, would tend to follow and be influenced in roughly equal amounts by two components as follow**:** manufacturing industry employment and services industry employment by county, all within the District jurisdiction. As such, the annual variation ratio value for each year, for each county involved, was developed as a hybrid, based on 50% of the appropriate county manufacturing industry employment value and 50% of the appropriate services industry employment value.

For Category #310, it was felt that annual emissions, over the years, would tend to follow and be influenced mainly by manufacturing industry employment by county, all within the District jurisdiction. As such, the annual variation ratio value for each year, for each county involved, was developed to follow the manufacturing industry employment value.

For Category #311, it was felt that annual emissions, over the years, would tend to follow and be influenced in roughly equal amounts by two components as follow**:** manufacturing industry employment and construction industry employment by county, all within the District jurisdiction. As such, the annual variation ratio value for each year, for each county involved, was developed as a hybrid, based on 50% of the appropriate county manufacturing industry employment value and 50% of the appropriate construction industry employment value.

For Category #312, it was felt that annual emissions, over the years, would tend to follow and be influenced in roughly equal amounts by two components as follows: one-third by manufacturing industry employment and two-thirds by population by county, all within the District jurisdiction. As such, the annual variation ratio value for each year, for each county involved, was developed as a hybrid, based on 33.3% of the county manufacturing industry employment value and 66.7% of the appropriate county population value.

The employment and population data used for the above growth profiles were obtained from two sources, the Association of Bay Area Government's (ABAG's) 2009 "Projections" report and the "California Statistical Abstracts" document.

Control

Regulation 9 controls emissions of NOx and SOx of combustion.

By: Sukarn Claire
Date: January 2011
Base Year: 2008

SECTION 8

BURNING OF WASTE MATERIAL

EMISSION INVENTORY

CATEGORY #313

BURNING OF WASTE MATERIAL
RESOURCE RECOVERY PROJECTS

EMISSIONS

Introduction

There were no sources operating within this category. Years ago, some permit applications for proposed resource recovery facilities had been submitted to the District for evaluation. None apparently completed the permit evaluation process (i.e., received a Permit to Operate) and none were operating. Consequently, there were no emissions for Category 313.

Methodology

There were no sources operating within this category, therefore no reported emissions.

In general, the District collects fuel usage data each year on a source-by-source basis from point source facilities operating in the Bay Area. Emissions are calculated using fuel usage data and emission factors in the database. Emission and control factors used are either source specific as reported by the plants or general factors, i.e., from the Environmental Protection Agency (EPA); the U.S. Department of Energy's (DOE's) Energy Information Administration (EIA); California Energy Commission (CEC) etc.

TRENDS

History

There is no historical data for this category.

Growth

No sources are projected to operate in this category.

Control

No sources are subject to any combustion rules.

By: Sukarn Claire
Date: January 2011
Base Year: 2008

EIC: 09908000120000

EMISSION INVENTORY

CATEGORY #314

BURNING OF WASTE MATERIAL - INCINERATION

EMISSIONS

Introduction

This category estimates criteria pollutant (particulate, organic, NO_x, SO_x, and CO) and greenhouse gas (GHG) emissions (Biogenic-CO_2, CH_4, and N_2O) from waste material combustion at dwellings (e.g., in fireplaces and apartment house incinerators), commercial firms (e.g., in crematories and pathological incinerators), and industrial plants (e.g., in incinerators for waste disposal, reduction or preparation for recycling operations). Emissions for this category were obtained as the sum of emission estimates from both point and area sources.

Carbon Dioxide emissions from this category are considered to be biogenic emissions. Biogenic Carbon Dioxide (Bio-CO_2) emissions are a subset of total CO_2 emissions which are emitted from materials that are derived from living cells, excluding fossil fuels, limestone and other materials that have been transformed by geological processes. Bio-CO_2 originates from carbon that is present in materials such as wood, paper, vegetable oils and food, animal, and yard waste.

This category does not include emissions from the combustion of any "auxiliary fuel" (e.g. natural gas or fuel oil) used to maintain the elevated temperatures needed to promote combustion of the waste material being incinerated (Emissions from such "auxiliary fuels" would be covered in categories #307, #309, #1590 and #1591). This category also does not include emissions from solid fuel combustion for heating, cooking, or recreational purposes, which is covered in category #289.

Methodology

Point Sources

The District updates the point source data each year on a source-by-source basis using as input the following:

1. Process material throughputs as reported by the plants.

2. Emissions factors (these may be source specific as reported by the plants or general factors, i.e. from the EPA).

3. Emissions control factors (device-specific or general - these may be supplied by the plants also).

Area Sources

Area source emissions were calculated based on an estimated household waste throughput in the Bay Area. Most of the household waste in the Bay Area is collected and disposed of at the waste landfills. About one percent of the total waste generated is assumed to be burnt through illegal fires. The throughput (tons/year) was estimated by multiplying the Bay Area population by an average amount of waste production per resident. An average residential daily waste production of 1.6 lbs./person/day was used for the Bay Area. The residential daily waste production data was obtained from the California Integrated Waste Management Board for the year 1998.

The emission factors for this categories in pounds per ton (Lb/Ton) of waste materials combusted are shown below.

Cat.#	PM	ORG	NOX	SO_2	CO	Bio-CO_2	CH_4	N_2O
314	2.7	2.2	2.6	0.88	6.4	1999	1.5	0.002

Emission factors were developed based on type of materials commonly disposed of in this manner. EPA's document AP-42 contains information on combustion of waste materials. The fuel specific emission coefficients for GHGs were obtained from the U.S. Department of Energy's (DOE's) Energy Information Administration (EIA), the U.S. Environmental Protection Agency's (EPA's) document AP-42, and the California Energy Commission (CEC).

TRENDS

History

Historical emission trends followed area population growth.

Growth

It was assumed that annual emission trends for waste burning would follow population growth in the Bay Area. The population growth data was obtained from the Association of Bay Area Government's (ABAG's) 2009 "Projections" reports.

Control

District Regulation 9 controls emissions of NOx and SOx from combustion.

By: Sukarn Claire
Date: January 2011
Base Year: 2008

EIC: 67099502400000

EMISSION INVENTORY

CATEGORY #315 - 319

PLANNED AGRICULTURAL DEBRIS BURNING PRUNINGS; FIELD CROPS; WEED BURNING; RANGE IMPROVEMENT BURNING; FOREST MANAGEMENT

EMISSIONS

Introduction

These area source categories estimate criteria pollutant (particulate, organic, NO_x, SO_x, and CO) and greenhouse gas emissions (Biogenic-CO_2, CH_4, and N_2O) resulting from managed burning of agricultural and forest debris in the San Francisco Bay Area. Categories 315, 316, 317, 318, and 319 account for emissions from open burning of orchard prunings (such as grape vines, apples, and olives), field crops (such as wheat and oats), weeds (such as ditch and canal bank, and marsh burning), range improvement (such as chaparral and grass land burning) and forest debris, respectively.

Carbon Dioxide emissions from these categories are considered to be biogenic emissions. Biogenic Carbon Dioxide (Bio-CO_2) emissions are a subset of total CO_2 emissions which are emitted from materials that are derived from living cells, excluding fossil fuels, limestone and other materials that have been transformed by geological processes. Bio-CO_2 originates from carbon that is present in materials such as wood, paper, vegetable oils and food, animal, and yard waste.

Methodologies

Annual activity or waste material burn information for these categories was obtained from the burn permits issued by the District's Enforcement Division for each county. Information on amounts of waste materials burned was provided to the District in various units such as acres, tons, pounds, and cubic yards. By applying the crop specific fuel loading factors and other conversion units, all burn activity was converted to tons of material burned per year.

Emissions were calculated by multiplying the activity (Tons/Year) for a given category by its composite emission factor (Lb/Tons). Composite emission factors were developed using crop specific emission factor data from the California Air Resources Board (CARB) and the Environmental Protection Agency (EPA). Background information for emission factors and fuel loading is explained in the CARB memo, the Agricultural Burning Emission Factors dated August 17, 2000. Emission factors for these categories in pounds per ton (Lb/Ton) are shown below.

Category	PART	ORG	NOx	SOx	CO	Bio-CO_2	CH_4	N_2O
315	8.7	11.7	5.2	0.17	71.0	173.8	0.14	0.35
316	17.8	24.6	4.8	0.60	123.9	120.8	5.40	0.24

317	16.2	18.8	4.8	0.64	114.0	120.0	3.00	0.24
318	16.2	18.8	4.5	0.60	114.0	147.3	4.40	0.30
319	8.1	11.1	5.2	0.10	66.0	173.8	5.70	0.35

Sample Equations

Activity (tons/year) = Crop Area (acres/year) * Fuel Loading (tons/acre)
Emissions = Activity * Emission Factor

Example for PM Emissions, Field Crops, Category 316

Activity - 1600 (tons/year)
PM Emission Factor - 17.8 (lbs /ton)

PM Emissions = (1600 tons/year) * 17.8 (lbs/ton)) / 2000 (lbs/ton)
PM Emissions = 14.24 (tons/year)

County Distribution

Distribution of emissions into counties is based on amounts of material burnt in each county.

Monthly Variation

Monthly distribution for all categories was made proportional to an average burn data reported on monthly basis.

TRENDS

History

The 1981 emissions and tonnage burned data was used to develop emission factors for base years 1987 and 1990. Prior to base year 2002, historical emission trends were based on Agriculture Dollar Output.

Growth

Emission projections are based on CARB's growth data for the Bay Area counties.

By: Sukarn Claire
Date: July 2011
Base Year: 2008

EIC: 67066002620000 (Cat. 315), 67066202620000 (Cat. 316), 67066802000000 (Cat. 317), 67066602000000, 67066402000000 (Cat.319)

SECTION 9

MOBILE COMBUSTION

EMISSION INVENTORY

CATEGORIES # 1647 - 1651

LAWN AND GARDEN EQUIPMENT

EMISSIONS

Introduction

These categories account for emissions from lawn, garden and other general utility equipment, powered by two and four stroke gasoline engines of less than 20 horsepower and diesel engines. Two-stroke engines have several attributes that are advantageous for applications such as leaf blowers. The two-stroke engines are lightweight and operate in multi-position, allowing for great flexibility in equipment applications. Typical two-stroke engines feed fuel/oil mixture into combustion chamber. A major disadvantage of two-stroke engines is high exhaust emissions. The major pollutants from a two-stroke engines are: oil-base particulates, reactive organics (a mixture of burned and unburned hydrocarbons), and carbon monoxide. Lawn, garden and other diesel equipment includes products such as walk behind mowers, garden tractors, hedge and lawn trimmers and leaf blowers. General utility equipment includes chain saws, generators, compressors, pumps, welding machines, grinders and shredders.

Methodologies

California Air Resources Board (CARB) developed the Off-road vehicle emission inventory (OFFROAD2007) model to estimate emissions from off-road motor vehicles for all counties and air basins in California. The OFFROAD2007 model contains a more comprehensive list of equipment from a wider range of categories compared to BAH. The model adds an inventory estimate for engines powered by diesel fuel, compressed natural gas (CNG) and liquid petroleum gas (LPG) which were not previously accounted for. The criteria and GHG emission data for lawn, garden and utility equipment categories in the Bay Area were obtained from the CARB's OFFROAD2007 model.

Monthly Variation

Monthly variation of emissions was assumed to be mainly in the late spring, summer and early fall. The heaviest usage of utility equipment occurs during weekdays for commercial and weekends for residential applications. Most of the daily activity occurs during daylight hours.

County Distribution

County emissions were provided by the CARB's OFFROAD model.

TRENDS

History

Prior to the 1999 Base year emissions, the methodology for the lawn and garden equipment was based on the published report "Report on Utility Equipment Emissions in the State of California" by Booze, Allen, and Hamilton (BAH). For each type of equipment, estimates were made of the in-use population in California and percentage of use for residential and commercial applications. This was based on national equipment sales data, interviews with domestic and foreign manufacturers. Average HP rating, hourly use and load factor for each type of equipment were estimated for both commercial and residential applications.

Growth

Projected emissions for lawn, garden and utility equipment categories were estimated based on ARB's Off-road vehicle emission inventory model. The growth factors utilized in the OFFROAD model are based on a report for the Air Resources Board entitled "A Study to Develop Projected Activity for "Non-Road Mobile" Categories in California, 1970-2020". In this report, certain economic indicators are used to project the growth in population and usage of small off-road engines in various applications.

Control

In December of 1990, the CARB adopted two levels of emission standards for small off-road engines. The first phase of standards (Tier 1) was implemented in 1995 and Tier 2 standards are scheduled for implementation in 1999. The deterioration rates for 4 stroke Tier 1 engines were derived from data supplied by engine manufacturers. Since engines meeting Tier 2 standards are not yet available, engineering judgment was used to estimate the effect of the more stringent standards. The first set of regulations for utility engines came into effect on January 1, 1994. These were in the form of specific emission standards for different sizes and types of engines used in this type of equipment. More stringent standards came into effect in January 1999.

By: Michael Nguyen
Date: February, 2011
Base Year 2008

EIC: 86088311000040 (Cat#1647)
86088311000020 (Cat#1648)
86088311000041 (Cat#1649)
86088311000021 (Cat#1650)
86088312100000 (Cat#1651)

LAWN AND GARDEN EQUIPMENT

Categories # 1647 – 1651

Annual Average Emissions (tons/day)

Year	PM	TOG	NOx	SOx	CO	CO_2	CH_4	N_2O
1990	0.70	29.39	2.77	0.16	182.10	271.04	3.02	0.19
1991	0.68	28.67	2.69	0.14	171.13	274.15	2.77	0.18
1992	0.67	28.40	2.71	0.12	170.06	277.25	2.44	0.19
1993	0.66	28.03	2.72	0.10	167.17	280.31	2.16	0.19
1994	0.64	27.75	2.75	0.08	166.37	283.36	1.94	0.19
1995	0.62	27.81	2.73	0.07	165.53	286.63	1.76	0.19
1996	0.61	27.28	2.65	0.02	153.43	289.62	1.10	0.19
1997	0.58	26.79	2.67	0.02	152.16	292.58	1.07	0.19
1998	0.58	26.52	2.68	0.02	151.28	295.57	1.05	0.20
1999	0.59	26.58	2.71	0.02	152.59	299.69	1.05	0.20
2000	0.43	23.44	2.73	0.02	147.46	303.79	0.87	0.21
2001	0.40	22.12	2.77	0.02	136.67	305.47	0.79	0.23
2002	0.39	20.83	2.88	0.02	124.91	307.17	0.72	0.24
2003	0.37	20.15	2.92	0.02	120.91	310.16	0.68	0.24
2004	0.36	21.18	2.91	0.02	118.83	313.12	0.67	0.25
2005	0.35	20.37	2.86	0.02	114.96	314.82	0.62	0.24
2006	0.34	19.17	2.81	0.02	112.96	316.52	0.60	0.25
2007	0.34	18.54	2.65	0.01	112.35	319.34	0.58	0.23
2008	0.33	17.85	2.44	0.01	111.88	322.20	0.56	0.22
2009	0.32	17.31	2.37	0.01	111.48	325.02	0.55	0.22
2010	0.32	16.77	2.33	0.01	111.13	327.85	0.54	0.22
2011	0.31	16.33	2.30	0.01	111.64	332.31	0.53	0.22
2012	0.31	15.87	2.28	0.01	111.69	335.22	0.53	0.22
2013	0.31	15.45	2.27	0.01	112.03	338.11	0.52	0.22
2014	0.31	15.05	2.26	0.01	112.49	341.02	0.52	0.22
2015	0.31	14.71	2.24	0.01	113.02	343.93	0.52	0.23
2016	0.31	14.39	2.24	0.01	113.60	346.80	0.52	0.23
2017	0.31	14.10	2.23	0.01	114.29	349.70	0.52	0.23
2018	0.31	13.92	2.23	0.01	115.06	352.61	0.52	0.23
2019	0.31	13.78	2.24	0.01	115.85	355.50	0.52	0.23
2020	0.31	13.67	2.24	0.01	116.68	358.41	0.53	0.23
2021	0.31	13.59	2.25	0.01	117.60	361.50	0.53	0.23
2022	0.32	13.58	2.26	0.01	118.62	364.84	0.53	0.23
2023	0.32	13.60	2.27	0.01	119.66	368.15	0.54	0.23
2024	0.32	13.62	2.29	0.01	120.70	371.42	0.54	0.23
2025	0.32	13.67	2.30	0.01	121.76	374.79	0.55	0.23
2026	0.33	13.71	2.31	0.01	122.84	378.17	0.55	0.23
2027	0.33	13.75	2.33	0.01	123.93	381.60	0.55	0.23
2028	0.33	13.80	2.34	0.01	125.02	385.05	0.55	0.23
2029	0.33	13.85	2.35	0.01	126.13	388.54	0.55	0.23
2030	0.33	13.90	2.37	0.01	127.25	392.05	0.55	0.23

EMISSION INVENTORY

CATEGORIES # 1652 - 1654

TRANSPORTATION REFRIGERATION UNITS (GASOLINE AND DIESEL)

EMISSIONS

Introduction

These categories cover emissions from the combustion of fuel in internal combustion engines that provide the power to operate refrigeration units on trucks and trailers. These units maintain low temperatures for certain products (e.g., perishable foods) while they are being transported.

Methodologies

California Air Resources Board (CARB) developed the Off-road vehicle emission inventory's OFFROAD2007 model to estimate emissions from off-road motor vehicles for all counties and air basins in California. The OFFROAD model contains a more comprehensive list of equipment from a wider range of categories compared to BAH. The OFFROAD model adds an inventory estimate for engines powered by diesel fuel, compressed natural gas (CNG) and liquid petroleum gas (LPG) which were not previously accounted for. The criteria and GHG emission data for transportation refrigeration unit categories in the Bay Area were obtained from the CARB's OFFROAD2007 model.

Monthly Variation

Monthly activity is assumed to be uniform throughout the year. Weekend activity is reduced compared with weekdays.

County Distribution

County emissions were provided by the CARB's OFFROAD2007 model.

TRENDS

History

Prior to the 1999 Base year emissions, the methodology for the transportation refrigeration units was based on the published report: "Report on Utility Equipment Emissions in the State of California". The average engine power, hours of use per year and emission factors for each type of unit were taken from a study conducted by Booze, Allen, and Hamilton Inc. (BAH). Total number of refrigeration units was based on the Department of Motor Vehicles' registration data for regular commercial trucks and

trailers by county. The total was distributed to counties using this data. The BAH study showed that all transportation refrigeration units consist of diesel units and there are no longer any gasoline power units.

Growth

Projected emissions for the transportation refrigeration units categories were estimated based on ARB's Off-road vehicle emission inventory model. The growth factors utilized in the OFFROAD model are based on a report for the Air Resources Board entitled "A Study to Develop Projected Activity for "Non-Road Mobile" Categories in California, 1970-2020". In this report, certain economic indicators are used to project the growth in population and usage of small off-road engines in various applications. In general, the population of small off-road equipment is expected to increase by approximately 34% between 1990 and the year 2010.

Control

In December of 1990, the CARB adopted two levels of emission standards for small off-road engines. The first phase of standards (Tier 1) was implemented in 1995 and Tier 2 standards are scheduled for implementation in 1999. The deterioration rates for 4 stroke Tier 1 engines were derived from data supplied by engine manufacturers. Since engines meeting Tier 2 standards are not yet available, engineering judgment was used to estimate the effect of the more stringent standards.

Projected emissions include expected benefits from ARB's Clean Diesel Regulations in 1993 and Re-Formulated Gasoline Phase II beginning 1999. These benefits were estimated using control factors developed by ARB.

By: Michael Nguyen
Date: February, 2011
Base Year 2008

EIC: 86088411000040 (Cat#1652)
86088411000041 (Cat#1653)
86088412100000 (Cat#1654)

TRANSPORTATION REFRIGERATION UNITS

Categories# 1652 - 1654

Annual Average Emissions (tons/day)

Year	PM	TOG	NOx	SOx	CO	CO_2	CH_4	N_2O
1990	0.64	4.06	4.06	0.04	11.51	310.29	0.40	0.005
1991	0.64	4.03	4.13	0.04	10.75	314.01	0.38	0.004
1992	0.64	4.11	4.35	0.04	11.19	317.58	0.39	0.004
1993	0.63	4.19	4.35	0.04	11.32	321.32	0.38	0.005
1994	0.63	4.08	4.61	0.04	11.35	325.19	0.33	0.005
1995	0.62	3.94	4.44	0.04	11.21	328.89	0.30	0.005
1996	0.62	3.96	4.47	0.04	10.57	331.87	0.29	0.004
1997	0.63	4.02	4.52	0.04	11.14	336.28	0.30	0.004
1998	0.62	3.95	4.54	0.04	11.20	340.69	0.29	0.005
1999	0.55	3.39	4.34	0.04	10.48	343.68	0.25	0.005
2000	0.52	3.13	4.20	0.04	10.15	346.62	0.23	0.005
2001	0.51	2.97	4.19	0.04	9.98	364.17	0.22	0.005
2002	0.51	2.89	4.28	0.05	9.29	382.63	0.21	0.005
2003	0.53	2.88	4.41	0.05	8.80	402.05	0.21	0.006
2004	0.53	2.81	4.51	0.05	8.74	422.44	0.21	0.006
2005	0.53	2.69	4.61	0.05	8.76	443.86	0.20	0.006
2006	0.52	2.53	4.73	0.06	8.80	466.39	0.19	0.006
2007	0.51	2.35	4.86	0.01	8.86	490.11	0.18	0.006
2008	0.48	2.13	4.99	0.01	8.92	515.03	0.16	0.006
2009	0.45	1.88	5.14	0.01	8.94	541.22	0.14	0.005
2010	0.42	1.65	5.32	0.01	8.98	568.79	0.12	0.005
2011	0.39	1.42	5.52	0.01	9.08	597.82	0.11	0.005
2012	0.36	1.22	5.74	0.01	9.18	628.30	0.09	0.005
2013	0.31	1.06	5.68	0.01	9.32	660.37	0.08	0.005
2014	0.26	0.95	5.61	0.01	9.51	694.08	0.07	0.005
2015	0.22	0.88	5.56	0.01	9.75	729.52	0.06	0.005
2016	0.18	0.85	5.53	0.01	10.02	766.80	0.06	0.005
2017	0.15	0.86	5.51	0.01	10.34	805.99	0.06	0.006
2018	0.12	0.88	5.52	0.01	10.68	847.21	0.06	0.006
2019	0.10	0.91	5.56	0.01	11.04	890.56	0.07	0.006
2020	0.08	0.95	5.63	0.01	11.42	936.13	0.07	0.006
2021	0.07	0.99	5.75	0.01	11.83	984.05	0.07	0.006
2022	0.06	1.03	5.92	0.01	12.25	1,034.47	0.08	0.006
2023	0.05	1.08	6.14	0.01	12.69	1,087.48	0.08	0.006
2024	0.05	1.13	6.40	0.02	13.16	1,143.23	0.08	0.006
2025	0.05	1.19	6.70	0.02	13.65	1,201.87	0.09	0.006
2026	0.05	1.24	7.02	0.02	14.17	1,263.52	0.09	0.006
2027	0.05	1.30	7.35	0.02	14.71	1,328.36	0.10	0.006
2028	0.05	1.37	7.70	0.02	15.28	1,396.53	0.10	0.006
2029	0.05	1.43	8.07	0.02	15.87	1,468.21	0.10	0.006
2030	0.05	1.50	8.45	0.02	16.50	1,543.59	0.11	0.006

EMISSION INVENTORY

CATEGORIES # 1655, 1656, 1646

AGRICULTURAL EQUIPMENT (GASOLINE & DIESEL POWERED)

EMISSIONS

Introduction

This category accounts for exhaust emissions from agricultural vehicles burning gasoline and diesel fuel while engaged in farming operations.

Methodologies

California Air Resources Board (CARB) developed the 2007 Off-road vehicle emission inventory (OFFROAD2007) model to estimate emissions from off-road motor vehicles for all counties and air basins in California. The 2007 OFFROAD model contains a more comprehensive list of equipment from a wider range of categories compared to BAH. The OFFROAD model adds an inventory estimate for engines powered by diesel fuel, compressed natural gas (CNG), and liquid petroleum gas (LPG). The criteria and GHG emission data for farm equipment categories in the Bay Area were obtained from the CARB's OFFROAD2007 model.

Monthly Variation

Monthly variation of emissions was assumed to be 75% for the months of June to October and 25% for the other remaining months.

County Distribution

County emissions were provided by the CARB's OFFROAD2007 model.

TRENDS

History

Prior to the 1999 Base Year emissions, the methodology for farm equipment was based on the published report: "Report on Utility Equipment Emissions in the State of California" by Booze, Allen, and Hamilton (BAH). For each type of equipment, such as tractors, bailers and combines, state-wide annual sales records were available for different types of engine (gasoline and diesel) and power rating (up to 500 hp). BAH also developed average hourly use and load factor for each type of equipment mentioned above. The statewide activity (in brake horse-power-hour) was thus estimated. The

annual activity was distributed to counties by the acreage harvested in each county taken from the Agricultural Crop Report. Emission factors were obtained from Power Research Systems, the Engine Manufactures Association.

Growth

Projected emissions for farm equipment categories were estimated based on ARB's Off-road vehicle emission inventory model. The growth factors utilized in the OFFROAD model are prepared in a report for the Air Resources Board entitled "A Study to Develop Projected Activity for "Non-Road Mobile" Categories in California, 1970-2020". In this report, certain economic indicators are used to project the growth in population and usage of small off-road engines in various applications.

Control

In December of 1990, the CARB adopted two levels of emission standards for small off-road engines. The first phase of standards (Tier 1) was implemented in 1995 and Tier 2 standards are scheduled for implementation in 1999. The deterioration rates for 4 stroke Tier 1 engines were derived from data supplied by engine manufacturers. Since engines meeting Tier 2 standards are not yet available, engineering judgment was used to estimate the effect of the more stringent standards.

Projected emissions include expected benefits from ARB's Clean Diesel Regulations in 1993, Re-Formulated Gasoline Phase II and EPA's diesel engine standards beginning 1999. These benefits were estimated using control factors developed by ARB.

By: Michael Nguyen
Date: February, 2011
Base Year 2008

EIC: 87089311000040 (Cat#1655)
87089311000041 (Cat#1656)
87089312100000 (Cat#1646)

AGRICULTURAL EQUIPMENT
Categories# 1655, 1656, 1646
Annual Average Emissions (tons/day)

Year	PM	TOG	NOx	SOx	CO	CO_2	CH_4	N_2O
1990	0.57	2.41	14.36	0.05	11.19	468.58	0.19	0.008
1991	0.57	2.38	13.72	0.06	10.19	482.20	0.18	0.008
1992	0.57	2.41	13.50	0.06	10.13	498.60	0.18	0.008
1993	0.57	2.45	13.28	0.06	10.06	515.55	0.17	0.008
1994	0.57	2.45	13.07	0.06	10.00	528.55	0.17	0.007
1995	0.57	2.26	9.57	0.06	9.94	538.42	0.16	0.007
1996	0.57	2.26	9.68	0.06	9.15	565.57	0.15	0.007
1997	0.57	2.26	9.66	0.06	9.09	582.30	0.15	0.007
1998	0.56	2.21	9.40	0.06	8.93	579.62	0.15	0.007
1999	0.55	2.16	9.13	0.06	8.79	576.91	0.15	0.007
2000	0.54	2.10	8.85	0.06	8.65	574.21	0.14	0.007
2001	0.53	2.04	8.56	0.06	8.53	571.53	0.14	0.007
2002	0.51	1.98	8.29	0.06	8.33	568.84	0.13	0.007
2003	0.50	1.92	8.00	0.06	8.13	566.18	0.13	0.007
2004	0.48	1.87	7.72	0.06	7.93	563.52	0.12	0.007
2005	0.46	1.79	7.44	0.06	7.78	560.83	0.12	0.006
2006	0.44	1.70	7.16	0.06	7.66	558.15	0.11	0.006
2007	0.41	1.61	6.82	0.01	7.54	555.45	0.10	0.006
2008	0.39	1.52	6.45	0.01	7.42	552.74	0.10	0.006
2009	0.37	1.44	6.15	0.01	7.34	550.06	0.09	0.006
2010	0.36	1.39	5.92	0.01	7.28	547.38	0.09	0.006
2011	0.34	1.30	5.60	0.01	7.18	544.66	0.08	0.006
2012	0.31	1.20	5.20	0.01	7.06	541.97	0.07	0.006
2013	0.28	1.09	4.81	0.01	6.95	539.28	0.07	0.006
2014	0.26	1.00	4.48	0.01	6.85	536.59	0.06	0.006
2015	0.24	0.92	4.15	0.01	6.76	533.90	0.06	0.006
2016	0.21	0.84	3.82	0.01	6.72	531.21	0.05	0.006
2017	0.19	0.77	3.50	0.01	6.69	528.52	0.05	0.006
2018	0.17	0.70	3.20	0.01	6.67	525.83	0.04	0.006
2019	0.15	0.64	2.93	0.01	6.65	523.14	0.04	0.006
2020	0.14	0.59	2.68	0.01	6.65	520.45	0.04	0.006
2021	0.12	0.56	2.46	0.01	6.69	518.39	0.03	0.006
2022	0.11	0.53	2.24	0.01	6.70	515.82	0.03	0.006
2023	0.10	0.50	2.06	0.01	6.71	513.26	0.03	0.006
2024	0.09	0.47	1.90	0.01	6.73	510.71	0.03	0.006
2025	0.08	0.45	1.76	0.01	6.75	508.18	0.03	0.006
2026	0.07	0.43	1.63	0.01	6.77	505.65	0.03	0.006
2027	0.06	0.41	1.51	0.01	6.80	503.15	0.03	0.006
2028	0.05	0.39	1.40	0.01	6.82	500.67	0.02	0.006
2029	0.05	0.37	1.30	0.01	6.85	498.20	0.02	0.006
2030	0.04	0.36	1.20	0.01	6.87	495.73	0.02	0.006

EMISSION INVENTORY

CATEGORIES #1657 - 1661

HEAVY DUTY CONSTRUCTION & MINING EQUIPMENT (GASOLINE & DIESEL POWERED)

EMISSIONS

Introduction

These categories account for exhaust emissions from heavy duty non-farm gasoline and diesel equipment used in construction, mining and logging operations.

Methodologies

California Air Research Board (CARB) developed an off-road vehicle emission inventory (OFFROAD2007) model to estimate emissions from off-road motor vehicles for all counties and air basins in California. The OFFROAD2007 model contained a more comprehensive list of equipment from a wider range of categories. The OFFROAD model added an inventory estimate for engines powered by diesel fuel, compressed natural gas (CNG) and liquid petroleum gas (LPG).

The criteria and GHG emissions for heavy duty construction and mining equipment categories in the Bay Area were obtained from the CARB's OFFROAD2007 model.

A review of available data on diesel fuel usage in the Bay Area for off-road equipment showed that the data was considerably lower than diesel fuel usage projected by the CARB's OFFROAD2007 model. As a result, off-road diesel construction equipment emission estimates have been reduced by 50% from the model estimates. In addition, at the time of finalizing this inventory, limited construction activity data were available regarding the impact of the economic recession. It is estimated that construction sector activity decreased approximately 12% between 2008 and 2011 due to the economic recession. The impact of this decrease is reflected in the 2008 inventory. It is assumed that this activity will slowly increase beginning in 2011.

Monthly Variation

Monthly variation of emissions was assumed to be 60% for the months of April to September and 40% for the other remaining months. Weekly activity takes place primarily during weekdays. Most of the daily activity occurs during daylight hours.

County Distribution

County emissions were provided by the CARB's 2007 OFFROAD model.

TRENDS

History

Prior to the 1999 Base Year emissions, the methodology for heavy duty non-farm equipment categories was based on Booze, Allen, and Hamilton's (BAH) "Report on Utility Equipment Emissions in the State of California". The report listed each type of equipment such as pavers, compactors, cranes and excavators, state-wide annual sales records by engine type (gasoline and diesel) and power rating (up to 500 hp). These were used, together with scrappage rates established by Power Systems Research (PSR), to establish equipment population. PSR also developed average hourly use and load factors for each type of equipment. The statewide activity (in brake horse-power-hour) by equipment type was thus estimated. Emission factors were obtained from the Engine Manufactures Association and a 1988 study by the Energy and Environmental Analysis.

Growth

Projected emissions for heavy duty non-farm equipment categories were estimated based on ARB's Off-road vehicle emission inventory model. The growth factors utilized in the OFFROAD model are based on a report for the Air Resources Board entitled "A Study to Develop Projected Activity for "Non-Road Mobile" Categories in California, 1970-2020". In this report, certain economic indicators are used to project the growth in population and usage of small off-road engines in various applications.

Control

In December of 1990, the CARB adopted two levels of emission standards for small off-road engines. The first phase of standards (Tier 1) was implemented in 1995 and Tier 2 standards were implemented in 1999. The deterioration rates for 4 stroke Tier 1 engines were derived from data supplied by engine manufacturers. Since engines meeting Tier 2 standards are not yet available, engineering judgment was used to estimate the effect of the more stringent standards.

Projected emissions include expected benefits from ARB's Clean Diesel Regulations in 1993, Re-Formulated Gasoline Phase II and EPA's diesel engine standards beginning 1999. These benefits were estimated using control factors developed by ARB.

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Base Year 2008

EIC: 86088711000040(Cat#1657)
86088711000020(Cat#1658)
86088711000041(Cat#1659)
86088711000021(Cat#1660)
86088712100000(Cat#1661)

HEAVY DUTY CONSTRUCTION & MINING EQUIPMENT

Categories# 1657 - 1661

Annual Average Emissions (tons/day)

Year	PM	TOG	NOx	SOx	CO	CO_2	CH_4	N_2O
1990	3.58	13.00	54.08	0.29	59.68	2,723.94	1.00	0.02
1991	3.56	12.96	56.93	0.30	56.55	2,802.86	0.98	0.02
1992	3.54	13.14	58.05	0.30	54.52	2,860.89	0.95	0.02
1993	3.52	13.33	60.33	0.31	52.80	2,915.85	0.92	0.02
1994	3.49	13.50	58.00	0.31	51.46	2,968.11	0.89	0.02
1995	3.47	11.55	57.56	0.31	50.50	3,018.04	0.86	0.02
1996	3.45	11.48	57.50	0.32	47.84	3,105.70	0.81	0.02
1997	3.45	11.31	57.04	0.32	45.90	3,170.20	0.80	0.02
1998	3.45	11.13	56.41	0.33	44.25	3,231.15	0.78	0.02
1999	3.45	10.97	55.78	0.34	42.95	3,289.10	0.77	0.02
2000	3.43	10.82	55.15	0.34	42.00	3,344.47	0.76	0.02
2001	3.42	10.71	54.57	0.35	41.33	3,402.09	0.75	0.02
2002	3.40	10.60	54.03	0.35	40.41	3,464.25	0.74	0.02
2003	3.37	10.36	53.23	0.36	38.83	3,525.11	0.73	0.02
2004	3.29	10.04	52.17	0.37	37.28	3,586.07	0.70	0.02
2005	3.20	9.62	51.04	0.37	36.10	3,647.71	0.67	0.02
2006	2.66	7.80	42.57	0.33	30.25	3,180.25	0.55	0.02
2007	2.49	7.37	41.09	0.04	29.73	3,234.54	0.52	0.02
2008	2.40	6.98	39.39	0.04	29.32	3,289.10	0.50	0.02
2009	2.16	6.17	35.45	0.03	26.07	3,138.52	0.45	0.02
2010	2.00	5.68	32.73	0.03	25.26	3,072.09	0.41	0.02
2011	1.76	5.01	28.69	0.03	24.03	2,876.02	0.36	0.02
2012	1.65	4.77	27.24	0.03	23.96	2,920.23	0.34	0.02
2013	1.53	4.55	25.83	0.03	23.93	2,964.20	0.33	0.02
2014	1.42	4.33	24.30	0.03	23.94	3,008.14	0.31	0.02
2015	1.31	4.12	22.56	0.03	23.97	3,052.00	0.30	0.02
2016	1.20	3.91	20.91	0.03	24.05	3,095.72	0.28	0.02
2017	1.10	3.71	19.37	0.04	24.16	3,139.33	0.27	0.02
2018	1.00	3.54	17.92	0.04	24.30	3,183.01	0.25	0.02
2019	0.91	3.37	16.58	0.04	24.46	3,226.81	0.24	0.02
2020	0.83	3.22	15.35	0.04	24.64	3,270.75	0.23	0.02
2021	0.76	3.10	14.23	0.04	24.88	3,314.94	0.22	0.02
2022	0.69	2.98	13.22	0.04	25.11	3,359.31	0.21	0.02
2023	0.64	2.88	12.30	0.04	25.36	3,403.97	0.20	0.02
2024	0.58	2.79	11.49	0.04	25.62	3,448.79	0.20	0.02
2025	0.54	2.71	10.77	0.04	25.90	3,493.68	0.19	0.02
2026	0.54	2.72	10.77	0.04	26.05	3,493.92	0.19	0.02
2027	0.54	2.72	10.77	0.04	26.20	3,494.15	0.19	0.02
2028	0.54	2.73	10.77	0.04	26.35	3,494.39	0.19	0.02
2029	0.54	2.73	10.77	0.04	26.51	3,494.63	0.19	0.02
2030	0.54	2.73	10.78	0.04	26.66	3,494.88	0.19	0.02

EMISSION INVENTORY

CATEGORIES #1662 - 1673

INDUSTRIAL/LIGHT COMMERCIAL EQUIPMENT (GASOLINE, DIESEL, & LPG POWERED)

EMISSIONS

Introduction

These categories account for combustion emissions from industrial and light commercial equipment burning gasoline, diesel, or liquefied petroleum gas.

Methodologies

Prior to the 1999 Base Year emissions, the methodology for these categories was based on Booze, Allen, and Hamilton's (BAH) "Report on Utility Equipment Emissions in the State of California". For each type of equipment, state-wide annual sales records were available by engine type (gasoline and diesel) and power rating (up to 175 hp). These were used, together with scrappage rates established by Power Systems Research (PSR), to establish equipment population. Emission factors were obtained from the Engine Manufactures Association and the Energy and Environmental Analysis's 1998 study.

The California Air Research Board (CARB) developed an off-road vehicle emission inventory (OFFROAD2007) model to estimate emissions from off-road motor vehicles for all counties and air basins in California. The OFFROAD2007 model contained a more comprehensive list of equipment from a wider range of categories compared to the BAH report. The OFFROAD model added an inventory estimate for engines powered by diesel fuel, compressed natural gas (CNG) and liquid petroleum gas (LPG) which were not previously accounted for in the BAH report. The criteria and GHG emission data for light duty construction categories in the Bay Area were obtained from the CARB's OFFROAD2007 model.

Monthly Variation

Monthly variation of emissions was assumed to be 60% for the months of April to September and 40% for the other remaining months. Weekly activity takes place during weekdays only. Most of the daily activity occurs during daylight hours.

County Distribution

County emissions were provided by the CARB's OFFROAD2007 model.

TRENDS

Growth

Projected emissions for light duty construction, oil drilling equipment and other portable equipment categories were estimated based on ARB's Off-road vehicle emission inventory model. The growth factors utilized in the OFFROAD2007 model are prepared in a report for the CARB entitled "A Study to Develop Projected Activity for "Non-Road Mobile" Categories in California, 1970-2020". In this report, certain economic indicators are used to project the growth in population and usage of small off-road engines in various applications.

Control

In December of 1990, the CARB adopted two levels of emission standards for small off-road engines. The first phase of standards (Tier 1) was implemented in 1995 and Tier 2 standards were implemented in 1999. The deterioration rates for 4 stroke Tier 1 engines were derived from data supplied by engine manufacturers. Since engines meeting Tier 2 standards are not yet available, engineering judgment was used to estimate the effect of the more stringent standards.

Projected emissions include expected benefits from ARB's Clean Diesel Regulations in 1993, Re-Formulated Gasoline Phase II and diesel engine standards beginning 1999. These benefits were estimated using control factors developed by ARB.

By: Michael Nguyen
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EIC: 86088611000040 (Cat#1662)
86088611000020 (Cat#1663)
86088611000041 (Cat#1664)
86088611000021 (Cat#1665)
86088612100000 (Cat#1666)
86088601100000 (Cat#1667)
86088511000040 (Cat#1668)
86088511000020 (Cat#1669)
86088511000041 (Cat#1670)
86088511000021 (Cat#1671)
86088512100000 (Cat#1672)
86088501100000 (Cat#1673)

INDUSTRIAL/LIGHT COMMERCIAL EQUIPMENT

Categories# 1662-1673

Annual Average Emissions (tons/day)

Year	PM	TOG	NOx	SOx	CO	CO_2	CH_4	N_2O
1990	1.37	16.32	31.49	0.39	192.75	1,709.33	3.28	0.25
1991	1.35	15.93	31.91	0.20	171.63	1,747.82	2.61	0.24
1992	1.34	15.71	32.69	0.19	168.75	1,778.11	2.54	0.24
1993	1.33	15.71	33.07	0.18	170.38	1,808.30	2.49	0.25
1994	1.32	15.58	33.37	0.17	171.52	1,835.86	2.45	0.25
1995	1.31	15.23	32.83	0.16	172.87	1,863.18	2.42	0.25
1996	1.29	14.70	32.12	0.11	153.86	1,906.21	2.04	0.24
1997	1.31	14.39	32.00	0.12	151.50	1,937.58	2.04	0.25
1998	1.33	14.33	31.92	0.12	153.18	1,969.11	2.06	0.25
1999	1.34	14.29	31.79	0.12	154.38	1,996.73	2.06	0.26
2000	1.35	14.28	31.69	0.12	155.79	2,024.53	2.08	0.26
2001	1.36	14.27	31.30	0.12	157.94	2,051.83	2.07	0.26
2002	1.35	14.03	30.62	0.12	158.17	2,079.05	2.04	0.26
2003	1.36	13.66	29.67	0.12	158.38	2,108.70	1.99	0.26
2004	1.35	13.44	27.83	0.12	156.73	2,138.22	1.84	0.25
2005	1.34	12.80	26.45	0.12	155.50	2,163.72	1.71	0.25
2006	1.33	12.02	25.11	0.13	154.68	2,189.14	1.58	0.24
2007	1.28	11.23	23.68	0.02	153.98	2,212.79	1.44	0.24
2008	1.25	10.43	22.31	0.02	152.63	2,236.32	1.29	0.23
2009	1.23	9.67	21.07	0.02	151.25	2,259.97	1.16	0.23
2010	1.20	8.95	19.90	0.02	150.10	2,283.59	1.03	0.22
2011	1.17	8.41	18.98	0.02	151.66	2,345.95	0.96	0.22
2012	1.13	7.90	17.97	0.02	152.33	2,376.99	0.89	0.22
2013	1.08	7.43	16.99	0.02	153.18	2,407.92	0.83	0.22
2014	1.03	7.03	16.12	0.02	154.14	2,439.02	0.79	0.22
2015	0.98	6.68	15.23	0.02	155.17	2,470.06	0.76	0.22
2016	0.93	6.40	14.41	0.02	156.34	2,500.99	0.74	0.22
2017	0.88	6.18	13.70	0.02	157.76	2,532.03	0.73	0.22
2018	0.85	6.01	13.05	0.02	159.04	2,562.97	0.72	0.22
2019	0.81	5.87	12.48	0.02	160.69	2,594.06	0.71	0.22
2020	0.77	5.77	11.99	0.02	162.46	2,625.01	0.71	0.23
2021	0.75	5.71	11.59	0.02	164.82	2,665.58	0.72	0.23
2022	0.72	5.68	11.24	0.02	166.91	2,701.01	0.72	0.23
2023	0.70	5.66	10.95	0.02	169.05	2,737.03	0.73	0.23
2024	0.69	5.65	10.71	0.03	171.27	2,773.66	0.73	0.23
2025	0.67	5.65	10.49	0.03	173.47	2,811.22	0.73	0.23
2026	0.66	5.66	10.30	0.03	175.70	2,849.27	0.74	0.23
2027	0.65	5.67	10.12	0.03	177.95	2,887.85	0.75	0.23
2028	0.65	5.68	9.97	0.03	180.24	2,926.97	0.75	0.23
2029	0.64	5.69	9.82	0.03	182.55	2,966.59	0.76	0.23
2030	0.64	5.70	9.70	0.03	184.90	3,006.75	0.77	0.23

EMISSION INVENTORY

CATEGORIES #1674 – 1675

OTHER OFF-ROAD DIESEL EQUIPMENT (OIL DRILLING & PORTABLE EQUIPMENT)

EMISSIONS

Introduction

These categories account for combustion emissions from oil drilling equipment and other portable equipment. Other portable equipment includes light duty industrial equipment such as forklifts, portable generators, mobile cranes, etc.

Methodologies

California Air Research Board (CARB) developed an off-road vehicle emission inventory (OFFROAD2007) model to estimate emissions from off-road motor vehicles for all counties and air basins in California. The criteria and GHG emission data for oil drilling equipment and other portable equipment categories in the Bay Area were obtained from the CARB's OFFROAD2007 model.

Monthly Variation

Monthly variation of emissions was assumed to be 60% for the months of April to September and 40% for the other remaining months. Weekly activity takes place during weekdays only. Most of the daily activity occurs during daylight hours.

County Distribution

County emissions were provided by the CARB's OFFROAD2007 model.

TRENDS

History

Prior to the 1999 Base Year emissions, the methodology for these categories was based on Booze, Allen, and Hamilton's (BAH) "Report on Utility Equipment Emissions in the State of California". For each type of equipment, state-wide annual sales records were available by engine type (gasoline and diesel) and power rating (up to 175 hp). These were used, together with scrappage rates established by Power Systems Research (PSR), to establish equipment population. Emission factors were obtained from the Engine Manufactures Association and the Energy and Environmental Analysis's 1998 study.

Growth

Projected emissions for light duty construction, oil drilling equipment and other portable equipment categories were estimated based on ARB's Off-road vehicle emission inventory model. The growth factors utilized in the OFFROAD model are prepared in a report for the CARB entitled "A Study to Develop Projected Activity for "Non-Road Mobile" Categories in California, 1970-2020". In this report, certain economic indicators are used to project the growth in population and usage of small off-road engines in various applications.

By: Michael Nguyen
Date: February, 2011
Base Year 2008

EIC: 86089112100000 (Cat#1674)
86099512100000 (Cat#1675)

OTHER OFF-ROAD DIESEL EQUIPMENT

Categories# 1674 - 1675

Annual Average Emissions (tons/day)

Year	PM	TOG	NOx	SOx	CO	CO_2	CH_4	N_2O
1990	0.13	0.42	2.59	0.01	1.91	132.32	0.03	-
1991	0.13	0.41	2.59	0.01	1.81	136.21	0.03	-
1992	0.13	0.40	2.57	0.01	1.71	138.76	0.03	-
1993	0.13	0.39	2.55	0.01	1.63	140.81	0.03	-
1994	0.12	0.39	2.54	0.01	1.56	143.00	0.03	-
1995	0.12	0.37	2.49	0.01	1.44	145.58	0.03	-
1996	0.12	0.36	2.49	0.01	1.37	149.91	0.03	-
1997	0.12	0.36	2.47	0.01	1.29	152.73	0.03	-
1998	0.11	0.35	2.45	0.01	1.23	155.01	0.03	-
1999	0.11	0.34	2.44	0.01	1.17	157.44	0.03	-
2000	0.11	0.33	2.39	0.02	1.09	160.31	0.02	-
2001	0.10	0.31	2.34	0.02	1.01	163.00	0.02	-
2002	0.10	0.30	2.28	0.02	0.93	165.28	0.02	-
2003	0.09	0.28	2.22	0.02	0.87	167.26	0.02	-
2004	0.09	0.27	2.16	0.02	0.82	168.93	0.02	-
2005	0.08	0.25	2.10	0.02	0.78	170.57	0.02	-
2006	0.08	0.23	2.00	0.02	0.74	172.13	0.02	-
2007	0.07	0.22	1.89	0.00	0.71	173.55	0.02	-
2008	0.07	0.20	1.78	0.00	0.68	174.90	0.02	-
2009	0.07	0.19	1.69	0.00	0.66	176.18	0.01	-
2010	0.06	0.18	1.60	0.00	0.63	177.34	0.01	-
2011	0.06	0.17	1.47	0.00	0.62	178.90	0.01	-
2012	0.05	0.16	1.36	0.00	0.60	180.46	0.01	-
2013	0.05	0.15	1.26	0.00	0.59	181.98	0.01	-
2014	0.04	0.14	1.16	0.00	0.57	183.44	0.01	-
2015	0.04	0.13	1.06	0.00	0.56	184.91	0.01	-
2016	0.03	0.13	0.98	0.00	0.55	186.38	0.01	-
2017	0.03	0.12	0.91	0.00	0.54	187.84	0.01	-
2018	0.03	0.11	0.85	0.00	0.54	189.29	0.01	-
2019	0.02	0.11	0.80	0.00	0.53	190.73	0.01	-
2020	0.02	0.10	0.76	0.00	0.53	192.13	0.01	-
2021	0.02	0.10	0.72	0.00	0.52	193.66	0.01	-
2022	0.02	0.09	0.69	0.00	0.52	195.18	0.01	-
2023	0.02	0.09	0.67	0.00	0.52	196.68	0.01	-
2024	0.02	0.09	0.65	0.00	0.52	198.15	0.01	-
2025	0.01	0.09	0.63	0.00	0.52	199.62	0.01	-
2026	0.01	0.08	0.61	0.00	0.52	201.10	0.01	-
2027	0.01	0.08	0.60	0.00	0.52	202.59	0.01	-
2028	0.01	0.08	0.58	0.00	0.52	204.09	0.01	-
2029	0.01	0.08	0.57	0.00	0.52	205.60	0.01	-
2030	0.01	0.08	0.56	0.00	0.52	207.13	0.01	-

EMISSION INVENTORY

CATEGORIES # 936, 1681, 1722

LOCOMOTIVES

EMISSIONS

Introduction

Locomotives are an important mode of transportation for the movement of goods in the state of California. The ability of locomotives to haul a large amount of goods and the established network of rails throughout the state of California make locomotive an ideal transportation device for goods movement. This emission inventory report accounts for emissions from three major types of locomotive operations. They include road hauling locomotive operations (category 936), switching locomotive operations (category 1681), and passenger operations (category 1722).

Methodology

Locomotive emission estimates for the San Francisco Bay Area are obtained from the California Air Resources Board (CARB). CARB locomotive emission inventory uses Booz-Allen Hamilton's, "Locomotive Emission Study", published in 1992 as a guideline for emission estimates. This study was commissioned by the Locomotive Emission Advisory Committee under Assembly Bill 234 that authorized CARB to conduct, jointly with the California railroad industry, a study of railroad locomotive emissions. An inventory was developed from this report and became the baseline inventory.

Since 1992, CARB has made updates to the locomotive emission inventory. In 2003, CARB updated the emission inventory by revising growth assumptions. In 2005, CARB updated the inventory to incorporate fuel correction factors, add passenger train data, and Class III locomotives. These changes have made a significant impact on the total inventory.

Greenhouse gas emissions for locomotives are calculated by multiplying activity data by standardized emission factors for each greenhouse gas. These emission factors take into account fuel-specific carbon content and the percent of carbon that oxidizes to convert to greenhouse gas emissions. Emission factor data was obtained from the U.S. Department of Energy's (DOE's), Energy Information Administration (EIA).

TRENDS

Historical and future emissions (1970-2010) were estimated based upon the CARB emission data.

Growth

Growth factors for locomotives are based on U.S. industrial production and various railroad statistics available from the Association of American railroads. It is assumed that railroad activity would increase primarily in the area of goods movement since greater goods are needed to accommodate for an increasing population.

Control

In 1997, the U.S. EPA finalized the locomotive emission standard regulation. Additionally, projected emissions include expected benefits from ARB's Clean Diesel Regulations (beginning 1993). In 2005, CARB entered into an agreement with Union Pacific Railroad and BNSF to reduce emissions from locomotives throughout California. The agreement establishes a statewide program to reduce diesel particulate emissions from locomotives at the State's rail yards by phasing out non-essential locomotive idling, installing idling reduction devices, and maximizing the use of low sulfur fuel. It is expected that the elements of these agreement will produce approximately 20% reduction in diesel particulate matter emissions around the rail yards.

By: Tan Dinh
Date: December 2010
Base Year: 2008

EIC Code: 820-820-1210-0000 (Cat 936)
820-822-1210-0000 (Cat 1681)
820-826-1210-0000 (Cat 1722)

EMISSION INVENTORY

CATEGORIES #1763 - 1768

OFF-ROAD MOTORCYCLES AND ALL TERRAIN VEHICLES

EMISSIONS

Introduction

These categories are used to inventory the emissions from off-road motorcycles and all-terrain vehicles (ATV).

Methodologies

California Air Research Board (CARB) developed an off-road vehicle emission inventory (OFFROAD2007) model to estimate emissions from off-road motor vehicles for all counties and air basins in California. The OFFROAD model contains a comprehensive list of equipment from a wider range of categories. The criteria and GHG emissions for off-road motorcycles and all-terrain vehicles in the Bay Area were obtained from the CARB's OFFROAD2007 model.

Most of the annual activity takes place in spring, summer and fall. Weekend activity is about twice as high as weekdays.

TRENDS

Estimates for past and future year emissions were also taken from the OFFROAD2007 model. These are based on Motorcycle Industry Council Reports on motorcycles and ATV sales, which are published annually.

Control

Emissions include expected benefits from ARB's Re-Formulated Gasoline Phase I and Phase II (1992 and 1996 respectively) and Off-Road Recreational Vehicles Regulations beginning 1997. Control factors developed by ARB were used for projecting emissions.

Annual average emissions for these categories are shown in the next page.

By: A. K. Fanai/Michael Nguyen
Date: February, 2011
Base Year 2008

OFF-ROAD MOTORCYCLES AND ALL TERRAIN VEHICLES

Categories# 1763 - 1768

Annual Average Emissions (tons/day)

Year	PM	TOG	NOx	SOx	CO	CO_2	CH_4	N_2O
1990	0.23	7.14	0.12	0.02	25.95	22.79	0.52	0.02
1991	0.25	7.68	0.13	0.02	28.14	24.68	0.57	0.02
1992	0.26	7.80	0.14	0.02	27.74	25.76	0.58	0.02
1993	0.28	8.42	0.15	0.02	30.07	27.90	0.62	0.02
1994	0.30	9.10	0.16	0.02	32.58	30.22	0.68	0.02
1995	0.25	7.67	0.17	0.02	29.72	29.64	0.57	0.02
1996	0.22	6.51	0.18	0.00	26.88	32.64	0.33	0.02
1997	0.18	5.56	0.17	0.00	24.14	29.27	0.27	0.02
1998	0.14	4.58	0.15	0.00	20.92	25.60	0.22	0.02
1999	0.11	3.68	0.13	0.00	17.92	22.23	0.17	0.02
2000	0.08	2.79	0.12	0.00	14.85	18.78	0.12	0.01
2001	0.05	2.02	0.10	0.00	12.01	15.62	0.08	0.01
2002	0.03	1.67	0.09	0.00	9.79	13.08	0.06	0.01
2003	0.02	1.39	0.07	0.00	7.13	10.27	0.04	0.01
2004	0.02	1.36	0.07	0.00	6.23	9.32	0.03	0.01
2005	0.01	1.26	0.07	0.00	5.63	8.67	0.02	0.01
2006	0.01	1.11	0.06	0.00	5.28	8.31	0.02	0.01
2007	0.01	1.04	0.06	0.00	5.07	8.09	0.02	0.01
2008	0.01	0.98	0.05	0.00	5.00	8.04	0.02	0.01
2009	0.01	0.96	0.05	0.00	5.03	8.12	0.01	0.01
2010	0.01	0.96	0.05	0.00	5.14	8.31	0.02	0.01
2011	0.01	0.97	0.05	0.00	5.29	8.55	0.02	0.01
2012	0.01	0.98	0.05	0.00	5.44	8.80	0.02	0.01
2013	0.01	1.00	0.05	0.00	5.59	9.04	0.02	0.01
2014	0.01	1.01	0.05	0.00	5.74	9.29	0.02	0.01
2015	0.01	1.04	0.05	0.00	5.89	9.54	0.02	0.01
2016	0.01	1.06	0.05	0.00	6.04	9.78	0.02	0.01
2017	0.01	1.08	0.05	0.00	6.19	10.03	0.02	0.01
2018	0.01	1.11	0.06	0.00	6.34	10.27	0.02	0.01
2019	0.01	1.14	0.06	0.00	6.49	10.52	0.02	0.01
2020	0.01	1.17	0.06	0.00	6.64	10.77	0.02	0.01
2021	0.01	1.20	0.06	0.00	6.66	10.80	0.02	0.01
2022	0.01	1.22	0.06	0.00	6.68	10.84	0.02	0.01
2023	0.01	1.25	0.06	0.00	6.69	10.87	0.02	0.01
2024	0.01	1.27	0.06	0.00	6.70	10.91	0.02	0.01
2025	0.01	1.30	0.06	0.00	6.71	10.95	0.02	0.01
2026	0.01	1.32	0.06	0.00	6.73	10.98	0.02	0.01
2027	0.01	1.35	0.06	0.00	6.74	11.02	0.02	0.01
2028	0.01	1.38	0.06	0.00	6.76	11.06	0.02	0.01
2029	0.01	1.41	0.06	0.00	6.77	11.10	0.02	0.01
2030	0.01	1.43	0.06	0.00	6.78	11.14	0.02	0.01

EMISSION INVENTORY

CATEGORIES # 1787-1887

SHIPS

EMISSIONS

Introduction

Emissions reported in these categories are from combustion of fuel from engines of commercial ocean-going vessels (OGVs). The emission estimates for OGVs are developed by the California Air Resources Board (CARB) and are based on numerous sources that include data from CARB OGV surveys, vessel population data from governmental agencies such as State Land Commissions, and engine characteristic data from various OGV studies and manufacturer reports. The inventory accounts for commercial OGVs greater than or equal to 400 feet in length or 10,000 gross tons or propelled by a marine compression ignition engine with a displacement equal to or greater than 30 liters per cylinder. The emission inventory includes all ocean-going vessel emissions occurring within 100 nautical miles from the coastline of the San Francisco Bay Area region.

Methodology

The methodology used to estimate OGV emissions is based on CARB's 2005 draft report titled, "Emissions Estimation Methodology for Ocean-Going Vessels". Although the report is in draft form, the emission data is derived based on methodology and findings given in this report.

Emissions from OGVs vary based on ship type and operating mode. There are eight ship types and three operating modes accounted for in the inventory. The ship types include auto vessels, bulk carriers, container ships, passenger ships, reefers, RORO ships, tankers, and general vessels (others). The operating modes include the hotelling/berthing mode (including anchorage), maneuvering mode, and in-transit mode.

Under each operating mode, the emissions are broken down by fuel. OGVs emissions vary depending on the type of fuel used to power the engines. Two fuel types, residual fuel and distillate fuel, are generally used in the operation of OGVs. These fuels are combusted in three areas: the ship's main engine(s), the auxiliary engine(s), and the ship's boiler(s). The emissions associated with the combustion of fuels from these OGV engines in relation to a particular ship type and operating mode are given by categories and accounted for in the inventory.

In addition to criteria pollutants, greenhouse gas emissions are included in the emission inventory. Greenhouse gas emissions, including CO2, CH4, and N2O, are taken from CARB data base. Greenhouse gas emission factors take into account fuel-specific carbon content and the percent of carbon that oxidizes to convert to greenhouse gas emissions.

Monthly Variation

Monthly distribution was estimated based on the ships traffic for each month as reported by the San Francisco Marine Exchange.

County Distribution

For maneuvering and in-transit categories, county fractions are not based on actual port location, but rather where the emissions activity occurred during the particular mode of operation of the vessel. For example, during the maneuvering or in-transit mode, vessels may pass through several counties on their way to and from port. Berthing operations occur at port, and therefore, county fractions here are based on the port's relevant activity.

TRENDS

Ship emission projections were developed by ARB based on expected growth rates in the ocean-going vessels populations and activity. They also include changes in emission factors over time as the new engine standards are implemented and the fleet is turn over.

Control

EPA currently regulates U.S. flag ocean-going ships engine types. The rule is designed to decrease air pollutants via requirements of new ships to have more efficient fuel burning engines (category 3 engines) installed and old ships retrofitted with new engines. The rule applies only to U.S. ships. In mid-2009 via rule enactment, ARB has begun to regulate the types of fuel use for all ocean going vessels traveling within 24 nautical miles from the California coast line. All ocean going vessels are required to use low sulfur fuel within this 24 nautical mile zone. Since the enactment of this rule, there has been a significant decrease in SOx and PM emissions from ocean going vessels. Additionally, shore power installation is currently being considered by various Bay Area Ports as a mean to further reduce ship emissions. It is anticipated that this technology will significantly reduce hotelling emissions from ocean going vessels.

By: Tan Dinh
Date: December 2010
Base Year: 2008

EIC Code: 83383112109972 to 83384915009993

EMISSION INVENTORY

CATEGORY # 1723

CARGO HANDLING EQUIPMENT

EMISSIONS

Introduction

Emissions reported in this category are from the combustion of diesel fuel engines of cargo handling equipment in San Francisco Bay Area ports and intermodal rail yards. Emission estimates are developed by the California Air Resources Board (CARB) and are based on its 2004 statewide cargo handling equipment survey and on various port and rail yard studies.

Methodologies

The methodology used to estimate cargo handling equipment emissions is based on the emission inventory report found in Appendix B of CARB's 2005 Technical Support Document: "Initial Statement of Reasons for Proposed Rulemaking, Regulation for Mobile Cargo Handling Equipment at Ports and Intermodal Rail Yards". Appendix B of this document contains both the emission estimation methodology for cargo handling equipment and the statewide cargo handling equipment survey.

Emission estimates for cargo handling equipment include nine equipment types: aerial lifts, cranes, excavators, forklifts, container handling equipment, sweeper/scrubbers, tractor/loader/backhoes, yard trucks, and other general industrial equipment. The other general industrial equipment includes a variety of equipment types including aerial lifts, euclids, rail-car movers, and heavy duty off-highway trucks.

Emissions are calculated based on an annual average emission per engine for each equipment type. Data on an engine including its power characteristics and hours of operation are obtained from CARB 2004 cargo handling equipment survey. A template, based on ARB's OFFROAD2007 model, was used to estimate annual emissions by engine and equipment type.

Adjustments, such as engine deterioration rate, load factor, and fuel correction factor were applied to the emission estimates. These adjustments can have a significant effect on emissions and are used in the calculation to obtain a more accurate estimate of the overall emissions. Data such as load factor, deterioration rate, and fuel factor were obtained from ARB's OFFROAD2007 model.

Greenhouse gas emissions for cargo handling equipment are calculated by multiplying activity data by standardized emission factors for each greenhouse gas. These emission

factors take into account fuel-specific carbon content and the percent of carbon that oxidizes to convert to greenhouse gas emissions.

Monthly Variation

Monthly variation for the cargo handling equipment category was assumed to be uniform throughout the year.

County Distribution

With major marine port and rail yard presence, Alameda County and Contra Costa County has the largest cargo handling equipment of all the San Francisco Bay Area counties.

TRENDS

History

Cargo handling equipment growth rate was based on data from studies and historical survey.

Growth

Projections to the year 2030 were based on CARB projections. Factors such as turnover or attrition of the cargo handling fleet, change in emission factors over time as new engine standards are implemented, and after treatment control technologies were considered in the projections.

Control

Projected emissions include expected benefits from ARB's Clean Diesel Fuel Regulations (Beginning 1993) and Re-Formulated Gasoline Phase II (beginning 1996). These benefits were estimated using control factors developed by ARB. ARB in 2005 enacted new rule requirements on cargo handling equipment, particularly new engine standards (Tier 3 and 4) and control technology requirements that would further reduce diesel PM emissions.

By: Tan Dinh
Date: December 2010
Base Year: 2008

EIC Code: 86089612105230

EMISSION INVENTORY

CATEGORIES # 1769-1786

COMMERCIAL HARBOR CRAFTS

EMISSIONS

Introduction

Emissions reported in these categories are from the combustion of fuel from engines of commercial harbor crafts operating in the San Francisco Bay Area. The emission estimates for harbor crafts are developed by the California Air Resources Board (CARB) and are based on numerous sources that include data from CARB 2004 harbor craft survey, vessel population data from governmental agencies such as California Department of Fish and Game, and engine characteristic data from various harbor craft studies and manufacturer reports. The definition for commercial harbor craft means any private, commercial, government, or military marine vessels including, but not limited to commercial/passenger fishing vessels, ferry/excursion vessels, crew and supply boats, tug/tow/push boats, work boats, pilot vessels, and others that do not otherwise meet the definition of ocean-going vessels or recreation vessels. The inventory accounts for emissions from harbor crafts that navigate within a 100 nautical miles from the coast line of the San Francisco Bay Area region.

Methodologies

The methodology used to estimate harbor craft emissions is based on the harbor craft methodology report found in Appendix B of CARB's 2007 Technical Support Document: "Initial Statement of Reasons for Proposed Rulemaking, Proposed Regulation for commercial Harbor Craft". Aside from the methodology report in Appendix B, this technical support document also includes in its appendix other reports, including the 2004 Harbor Craft Survey Report, that are used to develop some of the data used in the harbor craft emission estimates.

There are eight categories of commercial harbor craft included in the emissions inventory. They are commercial fishing, charter fishing, crew and supply vessel, ferries/excursion vessel, pilot vessel, towboat/pushboat, tug boat, work boat and others. The others category include vessels that do not fit into the other seven categories, such as vessels used to dispose of cremated remains. Most of the information used including engine population, engine hours of operation, and engine load originate from the habor craft survey. The inventory does not include vessels from the U.S. Navy and/or U.S. coast Guard vessels due to limited data available on them.

For each category of vessels, emissions were calculated based on emission factors specific to the main propulsion and auxiliary engine model year. Adjustments, such as engine deterioration rate, load factor, and fuel correction factor were applied to the

emission estimates. These adjustments can have a significant effect on emissions and are used in the calculation to obtain a more accurate estimate of the overall emissions. Data such as load factors were based on U.S. EPA's Nonroad model. Deterioration rate was based on ARB's OFFROAD2007 model. For this inventory, it is assumed that all harbor crafts operating in the San Francisco Bay Area use diesel engines for both propulsion and auxiliary power. Emission estimates for each category of vessel along with engine type (main and auxiliary) are accounted for the in the inventory.

In addition to criteria pollutants, greenhouse gas emissions are included in the emission inventory. Greenhouse gas emissions, including CO2, CH4, and N2O, are taken from CARB data base. Greenhouse gas emission factors take into account fuel-specific carbon content and the percent of carbon that oxidizes to convert to greenhouse gas emissions.

Monthly and Weekly Variation

For commercial harbor crafts, monthly activity was assumed to be higher in the summer months and reduced during the winter months. Weekly activity was assumed to be constant on the weekdays and reduced on the weekends.

County Distribution

County fractions are based on actual port location where the harbor craft is registered as home. Outer continental shelf emissions are proportioned to counties adjacent to where the emissions occurred from 3 out to 100 nautical miles.

TRENDS

Emission trends forecast are based on projected fleet growth, turnover, engine deterioration, and the change of emission rates.

Control

Emissions include benefits from ARB's Clean Diesel Fuel Regulations (Beginning 1993) and Re-Formulated Gasoline Phase II (beginning 1996). These benefits were estimated using control factors developed by ARB. In 1999, federal EPA enacted the marine engine standard requirements on new commercial marine diesel engines. Dependent on the timeline, new engines put in harbor craft must meet certain tier requirements that must comply with new emission standards. Also, in 2007, CARB approved of the commercial harbor craft regulation. This regulation became effective in 2009 and places further operation and new engine requirements for all commercial harbor craft operating in California waters. The regulation also put in-use engine requirement for ferries, excursion vessels, tug boats, and towboats. It is expected that NOx and PM emission will be reduced significantly with these regulatory requirements.

By: Tan Dinh
Date: December 2010
Base Year: 2008

EIC Code:

83585112109981
83585312109981
83585712109981
83585912109981
83586212109981
83586312109981
83586512109981
83586612109983
83586712109981
83586712109971
83586312109971
83586612109973
83585312109971
83585912109971
83586512109971
83586212109971
83585712109971
83585112109971

EMISSION INVENTORY

CATEGORIES # 1676 - 1680

RECREATIONAL BOATS

EMISSIONS

Introduction

These categories account for fuel combustion emissions from pleasure boats with inboard or outboard engines, and personal watercraft, etc. in the Bay Area. Nearly all outboard and personal watercraft motors utilized two-stroke engines. These engines burn gasoline inefficiently and discharge as much as 30% unburned fuel into water and subsequently into the air. Spark-ignition outboard engines are available in power ratings from 2 to 300 horsepower. They are used in a wide variety of applications including fishing, water skiing and water-borne transportation. The total population of gasoline powered outboard engines in California was 373,200 in 1990. Table 1 shows the estimated population of outboard and personal watercraft in 1997, 2010 and 2020. As shown in Table 1, the population of personal watercraft is projected to double by 2020 because of continued growth and popularity of this category of marine engine. This will have a significant impact on the emissions inventory attributed to recreational boats categories.

Table 1 Estimated Population of Outboard Engines and Personal Watercraft in 1997, 2010 and 2020 in California

	1997	**2010**	**2020**
Outboard Engines	346,000	349,000	333,000
Personal Watercraft	162,000	293,000	354,000
Total	**508,000**	**642,000**	**687,000**

Spark-ignition outboard engines include carbureted, fuel injected and direct-injected two-stroke, and carbureted and fuel injected four-stroke configurations. Personal watercraft are defined by U.S. EPA as marine vessels that are not outboards, inboards, or sterndrive, but they can more accurately be defined as small craft on which the rider sits or stands during operation. Personal watercraft are primarily used for recreation, including touring, and water skiing.

Methodologies

California Air Resources Board (CARB) developed the Off-road vehicle emission inventory (OFFROAD2007) model to estimate emissions from off-road motor vehicles for all counties and air basins in California. The criteria and GHG emission data for recreational boat categories in the Bay Area were obtained from the CARB's OFFROAD2007 model.

Monthly Variation

The monthly activity occurs primarily during late spring, summer and fall. Most of the daily activity occurs during daylight hours.

County Distribution

County emissions were provided by the CARB's OFFROAD2007 model.

TRENDS

History

Prior to the 1999 Base year emissions, the methodology was based upon a study by System Applications International (SAI) entitled "Development of an Improved Inventory of Emissions from Pleasure Craft in California". The study was carried out for the California Air Resources Board and was completed in June 1995. California Department of Motor Vehicles (DMV) Vessel Registration shows that over 98% of the boats registered are pleasure craft. The registration figures were sub-divided into 6 unique length groups and various methods of propulsion, such as inboard, outboard, jet powered and others. For each group, fuel usage was determined from a survey of 10,000 registered boat owners. The survey showed that inboard, inboard/outboard and jet powered craft were the biggest consumers of fuel. Outboard craft were found to be medium gasoline users. Others include sailboats and auxiliary sailboats and were found to have very low average annual consumption. Emission factors were obtained from National Marine Manufacturers Association. These emission factors were also used by Environmental Protection Agency (EPA) in their Non-road Engine and Vehicle Emissions Study. These were given for outboard 2 stroke gasoline engines and inboard 4 stroke gasoline and diesel engines from several engine manufacturers including Honda, Mercury Marine, Outboard Marine Corporation, Volvo and Yamaha. The SAI Report contained average monthly, weekly and diurnal profiles for northern, southern and central California. The figures for northern California were used to develop the annual average inventory.

Growth

Projected emissions for recreational boats were estimated based on ARB's Off-road vehicle emission inventory model. The growth factors utilized in the OFFROAD model are prepared in a report for the Air Resources Board entitled "A Study to Develop Projected Activity for "Non-Road Mobile" Categories in California, 1970-2020". In this report, certain economic indicators are used to project the growth in population and usage of small off-road engines in various applications.

Control

In 1998, the U.S. EPA began regulating exhaust emissions from marine engines (outboard motors and personal watercrafts) to reduce 75% emissions by 2025. In December of 1998, the CARB adopted standards to require cleaner engines. Beginning with 2001 models, new outboard engines, personal watercraft and jet boats must be 75% cleaner and 90% cleaner by 2008.

By: Michael Nguyen
Date: February, 2011
Base Year 2008

EIC: 84088641000040 (Cat#1676)
84088641000020 (Cat#1677)
84088641000041 (Cat#1678)
84088641000021 (Cat#1679)
84088642100000 (Cat#1680)

RECREATIONAL BOATS

Categories# 1676 – 1680

Annual Average Emissions (tons/day)

Year	PM	TOG	NOx	SOx	CO	CO_2	CH_4	N_2O
1990	0.61	12.45	1.84	0.04	62.17	350.18	0.57	0.09
1991	0.64	13.95	2.36	0.10	89.59	358.01	0.78	0.09
1992	0.66	14.43	2.41	0.10	86.89	360.65	0.78	0.09
1993	0.69	14.98	2.43	0.10	88.29	364.35	0.79	0.09
1994	0.72	15.54	2.44	0.10	89.80	368.51	0.80	0.09
1995	0.77	20.65	2.45	0.12	91.75	349.47	1.25	0.08
1996	0.78	19.95	2.23	0.02	78.45	355.13	0.80	0.08
1997	0.78	20.03	2.26	0.02	79.25	359.17	0.80	0.08
1998	0.79	20.08	2.27	0.02	79.63	363.72	0.81	0.08
1999	1.03	24.46	2.44	0.02	89.69	411.25	1.06	0.09
2000	0.97	22.45	2.45	0.02	84.77	398.38	0.98	0.09
2001	1.06	21.85	2.93	0.03	86.74	431.64	0.94	0.10
2002	0.95	19.75	2.79	0.02	81.03	405.76	0.84	0.10
2003	1.04	19.86	3.24	0.02	84.54	441.53	0.83	0.11
2004	0.94	18.98	3.01	0.02	79.12	415.16	0.76	0.10
2005	1.05	19.31	3.64	0.02	83.52	466.40	0.75	0.12
2006	1.10	18.94	3.88	0.02	83.24	480.93	0.73	0.12
2007	1.16	18.62	4.05	0.02	83.42	496.25	0.70	0.13
2008	1.22	18.07	4.08	0.02	82.88	512.35	0.67	0.13
2009	1.29	17.58	4.07	0.02	82.19	529.31	0.63	0.13
2010	1.36	17.17	4.05	0.02	81.72	546.97	0.60	0.13
2011	1.44	16.83	4.05	0.02	81.49	565.17	0.58	0.14
2012	1.52	16.56	4.06	0.02	81.47	583.95	0.56	0.14
2013	1.60	16.34	4.07	0.02	81.63	603.41	0.54	0.14
2014	1.69	16.16	4.09	0.02	81.97	623.68	0.52	0.14
2015	1.78	16.02	4.12	0.02	82.44	644.75	0.50	0.14
2016	1.87	15.90	4.15	0.02	83.06	666.49	0.49	0.15
2017	1.97	15.82	4.19	0.02	83.82	688.72	0.47	0.15
2018	2.07	15.75	4.22	0.02	84.71	711.44	0.46	0.15
2019	2.17	15.71	4.25	0.03	85.68	734.78	0.45	0.15
2020	2.28	15.68	4.27	0.03	86.71	759.04	0.44	0.16
2021	2.39	15.69	4.28	0.03	87.85	784.50	0.43	0.16
2022	2.51	15.76	4.30	0.03	89.14	811.36	0.42	0.16
2023	2.65	15.90	4.32	0.03	90.66	839.83	0.42	0.17
2024	2.80	16.11	4.35	0.03	92.40	870.07	0.42	0.17
2025	2.96	16.39	4.38	0.03	94.35	902.26	0.43	0.17
2026	3.13	16.66	4.42	0.03	96.34	935.88	0.43	0.17
2027	3.31	16.95	4.47	0.03	98.37	971.00	0.43	0.17
2028	3.50	17.24	4.52	0.04	100.45	1,007.70	0.44	0.17
2029	3.71	17.54	4.57	0.04	102.58	1,046.07	0.44	0.17
2030	3.92	17.84	4.63	0.04	104.74	1,086.18	0.44	0.17

EMISSION INVENTORY

CATEGORIES # 1115 - 1129

COMMERCIAL AIRCRAFT, JET

EMISSIONS

Introduction

Considered in these categories are criteria pollutant (particulate, organic, NO_x, SO_x, and CO) and greenhouse gas emissions (CO_2, CH_4, and N_2O) from commercial jet aircrafts during their operations at the three major airports in the Bay Area, namely, San Francisco International (SFO), Oakland International (OAK), and San Jose International (SJC). A classification system for commercial aircraft was formulated consisting of major passenger, cargo, and commuter/air taxi aircraft. The major passenger aircrafts are further broken down into sub-groups of short-ranged, medium-ranged, long-ranged, and seasonal/chartered aircraft. Both the major passenger and cargo aircraft categories are primarily jet aircraft.

The basic types of gas turbine engines used for commercial jet aircraft propulsion are turbojet and turbofan engines:

1. In a turbojet engine, large quantities of air enter the engine in the front and then compressed and squeezed by the compressor before passing into the combustion chamber. This resulting mixture of fuel and air is then burned to produce hot, expanding gases. These high velocity gases pass through a turbine that is used to drive the compressor. The remaining energy in the air stream is used for aircraft propulsion. The earlier centrifugal types of compressors used in turbojets were reliable and simple, but the amount of thrust produced was relatively low because the compression ratio is not very high. These engines were also noisy and had poor fuel economy. Therefore, the quieter and more fuel-efficient turbofan engines rapidly replaced these engines.

2. Turbofan aircraft engines power the majority of airline transports in service today. The air entering the forward end of the engine is compressed and then heated by burning fuel in the combustion chamber. The turbofan engine uses its fan to accelerate additional air around the outside of the engine (called the bypass flow) to produce a larger, slower-moving exhaust mass for efficient high subsonic propulsion.

Methodology

The pollutants emitted by an aircraft during take-off and landing operations are dependent on the emission rates and the duration of these operations. The emission rates are dependent upon the type of engine and its size or power rating. An aircraft operational cycle includes the landing and takeoff, or LTO cycle. For criteria pollutant

emission inventory, an LTO cycle includes all normal operational modes performed by an aircraft between its descent from an altitude of about 2300 feet on landing and subsequent takeoff to reach the 2300-foot altitude. The 2300-foot limit is a reasonable approximation to the meteorological mixing depth over the Bay Area metropolitan areas. The term "operation" is used by the Federal Aviation Administration to describe either a landing or a take-off cycle. Therefore, two operations make one LTO cycle.

For criteria pollutant emission calculations, the aircraft LTO cycle is divided into five segments or operational "modes" and categorized by:

1. Landing approach (descent from about 2,300 ft. to touch down),
2. Taxi/idle-in,
3. Taxi/idle-out,
4. Take-off,
5. Climb out (ascent from lift-off to about 2,300 ft.).

The emissions are based on the time of operation in each mode and the emission rates of the engines. The time in the landing approach and climbout modes are assumed to be 3.02 minutes and 1.55 minutes, respectively. Take-off time of 0.95 minute (including 0.25 minute for reverse thrust) is fairly standard for commercial aircraft and represents the time for initial climb from ground level to about 500 feet. The time in taxi/idle mode usually varies with airports.

For greenhouse gas (GHG) emission inventory, in addition to LTO cycle explained above, the aircraft landing approach and climb out modes above 2,300 feet elevation and aircraft cruise mode in the District's air space is also included.

The information on number of aircraft operations and fleet mix was obtained from the three major commercial airports in the Bay Area, the Federal Aviation Administration (FAA), and the Metropolitan Traffic Commission (MTC). Modal emission rates for aircraft engines in commercial use were obtained from the FAA's Aircraft Engine Emission Database, the U.S. Environmental Protection Agency (EPA), International Civil Aviation Organization (ICAO), and Intergovernmental Panel on Climate Change (IPCC).

Emission rates vary according to engine type and operating mode. Emission factors for specific aircraft were estimated by the equation:

$$EMF = N \sum \left(V_e / V_t \right)_{m,p} \times TIM$$

Where EMF = Emission Factor, with units in lbs. /LTO
N = number of engines,

$\left(V_e / V_t \right)_{m,p}$ = engine emission rates, lbs/hr at mode m, pollutant p, and
TIM = time in mode, hr.

Sample calculations: total organic (TOG) emissions

Data: 4,878 LTO/yr.

For B747-300 (long-range aircraft)
TOG emission factor = 24.56 lbs./LTO
Emission = 4,878 LTO/yr. x 24.56 lbs./ LTO / 365 days/yr / 2000 lbs./ton
= 0.164 ton/day of organics

County Distribution

The county location of each airport was used to distribute emissions into each county, where SFO is in San Mateo County; OAK is in Alameda County, and SJC in Santa Clara County.

Monthly Variation

Monthly distribution was based on the average monthly number of operations at each airport.

TRENDS

History

Emissions through the years were estimated based on the above methodology, and the actual number of operations from each airport. Selected years were calculated with corresponding estimates of the aircraft fleet mix during those times.

Growth

The continuing effort in aircraft improvement, development of newer engine technology and their phasing in will result in reduced emissions. Airport noise regulations are forcing changes to the commercial aircraft fleet resulting in replacement of loud and dirtier engines with newer, quieter, and cleaner burning engines. There is a continuing trend in the use of larger aircraft thereby increasing the passenger to LTO ratio. This will reduce the number of LTOs and consequently, lower emissions.

The projections for number of operations and fleet mix at each airport were developed based on the information from the airports, the FAA, and the MTC's Regional Airport System Plans (RASP). Emissions for selected years were calculated based on above methodology. Emission values for other years were obtained by interpolation and extrapolation method.

By: Sukarn Claire
Date: January 2011
Base Year: 2008

EIC: 81081014000000

EMISSION INVENTORY

CATEGORIES # 1130 - 1132

COMMERCIAL AIRCRAFT, PISTON

EMISSIONS

Introduction

Considered in these categories are criteria pollutant (particulate, organic, NO_x, SO_x, and CO) and greenhouse gas emissions (CO_2, CH_4, and N_2O) from commercial piston aircrafts during their operations at the three major airports in the Bay Area, namely, San Francisco International (SFO), Oakland International (OAK), and San Jose International (SJC). A classification system for commercial aircraft was formulated consisting of major passenger, cargo, and commuter/air taxi. The commuter/taxi class is primarily of the piston type.

In the piston engine, the basic element is the combustion chamber. Mixtures of fuel and air are burned in this chamber from which energy is extracted by a piston and crank mechanism driving a propeller. The turboprop engine has a propeller turned through a system of gears from a gas turbine system; it usually delivers more thrust--up to medium-high subsonic airspeeds. The majority of the commuter/taxi aircraft use this turboprop engine propulsion.

Methodology

The pollutants emitted by an aircraft during take-off and landing operations are dependent on the emission rates and the duration of these operations. The emission rates are dependent upon the type of engine and its size or power rating. An aircraft operational cycle includes landing and takeoff (LTO) cycle. For criteria pollutant emission inventory, an LTO cycle includes all normal operational modes performed by an aircraft between its descent from an altitude of about 2,300 feet on landing, and subsequent takeoff to reach the 2,300-foot altitude. The 2,300-foot limit is a reasonable approximation to the meteorological mixing depth over the Bay Area metropolitan areas. The term “operation” is used by the Federal Aviation Administration (FAA) to describe either a landing or a take-off cycle. Therefore, two operations make one LTO cycle.

For criteria pollutant emission calculations, the aircraft LTO cycle is divided into five segments or operational “modes” and categorized by:

1. Landing approach (descent from about 2,300 ft. to touch down),
2. Taxi/idle-in,
3. Taxi/idle-out,
4. Take-off,
5. Climb out (ascent from lift-off to about 2,300 ft.).

The emissions are based on the time of operation in each mode and the emission rates of the engines. The time in the landing approach and climb out modes are assumed to be 3.02 minutes and 1.55 minutes, respectively. Take-off time of 0.95 minute (including 0.25 minute for reverse thrust) is fairly standard for commercial aircraft and represents the time for initial climb from ground level to about 500 feet. The time in taxi/idle mode usually varies with airports.

For greenhouse gas (GHG) emission inventory, in addition to LTO cycle explained above, the aircraft landing approach and climb out modes above 2,300 feet elevation and aircraft cruise mode in the District's air space is also included.

The information on number of aircraft operations and fleet mix was obtained from the three major commercial airports in the Bay Area, the Federal Aviation Administration (FAA), and the Metropolitan Traffic Commission (MTC). Emission rates vary according to engine type and operating mode. Modal emission rates for aircraft engines in general commercial use were obtained from the FAA's Aircraft Engine Emission Database, the U.S. Environmental Protection Agency (EPA), International Civil Aviation Organization (ICAO), and Intergovernmental Panel on Climate Change (IPCC).

Emission factors for specific aircraft were estimated by the equation:

$$EMF = N\sum\left(V_e/V_t\right)_{m,p} \times TIM$$

Where EMF = Emission Factor, with units in lbs./LTO
N = number of engines,
$\left(V_e/V_t\right)_{m,p}$ = engine emission rates, lbs/hr at mode m, pollutant p, and
TIM = time in mode, hr.

Sample calculation: total organic (TOG) emissions

Data: 10,961 LTO/yr.,
For ATR72 (Commuter/Taxi aircraft)
TOG emission factor = 5.07 lbs/LTO

Emission = 10,961 LTO/yr x 5.07 lbs./LTO / 365 days/yr / 2000 lbs/T
= 0.076 ton/day of organics

County Distribution

The county location of each airport was used to distribute emissions into each county, where SFO is in San Mateo County; OAK is in Alameda County, and SJC in Santa Clara County.

Monthly Variation

Monthly distribution was based on the average monthly number of operations at each airport.

TRENDS

History

Emissions through the years were estimated based on the above methodology and the actual number of operations from each airport. Selected years were calculated with corresponding estimates of the aircraft fleet mix during those times.

Growth

The continuing effort in aircraft improvement, development of newer engine technology and their phasing in will result in reduced emissions. Airport noise regulations are forcing changes to the commercial aircraft fleet resulting in replacement of loud and dirtier engines with newer, quieter, and cleaner burning engines. There is a continuing trend in the use of larger aircraft thereby increasing the passenger to LTO ratio. This will reduce the number of LTOs and consequently, lower emissions.

The projections for number of operations and fleet mix at each airport were developed based on the information from the airports, the FAA, and the MTC's Regional Airport System Plans (RASP). Emissions for selected years were calculated based on above methodology. Emission values for other years were obtained by interpolation and extrapolation method.

By: Sukarn Claire
Date: January 2011
Base Year: 2008

EIC: 81080211400000

EMISSION INVENTORY

CATEGORY # 441 - 444, 446 - 453, 455

GENERAL AVIATION AIRCRAFT, JET

EMISSIONS

Introduction

Considered in these categories are criteria pollutant (particulate, organic, NO_x, SO_x, and CO) and greenhouse gas emissions (CO_2, CH_4, and N_2O) from gas turbine (jet) engines from general aviation aircraft during their operations at various airports in the San Francisco Bay Area. These general aviation jet aircraft operate from both, large commercial and smaller county airports. The gas turbine engine consists of a compressor, a combustion chamber and a turbine. Air entering the forward end of the engine is compressed and then heated by burning fuel in the combustion chamber. The engine uses its fan to accelerate additional air around the outside of the engine producing exhaust gases for efficient propulsion.

Methodology

Normal flight and ground operation modes of the aircraft constitutes the landing/takeoff (LTO) cycle. For criteria pollutant emission inventory, the aircraft LTO cycle is divided into five segments or operational "modes" and categorized by:

1. Startup, idle and taxi out,
2. Takeoff,
3. Climb out to about 2,300 feet--this height is considered the average mixing depth in the Bay Area and assumed inversion height, wherein aircraft exhaust emissions are released below it,
4. Descent/approach from 2,300 feet, touch down, and landing run, and
5. Taxi in, idle and shutdown.

For greenhouse gas (GHG) emission inventory, in addition to LTO cycle explained above, the aircraft landing approach and climb out modes above 2,300 feet elevation and aircraft cruise mode in the District's air space is also included.

The information on number of operations and fleet mix were obtained from the airports, the Federal Aviation Administration (FAA), and the Metropolitan Traffic Commission (MTC).

The LTO cycle has its equivalent operating time-in-mode (TIM) which is the time for a particular aircraft to go through each of the five modes. Composite modal emission rates (MER) for each of the various types of aircraft engines now in general aviation use were developed from various information sources on aircraft engines. These information sources include the FAA's Aircraft Engine Emission Database, the U.S. Environmental Protection Agency (EPA), International Civil Aviation Organization (ICAO), and the Intergovernmental Panel on Climate Change (IPCC).

Emission rates vary according to engine type and operating mode. Emission factors for a specific aircraft were estimated by the equation:

Emission Factor = N x $E(v_e/v_t)m,p$ x TIM
N = no. of engines
$(v_e/v_t)m,p$ = engine emission rates, lb/hr at mode m, pollutant p
TIM = time in mode, hr.

Estimates of aircraft mix for each of the airports were developed based on historical activity and data on home-based aircraft.

Sample calculations: total organic (TOG) emissions

Data: 7,942 LTO/yr. (Cessna Citation Jet)
Emissions = 7,942 LTO/yr x 1.82 lbs/LTO / 365 day/yr / 2000 lbs/T
= 0.02 ton/day of organics

County Distribution

Emissions were distributed to the county location of each airport, where SFO is in San Mateo County, OAK is in Alameda County, SJC in Santa Clara County, and to about a dozen smaller airports with jet aircraft activities in their corresponding counties.

Monthly Variation

Monthly distribution was based on an average number of monthly aircraft operations at each airport.

TRENDS

History

Emissions through the years were estimated based on the above methodology and from the actual number of operations for each airport.

Growth

Projections for the number of operations are based on information from the Airports, the FAA and MTC's "Regional Airport System Plan". For SFO, OAK, and SJC, emissions for selected years were calculated with corresponding estimates of the aircraft fleet mix during that period. Emission values for other years were obtained by interpolation.

By: Sukarn Claire
Date: January 2011
Base Year: 2008

EIC: 81081214000000

EMISSION INVENTORY

CATEGORY # 456, 463, 475, 489, 496, 503, 505, 507, 510-511, 520, 527, 534, 541, 548, 555, 562, 593, 597, 615, 619, 626, 632, 1689

GENERAL AVIATION AIRCRAFT, PISTON

EMISSIONS

Introduction

Considered in these categories are criteria pollutant (particulate, organic, NO_x, SO_x, and CO) and greenhouse gas emissions (CO_2, CH_4, and N_2O) from general aviation aircraft piston engines during their operations at the various airports in the Bay Area. In the piston engine, the basic element is the combustion chamber in which the mixture of fuel and air are burned and energy is extracted by a piston and crank mechanism driving a propeller.

Methodology

Normal flight and ground operation modes of the aircraft constitutes the landing/takeoff (LTO) cycle. For criteria pollutant emission inventory, the LTO cycle is grouped into five modes, which is equivalent to two operations in an airport activity. These include:

1. Startup, idle and taxi out,
2. Takeoff,
3. Climb out to about 2,300 feet--this height is considered the average mixing depth in the Bay Area and assumed inversion height, wherein aircraft exhaust emissions are released below it,
4. Descent/approach from about 2,300 feet, touch down, and landing run, and
5. Taxi in, idle and shutdown.

For greenhouse gas (GHG) emission inventory, in addition to LTO cycle explained above, the aircraft landing approach and climb out modes above 2,300 feet elevation and aircraft cruise mode in the District's air space is also included.

The information on number of operations and fleet mix were obtained from the airports, the Federal Aviation Administration (FAA), and the Metropolitan Traffic Commission (MTC). Estimates of aircraft mix for each of the airports were developed based on historical activity and data on home-based aircraft.

The LTO cycle has its equivalent operating time-in-mode (TIM) which is the time for a particular aircraft to go through each of the five modes. Composite modal emission rates (MER) for each of the various types of aircraft engines now in general aviation use were developed from various information sources on aircraft engines. These information sources include the FAA's Aircraft Engine Emission Database, the U.S. Environmental Protection Agency (EPA), International Civil Aviation Organization (ICAO), and the Intergovernmental Panel on Climate Change (IPCC).

Emission rates vary according to engine type and operating mode. Emission factors for a specific aircraft were estimated by the equation:

Emission Factor = N x $E(v_e/v_t)m,p$ x TIM
N = number of engines
$(v_e/v_t)m,p$ = engine emission rates, lbs/hr at mode m, pollutant p
TIM = time in mode, hr.

Sample calculations: total organic (TOG) emissions

Data: 61,199 LTO/yr.
Comp. Em. F. = 0.345 lbs organics / LTO
Emissions = 61,199 LTO/yr x 0.345 lb/LTO / 365 day/yr / 2000lbs/T
= 0.028 ton/day of organics

County Distribution

Emissions were distributed to the county location of each airport, where SFO is in San Mateo County, OAK is in Alameda County, SJC in Santa Clara County, and to about two dozen smaller airports with piston aircraft activities in their corresponding counties.

Monthly Variation

Monthly distribution was based on the average number of monthly operations at each airport.

TRENDS

History

Aircraft emissions were estimated based on actual number of operations at each airport during that period.

Growth

Projections for the number of operations are based on information from the Airports, FAA and MTC's "Regional Airport System Plan". For SFO, OAK, and SJC, emissions for selected years were calculated with corresponding estimates of the aircraft fleet mix during that period. Emission values for other years were obtained by interpolation.

By: Sukarn Claire
Date: January 2011
Base Year: 2008

EIC: 81080411400000

EMISSION INVENTORY

CATEGORY # 639, 646, 658, 670, 673, 676, 679

MILITARY AIRCRAFT, JET

EMISSIONS

Introduction

Considered in these categories are criteria pollutant (particulate, organic, NO_x, SO_x, and CO) and greenhouse gas emissions (CO_2, CH_4, and N_2O) from gas turbine (jet) engines from military aircraft at various air bases and naval field or airports in the Bay Area where military operations exist.

The engine consists of a compressor, a combustion chamber and a turbine. Air entering the forward end of the engine is compressed and then heated by burning fuel in the combustion chamber. The engine uses its fan to accelerate additional air around the outside of the engine producing exhaust gases for efficient propulsion.

Methodology

Normal flight and ground operation modes of the aircraft constitutes the landing/takeoff (LTO) cycle. For criteria pollutant emission inventory, the LTO cycle is grouped into five modes, which is equivalent to two operations in an airport activity. These include:

1. Startup, idle and taxi out,
2. Takeoff,
3. Climb out to about 2,300 feet--this height is considered the average mixing depth and assumed inversion height, wherein aircraft exhaust emissions are released below it,
4. Descent/approach from about 2,300 feet, touch down, and landing run, and
5. Taxi in, idle and shutdown.

For greenhouse gas (GHG) emission inventory, in addition to LTO cycle explained above, the aircraft landing approach and climb out modes above 2,300 feet elevation and aircraft cruise mode in the District's air space is also included.

The numbers of operations were obtained and/or estimated for the military air bases and naval facilities in the Bay Area. Modal emission rates for aircraft engines were obtained from the FAA's Aircraft Engine Emission Database, the U.S. Environmental Protection Agency (EPA), International Civil Aviation Organization (ICAO), and Intergovernmental Panel on Climate Change (IPCC). There are numerous types of military aircraft in use today. Aircraft types considered in these categories include only those believed to be of significant at present.

The LTO cycle has its equivalent operating time-in-mode (TIM), which is the time for a particular aircraft to go through each of the five modes. Composite modal emission rates

(MER) for each of the various types of aircraft engines now in military use were developed based on information from various references noted above. Emission rates vary according to engine type and mode. Emission factors for a specific aircraft were estimated by the equation:

Emission Factor = N x $E(v_e/v_t)$ m, p x TIM
N = no. of engines; TIM = time in mode, hr.
(v_e/v_t) m, p = engine emission rates, lbs/hr. at mode m, pollutant p

Composite emission factors for each of the military bases were developed using estimates of aircraft mix for each facility based on historical activity and data on home-based aircraft. Sample calculation for total organic emissions (TOG):

Data: 10,800 LTO/yr.
Emission Factor = 28.08 lbs. organics/LTO
Emissions = 10,800 LTO/yr x 28.08 lbs/LTO / 365 day/yr / 2000 lbs/T
= 0.42 tons/day of organics

County Distribution

The county location of each airbase, naval facility, or airport with military activities in the Bay Area was used to distribute emissions into each county.

Monthly Variation

Monthly distribution for military aircraft was estimated to be uniform for all months.

TRENDS

History

Emissions through the years were based on the reported and/or estimated number of operations for each airbase/naval facility/airport.

Growth

Projections are based on the airport reported data, the Regional Airport Plan Update Programs and other estimations.

By: Sukarn Claire
Date: January 2011
Base Year: 2008

EIC: 81080814000000

EMISSIONS INVENTORY

CATEGORY # 682, 687, 694, 699, 702, 705, 708

MILITARY AIRCRAFT, PISTON

EMISSIONS

Introduction

Considered in these categories are criteria pollutant (particulate, organic, NO_x, SO_x, and CO) and greenhouse gas emissions (CO_2, CH_4, and N_2O) from piston engines from military aircraft operations at various air bases and naval field or airports in the Bay Area where military operations exist. In the piston engine, the basic element is the combustion chamber in which the mixture of fuel and air are burned and from which energy is extracted by a piston and crank mechanism driving a propeller.

Methodology

Normal flight and ground operation modes of the aircraft constitutes the landing/takeoff (LTO) cycle. For criteria pollutant emission inventory, the LTO cycle is grouped into five modes, which is equivalent to two operations in an airport activity. These include:

1. Startup, idle and taxi out,
2. Takeoff,
3. Climb out to about 2,300 feet--this height is considered the average mixing depth in the Bay Area and assumed inversion height, wherein aircraft exhaust emissions are released below it,
4. Descent/approach from about 2,300 feet, touch down, and landing run, and
5. Taxi in, idle and shutdown.

For greenhouse gas (GHG) emission inventory, in addition to LTO cycle explained above, the aircraft landing approach and climb out modes above 2,300 feet elevation and aircraft cruise mode in the District's air space is also included.

The numbers of operations were obtained and/or estimated for the military air bases and naval facilities in the Bay Area. Modal emission rates for aircraft engines were obtained from the FAA's Aircraft Engine Emission Database, the U.S. Environmental Protection Agency (EPA), International Civil Aviation Organization (ICAO), and Intergovernmental Panel on Climate Change (IPCC). There are numerous types of military aircraft in use today. Aircraft types considered in these categories include only those believed to be of significant at present.

The LTO cycle has its equivalent operating time-in-mode (TIM), which is the time for a particular aircraft to go through each of the five modes. Composite modal emission rates (MER) for each of the various types of aircraft engines now in military use were

developed based on information from various references noted above. Emission rates vary according to engine type and mode. Emission factors for a specific aircraft were estimated by the equation:

Emission Factor = N x $E(v_e/v_t)$ m, p x TIM

N = number of engines

(v_e/v_t) m, p = engine emission rates, lbs/hr at mode m, pollutant p

TIM = time in mode, hr.

Composite Emission Factors for each of the military bases were estimated using estimates of aircraft mix for each facility based on historical activity and data on home-based aircraft. Sample calculations for total organic emissions (TOG):

Data: 2,000 LTO/yr.

Emission Factor = 6.641 lbs. organics/LTO

Emissions = 2,000 LTO/yr x 6.641 lbs/LTO / 365 day/yr / 2000 lbs/T

= 0.018 ton/day of organics

County Distribution

The county location of each airbase, naval facility, or airport with military activities in the Bay Area was used to distribute emissions into each county.

Monthly Variation

Monthly distribution for military aircraft was estimated to be uniform for all months.

TRENDS

History

Emissions through the years were estimated based on the reported and/or estimated number of operations for each airbase/naval facility/airport.

Growth

Projections are based on the airport reported data, the Regional Airport Plan Update Programs and other estimations.

By: Sukarn Claire
Date: January 2011
Base Year: 2008

EIC: 81080011400000

EMISSION INVENTORY

CATEGORY # 711

AGRICULTURAL AIRCRAFT

EMISSIONS

Introduction

Considered in this category are criteria pollutant (particulate, organic, NO_x, SO_x, and CO) and greenhouse gas emissions (CO_2, CH_4, and N_2O) from agricultural aircraft engines during spraying operations on agricultural crops in the San Francisco Bay Area. Only combustion products from the aircraft engine during spraying are estimated in this category. This does not include emissions from materials sprayed, which are inventoried under pesticide category.

The aircraft involved are usually piston engine type aircraft. The most common agricultural aircraft are fixed-wing but helicopters are also used. In the aircraft piston engine, mixture of fuel and air are burned from which energy is extracted by a piston and crank mechanism driving a propeller.

Methodology

Fuel consumption by agriculture aircraft in the Bay Area was estimated based on number of acres sprayed and fuel used per acre. The information on estimated number of acres sprayed was obtained from the county agricultural crop reports for 1996. Total acreage for field, vegetable, fruit, nut and nursery crops were used in estimating a District total of 178,705 acres sprayed.

An average fuel consumption of 0.1053 gal per acre sprayed was used based on the California Air Resources Board's (CARB's) report on the total number of acreage sprayed and total statewide fuel usage. From this information, an estimated total fuel usage was derived:

Total fuel usage = 0.1053 (gallon/acre) * 178,705 acres = 18,818 gallons.

Emission factors were derived based on EPA document AP-42 for a Lycoming 0-320 and Continental 0-200 aircraft engines. Only the takeoff mode was considered, assuming the aircraft would be at a similar power mode during spraying operations. The fuel specific greenhouse gas emission coefficients for this category were obtained from the U.S. Department of Energy's (DOE's) Energy Information Administration (EIA), the U.S. Environmental Protection Agency's (EPA's) document AP-42, and the California Energy Commission (CEC).

Sample Calculation, total organics (TOG):

Emission Factor = 76.979 lbs / 1000 gallons:

Emissions = 18818 gal. /yr. * 76.979 lbs /1000 gal. / 365 days/yr./ 2000 lbs/ton

= 0.002 (ton/day) of total organics

County Distribution

Rather than using specific airports of origin, the areas where agricultural aircraft operate were considered. So, county distribution was based on reported total crop acreage for each county.

Temporal Variation

Monthly distribution was estimated based on assumption that spraying operations occur primarily during the late spring and summer months. Weekly activity is assumed to be uniform, with reduced activity on weekends.

TRENDS

History

Emissions throughout the years were estimated based on CARB's growth profile on the dollar output of agricultural products.

Growth

Growth profile for this category is based on CARB's growth information for agricultural activities in the Bay Area.

By: Sukarn Claire
Date: January 2011
Base Year: 2008

EIC: 81080611400000

SOURCE INVENTORY

ON-ROAD MOTOR VEHICLES

EMISSIONS

Introduction

There are over 5.0 million on-road motor vehicles in the Bay Area, traveling an estimated daily average of 167 million miles.

On-road motor vehicles emissions account for a large portion of the Bay Area total emissions. Realistic estimation of the emission trends from motor vehicles is an essential element of controlling and improving air quality.

Methodologies

To estimate emissions from a large fleet of vehicles many variables are required. The most important is the rate at which a vehicle produces various pollutants. This is usually referred to as emission factor, it varies with vehicle age, type, and operating conditions, such as speed and ambient temperature. Another important variable is called the fleet activity. This term relates to the number of in-use vehicles, number of trips and the vehicle miles traveled (VMT).

Various computer models exist for estimating motor vehicle emissions. These are designed to carry out different tasks. One is to calculate emission factors, the other is to calculate daily emissions using activity data and the emission factors.

The computer model for calculation of emission factors and county-specific emissions in California was developed by the California Air Resources Board (CARB). It has undergone many improvements and refinements, the latest version EMFAC2007 (2.2, November 2006) was used for this inventory.

For a full description of the models and further supporting documentation, reference should be made to ARB's Website at http://www.arb.ca.gov/msei/msei.htm. Brief description of each model is given below:

EMISSION FACTORS MODEL: EMFAC

This program calculates pollutants emission rates for various combinations of vehicle type, engine technology and mode of operation. To account for vehicle age, the vehicle fleet is assumed to consists of vehicles up to 35 years old. The relevant emission factor, represents the weighted average for that vehicle type.

Emission factors vary with vehicle operating conditions, such as speed and ambient temperature. EMFAC series calculates emission factors for any desired operating condition.

The base data for the calculations are taken from the Federal Test Procedure results. These tests attempt to simulate various driving cycles for different vehicle types.

DAILY EMISSIONS MODEL: BURDEN

This program uses emission factors from EMFAC and a large data base of activity for each county to calculate total daily emissions. The activity is in the form of number of in-use vehicles, number of engine statrts and Vehicle Miles Traveled (VMT) for each vehicle type. The activity data for year 2000 were also supplied by CARB, based on Bay Area registration and Smog Check data.

Temperatures chosen for the calculations were averages of ten worst air quality days (Summer temperatures for high Ozone days and winter temperatures for high CO occurrences). The variation in temperature during the day is also taken into account.

Trends

Estimates of VMT and trips for 2001-2030 are based on the Metroplitan Transportation Commission (MTC) projections of travel activity growth in the Bay Area, which in turn is based on the 2030 Regional Transportation Plan (RTP2030).

Control

There are three types of controls for motor vehicle emissions:

1) Emission Standards.

Since 1972, introduction of more stringent emission standards has caused the entire motor vehicle fleet to become cleaner as newer vehicle replace the old ones. The introduction of California's Low Emissions Vehicles Program in 1994, will ensure that this trend has continued into the present century. Most recently, regualtions were adopted by ARB to reduce emissions from heavy-duty diesel trucks and buses. Benefits from these regulations were not included in the EMFAC2007 model as these were not finalized at time the model was released. However, using ARB's relevant Staff Reports, estimates of the benefits for the Bay Area were made by District staff and were included in the future year emissions estimates (2008 onwards).

2) Clean Fuels Program

This program includes Re-Formulated Gasoline Phase I (started January 1990), the Winter-time Oxygenated Fuels Program (introduced in November 1992) and Reformulated Gasoline Phase II (beginning January 1996). To reduce sulfur oxides (SOx) emissions, CARB has also regulated the sulfur content in both gasoline and diesel fuels. The latest regulations beginning 1997, reduced sulfur content of diesel fuel to 15 part per million.

3) Inspection and Maintenance program (I/M)

Also known as the Smog Check, this program was introduced in 1984. Enhancement to the original I/M were introduced in 1990, with further improvements phased in beginning 1994. In October 2003, ARB started implementing the Enhanced I/M Program (Smog Check II) in the Bay Area. As a result, further ROG, but more importantly NOx, emission reductions were achieved.

Benefits from these controls are included in the emissions estimates.

In addition, there are controls to reduce motor vehicle use and congestion . These are generally referred to as Transportation Control Measures. Examples of these are programs that increase transit usage and signal timing projects. The benefits from some of these measures are included as part of the travel data (less VMT, less congested speed, etc.), and hence, already included in the emissions estimates from the relevant version of the emissions model.

By: A. K. Fanai
Base Year 2008
December 2010

EMISSION INVENTORY

CATEGORIES # 1110 - 1112

GROUND SUPPORT EQUIPMENT

EMISSIONS

Introduction

Considered in these categories are criteria pollutant (particulate, organic, NO_x, SO_x, and CO) and greenhouse gas emissions (CO_2, CH_4, and N_2O) from Ground Support Equipment (GSE) that service the aircraft while loading and unloading passengers and freights at the major airports in the San Francisco Bay Area. The commercial airports are San Francisco International (SFO), Oakland International (OAK), and San Jose International (SJC). The Bay Area is also home to a military airbase in Solano County, the Travis Air Force Base (AFB). Examples of the equipment include baggage/aircraft tractors and tugs, ground power units, air start units, auxiliary power units, cargo belt loaders, cargo moving equipment, fuel trucks, food service trucks, and other assorted service vehicles. The majority of the equipment in use at the Bay Area commercial airport is fueled by gasoline or diesel; however, some equipment is fueled by alternative fuels such as compressed natural gas (CNG), liquefied petroleum gas (LPG), or electricity.

Methodology

Emissions, emission factors, equipment population and other factors such as break horsepower (BHP), load factors, typical hours of usage and equivalent ratios used are in accordance with the California Air Resources Board's Off-Road Model 2007. Categories 1110, 1111 and 1112 account for GSE emissions from San Francisco International (SFO), Oakland International (OAK) and San Jose International (SJC) airports respectively. Travis Air Force Base GSE emissions are relatively small and no category has been assigned yet. Combined ground support equipment population for the Bay Area commercial airports is estimated to be about 1100.

County Distribution

Distribution of emissions into each county is based on Ground Support Equipment activity and its population in each Bay Area county.

Monthly Variation

Monthly distribution was based on an average monthly number of aircraft operations at each airport.

TRENDS

History

Emissions growth through the years was estimated based on the number of aircraft operations at each airport.

Growth

Projections are based on aircraft operations forecasts in accordance with FAA, the Metropolitan Traffic Commission (MTC) and the San Francisco Bay Area airports.

By: Sukarn Claire
Date: January 2011
Base Year: 2008

EIC: 86088911000040, 86088912100000, 86088901100000 etc.

SECTION 10

MISCELLANEOUS OTHER SOURCES

EMISSION INVENTORY

CATEGORY # 744 - 748

CONSTRUCTION OPERATIONS

EMISSIONS

Introduction

These categories account for fugitive dust emissions generated from construction activities while building residential, commercial, industrial, institutional structures, and roads (Categories # 744 - 748, respectively). The PM emissions result from construction operations such as digging, loading, scraping, grading, compacting, light duty vehicle traffic, etc.

Emission factors were based on a study done by Midwest Research Institute. This study produced an average emission factor of 0.11 ton PM_{10}/acre-month for these construction operations. (This value is assumed to include the effects of typical control measures, such as watering. Watering is assumed to control dust by 50%.) However, in the Bay Area, it was assumed 20% of construction activity consisted of large-scale operations that involved substantial earthmoving operations. Under this "worst-case" scenario, the emission factor was 0.42 ton PM_{10}/acre-month. Therefore, the overall composite emission factor used for these construction activities in the Bay Area was 0.172 ton PM_{10}/acre-month. It is assumed that all the above-mentioned construction operations have the same emission factor.

The California Air Resources Board provided the PM speciation profile (PM_{10} fraction of 0.4893). Activity data (throughputs) are expressed in terms of acre-months for the above categories.

Methodologies

<u>Residential Construction (Category 744)</u>

The number of new housing units (single and multi-family), provided by the California Department of Finance, is used to calculate the acreage disturbed. The affected construction area for a single family living unit is estimated at 1/7th of an acre for Alameda, Contra Costa, Marin, San Francisco, San Mateo, and Santa Clara counties; and 1/5th of an acre for Napa, Solano, and Sonoma counties. The affected construction area for multi-family living units is estimated to be 1/20th of an acre. The construction time for residential units is assumed to be 6 months. . The throughput, expressed in acre-months, is estimated by multiplying the appropriate area factors, construction time and number of new units for each county.

Commercial, Industrial, and Institutional Construction (Categories 745 -747)

The estimated construction acreage for these categories is based on project valuations supplied from the California Department of Finance. The valuations for commercial, industrial, and institutional construction are 3.7, 4.0, and 4.4 acres per million dollars of valuation, respectively. Since these factors are 1977 values, multiplying the above valuations by the ratio of 1977 to a particular year's Association of Bay Area Government's (ABAG's) 2009 Consumer Price Index value makes inflationary corrections for that particular year. The construction time for commercial, industrial, institutional buildings is assumed to be 11 months. The throughput for a particular year, expressed in acre-months, is found by multiplying that year's inflationary adjusted project valuation by the county's construction valuation, and construction time.

Road Construction (Category 748)

The latest road construction for freeways, highways, county and city roads was estimated by the difference in their respective total mileage between that year's and prior year's data, as reported in the California Statistical Abstract. The affected area per mile of road for freeways, highways, and county and city roads are 12.1, 9.2, and 7.8 acres/mile, respectively. The construction time for roads is assumed to be 18 months for the average project. The throughput, expressed in acre-months, is estimated by multiplying the road construction miles, affected area per mile of road factor, and project duration time.

The emission factor (which includes any controls) used for all categories mentioned above was estimated at 0.3515 ton PM/acre-month (703.0 lbs. PM/acre-month), with the PM_{10} fraction at 0.4893. The total emissions for these categories are determined by multiplying the throughput and emission factor.

Monthly Variation

The monthly variations of emissions for the Bay Area counties in Category 744 – 748 were based on the ARB's seasonal profiles for Building and Road Construction Dust. Roughly, emissions were distributed as 55% during the months of April to September and 45% during the remaining months.

County Distribution

Distribution of emissions into counties was based on construction activity provided by the California Department of Finance.

TRENDS

History

The historical growth profile was based on a combination prior emissions data (back to 1987) and the ABAG's 2009 Construction Employment Growth Profile.

Growth

After 2010, projected emissions to 2030 for all categories were also based on ABAG's 2009 Construction Employment Growth Profile. For the years 2008-2010, the growth profile was based on information found in the California Energy Commission's Report "Transportation Energy Forecasts and Analyses for the 2009 Integrated Energy Policy Report", May 2010, Table 2.10. For the years 2008-2010, the activity decreased an average 4.3% per year to account for the downturn in the economy.

By: Stuart Schultz
Date: January 2011
Base Year 2008

EIC: 63062254000000 (Cat. 744)
63062454000000 (Cat. 745)
63062854000000 (Cat. 746)
63062654000000 (Cat. 747)
63063454000000 (Cat. 748)

EMISSION INVENTORY

CATEGORIES # 749 & 1435

FARMING OPERATIONS

EMISSIONS

Introduction

Farming Operations consist of two categories, Agricultural Land Preparation (Category 749) and Agricultural Harvest Operations (Category 1435). The methodology for emission calculation and temporal activity for both these categories were taken from the California Air Resources Board's (ARB's) Emission Inventory Procedural Manual Section 7.4 (Agricultural Land Preparation, revised January 2003) and Section 7.5 (Agricultural Harvest Operation, revised January 2003).

Category 749 accounts for particulate emissions generated by farming operations such as tilling, plowing, discing, leveling, etc. These activities are normally performed in the early spring and/or fall months. Therefore, particulate emissions from agricultural tilling are highly dependent on type of crop, climate, soil properties and equipment characteristics.

Category 1435 accounts for particulate emissions caused from harvest activities. These activities include harvest vehicles traveling over the soil, mechanical processing of crop and underlying soil, or removal of crop waste material through blowing or sweeping action. As of this writing, the only crops in California that had harvest particulate emissions factors were almonds, cotton, and wheat. All other relevant crops are assigned emission factors by scaling from these three measured values.

Emissions from fuel combustion of agricultural equipment, such as mowers, tractors, tillers, etc., are accounted for in Category 1655 (Agricultural Equipment, Gasoline-4 Stroke), Category 1656 (Agricultural Equipment, Evaporative-4 Stroke), and Category 1646 (Agricultural Equipment, Diesel).

Methodology

Category 749

Agricultural land preparation particulate emissions for each crop are estimated using the following equation:

$$\text{Emissions}_{crop} = \text{Emission Factor}_{crop} * \text{Acres}_{crop}$$

The crop specific PM_{10} emission factors are calculated by multiplying a land preparation emission factor (i.e. root cutting, discing, rippling, weeding, land planning, etc.) with the number of passes performed per acre that are needed to prepare a field for planting a particular crop (acre-pass). A crop may have multiple land preparation operations with its corresponding number of acre-passes. In this case, the crop specific emission factor is the sum of acre-pass weighted emission factor for each land preparation operation. For example, the crop PM_{10} emission factor for garlic is as follows:

Crop Profile	Land Preparation Operations	Operation E.F. (lbs PM_{10}/acre-pass)	Acre-Pass	Crop Specific E.F. (lbs PM_{10}/acre/yr)
Garlic	Land Maintenance	12.5	0.2	2.5
	Disc & Roll	1.2	1	1.2
	Chisel	1.2	1	1.2
	List	0.8	1	0.8
	Shape Beds	0.8	1	0.8
Crop Specific Emission Factor for Garlic (lbs PM_{10}/acre/yr)				6.5

There are 21 crop specific PM_{10} emission factors (see Table 2.a of ARB's Agricultural Land Preparation document) that include such crops as alfalfa, almonds, garlic, grapes (raisin, table and wine), tomatoes, wheat, etc. All other crops are assigned an emission factor from one of the 21 crop specific PM_{10} emission factors (see Table 3 of ARB's Agricultural Land Preparation document).

Example 1: Calculate the 2008 PM_{10} and total particulate emissions from land preparation activities for garlic in Santa Clara County, where

a) the crop specific PM_{10} emission factor = 6.5 lbs PM_{10}/acre/yr,
b) 297 acres were devoted to garlic in 2008, and
c) the PM_{10} factor is .4543.

- PM_{10} emissions = 6.5 lbs PM_{10}/acre/yr * 297 acres = 1,931 lbs PM_{10}/yr, or 0.97 ton PM_{10}/yr.
- PM emissions= 0.97 ton PM_{10}/yr/0.4543 = 2.12 ton PM/yr.

Each of the county's crops are estimated in this fashion and then summed for the total PM_{10} emissions. The nine counties within the Bay Area were summed to get the District total. (The District's portion of Solano and Sonoma Counties were 20% and 39%, respectively.) PM emissions are calculated by dividing PM_{10} value by 0.4543.

Category 1435

Agricultural Harvest Operations particulate emissions for each crop are estimated using the following equation:

$$\text{Emissions}_{crop} = \text{Emission Factor}_{crop} * \text{Acres Harvested}_{crop}$$

The individual crop emissions for each county were summed to produce county and District wide total particulate and PM_{10} agricultural harvest emissions. The PM_{10} emission factors were taken from Table 2 of ARB's Agricultural Harvest Operations document. Using the PM_{10} emissions factors for cotton, almonds, and wheat as a baseline, other crop's PM_{10} emission factors were estimated. The number of acres to each applicable crop was obtained from either the county's annual agricultural crop reports or the California Agricultural Statistics Service (CASS).

Example 2: Calculate the 2008 PM_{10} and total particulate emissions from agricultural harvest operations for walnuts in Contra Costa County, where

a) the Crop specific PM_{10} emission factor = 40.77 lbs PM_{10}/acre,
b) 466 acres were devoted to walnuts in 2008, and
c) the PM_{10} factor is .4543.

- PM_{10} emissions = 40.77 lbs PM_{10}/acre * 466 acres = 18,999 lbs PM_{10}/yr, or 9.50 tons PM_{10}/yr.
- PM emissions = 9.50 ton PM_{10}/yr/0.4543 = 20.91 tons PM/yr.

Each of the county's crops are estimated in this fashion and then summed for the total PM_{10} emissions. The nine counties within the Bay Area were summed to get the District total. (The District's portion of Solano and Sonoma Counties were 20% and 39%, respectively.) PM emissions are calculated by dividing PM_{10} value by 0.4543.

Monthly Variation

The monthly variations of emissions for the Bay Area counties in Category 749 were based on the ARB's seasonal profile for agricultural land preparation emissions (Table 4, Agricultural Land Preparation, Section 7.4). For Category 1435, the monthly variations of emissions were based on ARB's seasonal profile for agricultural harvest emissions (Table 3, Agricultural Harvest Operations, Section 7.5).

County Distribution

For both categories, the county distribution was based on the crop activity reported by the counties' annual agricultural crop reports or the CASS.

TRENDS

History

For Category 749, the historical growth profile was based on a combination of prior emissions data (back to 1987) and an annual activity increase of 1.0241% from 1986 back to 1967. This backcasting value represented the Bay Area's annual activity increase (in acres) from 2008 going back to 1987.)

For Category 1435, the historical growth profile was based on a combination of prior emissions data (back to 1987) and an annual activity increase of 1.0904% from 1986 back to 1967. This backcasting value represented the Bay Area's annual activity increase (in acres) from 2008 going back to 1987.)

Growth

Projected emissions to 2030 for both categories were based on ARB's growth profile for Agricultural Operations. For the Bay Area, this amounts to a 0.1% decrease in activity per year.

By: Stuart Schultz
Date: January 2011
Base Year 2008

EIC: 62061454000000 (Cat. 749)
62061554000000 (Cat. 1435)

EMISSION INVENTORY

CATEGORIES # 750

ACCIDENTAL FIRES - STRUCTURAL

EMISSIONS

Introduction

Category 750 estimates criteria pollutant (particulate, organic, NO_x, SO_x, and CO) and greenhouse gas emissions (CO_2, CH_4, and N_2O) from accidental structural fires. The Structural Fires category is an area source category that includes residential and commercial buildings as well as mobile and trailer home fires.

Methodology

The methods used to calculate emissions for this category conforms to the methods used by the California Air Resources Board (CARB). The total number of structural accidental fires in California was acquired from the State Fire Marshal's Office. Structural fires were apportioned to the Bay Area based on number of households in the Bay Area as compared to total California households.

For building and mobile home fires, an average percent structural loss per fire was calculated by dividing the total monetary damage due to fires by the product of the average value of a residence in California and the number of residential fires. The result is an average loss of 7.3% per fire. According to census data and the National Association of Home Builders, the average residence has approximately 1,649 square feet of floor space and an average of 11,000 board feet of lumber in its structure. Assuming an average of one ton of material per 1000 board feet, an average residence would have approximately 11 tons of combustible material. With a rate of loss of 7.3%, the structural loss would be 0.80 tons per fire.

The National Bureau of Standards lists the combustible contents per square foot of the functional areas of the average home. These figures were multiplied by the percent of fires originally estimated to occur within each of these areas, and the products were then added to give a weighted average of 7.91 lb/sq. ft. as shown in Table 1.

Table 1

Area	Origin of Fires (%)	Combustible (lbs./ft^2)	Weighted Ave. (lbs./ft^2)
Bedroom	28.96	10.4	3.012
Sleeping Area	0.20	10.4	0.021
Dining Area	2.20	7.2	0.159
Kitchen	53.92	6.8	3.667
Bathroom	6.32	7.0	0.443

Table 1 (continued)

Area	Origin of Fires (%)	Combustible (lbs./ft^2)	Weighted Ave. (lbs./ft^2)
Laundry	8.08	7.2	0.582
Office	0.17	7.9	0.013
Other	0.13	9.6	0.012
Sum of weighted averages			*7.909*

With a 7.3% loss rate and a factor of 7.91 pounds of combustible contents per square foot, and assuming an average floor space of 1300 square feet, the content loss for the average residential fire would be: [(1649) x (0.073) x (7.91)] / 2000 = 0.48 (tons/fire)

Amount burned per residential fire (fuel loading) = Structural loss + Content loss
= 0.80 + 0.48 = 1.28 (tons/fire)

Structural fire emission factors in pounds per ton of material burned for TOG, CO and PM were obtained from the results of tests on the burning of model wood buildings. The emission factor for NO_X was assumed to be similar to that listed in AP-42 for municipal refuse. These emission factors were converted to units of pounds per fire using the factor 1.28 ton/fire. The criteria pollutant composite emission factors (pound/fire) are as follow:

	PM	Organic	NO_X	SO_X	CO
Pounds/fire	13.8	17.8	5.1	0	215.0

The emission factors for greenhouse gas inventory were developed using above information and emission coefficient data from the Environmental Protection Agency (EPA), the U.S. Department of Energy's (DOE's) Energy Information Administration (EIA) and The California Energy Commission (CEC). The Greenhouse gas composite emission factors (pounds/fire) are as follow:

	Bio-CO_2	CH_4	N_2O
Pounds/fire	3133.4	7.25	0.115

Carbon Dioxide emissions from this category are considered to be biogenic emissions. Biogenic Carbon Dioxide (Bio-CO_2) emissions are a subset of total CO_2 emissions which are emitted from materials that are derived from living cells, excluding fossil fuels, limestone and other materials that have been transformed by geological processes. Bio-CO_2 originates from carbon that is present in materials such as wood, paper, vegetable oils and food, animal, and yard waste.

Temporal Variation

The monthly activity and the weekly activity are uniform. The daily activity occurs primarily during daylight hours.

County Distribution

Structural fires were apportioned to the Bay Area counties based on number of households in each county. Total number of households was used directly in the county distribution except for Solano and Sonoma which were adjusted to include only areas that are inside the District boundary.

TRENDS

History

Historical trends are based on data from the State Fire Marshal's Office and household population growth trends in the Bay Area.

Growth

Emissions growth profile is based on household population growth in the Bay Area. Household population data used in developing growth profile was obtained from the Association of Bay Area Government's (ABAG's) 2009 "Projections" reports.

By: Sukarn Claire
Date: January 2011
Base Year: 2008

EIC: 66065602000000

EMISSION INVENTORY
CATEGORIES # 1580
ACCIDENTAL FIRES - ALL VEGETATION

EMISSIONS

Introduction

Category 1580 is an area source category that accounts for criteria pollutant (particulate, organic, NO_x, SO_x, and CO) and greenhouse gas emissions (Biogenic-CO_2, CH_4, and N_2O) from wildfires in woodland, timber, brush and grass.

Carbon Dioxide emissions from this category are considered to be biogenic emissions. Biogenic Carbon Dioxide (Bio-CO_2) emissions are a subset of total CO_2 emissions which are emitted from materials that are derived from living cells, excluding fossil fuels, limestone and other materials that have been transformed by geological processes. Bio-CO_2 originates from carbon that is present in materials such as wood, paper, vegetable oils and food, animal, and yard waste.

Planned or prescribed fires such as weed burning, field crops, prunings, range improvement burning and forest management are covered in categories 315-319.

Methodology

Methodology for this category is in accordance with the California Air Resources Board's (CARB's) document "Methods for Assessing Area Source Emissions in California" for the Wildfires. Activity data (acreage burnt) estimates were obtained from the California Department of Forestry and Fire Protection (CDF) and CARB.

Wildfire emissions are calculated using the Geographic Information System (GIS) based Emission Estimating System (EES) model developed for ARB by UC Berkeley's Center for the Assessment and Monitoring of Forest and Environmental Resources (CAMFER) laboratory. Wildfire footprint is overlaid on vegetation landcover map, calculating the amount of each fuel consumed in the fire. Fuel loading is assigned for each fuel component that makes up the vegetation type.

Emission factors and vegetation acreage consumed vary from fire season to fire season depending on type of vegetation consumed and weather conditions. For example, average composite emission factors and amounts of acreage burnt in the Bay Area by county are shown below for year 2008.

Emission Factors (lbs/acre)

Cat.	PM	ORG	NO_x	SO_x	CO	Bio-CO_2	CH_4	N_2O
1580	229	237	76	23	2158	385	86	4.4

Acreage burn data by County (acres)

Cat.	Alameda	Contra Costa	Marin	Napa	San Francisco	San Mateo	Santa Clara	Solano	Sonoma
1580	300	300	503	4722	5	300	3008	300	1289

Other sources for the vegetation combustion emissions related information are the U.S. Department of Energy's (DOE's) Energy Information Administration (EIA); the Environmental Protection Agency's (EPA's) document AP-42, and the California Energy Commission (CEC).

County Distribution

County distribution of emissions is based on acreage burnt in each of the San Francisco Bay Area counties.

Monthly Variation

On the basis of historical data, the California Department of Forestry and Fire Protection (CDF) suggests most of the wild fires occurring from mid-May to mid-November. The percentage of wild fires by month is estimated as follow: May - 5%, June - 10%, July - 15%, August - 20%, September - 25%, October - 20% and November - 5%.

TRENDS

History

Prior to Base Year 2002 wildfire category 1580 was split into two categories, category 751 (Timber and Brush) and category 752 (Grass and Woodland).

Growth

Actual acreage burned can vary widely from year to year depending on weather conditions. Therefore, greater number of wildfires may occurr during a relatively dry year. Future emission trends are based on the average number of acres burned over the previous ten-year period in the San Francisco Bay Area.

By: Sukarn Claire
Date: January 2011
Base Year: 2008

EIC: 93093402000000

EMISSION INVENTORY

CATEGORY #753

ACCIDENTAL FIRES - AUTOMOBILES

EMISSIONS

Introduction

Category 753 is an area source category that estimates criteria pollutant (particulate, organic, NO_x, SO_x, and CO) and greenhouse gas emissions (CO_2, CH_4, and N_2O) from accidental automobile fires. The method used to calculate emissions for this category conforms to the method used by the California Air Resources Board (CARB).

Methodology

The total number of automobile accidental fires in California was acquired from the state fire marshal's office. Automobile fires were apportioned to the Bay Area based on Bay Area population as compared to California's total population.

The emission factors for automobile fires were derived from the Environmental Protection Agency's (EPA's) document AP-42, Section 2.2.2 and 2.4.2. Table 2.2-1 of AP-42 lists the emission factors for uncontrolled auto body incineration, which are based on automobiles that have been partially stripped (tires, seats, etc. removed). Table 2.4-1 lists the emission factors for open burning of automobile upholstery, belts, hoses, and tires in common.

It is assumed that tires are burned in 60% of the automobile fires. Composite emission factors were calculated as a weighted average of the emission factors listed in Table 2.2-1 and 2.4-1 of AP-42, with the assumption that the average car body weighs 3,700 pounds and the components weigh 500 pounds. The criteria pollutant composite emission factors (Lb/Fire) are listed below:

	PM	TOG	NO_X	SO_X	CO
Pounds/fire	17	7.21	0.7	0	21.25

The emission factors for greenhouse gas inventory were developed using above information and emission coefficient data from the Environmental Protection Agency (EPA), the U.S. Department of Energy's (DOE's) Energy Information Administration (EIA) and The California Energy Commission (CEC). The Greenhouse gas composite emission factors (Lb/Fire) are as follow:

	CO_2	CH_4	N_2O
Pounds/fire	626.8	2.0	0.135

Temporal Variation

The monthly activity and the weekly activity are uniform. The daily activity occurs primarily during daylight hours.

County Distribution

Automobile fires were apportioned to the Bay Area counties based on population by county. This was used directly in the county distribution except for Solano and Sonoma which were adjusted to include only areas inside the District using household population.

TRENDS

History

Historical trends were developed using data from the State Fire Marshal's Office and growth in Bay Area population.

Growth

Emission projections for this category are based on population growth in the San Francisco Bay Area. Population data used for emission growth profile was obtained from the Association of Bay Area Government's (ABAG's) 2009 "Projections" reports.

By: Sukarn Claire
Date: January 2011
Base Year: 2008

EIC: 66065802000000

SOURCE INVENTORY

CATEGORY # 1759-1762

PAVED ROADS - VEHICLE TRAVEL

EMISSIONS

Introduction

Fugitive dust particles raised from the movements of motor vehicles on paved road surfaces are included in this category.

Methodology

The methodology for estimating particulate emissions from vehicular travel on paved roads was updated in the Fifth Edition of U.S. EPA's Compilation of Air Pollutant Emission Factors AP42 document (January 1995, Updated November 2006). Emission rates are a function of vehicle weight and silt loading as shown in the following equation:

$$E= [k\ (sL/2)^{0.65}\ *\ (W/3)^{1.5}\ -C\ ]\ *\ (1-P/4N)$$

where: E is the particulate emission factors in grams per vehicle miles traveled (VMT)
k is the particle size multiplier used to compute PM_{10} and $PM_{2.5}$ (7.3 and 1.1 grams/mile respectively)
sL is the roadway silt loading in grams per square meter
W is the average vehicle weight in tons.
C is emission factor for 1980's vehicle fleet exhaust, brake wear and tire wear.
P is the number of "wet" days with at least 0.254 mm (0.01") of precipitation
N is the number of days in the averaging period, 365 for yearly or 30 for monthly

California specific silt loading for different road types were measured in a study carried out by Midwest Research Institute (MRI) in 1995. Roads were divided into four classes with the corresponding silt loading factors (grams/m^2):

freeway/expressway	0.02
major street/highway	0.032
collector and local street	0.32
rural	1.6

Average vehicle weight was assumed to be 2.4 tons, based on vehicle counts performed during the MRI study.

'C' Factors are 0.2119 g/VMT for PM_{10} and 0.1617 for $PM_{2.5}$.

Estimated fraction of county VMT in each of the four roadway types were taken from 2005 data by Highway Performance Monitoring Systems (HPMS). The 2008 fractions are assumed to be the same. County specific 2008 VMT data were taken from California Air Resources Board EMFAC2007 model.

The monthly fraction of annual VMT came from monthly Caltrans VMT highway data prepared for the Sacramento Office of the Federal Highway Administration. These were combined with the number of wet days in the relevant month to develop a monthly profile.

Number of wet days for each county was derived from the most appropriate meteorological station for that county.

TRENDS

VMT data was taken from ARB EMFAC2007 model for year 1980-2000. For 2001-2020 growth rates were based on MTC's projection of Bay Area travel growth.

By: A. K. Fanai
January 2011
Base Year 2008

EIC: 64063654000000

SOURCE INVENTORY

CATEGORIES # 755 - 758

UNPAVED ROAD TRAVEL

EMISSIONS

Introduction

Fugitive particulate emissions result from motor vehicles traveling on various types of unpaved road surfaces. Four types of unpaved roads are considered:

1) City and County
2) Parks and Forests
3) Bureau of Land Management and Bureau of Indian Affairs
4) Farm .

Methodologies

The number of miles of each type of unpaved roads (except for farm roads) were taken from Maintained Public Record Mileage for 2003 from Caltrans. The total VMT for each type of road was estimated by assuming 10 miles of travel per day for each mile of unpaved road.

For farm roads, county specific number of acres for various types of crops were taken from California Department of Food and Agriculture Summary of Crop Acreage Harvested in 2003. It was estimated that for each 40 acre lot of crop, there is 175 miles of travel per year.

Emission factor for all types of road used is assumed to be 2.27 pounds of PM_{10} per vehicle mile traveled. This is the average of 22 unpaved road dust emission tests performed in San Joaquin Valley for light-duty truck traffic. The measurements were performed as part of studies by University of California, Davis (UCD) "Evaluation of the Emissions of PM_{10} Particulates from Unpaved Roads in the San Joaquin Valley, Final Report, April 1994" and the Desert Research Institute (DRI) "Effectiveness Demonstration of Fugitive Dust Control Methods for Public Unpaved Roads and Unpaved Shoulders of Paved Roads, Final Report, December 1996".

Emissions for 2008 were estimated using growth rates described in the following section.

Temporal Variations

It was assumed that wet days (with precipitation over 0.01") prevent these emissions from occurring. The VMT is also assumed to drop significantly during winter months. ARB combined these factor to develop monthly variations for each county.

Activity is assumed to be the same during the week Daily activity is assumed to take place primarily during the day.

TRENDS

Two growth rates were used for these categories to estimate 1980-2020 emissions.

For farm roads, annual activity was assumed to grow by agricultural production. This growth code was developed by ARB.

For the remaining categories, in the absence of better data, annual variation activity was assumed to follow population by county.

By: A. K. Fanai
Base Year 2008
December 2010

EIC: 64563854000000 (Cat#755)
64564054000000 (Cat#756)
64564454000000 (Cat#757)
64564654000000 (Cat#758)

EMISSION INVENTORY

CATEGORIES # 1619 - 1627

ANIMAL WASTE - LIVESTOCK

EMISSIONS

Introduction

Livestock emissions including dairy cattle, range cattle, poultry, swine, sheep, horses, and goats are assumed to be directly related to animal population. Most available population data is based on annual sales data. For dairy cattle, range cattle, and feedlot cattle, year 2000 population was derived from the California Department of Food and Agriculture's (CDFA) summary of cattle and calves inventory of January 1, 2001. The populations are developed by the United States Department of Agriculture, and the CDFA 2001 Agricultural Resources Directory.

Methodology

This methodology is presently based on ARB's methodology. Livestock population in the Bay Area was divided into subcategories: dairy cattle, range cattle, poultry (layers and broilers), swine, sheep, horses, and goats. Table 1 shows livestock population in the Bay Area.

Table 1 – Bay Area Livestock Population

County	Dairy Cattle	Range Cattle	Layers	Broilers	Turkeys	Swine	Sheep	Horses	Goats
Alameda	3,620	22,380	318	331,655	8	80	1,268	1,943	228
Contra Costa	11,124	16,876	343	24	-----	65	299	2,523	374
Marin	20,896	18,104	170	-----	55,862	987	13,435	723	146
Napa	1,399	7,601	920	1,653,743	24,034	184	520	805	782
San Francisco	-----	-----	-----	-----	-----	-----	-----	-----	-----
San Mateo	-----	3,000	353	-----	169	38	109	1,129	-----
Santa Clara	2,394	17,606	141,897	113	23	157	742	2,815	136
Solano	3,355	1,203	376	54	40	63	3,804	91	9
Sonoma	19,996	12,623	297,372	979,101	62,312	327	8,761	1,633	547
Total	**62,783**	**99,214**	**441,750**	**2,964,690**	**142,448**	**1,902**	**28,937**	**11,662**	**2,222**

The estimated uncontrolled TOG, ROG, CH_4 and N_2O emission factors are summarized in Table 2.

Table 2 - Livestock Subcategories and Criteria and GHG Emission Factors

Category Number	Category	Subcategory	Emission Factors (lbs/head/day)			
			TOG	ROG	CH4	N2O
1619	Dairy Cattle	Dairy Cows, Dairy Bulls, Dairy, Heifers, Dairy Calves	160	12.8	611.62	4.57
1620	Range Cattle	Beef Cows, Beef Bulls, Beef Heifers, Beef Calves, Stockers	160	12.8	168.86	4.57
1624	Swine	Swine	58	4.64	64.81	0.07
1621,1622,1623	Poultry	Turkey, Broilers, Layers	2.4	0.19	0.17	0.001
1625	Sheep	Sheep and Lamb	12	0.96	11.85	0.02
1627	Goats	Goats	12	0.96	11.85	5.04
1626	Horses	Horses	160	12.8	51.56	5.04

For each category, the emissions are calculated by multiplying emission factor and population of each animal type.

Monthly Variation

Monthly distribution was estimated evenly over the twelve months.

County Distribution

The county distribution was based on the cattle population in Table 1 above for the nine counties.

TRENDS

History

Emissions through the years were estimated based on the ARB's growth profile on dollar values of Agricultural stock for each county.

Growth

The growth rate varies by county and by livestock and there is currently not a general surrogate to indicate the livestock growth or decline. In most cases, zero growth is assumed for livestock emissions, which is probably reasonable for most areas in the state. Projections to year 2030 are based on the ARB's growth profile.

By: Michael Nguyen
Date: February, 2011
Base Year 2008

EIC: 62061802620101(Cat#1619)
62061802620102(Cat#1620)
62061802620104(Cat#1621)
62061802620105(Cat#1622)
62061802620106(Cat#1623)
62061802620107(Cat#1624)
62061802620108(Cat#1625)
62061802620109(Cat#1626)
62061802620110(Cat#1627)

EMISSION INVENTORY

CATEGORY # 760

ANIMAL WASTE - OTHER

EMISSIONS

Introduction

Emissions from this category are from waste products of domestic animals (pets) and other native animals including dogs, cats, deer, and wild pigs.

Methodology

The animal population was estimated based on pet to human ratios taken from the report, "Evaluation of Emissions from Selected Uninventoried Sources in the State of California" by Dickson, R. and Tate, S. Population of dogs and cats was estimated based on this ratio with the population of each county. Of the wildlife animals, only deer and wild pigs were considered significant. Numbers of heads for these animals were made based on county land area ratios estimates by the Department of Fish and Game. The composite emission factors (see table below) were also derived from the above report.

Emissions Factors (lbs/1000 heads/day)		
PM	TOG	CH_4
1.143	2.531	1.772

Monthly Variation

Monthly distribution was estimated evenly over the twelve months.

County Distribution

The county distribution was based on dog population for the nine counties, and correspondingly, showed: Alameda-18.5%, Contra Costa-16.4%, Marin-4.6%, Napa-2.9%, San Francisco-10.6%, San Mateo-12.9%, Santa Clara-21.9%, Solano-5.3%, and Sonoma-6.9%.

TRENDS

History

Emissions through the years were estimated based on ARB's relative values of dollar output for growth in Agriculture-stock of each county.

Growth

Projections to 2030 were based on the same growth profile of ABAG's 2009 Projections.

By: Michael Nguyen
Date: February, 2011
Base Year 2008

EIC: 49999500100000(Cat#760)

EMISSION INVENTORY

CATEGORY # 761

SANITARY SEWERS

EMISSIONS

Introduction

This category includes organic compounds emissions from sanitary sewer lines in industrialized areas leading to sewage treatment plants. This category also includes waste material generated from portable or semi-permanent toilets and discharged to the sanitary sewer system.

Methodology

A report on "Evaluation of Emissions from Selected Uninventoried Sources in the State of California", by R. Dickson; W.R. Oliver, and S. Tate showed an estimate of discharged material to the sewer systems in the United States. This estimate of national loading to sewers was adjusted for the Bay Area. In the report, about 50% of volatile organic compounds (VOC) was assumed from the discharged material volatilizes in the sewer prior to becoming influent to treatment plants. It was further assumed that 50% of the volatilized materials have already been accounted for in other categories, such as cleanup solvent.

An emission factor of 250 lbs of organics per thousand pounds of industrial sewer loading was also developed based on the above report. The VOC Emissions are calculated by multiplying the throughput data with the emission factor.

Monthly Variation

Monthly distribution was estimated based on estimated load throughout the year.

County Distribution

The county population was used to distribute emissions into each county.

TRENDS

History

Emissions through the years were estimated by using historical data on household population.

Growth

ABAG's 2009 Projections Household Population profile was utilized to project future emissions to year 2030.

By: Michael Nguyen
Date: February, 2011
Base Year 2008

EIC: 49999500100000

EMISSION INVENTORY

CATEGORIES # 764 - 765

WIND BLOWN DUST

EMISSIONS

Introduction

Included in these categories are fugitive dust emissions resulting from wind erosion across agricultural fields (Category #764), and from wind erosion of soil on unpaved roads (Category #765).

Methodologies

Total acreage for field crops, vegetable crops, fruit and nut crops, nursery crops, plants, flowers and miscellaneous crops were obtained for each county as reported in the "Agricultural Crops". The estimated crop acres were used as throughput for the calculation of wind erosion from agricultural fields (Category# 764).

The number of miles of unpaved road for each county were estimated from the "California Abstracts", and converted into acreage. It was assumed a typical width of a road was 25 feet. The acreage of unpaved road was used as throughput for the calculation of windblown dust from unpaved roads (Category# 765). Particulate emission factor from dust emissions were developed based on the U.S. Department of Agriculture's equation:

Emission Factor = E x I x C x K x L x V in tons/acre/yr.

Where E = portion of total wind erosion loses as suspended particulates
I = soil erodibility, t/acre/yr.
C = climatic factor
K = surface roughness factor
L = unsheltered field width factor
V = vegetative cover factor
(K, L, V depends on the crop type)

Typical Values of above constants:		
	Agricultural Land	Unpaved Roads
E	0.025	.038
I	38 - 220	86, 47, 56
C	0.15	0.15
K	0.8,0.6, 0.1, 0.6	1.0
L	0.74, 0.83, 0.77, 0.56	.29 - .34
V	0.05, 0.91, 0.26, 0.26	1.0

Particulate emissions from agricultural windblown dust were calculated by multiplying the crop acres by the emission factors developed by the U.S. Department of Agriculture, as above.

Particulates emissions from windblown dust from unpaved roads were calculated by multiplying the unpaved acreage by the emission factors as developed above.

Monthly Variation

Emission distribution through the months was estimated to be equal throughout the year.

County Distribution

The report on Agricultural Crops for each county showed total acreage for each and are used in distributing emissions throughout the counties.

TRENDS

History

Emissions throughout the years were estimated based on the report of acreage of each county.

Growth

Projections to year 2030 were estimated to be the same, with the assumption there would be no major changes in the acreage on agricultural lands and unpaved roads.

By: Michael Nguyen
Date: February, 2011
Base Year 2008

EIC: 65065054000000(Cat#764,#765)

EMISSION INVENTORY

CATEGORY # 766

CIGARETTE/TOBACCO SMOKING

EMISSIONS

Introduction

Emissions from tobacco smoking, particularly from cigarettes, cigars, and pipes, are presented in this category. Mainstream smoke (MS), which is generated during puffs, is generally inhaled by the smoker and a small fraction is exhaled. Sidestream smoke (SS), or the smoke issued from the product between puffs, is viewed as the most important emissions. Burning cigarettes may include total particulate matter, nicotine, phenol, CO_2, CO, NO_X, NH_3, hydrogen cyanide, and formaldehyde.

Methodology

Cigarette consumption was based on a report from Atmospheric Environment Journal, Vol. 21, No. 2,"Measuring Environmental Emissions from Tobacco Combustion: Sidestream Cigarette Smoke Literature Review", by M.R. Guerin, Higgens, & Senkins. The reported stated that about 48% of the smokers smoked less than a pack of cigarettes, 32% smoked one pack, 15% smoked two packs, and 5% smoked 2.5 packs or more per day.

A recent finding showed that although there has been a decrease of adult smokers, there was also an increase in younger smokers, and therefore, it is still estimated 15% of the population (or 1,088,943 cigarette smokers) are still smoking regularly in the Bay Area.

The cigarette consumption is estimated as followed: 1,088,943 x (48% x 0.5 + 32% x 1 + 15% x 2 + 5% x 2.5) x 20 = 21,452,177 cigarettes/day

Emission factors were derived based on the Table 1 of the report.

Emission Factors (lbs/cigarettes)			
PM	TOG	N_2O	CO
83.8	6.2	3.9	72.9

Monthly Variation

Monthly distribution was estimated to be the same throughout the year.

County Distribution

County population was used to distribute emissions for each county.

TRENDS

History

The historical growth profile was based on the 2009 Association of Bay Area Government's Population data.

Growth

The current trends show cigarette/tobacco consumption for regular smokers decreasing slightly over the next several years.

By: Michael Nguyen
Date: February, 2011
Base Year 2008

EIC: 69999500000000(Cat#766)

EMISSION INVENTORY

CATEGORIES #1190 - 1193

PESTICIDES

EMISSIONS

Introduction

Categories 1190 – 1193 account for emissions from all pesticide usage for agricultural, commercial, and institutional purposes. Agricultural use includes pesticide applications to crops, rangelands, pastures, cemeteries, parks, golf courses, and along roadsides and railroad right-of-ways. Additionally, all post-harvest pesticide treatment of agricultural goods, along with pesticide use in poultry, fish production, and some livestock applications all fall under the agricultural definition. Non-agricultural use includes structural operators, professional gardeners, and (non-agricultural) pest control operators. These categories do not include pesticides sold from retail stores in small quantities for home consumers. Consumer pesticides are covered in consumer product categories 1494-1509.

Prior to 1996, the agricultural and non-agricultural pesticide divisions each consisted of application and residual categories for both synthetic and non-synthetic pesticides. The District had eleven categories associated with non-consumer product pesticides. Creosote application was considered a separate category. In 1996, the two divisions (agriculture and non-agriculture) were broken down into methyl bromide and other categories. The creosote application category is now incorporated in both the agricultural and non-agricultural pesticide's "Other" categories.

Methodologies

The following table lists the Pesticides Categories and their 2008 total organic emissions in tons/day.

Cat #	***Category Description***	***Tons/day***
	Agricultural Pesticides	
1190	Methyl Bromide	0.06
1191	Other	0.82
	Non-Agricultural Pesticides	
1192	Methyl Bromide	0.00
1193	Other	0.24

The California Department of Pesticide Regulation (DPR) provided the pesticide use data to the California Air Resources Board (ARB). For Categories 1190 and 1191, the 2005 emissions data was estimated using adjusted emissions. Both ARB and DPR agreed the use of a 5-year average of historical data as an adjusted value would account for weather and pest infestation variability in agricultural pesticide emissions.

Monthly Variation

Monthly activity variation data is based on pesticide usage in the Bay Area.

County Distribution

The county distribution is also based on pesticide usage for each county in the District.

TRENDS

Historical

The historical growth profile for the agricultural pesticides categories (Cats. 1190 and 1191) was based on a combination of prior adjusted emissions data (1990 - 2008) and a growth profile (from DRI94/DPR) provided by ARB.

Structural pesticide, Methyl Bromide (Cat. 1192) was phased out in 2001.

Growth

The annual growth profile for categories 1190 and 1191 is based on irrigated agricultural acreage data supplied by ARB. For the Bay Area's nine counties, this represents a -0.01% decrease/year. Emission projections for category 1193 are based on household population growth in the Bay Area. Household population data used for emission growth profile was obtained from the Association of Bay Area Government's (ABAG's) 2009 "Projections" reports.

Control

The District does not currently have any regulations governing these categories; however the State of California Department of Pesticide Regulation has adopted regulations controlling various agricultural and structural pesticides. Additionally, the Federal EPA has phased out methyl bromide because of its ozone depleting potential.

By: Stuart Schultz/Sukarn Claire
Date: January 2011
Base Year: 2008

EIC Codes: 53053032250000 (Cat. 1190),
53053057020000 (Cat. 1191),
53054032250000 (Cat. 1192),
53054032250000 (Cat. 1193)

EMISSION INVENTORY

CATEGORIES # 1440 - 1574

CONSUMER PRODUCTS

EMISSIONS

Introduction

This category group contains emissions from consumer products such as hair spray, shaving cream, deodorant, charcoal lighter fluid, etc.

Methodologies

Emissions are estimated from sales of consumer products on regional basis. The figures were developed by the California Air Resources Board based on consumer product surveys and re-tabulated for each region. Table below shows consumer product emissions for the San Francisco Bay Area.

Consumer Products - Annual Average Emissions
Year 2008 (Tons/Day)

Product Group	TOG
Adhesives	1.51
Pesticides / Herbicides / Sterilants	4.83
Aerosol Coatings	4.98
Automotive Products	12.88
Household / Personal Products	28.78
Total	52.98

County Distribution

County distribution is based on population of each county. Solano and Sonoma Counties are partially in the District, so population data were used for the cities that are within the District boundaries.

Monthly Variation

For most consumer product categories monthly variation is assumed to be constant. Charcoal lighter material usage is assumed to be higher during summer months.

TRENDS

History

Consumer product emission trends have followed population growth.

Growth

The consumer product emissions are projected to grow relative to population growth in the Bay Area. Future projections are made using population data in accordance with the Association of Bay Area Government's (ABAG's) 2009 report.

Control

All controls are in accordance with the California Air Resources Board (CARB).

By: Sukarn Claire
Date: January 2011
Base Year: 2008

EIC: 51050090000000, 51050090000000, 51050090000000, 51050090000000 etc.

EMISSION INVENTORY

CATEGORIES #784, 785, 786, 787

MISCELLANEOUS EMISSION SOURCES - BIOGENIC

- **ISOPRENE (Cat# 784)**
- **ALPHA PINENE (Cat# 785)**
- **MONOTERPENES (Cat# 786)**
- **OTHER UNIDENTIFIED ORGANICS (Cat# 787)**

EMISSIONS

Introduction

Living vegetation throughout the Bay Area produce the biogenic organic emissions covered by these four emission categories. (Such vegetation is considered to be part of the general group known as "area" sources). Chemical analysis of biogenic emissions by investigators has led to their being classified into four separate chemical groupings. This detail has been maintained in the four categories developed for this Base Year emission inventory, and covered by this methodology.

Methodologies

Emissions were obtained from a presentation at CARB's EITEAC Meeting on May 19, 2004. Biogenic emissions were estimated using the ARB's BEIGIS model. Model inputs include the California GAP Analysis Project, California Department of Water Resources crop reports, SCAG and SANDAG (councils of government) urban land use, and satellite-derived leaf area index (LAI) data. The BEIGIS model is driven by temperature and solar radiation, BVOC emission factors and specific leaf weight factors.

Estimated average annual organic emissions, in tons per day, are:

- Category #784 (Isoprene): 57.04
- Category #785 (Alpha Pinene): 18.48
- Category #786 (Monoterpene): 19.99
- Category #787 (Other Unidentified Organics): 14.75

Monthly variation

The monthly profile was estimated using monthly average ambient temperatures for the Bay Area. This information was obtained from the Climatological Summary Report from the National Climatic Document Center in North Carolina.

County Distribution

Data for each county consisted of four estimated emissions for the four organic compound classes represented by the categories covered by this methodology.

TRENDS

History

Prior to 2005, biogenic emissions were provided by Keith Baugues, EPA Source Receptor Analysis Branch of the Technical Support Division, Research Triangle Park, North Carolina.

Growth

For the years 2005 - 2030, for each category covered by this methodology, emissions were also maintained at the 2005 values.

By: Michael Nguyen
Date: February, 2011
Base Year 2008

EIC: 91091202500000(Cat#784)
91091202500000(Cat#785)
91091202500000(Cat#786)
91091202500000(Cat#787)