# Section 7

## Information Used To Determine Emissions

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**Information Used to Determine Emissions shall include the following**:

- ☐ If manufacturer data are used, include specifications for emissions units and control equipment, including control efficiencies specifications and sufficient engineering data for verification of control equipment operation, including design drawings, test reports, and design parameters that affect normal operation.
- ☐ If test data are used, include a copy of the complete test report. If the test data are for an emissions unit other than the one being permitted, the emission units must be identical. Test data may not be used if any difference in operating conditions of the unit being permitted and the unit represented in the test report significantly effect emission rates.
- **X** If the most current copy of AP-42 is used, reference the section and date located at the bottom of the page. Include a copy of the page containing the emissions factors, and clearly mark the factors used in the calculations.
- ☐ If an older version of AP-42 is used, include a complete copy of the section.
- ☐ If an EPA document or other material is referenced, include a complete copy.
- ☐ Fuel specifications sheet.
- ☐ If computer models are used to estimate emissions, include an input summary (if available) and a detailed report, and a disk containing the input file(s) used to run the model. For tank-flashing emissions, include a discussion of the method used to estimate tank-flashing emissions, relative thresholds (i.e., permit or major source (NSPS, PSD or Title V)), accuracy of the model, the input and output from simulation models and software, all calculations, documentation of any assumptions used, descriptions of sampling methods and conditions, copies of any lab sample analysis.

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|---|---|
| A-XXXX-7-AP42S1-4 | Hot Water Heater Combustion and HAPs Emission Factors |
| A-XXXX-7-AP42S11-12 | Concrete Plant Emission Factors |
| A-XXXX-7-AP42S11-19-2 | Transfer Point Emission Factors |
| A-XXXX-7-AP42S13-2-2 | Unpaved Road Emission Factors |
| A-XXXX-7-AP42S13-2-4 | Material Handling Emission Factors |
| A-XXXX-7-WindspeedsNewMexico | Ruidoso Wind Speed Annual Average 1996 to 2006 |
| A-XXXX-7-AltoCBP.xls | Alto CBP Emissions Spreadsheet |
| A-XXXX-7-Baghouse.xls | Baghouse Fabric Filter – Pulse-Jet Control Efficiency |

# 1.4 Natural Gas Combustion

## 1.4.1 General[1-2]

Natural gas is one of the major combustion fuels used throughout the country. It is mainly used to generate industrial and utility electric power, produce industrial process steam and heat, and heat residential and commercial space. Natural gas consists of a high percentage of methane (generally above 85 percent) and varying amounts of ethane, propane, butane, and inerts (typically nitrogen, carbon dioxide, and helium). The average gross heating value of natural gas is approximately 1,020 British thermal units per standard cubic foot (Btu/scf), usually varying from 950 to 1,050 Btu/scf.

## 1.4.2 Firing Practices[3-5]

There are three major types of boilers used for natural gas combustion in commercial, industrial, and utility applications: watertube, firetube, and cast iron. Watertube boilers are designed to pass water through the inside of heat transfer tubes while the outside of the tubes is heated by direct contact with the hot combustion gases and through radiant heat transfer. The watertube design is the most common in utility and large industrial boilers. Watertube boilers are used for a variety of applications, ranging from providing large amounts of process steam, to providing hot water or steam for space heating, to generating high-temperature, high-pressure steam for producing electricity. Furthermore, watertube boilers can be distinguished either as field erected units or packaged units.

Field erected boilers are boilers that are constructed on site and comprise the larger sized watertube boilers. Generally, boilers with heat input levels greater than 100 MMBtu/hr, are field erected. Field erected units usually have multiple burners and, given the customized nature of their construction, also have greater operational flexibility and $NO_x$ control options. Field erected units can also be further categorized as wall-fired or tangential-fired. Wall-fired units are characterized by multiple individual burners located on a single wall or on opposing walls of the furnace while tangential units have several rows of air and fuel nozzles located in each of the four corners of the boiler.

Package units are constructed off-site and shipped to the location where they are needed. While the heat input levels of packaged units may range up to 250 MMBtu/hr, the physical size of these units are constrained by shipping considerations and generally have heat input levels less than 100 MMBtu/hr. Packaged units are always wall-fired units with one or more individual burners. Given the size limitations imposed on packaged boilers, they have limited operational flexibility and cannot feasibly incorporate some $NO_x$ control options.

Firetube boilers are designed such that the hot combustion gases flow through tubes, which heat the water circulating outside of the tubes. These boilers are used primarily for space heating systems, industrial process steam, and portable power boilers. Firetube boilers are almost exclusively packaged units. The two major types of firetube units are Scotch Marine boilers and the older firebox boilers. In cast iron boilers, as in firetube boilers, the hot gases are contained inside the tubes and the water being heated circulates outside the tubes. However, the units are constructed of cast iron rather than steel. Virtually all cast iron boilers are constructed as package boilers. These boilers are used to produce either low-pressure steam or hot water, and are most commonly used in small commercial applications.

Natural gas is also combusted in residential boilers and furnaces. Residential boilers and furnaces generally resemble firetube boilers with flue gas traveling through several channels or tubes with water or air circulated outside the channels or tubes.

## 1.4.3 Emissions[3-4]

The emissions from natural gas-fired boilers and furnaces include nitrogen oxides ($NO_x$), carbon monoxide (CO), and carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$), volatile organic compounds (VOCs), trace amounts of sulfur dioxide ($SO_2$), and particulate matter (PM).

Nitrogen Oxides -

Nitrogen oxides formation occurs by three fundamentally different mechanisms. The principal mechanism of $NO_x$ formation in natural gas combustion is thermal $NO_x$. The thermal $NO_x$ mechanism occurs through the thermal dissociation and subsequent reaction of nitrogen ($N_2$) and oxygen ($O_2$) molecules in the combustion air. Most $NO_x$ formed through the thermal $NO_x$ mechanism occurs in the high temperature flame zone near the burners. The formation of thermal $NO_x$ is affected by three furnace-zone factors: (1) oxygen concentration, (2) peak temperature, and (3) time of exposure at peak temperature. As these three factors increase, $NO_x$ emission levels increase. The emission trends due to changes in these factors are fairly consistent for all types of natural gas-fired boilers and furnaces. Emission levels vary considerably with the type and size of combustor and with operating conditions (e.g., combustion air temperature, volumetric heat release rate, load, and excess oxygen level).

The second mechanism of $NO_x$ formation, called prompt $NO_x$, occurs through early reactions of nitrogen molecules in the combustion air and hydrocarbon radicals from the fuel. Prompt $NO_x$ reactions occur within the flame and are usually negligible when compared to the amount of $NO_x$ formed through the thermal $NO_x$ mechanism. However, prompt $NO_x$ levels may become significant with ultra-low-$NO_x$ burners.

The third mechanism of $NO_x$ formation, called fuel $NO_x$, stems from the evolution and reaction of fuel-bound nitrogen compounds with oxygen. Due to the characteristically low fuel nitrogen content of natural gas, $NO_x$ formation through the fuel $NO_x$ mechanism is insignificant.

Carbon Monoxide -

The rate of CO emissions from boilers depends on the efficiency of natural gas combustion. Improperly tuned boilers and boilers operating at off-design levels decrease combustion efficiency resulting in increased CO emissions. In some cases, the addition of $NO_x$ control systems such as low $NO_x$ burners and flue gas recirculation (FGR) may also reduce combustion efficiency, resulting in higher CO emissions relative to uncontrolled boilers.

Volatile Organic Compounds -

The rate of VOC emissions from boilers and furnaces also depends on combustion efficiency. VOC emissions are minimized by combustion practices that promote high combustion temperatures, long residence times at those temperatures, and turbulent mixing of fuel and combustion air. Trace amounts of VOC species in the natural gas fuel (e.g., formaldehyde and benzene) may also contribute to VOC emissions if they are not completely combusted in the boiler.

Sulfur Oxides -

Emissions of $SO_2$ from natural gas-fired boilers are low because pipeline quality natural gas typically has sulfur levels of 2,000 grains per million cubic feet. However, sulfur-containing odorants are added to natural gas for detecting leaks, leading to small amounts of $SO_2$ emissions. Boilers combusting unprocessed natural gas may have higher $SO_2$ emissions due to higher levels of sulfur in the natural gas. For these units, a sulfur mass balance should be used to determine $SO_2$ emissions.

Particulate Matter -

Because natural gas is a gaseous fuel, filterable PM emissions are typically low. Particulate matter from natural gas combustion has been estimated to be less than 1 micrometer in size and has filterable and condensable fractions. Particulate matter in natural gas combustion are usually larger molecular weight hydrocarbons that are not fully combusted. Increased PM emissions may result from poor air/fuel mixing or maintenance problems.

Greenhouse Gases -[6-9]

$CO_2$, $CH_4$, and $N_2O$ emissions are all produced during natural gas combustion. In properly tuned boilers, nearly all of the fuel carbon (99.9 percent) in natural gas is converted to $CO_2$ during the combustion process. This conversion is relatively independent of boiler or combustor type. Fuel carbon not converted to $CO_2$ results in $CH_4$, CO, and/or VOC emissions and is due to incomplete combustion. Even in boilers operating with poor combustion efficiency, the amount of $CH_4$, CO, and VOC produced is insignificant compared to $CO_2$ levels.

Formation of $N_2O$ during the combustion process is affected by two furnace-zone factors. $N_2O$ emissions are minimized when combustion temperatures are kept high (above 1475°F) and excess oxygen is kept to a minimum (less than 1 percent).

Methane emissions are highest during low-temperature combustion or incomplete combustion, such as the start-up or shut-down cycle for boilers. Typically, conditions that favor formation of $N_2O$ also favor emissions of methane.

## 1.4.4 Controls[4,10]

$NO_x$ Controls -

Currently, the two most prevalent combustion control techniques used to reduce $NO_x$ emissions from natural gas-fired boilers are flue gas recirculation (FGR) and low $NO_x$ burners. In an FGR system, a portion of the flue gas is recycled from the stack to the burner windbox. Upon entering the windbox, the recirculated gas is mixed with combustion air prior to being fed to the burner. The recycled flue gas consists of combustion products which act as inerts during combustion of the fuel/air mixture. The FGR system reduces $NO_x$ emissions by two mechanisms. Primarily, the recirculated gas acts as a dilutent to reduce combustion temperatures, thus suppressing the thermal $NO_x$ mechanism. To a lesser extent, FGR also reduces $NO_x$ formation by lowering the oxygen concentration in the primary flame zone. The amount of recirculated flue gas is a key operating parameter influencing $NO_x$ emission rates for these systems. An FGR system is normally used in combination with specially designed low $NO_x$ burners capable of sustaining a stable flame with the increased inert gas flow resulting from the use of FGR. When low $NO_x$ burners and FGR are used in combination, these techniques are capable of reducing $NO_x$ emissions by 60 to 90 percent.

Low $NO_x$ burners reduce $NO_x$ by accomplishing the combustion process in stages. Staging partially delays the combustion process, resulting in a cooler flame which suppresses thermal $NO_x$ formation. The two most common types of low $NO_x$ burners being applied to natural gas-fired boilers are staged air burners and staged fuel burners. $NO_x$ emission reductions of 40 to 85 percent (relative to uncontrolled emission levels) have been observed with low $NO_x$ burners.

Other combustion control techniques used to reduce $NO_x$ emissions include staged combustion and gas reburning. In staged combustion (e.g., burners-out-of-service and overfire air), the degree of staging is a key operating parameter influencing $NO_x$ emission rates. Gas reburning is similar to the use of overfire in the use of combustion staging. However, gas reburning injects additional amounts of natural gas in the upper furnace, just before the overfire air ports, to provide increased reduction of $NO_x$ to $NO_2$.

Two postcombustion technologies that may be applied to natural gas-fired boilers to reduce $NO_x$ emissions are selective noncatalytic reduction (SNCR) and selective catalytic reduction (SCR). The SNCR system injects ammonia ($NH_3$) or urea into combustion flue gases (in a specific temperature zone) to reduce $NO_x$ emission. The Alternative Control Techniques (ACT) document for $NO_x$ emissions from utility boilers, maximum SNCR performance was estimated to range from 25 to 40 percent for natural gas-fired boilers.[12] Performance data available from several natural gas fired utility boilers with SNCR show a 24 percent reduction in $NO_x$ for applications on wall-fired boilers and a 13 percent reduction in $NO_x$ for applications on tangential-fired boilers.[11] In many situations, a boiler may have an SNCR system installed to trim $NO_x$ emissions to meet permitted levels. In these cases, the SNCR system may not be operated to achieve maximum $NO_x$ reduction. The SCR system involves injecting $NH_3$ into the flue gas in the presence of a catalyst to reduce $NO_x$ emissions. No data were available on SCR performance on natural gas fired boilers at the time of this publication. However, the ACT Document for utility boilers estimates $NO_x$ reduction efficiencies for SCR control ranging from 80 to 90 percent.[12]

Emission factors for natural gas combustion in boilers and furnaces are presented in Tables 1.4-1, 1.4-2, 1.4-3, and 1.4-4.[11] Tables in this section present emission factors on a volume basis (lb/$10^6$ scf). To convert to an energy basis (lb/MMBtu), divide by a heating value of 1,020 MMBtu/$10^6$ scf. For the purposes of developing emission factors, natural gas combustors have been organized into three general categories: large wall-fired boilers with greater than 100 MMBtu/hr of heat input, boilers and residential furnaces with less than 100 MMBtu/hr of heat input, and tangential-fired boilers. Boilers within these categories share the same general design and operating characteristics and hence have similar emission characteristics when combusting natural gas.

Emission factors are rated from A to E to provide the user with an indication of how “good” the factor is, with “A” being excellent and “E” being poor. The criteria that are used to determine a rating for an emission factor can be found in the Emission Factor Documentation for AP-42 Section 1.4 and in the introduction to the AP-42 document.

## 1.4.5 Updates Since the Fifth Edition

The Fifth Edition was released in January 1995. Revisions to this section are summarized below. For further detail, consult the Emission Factor Documentation for this section. These and other documents can be found on the Emission Factor and Inventory Group (EFIG) home page (http://www.epa.gov/ttn/chief).

Supplement D, March 1998

- Text was revised concerning Firing Practices, Emissions, and Controls.

- All emission factors were updated based on 482 data points taken from 151 source tests. Many new emission factors have been added for speciated organic compounds, including hazardous air pollutants.

July 1998 - minor changes

- Footnote D was added to table 1.4-3 to explain why the sum of individual HAP may exceed VOC or TOC, the web address was updated, and the references were reordered.

Table 1.4-1. EMISSION FACTORS FOR NITROGEN OXIDES ($NO_x$) AND CARBON MONOXIDE (CO) FROM NATURAL GAS COMBUSTION[a]

| Combustor Type (MMBtu/hr Heat Input) [SCC] | $NO_x$[b] | | CO | |
|---|---|---|---|---|
| | Emission Factor ($lb/10^6$ scf) | Emission Factor Rating | Emission Factor ($lb/10^6$ scf) | Emission Factor Rating |
| Large Wall-Fired Boilers (>100) [1-01-006-01, 1-02-006-01, 1-03-006-01] | | | | |
| Uncontrolled (Pre-NSPS)[c] | 280 | A | 84 | B |
| Uncontrolled (Post-NSPS)[c] | 190 | A | 84 | B |
| Controlled - Low $NO_x$ burners | 140 | A | 84 | B |
| Controlled - Flue gas recirculation | 100 | D | 84 | B |
| Small Boilers (<100) [1-01-006-02, 1-02-006-02, 1-03-006-02, 1-03-006-03] | | | | |
| Uncontrolled | 100 | B | 84 | B |
| Controlled - Low $NO_x$ burners | 50 | D | 84 | B |
| Controlled - Low $NO_x$ burners/Flue gas recirculation | 32 | C | 84 | B |
| Tangential-Fired Boilers (All Sizes) [1-01-006-04] | | | | |
| Uncontrolled | 170 | A | 24 | C |
| Controlled - Flue gas recirculation | 76 | D | 98 | D |
| Residential Furnaces (<0.3) [No SCC] | | | | |
| Uncontrolled | 94 | B | 40 | B |

[a] Reference 11. Units are in pounds of pollutant per million standard cubic feet of natural gas fired. To convert from $lb/10^6$ scf to $kg/10^6$ $m^3$, multiply by 16. Emission factors are based on an average natural gas higher heating value of 1,020 Btu/scf. To convert from $1b/10^6$ scf to lb/MMBtu, divide by 1,020. The emission factors in this table may be converted to other natural gas heating values by multiplying the given emission factor by the ratio of the specified heating value to this average heating value. SCC = Source Classification Code. ND = no data. NA = not applicable.

[b] Expressed as $NO_2$. For large and small wall fired boilers with SNCR control, apply a 24 percent reduction to the appropriate $NO_X$ emission factor. For tangential-fired boilers with SNCR control, apply a 13 percent reduction to the appropriate $NO_X$ emission factor.

[c] NSPS=New Source Performance Standard as defined in 40 CFR 60 Subparts D and Db. Post-NSPS units are boilers with greater than 250 MMBtu/hr of heat input that commenced construction modification, or reconstruction after August 17, 1971, and units with heat input capacities between 100 and 250 MMBtu/hr that commenced construction modification, or reconstruction after June 19, 1984.

TABLE 1.4-2. EMISSION FACTORS FOR CRITERIA POLLUTANTS AND GREENHOUSE GASES FROM NATURAL GAS COMBUSTION[a]

| Pollutant | Emission Factor ($lb/10^6$ scf) | Emission Factor Rating |
|---|---|---|
| $CO_2$[b] | 120,000 | A |
| Lead | 0.0005 | D |
| $N_2O$ (Uncontrolled) | 2.2 | E |
| $N_2O$ (Controlled-low-$NO_X$ burner) | 0.64 | E |
| PM (Total)[c] | 7.6 | D |
| PM (Condensable)[c] | 5.7 | D |
| PM (Filterable)[c] | 1.9 | B |
| $SO_2$[d] | 0.6 | A |
| TOC | 11 | B |
| Methane | 2.3 | B |
| VOC | 5.5 | C |

[a] Reference 11. Units are in pounds of pollutant per million standard cubic feet of natural gas fired. Data are for all natural gas combustion sources. To convert from $lb/10^6$ scf to $kg/10^6\ m^3$, multiply by 16. To convert from $lb/10^6$ scf to 1b/MMBtu, divide by 1,020. The emission factors in this table may be converted to other natural gas heating values by multiplying the given emission factor by the ratio of the specified heating value to this average heating value. TOC = Total Organic Compounds. VOC = Volatile Organic Compounds.

[b] Based on approximately 100% conversion of fuel carbon to $CO_2$. $CO_2[lb/10^6\ scf] = (3.67)\ (CON)\ (C)(D)$, where CON = fractional conversion of fuel carbon to $CO_2$, C = carbon content of fuel by weight (0.76), and D = density of fuel, $4.2x10^4\ lb/10^6$ scf.

[c] All PM (total, condensible, and filterable) is assumed to be less than 1.0 micrometer in diameter. Therefore, the PM emission factors presented here may be used to estimate $PM_{10}$, $PM_{2.5}$ or $PM_1$ emissions. Total PM is the sum of the filterable PM and condensible PM. Condensible PM is the particulate matter collected using EPA Method 202 (or equivalent). Filterable PM is the particulate matter collected on, or prior to, the filter of an EPA Method 5 (or equivalent) sampling train.

[d] Based on 100% conversion of fuel sulfur to $SO_2$.
Assumes sulfur content is natural gas of 2,000 $grains/10^6$ scf. The $SO_2$ emission factor in this table can be converted to other natural gas sulfur contents by multiplying the $SO_2$ emission factor by the ratio of the site-specific sulfur content ($grains/10^6$ scf) to 2,000 $grains/10^6$ scf.

TABLE 1.4-3. EMISSION FACTORS FOR SPECIATED ORGANIC COMPOUNDS FROM NATURAL GAS COMBUSTION[a]

| CAS No. | Pollutant | Emission Factor ($lb/10^6$ scf) | Emission Factor Rating |
|---|---|---|---|
| 91-57-6 | 2-Methylnaphthalene[b, c] | 2.4E-05 | D |
| 56-49-5 | 3-Methylchloranthrene[b, c] | <1.8E-06 | E |
| | 7,12-Dimethylbenz(a)anthracene[b,c] | <1.6E-05 | E |
| 83-32-9 | Acenaphthene[b,c] | <1.8E-06 | E |
| 203-96-8 | Acenaphthylene[b,c] | <1.8E-06 | E |
| 120-12-7 | Anthracene[b,c] | <2.4E-06 | E |
| 56-55-3 | Benz(a)anthracene[b,c] | <1.8E-06 | E |
| 71-43-2 | Benzene[b] | 2.1E-03 | B |
| 50-32-8 | Benzo(a)pyrene[b,c] | <1.2E-06 | E |
| 205-99-2 | Benzo(b)fluoranthene[b,c] | <1.8E-06 | E |
| 191-24-2 | Benzo(g,h,i)perylene[b,c] | <1.2E-06 | E |
| 205-82-3 | Benzo(k)fluoranthene[b,c] | <1.8E-06 | E |
| 106-97-8 | Butane | 2.1E+00 | E |
| 218-01-9 | Chrysene[b,c] | <1.8E-06 | E |
| 53-70-3 | Dibenzo(a,h)anthracene[b,c] | <1.2E-06 | E |
| 25321-22-6 | Dichlorobenzene[b] | 1.2E-03 | E |
| 74-84-0 | Ethane | 3.1E+00 | E |
| 206-44-0 | Fluoranthene[b,c] | 3.0E-06 | E |
| 86-73-7 | Fluorene[b,c] | 2.8E-06 | E |
| 50-00-0 | Formaldehyde[b] | 7.5E-02 | B |
| 110-54-3 | Hexane[b] | 1.8E+00 | E |
| 193-39-5 | Indeno(1,2,3-cd)pyrene[b,c] | <1.8E-06 | E |
| 91-20-3 | Naphthalene[b] | 6.1E-04 | E |
| 109-66-0 | Pentane | 2.6E+00 | E |
| 85-01-8 | Phenanathrene[b,c] | 1.7E-05 | D |

TABLE 1.4-3. EMISSION FACTORS FOR SPECIATED ORGANIC COMPOUNDS FROM NATURAL GAS COMBUSTION (Continued)

| CAS No. | Pollutant | Emission Factor ($lb/10^6$ scf) | Emission Factor Rating |
|---|---|---|---|
| 74-98-6 | Propane | 1.6E+00 | E |
| 129-00-0 | Pyrene[b, c] | 5.0E-06 | E |
| 108-88-3 | Toluene[b] | 3.4E-03 | C |

[a] Reference 11. Units are in pounds of pollutant per million standard cubic feet of natural gas fired. Data are for all natural gas combustion sources. To convert from $lb/10^6$ scf to $kg/10^6$ $m^3$, multiply by 16. To convert from $1b/10^6$ scf to lb/MMBtu, divide by 1,020. Emission Factors preceeded with a less-than symbol are based on method detection limits.

[b] Hazardous Air Pollutant (HAP) as defined by Section 112(b) of the Clean Air Act.

[c] HAP because it is Polycyclic Organic Matter (POM). POM is a HAP as defined by Section 112(b) of the Clean Air Act.

[d] The sum of individual organic compounds may exceed the VOC and TOC emission factors due to differences in test methods and the availability of test data for each pollutant.

TABLE 1.4-4. EMISSION FACTORS FOR METALS FROM NATURAL GAS COMBUSTION[a]

| CAS No. | Pollutant | Emission Factor ($lb/10^6$ scf) | Emission Factor Rating |
|---|---|---|---|
| 7440-38-2 | Arsenic[b] | 2.0E-04 | E |
| 7440-39-3 | Barium | 4.4E-03 | D |
| 7440-41-7 | Beryllium[b] | <1.2E-05 | E |
| 7440-43-9 | Cadmium[b] | 1.1E-03 | D |
| 7440-47-3 | Chromium[b] | 1.4E-03 | D |
| 7440-48-4 | Cobalt[b] | 8.4E-05 | D |
| 7440-50-8 | Copper | 8.5E-04 | C |
| 7439-96-5 | Manganese[b] | 3.8E-04 | D |
| 7439-97-6 | Mercury[b] | 2.6E-04 | D |
| 7439-98-7 | Molybdenum | 1.1E-03 | D |
| 7440-02-0 | Nickel[b] | 2.1E-03 | C |
| 7782-49-2 | Selenium[b] | <2.4E-05 | E |
| 7440-62-2 | Vanadium | 2.3E-03 | D |
| 7440-66-6 | Zinc | 2.9E-02 | E |

[a] Reference 11. Units are in pounds of pollutant per million standard cubic feet of natural gas fired. Data are for all natural gas combustion sources. Emission factors preceeded by a less-than symbol are based on method detection limits. To convert from $lb/10^6$ scf to $kg/10^6$ $m^3$, multiply by l6. To convert from $lb/10^6$ scf to 1b/MMBtu, divide by 1,020.

[b] Hazardous Air Pollutant as defined by Section 112(b) of the Clean Air Act.

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# 11.12 Concrete Batching

## 11.12.1 Process Description [1-5]

Concrete is composed essentially of water, cement, sand (fine aggregate) and coarse aggregate. Coarse aggregate may consist of gravel, crushed stone or iron blast furnace slag. Some specialty aggregate products could be either heavyweight aggregate (of barite, magnetite, limonite, ilmenite, iron or steel) or lightweight aggregate (with sintered clay, shale, slate, diatomaceous shale, perlite, vermiculite, slag pumice, cinders, or sintered fly ash). Supplementary cementitious materials, also called mineral admixtures or pozzolan minerals may be added to make the concrete mixtures more economical, reduce permeability, increase strength, or influence other concrete properties. Typical examples are natural pozzolans, fly ash, ground granulated blast-furnace slag, and silica fume, which can be used individually with portland or blended cement or in different combinations. Chemical admixtures are usually liquid ingredients that are added to concrete to entrain air, reduce the water required to reach a required slump, retard or accelerate the setting rate, to make the concrete more flowable or other more specialized functions.

Approximately 75 percent of the U.S. concrete manufactured is produced at plants that store, convey, measure and discharge these constituents into trucks for transport to a job site. At most of these plants, sand, aggregate, cement and water are all gravity fed from the weight hopper into the mixer trucks. The concrete is mixed on the way to the site where the concrete is to be poured. At some of these plants, the concrete may also be manufactured in a central mix drum and transferred to a transport truck. Most of the remaining concrete manufactured are products cast in a factory setting. Precast products range from concrete bricks and paving stones to bridge girders, structural components, and panels for cladding. Concrete masonry, another type of manufactured concrete, may be best known for its conventional 8 x 8 x 16-inch block. In a few cases concrete is dry batched or prepared at a building construction site. Figure 11.12-1 is a generalized process diagram for concrete batching.

The raw materials can be delivered to a plant by rail, truck or barge. The cement is transferred to elevated storage silos pneumatically or by bucket elevator. The sand and coarse aggregate are transferred to elevated bins by front end loader, clam shell crane, belt conveyor, or bucket elevator. From these elevated bins, the constituents are fed by gravity or screw conveyor to weigh hoppers, which combine the proper amounts of each material.

## 11.12.2 Emissions and Controls [6-8]

Particulate matter, consisting primarily of cement and pozzolan dust but including some aggregate and sand dust emissions, is the primary pollutant of concern. In addition, there are emissions of metals that are associated with this particulate matter. All but one of the emission points are fugitive in nature. The only point sources are the transfer of cement and pozzolan material to silos, and these are usually vented to a fabric filter or “sock”. Fugitive sources include the transfer of sand and aggregate, truck loading, mixer loading, vehicle traffic, and wind erosion from sand and aggregate storage piles. The amount of fugitive emissions generated during the transfer of sand and aggregate depends primarily on the surface moisture content of these materials. The extent of fugitive emission control varies widely from plant to plant. Particulate emission factors for concrete batching are give in Tables 11.12-1 and 11.12-2.

TABLE 11.12-2 (ENGLISH UNITS)
EMISSION FACTORS FOR CONCRETE BATCHING [a]

| Source (SCC) | Uncontrolled | | | | Controlled | | | |
|---|---|---|---|---|---|---|---|---|
| | Total PM | Emission Factor Rating | Total $PM_{10}$ | Emission Factor Rating | Total PM | Emission Factor Rating | Total $PM_{10}$ | Emission Factor Rating |
| Aggregate transfer [b] (3-05-011-04,-21,23) | 0.0069 | D | 0.0033 | D | ND | | ND | |
| Sand transfer [b] (3-05-011-05,22,24) | 0.0021 | D | 0.00099 | D | ND | | ND | |
| Cement unloading to elevated storage silo (pneumatic)[c] (3-05-011-07) | 0.73 | E | 0.47 | E | 0.00099 | D | 0.00034 | D |
| Cement supplement unloading to elevated storage silo (pneumatic)[d] (3-05-011-17) | 3.14 | E | 1.10 | E | 0.0089 | D | 0.0049 | E |
| Weigh hopper loading [e] (3-05-011-08) | 0.0048 | D | 0.0028 | D | ND | | ND | |
| Mixer loading (central mix)[f] (3-05-011-09) | 0.572 or Eqn. 11.12-1 | B | 0.156 or Eqn. 11.12-1 | B | 0.0184 or Eqn. 11.12-1 | B | 0.0055 or Eqn. 11.12-1 | B |
| Truck loading (truck mix)[g] (3-05-011-10) | 1.118 | B | 0.310 | B | 0.098 or Eqn. 11.12-1 | B | 0.0263 or Eqn. 11.12-1 | B |
| Vehicle traffic (paved roads) | See AP-42 Section 13.2.1, Paved Roads | | | | | | | |
| Vehicle traffic (unpaved roads) | See AP-42 Section 13.2.2, Unpaved Roads | | | | | | | |
| Wind erosion from aggregate and sand storage piles | See AP-42 Section 13.2.5, Industrial Wind Erosion | | | | | | | |

ND = No data

[a] All emission factors are in lb of pollutant per ton of material loaded unless noted otherwise. Loaded material includes course aggregate, sand, cement, cement supplement and the surface moisture associated with these materials. The average material composition of concrete batches presented in references 9 and 10 was 1865 lbs course aggregate, 1428 lbs sand, 491 lbs cement and 73 lbs cement supplement. Approximately 20 gallons of water was added to this solid material to produce 4024 lbs (one cubic yard) of concrete.

[b] Reference 9 and 10. Emission factors are based upon an equation from AP-42, section 13.2.4 Aggregate Handling And Storage Piles, equation 1 with $k_{PM-10}$ =.35, $k_{PM}$ = .74, U = 10mph, $M_{aggregate}$ =1.77%, and $M_{sand}$ = 4.17%. These moisture contents of the materials ($M_{aggregate}$ and $M_{sand}$) are the averages of the values obtained from Reference 9 and Reference 10.

[c] The uncontrolled PM & PM-10 emission factors were developed from Reference 9. The controlled emission factor for PM was developed from References 9, 10, 11, and 12. The controlled emission factor for PM-10 was developed from References 9 and 10.

[d] The controlled PM emission factor was developed from Reference 10 and Reference 12, whereas the controlled PM-10 emission factor was developed from only Reference 10.

[e] Emission factors were developed by using the Aggregate and Sand Transfer Emission Factors in conjunction with the ratio of aggregate and sand used in an average $yard^3$ of concrete. The unit for these emission factors is lb of pollutant per ton of aggregate and sand.

[f] References 9, 10, and 14. The emission factor units are lb of pollutant per ton of cement and cement supplement. The general factor is the arithmetic mean of all test data.

[g] Reference 9, 10, and 14. The emission factor units are lb of pollutant per ton of cement and cement supplement. The general factor is the arithmetic mean of all test data.

The particulate matter emissions from truck mix and central mix loading operations are calculated in accordance with the values in Tables 11.12-1 or 11.12-2 or by Equation 11.12-1[14] when site specific data are available.

$$E = k\,(0.0032)\left[\frac{U^{a}}{M^{b}}\right] + c \qquad \text{Equation 11.12-1}$$

| | | |
|---|---|---|
| E | = | Emission factor in lbs./ton of cement and cement supplement |
| k | = | Particle size multiplier (dimensionless) |
| U | = | Wind speed at the material drop point, miles per hour (mph) |
| M | = | Minimum moisture (% by weight) of cement and cement supplement |
| a, b | = | Exponents |
| c | = | Constant |

The parameters for Equation 11.12-1 are summarized in Tables 11.12-3 and 11.12-4.

Table 11.12-3. Equation Parameters for Truck Mix Operations

| Condition | Parameter Category | k | a | b | c |
|---|---|---|---|---|---|
| Controlled[1] | Total PM | 0.8 | 1.75 | 0.3 | 0.013 |
| | $PM_{10}$ | 0.32 | 1.75 | 0.3 | 0.0052 |
| | $PM_{10-2.5}$ | 0.288 | 1.75 | 0.3 | 0.00468 |
| | $PM_{2.5}$ | 0.048 | 1.75 | 0.3 | 0.00078 |
| Uncontrolled[1] | Total PM | 0.995 | | | |
| | $PM_{10}$ | 0.278 | | | |
| | $PM_{10-2.5}$ | 0.228 | | | |
| | $PM_{2.5}$ | 0.050 | | | |

Table 11.12-4. Equation Parameters for Central Mix Operations

| Condition | Parameter Category | k | a | b | c |
|---|---|---|---|---|---|
| Controlled[1] | Total PM | 0.19 | 0.95 | 0.9 | 0.0010 |
| | $PM_{10}$ | 0.13 | 0.45 | 0.9 | 0.0010 |
| | $PM_{10-2.5}$ | 0.12 | 0.45 | 0.9 | 0.0009 |
| | $PM_{2.5}$ | 0.03 | 0.45 | 0.9 | 0.0002 |
| Uncontrolled[1] | Total PM | 5.90 | 0.6 | 1.3 | 0.120 |
| | $PM_{10}$ | 1.92 | 0.4 | 1.3 | 0.040 |
| | $PM_{10-2.5}$ | 1.71 | 0.4 | 1.3 | 0.036 |
| | $PM_{2.5}$ | 0.38 | 0.4 | 1.3 | 0 |

1. Emission factors expressed in lbs/tons of cement and cement supplement

To convert from units of lbs/ton to units of kilograms per mega gram, the emissions calculated by Equation 11.12-1 should be divided by 2.0.

Particulate emission factors per yard of concrete for an average batch formulation at a typical facility are given in Tables 11.12-5 and 11.12-6. For truck mix loading and central mix loading, the

## 11.19.2 Crushed Stone Processing and Pulverized Mineral Processing

11.19.2.1 Process Description [24, 25]

**Crushed Stone Processing**

Major rock types processed by the crushed stone industry include limestone, granite, dolomite, traprock, sandstone, quartz, and quartzite. Minor types include calcareous marl, marble, shell, and slate. Major mineral types processed by the pulverized minerals industry, a subset of the crushed stone processing industry, include calcium carbonate, talc, and barite. Industry classifications vary considerably and, in many cases, do not reflect actual geological definitions.

Rock and crushed stone products generally are loosened by drilling and blasting and then are loaded by power shovel or front-end loader into large haul trucks that transport the material to the processing operations. Techniques used for extraction vary with the nature and location of the deposit. Processing operations may include crushing, screening, size classification, material handling and storage operations. All of these processes can be significant sources of PM and PM-10 emissions if uncontrolled.

Quarried stone normally is delivered to the processing plant by truck and is dumped into a bin. A feeder is used as illustrated in Figure 11.19.2-1. The feeder or screens separate large boulders from finer rocks that do not require primary crushing, thus reducing the load to the primary crusher. Jaw, impactor, or gyratory crushers are usually used for initial reduction. The crusher product, normally 7.5 to 30 centimeters (3 to 12 inches) in diameter, and the grizzly throughs (undersize material) are discharged onto a belt conveyor and usually are conveyed to a surge pile for temporary storage or are sold as coarse aggregates.

The stone from the surge pile is conveyed to a vibrating inclined screen called the scalping screen. This unit separates oversized rock from the smaller stone. The undersized material from the scalping screen is considered to be a product stream and is transported to a storage pile and sold as base material. The stone that is too large to pass through the top deck of the scalping screen is processed in the secondary crusher. Cone crushers are commonly used for secondary crushing (although impact crushers are sometimes used), which typically reduces material to about 2.5 to 10 centimeters (1 to 4 inches). The material (throughs) from the second level of the screen bypasses the secondary crusher because it is sufficiently small for the last crushing step. The output from the secondary crusher and the throughs from the secondary screen are transported by conveyor to the tertiary circuit, which includes a sizing screen and a tertiary crusher.

Tertiary crushing is usually performed using cone crushers or other types of impactor crushers. Oversize material from the top deck of the sizing screen is fed to the tertiary crusher. The tertiary crusher output, which is typically about 0.50 to 2.5 centimeters (3/16th to 1 inch), is returned to the sizing screen. Various product streams with different size gradations are separated in the screening operation. The products are conveyed or trucked directly to finished product bins, to open area stock piles, or to other processing systems such as washing, air separators, and screens and classifiers (for the production of manufactured sand).

Some stone crushing plants produce manufactured sand. This is a small-sized rock product with a maximum size of 0.50 centimeters (3/16 th inch). Crushed stone from the tertiary sizing screen is sized in a vibrating inclined screen (fines screen) with relatively small mesh sizes.

## Table 11.19.2-2 (English Units). EMISSION FACTORS FOR CRUSHED STONE PROCESSING OPERATIONS (lb/Ton)[a]

| Source [b] | Total Particulate Matter [r,s] | EMISSION FACTOR RATING | Total PM-10 | EMISSION FACTOR RATING | Total PM-2.5 | EMISSION FACTOR RATING |
|---|---|---|---|---|---|---|
| Primary Crushing (SCC 3-05-020-01) | ND | | ND[n] | | ND[n] | |
| Primary Crushing (controlled) (SCC 3-05-020-01) | ND | | ND[n] | | ND[n] | |
| Secondary Crushing (SCC 3-05-020-02) | ND | | ND[n] | | ND[n] | |
| Secondary Crushing (controlled) (SCC 3-05-020-02) | ND | | ND[n] | | ND[n] | |
| Tertiary Crushing (SCC 3-050030-03) | 0.0054[d] | E | 0.0024[o] | C | ND[n] | |
| Tertiary Crushing (controlled) (SCC 3-05-020-03) | 0.0012[d] | E | 0.00054[p] | C | 0.00010[q] | E |
| Fines Crushing (SCC 3-05-020-05) | 0.0390[e] | E | 0.0150[e] | E | ND | |
| Fines Crushing (controlled) (SCC 3-05-020-05) | 0.0030[f] | E | 0.0012[f] | E | 0.000070[q] | E |
| Screening (SCC 3-05-020-02, 03) | 0.025[c] | E | 0.0087[l] | C | ND | |
| Screening (controlled) (SCC 3-05-020-02, 03) | 0.0022[d] | E | 0.00074[m] | C | 0.000050[q] | E |
| Fines Screening (SCC 3-05-020-21) | 0.30[g] | E | 0.072[g] | E | ND | |
| Fines Screening (controlled) (SCC 3-05-020-21) | 0.0036[g] | E | 0.0022[g] | E | ND | |
| Conveyor Transfer Point (SCC 3-05-020-06) | 0.0030[h] | E | 0.00110[h] | D | ND | |
| Conveyor Transfer Point (controlled) (SCC 3-05-020-06) | 0.00014[i] | E | $4.6 \times 10^{-5}$[i] | D | $1.3 \times 10^{-5}$[q] | E |
| Wet Drilling - Unfragmented Stone (SCC 3-05-020-10) | ND | | $8.0 \times 10^{-5}$[j] | E | ND | |
| Truck Unloading -Fragmented Stone (SCC 3-05-020-31) | ND | | $1.6 \times 10^{-5}$[j] | E | ND | |
| Truck Unloading - Conveyor, crushed stone (SCC 3-05-020-32) | ND | | 0.00010[k] | E | ND | |

a. Emission factors represent uncontrolled emissions unless noted. Emission factors in lb/Ton of material of throughput. SCC = Source Classification Code. ND = No data.

b. Controlled sources (with wet suppression) are those that are part of the processing plant that employs current wet suppression technology similar to the study group. The moisture content of the study group without wet suppression systems operating (uncontrolled) ranged from 0.21 to 1.3 percent, and the same facilities operating wet suppression systems (controlled) ranged from 0.55 to 2.88 percent. Due to carry over of the small amount of moisture required, it has been shown that each source, with the exception of crushers, does not need to employ direct water sprays. Although the moisture content was the only variable measured, other process features may have as much influence on emissions from a given source. Visual observations from each source under normal operating conditions are probably the best indicator of which emission factor is most appropriate. Plants that employ substandard control measures as indicated by visual observations should use the uncontrolled factor with an appropriate control efficiency that best reflects the effectiveness of the controls employed.

c. References 1, 3, 7, and 8

d. References 3, 7, and 8

e. Reference 4

f. References 4 and 15

g. Reference 4

h. References 5 and 6

i. References 5, 6, and 15

j. Reference 11

k. Reference 12

l. References 1, 3, 7, and 8

m. References 1, 3, 7, 8, and 15

n. No data available, but emission factors for PM-10 for tertiary crushers can be used as an upper limit for primary or secondary crushing

o. References 2, 3, 7, 8

p. References 2, 3, 7, 8, and 15

q. Reference 15

r. PM emission factors are presented based on PM-100 data in the Background Support Document for Section 11.19.2

s. Emission factors for PM-30 and PM-50 are available in Figures 11.19.2-3 through 11.19.2-6.

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## 13.2.2 Unpaved Roads

### 13.2.2.1 General

When a vehicle travels an unpaved road, the force of the wheels on the road surface causes pulverization of surface material. Particles are lifted and dropped from the rolling wheels, and the road surface is exposed to strong air currents in turbulent shear with the surface. The turbulent wake behind the vehicle continues to act on the road surface after the vehicle has passed.

The particulate emission factors presented in the previous draft version of this section of AP-42, dated October 2001, implicitly included the emissions from vehicles in the form of exhaust, brake wear, and tire wear as well as resuspended road surface material[25]. EPA included these sources in the emission factor equation for unpaved public roads (equation 1b in this section) since the field testing data used to develop the equation included both the direct emissions from vehicles and emissions from resuspension of road dust.

This version of the unpaved public road emission factor equation only estimates particulate emissions from resuspended road surface material [23, 26]. The particulate emissions from vehicle exhaust, brake wear, and tire wear are now estimated separately using EPA's MOBILE6.2 [24]. This approach eliminates the possibility of double counting emissions. Double counting results when employing the previous version of the emission factor equation in this section and MOBILE6.2 to estimate particulate emissions from vehicle traffic on unpaved public roads. It also incorporates the decrease in exhaust emissions that has occurred since the unpaved public road emission factor equation was developed. The previous version of the unpaved public road emission factor equation includes estimates of emissions from exhaust, brake wear, and tire wear based on emission rates for vehicles in the 1980 calendar year fleet. The amount of PM released from vehicle exhaust has decreased since 1980 due to lower new vehicle emission standards and changes in fuel characteristics.

### 13.2.2.2 Emissions Calculation And Correction Parameters[1-6]

The quantity of dust emissions from a given segment of unpaved road varies linearly with the volume of traffic. Field investigations also have shown that emissions depend on source parameters that characterize the condition of a particular road and the associated vehicle traffic. Characterization of these source parameters allow for "correction" of emission estimates to specific road and traffic conditions present on public and industrial roadways.

Dust emissions from unpaved roads have been found to vary directly with the fraction of silt (particles smaller than 75 micrometers [µm] in diameter) in the road surface materials.[1] The silt fraction is determined by measuring the proportion of loose dry surface dust that passes a 200-mesh screen, using the ASTM-C-136 method. A summary of this method is contained in Appendix C of AP-42. Table 13.2.2-1 summarizes measured silt values for industrial unpaved roads. Table 13.2.2-2 summarizes measured silt values for public unpaved roads. It should be noted that the ranges of silt content vary over two orders of magnitude. Therefore, the use of data from this table can potentially introduce considerable error. Use of this data is strongly discouraged when it is feasible to obtain locally gathered data.

Since the silt content of a rural dirt road will vary with geographic location, it should be measured for use in projecting emissions. As a conservative approximation, the silt content of the parent soil in the area can be used. Tests, however, show that road silt content is normally lower than in the surrounding parent soil, because the fines are continually removed by the vehicle traffic, leaving a higher percentage of coarse particles.

Other variables are important in addition to the silt content of the road surface material. For example, at industrial sites, where haul trucks and other heavy equipment are common, emissions are highly correlated with vehicle weight. On the other hand, there is far less variability in the weights of cars and pickup trucks that commonly travel publicly accessible unpaved roads throughout the United States. For those roads, the moisture content of the road surface material may be more dominant in determining differences in emission levels between, for example a hot, desert environment and a cool, moist location.

The PM-10 and TSP emission factors presented below are the outcomes from stepwise linear regressions of field emission test results of vehicles traveling over unpaved surfaces. Due to a limited amount of information available for PM-2.5, the expression for that particle size range has been scaled against the result for PM-10. Consequently, the quality rating for the PM-2.5 factor is lower than that for the PM-10 expression.

Table 13.2.2-1. TYPICAL SILT CONTENT VALUES OF SURFACE MATERIAL ON INDUSTRIAL UNPAVED ROADS[a]

| Industry | Road Use Or Surface Material | Plant Sites | No. Of Samples | Silt Content (%) | |
|---|---|---|---|---|---|
| | | | | Range | Mean |
| Copper smelting | Plant road | 1 | 3 | 16 - 19 | 17 |
| Iron and steel production | Plant road | 19 | 135 | 0.2 - 19 | 6.0 |
| Sand and gravel processing | Plant road | 1 | 3 | 4.1 - 6.0 | 4.8 |
| | Material storage area | 1 | 1 | - | 7.1 |
| Stone quarrying and processing | Plant road | 2 | 10 | 2.4 - 16 | 10 |
| | Haul road to/from pit | 4 | 20 | 5.0-15 | 8.3 |
| Taconite mining and processing | Service road | 1 | 8 | 2.4 - 7.1 | 4.3 |
| | Haul road to/from pit | 1 | 12 | 3.9 - 9.7 | 5.8 |
| Western surface coal mining | Haul road to/from pit | 3 | 21 | 2.8 - 18 | 8.4 |
| | Plant road | 2 | 2 | 4.9 - 5.3 | 5.1 |
| | Scraper route | 3 | 10 | 7.2 - 25 | 17 |
| | Haul road (freshly graded) | 2 | 5 | 18 - 29 | 24 |
| Construction sites | Scraper routes | 7 | 20 | 0.56-23 | 8.5 |
| Lumber sawmills | Log yards | 2 | 2 | 4.8-12 | 8.4 |
| Municipal solid waste landfills | Disposal routes | 4 | 20 | 2.2 - 21 | 6.4 |

[a]References 1,5-15.

The following empirical expressions may be used to estimate the quantity in pounds (lb) of size-specific particulate emissions from an unpaved road, per vehicle mile traveled (VMT):

For vehicles traveling on unpaved surfaces at industrial sites, emissions are estimated from the following equation:

$$E = k\ (s/12)^a (W/3)^b \tag{1a}$$

and, for vehicles traveling on publicly accessible roads, dominated by light duty vehicles, emissions may be estimated from the following:

$$E = \frac{k\ (s/12)^a (S/30)^d}{(M/0.5)^c} - C \tag{1b}$$

where k, a, b, c and d are empirical constants (Reference 6) given below and

E = size-specific emission factor (lb/VMT)
s = surface material silt content (%)
W = mean vehicle weight (tons)
M = surface material moisture content (%)
S = mean vehicle speed (mph)
*C* = emission factor for 1980's vehicle fleet exhaust, brake wear and tire wear.

The source characteristics s, W and M are referred to as correction parameters for adjusting the emission estimates to local conditions. The metric conversion from lb/VMT to grams (g) per vehicle kilometer traveled (VKT) is as follows:

1 lb/VMT = 281.9 g/VKT

The constants for Equations 1a and 1b based on the stated aerodynamic particle sizes are shown in Tables 13.2.2-2 and 13.2.2-4. The PM-2.5 particle size multipliers (k-factors) are taken from Reference 27.

Table 13.2.2-2. CONSTANTS FOR EQUATIONS 1a AND 1b

| Constant | Industrial Roads (Equation 1a) | | | Public Roads (Equation 1b) | | |
|---|---|---|---|---|---|---|
| | PM-2.5 | PM-10 | PM-30* | PM-2.5 | PM-10 | PM-30* |
| k (lb/VMT) | 0.15 | 1.5 | 4.9 | 0.18 | 1.8 | 6.0 |
| a | 0.9 | 0.9 | 0.7 | 1 | 1 | 1 |
| b | 0.45 | 0.45 | 0.45 | - | - | - |
| c | - | - | - | 0.2 | 0.2 | 0.3 |
| d | - | - | - | 0.5 | 0.5 | 0.3 |
| Quality Rating | B | B | B | B | B | B |

*Assumed equivalent to total suspended particulate matter (TSP)
"-" = not used in the emission factor equation

Table 13.2.2-2 also contains the quality ratings for the various size-specific versions of Equation 1a and 1b. The equation retains the assigned quality rating, if applied within the ranges of source conditions, shown in Table 13.2.2-3, that were tested in developing the equation:

Table 13.2.2-3. RANGE OF SOURCE CONDITIONS USED IN DEVELOPING EQUATION 1a AND 1b

| Emission Factor | Surface Silt Content, % | Mean Vehicle Weight | | Mean Vehicle Speed | | Mean No. of Wheels | Surface Moisture Content, % |
|---|---|---|---|---|---|---|---|
| | | Mg | ton | km/hr | mph | | |
| Industrial Roads (Equation 1a) | 1.8-25.2 | 1.8-260 | 2-290 | 8-69 | 5-43 | 4-17[a] | 0.03-13 |
| Public Roads (Equation 1b) | 1.8-35 | 1.4-2.7 | 1.5-3 | 16-88 | 10-55 | 4-4.8 | 0.03-13 |

[a] See discussion in text.

As noted earlier, the models presented as Equations 1a and 1b were developed from tests of traffic on unpaved surfaces. Unpaved roads have a hard, generally nonporous surface that usually dries quickly after a rainfall or watering, because of traffic-enhanced natural evaporation. (Factors influencing how fast a road dries are discussed in Section 13.2.2.3, below.) The quality ratings given above pertain to the mid-range of the measured source conditions for the equation. A higher mean vehicle weight and a higher than normal traffic rate may be justified when performing a worst-case analysis of emissions from unpaved roads.

The emission factors for the exhaust, brake wear and tire wear of a 1980's vehicle fleet (*C*) was obtained from EPA's MOBILE6.2 model [23]. The emission factor also varies with aerodynamic size range as shown in Table 13.2.2-4

Table 13.2.2-4. EMISSION FACTOR FOR 1980'S VEHICLE FLEET EXHAUST, BRAKE WEAR AND TIRE WEAR

| Particle Size Range[a] | *C*, Emission Factor for Exhaust, Brake Wear and Tire Wear[b] lb/VMT |
|---|---|
| $PM_{2.5}$ | 0.00036 |
| $PM_{10}$ | 0.00047 |
| $PM_{30}$[c] | 0.00047 |

[a] Refers to airborne particulate matter (PM-x) with an aerodynamic diameter equal to or less than x micrometers.
[b] Units shown are pounds per vehicle mile traveled (lb/VMT).
[c] PM-30 is sometimes termed "suspendable particulate" (SP) and is often used as a surrogate for TSP.

It is important to note that the vehicle-related source conditions refer to the average weight, speed, and number of wheels for all vehicles traveling the road. For example, if 98 percent of traffic on the road are 2-ton cars and trucks while the remaining 2 percent consists of 20-ton trucks, then the mean weight is 2.4 tons. More specifically, Equations 1a and 1b are *not* intended to be used to calculate a separate emission factor for each vehicle class within a mix of traffic on a given unpaved road. That is, in the example, one should *not* determine one factor for the 2-ton vehicles and a second factor for the 20-ton trucks. Instead, only one emission factor should be calculated that represents the "fleet" average of 2.4 tons for all vehicles traveling the road.

Moreover, to retain the quality ratings when addressing a group of unpaved roads, it is necessary that reliable correction parameter values be determined for the road in question. The field and laboratory procedures for determining road surface silt and moisture contents are given in AP-42 Appendices C.1 and C.2. Vehicle-related parameters should be developed by recording visual observations of traffic. In some cases, vehicle parameters for industrial unpaved roads can be determined by reviewing maintenance records or other information sources at the facility.

In the event that site-specific values for correction parameters cannot be obtained, then default values may be used.In the absence of site-specific silt content information, an appropriate mean value from Table 13.2.2-1 may be used as a default value, but the quality rating of the equation is reduced by two letters. Because of significant differences found between different types of road surfaces and between different areas of the country, use of the default moisture content value of 0.5 percent in Equation 1b is discouraged. The quality rating should be downgraded two letters when the default moisture content value is used. (It is assumed that readers addressing industrial roads have access to the information needed to develop average vehicle information in Equation 1a for their facility.)

The effect of routine watering to control emissions from unpaved roads is discussed below in Section 13.2.2.3, “Controls”. However, all roads are subject to some natural mitigation because of rainfall and other precipitation. The Equation 1a and 1b emission factors can be extrapolated to annual average uncontrolled conditions (but including natural mitigation) under the simplifying assumption that annual average emissions are inversely proportional to the number of days with measurable (more than 0.254 mm [0.01 inch]) precipitation:

$$E_{ext} = E\ [(365 - P)/365] \tag{2}$$

where:

$E_{ext}$ = annual size-specific emission factor extrapolated for natural mitigation, lb/VMT

E = emission factor from Equation 1a or 1b

P = number of days in a year with at least 0.254 mm (0.01 in) of precipitation (see below)

Figure 13.2.2-1 gives the geographical distribution for the mean annual number of "wet" days for the United States.

Equation 2 provides an estimate that accounts for precipitation on an annual average basis for the purpose of inventorying emissions. It should be noted that Equation 2 does not account for differences in the temporal distributions of the rain events, the quantity of rain during any event, or the potential for the rain to evaporate from the road surface. In the event that a finer temporal and spatial resolution is desired for inventories of public unpaved roads, estimates can be based on a more complex set of assumptions. These assumptions include:

1. The moisture content of the road surface material is increased in proportion to the quantity of water added;
2. The moisture content of the road surface material is reduced in proportion to the Class A pan evaporation rate;
3. The moisture content of the road surface material is reduced in proportion to the traffic volume; and
4. The moisture content of the road surface material varies between the extremes observed in the area. The CHIEF Web site (http://www.epa.gov/ttn/chief/ap42/ch13/related/c13s02-2.html) has a file which contains a spreadsheet program for calculating emission factors which are temporally and spatially resolved. Information required for use of the spreadsheet program includes monthly Class A pan evaporation values, hourly meteorological data for precipitation, humidity and snow cover, vehicle traffic information, and road surface material information.

It is emphasized that <u>the simple assumption underlying Equation 2 and the more complex set of assumptions underlying the use of the procedure which produces a finer temporal and spatial resolution</u> have not been verified in any rigorous manner. For this reason, the quality ratings for either approach should be downgraded one letter from the rating that would be applied to Equation 1.

### 13.2.2.3 Controls[18-22]

A wide variety of options exist to control emissions from unpaved roads. Options fall into the following three groupings:

1. <u>Vehicle restrictions</u> that limit the speed, weight or number of vehicles on the road;

2. Surface improvement, by measures such as (a) paving or (b) adding gravel or slag to a dirt road; and

3. Surface treatment, such as watering or treatment with chemical dust suppressants.

Available control options span broad ranges in terms of cost, efficiency, and applicability. For example, traffic controls provide moderate emission reductions (often at little cost) but are difficult to enforce. Although paving is highly effective, its high initial cost is often prohibitive. Furthermore, paving is not feasible for industrial roads subject to very heavy vehicles and/or spillage of material in transport. Watering and chemical suppressants, on the other hand, are potentially applicable to most industrial roads at moderate to low costs. However, these require frequent reapplication to maintain an acceptable level of control. Chemical suppressants are generally more cost-effective than water but not in cases of temporary roads (which are common at mines, landfills, and construction sites). In summary, then, one needs to consider not only the type and volume of traffic on the road but also how long the road will be in service when developing control plans.

Vehicle restrictions. These measures seek to limit the amount and type of traffic present on the road or to lower the mean vehicle speed. For example, many industrial plants have restricted employees from driving on plant property and have instead instituted bussing programs. This eliminates emissions due to employees traveling to/from their worksites. Although the heavier average vehicle weight of the busses increases the base emission factor, the decrease in vehicle-miles-traveled results in a lower overall emission rate.

# 13.2.4 Aggregate Handling And Storage Piles

## 13.2.4.1 General

Inherent in operations that use minerals in aggregate form is the maintenance of outdoor storage piles. Storage piles are usually left uncovered, partially because of the need for frequent material transfer into or out of storage.

Dust emissions occur at several points in the storage cycle, such as material loading onto the pile, disturbances by strong wind currents, and loadout from the pile. The movement of trucks and loading equipment in the storage pile area is also a substantial source of dust.

## 13.2.4.2 Emissions And Correction Parameters

The quantity of dust emissions from aggregate storage operations varies with the volume of aggregate passing through the storage cycle. Emissions also depend on 3 parameters of the condition of a particular storage pile: age of the pile, moisture content, and proportion of aggregate fines.

When freshly processed aggregate is loaded onto a storage pile, the potential for dust emissions is at a maximum. Fines are easily disaggregated and released to the atmosphere upon exposure to air currents, either from aggregate transfer itself or from high winds. As the aggregate pile weathers, however, potential for dust emissions is greatly reduced. Moisture causes aggregation and cementation of fines to the surfaces of larger particles. Any significant rainfall soaks the interior of the pile, and then the drying process is very slow.

Silt (particles equal to or less than 75 micrometers [µm] in diameter) content is determined by measuring the portion of dry aggregate material that passes through a 200-mesh screen, using ASTM-C-136 method.[1] Table 13.2.4-1 summarizes measured silt and moisture values for industrial aggregate materials.

The quantity of particulate emissions generated by either type of drop operation, per kilogram (kg) (ton) of material transferred, may be estimated, with a rating of A, using the following empirical expression:[11]

$$E = k(0.0016) \frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}} \text{ (kg/megagram [Mg])}$$

$$E = k(0.0032) \frac{\left(\frac{U}{5}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}} \text{ (pound [lb]/ton)} \quad (1)$$

where:

E = emission factor
k = particle size multiplier (dimensionless)
U = mean wind speed, meters per second (m/s) (miles per hour [mph])
M = material moisture content (%)

The particle size multiplier in the equation, k, varies with aerodynamic particle size range, as follows:

| Aerodynamic Particle Size Multiplier (k) For Equation 1 | | | | |
|---|---|---|---|---|
| < 30 µm | < 15 µm | < 10 µm | < 5 µm | < 2.5 µm |
| 0.74 | 0.48 | 0.35 | 0.20 | 0.053[a] |

[a] Multiplier for < 2.5 µm taken from Reference 14.

The equation retains the assigned quality rating if applied within the ranges of source conditions that were tested in developing the equation, as follows. Note that silt content is included, even though silt content does not appear as a correction parameter in the equation. While it is reasonable to expect that silt content and emission factors are interrelated, no significant correlation between the 2 was found during the derivation of the equation, probably because most tests with high silt contents were conducted under lower winds, and vice versa. It is recommended that estimates from the equation be reduced 1 quality rating level if the silt content used in a particular application falls outside the range given:

| Ranges Of Source Conditions For Equation 1 | | | |
|---|---|---|---|
| Silt Content (%) | Moisture Content (%) | Wind Speed | |
| | | m/s | mph |
| 0.44 - 19 | 0.25 - 4.8 | 0.6 - 6.7 | 1.3 - 15 |

To retain the quality rating of the equation when it is applied to a specific facility, reliable correction parameters must be determined for specific sources of interest. The field and laboratory procedures for aggregate sampling are given in Reference 3. In the event that site-specific values for

NEW MEXICO

AVERAGE WIND SPEED - MPH

| STATION | ID | Years | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Ann |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALAMOGORDO AIRPORT ASOS | KALM | 1996-2006 | 5.1 | 6.3 | 7.1 | 7.9 | 7.1 | 6.9 | 6.1 | 5.3 | 5.2 | 5.2 | 5.0 | 5.0 | 6.0 |
| ALAMOGORDO-HOLLOMAN AFB | KHMN | 1996-2006 | 8.5 | 9.7 | 10.6 | 11.8 | 10.8 | 10.6 | 9.8 | 9.1 | 8.8 | 8.5 | 8.1 | 8.3 | 9.6 |
| ALBUQUERQUE AP ASOS | KABQ | 1996-2006 | 7.0 | 8.2 | 9.3 | 11.1 | 10.0 | 10.0 | 8.7 | 8.3 | 8.0 | 7.9 | 7.2 | 6.9 | 8.5 |
| ALBUQUERQUE-DBLE EAGLE | KAEG | 1999-2006 | 7.1 | 7.9 | 9.0 | 10.6 | 9.5 | 8.6 | 7.0 | 6.2 | 7.0 | 6.5 | 6.5 | 6.1 | 7.7 |
| ARTESIA AIRPORT ASOS | KATS | 1997-2006 | 7.8 | 9.1 | 10.1 | 10.9 | 10.2 | 9.9 | 7.8 | 6.9 | 7.6 | 7.8 | 7.6 | 7.4 | 8.5 |
| CARLSBAD AIRPORT ASOS | KCNM | 1996-2006 | 9.2 | 9.8 | 10.9 | 11.4 | 10.4 | 9.9 | 8.5 | 7.7 | 8.2 | 8.5 | 8.4 | 8.8 | 9.3 |
| CLAYTON MUNI AP ASOS | KCAO | 1996-2006 | 11.9 | 12.7 | 13.4 | 14.6 | 13.4 | 13.0 | 11.7 | 10.8 | 11.8 | 12.1 | 12.1 | 12.0 | 12.4 |
| CLINES CORNERS | KCQC | 1998-2006 | 16.2 | 16.1 | 15.7 | 16.9 | 14.6 | 13.5 | 10.6 | 10.1 | 11.8 | 13.3 | 15.0 | 16.0 | 14.1 |
| CLOVIS AIRPORT AWOS | KCVN | 1996-2006 | 12.3 | 12.3 | 13.4 | 13.8 | 12.4 | 11.9 | 9.7 | 8.9 | 9.7 | 10.9 | 11.6 | 12.2 | 11.6 |
| CLOVIS-CANNON AFB | KCVS | 1996-2006 | 12.5 | 12.6 | 13.6 | 13.8 | 12.2 | 12.5 | 10.7 | 10.0 | 10.2 | 11.3 | 11.7 | 12.4 | 12.0 |
| DEMING AIRPORT ASOS | KDMN | 1996-2006 | 8.7 | 9.7 | 10.9 | 12.0 | 10.6 | 10.1 | 8.9 | 8.1 | 8.4 | 8.2 | 8.5 | 8.1 | 9.3 |
| FARMINGTON AIRPORT ASOS | KFMN | 1996-2006 | 7.3 | 8.3 | 9.0 | 9.8 | 9.4 | 9.4 | 8.7 | 8.2 | 8.0 | 7.8 | 7.6 | 7.3 | 8.4 |
| GALLUP AIRPORT ASOS | KGUP | 1996-2006 | 5.7 | 6.9 | 7.8 | 10.0 | 9.0 | 8.8 | 6.9 | 6.0 | 6.5 | 6.1 | 5.6 | 5.3 | 7.0 |
| GRANTS-MILAN AP ASOS | KGNT | 1997-2006 | 7.8 | 8.8 | 9.6 | 10.9 | 10.0 | 9.8 | 8.1 | 7.2 | 7.9 | 8.4 | 8.0 | 7.6 | 8.7 |
| HOBBS AIRPORT AWOS | KHOB | 1996-2006 | 11.3 | 11.9 | 12.6 | 13.4 | 12.5 | 12.3 | 11.0 | 10.0 | 10.2 | 10.6 | 10.7 | 11.1 | 11.4 |
| LAS CRUCES AIRPORT AWOS | KLRU | 2000-2006 | 6.4 | 7.5 | 8.8 | 10.1 | 8.7 | 8.2 | 6.8 | 6.0 | 6.2 | 6.1 | 6.4 | 6.0 | 7.3 |
| LAS VEGAS AIRPORT ASOS | KLVS | 1996-2006 | 10.9 | 12.2 | 12.5 | 14.3 | 12.4 | 11.8 | 10.0 | 9.2 | 10.9 | 10.8 | 11.0 | 10.9 | 11.4 |
| LOS ALAMOS AP AWOS | KLAM | 2005-2006 | 3.9 | 5.7 | 7.5 | 8.1 | 7.1 | 7.3 | 5.3 | 4.8 | 5.7 | 5.1 | 4.4 | 3.2 | 5.4 |
| RATON AIRPORT ASOS | KRTN | 1998-2006 | 8.9 | 9.4 | 10.4 | 12.2 | 10.8 | 10.2 | 8.4 | 8.1 | 8.6 | 9.0 | 8.6 | 8.5 | 9.4 |
| ROSWELL AIRPORT ASOS | KROW | 1996-2006 | 7.4 | 8.9 | 9.9 | 11.1 | 10.3 | 10.2 | 8.8 | 7.9 | 8.3 | 8.0 | 7.5 | 7.3 | 8.8 |
| RUIDOSO AIRPORT AWOS | KSRR | 1996-2006 | 8.8 | 9.6 | 10.0 | 11.6 | 10.0 | 8.4 | 5.9 | 5.3 | 6.4 | 7.4 | 7.9 | 8.7 | 8.3 |
| SANTA FE AIRPORT ASOS | KSAF | 1996-2006 | 8.9 | 9.5 | 9.9 | 11.2 | 10.6 | 10.5 | 9.2 | 8.8 | 8.8 | 9.1 | 8.7 | 8.5 | 9.5 |
| SILVER CITY AP AWOS | KSVC | 1999-2006 | 8.1 | 8.7 | 9.9 | 10.8 | 10.2 | 9.9 | 8.5 | 7.2 | 6.9 | 7.6 | 7.9 | 7.7 | 8.5 |
| TAOS AIRPORT AWOS | KSKX | 1996-2006 | 5.8 | 6.5 | 7.7 | 9.1 | 8.6 | 8.5 | 7.1 | 6.6 | 6.7 | 6.6 | 6.0 | 5.7 | 7.0 |
| TRUTH OR CONSEQ AP ASOS | KTCS | 1996-2006 | 7.4 | 8.7 | 9.9 | 11.1 | 10.4 | 9.8 | 8.1 | 7.4 | 7.7 | 8.0 | 7.7 | 7.3 | 8.6 |
| TUCUMCARI AIRPORT ASOS | KTCC | 1999-2006 | 10.0 | 11.2 | 11.9 | 13.6 | 11.9 | 11.6 | 9.9 | 9.3 | 10.0 | 10.0 | 10.4 | 10.2 | 10.8 |

**Roper Construction, Inc. Alto Concrete Batch Plant Emissions Inventory**
**125 CuFt/Hr; 50,000 CuFt per Year**

**Typical cuyd of concrete**

| | pound/yd | tons/hr | tons/yr | | |
|---|---|---|---|---|---|
| total concrete | 3881 | 242.6 | 97,025 | | |
| aggregate | 1900 | 118.8 | 47,500 | | |
| sand | 1100 | 68.8 | 27,500 | | |
| cement | 489 | 30.6 | 12,225 | | |
| flyash | 132 | 8.3 | 3,300 | Gallon/Hr | Gallons/Yr |
| water | 260 | 16.3 | 6,500 | 3896.9 | 1558753.0 |

| | | | |
|---|---|---|---|
| Max. plant capacity | 125 | cuyd/hr | |
| Max. plant capacity | 1875 | cuyd/day | |
| Max. plant capacity | 50000 | cuyd/yr | |
| Hours per year of operation based on annual throughput | 400 | hrs/yr | (not a requested permit limit) |
| Uncontrolled hrs/yr of operation | 8760 | hrs/yr | |

**Aggregate Storage Pile Handling**

| | | | | |
|---|---|---|---|---|
| AP-42 13.2.4 | E = k x (0.0032) x (U/5)^1.3 / (M/2)^1.4 lbs/ton | | | |
| Max tph | 118.75 tph | | 47500 ton/yr | |
| k(PM) | 0.74 | | | |
| k(pm10) | 0.35 | | | |
| k(pm2.5) | 0.053 | | | |
| Umax | 11 MPH | | NMED Default | |
| Uannual | 8.3 MPH | | Ruidoso Airport WS 1996-2006 | |
| M | 1.77 % | | AP-42 Section 11.12, Table 11.12-2, footnote b | |

| | lb/hr | tons/yr |
|---|---|---|
| E(PM) Uncontrolled | 0.92992 | 4.07304 |
| E(pm10) Uncontrolled | 0.43983 | 1.92644 |
| E(pm2.5) Uncontrolled | 0.06660 | 0.29172 |

| | lb/hr | tons/yr | Model lbs/hr | |
|---|---|---|---|---|
| E(PM) Controlled | 0.92992 | 0.12896 | 0.64482 | Limit Annual Material Throughput |
| E(pm10) Controlled | 0.43983 | 0.06100 | 0.30498 | Limit Annual Material Throughput |
| E(pm2.5) Controlled | 0.06660 | 0.00924 | 0.04618 | Limit Annual Material Throughput |

**Sand Storage Pile Handling**

| | | | | |
|---|---|---|---|---|
| AP-42 13.2.4 | E = k x (0.0032) x (U/5)^1.3 / (M/2)^1.4 lbs/ton | | | |
| Max tph | 68.75 tph | | 27500 ton/yr | |
| k(PM) | 0.74 | | | |
| k(pm10) | 0.35 | | | |
| k(pm2.5) | 0.053 | | | |
| Umax | 11 MPH | | NMED Default | |
| Uannual | 8.3 MPH | | Ruidoso Airport WS 1996-2006 | |
| M | 4.17 % | | AP-42 Section 11.12, Table 11.12-2, footnote b | |

| | lb/hr | tons/yr |
|---|---|---|
| E(PM) Uncontrolled | 0.16220 | 0.71044 |
| E(pm10) Uncontrolled | 0.07672 | 0.33602 |
| E(pm2.5) Uncontrolled | 0.01162 | 0.05088 |

| | lb/hr | tons/yr | Model lbs/hr | |
|---|---|---|---|---|
| E(PM) Controlled | 0.16220 | 0.02249 | 0.11247 | Limit Annual Material Throughput |
| E(pm10) Controlled | 0.07672 | 0.01064 | 0.05320 | Limit Annual Material Throughput |
| E(pm2.5) Controlled | 0.01162 | 0.00161 | 0.00806 | Limit Annual Material Throughput |

**Aggregate and Sand Feeder Loading**

| | | | | |
|---|---|---|---|---|
| AP-42 13.2.4 | E = k x (0.0032) x (U/5)^1.3 / (M/2)^1.4 lbs/ton | | | |
| Max tph | 187.5 tph | | 75000 ton/yr | |
| k(PM) | 0.74 | | | |
| k(pm10) | 0.35 | | | |
| k(pm2.5) | 0.053 | | | |
| Umax | 11 MPH | | NMED Default | |
| Uannual | 8.3 MPH | | Ruidoso Airport WS 1996-2006 | |
| M | 2.65 % | | Calculated weighted average aggregate and sand | |

| | lb/hr | tons/yr |
|---|---|---|
| E(PM) Uncontrolled | 0.83451 | 3.65514 |
| E(pm10) Uncontrolled | 0.39470 | 1.72878 |
| E(pm2.5) Uncontrolled | 0.05977 | 0.26179 |

| | lb/hr | tons/yr | Model lbs/hr | |
|---|---|---|---|---|
| E(PM) Uncontrolled | 0.83451 | 0.11573 | 0.57866 | Limit Annual Material Throughput |
| E(pm10) Uncontrolled | 0.39470 | 0.05474 | 0.27369 | Limit Annual Material Throughput |
| E(pm2.5) Uncontrolled | 0.05977 | 0.00829 | 0.04144 | Limit Annual Material Throughput |

**Roper Construction, Inc. Alto Concrete Batch Plant Emissions Inventory**
**125 CuFt/Hr; 50,000 CuFt per Year**

**Aggregate and Sand Feeder Unloading**

AP-42 11.19.2 Table 11.19.2-2 "Conveyor Transfer Point"

| | | | | |
|---|---|---|---|---|
| Max tph | 187.5 tph | | 2812.5 ton/day | 75000 ton/yr |
| E(PM) Uncontrolled | 0.003 lbs/ton | | | |
| E(pm10) Uncontrolled | 0.0011 lbs/ton | | | |
| E(pm2.5) Uncontrolled | 0.000167 lbs/ton | | | |

| | lb/hr | tons/yr |
|---|---|---|
| E(PM) Uncontrolled | 0.56250 | 2.46375 |
| E(pm10) Uncontrolled | 0.20625 | 0.90338 |
| E(pm10) Uncontrolled | 0.03123 | 0.13680 |

| | | |
|---|---|---|
| E(PM) Controlled | 0.00014 lbs/ton | |
| E(pm10) Controlled | 0.000046 lbs/ton | 95.82% Control Efficiency |
| E(pm2.5) Controlled | 0.000013 lbs/ton | |

| | lb/hr | tons/yr | |
|---|---|---|---|
| E(PM) Controlled | 0.02625 | 0.00525 | Limit Annual Material Throughput |
| E(pm10) Controlled | 0.00863 | 0.00173 | Limit Annual Material Throughput |
| E(pm10) Controlled | 0.00244 | 0.00049 | Limit Annual Material Throughput |

**Aggregate Bin Loading**

AP-42 11.19.2 Table 11.19.2-2 "Conveyor Transfer Point"

| | | |
|---|---|---|
| Max tph | 187.5 tph | 75000 ton/yr |
| E(PM) Uncontrolled | 0.003 lbs/ton | |
| E(pm10) Uncontrolled | 0.0011 lbs/ton | |
| E(pm2.5) Uncontrolled | 0.000167 lbs/ton | |

| | lb/hr | tons/yr |
|---|---|---|
| E(PM) Uncontrolled | 0.56250 | 2.46375 |
| E(pm10) Uncontrolled | 0.20625 | 0.90338 |
| E(pm2.5) Uncontrolled | 0.03123 | 0.13680 |

| | | |
|---|---|---|
| E(PM) Controlled | 0.00014 lbs/ton | |
| E(pm10) Controlled | 0.000046 lbs/ton | 95.82% Control Efficiency |
| E(pm2.5) Controlled | 0.000013 lbs/ton | |

| | lb/hr | tons/yr | |
|---|---|---|---|
| E(PM) Controlled | 0.02625 | 0.00525 | Limit Annual Material Throughput |
| E(pm10) Controlled | 0.00863 | 0.00173 | Limit Annual Material Throughput |
| E(pm2.5) Controlled | 0.00244 | 0.00049 | Limit Annual Material Throughput |

**Aggregate Weight Batcher Unloading to Batcher Conveyor**

AP-42 11.19.2 Table 11.19.2-2 "Conveyor Transfer Point"

| | | |
|---|---|---|
| Max tph | 187.5 tph | 75000 ton/yr |
| E(PM) Uncontrolled | 0.003 lbs/ton | |
| E(pm10) Uncontrolled | 0.0011 lbs/ton | |
| E(pm2.5) Uncontrolled | 0.000167 lbs/ton | |

| | lb/hr | tons/yr |
|---|---|---|
| E(PM) Uncontrolled | 0.56250 | 2.46375 |
| E(pm10) Uncontrolled | 0.20625 | 0.90338 |
| E(pm10) Uncontrolled | 0.03123 | 0.13680 |

| | | |
|---|---|---|
| E(PM) Controlled | 0.00014 lbs/ton | |
| E(pm10) Controlled | 0.000046 lbs/ton | 95.82% Control Efficiency |
| E(pm2.5) Controlled | 0.000013 lbs/ton | |

| | lb/hr | tons/yr | |
|---|---|---|---|
| E(PM) Controlled | 0.02625 | 0.00525 | Limit Annual Material Throughput |
| E(pm10) Controlled | 0.00863 | 0.00173 | Limit Annual Material Throughput |
| E(pm2.5) Controlled | 0.00244 | 0.00049 | Limit Annual Material Throughput |

**Truck Loading**

**Uncontrolled emissions based on AP-42 Section 11.12 "Concrete Batching" Table 11.12-2 "Uncontrolled Truck Loading"**

| | | |
|---|---|---|
| E(PM) = | 1.118 lbs/ton | Uncontrolled Truck Loading PM |
| E(PM10) = | 0.31 lbs/ton | Uncontrolled Truck Loading PM10 |
| E(PM2.5) = | 0.0558 lbs/ton | Uncontrolled Truck Loading PM2.5, Truck Loading Table 11.12-3 PM10 * PM2.5/PM10 (0.05/0.278) |

| | | |
|---|---|---|
| Max tph Cement and Flyash | 38.8125 tph | 15525 ton/yr |

| | lb/hr | tons/yr |
|---|---|---|
| E(pm) uncontrolled truck loading | 43.4 | 190 |
| E(pm10) uncontrolled truck loading | 12.0 | 53 |
| E(pm2.5) uncontrolled truck loading | 2.2 | 9.5 |

**Controlled based on baghouse exit control efficiency of 99.9%**

Control Efficiency 99.9%

| | lb/hr | tons/yr | |
|---|---|---|---|
| E(PM) controlled truck loading | 0.043 | 0.01 | |
| E(pm10) controlled truck loading | 0.012 | 0.002 | |
| E(pm2.5) controlled truck loading | 0.0018 | 0.0004 | Controlled Truck Loading PM2.5, Truck Loading Table 11.12-3 PM10 * PM2.5/PM10 (0.048/0.32) |

**Roper Construction, Inc. Alto Concrete Batch Plant Emissions Inventory**
**125 CuFt/Hr; 50,000 CuFt per Year**

**Cement/Fly Ash Weigh Batcher**

**Uncontrolled emissions based on AP-42 Section 11.12 "Concrete Batching" Table 11.12-2 "Uncontrolled Mixer Loading"**

| | | | |
|---|---|---|---|
| E(PM) = | 0.572 | lbs/ton | Uncontrolled Mixer Loading PM |
| E(PM10) = | 0.156 | lbs/ton | Uncontrolled Mixer Loading PM10 |
| E(PM2.5) = | 0.0309 | lbs/ton | Uncontrolled Mixer Loading PM2.5, Central Mix Operation Table 11.12-4 PM10 * PM2.5/PM10 (0.38/1.92) |

Max tph Cement and Flyash 38.8125 tph 15525 ton/yr

| | lb/hr | tons/yr |
|---|---|---|
| E(pm) uncontrolled batcher | 22.20 | 97.2 |
| E(pm10) uncontrolled batcher | 6.05 | 26.5 |
| E(pm2.5) uncontrolled batcher | 1.20 | 5.2 |

**Controlled based on baghouse exit control efficiency of 99.9%**
Control Efficiency 99.9%

| | lb/hr | tons/yr | |
|---|---|---|---|
| E(PM) controlled batcher | 0.022 | 0.004 | |
| E(pm10) controlled batcher | 0.0061 | 0.001 | |
| E(pm2.5) controlled batcher | 0.0014 | 0.0002 | Controlled Mixer Loading PM2.5, Central Mix Operation Table 11.12-4 PM10 * PM2.5/PM10 (0.03/0.13) |

**Cement Silo**

**Uncontrolled emissions based on AP-42 Section 11.12 "Concrete Batching" Table 11.12-2 "Cement Unloading to Elevated Storage Silo"**

| | | | |
|---|---|---|---|
| E(PM) = | 0.73 | lbs/ton | Uncontrolled Cement Silo Loading PM |
| E(PM10) = | 0.47 | lbs/ton | Uncontrolled Cement Silo Loading PM10 |
| E(PM2.5) = | 0.0930 | lbs/ton | Uncontrolled Mixer Loading PM2.5, Central Mix Operation Table 11.12-4 PM10 * PM2.5/PM10 (0.38/1.92) |

Max tph Cement 30.6 tph 12225 ton/yr

| | lb/hr | tons/yr |
|---|---|---|
| E(pm) uncontrolled cement | 22.31063 | 97.72054 |
| E(pm10) uncontrolled cement | 14.36438 | 62.91596 |
| E(pm2.5) uncontrolled cement | 2.84295 | 12.45212 |

**Controlled based on baghouse exit control efficiency of 99.9%**
Control Efficiency 99.9%

| | lb/hr | tons/yr | |
|---|---|---|---|
| E(PM) controlled cement | 0.022311 | 0.004 | |
| E(pm10) controlled cement | 0.014364 | 0.003 | |
| E(pm2.5) controlled cement | 0.003315 | 0.0006 | Controlled Mixer Loading PM2.5, Central Mix Operation Table 11.12-4 PM10 * PM2.5/PM10 (0.03/0.13) |

**Flyash Silo**

**Uncontrolled emissions based on AP-42 Section 11.12 "Concrete Batching" Table 11.12-2 "Cement Supplement Unloading to Elevated Storage Silo"**

| | | | |
|---|---|---|---|
| E(PM) = | 3.14 | lbs/ton | Uncontrolled Mixer Loading PM |
| E(PM10) = | 1.1 | lbs/ton | Uncontrolled Mixer Loading PM10 |
| E(PM10) = | 0.2177 | lbs/ton | Uncontrolled Mixer Loading PM2.5, Central Mix Operation Table 11.12-4 PM10 * PM2.5/PM10 (0.38/1.92) |

Max tph Fly Ash 8.25 tph 3300 ton/yr

| | lb/hr | tons/yr |
|---|---|---|
| E(pm) uncontrolled fly ash | 25.90500 | 113.46390 |
| E(pm10) uncontrolled fly ash | 9.07500 | 39.74850 |
| E(pm2.5) uncontrolled fly ash | 1.79609 | 7.86689 |

**Controlled based on baghouse exit control efficiency of 99.9%**
Control Efficiency 99.9%

| | lb/hr | tons/yr | |
|---|---|---|---|
| E(PM) controlled truck load | 0.026 | 0.005 | |
| E(pm10) controlled truck load | 0.009 | 0.002 | |
| E(pm2.5) controlled truck load | 0.0021 | 0.0004 | Controlled Mixer Loading PM2.5, Central Mix Operation Table 11.12-4 PM10 * PM2.5/PM10 (0.03/0.13) |

## Roper Construction, Inc. Alto Concrete Batch Plant Emissions Inventory
## 125 CuFt/Hr; 50,000 CuFt per Year

**Road Traffic**

AP-42 13.2 Unpaved Road (12/03)

Equation:

E = k(s/12)^a*(W/3)^b*[(365-p)/365] *Annual emissions only include p factor*

| | | | | |
|---|---|---|---|---|
| k PM | 4.9 | | | |
| k PM10 | 1.5 | | | |
| k PM2.5 | 0.15 | | | |
| a PM | 0.7 | | | |
| a PM10 | 0.9 | | | |
| a PM2.5 | 0.9 | | | |
| b PM | 0.45 | | | |
| b PM10 | 0.45 | | | |
| b PM2.5 | 0.45 | | | |
| % Silt Content = s | 4.8 | % | Sand and Gravel (AP-42 13.2.2-1) | |
| precipitation days/yr | 70 | days | AP-42 Figure 13.2.2-1 | |
| Vehicle control | | 95 % | | Paved and Sweep |

| | | | | |
|---|---|---|---|---|
| Cement Truck VMT | 93 | RT meter/vehicle | 0.11593223 | RT miles/vehicle |
| Flyash Truck VMT | 93 | RT meter/vehicle | 0.11593223 | RT miles/vehicle |
| Aggregate Truck VMT | 337 | RT meter/vehicle | 0.209749475 | RT miles/vehicle |
| Concrete Truck VMT | 93 | RT meter/vehicle | 0.11593223 | RT miles/vehicle |
| Water Truck VMT | 337 | RT meter/vehicle | 0.209749475 | RT miles/vehicle |

| | | | | | | |
|---|---|---|---|---|---|---|
| Max. Cement Truck/hr | 1.3 | truck/hr | 23 | tons/load | 30.6 | tons/hr |
| Max. Flyash Truck/hr | 0.4 | truck/hr | 23 | tons/load | 8.3 | tons/hr |
| Max. Aggregate Truck/hr | 8.2 | truck/hr | 23 | tons/load | 187.5 | tons/hr |
| Max. Concrete Truck/hr | 10.4 | truck/hr | 12 | cuyd/load | 125.0 | cuyd/hr |
| Max. Water Truck/hr | 1.0 | truck/hr | 4000 | gallons/load | 3896.9 | gallons/hr |
| | 21.2 | truck/hr | | | | |
| | 127.4 | truck/day | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Max. Cement Truck/yr | 531.5 | truck/yr | 23 | tons/load | 12225.0 | tons/yr |
| Max. Flyash Truck/yr | 143.5 | truck/yr | 23 | tons/load | 3300.0 | tons/yr |
| Max. Aggregate Truck/yr | 3260.9 | truck/yr | 23 | tons/load | 75000.0 | tons/yr |
| Max. Concrete Truck/yr | 4166.7 | truck/yr | 12 | cuyd/load | 50000.0 | tons/yr |
| Max. Water Truck/yr | 389.7 | truck/yr | 4000 | gallons/load | 1558753.0 | gallons/yr |
| | 8492.2 | truck/yr | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Cement Truck VMT | 0.15405 | RT miles/hr | 1349.49 | miles/yr uncontrolled | 61.62 | miles/yr controlled |
| Flyash Truck VMT | 0.04158 | RT miles/hr | 364.28 | miles/yr uncontrolled | 16.63 | miles/yr controlled |
| Aggregate Truck VMT | 1.70991 | RT miles/hr | 14978.85 | miles/yr uncontrolled | 683.97 | miles/yr controlled |
| Concrete Truck VMT | 1.20763 | RT miles/hr | 10578.82 | miles/yr uncontrolled | 483.05 | miles/yr controlled |
| Water Truck VMT | 0.11294 | RT miles/hr | 989.39 | miles/yr uncontrolled | 45.18 | miles/yr controlled |
| | 3.22612 | RT miles/hr | 28260.82 | | 1290.45 | |

| | | | | |
|---|---|---|---|---|
| Cement Truck weight | 26.5 | tons/average | 15 | (ton truck tare) |
| Flyash Truck weight | 26.5 | tons/average | 15 | (ton truck tare) |
| Aggregate Truck weight | 26.5 | tons/average | 15 | (ton truck tare) |
| Concrete Truck weight | 25 | tons/average | | |
| Water Truck weight | 23.3 | tons/average | 15 | (ton truck tare) |

| | | Uncontrolled | | | | Controlled | | |
|---|---|---|---|---|---|---|---|---|
| | | PM | | | | PM | | |
| Max. Cement Truck Emissions | | 1.06 | lbs/hr | 4.64 | tons/yr | 0.053 | lbs/hr | 0.0086 tons/yr |
| Max. Flyash Truck Emissions | | 0.29 | lbs/hr | 1.25 | tons/yr | 0.014 | lbs/hr | 0.0023 tons/yr |
| Max. Aggregate Truck Emissions | | 11.76 | lbs/hr | 51.50 | tons/yr | 0.59 | lbs/hr | 0.10 tons/yr |
| Max. Concrete Truck Emissions | | 8.09 | lbs/hr | 35.43 | tons/yr | 0.40 | lbs/hr | 0.065 tons/yr |
| Max. Water Truck Emissions | | 0.73 | lbs/hr | 3.21 | tons/yr | 0.037 | lbs/hr | 0.0059 tons/yr |
| | **total combined traffic** | 21.93 | lbs/hr | 96.04 | tons/yr | 1.10 | lbs/hr | 0.18 tons/yr |
| | | PM10 | | | | PM10 | | |
| Max. Cement Truck Emissions | | 0.27 | lbs/hr | 1.18 | tons/yr | 0.014 | lbs/hr | 0.0022 tons/yr |
| Max. Flyash Truck Emissions | | 0.073 | lbs/hr | 0.32 | tons/yr | 0.0036 | lbs/hr | 0.00059 tons/yr |
| Max. Aggregate Truck Emissions | | 3.00 | lbs/hr | 13.13 | tons/yr | 0.15 | lbs/hr | 0.024 tons/yr |
| Max. Concrete Truck Emissions | | 2.06 | lbs/hr | 9.03 | tons/yr | 0.10 | lbs/hr | 0.017 tons/yr |
| Max. Water Truck Emissions | | 0.19 | lbs/hr | 0.82 | tons/yr | 0.0093 | lbs/hr | 0.0015 tons/yr |
| | **total combined traffic** | 5.59 | lbs/hr | 24.48 | tons/yr | 0.28 | lbs/hr | 0.045 tons/yr |
| | | PM2.5 | | | | PM2.5 | | |
| Max. Cement Truck Emissions | | 0.027 | lbs/hr | 0.12 | tons/yr | 0.0014 | lbs/hr | 0.00022 tons/yr |
| Max. Flyash Truck Emissions | | 0.0073 | lbs/hr | 0.03 | tons/yr | 0.00036 | lbs/hr | 0.000059 tons/yr |
| Max. Aggregate Truck Emissions | | 0.30 | lbs/hr | 1.31 | tons/yr | 0.015 | lbs/hr | 0.0024 tons/yr |
| Max. Concrete Truck Emissions | | 0.21 | lbs/hr | 0.90 | tons/yr | 0.010 | lbs/hr | 0.0017 tons/yr |
| Max. Water Truck Emissions | | 0.019 | lbs/hr | 0.08 | tons/yr | 0.00093 | lbs/hr | 0.00015 tons/yr |
| | **total combined traffic** | 0.56 | lbs/hr | 2.45 | tons/yr | 0.028 | lbs/hr | 0.0045 tons/yr |

# Roper Construction, Inc. Heater Emissions

**Concrete Batch Heater**

| | | | | | |
|---|---|---|---|---|---|
| AP-42 1.4 (7/98) | NOx, CO, VOC and PM Emissions | | | | |
| Mass Balance | SO2 Emissions | | | | |
| Heater Size | | Natural Gas | | | |
| 600000 | BTU/hr | Heat Rate | | 945 | BTU/scf |
| 634.9 | scf/hr | %sulfur | | 0.75 | grains/100 scf |

| | |
|---|---|
| Uncontrolled Hours | 8760 |
| Controlled Hours | 8760 |

Emission Factors

| | | |
|---|---|---|
| NOx | 100.0 | lbs/10^6 scf |
| CO | 84.0 | lbs/10^6 scf |
| VOC | 11.0 | lbs/10^6 scf |
| SO2 | 0.75 | grains/100 scf |
| PM | 7.6 | lbs/10^6 scf |

Calculated Uncontrolled Emissions

| | | | | |
|---|---|---|---|---|
| NOx | 0.063 | lbs/hr | 0.28 | tpy |
| CO | 0.053 | lbs/hr | 0.23 | tpy |
| VOC | 0.0070 | lbs/hr | 0.031 | tpy |
| SOx | 0.00068 | lbs/hr | 0.0030 | tpy |
| PM | 0.0048 | lbs/hr | 0.021 | tpy |

Calculated Controlled Emissions

| | | | | |
|---|---|---|---|---|
| NOx | 0.063 | lbs/hr | 0.28 | tpy |
| CO | 0.053 | lbs/hr | 0.23 | tpy |
| VOC | 0.0070 | lbs/hr | 0.031 | tpy |
| SOx | 0.00068 | lbs/hr | 0.0030 | tpy |
| PM | 0.0048 | lbs/hr | 0.021 | tpy |

**Roper Construction, Inc Alto Concrete Batch Plant Emissions Inventory**
**125 CuFt/Hr; 50,000 CuFt per Year**
**Emission Totals**

**Uncontrolled Emission Totals**

| ID # | Source Description | NOx | | CO | | SO2 | | VOC | | PM | | PM10 | | PM2.5 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | lbs/hr | tons/yr | lbs/hr | tons/yr | lbs/hr | tons/yr | lbs/hr | tons/yr | lbs/hr | tons/yr | lbs/hr | tons/yr | lbs/hr | tons/yr |
| 1 | Haul Road | | | | | | | | | 21.9 | 96.0 | 5.59 | 24.5 | 0.56 | 2.45 |
| 2 | Feeder Hopper | | | | | | | | | 0.83 | 3.66 | 0.39 | 1.73 | 0.060 | 0.26 |
| 3 | Feed Hopper Conveyor | | | | | | | | | 0.56 | 2.46 | 0.21 | 0.90 | 0.031 | 0.14 |
| 4 | 4-Bin Aggregate Bin | | | | | | | | | 0.56 | 2.46 | 0.21 | 0.90 | 0.031 | 0.14 |
| 5,6 | Aggregate Weigh Batcher and Conveyor | | | | | | | | | 0.56 | 2.46 | 0.21 | 0.90 | 0.031 | 0.14 |
| 7 | Truck Loading | | | | | | | | | 43.4 | 190.1 | 12.0 | 52.7 | 2.16 | 9.48 |
| 8 | Cement/Fly Ash Batcher | | | | | | | | | 22.2 | 97.2 | 6.05 | 26.5 | 1.20 | 5.25 |
| 9 | Cement Split Silo | | | | | | | | | 22.3 | 97.7 | 14.4 | 62.9 | 2.84 | 12.5 |
| 10 | Fly Ash Split Silo | | | | | | | | | 25.9 | 113.5 | 25.9 | 113.5 | 9.08 | 39.7 |
| 11 | Aggregate/Sand Storage Piles | | | | | | | | | 1.09 | 4.78 | 0.52 | 2.26 | 0.078 | 0.34 |
| 12 | Concrete Batch Plant Heater | 0.063 | 0.28 | 0.053 | 0.23 | 0.00068 | 0.0030 | 0.0070 | 0.031 | 0.0048 | 0.021 | 0.0048 | 0.021 | 0.0048 | 0.021 |
| | **Total** | **0.063** | **0.28** | **0.053** | **0.23** | **0.00068** | **0.0030** | **0.0070** | **0.031** | **139** | **610** | **65** | **287** | **16.1** | **70** |

**Controlled Emission Totals**

| ID # | Source Description | NOx | | CO | | SO2 | | VOC | | PM | | PM10 | | PM2.5 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | lbs/hr | tons/yr | lbs/hr | tons/yr | lbs/hr | tons/yr | lbs/hr | tons/yr | lbs/hr | tons/yr | lbs/hr | tons/yr | lbs/hr | tons/yr |
| 1 | Haul Road | | | | | | | | | 1.10 | 0.18 | 0.28 | 0.045 | 0.028 | 0.0045 |
| 2 | Feeder Hopper | | | | | | | | | 0.83 | 0.12 | 0.39 | 0.055 | 0.060 | 0.0083 |
| 3 | Feed Hopper Conveyor | | | | | | | | | 0.026 | 0.0053 | 0.0086 | 0.0017 | 0.0024 | 0.00049 |
| 4 | 4-Bin Aggregate Bin | | | | | | | | | 0.026 | 0.0053 | 0.0086 | 0.0017 | 0.0024 | 0.00049 |
| 5,6 | Aggregate Weigh Batcher and Conveyor | | | | | | | | | 0.026 | 0.0053 | 0.0086 | 0.0017 | 0.0024 | 0.00049 |
| 7,8 | Truck Loading and Cement/Fly Ash Batcher Baghouse | | | | | | | | | 0.066 | 0.013 | 0.018 | 0.0036 | 0.0032 | 0.00060 |
| 9 | Cement Split Silo Bahouse | | | | | | | | | 0.022 | 0.0045 | 0.014 | 0.0029 | 0.0033 | 0.00057 |
| 10 | Fly Ash Split Silo Baghouse | | | | | | | | | 0.026 | 0.0052 | 0.0091 | 0.0018 | 0.0021 | 0.00036 |
| 11 | Aggregate/Sand Storage Piles | | | | | | | | | 1.09 | 0.15 | 0.52 | 0.072 | 0.078 | 0.011 |
| 12 | Concrete Batch Plant Heater | 0.063 | 0.28 | 0.053 | 0.23 | 0.00068 | 0.0030 | 0.0070 | 0.031 | 0.0048 | 0.021 | 0.0048 | 0.021 | 0.0048 | 0.021 |
| | **Total** | **0.063** | **0.28** | **0.053** | **0.23** | **0.00068** | **0.0030** | **0.0070** | **0.031** | **3.22** | **0.50** | **1.26** | **0.21** | **0.19** | **0.048** |

ROPER CONSTRUCTION, INC.
ALTO PLANT NM HWY 220
PLANT CAPACITY 125 YDS PER HOUR

| UNIT No. | COMPONENT | MANUFACTURER | MANF DATE | MODEL No. | CAPACITY | MANF EMISION FACTOR | |
|---|---|---|---|---|---|---|---|
| 1 | CEMENT BATCHER | JEL MANUFACTURING | TBD | TBD | 12 YDS -- 10,000 LBS | | |
| 2 | 1,000 BBL SPLIT SILO | JEL MANUFACTURING | TBD | TBD | 1,000 BBL | | TOP SILO HT 69 FT |
| 3 | CEMENT SILO BAGHOUSE | WAM SILOTOP ZERO | TBD | TBD | 264 SF FILTER SURFACE | 99.99% | |
| 4 | FLYASH SILO BAGHOUSE | WAM SILOTOP ZERO | TBD | TBD | 264 SF FILTER SURFACE | 99.99% | |
| 5 | AGGREGATE BATCHER | JEL MANUFACTURING | TBD | TBD | 12 YDS | | |
| 6 | 4 COMPART OH AGG BIN | JEL MANUFACTURING | TBD | TBD | 120 TONS | | |
| 7 | CHARGE CONVEYOR | JEL MANUFACTURING | TBD | TBD | 550 TONS/HOUR | | |
| 8 | FEED CONVEYOR | JEL MANUFACTURING | TBD | TBD | 340 TONS/HOUR | | |
| 9 | FEED HOPPER | JEL MANUFACTURING | TBD | TBD | 300 Cu Ft | | |
| 10 | TRUCK PICKUP DUST COLLECTOR | REX | | 200DCS | 4,500 CFM | 99.99% | |
| 11 | 3 -- INSTANT HOT WATER HEATERS | NAVIEN | TBD | TBD | 199,900 BTU X 3 | | |

| | |
|---|---|
| F1 | 1000 GAL DIESEL TANK |
| F2 | 1000 GAL DIESEL TANK |
| F3 | 1000 GAL DIESEL TANK |

POWER SOURCE IS LINE 480 VAC POWER

DUST FILTRATION DUST FILTRATION

# Silo Venting Filters
# SILOTOP™ zero


WAMGROUP®

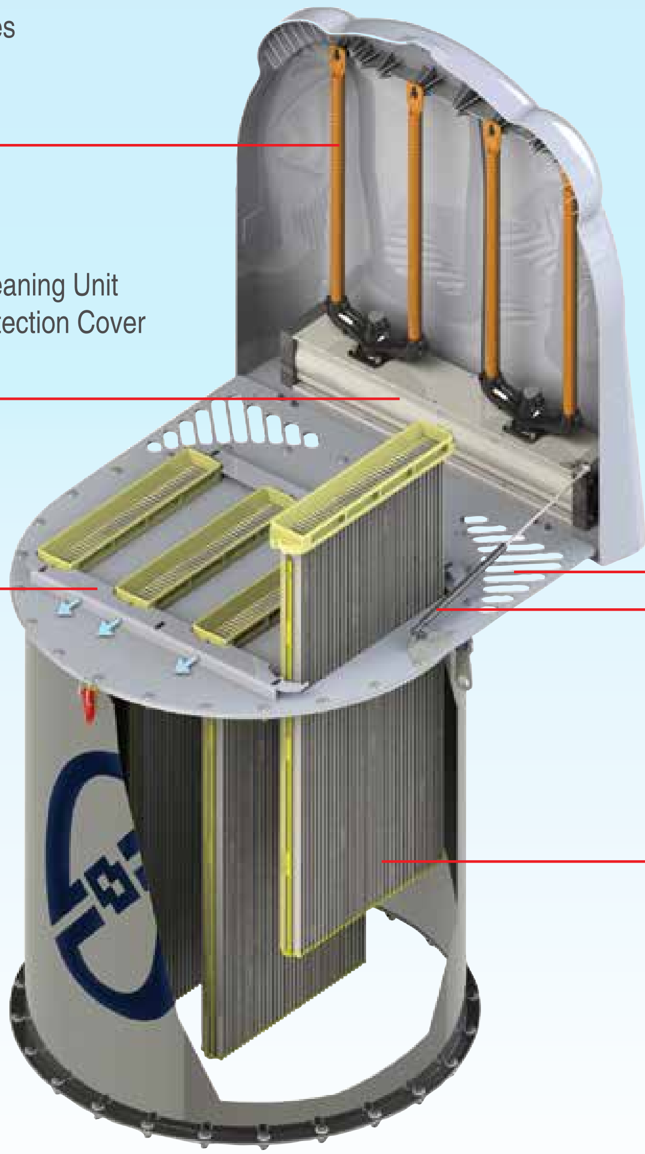
WAM®

# CUTTING-EDGE DUST FILTRATION TECHNOLOGY

**SILOTOP™zero** is a cylindrically shaped dust collector for venting pneumatically filled silos. Its stainless steel body contains vertically mounted POLYPLEAT™ filter elements. The air jet cleaning system is integrated into the hinged weather protection cover.

Dust separated from the air flow by special filter elements drops back into the silo after an integrated automatic pulse-jet air cleaning system has removed it from the filter media.

Air filtration capacity has been increased through new high performance filter media, which require less filter surface area. This results in a lower pressure drop and filtration efficiencies up to 99.99%.




SILOTOP™zero 150 ft²

SILOTOP™zero 264 ft²

Easy and safe dust emission sampling

Sampling pipe extension not supplied

## Overall Dimensions

| CODE | BODY Ø in | FILTER SURFACE ft² | MAX. HEIGHT WHEN CLOSED in | MAX. HEIGHT WHEN OPEN in | WEIGHT lbs |
|---|---|---|---|---|---|
| SILAB 14 | 32 | 150 | 73 | 44 | 150 |
| SILAB 24 | 32 | 264 | 73 | 44 | 174 |

## Features

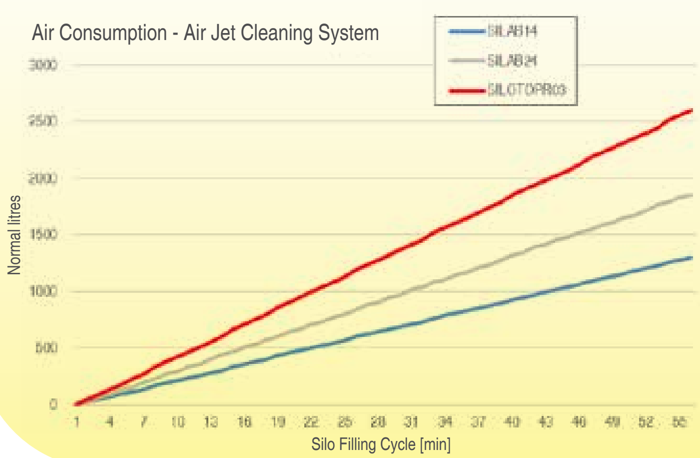
- Filtration efficiency up to 99.99% due to **filter media certified EN ISO 16890-1:2016, Group ISO ePM $_{2.5}$ 65%**
- Air flow **performance increased** by 30%
- **Compact** 30 in diameter stainless steel body with bottom flange
- **Maintenance-free** air jet cleaning unit integrated into weather protection cover
- Maintenance height = 44 in
- **Extended durability** due to zero filter media POLYPLEAT™ elements
- **Safe** weather protection cover with **lockable quick release**

**Easy and Safe Maintenance**

## Benefits

- **Perfectly accessible due to compact design**
- **Rugged construction**
- **Lightweight POLYPLEAT™ filter elements easily replaceable by one operator only**
- **Eco-friendly zero filter media**

### Economic Savings Using zero Filter Media




- **Up to 50% lower annual management costs due to lower air consumption**
- **Up to 30% savings in spare parts**
- **Up to 20% savings in silo filling time (in standard test conditions)**

## Accessories

- Weld-on bottom ring
- Multifunctional electronic differential pressure meter
- Winter protection for solenoid valves
- Emission sampling kit

# Application

February 2019    Rights reserved to modify technical specifications.

WAM® MAP™ SPECO® TOREX® EXTRAC™ RONCUZZI™ FLITECH® SEPCOM®

TECNO CM™ SILOFAB™ OWC™ MVM™ SAVI® SAVECO™ Enviro-Care® A WAMGROUP® Company

UNI EN ISO 9001
Certified Company

WAM®

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