

On-site Incineration Area Source Category Calculation Methodology Sheet

I. Source Category: On-site Incineration

II. Pollutants: PM_{2.5}, SO₂, NO_x, CO

III. SCC:

2601000000 - Waste Disposal, Treatment, and Recovery- On-site Incineration

IV. Description:

Institutional on-site incineration is the confined burning of waste on a small scale by institutions such as hospitals, nursing homes, veterinary offices, funeral homes and laboratories. Large-scale incineration is included in the point source inventory. Three main types of medical waste incinerators are used: controlled air, excess air, and rotary kiln. In AP-42's evaluation of incinerator types, they determined that over 95% of medical waste incinerators are controlled air units. Less than 2% were identified as excess air, and less than 1% as rotary kilns. Approximately 2% were found to be equipped with air pollution control devices.

Industrial incineration typically involves the burning of garbage and other nonhazardous solids, commonly called municipal solid waste (MSW). Types of combustion devices used to burn refuse include single chamber units, multiple chamber units, and trench incinerators. Large-scale incineration is included in the point source inventory.

There are approximately 170 sewage sludge incinerators (SSI) plants in operation in the U.S. Three main types of incinerators are used: multiple hearth, fluidized bed, and electric infrared. Over 80 percent of the identified operating sludge incinerators are of the multiple hearth design. About 15 percent are fluidized bed combustors and 3 percent are electric. The remaining combustors co-fire refuse with sludge.

Particulate matter is emitted as a result of incomplete combustion of organics and by the entrainment of noncombustible ash due to the turbulent movement of gases.

V. Current Methodology:

No seasonality is applied. The emission factor is chosen by type of incinerator: waste, pathological, hazardous, industrial, special medical, sewage sludge and municipal waste combustors. The burn rate is determined by stack test or AP-42. Hours of operation and tons of waste per day are supplied by the operator.

VI. Emission Calculation:

A. Annual Emissions

1. Institutional/Medical Waste Incineration

$$\text{PM}_{10} \ \& \ \text{PM}_{2.5}: \text{EM}_i = [(F \times \text{EF}_i) / 2000] * (S_i/100)$$

$$\text{Other Pollutants: } \text{EM}_i = [(F \times \text{EF}_i) / 2000]$$

Where:

EM_i = Emissions from incineration of pollutant i in tons.

F = Total annual throughput of waste in tons.

EF_i = Emission factor for pollutant i. See tables below.

S_i = Particulate size distribution percent for pollutant i. Applicable to PM10 & PM2.5 only - see table below.

From AP-42 Table 2.3-1 and 2.3-2. Emission Factors for controlled air medical waste incinerators				
Control Level	PM (Lb/ton)	SO ₂ (Lb/ton)	NO _x (Lb/ton)	CO (Lb/ton)
Uncontrolled	4.67 E+00	2.17 E+00	3.56 E+00	2.95 E+00
Low Energy Scrubber/Fabric Filter	9.09 E-01			
Medium Energy Scrubber/ Fabric Filter	1.61 E-01	3.75 E-01		
Fabric Filter	1.75 E-01	8.45 E-01		
Low Energy Scrubber	2.90 E+00	2.09 E+00		
High Energy Scrubber	1.48 E+00	2.57 E-02		
Dry Sorbent Injection/ Fabric Filter	3.37 E-01	3.83 E-01		
Dry Sorbent Injection/ Carbon Injection/Fabric Filter	7.23 E-02	7.41 E-01		
Dry Sorbent Injection/ Fabric Filter/Scrubber	2.68 E+00	1.51 E-02		
Dry Sorbent Injection/Electrostat ic Precipitator	7.34 E-01			

From AP-42 Table 2.3-15. Particle size distribution for controlled air medical waste incinerator particulate matter emissions.		
Pollutant	Uncontrolled cumulative mass % less than stated size	Scrubber cumulative mass % less than stated size
PM _{2.5}	43.3	2.7
PM ₁₀	65.0	71.9

2. Municipal Refuse Incineration

$$\text{PM}_{10} \ \& \ \text{PM}_{2.5}: \text{EM}_i = [(F \times \text{EF}_i) / 2000] * (\text{S}_i/100)$$

$$\text{Other Pollutants: } \text{EM}_i = [(F \times \text{EF}_i) / 2000]$$

Where:

EM_i = Emissions from incineration of pollutant i in tons.

F = Total annual throughput of waste in tons.

EF_i = Emission factor for pollutant i. See table below.

S_i = Particulate size distribution percent for pollutant i. In lieu of specific particulate size distribution factors for municipal refuse incineration, use alternative particulate size distribution factors such as from controlled air medical waste incinerator particulate matter emissions listed above. Applicable to PM₁₀ and PM_{2.5} only.

From AP-42 Tables 2.1-2, 2.1-8 and 2.1-9. Emission Factors					
Incinerator Type	Control Level	PM (Lb/ton)	SO ₂ (Lb/ton)	NO _x (Lb/ton)	CO (Lb/ton)
Mass burn and modular excess air combustors					
	Uncontrolled	2.51 E+01	3.46 E+00		
	Electrostatic Precipitator	2.10 E-01			
	Dry Sorbent Injection/ Electrostatic Precipitator	5.90 E-02	9.51 E-01		
	Spray Dryer/ Electrostatic Precipitator	7.03 E-02	6.53 E-01		
	Dry Sorbent Injection/ Fabric Filter	1.79 E-01	1.43 E-00		
	Spray Dryer/ Fabric Filter	6.02 E-02	5.54 E-01		
Refuse-derived fuel-fired combustors					
	Uncontrolled	6.96 E+01	3.90 E+00	5.02 E+00	1.92 E+00
	Electrostatic Precipitator	1.04 E+00		5.02 E+00	1.92 E+00
	Spray Dryer/ Electrostatic Precipitator	9.65 E-02	1.60 E+00	5.02 E+00	1.92 E+00
	Spray Dryer/ Fabric Filter	1.33 E-01	4.41 E-01	5.02 E+00	1.92 E+00
Modular excess air combustors					
	Uncontrolled			2.47 E+00	

	Electrostatic Precipitator			2.47 E+00	
	Dry Sorbent Injection/ Fabric Filter			2.47 E+00	
Modular starved-air combustors					
	Uncontrolled	3.43 E+00	3.23 E+00	3.16 E+00	2.99 E-01
	Electrostatic Precipitator	3.48 E-01	3.23 E+00	3.16 E+00	2.99 E-01
Mass burn refractory wall combustors					
	Uncontrolled			2.46 E+00	1.37 E+00
	Electrostatic Precipitator			2.46 E+00	1.37 E+00
	Spray Dryer/Electrostatic Precipitator			2.46 E+00	1.37 E+00
Mass burn rotary waterwall combustors					
	Uncontrolled			2.25 E+00	7.66 E-01
	Electrostatic Precipitator			2.25 E+00	7.66 E-01
	Dry Sorbent Injection/ Fabric Filter			2.25 E+00	7.66 E-01
	Spray Dryer/ Fabric Filter			2.25 E+00	7.66 E-01
Mass burn waterwall combustors					
	Uncontrolled			3.56 E+00	4.63 E-01
	Electrostatic Precipitator			3.56 E+00	4.63 E-01
	Spray Dryer/Electrostatic Precipitator			3.56 E+00	4.63 E-01
	Dry Sorbent Injection/ Fabric Filter			3.56 E+00	4.63 E-01
	Spray Dryer/ Fabric Filter			3.56 E+00	4.63 E-01

3. Refuse combustors other than municipal waste

$$\text{PM}_{2.5\&\text{PM}_{10}}: \text{EM}_I = [(F_I \times \text{EF}_R) / 2000] * S_I$$

$$\text{Other Pollutants: } \text{EM}_i = [(F \times \text{EF}_i) / 2000]$$

Where:

EM_I = Emissions from incineration from pollutant I.

F_I = Total annual throughput in tons.

EF_I = Emission factor for total particulate matter. See table below.
 S_I = Particulate size distribution percent for pollutant I. In lieu of specific particulate size distribution factors for municipal refuse incineration, use alternative particulate size distribution factors such as from controlled air medical waste incinerator particulate matter emissions listed above.

From AP-42 Table 2.1-12 Uncontrolled emission factors for refuse combustors other than municipal waste				
Emission Factor Rating: D				
Combustor Type	PM (Lb/ton)	SO ₂ (Lb/ton)	NO _x (Lb/ton)	CO (Lb/ton)
Industrial/commercial - Multiple chamber	7.00 E+00	2.50 E+00	3.00 E+00	1.00 E+01
Industrial/commercial - Single Chamber	1.50 E+01	2.50 E+00	2.00 E+00	2.00 E+01
Trench – wood	1.30 E+01	1.00 E-01	4.00 E+00	
Trench – rubber tires	1.38 E+02			
Trench – municipal refuse	3.70 E+01	2.50 E+00		
Flue-fed single chamber	3.00 E+01	5.00 E-01	3.00 E+00	2.00 E+01
Flue-fed (modified)	6.00 E+00	5.00 E	1.00 E+01	1.00 E+01
Domestic single chamber – w/o primary burner	3.50 E+01	5.00 E	1.00 E+00	3.00 E+02
Domestic single chamber – w/ primary burner	7.00 E+00	5.00 E	2.00 E+00	Neg

4. Sewage sludge incineration

PM: $EM_I = [(F_I \times EF_R) / 2000] * S_I$
 Other Pollutants: $EM_i = [(F \times EF_i) / 2000]$

Where:

EM_I = Emissions from incineration from pollutant I.

F_I = Total annual throughput in tons.

EF_I = Emission factor for total particulate matter. See table below.

S_I = Particulate size distribution percent for pollutant I. See table below.

From AP-42 Table 2.2-1 Emission Factors for SO ₂ and NO _x (lb/ton)	
SO ₂	2.8E+01
NO _x	5.0E+00

From AP-42 Table 2.2 PM Emission Factors			
Incinerator Type	Source Category	Lb/ton	Rating
Multiple hearth sewage sludge incinerators			
	Uncontrolled	1.0 E+02	B

	Cyclone	4.0 E+00	E
	Cyclone/impingement	8.0 E-01	E
	Cyclone/venturi	5.0 E-01	D
	Cyclone/venturi/impingement	6.2 E-01	E
	Fabric filter	4.0 E-03	E
	Impingement	1.4 E+00	B
	Venturi	3.2 E+00	B
	Venturi/impingement	2.2 E+00	A
	Venturi/impingement/wet ESP	4.0 E-01	E
Fluidized bed sewage sludge incinerators			
	Uncontrolled	4.6 E+02	E
	Cyclone/venturi/impingement	1.0 E+00	E
	Impingement	2.6 E-01	E
	Venturi/impingement	1.1 E+00	E
	Venturi/impingement/wet ESP	2.0 E-01	E
Electric Infrared Sewage Sludge Incinerators			
	Uncontrolled	7.4 E+00	E
	Cyclone/venturi	3.8 E+00	E
	Impingement	1.6 E+00	E
	Venturi/impingement	1.9 E+00	E

From AP-42 Table 2.2-10 Cumulative Particle size distribution for sewage sludge incinerators					
Pollutant	Cumulative mass % stated size				
	Uncontrolled		Controlled (scrubber)		
	Multiple hearth incinerator	Electric infrared incinerator	Multiple hearth incinerator	Fluidized bed incinerator	Electric infrared incinerator
PM ₁₀	10	30	27	7.3	50
PM _{2.5}	2.8	10	22	6.0	25

VII. Point Source Adjustments:

It is likely that states will require incinerators to submit point source emissions inventories. If necessary, however, estimated area source activity of emissions should be adjusted by subtracting the activity or emissions attributable to point sources. See EIIP Volume III, Chapter 1, Section 4 for methodology to account for point sources in an area source emissions inventory.

VIII. Adjustments for Controls:

Regulations for emissions from incineration are likely to apply to this source, and AP-42 emission factors reflect multiple types of control equipment.

IX. Spatial Adjustments:

Unless more specific information is available use the following equation to spatially allocate incineration emissions to county level:

$$\text{County Emissions} = \text{Regional Emissions} / \text{Number of counties in Region}$$

X. Temporal Adjustments:

Emissions from on-site incineration may be assumed to be constant through the year.

XI. Assumptions:

Particulate emissions from incineration vary depending on the operation type at each facility, so we assume that the emission factors are representative of all each type of incinerator.

XII. Rule Effectiveness:

Not applicable.

XIII. Recommendations to Improve Methods/Data

Improvements can be achieved through surveys of state/local sanitation agencies to identify the location and specific process information of incinerators.

XIV. References:

Maryland Department of the Environment, *Calculation Methodologies (draft)*, June 2002.

U.S. Environmental Protection Agency, *Compilation of Air Pollutant Emission Factors, Fifth Edition, Volume I, Chapter 2: Refuse Combustion*, October 1996.

U.S. Environmental Protection Agency, *Compilation of Air Pollutant Emission Factors, Fifth Edition, Volume I, Chapter 2: Sewage Sludge Incineration*, January 1995.

U.S. Environmental Protection Agency, *Compilation of Air Pollutant Emission Factors, Fifth Edition, Volume I, Chapter 2: Solid Waste Disposal*, July 1993.