Estimates for State Toxic Air Pollutants (Calcium Hydroxide)

A potential mineral filler that will be used is lime (calcium hydroxide). Calcium hydroxide is listed in the NMED's 20.2.72 NMAC, 502 "Toxic Air Pollutants and Emissions", Table A. Controlled emissions of lime from the mineral filler silo during loading is 0.18 pounds per hour.

Estimates for Federal HAPs Air Pollutants

The Hot Mix Asphalt Plant (HMA) drum dryer (Unit 68), asphalt heater (Unit 72), HMA plant generator/engine (Unit 74), and HMA plant standby generator/engine (Unit 75) are sources of HAPs as it appears in Section 112 (b) of the 1990 CAAA. Emissions of HAPs were determined for the drum mixer using AP-42 Section 11.1 Tables 11.1-10, 11.1-12. Emissions of HAPs were determined for the main and standby plant generators using AP-42 Section 3.3 and Section 1.3. Emissions of HAPs were determined for the asphalt heaters using AP-42 Section 1.3.

The following tables summarize the HAPs emission rates from the drum mixer, HMA plant generator/engine, HMA plant standby generator/engine, and asphalt heater. Total combined HAPs emissions from Kirtland HMA is 4.26 pounds per hour and 2.11 tons per year.

Table 6-32: HAPs Emission Rates from the Drum Dryer/Mixer

EPA HAPS Emissions Drum Mixer Hot Mix Asphalt Plant with Fabric Filter

Average Hourly Production Rate:	400	tons per hour
Yearly Production Rate:	400000	tons per year

Type of Fuel:	Waste Fuel Oil
Emission Factors	AP-42 Section 11.1 Tables 11.1-10, 11.1-12

Non-PAH HAPS	**CAS#**		**Emission Factor (lbs/ton)**	**Emission Rate (lbs/hr)**	**Emission Rate (ton/yr)**
Acetalehyde	75-07-0		1.3E-03	0.520000	0.260000
Acrolein	107-02-8		2.6E-05	0.010400	0.005200
Benzene	71-43-2		3.9E-04	0.156000	0.078000
Ethylbenzene	100-41-4		2.4E-04	0.096000	0.048000
Formaldehyde	50-00-0		3.1E-03	1.240000	0.620000
Hexane	110-54-3		9.2E-04	0.368000	0.184000
Isooctane	540-84-1		4.0E-05	0.016000	0.008000
Methyl Ethyl Ketone	78-93-3		2.0E-05	0.008000	0.004000
Propionaldehyde	123-38-6		1.3E-04	0.052000	0.026000
Quinone	106-51-4		1.6E-04	0.064000	0.032000
Methyl chorlform	71-55-6		4.8E-05	0.019200	0.009600
Toluene	108-88-3		2.9E-03	1.160000	0.580000
Xylene	1330-20-7		2.0E-04	0.080000	0.040000
		Total Non-PAH HAPS	9.5E-03	3.789600	1.894800

PAH HAPS	**CAS#**		**Emission Factor (lbs/ton)**	**Emission Rate (lbs/hr)**	**Emission Rate (ton/yr)**
2-Methylnaphthalene	91-57-6		1.7E-04	0.068000	0.034000
Acenaphthene	83-32-9		1.4E-06	0.000560	0.000280
Acenaphthylene	208-96-8		2.2E-05	0.008800	0.004400
Anthracene	120-12-7		3.1E-06	0.001240	0.000620
Benzo(a)anthracene	56-55-3		2.1E-07	0.000084	0.000042
Benzo(a)pyrene	50-32-8		9.8E-09	0.000004	0.000002
Benzo(b)fluoranthene	205-99-2		1.0E-07	0.000040	0.000020
Benzo(b)pyrene	192-97-2		1.1E-07	0.000044	0.000022
Benzo(g,h,I)perylene	191-24-2		4.0E-08	0.000016	0.000008
Benzo(k)fluoranthene	207-08-9		4.1E-08	0.000016	0.000008
Chrysene	218-01-9		1.8E-07	0.000072	0.000036
Fluoranthene	206-44-0		6.1E-07	0.000244	0.000122
Fluorene	86-73-7		1.1E-05	0.004400	0.002200
Indeno(1,2,3-cd)pyrene	193-39-5		7.0E-09	0.000003	0.000001
Naphthalene	91-20-3		6.5E-04	0.260000	0.130000
Perylene	198-55-0		8.8E-09	0.000004	0.000002
Phenanthrene	85-01-8		2.3E-05	0.009200	0.004600
Pyrene	129-00-0		3.0E-06	0.001200	0.000600
		Total PAH HAPS	8.8E-04	0.353927	0.176963

HAPS Metals		**Emission Factor (lbs/ton)**	**Emission Rate (lbs/hr)**	**Emission Rate (ton/yr)**
Arsenic		5.6E-07	0.000224	0.000112
Beryllium		0.0E+00	0.000000	0.000000
Cadmium		4.1E-07	0.000164	0.000082
Chromium		5.5E-06	0.002200	0.001100
Cobalt		2.6E-08	0.000010	0.000005
Hexavalent Chromium		4.5E-07	0.000180	0.000090
Lead		1.5E-05	0.006000	0.003000
Manganese		7.7E-06	0.003080	0.001540
Mercury		2.6E-06	0.001040	0.000520
Nickel		6.3E-05	0.025200	0.012600
Phosphorus		2.8E-05	0.011200	0.005600
Selenium		3.5E-07	0.000140	0.000070
	Total Metals HAPS	1.2E-04	0.049438	0.024719
	Total HAPS		**4.19**	**2.10**

Table 6-33: HAPs Emission Rates from the HMA Plant Main Generator (74)

Horsepower Rating:	1429	horsepower	
Fuel Usage:	72.6	gallons/hr	
MMBtu/hr:	9.2928	Btu	(based on 128000 Btu/gallon)
Btu x 10^-12/hr:	9.2928E-06	Btu x10^-12	(based on 128000 Btu/gallon)
Yearly Operating Hours:	4800	hours per year	

Type of Fuel:	Diesel
Emission Factors	AP-42 Section 3.3 and Section 1.3

Non-PAH HAPS	**CAS#**		**Emission Factor (lbs/mmBtu)**	**Emission Rate (lbs/hr)**	**Emission Rate (ton/yr)**
Acetalehyde	75-07-0		7.67E-04	0.007128	0.017106
Acrolein	107-02-8		9.25E-05	0.000860	0.002063
Benzene	71-43-2		9.33E-04	0.008670	0.020808
1,3-Butadiene	106-99-0		3.91E-05	0.000363	0.000872
Formaldehyde	50-00-0		1.18E-03	0.010966	0.026317
Propylene	115-07-1		2.58E-03	0.023975	0.057541
Toluene	108-88-3		4.09E-04	0.003801	0.009122
Xylene	1330-20-7		2.85E-04	0.002648	0.006356
		Total Non-PAH HAPS	6.29E-03	0.058411	0.140186

PAH HAPS	**CAS#**		**Emission Factor (lbs/mmBtu)**	**Emission Rate (lbs/hr)**	**Emission Rate (ton/yr)**
Acenaphthene	83-32-9		1.42E-06	0.000013	0.000032
Acenaphthylene	208-96-8		5.06E-06	0.000047	0.000113
Anthracene	120-12-7		1.87E-06	0.000017	0.000042
Benzo(a)anthracene	56-55-3		1.68E-06	0.000016	0.000037
Benzo(a)pyrene	50-32-8		1.88E-07	0.000002	0.000004
Benzo(b)fluoranthene	205-99-2		9.91E-08	0.000001	0.000002
Benzo(a)pyrene	192-97-2		1.55E-07	0.000001	0.000003
Benzo(g,h,I)perylene	191-24-2		4.89E-07	0.000005	0.000011
Benzo(k)fluoranthene	207-08-9		1.55E-07	0.000001	0.000003
Dibenz(a,h)anthracene			5.83E-07	0.000005	0.000013
Chrysene	218-01-9		3.53E-07	0.000003	0.000008
Fluoranthene	206-44-0		7.61E-06	0.000071	0.000170
Fluorene	86-73-7		2.92E-05	0.000271	0.000651
Indeno(1,2,3-cd)pyrene	193-39-5		3.75E-07	0.000003	0.000008
Naphthalene	91-20-3		8.48E-05	0.000788	0.001891
Phenanthrene	85-01-8		2.94E-05	0.000273	0.000656
Pyrene	129-00-0		4.78E-06	0.000044	0.000107
		Total PAH HAPS	1.68E-04	0.001563	0.003752

HAPS Metals		**Emission Factor (lbs/Btu^12)**	**Emission Rate (lbs/hr)**	**Emission Rate (ton/yr)**
Arsenic		4	0.000037	0.000089
Beryllium		3	0.000028	0.000067
Cadmium		3	0.000028	0.000067
Chromium		3	0.000028	0.000067
Lead		9	0.000084	0.000201
Manganese		6	0.000056	0.000134
Mercury		3	0.000028	0.000067
Nickel		3	0.000028	0.000067
Selenium		15	0.000139	0.000335
	Total Metals HAPS	49	0.000455	0.001093
	Total HAPS		**0.060**	**0.011**

Table 6-34: HAPs Emission Rates from the HMA Plant Standby Generator (75)

Horsepower Rating:	158	horsepower	
Fuel Usage:	6.1	gallons/hr	
MMBtu/hr:	0.7808	Btu	(based on 128000 Btu/gallon)
Btu x 10^-12/hr:	7.808E-07	Btu x10^-12	(based on 128000 Btu/gallon)
Yearly Operating Hours:	3960	hours per year	

Type of Fuel:	Diesel
Emission Factors	AP-42 Section 3.3 and Section 1.3

Non-PAH HAPS	**CAS#**		**Emission Factor (lbs/mmBtu)**	**Emission Rate (lbs/hr)**	**Emission Rate (ton/yr)**
Acetalehyde	75-07-0		7.67E-04	0.000599	0.001186
Acrolein	107-02-8		9.25E-05	0.000072	0.000143
Benzene	71-43-2		9.33E-04	0.000728	0.001442
1,3-Butadiene	106-99-0		3.91E-05	0.000031	0.000060
Formaldehyde	50-00-0		1.18E-03	0.000921	0.001824
Propylene	115-07-1		2.58E-03	0.002014	0.003989
Toluene	108-88-3		4.09E-04	0.000319	0.000632
Xylene	1330-20-7		2.85E-04	0.000223	0.000441
		Total Non-PAH HAPS	6.29E-03	0.004908	0.009717

PAH HAPS	**CAS#**		**Emission Factor (lbs/mmBtu)**	**Emission Rate (lbs/hr)**	**Emission Rate (ton/yr)**
Acenaphthene	83-32-9		1.42E-06	0.000001	0.000002
Acenaphthylene	208-96-8		5.06E-06	0.000004	0.000008
Anthracene	120-12-7		1.87E-06	0.000001	0.000003
Benzo(a)anthracene	56-55-3		1.68E-06	0.000001	0.000003
Benzo(a)pyrene	50-32-8		1.88E-07	0.000000	0.000000
Benzo(b)fluoranthene	205-99-2		9.91E-08	0.000000	0.000000
Benzo(a)pyrene	192-97-2		1.55E-07	0.000000	0.000000
Benzo(g,h,I)perylene	191-24-2		4.89E-07	0.000000	0.000001
Benzo(k)fluoranthene	207-08-9		1.55E-07	0.000000	0.000000
Dibenz(a,h)anthracene			5.83E-07	0.000000	0.000001
Chrysene	218-01-9		3.53E-07	0.000000	0.000001
Fluoranthene	206-44-0		7.61E-06	0.000006	0.000012
Fluorene	86-73-7		2.92E-05	0.000023	0.000045
Indeno(1,2,3-cd)pyrene	193-39-5		3.75E-07	0.000000	0.000001
Naphthalene	91-20-3		8.48E-05	0.000066	0.000131
Phenanthrene	85-01-8		2.94E-05	0.000023	0.000045
Pyrene	129-00-0		4.78E-06	0.000004	0.000007
		Total PAH HAPS	1.68E-04	0.000131	0.000260

HAPS Metals		**Emission Factor (lbs/Btu^12)**	**Emission Rate (lbs/hr)**	**Emission Rate (ton/yr)**
Arsenic		4	0.000003	0.000006
Beryllium		3	0.000002	0.000005
Cadmium		3	0.000002	0.000005
Chromium		3	0.000002	0.000005
Lead		9	0.000007	0.000014
Manganese		6	0.000005	0.000009
Mercury		3	0.000002	0.000005
Nickel		3	0.000002	0.000005
Selenium		15	0.000012	0.000023
	Total Metals HAPS	49	0.000038	0.000076
	Total HAPS		**0.0051**	**0.00078**

Table B-35: HAPs Emission Rates from the Asphalt Heater

Btu Rating	1.0	MMBtu/hr	(based on 128000 Btu/gallon)
Fuel Usage:	7.8	gallons/hr	
Btu x 10^-12/hr:	0.000001	Btu x10^-12	(based on 128000 Btu/gallon)
Yearly Operating Hours:	8760	hours per year	

Type of Fuel:	Diesel
Emission Factors	AP-42 Section 1.3

Organic Compounds	**CAS#**		**Emission Factor (lbs/10^3 gal)**	**Emission Rate (lbs/hr)**	**Emission Rate (ton/yr)**
Acenaphthene	83-32-9		2.11E-05	0.000000	0.000001
Acenaphthylene	208-96-8		2.53E-07	0.000000	0.000000
Anthracene	120-12-7		1.22E-06	0.000000	0.000000
Benzene	71-43-2		2.14E-04	0.000002	0.000007
Benzo(a)anthracene	56-55-3		4.01E-06	0.000000	0.000000
Benzo(b,k)fluoranthene	205-99-2		1.48E-06	0.000000	0.000000
Benzo(g,h,I)perylene	191-24-2		2.26E-06	0.000000	0.000000
Chrysene	218-01-9		2.38E-06	0.000000	0.000000
Dibenz(a,h)anthracene			1.67E-06	0.000000	0.000000
Ethylbenzene	100-41-4		6.36E-05	0.000000	0.000002
Fluoranthene	206-44-0		4.84E-06	0.000000	0.000000
Fluorene	86-73-7		4.47E-06	0.000000	0.000000
Formaldehyde	50-00-0		6.10E-02	0.000476	0.002084
Indeno(1,2,3-cd)pyrene	193-39-5		2.14E-06	0.000000	0.000000
Naphthalene	91-20-3		1.13E-03	0.000009	0.000039
Phenanthrene	85-01-8		1.05E-05	0.000000	0.000000
Pyrene	129-00-0		4.25E-06	0.000000	0.000000
Toluene	108-88-3		6.20E-03	0.000048	0.000212
Xylene	1330-20-7		1.09E-04	0.000001	0.000004
		Total Organic Compounds	6.88E-02	0.000536	0.002350

HAPS Metals		**Emission Factor (lbs/Btu^12)**	**Emission Rate (lbs/hr)**	**Emission Rate (ton/yr)**
Arsenic		4	0.000004	0.000018
Beryllium		3	0.000003	0.000013
Cadmium		3	0.000003	0.000013
Chromium		3	0.000003	0.000013
Lead		9	0.000009	0.000039
Manganese		6	0.000006	0.000026
Mercury		3	0.000003	0.000013
Nickel		3	0.000003	0.000013
Selenium		15	0.000015	0.000066
	Total Metals HAPS	49	0.000049	0.000215
	Total HAPS		**0.0011**	**0.0026**

Section 6.a

Green House Gas Emissions

(Submitting under 20.2.70, 20.2.72 20.2.74 NMAC)

Title V (20.2.70 NMAC), Minor NSR (20.2.72 NMAC), and PSD (20.2.74 NMAC) applicants must estimate and report greenhouse gas (GHG) emissions to verify the emission rates reported in the public notice, determine applicability to 40 CFR 60 Subparts, and to evaluate Prevention of Significant Deterioration (PSD) applicability. GHG emissions that are subject to air permit regulations consist of the sum of an aggregate group of these six greenhouse gases: carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6).

Calculating GHG Emissions:

1. Calculate the ton per year (tpy) GHG mass emissions and GHG CO_2e emissions from your facility.
2. GHG mass emissions are the sum of the total annual tons of greenhouse gases without adjusting with the global warming potentials (GWPs). GHG CO_2e emissions are the sum of the mass emissions of each individual GHG multiplied by its GWP found in Table A-1 in 40 CFR 98 Mandatory Greenhouse Gas Reporting.
3. Emissions from routine or predictable start up, shut down, and maintenance must be included.
4. Report GHG mass and GHG CO_2e emissions in Table 2-P of this application. Emissions are reported in **short** tons per year and represent each emission unit's Potential to Emit (PTE).
5. All Title V major sources, PSD major sources, and all power plants, whether major or not, must calculate and report GHG mass and CO2e emissions for each unit in Table 2-P.
6. For minor source facilities that are not power plants, are not Title V, and are not PSD there are three options for reporting GHGs in Table 2-P: 1) report GHGs for each individual piece of equipment; 2) report all GHGs from a group of unit types, for example report all combustion source GHGs as a single unit and all venting GHGs as a second separate unit; 3) or check the following ☐ By checking this box, the applicant acknowledges the total CO2e emissions are less than 75,000 tons per year.

Sources for Calculating GHG Emissions:

- Manufacturer's Data
- AP-42 Compilation of Air Pollutant Emission Factors at http://www.epa.gov/ttn/chief/ap42/index.html
- EPA's Internet emission factor database WebFIRE at http://cfpub.epa.gov/webfire/
- 40 CFR 98 Mandatory Green House Gas Reporting except that tons should be reported in short tons rather than in metric tons for the purpose of PSD applicability.
- API Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Natural Gas Industry. August 2009 or most recent version.
- Sources listed on EPA's NSR Resources for Estimating GHG Emissions at http://www.epa.gov/nsr/clean-air-act-permitting-greenhouse-gases:

Global Warming Potentials (GWP):
Applicants must use the Global Warming Potentials codified in Table A-1 of the most recent version of 40 CFR 98 Mandatory Greenhouse Gas Reporting. The GWP for a particular GHG is the ratio of heat trapped by one unit mass of the GHG to that of one unit mass of CO_2 over a specified time period.

"Greenhouse gas" for the purpose of air permit regulations is defined as the aggregate group of the following six gases: carbon dioxide, nitrous oxide, methane, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. **(20.2.70.7 NMAC, 20.2.74.7 NMAC).** You may also find GHGs defined in 40 CFR 86.1818-12(a).

Metric to Short Ton Conversion:
Short tons for GHGs and other regulated pollutants are the standard unit of measure for PSD and title V permitting programs. 40 CFR 98 Mandatory Greenhouse Reporting requires metric tons.
1 metric ton = 1.10231 short tons (per Table A-2 to Subpart A of Part 98 – Units of Measure Conversions)

Section 7

Information Used To Determine Emissions

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.
- ■ 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.

A-XXXX-7-AP42S1-3and S1-5	Asphalt Heater Combustion and HAPs Emission Factors
A-XXXX-7-AP42S1-3	Diesel-Fired Engine HAPs Emission Factors
A-XXXX-7-AP42S3-3	Diesel-Fired Engine HAPs Emission Factors
A-XXXX-7-AP42S3-4	Diesel-Fired Engine HAPs Emission Factors
A-XXXX-7-AP42S11-1	HMA Plant and HAPs Emission Factors
A-XXXX-7-AP42S11-12	Mineral Filler Silo Emission Factors
A-XXXX-7-AP42S11-19-2	Crushers, Screens, and 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-ii03	EIIP Volume II Chapter 03
A-XXXX-7-WindspeedsNewMexico	Farmington Wind Speed Annual Average 1996 to 2006
A-XXXX-7-1429	Unit 34 and 74: Main Aggregate and HMA Plant Generators
A-XXXX-7-113	Unit 35: Aggregate Standby Generator
A-XXXX-7-475	Unit 50: Wash Plant Generator
A-XXXX-7-Tier3	Unit 75: HMA Standby Generator
A-XXXX-7-ACTANK1and2	Unit 73: Asphalt Cement Storage Tanks (2)
A-XXXX-7-AggPlant.xls	Kirtland Aggregate Plant Emissions Spreadsheet
A-XXXX-7-HMA.xls	Kirtland HMA Plant Emissions Spreadsheet

1.3 Fuel Oil Combustion

1.3.1 General[1-3]

Two major categories of fuel oil are burned by combustion sources: distillate oils and residual oils. These oils are further distinguished by grade numbers, with Nos. 1 and 2 being distillate oils; Nos. 5 and 6 being residual oils; and No. 4 being either distillate oil or a mixture of distillate and residual oils. No. 6 fuel oil is sometimes referred to as Bunker C. Distillate oils are more volatile and less viscous than residual oils. They have negligible nitrogen and ash contents and usually contain less than 0.3 percent sulfur (by weight). Distillate oils are used mainly in domestic and small commercial applications, and include kerosene and diesel fuels. Being more viscous and less volatile than distillate oils, the heavier residual oils (Nos. 5 and 6) may need to be heated for ease of handling and to facilitate proper atomization. Because residual oils are produced from the residue remaining after the lighter fractions (gasoline, kerosene, and distillate oils) have been removed from the crude oil, they contain significant quantities of ash, nitrogen, and sulfur. Residual oils are used mainly in utility, industrial, and large commercial applications.

1.3.2 Firing Practices[4]

The major boiler configurations for fuel oil-fired combustors are watertube, firetube, cast iron, and tubeless design. Boilers are classified according to design and orientation of heat transfer surfaces, burner configuration, and size. These factors can all strongly influence emissions as well as the potential for controlling emissions.

Watertube boilers are used in a variety of applications ranging from supplying large amounts of process steam to providing space heat for industrial facilities. In a watertube boiler, combustion heat is transferred to water flowing through tubes which line the furnace walls and boiler passes. The tube surfaces in the furnace (which houses the burner flame) absorb heat primarily by radiation from the flames. The tube surfaces in the boiler passes (adjacent to the primary furnace) absorb heat primarily by convective heat transfer.

Firetube boilers are used primarily for heating systems, industrial process steam generators, and portable power boilers. In firetube boilers, the hot combustion gases flow through the tubes while the water being heated circulates outside of the tubes. At high pressures and when subjected to large variations in steam demand, firetube units are more susceptible to structural failure than watertube boilers. This is because the high-pressure steam in firetube units is contained by the boiler walls rather than by multiple small-diameter watertubes, which are inherently stronger. As a consequence, firetube boilers are typically small and are used primarily where boiler loads are relatively constant. Nearly all firetube boilers are sold as packaged units because of their relatively small size.

A cast iron boiler is one in which combustion gases rise through a vertical heat exchanger and out through an exhaust duct. Water in the heat exchanger tubes is heated as it moves upward through the tubes. Cast iron boilers produce low pressure steam or hot water, and generally burn oil or natural gas. They are used primarily in the residential and commercial sectors.

Another type of heat transfer configuration used on smaller boilers is the tubeless design. This design incorporates nested pressure vessels with water in between the shells. Combustion gases are fired into the inner pressure vessel and are then sometimes recirculated outside the second vessel.

Table 1.3-1. (cont.)

Firing Configuration (SCC)[a]	SO$_2$[b]		SO$_3$[c]		NO$_x$[d]		CO[e]		Filterable PM[f]	
	Emission Factor (lb/10^3 gal)	EMISSION FACTOR RATING	Emission Factor (lb/10^3 gal)	EMISSION FACTOR RATING	Emission Factor (lb/10^3 gal)	EMISSION FACTOR RATING	Emission Factor (lb/10^3 gal)	EMISSION FACTOR RATING	Emission Factor (lb/10^3 gal)	EMISSION FACTOR RATING
Boilers < 100 Million Btu/hr										
No. 6 oil fired (1-02-004-02/03) (1-03-004-02/03)	157S	A	2S	A	55	A	5	A	9.19(S)+3.22[i]	B
No. 5 oil fired (1-03-004-04)	157S	A	2S	A	55	A	5	A	10[i]	A
No. 4 oil fired (1-03-005-04)	150S	A	2S	A	20	A	5	A	7	B
Distillate oil fired (1-02-005-02/03) (1-03-005-02/03)	142S	A	2S	A	20	A	5	A	2	A
Residential furnace (A2104004/A2104011)	142S	A	2S	A	18	A	5	A	0.4[g]	B

[a] To convert from lb/103 gal to kg/103 L, multiply by 0.120. SCC = Source Classification Code.

[b] References 1-2,6-9,14,56-60. S indicates that the weight % of sulfur in the oil should be multiplied by the value given. For example, if the fuel is 1% sulfur, then S = 1.

[c] References 1-2,6-8,16,57-60. S indicates that the weight % of sulfur in the oil should be multiplied by the value given. For example, if the fuel is 1% sulfur, then S = 1.

[d] References 6-7,15,19,22,56-62. Expressed as NO2. Test results indicate that at least 95% by weight of NOx is NO for all boiler types except residential furnaces, where about 75% is NO. For utility vertical fired boilers use 105 lb/103 gal at full load and normal (>15%) excess air. Nitrogen oxides emissions from residual oil combustion in industrial and commercial boilers are related to fuel nitrogen content, estimated by the following empirical relationship: lb NO2 /103 gal = 20.54 + 104.39(N), where N is the weight % of nitrogen in the oil. For example, if the fuel is 1% nitrogen, then N = 1.

[e] References 6-8,14,17-19,56-61. CO emissions may increase by factors of 10 to 100 if the unit is improperly operated or not well maintained.

[f] References 6-8,10,13-15,56-60,62-63. Filterable PM is that particulate collected on or prior to the filter of an EPA Method 5 (or equivalent) sampling train. Particulate emission factors for residual oil combustion are, on average, a function of fuel oil sulfur content where S is the weight % of sulfur in oil. For example, if fuel oil is 1% sulfur, then S = 1.

[g] Based on data from new burner designs. Pre-1970's burner designs may emit filterable PM as high as 3.0 1b/103 gal.

[h] The SO2 emission factor for both no. 2 oil fired and for no. 2 oil fired with LNB/FGR, is 142S, not 157S. Errata dated April 28, 2000. Section corrected May 2010.

[i] The PM factors for No.6 and No. 5 fuel were reversed. Errata dated April 28, 2000. Section corrected May 2010.

Table 1.3-2. CONDENSABLE PARTICULATE MATTER EMISSION FACTORS FOR OIL COMBUSTION[a]

Firing Configuration[b] (SCC)	Controls	CPM - TOT[c, d]		CPM - IOR[c, d]		CPM - ORG[c, d]	
		Emission Factor (lb/10^3 gal)	EMISSION FACTOR RATING	Emission Factor (lb/10^3 gal)	EMISSION FACTOR RATING	Emission Factor (lb/10^3 gal)	EMISSION FACTOR RATING
No. 2 oil fired (1-01-005-01, 1-02-005-01, 1-03-005-01)	All controls, or uncontrolled	1.3[d, e]	D	65% of CPM-TOT emission factor[c]	D	35% of CPM-TOT emission factor[c]	D
No. 6 oil fired (1-01-004-01/04, 1-02-004-01, 1-03-004-01)	All controls, or uncontrolled	1.5[f]	D	85% of CPM-TOT emission factor[d]	E	15% of CPM-TOT emission factor[d]	E

[a] All condensable PM is assumed to be less than 1.0 micron in diameter.

[b] No data are available for numbers 3, 4, and 5 oil. For number 3 oil, use the factors provided for number 2 oil. For numbers 4 and 5 oil, use the factors provided for number 6 oil.

[c] CPM-TOT = total condensable particulate matter.
CPM-IOR = inorganic condensable particulate matter.
CPM-ORG = organic condensable particulate matter.

[d] To convert to lb/MMBtu of No. 2 oil, divide by 140 MMBtu/10^3 gal. To convert to lb/MMBtu of No. 6 oil, divide by 150 MMBtu/10^3 gal.

[e] References: 76-78.

[f] References: 79-82.

Table 1.3-3. EMISSION FACTORS FOR TOTAL ORGANIC COMPOUNDS (TOC), METHANE, AND NONMETHANE TOC (NMTOC) FROM UNCONTROLLED FUEL OIL COMBUSTION[a]

EMISSION FACTOR RATING: A

Firing Configuration (SCC)	TOC[b] Emission Factor (lb/10^3 gal)	Methane[b] Emission Factor (lb/10^3 gal)	NMTOC[b] Emission Factor (lb/10^3 gal)
Utility boilers			
No. 6 oil fired, normal firing (1-01-004-01)	1.04	0.28	0.76
No. 6 oil fired, tangential firing (1-01-004-04)	1.04	0.28	0.76
No. 5 oil fired, normal firing (1-01-004-05)	1.04	0.28	0.76
No. 5 oil fired, tangential firing (1-01-004-06)	1.04	0.28	0.76
No. 4 oil fired, normal firing (1-01-005-04)	1.04	0.28	0.76
No. 4 oil fired, tangential firing (1-01-005-05)	1.04	0.28	0.76
Industrial boilers			
No. 6 oil fired (1-02-004-01/02/03)	1.28	1.00	0.28
No. 5 oil fired (1-02-004-04)	1.28	1.00	0.28
Distillate oil fired (1-02-005-01/02/03)	0.252	0.052	0.2
No. 4 oil fired (1-02-005-04)	0.252	0.052	0.2
Commercial/institutional/residential combustors			
No. 6 oil fired (1-03-004-01/02/03)	1.605	0.475	1.13
No. 5 oil fired (1-03-004-04)	1.605	0.475	1.13
Distillate oil fired (1-03-005-01/02/03)	0.556	0.216	0.34
No. 4 oil fired (1-03-005-04)	0.556	0.216	0.34
Residential furnace (A2104004/A2104011)	2.493	1.78	0.713

a To convert from lb/103 gal to kg/103 L, multiply by 0.12. SCC = Source Classification Code.

b References 29-32. Volatile organic compound emissions can increase by several orders of magnitude if the boiler is improperly operated or is not well maintained.

Table 1.3-9. EMISSION FACTORS FOR SPECIATED ORGANIC COMPOUNDS FROM FUEL OIL COMBUSTION[a]

Organic Compound	Average Emission Factor[b] (lb/10^3 Gal)	EMISSION FACTOR RATING
Benzene	2.14E-04	C
Ethylbenzene	6.36E-05[c]	E
Formaldehyde[d]	3.30E-02	C
Naphthalene	1.13E-03	C
1,1,1-Trichloroethane	2.36E-04[c]	E
Toluene	6.20E-03	D
o-Xylene	1.09E-04[c]	E
Acenaphthene	2.11E-05	C
Acenaphthylene	2.53E-07	D
Anthracene	1.22E-06	C
Benz(a)anthracene	4.01E-06	C
Benzo(b,k)fluoranthene	1.48E-06	C
Benzo(g,h,i)perylene	2.26E-06	C
Chrysene	2.38E-06	C
Dibenzo(a,h) anthracene	1.67E-06	D
Fluoranthene	4.84E-06	C
Fluorene	4.47E-06	C
Indo(1,2,3-cd)pyrene	2.14E-06	C
Phenanthrene	1.05E-05	C
Pyrene	4.25E-06	C
OCDD	3.10E-09[c]	E

[a] Data are for residual oil fired boilers, Source Classification Codes (SCCs) 1-01-004-01/04.

[b] References 64-72. To convert from lb/10^3 gal to kg/10^3 L, multiply by 0.12.

[c] Based on data from one source test (Reference 67).

[d] The formaldehyde number presented here is based only on data from utilities using No. 6 oil. The number presented in Table 1.3-7 is based on utility, commercial, and industrial boilers.

Table 1.3-10. EMISSION FACTORS FOR TRACE ELEMENTS FROM DISTILLATE FUEL OIL COMBUSTION SOURCES[a]

EMISSION FACTOR RATING: E

Firing Configuration (SCC)	Emission Factor (lb/10^{12} Btu)										
	As	Be	Cd	Cr	Cu	Pb	Hg	Mn	Ni	Se	Zn
Distillate oil fired (1-01-005-01, 1-02-005-01, 1-03-005-01)	4	3	3	3	6	9	3	6	3	15	4

[a] Data are for distillate oil fired boilers, SCC codes 1-01-005-01, 1-02-005-01, and 1-03-005-01. References 29-32, 40-44 and 83. To convert from lb/10^{12} Btu to pg/J, multiply by 0.43.

1.5 Liquefied Petroleum Gas Combustion

1.5.1 General[1]

Liquefied petroleum gas (LPG or LP-gas) consists of propane, propylene, butane, and butylenes; the product used for domestic heating is composed primarily of propane. This gas, obtained mostly from gas wells (but also, to a lesser extent, as a refinery by-product) is stored as a liquid under moderate pressures. There are three grades of LPG available as heating fuels: commercial-grade propane, engine fuel-grade propane (also known as HD-5 propane), and commercial-grade butane. In addition, there are high-purity grades of LPG available for laboratory work and for use as aerosol propellants. Specifications for the various LPG grades are available from the American Society for Testing and Materials and the Gas Processors Association. A typical heating value for commercial-grade propane and HD-5 propane is 90,500 British thermal units per gallon (Btu/gal), after vaporization; for commercial-grade butane, the value is 97,400 Btu/gal.

The largest market for LPG is the domestic/commercial market, followed by the chemical industry (where it is used as a petrochemical feedstock) and the agriculture industry. Propane is also used as an engine fuel as an alternative to gasoline and as a standby fuel for facilities that have interruptible natural gas service contracts.

1.5.2 Firing Practices[2]

The combustion processes that use LPG are very similar to those that use natural gas. Use of LPG in commercial and industrial applications may require a vaporizer to provide the burner with the proper mix of air and fuel. The burner itself will usually have different fuel injector tips as well as different fuel-to-air ratio controller settings than a natural gas burner since the LPG stoichiometric requirements are different than natural gas requirements. LPG is fired as a primary and backup fuel in small commercial and industrial boilers and space heating equipment and can be used to generate heat and process steam for industrial facilities and in most domestic appliances that typically use natural gas.

1.5.3 Emissions[1,3-5]

1.5.3.1 Criteria Pollutants -

LPG is considered a "clean" fuel because it does not produce visible emissions. However, gaseous pollutants such as nitrogen oxides (NO_x), carbon monoxide (CO), and organic compounds are produced as are small amounts of sulfur dioxide (SO_2) and particulate matter (PM). The most significant factors affecting NO_x, CO, and organic emissions are burner design, burner adjustment, boiler operating parameters, and flue gas venting. Improper design, blocking and clogging of the flue vent, and insufficient combustion air result in improper combustion and the emission of aldehydes, CO, hydrocarbons, and other organics. NO_x emissions are a function of a number of variables, including temperature, excess air, fuel and air mixing, and residence time in the combustion zone. The amount of SO_2 emitted is directly proportional to the amount of sulfur in the fuel. PM emissions are very low and result from soot, aerosols formed by condensable emitted species, or boiler scale dislodged during combustion. Emission factors for LPG combustion are presented in Table 1.5-1.

Table 1.5-1 presents emission factors on a volume basis ($lb/10^3gal$). To convert to an energy basis (lb/MMBtu), divide by a heating value of 91.5 $MMBtu/10^3gal$ for propane and 102 $MMBtu/10^3gal$ for butane.

1.5.3.2 Greenhouse Gases[6-11] -

Carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) emissions are all produced during LPG combustion. Nearly all of the fuel carbon (99.5 percent) in LPG is converted to CO_2 during the combustion process. This conversion is relatively independent of firing configuration. Although the formation of CO acts to reduce CO_2 emissions, the amount of CO produced is insignificant compared to the amount of CO_2 produced. The majority of the 0.5 percent of fuel carbon not converted to CO_2 is due to incomplete combustion in the fuel stream.

Table 1.5-1. EMISSION FACTORS FOR LPG COMBUSTION[a]

EMISSION FACTOR RATING: E

Pollutant	Butane Emission Factor ($lb/10^3$ gal)		Propane Emission Factor ($lb/10^3$ gal)	
	Industrial Boilers[b] (SCC 1-02-010-01)	Commercial Boilers[c] (SCC 1-03-010-01)	Industrial Boilers[b] (SCC 1-02-010-02)	Commercial Boilers[c] (SCC 1-03-010-02)
PM, Filterable [d]	0.2	0.2	0.2	0.2
PM, Condensable	0.6	0.6	0.5	0.5
PM, Total	0.8	0.8	0.7	0.7
SO_2[e]	0.09S	0.09S	0.10S	0.10S
NO_x[f]	15	15	13	13
N_2O[g]	0.9	0.9	0.9	0.9
CO_2[h,j]	14,300	14,300	12,500	12,500
CO	8.4	8.4	7.5	7.5
TOC	1.1	1.1	1.0	1.0
CH_4[k]	0.2	0.2	0.2	0.2

[a] Assumes PM, CO, and TOC emissions are the same, on a heat input basis, as for natural gas combustion. Use heat contents of 91.5 x 10^6 Btu/10^3 gallon for propane, 102 x 10^6 Btu/10^3 gallon for butane, 1020 x 10^6 Btu/10^6 scf for methane when calculating an equivalent heat input basis. For example, the equation for converting from methane's emissions factors to propane's emissions factors is as follows: lb pollutant/10^3 gallons of propane = (lb pollutant /10^6 ft^3 methane) $*$ (91.5 x 10^6 Btu/10^3 gallons of propane) / (1020 x 10^6 Btu/10^6 scf of methane). The NO_x emission factors have been multiplied by a correction factor of 1.5, which is the approximate ratio of propane/butane NO_x emissions to natural gas NO_x emissions. To convert from lb/10^3 gal to kg/10^3 L, multiply by 0.12. SCC = Source Classification Code.

[b] Heat input capacities generally between 10 and 100 million Btu/hour.

[c] Heat input capacities generally between 0.3 and 10 million Btu/hour.

[d] Filterable particulate matter (PM) is that PM collected on or prior to the filter of an EPA Method 5 (or equivalent) sampling train. For natural gas, a fuel with similar combustion characteristics, all PM is less than 10 µm in aerodynamic equivalent diameter (PM-10).

[e] S equals the sulfur content expressed in gr/100 ft^3 gas vapor. For example, if the butane sulfur content is 0.18 gr/100 ft^3, the emission factor would be (0.09 x 0.18) = 0.016 lb of $SO_2/10^3$ gal butane burned.

[f] Expressed as NO_2.

[g] Reference 12.

[h] Assuming 99.5% conversion of fuel carbon to CO_2.

[j] EMISSION FACTOR RATING = C.

[k] Reference 13.

3.3 Gasoline And Diesel Industrial Engines

3.3.1 General

The engine category addressed by this section covers a wide variety of industrial applications of both gasoline and diesel internal combustion (IC) engines such as aerial lifts, fork lifts, mobile refrigeration units, generators, pumps, industrial sweepers/scrubbers, material handling equipment (such as conveyors), and portable well-drilling equipment. The three primary fuels for reciprocating IC engines are gasoline, diesel fuel oil (No.2), and natural gas. Gasoline is used primarily for mobile and portable engines. Diesel fuel oil is the most versatile fuel and is used in IC engines of all sizes. The rated power of these engines covers a rather substantial range, up to 250 horsepower (hp) for gasoline engines and up to 600 hp for diesel engines. (Diesel engines greater than 600 hp are covered in Section 3.4, "Large Stationary Diesel And All Stationary Dual-fuel Engines".) Understandably, substantial differences in engine duty cycles exist. It was necessary, therefore, to make reasonable assumptions concerning usage in order to formulate some of the emission factors.

3.3.2 Process Description

All reciprocating IC engines operate by the same basic process. A combustible mixture is first compressed in a small volume between the head of a piston and its surrounding cylinder. The mixture is then ignited, and the resulting high-pressure products of combustion push the piston through the cylinder. This movement is converted from linear to rotary motion by a crankshaft. The piston returns, pushing out exhaust gases, and the cycle is repeated.

There are 2 methods used for stationary reciprocating IC engines: compression ignition (CI) and spark ignition (SI). This section deals with both types of reciprocating IC engines. All diesel-fueled engines are compression ignited, and all gasoline-fueled engines are spark ignited.

In CI engines, combustion air is first compression heated in the cylinder, and diesel fuel oil is then injected into the hot air. Ignition is spontaneous because the air temperature is above the autoignition temperature of the fuel. SI engines initiate combustion by the spark of an electrical discharge. Usually the fuel is mixed with the air in a carburetor (for gasoline) or at the intake valve (for natural gas), but occasionally the fuel is injected into the compressed air in the cylinder.

CI engines usually operate at a higher compression ratio (ratio of cylinder volume when the piston is at the bottom of its stroke to the volume when it is at the top) than SI engines because fuel is not present during compression; hence there is no danger of premature autoignition. Since engine thermal efficiency rises with increasing pressure ratio (and pressure ratio varies directly with compression ratio), CI engines are more efficient than SI engines. This increased efficiency is gained at the expense of poorer response to load changes and a heavier structure to withstand the higher pressures.[1]

3.3.3 Emissions

Most of the pollutants from IC engines are emitted through the exhaust. However, some total organic compounds (TOC) escape from the crankcase as a result of blowby (gases that are vented from the oil pan after they have escaped from the cylinder past the piston rings) and from the fuel tank and carburetor because of evaporation. Nearly all of the TOCs from diesel CI engines enter the

Table 3.3-2. SPECIATED ORGANIC COMPOUND EMISSION FACTORS FOR UNCONTROLLED DIESEL ENGINES[a]

EMISSION FACTOR RATING: E

Pollutant	Emission Factor (Fuel Input) (lb/MMBtu)
Benzene[b]	9.33 E-04
Toluene[b]	4.09 E-04
Xylenes[b]	2.85 E-04
Propylene	2.58 E-03
1,3-Butadiene[b,c]	<3.91 E-05
Formaldehyde[b]	1.18 E-03
Acetaldehyde[b]	7.67 E-04
Acrolein[b]	<9.25 E-05
Polycyclic aromatic hydrocarbons (PAH)	
Naphthalene[b]	8.48 E-05
Acenaphthylene	<5.06 E-06
Acenaphthene	<1.42 E-06
Fluorene	2.92 E-05
Phenanthrene	2.94 E-05
Anthracene	1.87 E-06
Fluoranthene	7.61 E-06
Pyrene	4.78 E-06
Benzo(a)anthracene	1.68 E-06
Chrysene	3.53 E-07
Benzo(b)fluoranthene	<9.91 E-08
Benzo(k)fluoranthene	<1.55 E-07
Benzo(a)pyrene	<1.88 E-07
Indeno(1,2,3-cd)pyrene	<3.75 E-07
Dibenz(a,h)anthracene	<5.83 E-07
Benzo(g,h,l)perylene	<4.89 E-07
TOTAL PAH	1.68 E-04

[a] Based on the uncontrolled levels of 2 diesel engines from References 6-7. Source Classification Codes 2-02-001-02, 2-03-001-01. To convert from lb/MMBtu to ng/J, multiply by 430.

[b] Hazardous air pollutant listed in the *Clean Air Act*.

[c] Based on data from 1 engine.

3.4 Large Stationary Diesel And All Stationary Dual-fuel Engines

3.4.1 General

The primary domestic use of large stationary diesel engines (greater than 600 horsepower [hp]) is in oil and gas exploration and production. These engines, in groups of 3 to 5, supply mechanical power to operate drilling (rotary table), mud pumping, and hoisting equipment, and may also operate pumps or auxiliary power generators. Another frequent application of large stationary diesels is electricity generation for both base and standby service. Smaller uses include irrigation, hoisting, and nuclear power plant emergency cooling water pump operation.

Dual-fuel engines were developed to obtain compression ignition performance and the economy of natural gas, using a minimum of 5 to 6 percent diesel fuel to ignite the natural gas. Large dual-fuel engines have been used almost exclusively for prime electric power generation. This section includes all dual-fuel engines.

3.4.2 Process Description

All reciprocating internal combustion (IC) engines operate by the same basic process. A combustible mixture is first compressed in a small volume between the head of a piston and its surrounding cylinder. The mixture is then ignited, and the resulting high-pressure products of combustion push the piston through the cylinder. This movement is converted from linear to rotary motion by a crankshaft. The piston returns, pushing out exhaust gases, and the cycle is repeated.

There are 2 ignition methods used in stationary reciprocating IC engines, compression ignition (CI) and spark ignition (SI). In CI engines, combustion air is first compression heated in the cylinder, and diesel fuel oil is then injected into the hot air. Ignition is spontaneous because the air temperature is above the autoignition temperature of the fuel. SI engines initiate combustion by the spark of an electrical discharge. Usually the fuel is mixed with the air in a carburetor (for gasoline) or at the intake valve (for natural gas), but occasionally the fuel is injected into the compressed air in the cylinder. Although all diesel- fueled engines are compression ignited and all gasoline- and gas-fueled engines are spark ignited, gas can be used in a CI engine if a small amount of diesel fuel is injected into the compressed gas/air mixture to burn any mixture ratio of gas and diesel oil (hence the name dual fuel), from 6 to 100 percent diesel oil.

CI engines usually operate at a higher compression ratio (ratio of cylinder volume when the piston is at the bottom of its stroke to the volume when it is at the top) than SI engines because fuel is not present during compression; hence there is no danger of premature autoignition. Since engine thermal efficiency rises with increasing pressure ratio (and pressure ratio varies directly with compression ratio), CI engines are more efficient than SI engines. This increased efficiency is gained at the expense of poorer response to load changes and a heavier structure to withstand the higher pressures.[1]

3.4.3 Emissions And Controls

Most of the pollutants from IC engines are emitted through the exhaust. However, some total organic compounds (TOC) escape from the crankcase as a result of blowby (gases that are vented from the oil pan after they have escaped from the cylinder past the piston rings) and from the fuel tank

Table 3.4-3. SPECIATED ORGANIC COMPOUND EMISSION FACTORS FOR LARGE UNCONTROLLED STATIONARY DIESEL ENGINES[a]

EMISSION FACTOR RATING: E

Pollutant	Emission Factor (lb/MMBtu) (fuel input)
Benzene[b]	7.76 E-04
Toluene[b]	2.81 E-04
Xylenes[b]	1.93 E-04
Propylene	2.79 E-03
Formaldehyde[b]	7.89 E-05
Acetaldehyde[b]	2.52 E-05
Acrolein[b]	7.88 E-06

[a] Based on 1 uncontrolled diesel engine from Reference 7. Source Classification Code 2-02-004-01. Not enough information to calculate the output-specific emission factors of lb/hp-hr. To convert from lb/MMBtu to ng/J, multiply by 430.

[b] Hazardous air pollutant listed in the *Clean Air Act*.

Table 3.4-4. PAH EMISSION FACTORS FOR LARGE UNCONTROLLED STATIONARY DIESEL ENGINES[a]

EMISSION FACTOR RATING: E

PAH	Emission Factor (lb/MMBtu) (fuel input)
Naphthalene[b]	1.30 E-04
Acenaphthylene	9.23 E-06
Acenaphthene	4.68 E-06
Fluorene	1.28 E-05
Phenanthrene	4.08 E-05
Anthracene	1.23 E-06
Fluoranthene	4.03 E-06
Pyrene	3.71 E-06
Benz(a)anthracene	6.22 E-07
Chrysene	1.53 E-06
Benzo(b)fluoranthene	1.11 E-06
Benzo(k)fluoranthene	<2.18 E-07
Benzo(a)pyrene	<2.57 E-07
Indeno(1,2,3-cd)pyrene	<4.14 E-07
Dibenz(a,h)anthracene	<3.46 E-07
Benzo(g,h,l)perylene	<5.56 E-07
TOTAL PAH	<2.12 E-04

[a] Based on 1 uncontrolled diesel engine from Reference 7. Source Classification Code 2-02-004-01. Not enough information to calculate the output-specific emission factors of lb/hp-hr. To convert from lb/MMBtu to ng/J, multiply by 430.

[b] Hazardous air pollutant listed in the *Clean Air Act*.

11.1 Hot Mix Asphalt Plants

11.1.1 General[1-3,23, 392-394]

Hot mix asphalt (HMA) paving materials are a mixture of size-graded, high quality aggregate (which can include reclaimed asphalt pavement [RAP]), and liquid asphalt cement, which is heated and mixed in measured quantities to produce HMA. Aggregate and RAP (if used) constitute over 92 percent by weight of the total mixture. Aside from the amount and grade of asphalt cement used, mix characteristics are determined by the relative amounts and types of aggregate and RAP used. A certain percentage of fine aggregate (less than 74 micrometers [µm] in physical diameter) is required for the production of good quality HMA.

Hot mix asphalt paving materials can be manufactured by: (1) batch mix plants, (2) continuous mix (mix outside dryer drum) plants, (3) parallel flow drum mix plants, and (4) counterflow drum mix plants. This order of listing generally reflects the chronological order of development and use within the HMA industry.

In 1996, approximately 500 million tons of HMA were produced at the 3,600 (estimated) active asphalt plants in the United States. Of these 3,600 plants, approximately 2,300 are batch plants, 1,000 are parallel flow drum mix plants, and 300 are counterflow drum mix plants. The total 1996 HMA production from batch and drum mix plants is estimated at about 240 million tons and 260 million tons, respectively. About 85 percent of plants being manufactured today are of the counterflow drum mix design, while batch plants and parallel flow drum mix plants account for 10 percent and 5 percent respectively. Continuous mix plants represent a very small fraction of the plants in use ($\leq$0.5 percent) and, therefore, are not discussed further.

An HMA plant can be constructed as a permanent plant, a skid-mounted (easily relocated) plant, or a portable plant. All plants can have RAP processing capabilities. Virtually all plants being manufactured today have RAP processing capability. Most plants have the capability to use either gaseous fuels (natural gas) or fuel oil. However, based upon Department of Energy and limited State inventory information, between 70 and 90 percent of the HMA is produced using natural gas as the fuel to dry and heat the aggregate.

11.1.1.1 Batch Mix Plants –

Figure 11.1-1 shows the batch mix HMA production process. Raw aggregate normally is stockpiled near the production unit. The bulk aggregate moisture content typically stabilizes between 3 to 5 percent by weight.

Processing begins as the aggregate is hauled from the storage piles and is placed in the appropriate hoppers of the cold feed unit. The material is metered from the hoppers onto a conveyer belt and is transported into a rotary dryer (typically gas- or oil-fired). Dryers are equipped with flights designed to shower the aggregate inside the drum to promote drying efficiency.

As the hot aggregate leaves the dryer, it drops into a bucket elevator and is transferred to a set of vibrating screens, where it is classified into as many as four different grades (sizes) and is dropped into individual “hot” bins according to size. At newer facilities, RAP also may be transferred to a separate heated storage bin. To control aggregate size distribution in the final batch mix, the operator opens various hot bins over a weigh hopper until the desired mix and weight are obtained. Concurrent with the aggregate being weighed, liquid asphalt cement is pumped from a heated storage tank to an asphalt bucket, where it is weighed to achieve the desired aggregate-to-asphalt cement ratio in the final mix.

bins or storage silos. The fugitive dust sources associated with drum mix plants are similar to those of batch mix plants with regard to truck traffic and to aggregate material feed and handling operations.

Table 11.1-1 presents emission factors for filterable PM and PM-10, condensable PM, and total PM for batch mix HMA plants. Particle size data for batch mix HMA plants, based on the control technology used, are shown in Table 11.1-2. Table 11.1-3 presents filterable PM and PM-10, condensable PM, and total PM emission factors for drum mix HMA plants. Particle size data for drum mix HMA plants, based on the control technology used, are shown in Table 11.1-4. Tables 11.1-5 and -6 present emission factors for CO, CO_2, NO_x, sulfur dioxide (SO_2), total organic compounds (TOC), formaldehyde, CH_4, and VOC from batch mix plants. Tables 11.1-7 and -8 present emission factors for CO, CO_2, NO_x, SO_2, TOC, CH_4, VOC, and hydrochloric acid (HCl) from drum mix plants. The emission factors for CO, NO_x, and organic compounds represent normal plant operations without scrutiny of the burner design, operation, and maintenance. Information provided in Reference 390 indicates that attention to burner design, periodic evaluation of burner operation, and appropriate maintenance can reduce these emissions. Table 11.1-9 presents organic pollutant emission factors for batch mix plants. Table 11.1-10 presents organic pollutant emission factors for drum mix plants. Tables 11.1-11 and -12 present metals emission factors for batch and drum mix plants, respectively. Table 11.1-13 presents organic pollutant emission factors for hot (asphalt) oil systems.

11.1.2.5 Fugitive Emissions from Production Operations -

Emission factors for HMA load-out and silo filling operations can be estimated using the data in Tables 11.1-14, -15, and -16. Table 11.1-14 presents predictive emission factor equations for HMA load-out and silo filling operations. Separate equations are presented for total PM, extractable organic PM (as measured by EPA Method 315), TOC, and CO. For example, to estimate total PM emissions from drum mix or batch mix plant load-out operations using an asphalt loss-on-heating of 0.41 percent and temperature of 290°F, the following calculation is made:

$$
\begin{aligned}
EF &= 0.000181 + 0.00141(-V)e^{((0.0251)(290 + 460) - 20.43)} \\
&= 0.000181 + 0.00141(-(-0.41))e^{((0.0251)(290 + 460) - 20.43)} \\
&= 0.000181 + 0.00141(0.41)e^{(-1.605)} \\
&= 0.000181 + 0.00141(0.41)(0.2009) \\
&= 0.000181 + 0.000116 \\
&= 0.00030 \text{ lb total PM/ton of asphalt loaded}
\end{aligned}
$$

Tables 11.1-15 and -16 present speciation profiles for organic particulate-based and volatile particulate-based compounds, respectively. The speciation profile shown in Table 11.1-15 can be applied to the extractable organic PM emission factors estimated by the equations in Table 11.1-14 to estimate emission factors for specific organic PM compounds. The speciation profile presented in Table 11.1-16 can be applied to the TOC emission factors estimated by the equations in Table 11.1-14 to estimate emission factors for specific volatile organic compounds. The derivations of the predictive emission factor equations and the speciation profiles can be found in Reference 1.

For example, to estimate TOC emissions from drum mix plant load-out operations using an asphalt loss-on-heating of 0.41 percent and temperature of 290°F, the following calculation is made:

$$
\begin{aligned}
EF &= 0.0172(-V)e^{((0.0251)(290 + 460) - 20.43)} \\
&= 0.0172(-(-0.41))e^{((0.0251)(290 + 460) - 20.43)} \\
&= 0.0172(0.41)e^{(-1.605)} \\
&= 0.0172(0.41)(0.2009) \\
&= 0.0014 \text{ lb TOC/ton of asphalt loaded}
\end{aligned}
$$

To estimate the benzene emissions from the same operation, use the TOC emission factor calculated above and apply the benzene fraction for load-out emissions from Table 11.1-16:

$$\begin{aligned} EF &= 0.0014\ (0.00052) \\ &= 7.3 \times 10^{-7} \text{ lb benzene/ton of asphalt loaded} \end{aligned}$$

Emissions from asphalt storage tanks can be estimated using the procedures described in AP-42 Section 7.1, Organic Liquid Storage Tanks, and the TANKS software. Site-specific data should be used for storage tank specifications and operating parameters, such as temperature. If site-specific data for Antoine's constants for an average asphalt binder used by the facility are unavailable, the following values for an average liquid asphalt binder can be used:

A = 75,350.06
B = 9.00346

These values should be inserted into the Antoine's equation in the following form:

$$\log_{10} P = \frac{-0.05223A}{T} + B$$

where:

P = vapor pressure, mm Hg
T = absolute temperature, Kelvin

The assumed average liquid molecular weight associated with these Antoine's constants is 1,000 atomic mass units and the average vapor molecular weight is 105. Emission factors estimated using these default values should be assigned a rating of E. Carbon monoxide emissions can be estimated by multiplying the THC emissions calculated by the TANKS program by 0.097 (the ratio of silo filling CO emissions to silo filling TOC emissions).

Vapors from the HMA loaded into transport trucks continue following load-out operations. The TOC emissions for the 8-minute period immediately following load-out (yard emissions) can be estimated using an emission factor of 0.00055 kg/Mg (0.0011 lb/ton) of asphalt loaded. This factor is assigned a rating of E. The derivation of this emission factor is described in Reference 1. Carbon monoxide emissions can be estimated by multiplying the TOC emissions by 0.32 (the ratio of truck load-out CO emissions to truck load-out THC emissions).

11.2.3 Updates Since the Fifth Edition

The Fifth Edition was released in January 1995. Revisions to this section since that date are summarized below. For further detail, consult the background report for this section. This and other documents can be found on the CHIEF Web Site at http://www.epa.gov/ttn/chief/, or by calling the Info CHIEF Help Desk at (919)541-1000.

December 2000

- All emission factors were revised and new factors were added. For selected pollutant emissions, separate factors were developed for distilate oil, No. 6 oil and waste oil fired dryers. Dioxin and Furan emission factors were developed for oil fired drum mix plants. Particulate, VOC and CO factors were developed for silo filling, truck load out and post truck load out operations at batch plants and drum mix plants. Organic species profiles were developed for silo filling, truck load out and post truck load out operations.

Table 11.1-3. PARTICULATE MATTER EMISSION FACTORS FOR DRUM MIX HOT MIX ASPHALT PLANTS[a]

Process	Filterable PM				Condensable PM[b]				Total PM			
	PM[c]	EMISSION FACTOR RATING	PM-10[d]	EMISSION FACTOR RATING	Inorganic	EMISSION FACTOR RATING	Organic	EMISSION FACTOR RATING	PM[e]	EMISSION FACTOR RATING	PM-10[f]	EMISSION FACTOR RATING
Dryer[g] (SCC 3-05-002-05,-55 to -63)												
Uncontrolled	28[h]	D	6.4	D	0.0074[j]	E	0.058[k]	E	28	D	6.5	D
Venturi or wet scrubber	0.026[m]	A	ND	NA	0.0074[n]	A	0.012[p]	A	0.045	A	ND	NA
Fabric filter	0.014[q]	A	0.0039	C	0.0074[n]	A	0.012[p]	A	0.033	A	0.023	C

[a] Factors are lb/ton of product. SCC = Source Classification Code. ND = no data. NA = not applicable. To convert from lb/ton to kg/Mg, multiply by 0.5.

[b] Condensable PM is that PM collected using an EPA Method 202, Method 5 (analysis of "back-half" or impingers), or equivalent sampling train.

[c] Filterable PM is that PM collected on or before the filter of an EPA Method 5 (or equivalent) sampling train.

[d] Particle size data from Reference 23 were used in conjunction with the filterable PM emission factors shown.

[e] Total PM is the sum of filterable PM, condensable inorganic PM, and condensable organic PM.

[f] Total PM-10 is the sum of filterable PM-10, condensable inorganic PM, and condensable organic PM.

[g] Drum mix dryer fired with natural gas, propane, fuel oil, and waste oil. The data indicate that fuel type does not significantly effect PM emissions.

[h] References 31, 36-38, 340.

[j] Because no data are available for uncontrolled condensable inorganic PM, the emission factor is assumed to be equal to the maximum controlled condensable inorganic PM emission factor.

[k] References 36-37.

[m] Reference 1, Table 4-14. Average of data from 36 facilities. Range: 0.0036 to 0.097 lb/ton. Median: 0.020 lb/ton. Standard deviation: 0.022 lb/ton.

[n] Reference 1, Table 4-14. Average of data from 30 facilities. Range: 0.0012 to 0.027 lb/ton. Median: 0.0051 lb/ton. Standard deviation: 0.0063 lb/ton.

[p] Reference 1, Table 4-14. Average of data from 41 facilities. Range: 0.00035 to 0.074 lb/ton. Median: 0.0046 lb/ton. Standard deviation: 0.016 lb/ton.

[q] Reference 1, Table 4-14. Average of data from 155 facilities. Range: 0.00089 to 0.14 lb/ton. Median: 0.010 lb/ton. Standard deviation: 0.017 lb/ton.

Table 11.1-4. SUMMARY OF PARTICLE SIZE DISTRIBUTION FOR DRUM MIX DRYERS[a]

EMISSION FACTOR RATING: E

Particle Size, µm[b]	Cumulative Mass Less Than or Equal to Stated Size (%)[c]		Emission Factors, lb/ton	
	Uncontrolled[d]	Fabric Filter	Uncontrolled[d]	Fabric Filter
1.0	ND	15[e]	ND	0.0021[e]
2.5	5.5	21[f]	1.5	0.0029[f]
10.0	23	30[g]	6.4	0.0042[g]
15.0	27	35[d]	7.6	0.0049[d]

[a] Emission factor units are lb/ton of HMA produced. Rounded to two significant figures. SCC 3-05-002-05, and 3-05-002-55 to -63. ND = no data available. To convert from lb/ton to kg/Mg, multiply by 0.5.

[b] Aerodynamic diameter.

[c] Applies only to the mass of filterable PM.

[d] Reference 23, Table 3-35. The emission factors are calculated using the particle size data from this reference in conjunction with the filterable PM emission factor shown in Table 11.1-3.

[e] References 214, 229. The emission factors are calculated using the particle size data from these references in conjunction with the filterable PM emission factor shown in Table 11.1-3.

[f] References 23, 214, 229. The emission factors are calculated using the particle size data from these references in conjunction with the filterable PM emission factor shown in Table 11.1-3.

[g] Reference 23, 25, 229. The emission factors are calculated using the particle size data from these references in conjunction with the filterable PM emission factor shown in Table 11.1-3. EMISSION FACTOR RATING: D.

Table 11.1-7. EMISSION FACTORS FOR CO, CO_2, NO_x, AND SO_2 FROM DRUM MIX HOT MIX ASPHALT PLANTS[a]

Process	CO[b]	EMISSION FACTOR RATING	CO_2[c]	EMISSION FACTOR RATING	NO_x	EMISSION FACTOR RATING	SO_2[c]	EMISSION FACTOR RATING
Natural gas-fired dryer (SCC 3-05-002-55,-56,-57)	0.13	B	33[d]	A	0.026[e]	D	0.0034[f]	D
No. 2 fuel oil-fired dryer (SCC 3-05-002-58,-59,-60)	0.13	B	33[d]	A	0.055[g]	C	0.011[h]	E
Waste oil-fired dryer (SCC 3-05-002-61,-62,-63)	0.13	B	33[d]	A	0.055[g]	C	0.058[j]	B
Coal-fired dryer[k] (SCC 3-05-002-98)	ND	NA	33[d]	A	ND	NA	0.19[m]	E

[a] Emission factor units are lb per ton of HMA produced. SCC = Source Classification Code. ND = no data available. NA = not applicable. To convert from lb/ton to kg/Mg, multiply by 0.5.

[b] References 25, 44, 48, 50, 149, 154, 197, 214, 229, 254, 339-342, 344, 346, 347, 390. The CO emission factors represent normal plant operations without scrutiny of the burner design, operation, and maintenance. Information is available that indicates that attention to burner design, periodic evaluation of burner operation, and appropriate maintenance can reduce CO emissions. Data for dryers firing natural gas, No. 2 fuel oil, and No. 6 fuel oil were combined to develop a single emission factor because the magnitude of emissions was similar for dryers fired with these fuels.

[c] Emissions of CO_2 and SO_2 can also be estimated based on fuel usage and the fuel combustion emission factors (for the appropriate fuel) presented in AP-42 Chapter 1. The CO_2 emission factors are an average of all available data, regardless of the dryer fuel (emissions were similar from dryers firing any of the various fuels). Fifty percent of the fuel-bound sulfur, up to a maximum (as SO_2) of 0.1 lb/ton of product, is expected to be retained in the product, with the remainder emitted as SO_2.

[d] Reference 1, Table 4-15. Average of data from 180 facilities. Range: 2.6 to 96 lb/ton. Median: 31 lb/ton. Standard deviation: 13 lb/ton.

[e] References 44-45, 48, 209, 341, 342.

[f] References 44-45, 48.

[g] References 25, 50, 153, 214, 229, 344, 346, 347, 352-354.

[h] References 50, 119, 255, 340

[j] References 25, 299, 300, 339, 345, 351, 371-377, 379, 380, 386-388.

[k] Dryer fired with coal and supplemental natural gas or fuel oil.

[m] References 88, 108, 189-190.

Table 11.1-8. EMISSION FACTORS FOR TOC, METHANE, VOC, AND HCl FROM DRUM MIX HOT MIX ASPHALT PLANTS[a]

Process	TOC[b]	EMISSION FACTOR RATING	CH_4[c]	EMISSION FACTOR RATING	VOC[d]	EMISSION FACTOR RATING	HCl[e]	EMISSION FACTOR RATING
Natural gas-fired dryer (SCC 3-05-002-55, -56,-57)	0.044[f]	B	0.012	C	0.032	C	ND	NA
No. 2 fuel oil-fired dryer (SCC 3-05-002-58, -59,-60)	0.044[f]	B	0.012	C	0.032	C	ND	NA
Waste oil-fired dryer (SCC 3-05-002-61, -62,-63)	0.044[f]	E	0.012	C	0.032	E	0.00021	D

[a] Emission factor units are lb per ton of HMA produced. SCC = Source Classification Code. ND = no data available. NA = not applicable. To convert from lb/ton to kg/Mg, multiply by 0.5.

[b] TOC equals total hydrocarbons as propane as measured with an EPA Method 25A or equivalent sampling train plus formaldehyde.

[c] References 25, 44-45, 48, 50, 339-340, 355. Factor includes data from natural gas-, No. 2 fuel oil, and waste oil-fired dryers. Methane measured with an EPA Method 18 or equivalent sampling train.

[d] The VOC emission factors are equal to the TOC factors minus the sum of the methane emission factors and the emission factors for compounds with negligible photochemical reactivity shown in Table 11.1-10; differences in values reported are due to rounding.

[e] References 348, 374, 376, 379, 380.

[f] References 25, 44-45, 48, 50, 149, 153-154, 209-212, 214, 241, 242, 339-340, 355.

Table 11.1-10. EMISSION FACTORS FOR ORGANIC POLLUTANT EMISSIONS FROM DRUM MIX HOT MIX ASPHALT PLANTS[a]

Process	Pollutant		Emission Factor, lb/ton	Emission Factor Rating	Ref. No.
	CASRN	Name			
Natural gas-fired dryer with fabric filter[b] (SCC 3-05-002-55, -56,-57)	Non-PAH hazardous air pollutants[c]				
	71-43-2	Benzene[d]	0.00039	A	25,44,45,50, 341, 342, 344-351, 373, 376, 377, 383, 384
	100-41-4	Ethylbenzene	0.00024	D	25,44,45
	50-00-0	Formaldehyde[e]	0.0031	A	25,35,44,45,50, 339-344, 347-349, 371-373, 384, 388
	110-54-3	Hexane	0.00092	E	339-340
	540-84-1	Isooctane (2,2,4-trimethylpentane)	$4.0\text{x}10^{-5}$	E	339-340
	71-55-6	Methyl chloroform[f]	$4.8\text{x}10^{-5}$	E	35
	108-88-3	Toluene	0.00015	D	35,44,45
	1330-20-7	Xylene	0.00020	D	25,44,45
		Total non-PAH HAPs	0.0051		
	PAH HAPs				
	91-57-6	2-Methylnaphthalene[g]	$7.4\text{x}10^{-5}$	D	44,45,48
	83-32-9	Acenaphthene[g]	$1.4\text{x}10^{-6}$	E	48
	208-96-8	Acenaphthylene[g]	$8.6\text{x}10^{-6}$	D	35,45,48
	120-12-7	Anthracene[g]	$2.2\text{x}10^{-7}$	E	35,48
	56-55-3	Benzo(a)anthracene[g]	$2.1\text{x}10^{-7}$	E	48
	50-32-8	Benzo(a)pyrene[g]	$9.8\text{x}10^{-9}$	E	48
	205-99-2	Benzo(b)fluoranthene[g]	$1.0\text{x}10^{-7}$	E	35,48
	192-97-2	Benzo(e)pyrene[g]	$1.1\text{x}10^{-7}$	E	48
	191-24-2	Benzo(g,h,i)perylene[g]	$4.0\text{x}10^{-8}$	E	48
	207-08-9	Benzo(k)fluoranthene[g]	$4.1\text{x}10^{-8}$	E	35,48
	218-01-9	Chrysene[g]	$1.8\text{x}10^{-7}$	E	35,48
	206-44-0	Fluoranthene[g]	$6.1\text{x}10^{-7}$	D	35,45,48
	86-73-7	Fluorene[g]	$3.8\text{x}10^{-6}$	D	35,45,48,163
	193-39-5	Indeno(1,2,3-cd)pyrene[g]	$7.0\text{x}10^{-9}$	E	48
	91-20-3	Naphthalene[g]	$9.0\text{x}10^{-5}$	D	35,44,45,48,163
	198-55-0	Perylene[g]	$8.8\text{x}10^{-9}$	E	48
	85-01-8	Phenanthrene[g]	$7.6\text{x}10^{-6}$	D	35,44,45,48,163
	129-00-0	Pyrene[g]	$5.4\text{x}10^{-7}$	D	45,48
		Total PAH HAPs	0.00019		

Table 11.1-10 (cont.)

Process	Pollutant		Emission Factor, lb/ton	Emission Factor Rating	Ref. No.
	CASRN	Name			
Natural gas-fired dryer with fabric filter[b] (SCC 3-05-002-55, -56,-57) (cont.)	Total HAPs		0.0053		
	Non-HAP organic compounds				
	106-97-8	Butane	0.00067	E	339
	74-85-1	Ethylene	0.0070	E	339-340
	142-82-5	Heptane	0.0094	E	339-340
	763-29-1	2-Methyl-1-pentene	0.0040	E	339,340
	513-35-9	2-Methyl-2-butene	0.00058	E	339,340
	96-14-0	3-Methylpentane	0.00019	D	339,340
	109-67-1	1-Pentene	0.0022	E	339-340
	109-66-0	n-Pentane	0.00021	E	339-340
		Total non-HAP organics	0.024		
No. 2 fuel oil-fired dryer with fabric filter (SCC 3-05-002-58, -59,-60)	Non-PAH HAPs[c]				
	71-43-2	Benzene[d]	0.00039	A	25,44,45,50, 341, 342, 344-351, 373, 376, 377, 383, 384
	100-41-4	Ethylbenzene	0.00024	D	25,44,45
	50-00-0	Formaldehyde[e]	0.0031	A	25,35,44,45,50, 339-344, 347-349, 371-373, 384, 388
	110-54-3	Hexane	0.00092	E	339-340
	540-84-1	Isooctane (2,2,4-trimethylpentane)	4.0×10^{-5}	E	339-340
	71-55-6	Methyl chloroform[f]	4.8×10^{-5}	E	35
	108-88-3	Toluene	0.0029	E	25, 50, 339-340
	1330-20-7	Xylene	0.00020	D	25,44,45
		Total non-PAH HAPs	0.0078		
	PAH HAPs				
	91-57-6	2-Methylnaphthalene[g]	0.00017	E	50
	83-32-9	Acenaphthene[g]	1.4×10^{-6}	E	48
	208-96-8	Acenaphthylene[g]	2.2×10^{-5}	E	50
	120-12-7	Anthracene[g]	3.1×10^{-6}	E	50,162
	56-55-3	Benzo(a)anthracene[g]	2.1×10^{-7}	E	48
	50-32-8	Benzo(a)pyrene[g]	9.8×10^{-9}	E	48
	205-99-2	Benzo(b)fluoranthene[g]	1.0×10^{-7}	E	35,48
	192-97-2	Benzo(e)pyrene[g]	1.1×10^{-7}	E	48

Table 11.1-10 (cont.)

Process	Pollutant		Emission Factor, lb/ton	Emission Factor Rating	Ref. No.
	CASRN	Name			
No. 2 fuel oil-fired dryer with fabric filter (SCC 3-05-002-58, -59,-60) (cont.)	191-24-2	Benzo(g,h,i)perylene[g]	4.0×10^{-8}	E	48
	207-08-9	Benzo(k)fluoranthene[g]	4.1×10^{-8}	E	35,48
	218-01-9	Chrysene[g]	1.8×10^{-7}	E	35,48
	206-44-0	Fluoranthene[g]	6.1×10^{-7}	D	35,45,48
	86-73-7	Fluorene[g]	1.1×10^{-5}	E	50,164
	193-39-5	Indeno(1,2,3-cd)pyrene[g]	7.0×10^{-9}	E	48
	91-20-3	Naphthalene[g]	0.00065	D	25,50,162,164
	198-55-0	Perylene[g]	8.8×10^{-9}	E	48
	85-01-8	Phenanthrene[g]	2.3×10^{-5}	D	50,162,164
	129-00-0	Pyrene[g]	3.0×10^{-6}	E	50
		Total PAH HAPs	0.00088		
		Total HAPs	0.0087		
	Non-HAP organic compounds				
	106-97-8	Butane	0.00067	E	339
	74-85-1	Ethylene	0.0070	E	339-340
	142-82-5	Heptane	0.0094	E	339-340
	763-29-1	2-Methyl-1-pentene	0.0040	E	339,340
	513-35-9	2-Methyl-2-butene	0.00058	E	339,340
	96-14-0	3-Methylpentane	0.00019	D	339,340
	109-67-1	1-Pentene	0.0022	E	339-340
	109-66-0	n-Pentane	0.00021	E	339-340
		Total non-HAP organics	0.024		

Table 11.1-10 (cont.)

Process	Pollutant		Emission Factor, lb/ton	Emission Factor Rating	Ref. No.
	CASRN	Name			
Fuel oil- or waste oil-fired dryer with fabric filter (SCC 3-05-002-58, -59,-60,-61,-62, -63)	Dioxins				
	1746-01-6	2,3,7,8-TCDD[g]	$2.1x10^{-13}$	E	339
		Total TCDD[g]	$9.3x10^{-13}$	E	339
	40321-76-4	1,2,3,7,8-PeCDD[g]	$3.1x10^{-13}$	E	339
		Total PeCDD[g]	$2.2x10^{-11}$	E	339-340
	39227-28-6	1,2,3,4,7,8-HxCDD[g]	$4.2x10^{-13}$	E	339
	57653-85-7	1,2,3,6,7,8-HxCDD[g]	$1.3x10^{-12}$	E	339
	19408-24-3	1,2,3,7,8,9-HxCDD[g]	$9.8x10^{-13}$	E	339
		Total HxCDD[g]	$1.2x10^{-11}$	E	339-340
	35822-46-9	1,2,3,4,6,7,8-HpCDD[g]	$4.8x10^{-12}$	E	339
		Total HpCDD[g]	$1.9x10^{-11}$	E	339-340
	3268-87-9	Octa CDD[g]	$2.5x10^{-11}$	E	339
		Total PCDD[g]	$7.9x10^{-11}$	E	339-340
	Furans				
	51207-31-9	2,3,7,8-TCDF[g]	$9.7x10^{-13}$	E	339
		Total TCDF[g]	$3.7x10^{-12}$	E	339-340
		1,2,3,7,8-PeCDF[g]	$4.3x10^{-12}$	E	339-340
		2,3,4,7,8-PeCDF[g]	$8.4x10^{-13}$	E	339
		Total PeCDF[g]	$8.4x10^{-11}$	E	339-340
		1,2,3,4,7,8-HxCDF[g]	$4.0x10^{-12}$	E	339
		1,2,3,6,7,8-HxCDF[g]	$1.2x10^{-12}$	E	339
		2,3,4,6,7,8-HxCDF[g]	$1.9x10^{-12}$	E	339
		1,2,3,7,8,9-HxCDF[g]	$8.4x10^{-12}$	E	340
		Total HxCDF[g]	$1.3x10^{-11}$	E	339-340
		1,2,3,4,6,7,8-HpCDF[g]	$6.5x10^{-12}$	E	339
		1,2,3,4,7,8,9-HpCDF[g]	$2.7x10^{-12}$	E	339
		Total HpCDF[g]	$1.0x10^{-11}$	E	339-340
	39001-02-0	Octa CDF[g]	$4.8x10^{-12}$	E	339
		Total PCDF[g]	$4.0x10^{-11}$	E	339-340
		Total PCDD/PCDF[g]	$1.2x10^{-10}$	E	339-340

Table 11.1-10 (cont.)

Process	Pollutant		Emission Factor, lb/ton	Emission Factor Rating	Ref. No.
	CASRN	Name			
Fuel oil- or waste oil-fired dryer (uncontrolled) (SCC 3-05-002-58, -59,-60,-61,-62, -63)	Hazardous air pollutants[c]				
	Dioxins				
		Total HxCDD[g]	$5.4\text{x}10^{-12}$	E	340
	35822-46-9	1,2,3,4,6,7,8-HpCDD[g]	$3.4\text{x}10^{-11}$	E	340
		Total HpCDD[g]	$7.1\text{x}10^{-11}$	E	340
	3268-87-9	Octa CDD[g]	$2.7\text{x}10^{-9}$	E	340
		Total PCDD[g]	$2.8\text{x}10^{-9}$	E	340
	Furans				
		Total TCDF[g]	$3.3\text{x}10^{-11}$	E	340
		Total PeCDF[g]	$7.4\text{x}10^{-11}$	E	340
		1,2,3,4,7,8-HxCDF[g]	$5.4\text{x}10^{-12}$	E	340
		2,3,4,6,7,8-HxCDF[g]	$1.6\text{x}10^{-12}$	E	340
		Total HxCDF[g]	$8.1\text{x}10^{-12}$	E	340
Fuel oil- or waste oil-fired dryer (uncontrolled) (SCC 3-05-002-58, -59,-60,-61,-62, -63) (cont.)		1,2,3,4,6,7,8-HpCDF[g]	$1.1\text{x}10^{-11}$	E	340
		Total HpCDF[g]	$3.8\text{x}10^{-11}$	E	340
		Total PCDF[g]	$1.5\text{x}10^{-10}$	E	340
		Total PCDD/PCDF[g]	$3.0\text{x}10^{-9}$	E	340

Table 11.1-10 (cont.)

Process	Pollutant		Emission Factor, lb/ton	Emission Factor Rating	Ref. No.
	CASRN	Name			
Waste oil-fired dryer with fabric filter (SCC 3-05-002-61, -62,-63)	Non-PAH HAPs[c]				
	75-07-0	Acetaldehyde	0.0013	E	25
	107-02-8	Acrolein	2.6×10^{-5}	E	25
	71-43-2	Benzene[d]	0.00039	A	25,44,45,50,341,342, 344-351, 373, 376, 377, 383, 384
	100-41-4	Ethylbenzene	0.00024	D	25,44,45
	50-00-0	Formaldehyde[e]	0.0031	A	25,35,44,45,50,339-344,347-349,371-373, 384, 388
	110-54-3	Hexane	0.00092	E	339-340
	540-84-1	Isooctane (2,2,4-trimethylpentane)	4.0×10^{-5}	E	339-340
	78-93-3	Methyl Ethyl Ketone	2.0×10^{-5}	E	25
	123-38-6	Propionaldehyde	0.00013	E	25
	106-51-4	Quinone	0.00016	E	25
	71-55-6	Methyl chloroform[f]	4.8×10^{-5}	E	35
	108-88-3	Toluene	0.0029	E	25, 50, 339-340
	1330-20-7	Xylene	0.00020	D	25,44,45
		Total non-PAH HAPs	0.0095		
	PAH HAPs				
	91-57-6	2-Methylnaphthalene[g]	0.00017	E	50
	83-32-9	Acenaphthene[g]	1.4×10^{-6}	E	48
	208-96-8	Acenaphthylene[g]	2.2×10^{-5}	E	50
	120-12-7	Anthracene[g]	3.1×10^{-6}	E	50,162
	56-55-3	Benzo(a)anthracene[g]	2.1×10^{-7}	E	48
	50-32-8	Benzo(a)pyrene[g]	9.8×10^{-9}	E	48
	205-99-2	Benzo(b)fluoranthene[g]	1.0×10^{-7}	E	35,48
	192-97-2	Benzo(e)pyrene[g]	1.1×10^{-7}	E	48
	191-24-2	Benzo(g,h,i)perylene[g]	4.0×10^{-8}	E	48

Table 11.1-10 (cont.)

Process	Pollutant		Emission Factor, lb/ton	Emission Factor Rating	Ref. No.
	CASRN	Name			
Waste oil-fired dryer with fabric filter (SCC 3-05-002-61, -62,-63) (cont.)	207-08-9	Benzo(k)fluoranthene[g]	$4.1x10^{-8}$	E	35,48
	218-01-9	Chrysene[g]	$1.8x10^{-7}$	E	35,48
	206-44-0	Fluoranthene[g]	$6.1x10^{-7}$	D	35,45,48
	86-73-7	Fluorene[g]	$1.1x10^{-5}$	E	50,164
	193-39-5	Indeno(1,2,3-cd)pyrene[g]	$7.0x10^{-9}$	E	48
	91-20-3	Naphthalene[g]	0.00065	D	25,50,162,164
	198-55-0	Perylene[g]	$8.8x10^{-9}$	E	48
	85-01-8	Phenanthrene[g]	$2.3x10^{-5}$	D	50,162,164
	129-00-0	Pyrene[g]	$3.0x10^{-6}$	E	50
		Total PAH HAPs	0.00088		
		Total HAPs	0.010		
	Non-HAP organic compounds				
	67-64-1	Acetone[f]	0.00083	E	25
	100-52-7	Benzaldehyde	0.00011	E	25
	106-97-8	Butane	0.00067	E	339
	78-84-2	Butyraldehyde	0.00016	E	25
	4170-30-3	Crotonaldehyde	$8.6x10^{-5}$	E	25
	74-85-1	Ethylene	0.0070	E	339, 340
	142-82-5	Heptane	0.0094	E	339, 340
	66-25-1	Hexanal	0.00011	E	25
	590-86-3	Isovaleraldehyde	$3.2x10^{-5}$	E	25
	763-29-1	2-Methyl-1-pentene	0.0040	E	339, 340
	513-35-9	2-Methyl-2-butene	0.00058	E	339, 340
	96-14-0	3-Methylpentane	0.00019	D	339, 340
	109-67-1	1-Pentene	0.0022	E	339, 340
	109-66-0	n-Pentane	0.00021	E	339, 340
	110-62-3	Valeraldehyde	$6.7x10^{-5}$	E	25
		Total non-HAP organics	0.026		

[a] Emission factor units are lb/ton of hot mix asphalt produced. Table includes data from both parallel flow and counterflow drum mix dryers. Organic compound emissions from counterflow systems are expected to be less than from parallel flow systems, but the available data are insufficient to quantify

Table 11.1-10 (cont.)

accurately the difference in these emissions. CASRN = Chemical Abstracts Service Registry Number. SCC = Source Classification Code. To convert from lb/ton to kg/Mg, multiply by 0.5.

[b] Tests included dryers that were processing reclaimed asphalt pavement. Because of limited data, the effect of RAP processing on emissions could not be determined.

[c] Hazardous air pollutants (HAP) as defined in the 1990 Clean Air Act Amendments (CAAA).

[d] Based on data from 19 tests. Range: 0.000063 to 0.0012 lb/ton; median: 0.00030; Standard deviation: 0.00031.

[e] Based on data from 21 tests. Range: 0.0030 to 0.014 lb/ton; median: 0.0020; Standard deviation: 0.0036.

[f] Compound has negligible photochemical reactivity.

[g] Compound is classified as polycyclic organic matter, as defined in the 1990 CAAA. Total PCDD is the sum of the total tetra through octa dioxins; total PCDF is sum of the total tetra through octa furans; and total PCDD/PCDF is the sum of total PCDD and total PCDF.

Table 11.1-12. EMISSION FACTORS FOR METAL EMISSIONS FROM DRUM MIX HOT MIX ASPHALT PLANTS[a]

Process	Pollutant	Emission Factor, lb/ton	Emission Factor Rating	Reference Numbers
Fuel oil-fired dryer, uncontrolled (SCC 3-05-002-58, -59,-60)	Arsenic[b]	1.3×10^{-6}	E	340
	Barium	0.00025	E	340
	Beryllium[b]	0.0	E	340
	Cadmium[b]	4.2×10^{-6}	E	340
	Chromium[b]	2.4×10^{-5}	E	340
	Cobalt[b]	1.5×10^{-5}	E	340
	Copper	0.00017	E	340
	Lead[b]	0.00054	E	340
	Manganese[b]	0.00065	E	340
	Nickel[b]	0.0013	E	340
	Phosphorus[b]	0.0012	E	340
	Selenium[b]	2.4×10^{-6}	E	340
	Thallium	2.2×10^{-6}	E	340
	Zinc	0.00018	E	340
Natural gas- or propane-fired dryer, with fabric filter (SCC 3-05-002-55, -56,-57))	Antimony	1.8×10^{-7}	E	339
	Arsenic[b]	5.6×10^{-7}	D	25, 35, 339-340
	Barium	5.8×10^{-6}	E	25, 339-340
	Beryllium[b]	0.0	E	339-340
	Cadmium[b]	4.1×10^{-7}	D	25, 35, 162, 301, 339-340
	Chromium[b]	5.5×10^{-6}	C	25, 162-164, 301, 339-340
	Cobalt[b]	2.6×10^{-8}	E	339-340
	Copper	3.1×10^{-6}	D	25, 162-164, 339-340
	Hexavalent chromium[b]	4.5×10^{-7}	E	163
	Lead[b]	6.2×10^{-7}	E	35
	Manganese[b]	7.7×10^{-6}	D	25, 162-164, 339-340
	Mercury[b]	2.4×10^{-7}	E	35, 163
	Nickel[b]	6.3×10^{-5}	D	25, 163-164, 339-340
	Phosphorus[b]	2.8×10^{-5}	E	25, 339-340
	Silver	4.8×10^{-7}	E	25, 339-340
	Selenium[b]	3.5×10^{-7}	E	339-340
	Thallium	4.1×10^{-9}	E	339-340
	Zinc	6.1×10^{-5}	C	25, 35, 162-164, 339-340

Table 11.1-12 (cont.)

Process	Pollutant	Emission Factor, lb/ton	Emission Factor Rating	Reference Numbers
No. 2 fuel oil-fired dryer or waste oil/drain oil/No. 6 fuel oil-fired dryer, with fabric filter (SCC 3-05-002-58, -59,-60,-61,-62,-63)	Antimony	1.8×10^{-7}	E	339
	Arsenic[b]	5.6×10^{-7}	D	25, 35, 339-340
	Barium	5.8×10^{-6}	E	25, 339-340
	Beryllium[b]	0.0	E	339-340
	Cadmium[b]	4.1×10^{-7}	D	25, 35, 162, 301, 339-340
	Chromium[b]	5.5×10^{-6}	C	25, 162-164, 301, 339-340
	Cobalt[b]	2.6×10^{-8}	E	339-340
	Copper	3.1×10^{-6}	D	25, 162-164, 339-340
	Hexavalent chromium[b]	4.5×10^{-7}	E	163
	Lead[b]	1.5×10^{-5}	C	25, 162, 164, 178-179, 183, 301, 315, 339-340
	Manganese[b]	7.7×10^{-6}	D	25, 162-164, 339-340
	Mercury[b]	2.6×10^{-6}	D	162, 164, 339-340
	Nickel[b]	6.3×10^{-5}	D	25, 163-164, 339-340
	Phosphorus[b]	2.8×10^{-5}	E	25, 339-340
	Silver	4.8×10^{-7}	E	25, 339-340
	Selenium[b]	3.5×10^{-7}	E	339-340
	Thallium	4.1×10^{-9}	E	339-340
	Zinc	6.1×10^{-5}	C	25, 35, 162-164, 339-340

[a] Emission factor units are lb/ton of HMA produced. SCC = Source Classification Code. To convert from lb/ton to kg/Mg, multiply by 0.5. Emission factors apply to facilities processing virgin aggregate or a combination of virgin aggregate and RAP.

[b] Arsenic, beryllium, cadmium, chromium, hexavalent chromium, cobalt, lead, manganese, mercury, nickel, and selenium compounds are HAPs as defined in the 1990 CAAA. Elemental phosphorus also is a listed HAP, but the phosphorus measured by Method 29 is not elemental phosphorus.

Table 11.1-14. PREDICTIVE EMISSION FACTOR EQUATIONS
FOR LOAD-OUT AND SILO FILLING OPERATIONS[a]

EMISSION FACTOR RATING: C

Source	Pollutant	Equation
Drum mix or batch mix plant load-out (SCC 3-05-002-14)	Total PM[b]	$\text{EF} = 0.000181 + 0.00141(\text{-V})e^{((0.0251)(T + 460) - 20.43)}$
	Organic PM[c]	$\text{EF} = 0.00141(\text{-V})e^{((0.0251)(T + 460) - 20.43)}$
	TOC[d]	$\text{EF} = 0.0172(\text{-V})e^{((0.0251)(T + 460) - 20.43)}$
	CO	$\text{EF} = 0.00558(\text{-V})e^{((0.0251)(T + 460) - 20.43)}$
Silo filling (SCC 3-05-002-13)	Total PM[b]	$\text{EF} = 0.000332 + 0.00105(\text{-V})e^{((0.0251)(T + 460) - 20.43)}$
	Organic PM[c]	$\text{EF} = 0.00105(\text{-V})e^{((0.0251)(T + 460) - 20.43)}$
	TOC[d]	$\text{EF} = 0.0504(\text{-V})e^{((0.0251)(T + 460) - 20.43)}$
	CO	$\text{EF} = 0.00488(\text{-V})e^{((0.0251)(T + 460) - 20.43)}$

[a] Emission factor units are lb/ton of HMA produced. SCC = Source Classification Code. To convert from lb/ton to kg/Mg, multiply by 0.5. EF = emission factor; V = asphalt volatility, as determined by ASTM Method D2872-88 "Effects of Heat and Air on a Moving Film of Asphalt (Rolling Thin Film Oven Test - RTFOT)," where a 0.5 percent loss-on-heating is expressed as "-0.5." Regional- or site-specific data for asphalt volatility should be used, whenever possible; otherwise, a default value of -0.5 should be used for V in these equations. T = HMA mix temperature in °F. Site-specific temperature data should be used, whenever possible; otherwise a default temperature of 325°F can be used. Reference 1, Tables 4-27 through 4-31, 4-34 through 4-36, and 4-38 through 4-41.

[b] Total PM, as measured by EPA Method 315 (EPA Method 5 plus the extractable organic particulate from the impingers). Total PM is assumed to be predominantly PM-2.5 since emissions consist of condensed vapors.

[c] Extractable organic PM, as measured by EPA Method 315 (methylene chloride extract of EPA Method 5 particulate plus methylene chloride extract of impinger particulate).

[d] TOC as propane, as measured with an EPA Method 25A sampling train or equivalent sampling train.

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)	0.72	E	0.46	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)	0.0051	D	0.0024	D	ND		ND	
Mixer loading (central mix)[f] (3-05-011-09)	0.544 or Eqn. 11.12-1	B	0.134 or Eqn. 11.12-1	B	0.0173 or Eqn. 11.12-1	B	0.0048 or Eqn. 11.12-1	B
Truck loading (truck mix)[g] (3-05-011-10)	0.995	B	0.278	B	0.0568 or Eqn. 11.12-1	B	0.0160 or Eqn. 11.12-1	B
Vehicle traffic (paved roads)	See AP-42 Section 13.2.1							
Vehicle traffic (unpaved roads)	See AP-42 Section 13.2.2							
Wind erosion from aggregate and sand storage piles	See AP-42 Section 13.2.5							

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 13.2.2, 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, 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 11.12-4 and 11.12-5. 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	4.6×10^{-5}[i]	D	1.3×10^{-5}[q]	E
Wet Drilling - Unfragmented Stone (SCC 3-05-020-10)	ND		8.0×10^{-5}[j]	E	ND	
Truck Unloading -Fragmented Stone (SCC 3-05-020-31)	ND		1.6×10^{-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.

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 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:

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

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;

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.

Table 13.2.4-1. TYPICAL SILT AND MOISTURE CONTENTS OF MATERIALS AT VARIOUS INDUSTRIES[a]

Industry	No. Of Facilities	Material	Silt Content (%)			Moisture Content (%)		
			No. Of Samples	Range	Mean	No. Of Samples	Range	Mean
Iron and steel production	9	Pellet ore	13	1.3 - 13	4.3	11	0.64 - 4.0	2.2
		Lump ore	9	2.8 - 19	9.5	6	1.6 - 8.0	5.4
		Coal	12	2.0 - 7.7	4.6	11	2.8 - 11	4.8
		Slag	3	3.0 - 7.3	5.3	3	0.25 - 2.0	0.92
		Flue dust	3	2.7 - 23	13	1	—	7
		Coke breeze	2	4.4 - 5.4	4.9	2	6.4 - 9.2	7.8
		Blended ore	1	—	15	1	—	6.6
		Sinter	1	—	0.7	0	—	—
		Limestone	3	0.4 - 2.3	1.0	2	ND	0.2
Stone quarrying and processing	2	Crushed limestone	2	1.3 - 1.9	1.6	2	0.3 - 1.1	0.7
		Various limestone products	8	0.8 - 14	3.9	8	0.46 - 5.0	2.1
Taconite mining and processing	1	Pellets	9	2.2 - 5.4	3.4	7	0.05 - 2.0	0.9
		Tailings	2	ND	11	1	—	0.4
Western surface coal mining	4	Coal	15	3.4 - 16	6.2	7	2.8 - 20	6.9
		Overburden	15	3.8 - 15	7.5	0	—	—
		Exposed ground	3	5.1 - 21	15	3	0.8 - 6.4	3.4
Coal-fired power plant	1	Coal (as received)	60	0.6 - 4.8	2.2	59	2.7 - 7.4	4.5
Municipal solid waste landfills	4	Sand	1	—	2.6	1	—	7.4
		Slag	2	3.0 - 4.7	3.8	2	2.3 - 4.9	3.6
		Cover	5	5.0 - 16	9.0	5	8.9 - 16	12
		Clay/dirt mix	1	—	9.2	1	—	14
		Clay	2	4.5 - 7.4	6.0	2	8.9 - 11	10
		Fly ash	4	78 - 81	80	4	26 - 29	27
		Misc. fill materials	1	—	12	1	—	11

[a] References 1-10. ND = no data.

13.2.4.3 Predictive Emission Factor Equations

Total dust emissions from aggregate storage piles result from several distinct source activities within the storage cycle:

1. Loading of aggregate onto storage piles (batch or continuous drop operations).
2. Equipment traffic in storage area.
3. Wind erosion of pile surfaces and ground areas around piles.
4. Loadout of aggregate for shipment or for return to the process stream (batch or continuous drop operations).

Either adding aggregate material to a storage pile or removing it usually involves dropping the material onto a receiving surface. Truck dumping on the pile or loading out from the pile to a truck with a front-end loader are examples of batch drop operations. Adding material to the pile by a conveyor stacker is an example of a continuous drop operation.

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]

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

(1)

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

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 correction parameters cannot be obtained, the appropriate mean from Table 13.2.4-1 may be used, but the quality rating of the equation is reduced by 1 letter.

For emissions from equipment traffic (trucks, front-end loaders, dozers, etc.) traveling between or on piles, it is recommended that the equations for vehicle traffic on unpaved surfaces be used (see Section 13.2.2). For vehicle travel between storage piles, the silt value(s) for the areas among the piles (which may differ from the silt values for the stored materials) should be used.

Worst-case emissions from storage pile areas occur under dry, windy conditions. Worst-case emissions from materials-handling operations may be calculated by substituting into the equation appropriate values for aggregate material moisture content and for anticipated wind speeds during the worst case averaging period, usually 24 hours. The treatment of dry conditions for Section 13.2.2, vehicle traffic, "Unpaved Roads", follows the methodology described in that section centering on parameter p. A separate set of nonclimatic correction parameters and source extent values corresponding to higher than normal storage pile activity also may be justified for the worst-case averaging period.

13.2.4.4 Controls[12-13]

Watering and the use of chemical wetting agents are the principal means for control of aggregate storage pile emissions. Enclosure or covering of inactive piles to reduce wind erosion can also reduce emissions. Watering is useful mainly to reduce emissions from vehicle traffic in the storage pile area. Watering of the storage piles themselves typically has only a very temporary slight effect on total emissions. A much more effective technique is to apply chemical agents (such as surfactants) that permit more extensive wetting. Continuous chemical treating of material loaded onto piles, coupled with watering or treatment of roadways, can reduce total particulate emissions from aggregate storage operations by up to 90 percent.[12]

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VOLUME II: CHAPTER 3

PREFERRED AND ALTERNATIVE METHODS FOR ESTIMATING AIR EMISSIONS FROM HOT-MIX ASPHALT PLANTS

Final Report

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In the counterflow drum mixing process, the aggregate is proportioned through a cold feed system prior to introduction to the drying process. As opposed to the parallel flow drum mixing process though, the aggregate moves opposite to the flow of the exhaust gases. After drying and heating take place, the aggregate is transferred to a part of the drum that is not exposed to the exhaust gas and coated with asphalt cement. This process prevents stripping of the asphalt cement by the hot exhaust gas. If RAP is used, it is usually introduced into the coating chamber.

2.2 EMISSION SOURCES

Emissions from HMA plants derive from both controlled (i.e., ducted) and uncontrolled sources. Section 7 lists the source classification codes (SCCs) for these emission points.

2.2.1 MATERIAL HANDLING (FUGITIVE EMISSIONS)

Material handling includes the receipt, movement, and processing of fuel and materials used at the HMA facility. Fugitive particulate matter (PM) emissions from aggregate storage piles are typically caused by front-end loader operations that transport the aggregate to the cold feed unit hoppers. The amount of fugitive PM emissions from aggregate piles will be greater in strong winds (Gunkel, 1992). Piles of RAP, because RAP is coated with asphalt cement, are not likely to cause significant fugitive dust problems. Other pre-dryer fugitive emission sources include the transfer of aggregate from the cold feed unit hoppers to the dryer feed conveyor and, subsequently, to the dryer entrance. Aggregate moisture content prior to entry into the dryer is typically 3 percent to 7 percent. This moisture content, along with aggregate size classification, tend to minimize emissions from these sources, which contribute little to total facility PM emissions. PM less than or equal to 10 µm in diameter (PM_{10}) emissions from these sources are reported to account for about 19 percent of their total PM emissions (NAPA, 1995).

If crushing, breaking, or grinding operations occur at the plant, these may result in fugitive PM emissions (TNRCC, 1994). Also, fine particulate collected from the baghouses can be a source of fugitive emissions as the overflow PM is transported by truck (enclosed or tarped) for on-site disposal. At all HMA plants there may be PM and slight process fugitive volatile organic compound (VOC) emissions from the transport and handling of the hot-mix from the mixer to the storage silo and also from the load-out operations to the delivery trucks (EPA, 1994a). Small amounts of VOC emissions can also result from the transfer of liquid and gaseous fuels, although natural gas is normally transported in a pipeline (Gunkel, 1992, Wiese, 1995).

TABLE 3.2-1

TYPICAL HOT-MIX ASPHALT PLANT EMISSION CONTROL TECHNIQUES

Emission Source	Pollutant	Control Technique	Typical Efficiency (%)
Process	PM and PM_{10}	Cyclones	50 - 75[a,b]
		Multiple cyclones	90[c]
		Settling chamber	<50[b]
		Baghouse	99 - 99.97[a,d]
		Venturi scrubber	90 - 99.5[d,e]
	VOC	Dryer and combustion process modifications	37 - 86[f,g]
	SO_x	Limestone	50[b,e]
		Low sulfur fuel	80[c]
Fugitive dust	PM and PM_{10}	Paving and maintenance	60 - 99[g]
		Wetting and crusting agents	70[b] - 80[c]
		Crushed RAP material, asphalt shingles	70[h]

[a] Control efficiency dependent on particle size ratio and size of equipment.
[b] Source: Patterson, 1995c.
[c] Source: EIIP, 1995.
[d] Typical efficiencies at a hot-mix asphalt plant.
[e] Source: TNRCC, 1995.
[f] Source: Gunkel, 1992.
[g] Source: TNRCC, 1994.
[h] Source: Patterson, 1995a.

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

CATERPILLAR®

Facility	Engine Division
Date	5/1/2017
Plant/Office	Lafayette, IN
Department	Customer Service
Attention	Kit Cadwallader

Request # 17002

Data for the engine configuration requested is not available with the correct engine hardware and / or settings. This estimate of emissions levels is based on measured data available for an engine with the closest hardware and / or settings to the requested one using test methods consistent with those described in ISO 8178-1 for measuring HC, CO, CO2, and NOx. This data is an estimate of the emissions for this particular rating, and should not be used for guarantee purposes.

Engine Model: 3512 DITA running at 100% load, 1429 Hp at 1800 RPM, with dry manifolds.
Set at standard production timing. Arr# : 2W8405 PL# : PP9871
Application: A 60 HZ standby generator set rated at 1015 EKW.

	Lb/Hr	g/Hr	g/Hp-Hr	PPM (Wet)	% BY Vol.	% BY Wt.
CO_2	1599.4	725456	507.48	71349	7.13	11.27
N_2	10488.9	4757670	3328.14	762428	76.24	73.90
O_2	1443.6	654809	458.06	94870	9.49	10.17
H_2O	632.9	287061	200.81	69326	6.93	4.46
CO	5.0	2283	1.60	367	0.04	0.04
NO~	21.7	9890	6.92		0.15	0.15
NOx~	33.3	15161	10.61	1486		
HC	1.1	487	0.34	157	0.02	0.01
SO_2^	0.5	230	0.16	16	0.00	0.00
TSP	0.31	142.30	0.10			

	g/Hr	g/Hp-Hr	g/n cu.M`
NOx	15161	10.61	4.206
CO	2283	1.60	0.635
HC	487	0.34	0.135
SMOKE (Cat Number)			0.021
FUEL RATE			508.33 Lb/Hr
INLET AIR FLOW			13685 Lb/Hr
EXHAUST FLOW:			
Rate			14193 Lb/Hr
at 60 deg F and 760 mm Hg.			3114 SCFM
at 970 deg F stack temp.			8569 CFM

Notes: * This data is based on steady-state engine operating conditions of 77 deg. F, and 28.35 in. Hg. and No. 2 diesel fuel. This data is also subject to instrumentation, measurement, and engine-to-engine variability.

~ The NOx shown is not actually present in the exhaust. It is based on the assumption that the NO present in the exhaust is converted to NO_2 in the atmosphere. NO and NOx are corrected to 75 grains humidity.

^ SO2 is proportional to a sulfur content of 0.05 % by weight of the fuel.

` Grams per normal cubic meter values are corrected to 5% oxygen.

This report provides the best information available at this time. It should not be used at a future date without verification as to its validity for the current engine.

Brian Layton
Dennis Walling
Performance Production Support
Ext. 448-5238

PWRS # 61249

JOHN DEERE POWER SYSTEMS
Waterloo, IA 50704-5100

Engine serial number:

Engine build date:

Non-Power Tech

4045T 113hp (84kW) @ 1800 Gen-Set ENGINE EXHAUST EMISSIONS

Exhaust emissions levels for this gen-set engine at full load rated speed are as follows:

			GRAMS/HR			EXHAUST FLOW	EXHAUST TEMP	Fuel consumption
ENGINE	**RPM**	**HP**	**CO**	**HC**	**N0x**	**(cubic meters per minute)**	**(degrees Celsius)**	**at rated HP (pounds per hour)**
4045T	1800	113	250	23	1500	18.9	534	38.7

Some of our published data is derived from measured data on similar engines. Data applies to steady state operation of the engine at full load (standby) and rated speed. N0x is measured per SAE J177 and reported as NO2. HC are the total hydrocarbons (methane basis) measured per SAE J215. CO is measured per SAE J177. Particulates are not reported as there was no steady state method defined for laboratory measurement of particulates at the time most of the engines were evaluated.

CATERPILLAR®

GEN SET PACKAGE PERFORMANCE DATA [1LS01691]

SEPTEMBER 29, 2017

For Help Desk Phone Numbers Click here

Performance Number: DM2328

Change Level: 01

Sales Model: 3406CDITA

Combustion: DI

Aspr: TA

Engine Power:
320 W/F EKW
331 W/O F EKW
475 HP

Speed: 1,800 RPM

After Cooler: JWAC

Manifold Type: DRY

Governor Type: HYDRA

After Cooler Temp(F): --

Turbo Quantity: 1

Engine App: GP

Turbo Arrangement:

Hertz: 60

Application Type: PACKAGE-DIE

Engine Rating: PGS

Strategy:

Rating Type: PRIME

Certification: EPA TIER-I 1996 - 2000
EU STAGE-1 1999 - 2001

General Performance Data

GEN W/F EKW	PERCENT LOAD	ENGINE POWER BHP	ENGINE BMEP PSI	FUEL BSFC LB/BHP-HR	FUEL RATE GPH	INTAKE MFLD TEMP DEG F	INTAKE MFLD P IN-HG	INTAKE AIR FLOW CFM	EXH MFLD TEMP DEG F	EXH STACK TEMP DEG F	EXH GAS FLOW CFM
320	100	474	233.51	0.34	22.98	194.9	47.97	981.75	1,224.14	971.96	2,765.14
288	90	427	210.02	0.34	20.53	189.86	41.46	904.06	1,170.32	940.82	2,493.22
256	80	380	186.96	0.34	18.31	185.54	35.15	833.43	1,121.54	912.02	2,242.48
240	75	357	175.64	0.34	17.22	183.74	32.13	798.11	1,097.96	897.98	2,122.41
224	70	334	164.19	0.34	16.19	182.12	29.2	759.27	1,074.56	883.94	2,005.88
192	60	288	141.85	0.34	14.16	179.42	23.6	692.17	1,028.12	856.22	1,779.86
160	50	243	119.66	0.35	12.2	177.62	18.39	625.07	977.36	823.46	1,567.97
128	40	200	98.19	0.36	10.33	176.54	13.89	565.04	915.44	778.46	1,370.21
96	30	155	76.15	0.38	8.43	175.64	9.8	512.06	840.92	721.94	1,179.51
80	25	132	64.98	0.4	7.48	175.28	7.94	487.34	798.44	689	1,084.16
64	20	109	53.66	0.42	6.53	174.74	6.37	466.15	745.34	648.32	999.41
32	10	62	30.6	0.52	4.6	174.02	3.73	427.31	620.96	552.56	836.96

Engine Heat Rejection Data

GEN W/F EKW	PERCENT LOAD	REJ TO JW BTU/MN	REJ TO ATMOS BTU/MN	REJ TO EXHAUST BTU/MN	EXH RCOV TO 350F BTU/MN	FROM OIL CLR BTU/MN	FROM AFT CLR BTU/MN	WORK ENERGY BTU/MN	LHV ENERGY BTU/MN	HHV ENERGY BTU/MN
320	100	11,430.8	3,855.8	17,515.9	10,009.1	2,644.4	2,104.2	20,131.9	49,704.3	52,945.9
288	90	10,293.5	3,355.3	15,525.5	8,701.1	2,365.8	1,598.0	18,084.6	44,415.4	47,315.7
256	80	9,269.8	2,951.6	13,876.2	7,677.4	2,109.9	1,148.8	16,094.2	39,581.4	42,140.6
240	75	8,758.0	2,769.6	13,080.1	7,165.6	1,984.8	944.0	15,127.4	37,249.8	39,695.2
224	70	8,246.1	2,587.6	12,283.9	6,710.6	1,865.3	756.4	14,160.6	34,975.0	37,249.8
192	60	7,279.3	2,252.1	10,862.2	5,800.7	1,632.2	420.8	12,227.0	30,596.0	32,586.4
160	50	6,312.6	1,927.9	9,497.3	5,004.5	1,404.7	142.2	10,293.5	26,330.8	28,093.7
128	40	5,402.6	1,620.8	8,246.1	4,208.4	1,188.6	-68.2	8,473.6	22,293.0	23,771.6
96	30	4,492.7	1,319.4	7,051.9	3,412.2	972.5	-233.2	6,540.0	18,198.4	19,392.6
80	25	3,980.9	1,165.8	6,426.3	3,014.1	858.7	-301.4	5,630.1	16,151.0	17,231.6
64	20	3,525.9	1,018.0	5,857.6	2,616.0	750.7	-352.6	4,606.5	14,103.7	15,013.7
32	10	2,502.3	716.6	4,720.2	1,763.0	528.9	-420.8	2,616.0	9,952.2	10,577.8

EXHAUST Sound Data: 4.92 FEET

GEN W/F EKW	PERCENT LOAD	OVERALL SOUND DB(A)	OBCF 63HZ DB	OBCF 125HZ DB	OBCF 250HZ DB	OBCF 500HZ DB	OBCF 1000HZ DB	OBCF 2000HZ DB	OBCF 4000HZ DB	OBCF 8000HZ DB
320	100	108	105	107	104	106	101	101	96	86
288	90	107	104	106	104	106	100	101	96	85
256	80	106	103	105	103	105	99	100	95	84
240	75	106	103	105	102	104	99	99	94	84
224	70	105	103	105	102	104	99	99	94	84
192	60	105	102	104	101	103	98	98	93	83
160	50	104	101	103	100	102	97	97	92	82
128	40	102	100	102	99	101	96	96	91	81
96	30	101	98	100	98	100	94	95	90	79
80	25	101	98	100	97	99	94	94	89	79
64	20	100	97	99	96	98	93	93	88	78
32	10	98	95	97	95	97	91	92	87	76

EXHAUST Sound Data: 22.97 FEET

GEN W/F EKW	PERCENT LOAD	OVERALL SOUND DB(A)	OBCF 63HZ DB	OBCF 125HZ DB	OBCF 250HZ DB	OBCF 500HZ DB	OBCF 1000HZ DB	OBCF 2000HZ DB	OBCF 4000HZ DB	OBCF 8000HZ DB
320	100	95	90	93	88	95	87	87	81	74
288	90	94	90	92	87	94	86	86	81	73
256	80	93	89	91	86	93	85	85	80	72
240	75	93	88	91	86	93	85	85	79	72
224	70	92	88	90	85	92	84	84	79	71
192	60	91	87	89	85	91	83	84	78	71
160	50	90	86	88	84	90	82	83	77	70
128	40	89	85	87	83	89	81	82	76	68
96	30	88	84	86	81	88	80	80	75	67
80	25	87	83	85	81	87	79	80	74	67
64	20	87	82	85	80	87	79	79	73	66
32	10	85	81	83	78	85	77	77	72	64

EXHAUST Sound Data: 49.21 FEET

GEN W/F EKW	PERCENT LOAD	OVERALL SOUND DB(A)	OBCF 63HZ DB	OBCF 125HZ DB	OBCF 250HZ DB	OBCF 500HZ DB	OBCF 1000HZ DB	OBCF 2000HZ DB	OBCF 4000HZ DB	OBCF 8000HZ DB
320	100	88	84	86	81	88	80	80	75	67
288	90	87	83	85	81	87	79	80	74	67
256	80	86	82	84	80	86	78	79	73	66
240	75	86	82	84	79	86	78	78	73	65
224	70	85	81	84	79	86	78	78	72	65
192	60	85	80	83	78	85	77	77	71	64
160	50	84	79	82	77	84	76	76	70	63
128	40	82	78	81	76	83	75	75	69	62
96	30	81	77	79	75	81	73	74	68	61
80	25	81	76	79	74	81	73	73	67	60
64	20	80	76	78	73	80	72	72	67	59
32	10	78	74	76	72	78	70	71	65	58

MECHANICAL Sound Data: 3.28 FEET

GEN W/F EKW	PERCENT LOAD	OVERALL SOUND DB(A)	OBCF 63HZ DB	OBCF 125HZ DB	OBCF 250HZ DB	OBCF 500HZ DB	OBCF 1000HZ DB	OBCF 2000HZ DB	OBCF 4000HZ DB	OBCF 8000HZ DB
320	100	100	98	107	98	93	94	92	88	95
288	90	100	98	107	98	93	94	92	88	95
256	80	100	98	107	98	93	94	92	88	95
240	75	100	98	107	98	93	94	92	88	95
224	70	100	98	107	98	93	94	92	88	95
192	60	100	98	107	98	93	94	92	88	95
160	50	100	98	107	98	93	94	92	88	95
128	40	100	98	107	98	93	94	92	88	95
96	30	100	98	107	98	93	94	92	88	95
80	25	100	98	107	98	93	94	92	88	95
64	20	100	98	107	98	93	94	92	88	95
32	10	100	98	107	98	93	94	92	88	95

MECHANICAL Sound Data: 22.97 FEET

GEN W/F EKW	PERCENT LOAD	OVERALL SOUND DB(A)	OBCF 63HZ DB	OBCF 125HZ DB	OBCF 250HZ DB	OBCF 500HZ DB	OBCF 1000HZ DB	OBCF 2000HZ DB	OBCF 4000HZ DB	OBCJ 8000HZ DB
320	100	88	87	95	87	81	82	81	76	82
288	90	88	87	95	87	81	82	81	76	82
256	80	88	87	95	87	81	82	81	76	82
240	75	88	87	95	87	81	82	81	76	82
224	70	88	87	95	87	81	82	81	76	82
192	60	88	87	95	87	81	82	81	76	82
160	50	88	87	95	87	81	82	81	76	82
128	40	88	87	95	87	81	82	81	76	82
96	30	88	87	95	87	81	82	81	76	82
80	25	88	87	95	87	81	82	81	76	82
64	20	88	87	95	87	81	82	81	76	82
32	10	88	87	95	87	81	82	81	76	82

MECHANICAL Sound Data: 49.21 FEET

GEN W/F EKW	PERCENT LOAD	OVERALL SOUND DB(A)	OBCF 63HZ DB	OBCF 125HZ DB	OBCF 250HZ DB	OBCF 500HZ DB	OBCF 1000HZ DB	OBCF 2000HZ DB	OBCF 4000HZ DB	OBCF 8000HZ DB
320	100	82	81	89	81	72	76	76	72	75
288	90	82	81	89	81	72	76	76	72	75
256	80	82	81	89	81	72	76	76	72	75
240	75	82	81	89	81	72	76	76	72	75
224	70	82	81	89	81	72	76	76	72	75
192	60	82	81	89	81	72	76	76	72	75
160	50	82	81	89	81	72	76	76	72	75
128	40	82	81	89	81	72	76	76	72	75
96	30	82	81	89	81	72	76	76	72	75
80	25	82	81	89	81	72	76	76	72	75
64	20	82	81	89	81	72	76	76	72	75
32	10	82	81	89	81	72	76	76	72	75

EMISSIONS DATA

EPA TIER-I 1996 - 2000 ** A3

Gaseous emissions data measurements are consistent with those described in EPA 40 CFR PART 89 SUBPART D and ISO 8178 for measuring HC, CO, PM, and NOx.

Gaseous emissions values are WEIGHTED CYCLE AVERAGES and are in compliance with the following non-road regulations:

LOCALITY	AGENCY/LEVEL	MAX LIMITS - g/kW-hr
U. S. (incl Calif)	EPA/Tier-1	CO:11.4 HC:1.3 NOx:9.2 PM:0.5
Europe	EU/Stage-I	CO:5.0 HC:1.3 NOx:9.2 PM:0.5

EU STAGE-1 1999 - 2001 ** A3

Gaseous emissions data measurements are consistent with those described in EPA 40 CFR PART 89 SUBPART D and ISO 8178 for measuring HC, CO, PM, and NOx.

Gaseous emissions values are WEIGHTED CYCLE AVERAGES and are in compliance with the following non-road regulations:

LOCALITY	AGENCY/LEVEL	MAX LIMITS - g/kW-hr
U. S. (incl Calif)	EPA/Tier-1	CO:11.4 HC:1.3 NOx:9.2 PM:0.5
Europe	EU/Stage-I	CO:5.0 HC:1.3 NOx:9.2 PM:0.5

REFERENCE EXHAUST STACK DIAMETER	5 IN
WET EXHAUST MASS	4,519.5 LB/HR
WET EXHAUST FLOW (971.60 F STACK TEMP)	2,768.32 CFM
WET EXHAUST FLOW RATE (32 DEG F AND 29.98 IN HG)	928.00 STD CFM
DRY EXHAUST FLOW RATE (32 DEG F AND 29.98 IN HG)	850.38 STD CFM
FUEL FLOW RATE	23 GAL/HR

RATED SPEED "Potential site variation"

GEN PWR EKW	PERCENT LOAD	ENGINE POWER BHP	TOTAL NOX (AS NO2) LB/HR	TOTAL CO LB/HR	TOTAL HC LB/HR	PART MATTER LB/HR	OXYGEN IN EXHAUST PERCENT	DRY SMOKE OPACITY PERCENT	BOSCH SMOKE NUMBER
320	100	474	7.7400	1.4700	.0900	.1600	9.9000	.9000	1.2800
240	75	357	6.2600	1.0100	.0800	.1000	10.8000	.7000	1.2800
160	50	243	4.4300	.7700	.0900	.1000	11.8000	.9000	1.2800
80	25	132	2.3100	.4700	.0900	.0800	13.8000	1.0000	1.2800
32	10	62	1.2600	.5800	.1300	.0800	16.0000	1.1000	1.2800

RATED SPEED "Nominal Data"

GEN PWR EKW	PERCENT LOAD	ENGINE POWER BHP	TOTAL NOX (AS NO2) LB/HR	TOTAL CO LB/HR	TOTAL HC LB/HR	TOTAL CO2 LB/HR	PART MATTER LB/HR	OXYGEN IN EXHAUST PERCENT	DRY SMOKE OPACITY PERCENT	BOSCH SMOKE NUMBER
320	100	474	6.4000	.7900	.0500	507.7	.0800	9.9000	.9000	1.2800
240	75	357	5.1700	.5400	.0400	381.1	.0500	10.8000	.7000	1.2800
160	50	243	3.6600	.4100	.0500	271.7	.0500	11.8000	.9000	1.2800
80	25	132	1.9100	.2500	.0500	167.9	.0400	13.8000	1.0000	1.2800
32	10	62	1.0400	.3100	.0700	103.4	.0400	16.0000	1.1000	1.2800

Altitude Capability Data(Corrected Power Altitude Capability)

Ambient Operating Temp. Altitude	50 F	68 F	86 F	104 F	122 F	NORMAL
0 FT	474.72 hp	474.72 hp	474.72 hp	474.72 hp	474.72 hp	474.72 hp
984.25 FT	474.72 hp	474.72 hp	474.72 hp	474.72 hp	474.72 hp	474.72 hp
1,640.42 FT	474.72 hp	474.72 hp	474.72 hp	474.72 hp	474.72 hp	474.72 hp
3,280.84 FT	474.72 hp	474.72 hp	474.72 hp	468.02 hp	453.26 hp	474.72 hp
4,921.26 FT	474.72 hp	469.36 hp	454.61 hp	439.85 hp	426.44 hp	469.36 hp
6,561.68 FT	457.29 hp	441.2 hp	426.44 hp	413.03 hp	400.96 hp	445.22 hp
8,202.1 FT	429.13 hp	414.38 hp	400.96 hp	388.9 hp	376.83 hp	423.76 hp
9,842.52 FT	403.65 hp	388.9 hp	376.83 hp	364.76 hp	352.69 hp	402.31 hp
10,498.69 FT	392.92 hp	379.51 hp	367.44 hp	355.37 hp	344.64 hp	394.26 hp

The powers listed above and all the Powers displayed are Corrected Powers

Identification Reference and Notes

Engine Arrangement:	1316598	**Lube Oil Press @ Rated Spd(PSI):**	59.5
Effective Serial No:	1LS/4JK	**Piston Speed @ Rated Eng SPD (FT/Min):**	1,789.4
Primary Engine Test Spec:	2T8139	**Max Operating Altitude(FT):**	4,429.1
Performance Parm Ref:	TM5739	**PEEC Elect Control Module Ref**	
Performance Data Ref:	DM2328	**PEEC Personality Cont Mod Ref**	
Aux Coolant Pump Perf Ref:			
Cooling System Perf Ref:		**Turbocharger Model**	S4DS034-1.58
Certification Ref:	EPA	**Fuel Injector**	1305187
Certification Year:	1996	**Timing-Static (DEG):**	17.50
Compression Ratio:	14.6	**Timing-Static Advance (DEG):**	40.00
Combustion System:	DI	**Timing-Static (MM):**	404.00
Aftercooler Temperature (F):	--	**Unit Injector Timing (MM):**	--
Crankcase Blowby Rate(CFH):	--	**Torque Rise (percent)**	--
Fuel Rate (Rated RPM) No Load (Gal/HR):	--	**Peak Torque Speed RPM**	--
Lube Oil Press @ Low Idle Spd(PSI):	51.9	**Peak Torque (LB.FT):**	--

Reference Number: DM2328

THIS DATA CURVE IS ALSO APPLICABLE TO BASIC ENGINE ARANGEMENT 130-9415 WITH TEST SPEC 2T8141
EPA TIER-I 19962000A3EU STAGE-1 19992001A3

Parameters Reference: TM5739

GEN SET - PACKAGED - DIESEL

TOLERANCES:
AMBIENT AIR CONDITIONS AND FUEL USED WILL AFFECT THESE VALUES. EACH OF THE VALUES MAY VARY IN ACCORDANCE WITH THE FOLLOWING TOLERANCES.

Power	+/- 3%
Exhaust Stack Temperature	+/- 8%
Generator Power	+/- 5%
Inlet Airflow	+/- 5%
Intake Manifold Pressure-gage	+/- 10%
Exhaust Flow	+/- 6%
Specific Fuel Consumption	+/- 3%
Fuel Rate	+/- 5%
Heat Rejection	+/- 5%
Heat Rejection - Exhaust Only	+/- 10%

T4i Tolerance Exceptions

C15:	Power Tolerance	+4% , -0%
C27:	Power Tolerance	+0% , -4%

CONDITIONS:
ENGINE PERFORMANCE IS CORRECTED TO INLET AIR STANDARD CONDITIONS OF 99 KPA (29.31 IN HG) AND 25 DEG C (77 DEG F).

THESE VALUES CORRESPOND TO THE STANDARD ATMOSPHERIC PRESSURE AND TEMPERATURE IN ACCORDANCE WITH SAE J1349. ALSO INCLUDED IS A CORRECTION TO STANDARD FUEL GRAVITY OF 35 DEGREES API HAVING A LOWER HEATING VALUE OF 42,780 KJ/KG (18,390 BTU/LB) WHEN USED AT 29 DEG C (84.2 DEG F) WHERE THE DENSITY IS 838.9 G/L (7.002 LB/GAL).

THE CORRECTED PERFORMANCE VALUES SHOWN FOR CATERPILLAR ENGINES WILL APPROXIMATE THE VALUES OBTAINED WHEN THE OBSERVED PERFORMANCE DATA IS CORRECTED TO SAE J1349, ISO 3046-2 & 8665 & 2288 & 9249 & 1585, EEC 80/1269 AND DIN70020 STANDARD REFERENCE CONDITIONS.

ENGINES ARE EQUIPPED WITH STANDARD ACCESSORIES; LUBE OIL, FUEL PUMP AND JACKET WATER PUMP. THE POWER REQUIRED TO DRIVE AUXILIARIES MUST BE DEDUCTED FROM THE GROSS OUTPUT TO ARRIVE AT THE NET POWER AVAILABLE FOR THE EXTERNAL (FLYWHEEL) LOAD. TYPICAL AUXILIARIES INCLUDE COOLING FANS, AIR COMPRESSORS, AND CHARGING ALTERNATORS.

RATINGS MUST BE REDUCED TO COMPENSATE FOR ALTITUDE AND/OR AMBIENT TEMPERATURE CONDITIONS ACCORDING TO THE APPLICABLE DATA SHOWN ON THE PERFORMANCE DATA SET.

ALTITUDE:
ALTITUDE CAPABILITY - THE RECOMMENDED REDUCED POWER VALUES FOR SUSTAINED ENGINE OPERATION AT SPECIFIC ALTITUDE LEVELS AND AMBIENT TEMPERATURES.

COLUMN "N" DATA - THE FLYWHEEL POWER OUTPUT AT NORMAL AMBIENT TEMPERATURE.

AMBIENT TEMPERATURE - TO BE MEASURED AT THE AIR CLEANER AIR INLET DURING NORMAL ENGINE OPERATION.

NORMAL TEMPERATURE - THE NORMAL TEMPERATURE AT VARIOUS SPECIFIC ALTITUDE LEVELS IS FOUND ON TM2001.

THE GENERATOR POWER CURVE TABULAR DATA REPRESENTS THE NET ELECTRICAL POWER OUTPUT OF THE GENERATOR.

GENERATOR SET RATINGS

EMERGENCY STANDBY POWER (ESP)

OUTPUT AVAILABLE WITH VARYING LOAD FOR THE DURATION OF AN EMERGENCY OUTAGE. AVERAGE POWER OUTPUT IS 70% OF THE ESP RATING. TYPICAL OPERATION IS 50 HOURS PER YEAR, WITH MAXIMUM EXPECTED USAGE OF 200 HOURS PER YEAR.

STANDBY POWER RATING

OUTPUT AVAILABLE WITH VARYING LOAD FOR THE DURATION OF AN EMERGENCY OUTAGE. AVERAGE POWER OUTPUT IS 70% OF THE STANDBY POWER RATING. TYPICAL OPERATION IS 200 HOURS PER YEAR, WITH MAXIMUM EXPECTED USAGE OF 500 HOURS PER YEAR.

PRIME POWER RATING

OUTPUT AVAILABLE WITH VARYING LOAD FOR AN UNLIMITED TIME. AVERAGE POWER OUTPUT IS 70% OF THE PRIME POWER RATING. TYPICAL PEAK DEMAND IS 100% OF PRIME RATED EKW WITH 10% OVERLOAD CAPABILITY FOR EMERGENCY USE FOR A MAXIMUM OF 1 HOUR IN 12. OVERLOAD OPERATION CANNOT EXCEED 25 HOURS PER YEAR.

CONTINUOUS POWER RATING

OUTPUT AVAILABLE WITH NON-VARYING LOAD FOR AN UNLIMITED TIME. AVERAGE POWER OUTPUT IS 70-100% OF THE CONTINUOUS POWER RATING. TYPICAL PEAK DEMAND IS 100% OF CONTINUOUS RATED EKW FOR 100% OF OPERATING HOURS.

SOUND DEFINITIONS:

Sound Power : DM8702
Sound Pressure : TM7080

United States
Environmental Protection
Agency

Office of Transportation and Air Quality
EPA-420-B-16-022
March 2016

Nonroad Compression-Ignition Engines: Exhaust Emission Standards

	Rated Power (kW)	Tier	Model Year	NMHC (g/kW-hr)	NMHC + NOx (g/kW-hr)	NOx (g/kW-hr)	PM (g/kW-hr)	CO (g/kW-hr)	Smoke [a] (Percentage)	Useful Life (hours /years) [b]	Warranty Period (hours /years) [b]
Federal	kW < 8	1	2000-2004	-	10.5	-	1.0	8.0	20/15/50	3,000/5	1,500/2
		2	2005-2007	-	7.5	-	0.80	8.0			
		4	2008+	-	7.5	-	0.40 [c]	8.0			
	8 ≤ kW < 19	1	2000-2004	-	9.5	-	0.80	6.6		3,000/5	1,500/2
		2	2005-2007	-	7.5	-	0.80	6.6			
		4	2008+	-	7.5	-	0.40	6.6			
	19 ≤ kW < 37	1	1999-2003	-	9.5	-	0.80	5.5		5,000/7 [d]	3,000/5 [e]
		2	2004-2007	-	7.5	-	0.60	5.5			
		4	2008-2012	-	7.5	-	0.30	5.5			
			2013+	-	4.7	-	0.03	5.5			
	37 ≤ kW < 56	1	1998-2003	-	-	9.2	-	-		8,000/10	3,000/5
		2	2004-2007	-	7.5	-	0.40	5.0			
		3 [f]	2008-2011	-	4.7	-	0.40	5.0			
		4 (Option 1) [g]	2008-2012	-	4.7	-	0.30	5.0			
		4 (Option 2) [g]	2012	-	4.7	-	0.03	5.0			
		4	2013+	-	4.7	-	0.03	5.0			
	56 ≤ kW < 75	1	1998-2003	-	-	9.2	-	-			
		2	2004-2007	-	7.5	-	0.40	5.0			
		3	2008-2011	-	4.7	-	0.40	5.0			
		4	2012-2013 [h]	-	4.7	-	0.02	5.0			
			2014+ [i]	0.19	-	0.40	0.02	5.0			
	75 ≤ kW < 130	1	1997-2002	-	-	9.2	-	-			
		2	2003-2006	-	6.6	-	0.30	5.0			
		3	2007-2011	-	4.0	-	0.30	5.0			
		4	2012-2013 [h]	-	4.0	-	0.02	5.0			
			2014+	0.19	-	0.40	0.02	5.0			

Continued

	Rated Power (kW)	Tier	Model Year	NMHC (g/kW-hr)	NMHC + NOx (g/kW-hr	NOx (g/kW-hr	PM (g/kW-hr	CO (g/kW-hr)	Smoke [a] (Percentage)	Useful Life (hours /years) [b]	Warranty Period (hours /years) [b]
Federal	130 ≤ kW < 225	1	1996-2002	1.3 [j]	-	9.2	0.54	11.4	20/15/50	8,000/10	3,000/5
		2	2003-2005	-	6.6	-	0.20	3.5			
		3	2006-2010	-	4.0	-	0.20	3.5			
		4	2011-2013 [h]	-	4.0	-	0.02	3.5			
			2014+ [i]	0.19	-	0.40	0.02	3.5			
	225 ≤ kW < 450	1	1996-2000	1.3 [j]	-	9.2	0.54	11.4			
		2	2001-2005	-	6.4	-	0.20	3.5			
		3	2006-2010	-	4.0	-	0.20	3.5			
		4	2011-2013 [h]	-	4.0	-	0.02	3.5			
			2014+ [i]	0.19	-	0.40	0.02	3.5			
	450 ≤ kW < 560	1	1996-2001	1.3 [j]	-	9.2	0.54	11.4			
		2	2002-2005	-	6.4	-	0.20	3.5			
		3	2006-2010	-	4.0	-	0.20	3.5			
		4	2011-2013 [h]	-	4.0	-	0.02	3.5			
			2014+ [i]	0.19	-	0.40	0.02	3.5			
	560 ≤ kW < 900	1	2000-2005	1.3 [j]	-	9.2	0.54	11.4			
		2	2006-2010	-	6.4	-	0.20	3.5			
		4	2011-2014	0.40	-	3.5	0.10	3.5			
			2015+ [i]	0.19	-	3.5 [k]	0.04 [l]	3.5			
	kW > 900	1	2000-2005	1.3 [j]	-	9.2	0.54	11.4			
		2	2006-2010	-	6.4	-	0.20	3.5			
		4	2011-2014	0.40	-	3.5 [k]	0.10	3.5			
			2015+ [i]	0.19	-	3.5 [k]	0.04 [l]	3.5			

Notes on following page.

Notes:

- For Tier 1, 2, and 3 standards, exhaust emissions of nitrogen oxides (NOx), carbon monoxide (CO), hydrocarbons (HC), and non-methane hydrocarbons (NMHC) are measured using the procedures in 40 Code of Federal Regulations (CFR) Part 89 Subpart E. For Tier 1, 2, and 3 standards, particulate matter (PM) exhaust emissions are measured using the California Regulations for New 1996 and Later Heavy-Duty Off-Road Diesel Cycle Engines.
- For Tier 4 standards, engines are tested for transient and steady-state exhaust emissions using the procedures in 40 CFR Part 1039 Subpart F. Transient standards do not apply to engines below 37 kilowatts (kW) before the 2013 model year, constant-speed engines, engines certified to Option 1, and engines above 560 kW.
- Tier 2 and later model naturally aspirated nonroad engines shall not discharge crankcase emissions into the atmosphere unless these emissions are permanently routed into the exhaust. This prohibition does not apply to engines using turbochargers, pumps, blowers, or superchargers.
- In lieu of the Tier 1, 2, and 3 standards for NOX, NMHC + NOX, and PM, manufacturers may elect to participate in the averaging, banking, and trading (ABT) program described in 40 CFR Part 89 Subpart C.

a Smoke emissions may not exceed 20 percent during the acceleration mode, 15 percent during the lugging mode, and 50 percent during the peaks in either mode. Smoke emission standards do not apply to single-cylinder engines, constant-speed engines, or engines certified to a PM emission standard of 0.07 grams per kilowatt-hour (g/kW-hr) or lower. Smoke emissions are measured using procedures in 40 CFR Part 86 Subpart I.

b Useful life and warranty period are expressed hours and years, whichever comes first.

c Hand-startable air-cooled direct injection engines may optionally meet a PM standard of 0.60 g/kW-hr. These engines may optionally meet Tier 2 standards through the 2009 model years. In 2010 these engines are required to meet a PM standard of 0.60 g/kW-hr.

d Useful life for constant speed engines with rated speed 3,000 revolutions per minute (rpm) or higher is 5 years or 3,000 hours, whichever comes first.

e Warranty period for constant speed engines with rated speed 3,000 rpm or higher is 2 years or 1,500 hours, whichever comes first.

f These Tier 3 standards apply only to manufacturers selecting Tier 4 Option 2. Manufacturers selecting Tier 4 Option 1 will be meeting those standards in lieu of Tier 3 standards.

g A manufacturer may certify all their engines to either Option 1 or Option 2 sets of standards starting in the indicated model year. Manufacturers selecting Option 2 must meet Tier 3 standards in the 2008-2011 model years.

h These standards are phase-out standards. Not more than 50 percent of a manufacturer's engine production is allowed to meet these standards in each model year of the phase out period. Engines not meeting these standards must meet the final Tier 4 standards.

i These standards are phased in during the indicated years. At least 50 percent of a manufacturer's engine production must meet these standards during each year of the phase in. Engines not meeting these standards must meet the applicable phase-out standards.

j For Tier 1 engines the standard is for total hydrocarbons.

k The NOx standard for generator sets is 0.67 g/kW-hr.

l The PM standard for generator sets is 0.03 g/kW-hr.

Citations: Code of Federal Regulations (CFR) citations:

- 40 CFR 89.112 = Exhaust emission standards
- 40 CFR 1039.101 = Exhaust emission standards for after 2014 model year
- 40 CFR 1039.102 = Exhaust emission standards for model year 2014 and earlier
- 40 CFR 1039 Subpart F = Exhaust emissions transient and steady state test procedures
- 40 CFR 86 Subpart I = Smoke emission test procedures
- 40 CFR 1065 = Test equipment and emissions measurement procedures

TANKS 4.0.9d

Emissions Report - Detail Format

Tank Identification and Physical Characteristics

Identification

User Identification:	Kirtland HMA 10K Asphalt Tank
City:	Farmington
State:	New Mexico
Company:	Elam Construction
Type of Tank:	Horizontal Tank
Description:	Kirtland Sand & Gravel

Tank Dimensions

Shell Length (ft):	30.00
Diameter (ft):	7.50
Volume (gallons):	10,000.00
Turnovers:	260.30
Net Throughput(gal/yr):	2,603,000.00
Is Tank Heated (y/n):	Y
Is Tank Underground (y/n):	N

Paint Characteristics

Shell Color/Shade:	Red/Primer
Shell Condition	Good

Breather Vent Settings

Vacuum Settings (psig):	0.00
Pressure Settings (psig)	0.00

Meterological Data used in Emissions Calculations: Albuquerque, New Mexico (Avg Atmospheric Pressure = 12.15 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

Kirtland HMA 10K Asphalt Tank - Horizontal Tank
Farmington, New Mexico

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Asphalt Cement	All	350.00	350.00	350.00	350.00	0.0347	0.0347	0.0347	105.0000			1,000.00	Option 3: A=75350.06, B=9.00346

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

Kirtland HMA 10K Asphalt Tank - Horizontal Tank
Farmington, New Mexico

Annual Emission Calcaulations

Standing Losses (lb):	0.0000
Vapor Space Volume (cu ft):	844.1780
Vapor Density (lb/cu ft):	0.0004
Vapor Space Expansion Factor:	0.0000
Vented Vapor Saturation Factor:	0.9931
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	844.1780
Tank Diameter (ft):	7.5000
Effective Diameter (ft):	16.9300
Vapor Space Outage (ft):	3.7500
Tank Shell Length (ft):	30.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0004
Vapor Molecular Weight (lb/lb-mole):	105.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0347
Daily Avg. Liquid Surface Temp. (deg. R):	809.6700
Daily Average Ambient Temp. (deg. F):	56.1542
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	809.6700
Tank Paint Solar Absorptance (Shell):	0.8900
Daily Total Solar Insulation Factor (Btu/sqft day):	1,765.3167
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.0000
Daily Vapor Temperature Range (deg. R):	0.0000
Daily Vapor Pressure Range (psia):	0.0000
Breather Vent Press. Setting Range(psia):	0.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0347
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	0.0347
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	0.0347
Daily Avg. Liquid Surface Temp. (deg R):	809.6700
Daily Min. Liquid Surface Temp. (deg R):	809.6700
Daily Max. Liquid Surface Temp. (deg R):	809.6700
Daily Ambient Temp. Range (deg. R):	27.9250
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.9931
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	0.0347
Vapor Space Outage (ft):	3.7500
Working Losses (lb):	63.7072
Vapor Molecular Weight (lb/lb-mole):	105.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	0.0347
Annual Net Throughput (gal/yr.):	2,603,000.0000
Annual Turnovers:	260.3000
Turnover Factor:	0.2819
Tank Diameter (ft):	7.5000
Working Loss Product Factor:	1.0000
Total Losses (lb):	63.7072

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

Kirtland HMA 10K Asphalt Tank - Horizontal Tank
Farmington, New Mexico

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Asphalt Cement	63.71	0.00	63.71

Elam Construction
Kirtland Sand Gravel Aggregate Plants
Uncontrolled Emission Rates

Main Plant Throughput	500	tph	2190000	tons per year
Uncontrolled Hours Operation	4380	hours/yr		
Wash Plant Throughput	500	tph	2190000	tons per year
Uncontrolled Hours Operation	4380	hours/yr		

AP-42 Section 13.2.4 "Aggregate Handling" (ver 11/2006)
E = k x (0.0032) x (U/5)^1.3 / (M/2)^1.4 lbs/ton

k(tsp)	0.74		
k(pm10)	0.35		
k(pm2.5)	0.053		
U Max Hour	11.0	Max MPH	NMED Default
U Annual Hour	8.4	Max MPH	Farmington 1996-2006
M	2.00	%	NMED Default

E(TSP) Max Hour = 0.00660 lbs/ton
E(PM10) Max Hour = 0.00312 lbs/ton
E(PM2.5) Max Hour = 0.00047 lbs/ton

E(TSP) Annual Hour = 0.00465 lbs/ton
E(PM10) Annual Hour = 0.00220 lbs/ton
E(PM2.5) Annual Hour = 0.00033 lbs/ton

Uncontrolled Emission Factors	TSP	PM10	PM2.5	
Crusher	0.00540 lbs/ton	0.00240 lbs/ton	0.000444 lbs/ton	AP-42 Table 11.19.2-2 "Tertiary Crushing Uncontrolled"
Screen	0.02500 lbs/ton	0.00870 lbs/ton	0.000588 lbs/ton	AP-42 Table 11.19.2-2 "Screening Uncontrolled"
Conveyor	0.00300 lbs/ton	0.00110 lbs/ton	0.000325 lbs/ton	AP-42 Table 11.19.2-2 "Conveyor Transfer Point Uncontrolled"
Material Handling Max hour	0.00660 lbs/ton	0.00312 lbs/ton	0.000473 lbs/ton	AP-42 Section 13.2.4 "Aggregate Handling" w=11.0 MPH;M=2%
Material Handling Annual hour	0.00465 lbs/ton	0.00220 lbs/ton	0.000333 lbs/ton	AP-42 Section 13.2.4 "Aggregate Handling" w=6.0 MPH;M=2%

Elam Construction
Kirtland Sand Gravel Aggregate Plants
Uncontrolled Emission Rates

PTE

Emission Point #	Process Unit Description	% of Throughput	Process Rate	TSP	TSP	PM10	PM10	PM2.5	PM2.5
				lbs/hr	ton/yr	lbs/hr	ton/yr	lbs/hr	ton/yr
Quarry	Quarry Mining	100.00	500	3.30	5.09	1.56	2.41	0.24	0.36
1	Feeder	100.00	500	3.30	5.09	1.56	2.41	0.24	0.36
2	Cedarapids Jaw Crusher	100.00	500	2.70	5.91	1.20	2.63	0.22	0.49
3	Transfer Conveyor	100.00	500	1.50	3.29	0.55	1.20	0.16	0.36
4	Transfer Conveyor	100.00	500	1.50	3.29	0.55	1.20	0.16	0.36
5	Cedarapids 6'x20' Screen	100.00	500	12.5	27.4	4.35	9.53	0.29	0.64
6	Stacker Conveyor	100.00	500	1.50	3.29	0.55	1.20	0.16	0.36
7	Under Screen Transfer Conveyor	100.00	500	1.50	3.29	0.55	1.20	0.16	0.36
8	Transfer Conveyor	100.00	500	1.50	3.29	0.55	1.20	0.16	0.36
9	Secondary Cone Crusher	100.00	500	2.70	5.91	1.20	2.63	0.22	0.49
10	Secondary Cone Crusher Transfer Conveyor	100.00	500	1.50	3.29	0.55	1.20	0.16	0.36
11	Transfer Conveyor	100.00	500	1.50	3.29	0.55	1.20	0.16	0.36
12	Under Screen Transfer Conveyor	100.00	500	1.50	3.29	0.55	1.20	0.16	0.36
13	Transfer Conveyor	100.00	500	1.50	3.29	0.55	1.20	0.16	0.36
14	Secondary Cone Crusher	100.00	500	2.70	5.91	1.20	2.63	0.22	0.49
15	Secondary Cone Crusher Transfer Conveyor	100.00	500	1.50	3.29	0.55	1.20	0.16	0.36
16	Transfer Conveyor	100.00	500	1.50	3.29	0.55	1.20	0.16	0.36
17	Cedarapids 6'x20' Screen	100.00	500	12.5	27.4	4.35	9.53	0.29	0.64
18	Transfer Conveyor	100.00	500	1.50	3.29	0.55	1.20	0.16	0.36
19	Stacker Conveyor	100.00	500	1.50	3.29	0.55	1.20	0.16	0.36
20	Transfer Conveyor	100.00	500	1.50	3.29	0.55	1.20	0.16	0.36
21	Transfer Conveyor	100.00	500	1.50	3.29	0.55	1.20	0.16	0.36
22	Transfer Conveyor	100.00	500	1.50	3.29	0.55	1.20	0.16	0.36
23	Stacker Conveyor	100.00	500	1.50	3.29	0.55	1.20	0.16	0.36
24	Under Screen Transfer Conveyor	100.00	500	1.50	3.29	0.55	1.20	0.16	0.36
25	Transfer Conveyor	100.00	500	1.50	3.29	0.55	1.20	0.16	0.36
26	Cedarapids 6'x20' Screen	100.00	500	12.5	27.4	4.35	9.53	0.29	0.64
27	Under Screen Transfer Conveyor	100.00	500	1.50	3.29	0.55	1.20	0.16	0.36
28	Stacker Conveyor	100.00	500	1.50	3.29	0.55	1.20	0.16	0.36
29	Under Screen Transfer Conveyor	100.00	500	1.50	3.29	0.55	1.20	0.16	0.36
30	Stacker Conveyor	100.00	500	1.50	3.29	0.55	1.20	0.16	0.36
31	Stacker Conveyor Drop to Pile	100.00	500	3.30	5.09	1.56	2.41	0.24	0.36
32	Finish Product Storage Pile	100.00	500	3.30	5.09	1.56	2.41	0.24	0.36
33	Product Truck Loading - Finish Pile	100.00	500	3.30	5.09	1.56	2.41	0.24	0.36

Elam Construction
Kirtland Sand Gravel Aggregate Plants
Uncontrolled Emission Rates

			Wet Plant						
36	Wet Plant Feeder	100.00	500	3.30	5.09	1.56	2.41	0.24	0.36
37	Wet Plant Transfer Conveyor	100.00	500	1.50	3.29	0.55	1.2	0.16	0.36
38	Wet Plant Transfer Conveyor	100.00	500	1.50	3.29	0.55	1.2	0.16	0.36
39	Twin Screw Wash Plant								
40	Wet Plant Stacker Conveyor								
41	Wet Plant Transfer Conveyor								
42	Wet Plant Stacker Conveyor								
43	Wet Plant Transfer Conveyor								
44	Wet Plant Transfer Conveyor								
45	Wet Plant Stacker Conveyor								
46	Wet Plant Transfer Conveyor								
47	Wet Plant Stacker Conveyor								
48	Wet Plant Finish Product Storage Pile	100.00	500	3.30	5.09	1.56	2.41	0.24	0.36
49	Wet Plant Product Truck Loading - Finish Pile	100.00	500	3.30	5.09	1.56	2.41	0.24	0.36
51	Haul Road Crusher to HMA			84.9	150.3	21.6	38.3	2.16	3.83
51	Haul Road Crusher to Exit			21.5	38.0	5.48	9.7	0.55	0.97
51	Haul Road Crusher to Wash Plant			72.9	129.1	18.6	32.9	1.86	3.29
51	Haul Road Wash Plant to Exit			57.3	101.5	14.6	25.9	1.46	2.59
51	Haul Road Quarry Trucks to Crusher			12.0	20.5	3.05	5.22	0.31	0.52
			Total PM Engine	0.7	1.7	0.7	1.7	0.7	1.7
			Total PM Crushing Equipment	96.60	200.87	37.10	76.20	6.47	13.40
			Total PM Wet Plant Equipment	12.90	21.84	5.78	9.63	1.03	1.81
			Total Haul Roads	249	439	63	112	6.34	11.2
			Total PM	359	664	107	199	14.6	28.1

Elam Construction
Kirtland Sand Gravel Aggregate Plants
Uncontrolled Emission Rates

34	Process Unit Number		Emission Factor	Emission Rate				
	Crusher Plant Generator	Emitted Pollutants	lbs/hp-hr	lbs/hr	Hour	Horsepower	lbs/hr	ton/yr
		NOX		33.30	4380	1429	33.30	72.93
		CO		5.00	4380	1429	5.00	10.95
SO2 emissions based on 72.6 gallons fuel * 7 lbs fuel/gallon * 0.05% sulfur content * a factor of 2.		SO2		0.51	4380	1429	0.51	1.11
		VOC		1.10	4380	1429	1.10	2.41
		PM		0.31	4380	1429	0.31	0.68
			Emission Factor	Emission Rate				
35	Process Unit Number	Emitted Pollutants	grams/hr	lbs/hr	Hour	Horsepower	lbs/hr	ton/yr
	Crusher Plant Standby Generator	NOX	1500	3.31	4880	113	3.31	8.07
		CO	250	0.55	4880	113	0.55	1.34
SO2 emissions based on 5.5 gallons fuel * 7 lbs fuel/gallon * 0.05% sulfur content * a factor of 2.		SO2		0.039	4880	113	0.039	0.094
		VOC	113	0.25	4880	113	0.25	0.61
	AP-42 Section 3.3 Emission Factor 1bs/hp-hr	PM	0.00220	0.25	4880	113	0.25	0.61
			Emission Factor	Emission Rate				
50	Process Unit Number	Emitted Pollutants	lbs/hp-hr	lbs/hr	Hour	Horsepower	lbs/hr	ton/yr
	Wash Plant Generator	NOX		7.74	4571	475	7.74	17.7
		CO		1.47	4571	475	1.47	3.36
SO2 emissions based on 23 gallons fuel * 7 lbs fuel/gallon * 0.05% sulfur content * a factor of 2.		SO2		0.16	4571	475	0.16	0.37
		VOC		0.09	4571	475	0.090	0.21
		PM		0.16	4571	475	0.16	0.37
				NOx Total	44.35	lbs/hr	98.69	tons/yr
				CO Total	7.02	lbs/hr	15.65	tons/yr
				SO2 Total	0.71	lbs/hr	1.57	tons/yr
				VOC Total	1.44	lbs/hr	3.22	tons/yr
				TSP Total	358.84	lbs/hr	663.70	tons/yr
				PM10 Total	106.97	lbs/hr	199.46	tons/yr
				PM2.5 Total	14.56	lbs/hr	28.05	tons/yr

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Elam Construction
Kirtland Sand Gravel Aggregate Plants
Uncontrolled Emission Rates

Haul Road Crusher to HMA
AP-42 13.2 (ver 11/06) "Unpaved Road"
Sand and Gravel Conditions - NMED Equation
Equation:
E = k(s/12)^a*(W/3)^b*[(365-p)/365]

k TSP	4.9			
k PM10	1.5			
k PM2.5	0.15			
a TSP	0.7			
a PM10	0.9			
a PM2.5	0.9			
b TSP	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	
Hours per year	4380	hrs		
Vehicle control	0	%		
Aggregate Truck VMT	993.21	meters one way		
	1.234570058	miles/vehicle		
Max. Aggregate Truck/hr	10	truck/hr	23	tons/load
	43800	truck/yr	230	tons/hr
Aggregate Truck VMT	12.346	miles/hr		
	54074.169	miles/yr		
Aggregate Truck weight	26.5	tons		
		TSP Uncontrolled		
Max. Aggregate Truck Emissions	84.90	lbs/hr	150.27	tons/yr
		PM10 Uncontrolled		
Max. Aggregate Truck Emissions	21.64	lbs/hr	38.30	tons/yr
		PM2.5 Uncontrolled		
Max. Aggregate Truck Emissions	2.16	lbs/hr	3.83	tons/yr

Elam Construction
Kirtland Sand Gravel Aggregate Plants
Uncontrolled Emission Rates

Haul Road Crusher to Exit
AP-42 13.2 (ver 11/06) "Unpaved Road"
Sand and Gravel Conditions - NMED Equation
Equation:
E = k(s/12)^a*(W/3)^b*[(365-p)/365]

k TSP	4.9		
k PM10	1.5		
k PM2.5	0.15		
a TSP	0.7		
a PM10	0.9		
a PM2.5	0.9		
b TSP	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
Hours per year	4380	hrs	

Vehicle control	0	%		
Aggregate Truck VMT	705.11	meters one way		
	0.876456581	miles/vehicle		
Max. Aggregate Truck/hr	3.565217391	truck/hr	23	tons/load
	15615.65217	truck/yr	82	tons/hr
Aggregate Truck VMT	3.125	miles/hr		
	13686.441	miles/yr		
Aggregate Truck weight	26.5	tons		
		TSP Uncontrolled		
Max. Aggregate Truck Emissions	21.49	lbs/hr	38.04	tons/yr
		PM10 Uncontrolled		
Max. Aggregate Truck Emissions	5.48	lbs/hr	9.69	tons/yr
		PM2.5 Uncontrolled		
Max. Aggregate Truck Emissions	0.55	lbs/hr	0.97	tons/yr

Elam Construction
Kirtland Sand Gravel Aggregate Plants
Uncontrolled Emission Rates

Haul Road Crusher to Wash Plant
AP-42 13.2 (ver 11/06) "Unpaved Road"
Sand and Gravel Conditions - NMED Equation
Equation:
E = k(s/12)^a*(W/3)^b*[(365-p)/365]

k TSP	4.9			
k PM10	1.5			
k PM2.5	0.15			
a TSP	0.7			
a PM10	0.9			
a PM2.5	0.9			
b TSP	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	
Hours per year	4380	hrs		
Vehicle control	0	%		
Aggregate Truck VMT	1046.51	meters one way		
	1.30081708	miles/vehicle		
Max. Aggregate Truck/hr	8.152173913	truck/hr	23	tons/load
	35706.52174	truck/yr	188	tons/hr
Aggregate Truck VMT	10.604	miles/hr		
	46447.653	miles/yr		
Aggregate Truck weight	26.5	tons		
		TSP Uncontrolled		
Max. Aggregate Truck Emissions	72.93	lbs/hr	129.08	tons/yr
		PM10 Uncontrolled		
Max. Aggregate Truck Emissions	18.59	lbs/hr	32.90	tons/yr
		PM2.5 Uncontrolled		
Max. Aggregate Truck Emissions	1.86	lbs/hr	3.29	tons/yr

Elam Construction
Kirtland Sand Gravel Aggregate Plants
Uncontrolled Emission Rates

Haul Road Wash Plant to Exit
AP-42 13.2 (ver 11/06) "Unpaved Road"
Sand and Gravel Conditions - NMED Equation
Equation:
E = k(s/12)^a*(W/3)^b*[(365-p)/365]

k TSP	4.9					
k PM10	1.5					
k PM2.5	0.15					
a TSP	0.7					
a PM10	0.9					
a PM2.5	0.9					
b TSP	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		
Hours per year	4380	hrs				
Vehicle control			0	%		
Aggregate Truck VMT			822.82	meters one way		
			1.022766043	miles/vehicle		
Max. Aggregate Truck/hr			8.152173913	truck/hr	23	tons/load
			35706.52174	truck/yr	188	tons/hr
Aggregate Truck VMT			8.338	miles/hr		
			36519.418	miles/yr		
Aggregate Truck weight			26.5	tons		
				TSP Uncontrolled		
Max. Aggregate Truck Emissions			57.34	lbs/hr	101.49	tons/yr
				PM10 Uncontrolled		
Max. Aggregate Truck Emissions			14.61	lbs/hr	25.87	tons/yr
				PM2.5 Uncontrolled		
Max. Aggregate Truck Emissions			1.46	lbs/hr	2.59	tons/yr

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Elam Construction
Kirtland Sand Gravel Aggregate Plants
Uncontrolled Emission Rates

Haul Road Quarry Trucks
AP-42 13.2 (ver 11/06) "Unpaved Road"
Sand and Gravel Conditions - NMED Equation
Equation:
E = k(s/12)^a*(W/3)^b*[(365-p)/365]

k TSP	4.9					
k PM10	1.5					
k PM2.5	0.15					
a TSP	0.7					
a PM10	0.9					
a PM2.5	0.9					
b TSP	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	80	days		AP-42 Figure 13.2.2-1		
Hours per year	2000	hrs				
Vehicle control			0	%		
Aggregate Truck VMT			130.00	meters one way		
			0.16159105	miles/vehicle		
Max. Aggregate Truck/hr			7.142857143	truck/hr	70	tons/load
			31285.71429	truck/yr	500	tons/hr
Aggregate Truck VMT			1.154	miles/hr		
			5055.491	miles/yr		
Aggregate Truck weight			66	tons		
				TSP Controlled		
Max. Aggregate Truck Emissions			11.97	lbs/hr	20.47	tons/yr
				PM10Controlled		
Max. Aggregate Truck Emissions			3.05	lbs/hr	5.22	tons/yr
				PM2.5 Controlled		
Max. Aggregate Truck Emissions			0.31	lbs/hr	0.52	tons/yr

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Elam Construction
Kirtland Sand Gravel Aggregate Plants
Allowable Emission Rates

Main Plant Throughput	500	tph	1000000 tons per year
Controlled Hours Operation	2000	hours/yr	Max hours at full hourly operation not a requested permit condition
Wash Plant Throughput	500	tph	1000000 tons per year
Controlled Hours Operation	2000	hours/yr	Max hours at full hourly operation not a requested permit condition

Quarry, Raw Ore Pile, Feeder Loading, Finish Pile

AP-42 Section 13.2.4 "Aggregate Handling" (ver 11/2006)

E = k x (0.0032) x (U/5)^1.3 / (M/2)^1.4 lbs/ton

k(tsp)	0.74		
k(pm10)	0.35		
k(pm2.5)	0.053		
U Max Hourly	11.0	MPH	NMED Default
U Annual Hour	8.4	MPH	Farmington 1996-2006
M	2.00	%	NMED Default

E(TSP) Max Hour =	0.00660	lbs/ton
E(PM10) Max Hour =	0.00312	lbs/ton
E(PM2.5) Max Hour =	0.00047	lbs/ton
E(TSP) Annual Hour =	0.00465	lbs/ton
E(PM10) Annual Hour =	0.00220	lbs/ton
E(PM2.5) Annual Hour =	0.00033	lbs/ton

Stacker to Storage Pile Loading

AP-42 Section 13.2.4 "Aggregate Handling" (ver 11/2006)

E = k x (0.0032) x (U/5)^1.3 / (M/2)^1.4 lbs/ton

k(tsp)	0.74		
k(pm10)	0.35		
k(pm2.5)	0.053		
U Max Hourly	11.0	MPH	NMED Default
U Annual Hour	8.4	MPH	Farmington 1996-2006
M	2.88	%	NMED Approved

E(TSP) Max Hour =	0.00396	lbs/ton
E(PM10) Max Hour =	0.00187	lbs/ton
E(PM2.5) Max Hour =	0.00028	lbs/ton
E(TSP) Annual Hour =	0.00279	lbs/ton
E(PM10) Annual Hour =	0.00132	lbs/ton
E(PM2.5) Annual Hour =	0.00020	lbs/ton

Controlled Emission Factors	TSP		PM10		PM2.5		
Crusher	0.00120	lbs/ton	0.00054	lbs/ton	0.00010	lbs/ton	AP-42 Table 11.19.2-2 "Tertiary Crushing Controlled"
Screen	0.00220	lbs/ton	0.00074	lbs/ton	0.00005	lbs/ton	AP-42 Table 11.19.2-2 "Screening Controlled"
Uncontrolled Conveyor	0.00300	lbs/ton	0.00110	lbs/ton	0.00033	lbs/ton	AP-42 Table 11.19.2-2 "Conveyor Transfer Point Uncontrolled"
Controlled Conveyor	0.00014	lbs/ton	0.00005	lbs/ton	0.000013	lbs/ton	AP-42 Table 11.19.2-2 "Conveyor Transfer Point Controlled"
Stacker Max Hour	0.00396	lbs/ton	0.00187	lbs/ton	0.00028	lbs/ton	AP-42 Section 13.2.4 "Aggregate Handling" w=11 MPH;M=2.88%
Stacker Annual Hour	0.00279	lbs/ton	0.00132	lbs/ton	0.00020	lbs/ton	AP-42 Section 13.2.4 "Aggregate Handling" w=8.4 MPH;M=2.88%
Pug Mill	0.00014	lbs/ton	0.00005	lbs/ton	0.000013	lbs/ton	AP-42 Table 11.19.2-2 "Conveyor Transfer Point Controlled"
Feeder Max Hour	0.00660	lbs/ton	0.00312	lbs/ton	0.00047	lbs/ton	AP-42 Section 13.2.4 "Aggregate Handling" w=11 MPH;M=2%
Feeder Annual Hour	0.00465	lbs/ton	0.00220	lbs/ton	0.00033	lbs/ton	AP-42 Section 13.2.4 "Aggregate Handling" w=8.4 MPH;M=2%
Storage Pile Max Hour	0.00660	lbs/ton	0.00312	lbs/ton	0.00047	lbs/ton	AP-42 Section 13.2.4 "Aggregate Handling" w=11 MPH;M=2%
Storage Pile Annual Hour	0.00465	lbs/ton	0.00220	lbs/ton	0.00033	lbs/ton	AP-42 Section 13.2.4 "Aggregate Handling" w=8.4 MPH;M=2%
Pit Max Hour	0.00660	lbs/ton	0.00312	lbs/ton	0.00047	lbs/ton	AP-42 Section 13.2.4 "Aggregate Handling" w=11 MPH;M=2%
Pit Annual Hour	0.00465	lbs/ton	0.00220	lbs/ton	0.00033	lbs/ton	AP-42 Section 13.2.4 "Aggregate Handling" w=8.4 MPH;M=2%
Product Piles Max hour	0.00660	lbs/ton	0.00312	lbs/ton	0.00047	lbs/ton	AP-42 Section 13.2.4 "Aggregate Handling" w=11 MPH;M=2%
Product Piles Annual hour	0.00465	lbs/ton	0.00220	lbs/ton	0.00033	lbs/ton	AP-42 Section 13.2.4 "Aggregate Handling" w=8.4 MPH;M=2%

Elam Construction
Kirtland Sand Gravel Aggregate Plants
Allowable Emission Rates

PTE

										Modeled Hourly Emission Rates		
Emission Point #	Process Unit Description	% of Throughput	Process Rate	TSP	TSP	PM10	PM10	PM2.5	PM2.5	TSP	PM10	PM2.5
				lbs/hr	ton/yr	lbs/hr	ton/yr	lbs/hr	ton/yr	lbs/hr	lbs/hr	lbs/hr
Quarry	Quarry Mining	100.00	500	3.30	2.32	1.56	1.10	0.24	0.17	2.32409	1.09923	0.16646
1	Feeder	100.00	500	3.30	2.32	1.56	1.10	0.24	0.17	2.32409	1.09923	0.16646
2	Cedarapids Jaw Crusher	100.00	500	0.60	0.60	0.27	0.27	0.050	0.050	0.60000	0.27000	0.05000
3	Transfer Conveyor	100.00	500	0.070	0.070	0.023	0.023	0.0065	0.0065	0.07000	0.02300	0.00650
4	Transfer Conveyor	100.00	500	0.070	0.070	0.023	0.023	0.0065	0.0065	0.07000	0.02300	0.00650
5	Cedarapids 6'x20' Screen	100.00	500	1.10	1.10	0.37	0.37	0.025	0.025	1.10000	0.37000	0.02500
6	Stacker Conveyor	100.00	500	0.070	0.070	0.023	0.023	0.0065	0.0065	0.07000	0.02300	0.00650
7	Under Screen Transfer Conveyor	100.00	500	0.070	0.070	0.023	0.023	0.0065	0.0065	0.07000	0.02300	0.00650
8	Transfer Conveyor	100.00	500	0.070	0.070	0.023	0.023	0.0065	0.0065	0.07000	0.02300	0.00650
9	Secondary Cone Crusher	100.00	500	0.60	0.60	0.27	0.27	0.050	0.050	0.60000	0.27000	0.05000
10	Secondary Cone Crusher Transfer Conveyor	100.00	500	0.070	0.070	0.023	0.023	0.0065	0.0065	0.07000	0.02300	0.00650
11	Transfer Conveyor	100.00	500	0.070	0.070	0.023	0.023	0.0065	0.0065	0.07000	0.02300	0.00650
12	Under Screen Transfer Conveyor	100.00	500	0.070	0.070	0.023	0.023	0.0065	0.0065	0.07000	0.02300	0.00650
13	Transfer Conveyor	100.00	500	0.070	0.070	0.023	0.023	0.0065	0.0065	0.07000	0.02300	0.00650
14	Secondary Cone Crusher	100.00	500	0.60	0.60	0.27	0.27	0.050	0.050	0.60000	0.27000	0.05000
15	Secondary Cone Crusher Transfer Conveyor	100.00	500	0.070	0.070	0.023	0.023	0.0065	0.0065	0.07000	0.02300	0.00650
16	Transfer Conveyor	100.00	500	0.070	0.070	0.023	0.023	0.0065	0.0065	0.07000	0.02300	0.00650
17	Cedarapids 6'x20' Screen	100.00	500	1.10	1.10	0.37	0.37	0.025	0.025	1.10000	0.37000	0.02500
18	Transfer Conveyor	100.00	500	0.070	0.070	0.023	0.023	0.0065	0.0065	0.07000	0.02300	0.00650
19	Stacker Conveyor	100.00	500	0.070	0.070	0.023	0.023	0.0065	0.0065	0.07000	0.02300	0.00650
20	Transfer Conveyor	100.00	500	0.070	0.070	0.023	0.023	0.0065	0.0065	0.07000	0.02300	0.00650
21	Transfer Conveyor	100.00	500	0.070	0.070	0.023	0.023	0.0065	0.0065	0.07000	0.02300	0.00650
22	Transfer Conveyor	100.00	500	0.070	0.070	0.023	0.023	0.0065	0.0065	0.07000	0.02300	0.00650
23	Stacker Conveyor	100.00	500	0.070	0.070	0.023	0.023	0.0065	0.0065	0.07000	0.02300	0.00650
24	Under Screen Transfer Conveyor	100.00	500	0.070	0.070	0.023	0.023	0.0065	0.0065	0.07000	0.02300	0.00650
25	Transfer Conveyor	100.00	500	0.070	0.070	0.023	0.023	0.0065	0.0065	0.07000	0.02300	0.00650
26	Cedarapids 6'x20' Screen	100.00	500	1.10	1.10	0.37	0.37	0.025	0.025	1.10000	0.37000	0.02500
27	Under Screen Transfer Conveyor	100.00	500	0.070	0.070	0.023	0.023	0.0065	0.0065	0.07000	0.02300	0.00650
28	Stacker Conveyor	100.00	500	0.070	0.070	0.023	0.023	0.0065	0.0065	0.07000	0.02300	0.00650
29	Under Screen Transfer Conveyor	100.00	500	0.070	0.070	0.023	0.023	0.0065	0.0065	0.07000	0.02300	0.00650
30	Stacker Conveyor	100.00	500	0.070	0.070	0.023	0.023	0.0065	0.0065	0.07000	0.02300	0.00650
31	Stacker Conveyor Drop to Pile	100.00	500	1.98	1.39	0.94	0.66	0.14	0.10	1.39491	0.65975	0.09991
32	Finish Product Storage Pile	100.00	500	3.30	2.32	1.56	1.10	0.24	0.17	2.32409	1.09923	0.16646
33	Product Truck Loading - Finish Pile	100.00	500	3.30	2.32	1.56	1.10	0.24	0.17	2.32409	1.09923	0.16646

Elam Construction
Kirtland Sand Gravel Aggregate Plants
Allowable Emission Rates

			Wet Plant									
36	Wet Plant Feeder	100.00	500	3.30	2.32	1.56	1.10	0.24	0.17	2.32409	1.09923	0.16646
37	Wet Plant Transfer Conveyor	100.00	500	0.070	0.070	0.023	0.023	0.0065	0.0065	0.07000	0.02300	0.00650
38	Wet Plant Transfer Conveyor	100.00	500	0.070	0.070	0.023	0.023	0.0065	0.0065	0.07000	0.02300	0.00650
39	Twin Screw Wash Plant											
40	Wet Plant Stacker Conveyor											
41	Wet Plant Transfer Conveyor											
42	Wet Plant Stacker Conveyor											
43	Wet Plant Transfer Conveyor											
44	Wet Plant Transfer Conveyor											
45	Wet Plant Stacker Conveyor											
46	Wet Plant Transfer Conveyor											
47	Wet Plant Stacker Conveyor											
48	Wet Plant Finish Product Storage Pile	100.00	500	3.30	2.32	1.56	1.10	0.24	0.17	2.32409	1.09923	0.16646
49	Wet Plant Product Truck Loading - Finish Pile	100.00	500	3.30	2.32	1.56	1.10	0.24	0.17	2.32409	1.09923	0.16646
			Crusher Plant Emissions	21.89	17.40	9.63	7.51	1.46	1.14	17.40129	7.50569	1.14023
			Wash Plant Emissions	10.04	7.11	4.73	3.34	0.72	0.51	7.11228	3.34370	0.51237
			Total	31.93	24.51	14.36	10.85	2.18	1.65	24.51357	10.84939	1.65259
51	Haul Road Crusher to HMA			8.49	6.86	2.16	1.75	0.22	0.17	8.49004	2.16380	0.21638
51	Haul Road Crusher to Exit			2.15	1.74	0.55	0.44	0.055	0.044	2.14887	0.54767	0.05477
51	Haul Road Crusher to Wash Plant			7.29	5.89	1.86	1.50	0.19	0.15	7.29262	1.85862	0.18586
51	Haul Road Wash Plant to Exit			5.73	4.63	1.46	1.18	0.15	0.12	5.73382	1.46134	0.14613
51	Haul Road Quarry Trucks to Crusher			2.39	1.87	0.61	0.48	0.061	0.048	2.39358	0.61003	0.06100
			Total PM Engine	0.7	1.6	0.7	1.6	0.7	1.6	0.71860	0.71860	0.71860
			Total PM Main Plant Equipment	21.9	17.4	9.6	7.5	1.5	1.1	17.40129	7.50569	1.14023
			Total PM Wet Plant Equipment	10.0	7.1	4.7	3.3	0.72	0.51	7.11228	3.34370	0.51237
			Total Haul Roads	26.1	21.0	6.64	5.35	0.66	0.54	23.66536	6.03143	0.60314
			Total PM	58.7	47.1	21.7	17.8	3.57	3.77	48.89753	17.59942	2.97434
			Total Material Handling Fugitives	23.1	16.3	10.9	7.7	1.7	1.17			
			Total Regulated Process Equipment	8.8	8.2	3.4	3.2	0.53	0.49			
			Total Regulated Equipment	9.5	9.8	4.2	4.7	1.2	2.1	44.3	90.8	7.02

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Process Unit Number			Emission Factor	Emission Rate				
34	Crusher Plant Generator	Emitted Pollutants	lbs/hp-hr	lbs/hr	Hour	Horsepower	lbs/hr	ton/yr
	Manufacturer Specification	NOX		33.30	3904	1429	33.30	65.00
	Manufacturer Specification	CO		5.00	3904	1429	5.00	9.76
	SO2 emissions based on 72.6 gallons fuel * 7 lbs fuel/gallon * 0.05% sulfur content * a factor of 2.	SO2		0.51	3904	1429	0.51	0.99
	Manufacturer Specification	VOC		1.10	3904	1429	1.10	2.15
	Manufacturer Specification	PM		0.31	3904	1429	0.31	0.61
	AP-42 Emission Factor lbs/hp-hr	CO2	1.080000	1543.32	3904	1429	1543	3013
	AP-42 Emission Factor lbs/hp-hr	CH4	0.000705	1.01	3904	1429	1.01	1.97

Process Unit Number			Emission Factor	Emission Rate				
35	Crusher Plant Standby Generator	Emitted Pollutants	grams/hr	lbs/hr	Hour	Horsepower	lbs/hr	ton/yr
		NOX	1500	3.31	4880	113	3.31	8.07
		CO	250	0.55	4880	113	0.55	1.34
	SO2 emissions based on 5.5 gallons fuel * 7 lbs fuel/gallon * 0.05% sulfur content * a factor of 2.	SO2		0.039	4880	113	0.039	0.094
		VOC	113	0.25	4880	113	0.25	0.61
	AP-42 Section 3.3 Emission Factor 1bs/hp-hr	PM	0.00220	0.25	4880	113	0.25	0.61
	AP-42 Emission Factor lbs/hp-hr	CO2	1.080000	122.04	4880	113	122	298
	AP-42 Emission Factor lbs/hp-hr	CH4	0.000705	0.08	4880	113	0.080	0.194

Process Unit Number								
50	Wash Plant Generator		Emission Factor	Emission Rate				
		Emitted Pollutants	lbs/hp-hr	lbs/hr	Hour	Horsepower	lbs/hr	ton/yr
	Manufacturer Specification	NOX		7.74	4571	475	7.74	17.7
	Manufacturer Specification	CO		1.47	4571	475	1.47	3.36
	SO2 emissions based on 23 gallons fuel * 7 lbs fuel/gallon * 0.05% sulfur content * a factor of 2.	SO2		0.16	4571	475	0.16	0.37
	Manufacturer Specification	VOC		0.09	4571	475	0.09	0.21
	Manufacturer Specification	PM		0.16	4571	475	0.16	0.37
	AP-42 Emission Factor lbs/hp-hr	CO2	1.080000	513.00	4571	475	513	1172
	AP-42 Emission Factor lbs/hp-hr	CH4	0.000705	0.33	4571	475	0.33	0.77

NOx Total	44.3	lbs/hr	90.8	tons/yr
CO Total	7.0	lbs/hr	14.5	tons/yr
SO2 Total	0.71	lbs/hr	1.5	tons/yr
VOC Total	1.4	lbs/hr	3.0	tons/yr
TSP Total	58.7	lbs/hr	47	tons/yr
PM10 Total	21.7	lbs/hr	17.8	tons/yr
PM2.5 Total	3.57	lbs/hr	3.8	tons/yr
CO2 Total	2178.4	lbs/hr	4482.8	tons/yr
CH4 Total	1.4	lbs/hr	2.9	tons/yr

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Elam Construction
Kirtland Sand Gravel Aggregate Plants
Allowable Emission Rates

Haul Road Crusher to HMA
AP-42 13.2 (ver 11/06) "Unpaved Road"
Sand and Gravel Conditions - NMED Equation
Equation:
E = k(s/12)^a*(W/3)^b*[(365-p)/365]

k TSP		4.9			
k PM10		1.5			
k PM2.5		0.15			
a TSP		0.7			
a PM10		0.9			
a PM2.5		0.9			
b TSP		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	
Hours per year		2000	hrs		
Vehicle control		90	%	water and base course	
Aggregate Truck VMT		993.21	meters one way		
		1.234570058	miles/vehicle		
Max. Aggregate Truck/hr		10	truck/hr	23	tons/load
		20000	truck/yr	230	tons/hr
Aggregate Truck VMT		12.35	miles/hr		
		24691.40	miles/yr		
Aggregate Truck weight		26.5	tons		
			TSP Controlled		
Max. Aggregate Truck Emissions	Base Course and Water	8.49	lbs/hr	6.86	tons/yr
			PM10Controlled		
Max. Aggregate Truck Emissions	Base Course and Water	2.16	lbs/hr	1.75	tons/yr
			PM2.5 Controlled		
Max. Aggregate Truck Emissions	Base Course and Water	0.22	lbs/hr	0.17	tons/yr

Elam Construction
Kirtland Sand Gravel Aggregate Plants
Allowable Emission Rates

Haul Road Crusher to Exit
AP-42 13.2 (ver 11/06) "Unpaved Road"
Sand and Gravel Conditions - NMED Equation
Equation:
E = k(s/12)^a*(W/3)^b*[(365-p)/365]

k TSP		4.9			
k PM10		1.5			
k PM2.5		0.15			
a TSP		0.7			
a PM10		0.9			
a PM2.5		0.9			
b TSP		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	
Hours per year		2000	hrs		
Vehicle control		90	%	water and base course	
Aggregate Truck VMT		705.11	meters one way		
		0.876456581	miles/vehicle		
Max. Aggregate Truck/hr		3.565217391	truck/hr	23	tons/load
		7130.434783	truck/yr	82	tons/hr
Aggregate Truck VMT		3.12	miles/hr		
		6249.52	miles/yr		
Aggregate Truck weight		26.5	tons		
			TSP Controlled		
Max. Aggregate Truck Emissions	Base Course and Water	2.15	lbs/hr	1.74	tons/yr
			PM10Controlled		
Max. Aggregate Truck Emissions	Base Course and Water	0.55	lbs/hr	0.44	tons/yr
			PM2.5 Controlled		
Max. Aggregate Truck Emissions	Base Course and Water	0.05	lbs/hr	0.04	tons/yr

Elam Construction
Kirtland Sand Gravel Aggregate Plants
Allowable Emission Rates

Haul Road Crusher to Wash Plant
AP-42 13.2 (ver 11/06) "Unpaved Road"
Sand and Gravel Conditions - NMED Equation
Equation:
E = k(s/12)^a*(W/3)^b*[(365-p)/365]

k TSP		4.9				
k PM10		1.5				
k PM2.5		0.15				
a TSP		0.7				
a PM10		0.9				
a PM2.5		0.9				
b TSP		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		
Hours per year		2000	hrs			
Vehicle control		90	%		water and base course	
Aggregate Truck VMT		1046.51	meters one way			
		1.30081708	miles/vehicle			
Max. Aggregate Truck/hr		8.152173913	truck/hr		23	tons/load
		16304.34783	truck/yr		188	tons/hr
Aggregate Truck VMT		10.60	miles/hr			
		21208.97	miles/yr			
Aggregate Truck weight		26.5	tons			
				TSP Controlled		
Max. Aggregate Truck Emissions	Base Course and Water	7.29	lbs/hr		5.89	tons/yr
				PM10Controlled		
Max. Aggregate Truck Emissions	Base Course and Water	1.86	lbs/hr		1.50	tons/yr
				PM2.5 Controlled		
Max. Aggregate Truck Emissions	Base Course and Water	0.19	lbs/hr		0.15	tons/yr

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Elam Construction
Kirtland Sand Gravel Aggregate Plants
Allowable Emission Rates

Haul Road Wash Plant to Exit
AP-42 13.2 (ver 11/06) "Unpaved Road"
Sand and Gravel Conditions - NMED Equation
Equation:
E = k(s/12)^a*(W/3)^b*[(365-p)/365]

k TSP	4.9		
k PM10	1.5		
k PM2.5	0.15		
a TSP	0.7		
a PM10	0.9		
a PM2.5	0.9		
b TSP	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
Hours per year	2000	hrs	

Vehicle control		90	%	water and base course	
Aggregate Truck VMT		822.82	meters one way		
		1.022766043	miles/vehicle		
Max. Aggregate Truck/hr		8.152173913	truck/hr	23	tons/load
		16304.34783	truck/yr	188	tons/hr
Aggregate Truck VMT		8.34	miles/hr		
		16675.53	miles/yr		
Aggregate Truck weight		26.5	tons		
			TSP Controlled		
Max. Aggregate Truck Emissions	Base Course and Water	5.73	lbs/hr	4.63	tons/yr
			PM10Controlled		
Max. Aggregate Truck Emissions	Base Course and Water	1.46	lbs/hr	1.18	tons/yr
			PM2.5 Controlled		
Max. Aggregate Truck Emissions	Base Course and Water	0.15	lbs/hr	0.12	tons/yr