Section 7

Information Used To Determine Emissions

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Information Used to Determine Emissions shall include the following:

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

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A-XXXX-7-AP42S1-4	Hot Water Heater Combustion and HAPs Emission Factors
A-XXXX-7-AP42S11-12	Concrete Plant Emission Factors
A-XXXX-7-AP42S11-19-2	Transfer Point Emission Factors
A-XXXX-7-AP42S13-2-1	Paved Road Emission Factors
A-XXXX-7-AP42S13-2-4	Material Handling Emission Factors
A-XXXX-7-WindspeedsNewMexico	Ruidoso Wind Speed Annual Average 1996 to 2006
A-XXXX-7-AltoCBP.xls	Alto CBP Emissions Spreadsheet
A-XXXX-7-Baghouse.xls	Baghouse Fabric Filter – Pulse-Jet Control Efficiency

11.12 Concrete Batching

11.12.1 Process Description [1-5]

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

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

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

11.12.2 Emissions and Controls [6-8]

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

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

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

ND = No data

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

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

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

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

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

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

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

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

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

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

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

Table 11.12-3. Equation Parameters for Truck Mix Operations

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

Table 11.12-4. Equation Parameters for Central Mix Operations

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

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

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

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

11.19.2 Crushed Stone Processing and Pulverized Mineral Processing

11.19.2.1 Process Description [24, 25]

Crushed Stone Processing

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

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

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

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

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

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

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

Source [b]	Total Particulate Matter [r,s]	EMISSION FACTOR RATING	Total PM-10	EMISSION FACTOR RATING	Total PM-2.5	EMISSION FACTOR RATING
Primary Crushing (SCC 3-05-020-01)	ND		ND[n]		ND[n]	
Primary Crushing (controlled) (SCC 3-05-020-01)	ND		ND[n]		ND[n]	
Secondary Crushing (SCC 3-05-020-02)	ND		ND[n]		ND[n]	
Secondary Crushing (controlled) (SCC 3-05-020-02)	ND		ND[n]		ND[n]	
Tertiary Crushing (SCC 3-050030-03)	0.0054[d]	E	0.0024[o]	C	ND[n]	
Tertiary Crushing (controlled) (SCC 3-05-020-03)	0.0012[d]	E	0.00054[p]	C	0.00010[q]	E
Fines Crushing (SCC 3-05-020-05)	0.0390[e]	E	0.0150[e]	E	ND	
Fines Crushing (controlled) (SCC 3-05-020-05)	0.0030[f]	E	0.0012[f]	E	0.000070[q]	E
Screening (SCC 3-05-020-02, 03)	0.025[c]	E	0.0087[l]	C	ND	
Screening (controlled) (SCC 3-05-020-02, 03)	0.0022[d]	E	0.00074[m]	C	0.000050[q]	E
Fines Screening (SCC 3-05-020-21)	0.30[g]	E	0.072[g]	E	ND	
Fines Screening (controlled) (SCC 3-05-020-21)	0.0036[g]	E	0.0022[g]	E	ND	
Conveyor Transfer Point (SCC 3-05-020-06)	0.0030[h]	E	0.00110[h]	D	ND	
Conveyor Transfer Point (controlled) (SCC 3-05-020-06)	0.00014[i]	E	4.6×10^{-5i}	D	1.3×10^{-5q}	E
Wet Drilling - Unfragmented Stone (SCC 3-05-020-10)	ND		8.0×10^{-5j}	E	ND	
Truck Unloading -Fragmented Stone (SCC 3-05-020-31)	ND		1.6×10^{-5j}	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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13.2.1 Paved Roads

13.2.1.1 General

Particulate emissions occur whenever vehicles travel over a paved surface such as a road or parking lot. Particulate emissions from paved roads are due to direct emissions from vehicles in the form of exhaust, brake wear and tire wear emissions and resuspension of loose material on the road surface. In general terms, resuspended particulate emissions from paved roads originate from, and result in the depletion of, the loose material present on the surface (i.e., the surface loading). In turn, that surface loading is continuously replenished by other sources. At industrial sites, surface loading is replenished by spillage of material and trackout from unpaved roads and staging areas. Figure 13.2.1-1 illustrates several transfer processes occurring on public streets.

Various field studies have found that public streets and highways, as well as roadways at industrial facilities, can be major sources of the atmospheric particulate matter within an area.[1-9] Of particular interest in many parts of the United States are the increased levels of emissions from public paved roads when the equilibrium between deposition and removal processes is upset. This situation can occur for various reasons, including application of granular materials for snow and ice control, mud/dirt carryout from construction activities in the area, and deposition from wind and/or water erosion of surrounding unstabilized areas. In the absence of continuous addition of fresh material (through localized track out or application of antiskid material), paved road surface loading should reach an equilibrium value in which the amount of material resuspended matches the amount replenished. The equilibrium surface loading value depends upon numerous factors. It is believed that the most important factors are: mean speed of vehicles traveling the road; the average daily traffic (ADT); the number of lanes and ADT per lane; the fraction of heavy vehicles (buses and trucks); and the presence/absence of curbs, storm sewers and parking lanes.[10]

The particulate emission factors presented in a previous version of this section of AP-42, dated October 2002, implicitly included the emissions from vehicles in the form of exhaust, brake wear, and tire wear as well as resuspended road surface material. EPA included these sources in the emission factor equation for paved roads 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 paved road emission factor equation only estimates particulate emissions from resuspended road surface material[28]. The particulate emissions from vehicle exhaust, brake wear, and tire wear are now estimated separately using EPA's MOVES[29] model. 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 MOVES to estimate particulate emissions from vehicle traffic on paved roads. It also incorporates the decrease in exhaust emissions that has occurred since the paved road emission factor equation was developed. Earlier versions of the paved 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.

13.2.1.3 Predictive Emission Factor Equations[10,29]

The quantity of particulate emissions from resuspension of loose material on the road surface due to vehicle travel on a dry paved road may be estimated using the following empirical expression:

$$E = k \, (sL)^{0.91} \times (W)^{1.02} \qquad\qquad (1)$$

where: E = particulate emission factor (having units matching the units of k),
k = particle size multiplier for particle size range and units of interest (see below),
sL = road surface silt loading (grams per square meter) (g/m^2), and
W = average weight (tons) of the vehicles traveling the road.

It is important to note that Equation 1 calls for the average weight of all vehicles traveling the road. For example, if 99 percent of traffic on the road are 2 ton cars/trucks while the remaining 1 percent consists of 20 ton trucks, then the mean weight "W" is 2.2 tons. More specifically, Equation 1 is *not* intended to be used to calculate a separate emission factor for each vehicle weight class. Instead, only one emission factor should be calculated to represent the "fleet" average weight of all vehicles traveling the road.

The particle size multiplier (k) above varies with aerodynamic size range as shown in Table 13.2.1-1. To determine particulate emissions for a specific particle size range, use the appropriate value of k shown in Table 13.2.1-1.

To obtain the total emissions factor, the emission factors for the exhaust, brake wear and tire wear obtained from either EPA's MOBILE6.2 [27] or MOVES2010 [29] model should be added to the emissions factor calculated from the empirical equation.

Table 13.2.1-1. PARTICLE SIZE MULTIPLIERS FOR PAVED ROAD EQUATION

Size range[a]	Particle Size Multiplier k[b]		
	g/VKT	g/VMT	lb/VMT
PM-2.5[c]	0.15	0.25	0.00054
PM-10	0.62	1.00	0.0022
PM-15	0.77	1.23	0.0027
PM-30[d]	3.23	5.24	0.011

[a] Refers to airborne particulate matter (PM-x) with an aerodynamic diameter equal to or less than x micrometers.

[b] Units shown are grams per vehicle kilometer traveled (g/VKT), grams per vehicle mile traveled (g/VMT), and pounds per vehicle mile traveled (lb/VMT). The multiplier k includes unit conversions to produce emission factors in the units shown for the indicated size range from the mixed units required in Equation 1.

[c] The k-factors for $PM_{2.5}$ were based on the average $PM_{2.5}$:PM_{10} ratio of test runs in Reference 30.

[d] PM-30 is sometimes termed "suspendable particulate" (SP) and is often used as a surrogate for TSP.

Equation 1 is based on a regression analysis of 83 tests for PM-10.[3, 5-6, 8, 27-29, 31-36] Sources tested include public paved roads, as well as controlled and uncontrolled industrial paved roads. The majority of tests involved freely flowing vehicles traveling at constant speed on relatively level roads. However, 22 tests of slow moving or "stop-and-go" traffic or vehicles under load were available for inclusion in the data base.[32-36] Engine exhaust, tire wear and break wear were subtracted from the emissions measured in the test programs prior to stepwise regression to determine Equation 1.[37, 39] The equations retain the quality rating of A (D for PM-2.5), if applied within the range of source conditions that were tested in developing the equation as follows:

Silt loading:	0.03 - 400 g/m^2
	0.04 - 570 grains/square foot (ft^2)
Mean vehicle weight:	1.8 - 38 megagrams (Mg)
	2.0 - 42 tons
Mean vehicle speed:	1 - 88 kilometers per hour (kph)
	1 - 55 miles per hour (mph)

The upper and lower 95% confidence levels of equation 1 for PM$_{10}$ is best described with equations using an exponents of 1.14 and 0.677 for silt loading and an exponents of 1.19 and 0.85 for weight. Users are cautioned that application of equation 1 outside of the range of variables and operating conditions specified above, e.g., application to roadways or road networks with speeds above 55 mph and average vehicle weights of 42 tons, will result in emission estimates with a higher level of uncertainty. In these situations, users are encouraged to consider an assessment of the impacts of the influence of extrapolation to the overall emissions and alternative methods that are equally or more plausible in light of local emissions data and/or ambient concentration or compositional data.

To retain the quality rating for the emission factor equation when it is applied to a specific paved road, it is necessary that reliable correction parameter values for the specific road in question be determined. With the exception of limited access roadways, which are difficult to sample, the collection and use of site-specific silt loading (sL) data for public paved road emission inventories are strongly recommended. The field and laboratory procedures for determining surface material silt content and surface dust loading are summarized in Appendices C.1 and C.2. In the event that site-specific values cannot be obtained, an appropriate value for a paved public road may be selected from the values in Table 13.2.1-2, but the quality rating of the equation should be reduced by 2 levels.

Equation 1 may be extrapolated to average uncontrolled conditions (but including natural mitigation) under the simplifying assumption that annual (or other long-term) average emissions are inversely proportional to the frequency of measurable (> 0.254 mm [0.01 inch]) precipitation by application of a precipitation correction term. The precipitation correction term can be applied on a daily or an hourly basis [26, 38].

For the daily basis, Equation 1 becomes:

$$E_{ext} = [\; k\; (sL)^{0.91} \; \text{x} \; (W)^{1.02}\;]\; (1 - P/4N) \qquad\qquad (2)$$

where k, sL, W, and S are as defined in Equation 1 and

E_{ext} = annual or other long-term average emission factor in the same units as k,

P = number of "wet" days with at least 0.254 mm (0.01 in) of precipitation during the averaging period, and

N = number of days in the averaging period (e.g., 365 for annual, 91 for seasonal, 30 for monthly).

Note that the assumption leading to Equation 2 is based on analogy with the approach used to develop long-term average unpaved road emission factors in Section 13.2.2. However, Equation 2 above incorporates an additional factor of "4" in the denominator to account for the fact that paved roads dry more quickly than unpaved roads and that the precipitation may not occur over the complete 24-hour day.

For the hourly basis, equation 1 becomes:

$$E_{ext} = [\ k\ (sL)^{0.91} \times (W)^{1.02}\ ]\ (1 - 1.2P/N) \qquad (3)$$

where k, sL, W, and S are as defined in Equation 1 and

E_{ext} = annual or other long-term average emission factor in the same units as k,

P = number of hours with at least 0.254 mm (0.01 in) of precipitation during the averaging period, and

N = number of hours in the averaging period (e.g., 8760 for annual, 2124 for season 720 for monthly)

Note: In the hourly moisture correction term (1-1.2P/N) for equation 3, the 1.2 multiplier is applied to account for the residual mitigative effect of moisture. For most applications, this equation will produce satisfactory results. Users should select a time interval to include sufficient "dry" hours such that a reasonable emissions averaging period is evaluated. For the special case where this equation is used to calculate emissions on an hour by hour basis, such as would be done in some emissions modeling situations, the moisture correction term should be modified so that the moisture correction "credit" is applied to the first hours following cessation of precipitation. In this special case, it is suggested that this 20% "credit" be applied on a basis of one hour credit for each hour of precipitation up to a maximum of 12 hours.

Note that the assumption leading to Equation 3 is based on analogy with the approach used to develop long-term average unpaved road emission factors in Section 13.2.2.

Figure 13.2.1-2 presents the geographical distribution of "wet" days on an annual basis for the United States. Maps showing this information on a monthly basis are available in the *Climatic Atlas of the United States*[23]. Alternative sources include other Department of Commerce publications (such as local climatological data summaries). The National Climatic Data Center (NCDC) offers several products that provide hourly precipitation data. In particular, NCDC offers *Solar and Meteorological Surface Observation Network 1961-1990* (SAMSON) CD-ROM, which contains 30 years worth of hourly meteorological data for first-order National Weather Service locations. Whatever meteorological data are used, the source of that data and the averaging period should be clearly specified.

It is emphasized that the simple assumption underlying Equations 2 and 3 has not been verified in any rigorous manner. For that reason, the quality ratings for Equations 2 and 3 should be downgraded one letter from the rating that would be applied to Equation 1.
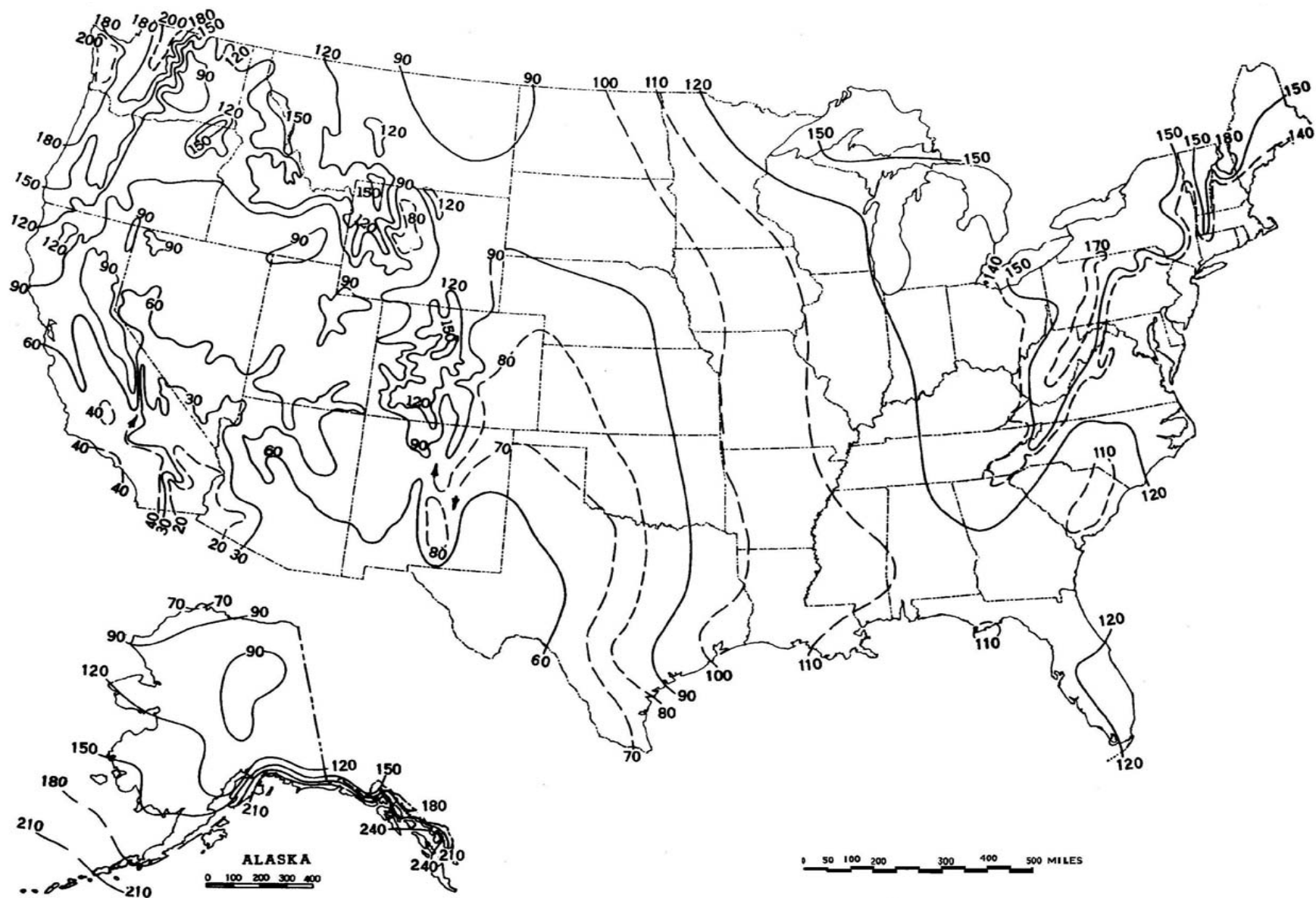
Figure 13.2.1-2. Mean number of days with 0.01 inch or more of precipitation in the United States.

Table 13.2.1-2 presents recommended default silt loadings for normal baseline conditions and for wintertime baseline conditions in areas that experience frozen precipitation with periodic application of antiskid material[24]. The winter baseline is represented as a multiple of the non-winter baseline, depending on the ADT value for the road in question. As shown, a multiplier of 4 is applied for low volume roads (< 500 ADT) to obtain a wintertime baseline silt loading of 4 X 0.6 = 2.4 g/m^2.

Table 13.2.1-2. Ubiquitous Silt Loading Default Values with Hot Spot
Contributions from Anti-Skid Abrasives (g/m^2)

ADT Category	< 500	500-5,000	5,000-10,000	> 10,000
Ubiquitous Baseline g/m^2	0.6	0.2	0.06	0.03 0.015 limited access
Ubiquitous Winter Baseline Multiplier during months with frozen precipitation	X4	X3	X2	X1
Initial peak additive contribution from application of antiskid abrasive (g/m^2)	2	2	2	2
Days to return to baseline conditions (assume linear decay)	7	3	1	0.5

It is suggested that an additional (but temporary) silt loading contribution of 2 g/m^2 occurs with each application of antiskid abrasive for snow/ice control. This was determined based on a typical application rate of 500 lb per lane mile and an initial silt content of 1 % silt content. Ordinary rock salt and other chemical deicers add little to the silt loading, because most of the chemical dissolves during the snow/ice melting process.

To adjust the baseline silt loadings for mud/dirt trackout, the number of trackout points is required. It is recommended that in calculating PM$_{10}$ emissions, six additional miles of road be added for each active trackout point from an active construction site, to the paved road mileage of the specified category within the county. In calculating PM$_{2.5}$ emissions, it is recommended that three additional miles of road be added for each trackout point from an active construction site.

It is suggested the number of trackout points for activities other than road and building construction areas be related to land use. For example, in rural farming areas, each mile of paved road would have a specified number of trackout points at intersections with unpaved roads. This value could be estimated from the unpaved road density (mi/sq. mi.).

The use of a default value from Table 13.2.1-2 should be expected to yield only an order-of-magnitude estimate of the emission factor. Public paved road silt loadings are dependent

13.2.4 Aggregate Handling And Storage Piles

13.2.4.1 General

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

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

13.2.4.2 Emissions And Correction Parameters

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

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

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

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

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

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

(1)

where:

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

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

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

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

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

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

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

1.4   Natural Gas Combustion

1.4.1   General[1-2]

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

1.4.2   Firing Practices[3-5]

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

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

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

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

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

1.4.3 Emissions[3-4]

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

Nitrogen Oxides -

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

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

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

Carbon Monoxide -

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

Volatile Organic Compounds -

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

Sulfur Oxides -

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

Particulate Matter -

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

Greenhouse Gases -[6-9]

CO$_2$, CH$_4$, and N$_2$O emissions are all produced during natural gas combustion. In properly tuned boilers, nearly all of the fuel carbon (99.9 percent) in natural gas is converted to CO$_2$ during the combustion process. This conversion is relatively independent of boiler or combustor type. Fuel carbon not converted to CO$_2$ results in CH$_4$, CO, and/or VOC emissions and is due to incomplete combustion. Even in boilers operating with poor combustion efficiency, the amount of CH$_4$, CO, and VOC produced is insignificant compared to CO$_2$ levels.

Formation of N$_2$O during the combustion process is affected by two furnace-zone factors. N$_2$O emissions are minimized when combustion temperatures are kept high (above 1475°F) and excess oxygen is kept to a minimum (less than 1 percent).

Methane emissions are highest during low-temperature combustion or incomplete combustion, such as the start-up or shut-down cycle for boilers. Typically, conditions that favor formation of N$_2$O also favor emissions of methane.

1.4.4 Controls[4,10]

NO$_x$ Controls -

Currently, the two most prevalent combustion control techniques used to reduce NO$_x$ emissions from natural gas-fired boilers are flue gas recirculation (FGR) and low NO$_x$ burners. In an FGR system, a portion of the flue gas is recycled from the stack to the burner windbox. Upon entering the windbox, the recirculated gas is mixed with combustion air prior to being fed to the burner. The recycled flue gas consists of combustion products which act as inerts during combustion of the fuel/air mixture. The FGR system reduces NO$_x$ emissions by two mechanisms. Primarily, the recirculated gas acts as a diluent to reduce combustion temperatures, thus suppressing the thermal NO$_x$ mechanism. To a lesser extent, FGR also reduces NO$_x$ formation by lowering the oxygen concentration in the primary flame zone. The amount of recirculated flue gas is a key operating parameter influencing NO$_x$ emission rates for these systems. An FGR system is normally used in combination with specially designed low NO$_x$ burners capable of sustaining a stable flame with the increased inert gas flow resulting from the use of FGR. When low NO$_x$ burners and FGR are used in combination, these techniques are capable of reducing NO$_x$ emissions by 60 to 90 percent.

Low NO$_x$ burners reduce NO$_x$ by accomplishing the combustion process in stages. Staging partially delays the combustion process, resulting in a cooler flame which suppresses thermal NO$_x$ formation. The two most common types of low NO$_x$ burners being applied to natural gas-fired boilers are staged air burners and staged fuel burners. NO$_x$ emission reductions of 40 to 85 percent (relative to uncontrolled emission levels) have been observed with low NO$_x$ burners.

Other combustion control techniques used to reduce NO$_x$ emissions include staged combustion and gas reburning. In staged combustion (e.g., burners-out-of-service and overfire air), the degree of staging is a key operating parameter influencing NO$_x$ emission rates. Gas reburning is similar to the use of overfire

in the use of combustion staging. However, gas reburning injects additional amounts of natural gas in the upper furnace, just before the overfire air ports, to provide increased reduction of NO_x to NO_2.

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

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

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

1.4.5   Updates Since the Fifth Edition

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

Supplement D, March 1998

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

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

July 1998 - minor changes

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

Table 1.4-1. EMISSION FACTORS FOR NITROGEN OXIDES (NO$_x$) AND CARBON MONOXIDE (CO)
FROM NATURAL GAS COMBUSTION[a]

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

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

[b] Expressed as NO$_2$. For large and small wall fired boilers with SNCR control, apply a 24 percent reduction to the appropriate NO$_x$ emission factor. For tangential-fired boilers with SNCR control, apply a 13 percent reduction to the appropriate NO$_x$ emission factor.

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

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

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

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

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

[c] All PM (total, condensible, and filterable) is assumed to be less than 1.0 micrometer in diameter. Therefore, the PM emission factors presented here may be used to estimate PM$_{10}$, PM$_{2.5}$ or PM$_1$ emissions. Total PM is the sum of the filterable PM and condensible PM. Condensible PM is the particulate matter collected using EPA Method 202 (or equivalent). Filterable PM is the particulate matter collected on, or prior to, the filter of an EPA Method 5 (or equivalent) sampling train.

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

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

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

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

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

[a] Reference 11. Units are in pounds of pollutant per million standard cubic feet of natural gas fired. Data are for all natural gas combustion sources. To convert from lb/10^6 scf to kg/10^6 m^3, multiply by 16. To convert from 1b/10^6 scf to lb/MMBtu, divide by 1,020. Emission Factors preceeded with a less-than symbol are based on method detection limits.
[b] Hazardous Air Pollutant (HAP) as defined by Section 112(b) of the Clean Air Act.
[c] HAP because it is Polycyclic Organic Matter (POM). POM is a HAP as defined by Section 112(b) of the Clean Air Act.
[d] The sum of individual organic compounds may exceed the VOC and TOC emission factors due to differences in test methods and the availability of test data for each pollutant.

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

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

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

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

References For Section 1.4

1.	*Exhaust Gases From Combustion And Industrial Processes*, EPA Contract No. EHSD 71-36, Engineering Science, Inc., Washington, DC, October 1971.

2.	*Chemical Engineers' Handbook, Fourth Edition*, J. H. Perry, Editor, McGraw-Hill Book Company, New York, NY, 1963.

3.	*Background Information Document For Industrial Boilers*, EPA-450/3-82-006a, U. S. Environmental Protection Agency, Research Triangle Park, NC, March 1982.

4.	*Background Information Document For Small Steam Generating Units*, EPA-450/3-87-000, U. S . Environmental Protection Agency, Research Triangle Park, NC, 1987.

5.	J. L. Muhlbaier, "Particulate and Gaseous Emissions From Natural Gas Furnaces and Water Heaters", *Journal Of The Air Pollution Control Association*, December 1981.

6.	L. P. Nelson, *et al.*, *Global Combustion Sources Of Nitrous Oxide Emissions*, Research Project 2333-4 Interim Report, Sacramento: Radian Corporation, 1991.

7.	R. L. Peer, *et al.*, *Characterization Of Nitrous Oxide Emission Sources*, Prepared for the U. S. EPA Contract 68-D1-0031, Research Triangle Park, NC: Radian Corporation, 1995.

8.	S. D. Piccot, *et al.*, *Emissions and Cost Estimates For Globally Significant Anthropogenic Combustion Sources Of NO_x, N_2O, CH_4, CO, and CO_2,* EPA Contract No. 68-02-4288, Research Triangle Park, NC: Radian Corporation, 1990.

9.	*Sector-Specific Issues and Reporting Methodologies Supporting the General Guidelines for the Voluntary Reporting of Greenhouse Gases under Section 1605(b) of the Energy Policy Act of 1992* (1994) DOE/PO-0028, Volume 2 of 3, U.S. Department of Energy.

10.	J. P. Kesselring and W. V. Krill, "A Low-NO_x Burner For Gas-Fired Firetube Boilers", *Proceedings: 1985 Symposium On Stationary Combustion NO_x Control, Volume 2*, EPRI CS-4360, Electric Power Research Institute, Palo Alto, CA, January 1986.

11.	*Emission Factor Documentation for AP-42 Section 1.4—Natural Gas Combustion*, Technical Support Division, Office of Air Quality Planning and Standards, U. S. Environmental Protection Agency, Research Triangle Park, NC, 1997.

12.	*Alternate Control Techniques Document - NO_x Emissions from Utility Boilers*, EPA-453/R-94-023, U. S. Environmental Protection Agency, Research Triangle Park, NC, March 1994.

AP-42 Section 1.4: Natural Gas Combustion Data Files

The data that supports the emission factors are presented in summary in the background report and are reported more completely in an electronic database. The database is in Microsoft Access 97®. The file is located on the CHIEF web site at http://www.epa.gov/ttn/chief/ap42c1.html.

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

Typical cuyd of concrete

	pound/yd	tons/hr	tons/yr
total concrete	3881	242.6	970,250
aggregate	1900	118.8	475,000
sand	1100	68.8	275,000
cement	489	30.6	122,250
flyash	132	8.3	33,000
water	260	16.3	65,000

Max. plant capacity	125 cuyd/hr	
Max. plant capacity	1875 cuyd/day	
Max. plant capacity	500000 cuyd/yr	
Hours per year of operation based on annual throughput	4000 hrs/yr	(not a requested permit limit)
Uncontrolled hrs/yr of operation	8760 hrs/yr	

Aggregate Storage Pile Handling   **AP-42 Rated: A**

AP-42 13.2.4 $E = k \times (0.0032) \times (U/5)^{1.3} / (M/2)^{1.4}$ lbs/ton

Max tph	118.75 tph		475000 ton/yr
k(PM)	0.74		
k(pm10)	0.35		
k(pm2.5)	0.053		
Umax	11 MPH	NMED Default	
Uannual	8.3 MPH	Ruidoso Airport WS 1996-2006	
M	1.77 %	AP-42 Section 11.12, Table 11.12-2, footnote b	

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

	lb/hr	tons/yr	Model lbs/hr	
E(PM) Controlled	0.92992	1.28963	0.64482	Limit Annual Material Throughput
E(pm10) Controlled	0.43983	0.60996	0.30498	Limit Annual Material Throughput
E(pm2.5) Controlled	0.06660	0.09237	0.04618	Limit Annual Material Throughput

Sand Storage Pile Handling   **AP-42 Rated: A**

AP-42 13.2.4 $E = k \times (0.0032) \times (U/5)^{1.3} / (M/2)^{1.4}$ lbs/ton

Max tph	68.75 tph		275000 ton/yr
k(PM)	0.74		
k(pm10)	0.35		
k(pm2.5)	0.053		
Umax	11 MPH	NMED Default	
Uannual	8.3 MPH	Ruidoso Airport WS 1996-2006	
M	4.17 %	AP-42 Section 11.12, Table 11.12-2, footnote b	

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

	lb/hr	tons/yr	Model lbs/hr	
E(PM) Controlled	0.16220	0.22495	0.11247	Limit Annual Material Throughput
E(pm10) Controlled	0.07672	0.10639	0.05320	Limit Annual Material Throughput
E(pm2.5) Controlled	0.01162	0.01611	0.00806	Limit Annual Material Throughput

Aggregate and Sand Feeder Loading   **AP-42 Rated: A**

AP-42 13.2.4 $E = k \times (0.0032) \times (U/5)^{1.3} / (M/2)^{1.4}$ lbs/ton

Max tph	187.5 tph		750000 ton/yr
k(PM)	0.74		
k(pm10)	0.35		
k(pm2.5)	0.053		
Umax	11 MPH	NMED Default	
Uannual	8.3 MPH	Ruidoso Airport WS 1996-2006	
M	2.65 %	Calculated weighted average aggregate and sand	

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

	lb/hr	tons/yr	Model lbs/hr	
E(PM) Uncontrolled	0.83451	1.15731	0.57866	Limit Annual Material Throughput
E(pm10) Uncontrolled	0.39470	0.54738	0.27369	Limit Annual Material Throughput
E(pm2.5) Uncontrolled	0.05977	0.08289	0.04144	Limit Annual Material Throughput

Roper Construction, Inc. Alto Concrete Batch Plant Emissions Inventory
125 CuFt/Hr; 500,000 CuFt per Year

Aggregate and Sand Feeder Unloading   **AP-42 Rated: D**
AP-42 11.19.2 Table 11.19.2-2 "Conveyor Transfer Point"

Max tph	187.5 tph	2812.5 ton/day	750000 ton/yr
E(PM) Uncontrolled	0.003 lbs/ton		
E(pm10) Uncontrolled	0.0011 lbs/ton		
E(pm2.5) Uncontrolled	0.000167 lbs/ton		

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

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

	lb/hr	tons/yr	
E(PM) Controlled	0.02625	0.05250	Limit Annual Material Throughput
E(pm10) Controlled	0.00863	0.01725	Limit Annual Material Throughput
E(pm10) Controlled	0.00244	0.00488	Limit Annual Material Throughput

Aggregate Bin Loading   **AP-42 Rated: D**
AP-42 11.19.2 Table 11.19.2-2 "Conveyor Transfer Point"

Max tph	187.5 tph	750000 ton/yr
E(PM) Uncontrolled	0.003 lbs/ton	
E(pm10) Uncontrolled	0.0011 lbs/ton	
E(pm2.5) Uncontrolled	0.000167 lbs/ton	

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

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

	lb/hr	tons/yr	
E(PM) Controlled	0.02625	0.05250	Limit Annual Material Throughput
E(pm10) Controlled	0.00863	0.01725	Limit Annual Material Throughput
E(pm2.5) Controlled	0.00244	0.00488	Limit Annual Material Throughput

Aggregate Weight Batcher Unloading to Batcher Conveyor   **AP-42 Rated: D**
AP-42 11.19.2 Table 11.19.2-2 "Conveyor Transfer Point"

Max tph	187.5 tph	750000 ton/yr
E(PM) Uncontrolled	0.003 lbs/ton	
E(pm10) Uncontrolled	0.0011 lbs/ton	
E(pm2.5) Uncontrolled	0.000167 lbs/ton	

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

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

	lb/hr	tons/yr	
E(PM) Controlled	0.02625	0.05250	Limit Annual Material Throughput
E(pm10) Controlled	0.00863	0.01725	Limit Annual Material Throughput
E(pm2.5) Controlled	0.00244	0.00488	Limit Annual Material Throughput

Truck Loading   **AP-42 Rated: B**

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

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

Max tph Cement and Flyash	38.8125 tph	155250 ton/yr

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

Controlled based on baghouse exit control efficiency of 99.9%

Control Efficiency	99.9%	

	lb/hr	tons/yr	
E(PM) controlled truck loading	0.043	0.09	
E(pm10) controlled truck loading	0.012	0.024	
E(pm2.5) controlled truck loading	0.0018	0.0036	Controlled Truck Loading PM2.5, Truck Loading Table 11.12-3 PM10 * PM2.5/PM10 (0.048/0.32)

Cement/Fly Ash Weigh Batcher   **AP-42 Rated: B**

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

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

Max tph Cement and Flyash   38.8125 tph   155250 ton/yr

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

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

	lb/hr	tons/yr	
E(PM) controlled batcher	0.022	0.044	
E(pm10) controlled batcher	0.0061	0.012	
E(pm2.5) controlled batcher	0.0014	0.0024	Controlled Mixer Loading PM2.5, Central Mix Operation Table 11.12-4 PM10 * PM2.5/PM10 (0.03/0.13)

Cement Silo   **AP-42 Rated: E**

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

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

Max tph Cement   30.6 tph   122250 ton/yr

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

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

	lb/hr	tons/yr	
E(PM) controlled cement	0.022311	0.045	
E(pm10) controlled cement	0.014364	0.029	
E(pm2.5) controlled cement	0.003315	0.0057	Controlled Mixer Loading PM2.5, Central Mix Operation Table 11.12-4 PM10 * PM2.5/PM10 (0.03/0.13)

Flyash Silo   **AP-42 Rated: E**

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

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

Max tph Fly Ash   8.25 tph   33000 ton/yr

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

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

	lb/hr	tons/yr	
E(PM) controlled truck load	0.026	0.052	
E(pm10) controlled truck load	0.009	0.018	
E(pm2.5) controlled truck load	0.0021	0.0036	Controlled Mixer Loading PM2.5, Central Mix Operation Table 11.12-4 PM10 * PM2.5/PM10 (0.03/0.13)

Roper Construction, Inc. Alto Concrete Batch Plant Emissions Inventory
125 CuFt/Hr; 500,000 CuFt per Year

<u>Road Traffic - Paved</u>   AP-42 13.2.1   **AP-42 Rated: B**

Equation:

E = k(sL)^0.91*(W)^1.02*[1-P/4N]   *Annual emissions only include p factor*

k TSP	0.011	
k PM10	0.0022	
k PM25	0.00054	
sL	0.6	road surface silt loading (g/m2)
P = days with precipitation over 0.01 inches	60	
N = number of days in averaging period	365	

Cement Truck VMT	214	RT meter/vehicle	0.133178829 RT miles/vehicle
Flyash Truck VMT	214	RT meter/vehicle	0.133178829 RT miles/vehicle
Aggregate Truck VMT	392	RT meter/vehicle	0.243855317 RT miles/vehicle
Concrete Truck VMT	214	RT meter/vehicle	0.133178829 RT miles/vehicle

Max. Cement Truck/hr	1.3 truck/hr	23 tons/load	30.6 tons/hr
Max. Flyash Truck/hr	0.4 truck/hr	23 tons/load	8.3 tons/hr
Max. Aggregate Truck/hr	8.2 truck/hr	23 tons/load	187.5 tons/hr
Max. Concrete Truck/hr	10.4 truck/hr	12 cuyd/load	125.0 cuyd/hr
	20.3 truck/hr		

Max. Cement Truck/yr	5315.2 truck/yr	23 tons/load	122250.0 tons/yr
Max. Flyash Truck/yr	1434.8 truck/yr	23 tons/load	33000.0 tons/yr
Max. Aggregate Truck/yr	32608.7 truck/yr	23 tons/load	750000.0 tons/yr
Max. Concrete Truck/yr	41666.7 truck/yr	12 cuyd/load	500000.0 tons/yr
	81025.4 truck/yr		

Cement Truck VMT	0.17697 RT miles/hr	1550.25 miles/yr uncontrolled	707.87 miles/yr controlled
Flyash Truck VMT	0.04777 RT miles/hr	418.47 miles/yr uncontrolled	191.08 miles/yr controlled
Aggregate Truck VMT	1.98795 RT miles/hr	17414.45 miles/yr uncontrolled	7951.80 miles/yr controlled
Concrete Truck VMT	1.38728 RT miles/hr	12152.57 miles/yr uncontrolled	5549.12 miles/yr controlled
	3.59997 RT miles/hr	31535.73	14399.88

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

	PM Uncontrolled		PM Control	
Max. Cement Truck Emissions	0.0346 lbs/hr	0.1453 tons/yr	0.0346 lbs/hr	0.0664 tons/yr
Max. Flyash Truck Emissions	0.0093 lbs/hr	0.0392 tons/yr	0.0093 lbs/hr	0.0179 tons/yr
Max. Aggregate Truck Emissions	0.3887 lbs/hr	1.6326 tons/yr	0.3887 lbs/hr	0.7455 tons/yr
Max. Concrete Truck Emissions	0.2556 lbs/hr	1.0736 tons/yr	0.2556 lbs/hr	0.4902 tons/yr
total combined traffic	0.6883 lbs/hr	2.8907 tons/yr	0.6883 lbs/hr	1.3200 tons/yr

	PM10 Uncontrolled		PM10 Control	
Max. Cement Truck Emissions	0.0069 lbs/hr	0.0291 tons/yr	0.0069 lbs/hr	0.0133 tons/yr
Max. Flyash Truck Emissions	0.0019 lbs/hr	0.0078 tons/yr	0.0019 lbs/hr	0.0036 tons/yr
Max. Aggregate Truck Emissions	0.0777 lbs/hr	0.3265 tons/yr	0.0777 lbs/hr	0.1491 tons/yr
Max. Concrete Truck Emissions	0.0511 lbs/hr	0.2147 tons/yr	0.0511 lbs/hr	0.0980 tons/yr
total combined traffic	0.1377 lbs/hr	0.5781 tons/yr	0.1377 lbs/hr	0.2640 tons/yr

	PM2.5 Uncontrolled		PM2.5 Control	
Max. Cement Truck Emissions	0.0017 lbs/hr	0.0071 tons/yr	0.0017 lbs/hr	0.0033 tons/yr
Max. Flyash Truck Emissions	0.0005 lbs/hr	0.0019 tons/yr	0.0005 lbs/hr	0.0009 tons/yr
Max. Aggregate Truck Emissions	0.0191 lbs/hr	0.0801 tons/yr	0.0191 lbs/hr	0.0366 tons/yr
Max. Concrete Truck Emissions	0.0125 lbs/hr	0.0527 tons/yr	0.0125 lbs/hr	0.0241 tons/yr
total combined traffic	0.0338 lbs/hr	0.1419 tons/yr	0.0338 lbs/hr	0.0648 tons/yr

Roper Construction, Inc. Heater Emissions

Concrete Batch Heater

AP-42 1.4 (7/98)	NOx, CO, VOC and PM Emissions	
Mass Balance	SO2 Emissions	
Heater Size	Natural Gas	

600000 BTU/hr		Heat Rate	945 BTU/scf
634.9 scf/hr		%sulfur	0.75 grains/100 scf

Uncontrolled Hours	8760
Controlled Hours	8760

Emission Factors

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

Calculated Uncontrolled Emissions

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

Calculated Controlled Emissions

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

Roper Construction, Inc Alto Concrete Batch Plant Emissions Inventory
125 CuFt/Hr; 500,000 CuFt per Year
Emission Totals

Uncontrolled Emission Totals

ID #	Source Description	NOx		CO		SO2		VOC		PM		PM10		PM2.5	
		lbs/hr	tons/yr	lbs/hr	tons/yr	lbs/hr	tons/yr	lbs/hr	tons/yr	lbs/hr	tons/yr	lbs/hr	tons/yr	lbs/hr	tons/yr
1	Haul Road									0.69	2.89	0.14	0.58	0.034	0.14
2	Feeder Hopper									0.83	3.66	0.39	1.73	0.060	0.26
3	Feed Hopper Conveyor									0.56	2.46	0.21	0.90	0.031	0.14
4	4-Bin Aggregate Bin									0.56	2.46	0.21	0.90	0.031	0.14
5,6	Aggregate Weigh Batcher and Conveyor									0.56	2.46	0.21	0.90	0.031	0.14
7	Truck Loading									43.4	190.1	12.0	52.7	2.16	9.48
8	Cement/Fly Ash Batcher									22.2	97.2	6.05	26.5	1.20	5.25
9	Cement Split Silo									22.3	97.7	14.4	62.9	2.84	12.5
10	Fly Ash Split Silo									25.9	113.5	25.9	113.5	9.08	39.7
11	Aggregate/Sand Storage Piles									1.09	4.78	0.52	2.26	0.078	0.34
12,13,14	Concrete Batch Plant Heater	0.063	0.28	0.053	0.23	0.00068	0.0030	0.0070	0.031	0.0048	0.021	0.0048	0.021	0.0048	0.021
	Total	**0.063**	**0.28**	**0.053**	**0.23**	**0.00068**	**0.0030**	**0.0070**	**0.031**	**118**	**517**	**60**	**263**	**15.6**	**68**

Controlled Emission Totals

| ID #	Source Description	NOx		CO		SO2		VOC		PM		PM10		PM2.5	
		lbs/hr	tons/yr	lbs/hr	tons/yr	lbs/hr	tons/yr	lbs/hr	tons/yr	lbs/hr	tons/yr	lbs/hr	tons/yr	lbs/hr	tons/yr
1	Haul Road									0.69	1.32	0.14	0.26	0.034	0.065
2	Feeder Hopper									0.83	1.16	0.39	0.55	0.060	0.083
3	Feed Hopper Conveyor									0.026	0.053	0.0086	0.017	0.0024	0.0049
4	4-Bin Aggregate Bin									0.026	0.053	0.0086	0.017	0.0024	0.0049
5,6	Aggregate Weigh Batcher and Conveyor									0.026	0.053	0.0086	0.017	0.0024	0.0049
7,8	Truck Loading and Cement/Fly Ash Batcher Baghouse									0.066	0.13	0.018	0.036	0.0032	0.0060
9	Cement Split Silo Bahouse									0.022	0.045	0.014	0.029	0.0033	0.0057
10	Fly Ash Split Silo Baghouse									0.026	0.052	0.0091	0.018	0.0021	0.0036
11	Aggregate/Sand Storage Piles									1.09	1.51	0.52	0.72	0.078	0.11
12,13,14	Concrete Batch Plant Heater	0.063	0.28	0.053	0.23	0.00068	0.0030	0.0070	0.031	0.0048	0.021	0.0048	0.021	0.0048	0.021
	Total	**0.063**	**0.28**	**0.053**	**0.23**	**0.00068**	**0.0030**	**0.0070**	**0.031**	**2.81**	**4.40**	**1.12**	**1.68**	**0.19**	**0.31**

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

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

F1   1000 GAL DIESEL TANK
F2   1000 GAL DIESEL TANK
F3   1000 GAL DIESEL TANK

POWER SOURCE IS LINE 480 VAC POWER

Silo Venting Filters
SILOTOP™ zero

HIGH PERFORMANCE
FEW COMPONENTS
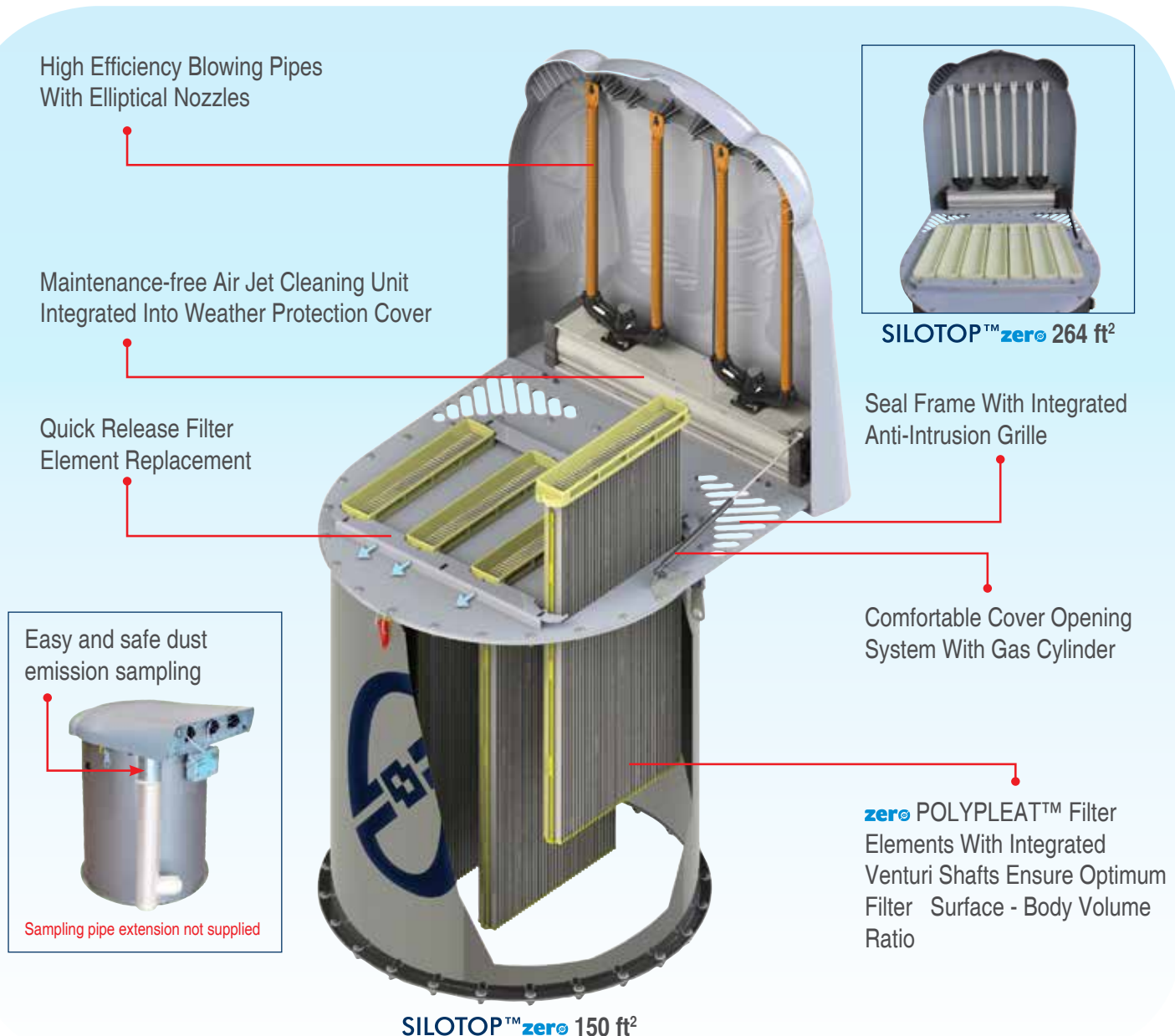
DUST FILTRATION DUST FILTRATION

WAMGROUP®

WAM®
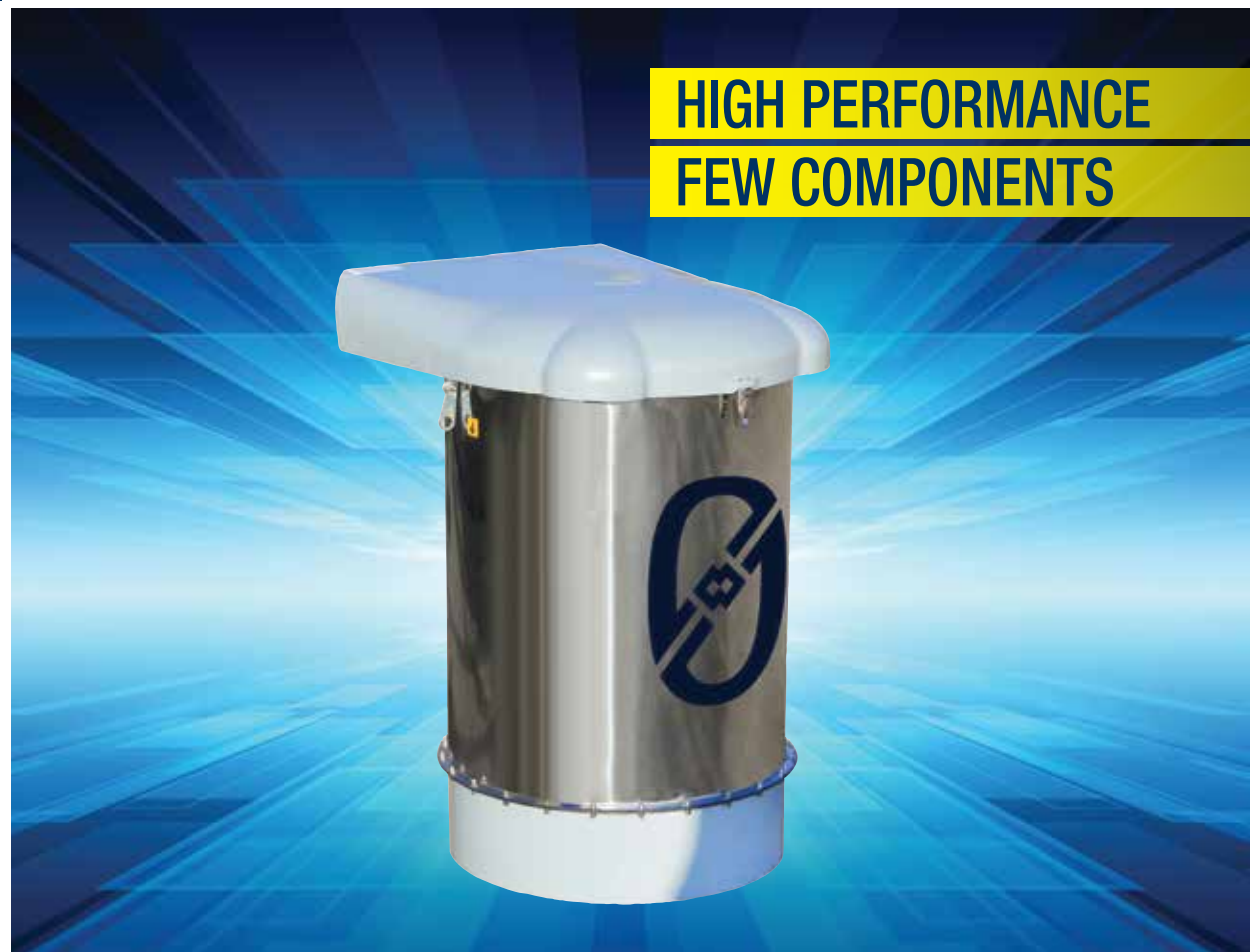
CUTTING-EDGE DUST FILTRATION TECHNOLOGY

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

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

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

High Efficiency Blowing Pipes With Elliptical Nozzles

Maintenance-free Air Jet Cleaning Unit Integrated Into Weather Protection Cover

Quick Release Filter Element Replacement

Easy and safe dust emission sampling

Sampling pipe extension not supplied

SILOTOP™**zero** 264 ft²

Seal Frame With Integrated Anti-Intrusion Grille

Comfortable Cover Opening System With Gas Cylinder

zero POLYPLEAT™ Filter Elements With Integrated Venturi Shafts Ensure Optimum Filter Surface - Body Volume Ratio

SILOTOP™**zero** 150 ft²

Overall Dimensions

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

Features

- Filtration efficiency up to 99.99% due to **filter media certified EN ISO 16890-1:2016, Group ISO ePM$_{2.5}$ 65%**

- Air flow **performance increased** by 30%

- **Compact** 30 in diameter stainless steel body with bottom flange

- **Maintenance-free** air jet cleaning unit integrated into weather protection cover

- Maintenance height = 44 in

- **Extended durability** due to zero filter media POLYPLEAT™ elements

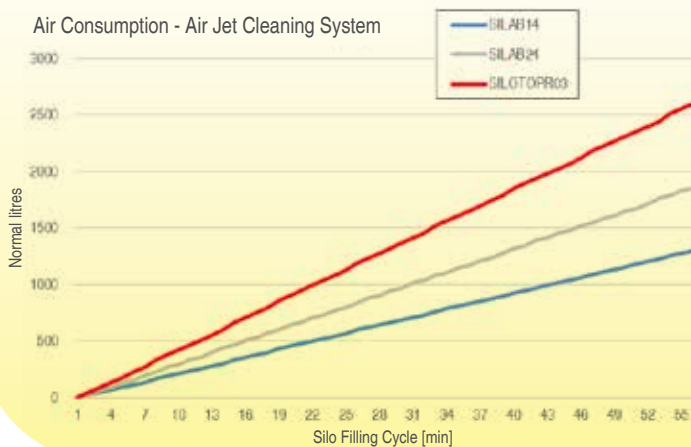- **Safe** weather protection cover with **lockable quick release**

Easy and Safe Maintenance

Benefits

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

Economic Savings Using zero Filter Media

Air Consumption - Air Jet Cleaning System

SILAB14
SILAB24
SILOTOPR03

Normal litres

3000
2500
2000
1500
1000
500
0

1 4 7 10 13 16 19 22 25 28 31 34 37 40 43 46 49 52 55

Silo Filling Cycle [min]

- **Up to 50% lower annual management costs due to lower air consumption**

- **Up to 30% savings in spare parts**

- **Up to 20% savings in silo filling time (in standard test conditions)**

Accessories

- Weld-on bottom ring
- Multifunctional electronic differential pressure meter

- Winter protection for solenoid valves
- Emission sampling kit

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

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

TÜV SÜD   UNI EN ISO 9001
Certified Company

WAM®

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