Chapter 4

Incineration of Biosolids

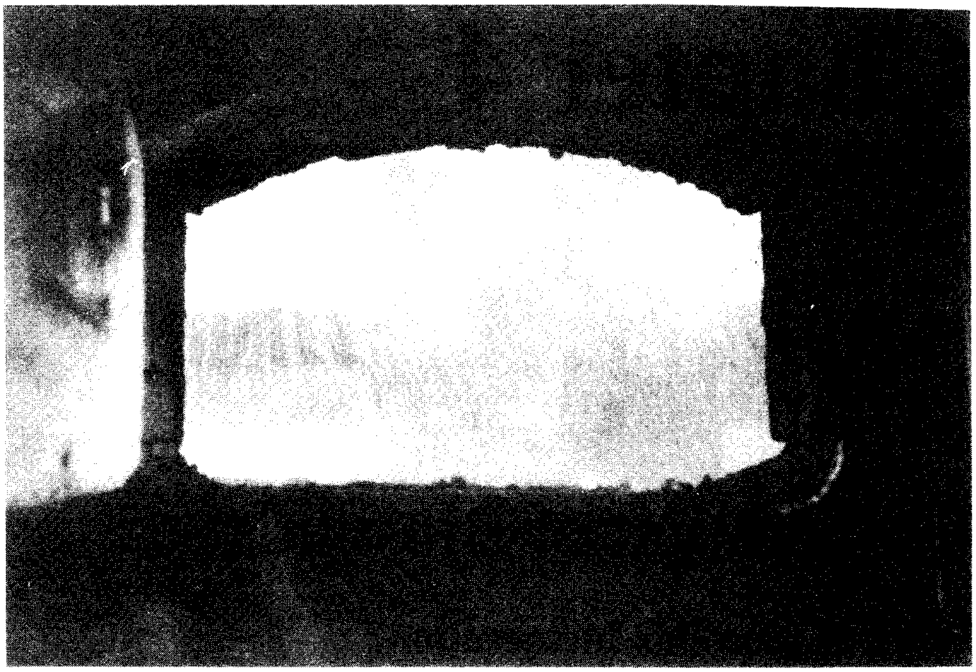
What Is Biosolids Incineration?

Biosolids incineration is the firing of biosolids at high temperatures in an enclosed device. Anyone who fires biosolids in an incinerator, except as described below, must meet the requirements in Subpart E of the Part 503 rule.

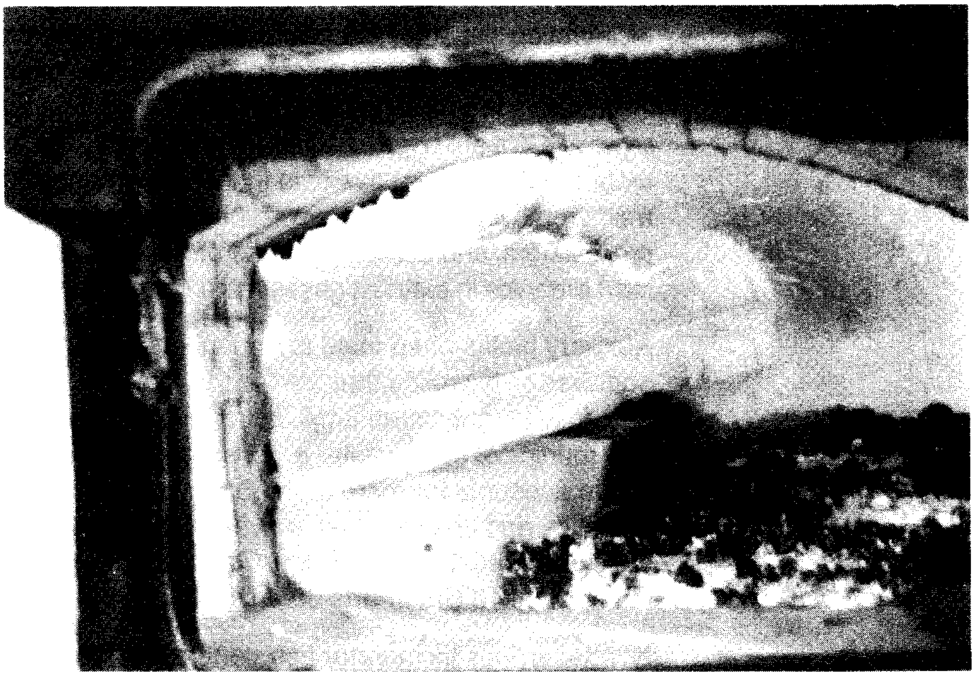
Incineration systems generally consist of an incinerator (furnace) and one or more air pollution control devices (APCDs). The most commonly used incinerators are multiple-hearth, fluidized-bed, and electric infrared furnaces. Most APCDs are used to either remove small particles and their adhering metals in the exhaust gas or to further decompose organics. Examples of metal-removing APCDs are wet scrubbers, dry and wet electrostatic precipitators, and fabric filters. Afterburners, another type of APCD, are used to burn organics in exhaust gases more completely.

Auxiliary fuel is often used to enhance the burning of biosolids. Any additives to biosolids that are fired in a biosolids incinerator, such as natural gas, fuel oil, grit, screenings, scum, wood chips, coal, dewatering chemicals, and municipal solid waste, is considered auxiliary fuel. If municipal solid waste accounts for more than 30 percent (by dry weight) of the mixture of biosolids and auxiliary fuel, however, the municipal solid waste is not considered auxiliary fuel under Part 503. (Instead, the process would be covered by 40 CFR Parts 60 and 61.)

Nonhazardous incinerator ash generated during the firing of biosolids is not covered by the Part 503 rule when it is used or disposed. Instead, it must be disposed according to the solid waste disposal regulations in 40 CFR Part 258;



Biosolids being burned in a biosolids incinerator in Columbus, Ohio.



Biosolids mass is greatly reduced when incinerated, and the residues can be beneficially used (Columbus, Ohio).

however, if the ash is applied to the land or placed on other than a municipal solid waste landfill, the regulations in 40 CFR Part 257 must be followed.

Hazardous wastes are not considered auxiliary fuels under Part 503. Thus, an incinerator that burns hazardous wastes with biosolids is considered a hazardous waste incinerator, not a biosolids incinerator, and is covered by 40 CFR Parts 261 through 268.

Subpart E of the Part 503 rule covers requirements for biosolids incineration, including pollutant limits for seven metals, and limits for total hydrocarbons, general requirements and management practices, frequency of monitoring requirements, and recordkeeping and reporting requirements. These biosolids incineration requirements are discussed in this chapter.

Pollutant Limits for Biosolids Fired in a Biosolids Incinerator

A pollutant limit is the amount of pollutant allowed per unit amount of biosolids before incineration. Subpart E of the Part 503 rule regulates seven metals—arsenic, beryllium, cadmium, chromium, lead, mercury, and nickel. The limits protect human health from the reasonably anticipated harmful effects of these pollutants when biosolids are incinerated. The approaches for determining the limit for each pollutant and for total hydrocarbons are summarized in Table 4-1 and discussed below.

Beryllium and Mercury Pollutant Limits

Levels of beryllium and mercury emitted from a biosolids incinerator must meet the National Emission Standards for Hazardous Air Pollutants (NESHAPs, 40 CFR Part 61).

The NESHAP for beryllium requires that the total quantity of beryllium emitted from each incinerator not exceed 10 grams during any 24-hour period. The NESHAP for beryllium does not apply if written approval has been obtained from the Regional Administrator (1) when the ambient concentration of beryllium in the proximity of the biosolids incinerator does not exceed 0.01$\mu g/m^3$ when averaged over a 30-day period, or (2) if the biosolids incinerator operator can prove (with historical data) that the biosolids fired in the incinerator do not contain beryllium.

The NESHAP for mercury requires that the total quantity of mercury emitted into the atmosphere from all incinerators at a given site does not exceed 3,200 grams during any 24-hour period.

The NESHAP regulations should be consulted for specific requirements except for monitoring frequency, which is shown in Table 4-6.

TABLE 4-1
Summary of Pollutant Limits for Biosolids Incineration

Pollutant	How To Figure Out Pollutant Limits	Determine Dispersion Factor (DF)	Determine Control Efficiency (CE)	Use National Ambient Air Quality Standard (NAAQS)	Use Risk Specific Concen-tration (RSC)	Use Correction Factor for Oxygen	Use Correction Factor for Moisture
Pollutant Limits							
Arsenic	Use equation for arsenic	Yes	Yes	No	Yes	No	No
Beryllium	Use NESHAPs[a]	No	No	No	No	No	No
Cadmium	Use equation for cadmium	Yes	Yes	No	Yes	No	No
Chromium	Use equation for chromium	Yes	Yes	No	Yes	No	No
Lead	Use equation for lead	Yes	Yes	Yes	No	No	No
Mercury	Use NESHAPs[a]	No	No	No	No	No	No
Nickel	Use equation for nickel	Yes	Yes	No	Yes	No	No
Operational Standard							
Total Hydrocarbons or Carbon Monoxide[b]	Limit is 100 ppm_v	No	No	No	No	Yes	Yes

Note: Each of the requirements mentioned (e.g., dispersion factor, NAAQS) is explained in the text.

[a] National Emissions Standards for Hazardous Air Pollutant requirements are summarized in the text.

[b] THC or CO determinations are technology-based standards that in the judgment of EPA protect public health and the environment from the reasonably anticipated adverse effects of organic pollutants in the exit gas of biosolids incinerator.

Control Efficiency, Dispersion Factor, Feed Rate, and Pollutant Limit Calculations for Lead

A person firing biosolids (e.g., the manager of an incineration operation) must determine the pollutant limit for lead in biosolids by using the equation in Figure 4-1. The equation requires determination of certain characteristics of the incineration operation such as control efficiency, the dispersion factor, and the feed rate (see Figure 4-2). The permitting authority can provide

FIGURE 4-1
Equation for Calculating the Pollutant Limit for Lead

The equation for determining the pollutant limit for lead is:

$$C_{lead} = \frac{0.1 \ x \ NAAQS \ x \ 86{,}400}{DF \ x \ (1 - CE) \ x \ SF} \qquad \text{(Eq. 4 of Section 503.43)}$$

Where:

C	=	The pollutant limit (allowable daily concentration of lead in biosolids, in milligrams per kilogram [mg/kg] of total solids, dry-weight basis)
0.1	=	The allowable ground level concentration of lead from biosolids is 10 percent of the NAAQS for lead.
NAAQS	=	National Ambient Air Quality Standard for lead (in micrograms per cubic meter—$\mu g/m^3$) (currently this standard is $1.5 \mu g/m^3$)
DF	=	Dispersion factor (in micrograms per cubic meter per gram per second [$\mu g/m^3/g/sec$]; based on an air dispersion model)
CE	=	Biosolids incinerator control efficiency for lead (in hundredths; based on a performance test)
SF	=	Biosolids feed rate (in dry metric tons per day—dmt/day)
86,400	=	Time conversion factor (number of seconds per day)

Example:

If:

the dispersion factor is 3.4 ($\mu g/m^3/g/sec$)

the control efficiency is 0.916

the biosolids feed rate is 12.86 dmt/day

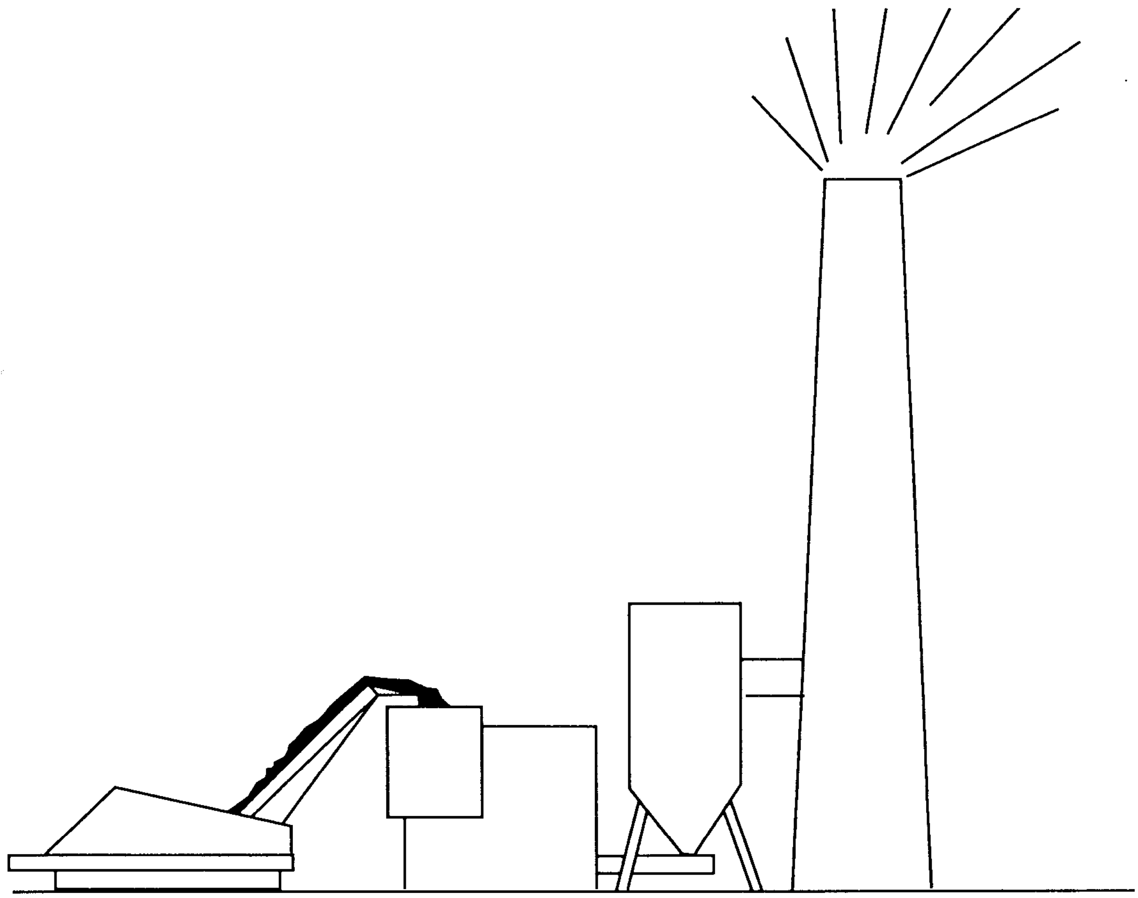
the NAAQS for lead is 1.5 $\mu g/m^3$

Then:

$$C_{lead} = \frac{0.1 \ x \ 1.5 \ \mu g/m^3 \ x \ 86{,}400}{3.4 \ (\mu g/m^3/g/sec) \ x \ (1 - 0.916) \ x \ 12.86 \ dmt/day}$$

$$C_{lead} = 3{,}529 \ mg/kg$$

FIGURE 4-2
Several Factors Affect the Pollutant Limits for Biosolids Fired in an Incinerator



Feed Rate

The rate at which biosolids are fed to the incinerator influence the emission of pollutants

Control Efficiency

The incineration process and the air pollution control devices, if any, remove some pollutants in the biosolids

Dispersion Factor

The surrounding structures and terrain influence how pollutants are dispersed in the air

Individuals at ground level in the surrounding area are exposed to some fraction of the pollutants originally present in biosolids guidance for developing information about an incinerator's control efficiency and dispersion factor, which are described briefly below:

> ***Control efficiency*** measures the degree to which a biosolids incinerator furnace in conjunction with an air pollution control system, if used, remove a particular pollutant. For example, if a quantity of biosolids fed to an incinerator contains 100 grams of lead, and 1 gram of lead is released from the stack, the incinerator has a 99 percent control efficiency for lead.
>
> A ***dispersion factor*** is the ratio of the increase in the concentration of a pollutant in the air at or beyond the property line of an incinerator site relative to the rate pollutants are emitted from the stack. The dispersion factor is determined through an "air dispersion model," in which particular site conditions are considered, such as type of terrain or adjacent buildings, whether an area is urban or rural, the temperature and velocity of the gas in the incinerator stack, and the emission rate for the pollutant.

Control efficiency is determined through a performance test of the incinerator, as specified by the permitting authority. Generally, the permitting authority will require that the performance test be conducted under conditions that represent normal operating circumstances. The incinerator will be allowed to operate with more flexibility, however, if the performance test covers a broader range of operational parameters. The control efficiency determination is based on the concentrations of regulated metals in the biosolids, the concentrations of regulated metals in the incinerator air emissions, and documentation on the incinerator, as well as APCD operating conditions (e.g., biosolids feed rate, exhaust flow rate, combustion temperature, and biosolids characteristics), during the test.

The permitting authority should be consulted on which air dispersion model to use. Air dispersion models range from simple screening tools to complex computer models. Screening techniques, though inexpensive, tend to be more conservative in their predictions, resulting in higher estimates of pollutants emitted. Complex models require qualified air quality modelers to perform analyses, but result in more accurate estimations. Guidance about the appropriate model(s) to use is provided in ***Guideline on Air Quality Models (Revised)(Appendix W of 40 CFR Part 51)***, U.S. EPA, EPA-450/2-78-027R, August 1993.

Stack height is an important consideration in determining a dispersion factor. For incinerators with stack heights of 65 meters or less, the stack height should be factored into the air dispersion model. For incinerators with stack heights above 65 meters, the stack height measurement used in the air dispersion model is based on "good engineering practices," as presented in another regulation (40 CFR 51.100). Good engineering practices utilize an equation that considers the size of the surrounding buildings to determine the correct value to use in the model. In general, the higher the stack, the more dispersion occurs.

The incinerator operator usually determines the biosolids feed rate based on the design capacity of the incinerator and the rate at which biosolids are generated and must be disposed. The biosolids feed rate is needed to calculate biosolids pollutant limits in the equations shown in Figures 4-1 and 4-5. Feed rate itself can be determined based on either (see Figure 4-3):

> the average daily design capacity for all biosolids incinerators within a site,
>
> or
>
> the average daily amount of biosolids fired in all incinerators within the property line of a site for the number of days that the incinerator operates during a 365-day period.

Biosolids incinerator operators will have more flexibility if they use the design capacity to calculate the feed rate. This calculation results in stricter pollutant limits than a calculation based on the average amount of biosolids fired daily; however, basing the feed rate on design capacity allows incinerator operators to increase their feed rate from a more typical less-than-design-capacity operation to maximum-design-capacity operation without exceeding the permitted pollutant limits. If, on the other hand, the feed rate in the permit was calculated on the average daily amount of biosolids fired and the operator wished to increase the feed rate, permission generally would have to be obtained from the permitting authority.

Many incinerator facility operators are finding that they are not limited by biosolids pollutant concentrations under the Part 503 rule. Figure 4-4 provides incinerator test data that are typical for most biosolids incineration facilities. The figure shows allowable metal concentration rates that are significantly higher than actual limits. Thus, incinerator operators should not expect to encounter difficulty meeting the more strict pollutant limits that were calculated based on incinerator design capacity.

Often the Part 503 rule requirements can be met for most metals even if control efficiency is low, given the dispersion factors typically found in the field.

Information about **lead** is also required to use the equation in Figure 4-1. Emission standards have been set nationally for several substances. These limits, known as National Ambient Air Quality Standards (NAAQS, 40 CFR 50.12), protect human health and the environment from the possible harmful effects of pollutants in air. The manager of a biosolids incinerator must use the NAAQS for lead in the lead equation. The current NAAQS for lead is 1.5 micrograms per cubic meter ($\mu g/m^3$); if the NAAQS for lead changes in the future, the number used in the equation also must change.

FIGURE 4-3
Examples of Two Methods for Calculating the Biosolids Feed Rate for Use in the Pyollutant Limit Calculations

A site has three incinerators. Their design capacities are as follows:

Unit 1: 100 dry metric tons per day (dmt/day)

Unit 2: 100 dmt/day

Unit 3: 200 dmt/day

Part 503 allows the operator to choose one of two methods to calculate the biosolids feed rate, which is used in the pollutant limit calculations:

Method 1—Design Capacity for All Incinerators

Calculate the total design capacity for all incinerators at the site:

Total capacity = 100 dmt/day + 100 dmt/day + 200 dmt/day = 400 dmt/day

Method 2—Average Daily Feed Rate for All Incinerators

Case 1.

For the first 20 days of the year, unit 1 operated at 50 dmt/day; for the first 100 days of the year, unit 2 operated at 50 dmt/day and unit 3 operated at 100 dmt/day.

Calculate the total amount of biosolids fired in a 365-day period:

Unit 1: 50 dmt/day x 20 days = 1,000 dmt (shut down 345 days)

Unit 2: 50 dmt/day x 100 days = 5,000 dmt (shut down 265 days)

Unit 3: 100 dmt/day x 100 days = 10,000 dmt (shut down 265 days)

Total = 1,000 dmt + 5,000 dmt + 10,000 dmt = 16,000 dmt

Calculate the average daily amount of biosolids fired during the total number of days the incinerators operated during a 365-day period:

$$\text{Average} = \frac{16{,}000 \text{ dmt}}{100 \text{ days}} = 160 \text{ dmt/day (rounded).}$$

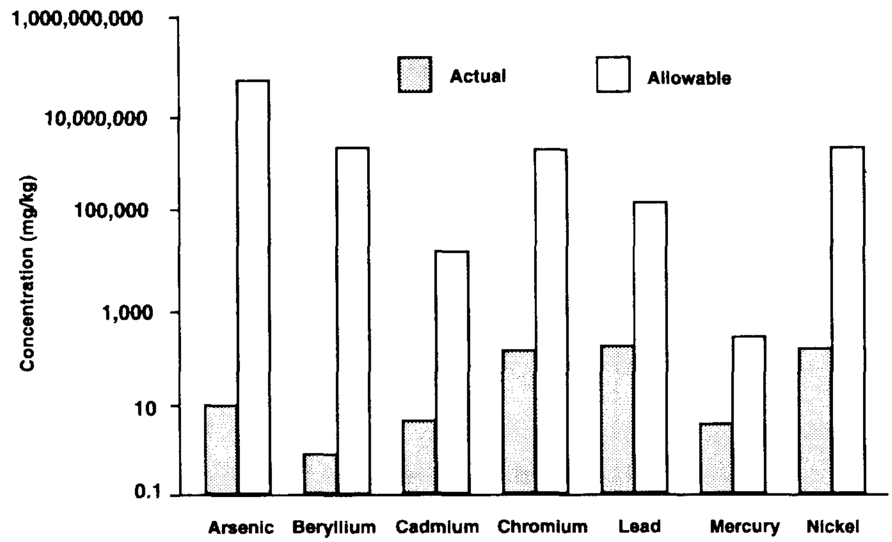
Case 2.

If the incinerators in the above example did not operate at the same time, but instead operated sequentially, the average would be based on the total number of days any incinerator at the site was operated, which is 220 days. In that case, the average daily feed rate would be:

$$\frac{16{,}000 \text{ dmt}}{220 \text{ days}} = 73 \text{ dmt/day (rounded).}$$

For greater flexibility, the operator may want to consider using Method 1 to calculate pollutant limits to have greater latitude in the amount of biosolids fed to the incinerator.

FIGURE 4-4
Allowable vs. Actual Byiosolids Metal Concentrations*



Source: *Meeting the Challenge of Federal 503 Regulations for Sludge Incinerators*, G.P. Van Durme, P.M. Martin, and J.M. Rowan, 1993, Kansas City, MO.

* Data are for one of several sites investigated.

Arsenic, Cadmium, Chromium, and Nickel Pollutant Limits

As with lead, the pollutant limits for arsenic, cadmium, chromium, and nickel in biosolids fired in a biosolids incinerator are calculated using the equation presented in Figure 4-5. Also, the control efficiencies, dispersion factor, and biosolids feed rates must be determined to calculate the limits for these four pollutants. (For an explanation of control efficiency, dispersion factor, and feed rate, see the preceding discussion on the pollutant limit for lead.)

Instead of using a NAAQS, however, as is done for lead, risk specific concentrations (RSCs) are used to calculate limits for arsenic, cadmium, chromium, and nickel. RSCs, which are based on human health concerns, represent the allowable increase in the average daily ground-level ambient air concentrations of pollutants at or beyond the property line of the site where the biosolids incinerator is located. RSCs for arsenic, cadmium, and nickel are listed in Table 4-2.

In contrast, the RSC for chromium is based on either (1) the type of incinerator used, or (2) analytical sampling and an equation (see Table 4-3). The analysis involves sampling stack gas to determine the ratio of hexavalent chromium to total chromium analytes. In lieu of testing,

FIGURE 4-5
Equation for Calculating the Pollutant Limits for Arsenic, Cadmium, Chromium, and Nickel

The equation for determining the pollutant limits for arsenic, cadmium, chromium, and nickel is:

$$C = RSC \times \frac{86{,}400}{DF \times (1 - CE) \times SF} \qquad \text{(Eq. 5 of Section 503.43)}$$

Where:

C	=	The pollutant limit (allowable daily concentration of arsenic, cadmium, chromium, or nickel in milligrams per kilogram [mg/kg] of total solids, dry-weight basis)
RSC	=	Risk specific concentration (the allowable increase in the average daily ground-level ambient air concentration for a pollutant at or beyond the property line of the site in micrograms per cubic meter [$\mu g/m^3$] [from Table 4-2 or Table 4-3])
86,400	=	Conversion factor (seconds per day)
DF	=	Dispersion factor (in micrograms per cubic meter per gram per second [$\mu g/m^3/g/sec$]; based on an air dispersion model)
CE	=	Control efficiency for arsenic, cadmium, chromium, or nickel (in hundredths; based on a performance test)
SF	=	Biosolids feed rate (in dry metric tons per day [dmt/day])

Example for Arsenic:

If:

the RSC is 0.023 $\mu g/m^3$

the dispersion factor is 3.4 $\mu g/m^3/g/sec$

the control efficiency is 0.975

the biosolids feed rate is 12.86 dmt/day

Then:

$$C_{arsenic} = \frac{0.023\ g/m^3\ x\ 86{,}400}{3.4\ (\mu g/m^3/g/sec)\ x\ (1 - 0.975)\ x\ 12.86\ dmt/day}$$

$$C_{arsenic} = 1{,}818\ mg/kg$$

If the dispersion factor were 0.6 instead of 3.4 $\mu g/m^3/g/sec$, then the allowable concentration for arsenic would be 3.4/0.6, or 5.667 times greater at 10,300 mg/kg.

TABLE 4-2
Risk Specific Concentrations for Arsenic, Cadmium, and Nickel

Pollutant	Risk Specific Concentrations (RSC) (micrograms per cubic meters)
Arsenic	0.023
Cadmium	0.057
Nickel	2.0

Source: Table 1 of Section 503.43.

incinerator operators can use the values given in Table 4-3, which are based on incinerator type.

Limit Exceedance

If measurements in biosolids for beryllium and mercury (where required) and lead, arsenic, cadmium, chromium, or nickel are higher than the pollutant limits derived as discussed above, the biosolids incinerator will be "in violation" until adjustments are made that allow the limits to be met. Such adjustments include, but are not limited to, improvements in biosolids quality through pretreatment efforts, reduction in the biosolids feed rate, or improved furnace operations and/or the addition of APCDs to improve the control efficiency. Better control efficiency will allow higher pollutant limits. If significant furnace or APCD improvements are made, however, the performance test must be repeated. Then the approved operating conditions under which emissions were in compliance during the performance test must be maintained whenever the incinerator is operating.

Total Hydrocarbons

Organic compounds that are emitted as a result of incomplete combustion or the generation of combustion byproducts (e.g., benzene, phenol, vinyl chloride) can be present in biosolids incinerator emissions. Because these compounds can be harmful to the public health, the Part 503 rule regulates the emission of organic pollutants from biosolids incinerators through an operational standard that limits the amount of total hydrocarbons (THC)—or carbon monoxide (CO)—allowed in stack gas. The Part 503 rule as amended is structured to use THC or CO to represent all organic compounds, as discussed below.

TABLE 4-3
Risk Specific Concentration To Use When Calculating the Pollutant Limit for Chromium

For the equation in Figure 4-5, use RSC from either option 1 (based on type of incinerator) or option 2 (derived from the equation below), as specified by the permitting authority.

Option 1: RSC From Table 2 of Section 503.43

Type of Incinerator	RSC (micrograms per cubic meter)
Fluidized bed with wet scrubber	0.65
Fluidized bed with wet scrubber and wet electrostatic precipitator	0.23
Other types with wet scrubber	0.064
Other types with wet scrubber and wet electrostatic precipitator	0.016

or

Option 2 Equation: RSC Using Equation 6 of Section 503.43

$$RSC = \frac{0.0085}{r}$$

Where:

r = The decimal fraction of the hexavalent chromium concentration in the total chromium concentration measured in the exit gas from the biosolids incinerator stack in hundredths. This is an analytical measurement based on an average of representative samples.

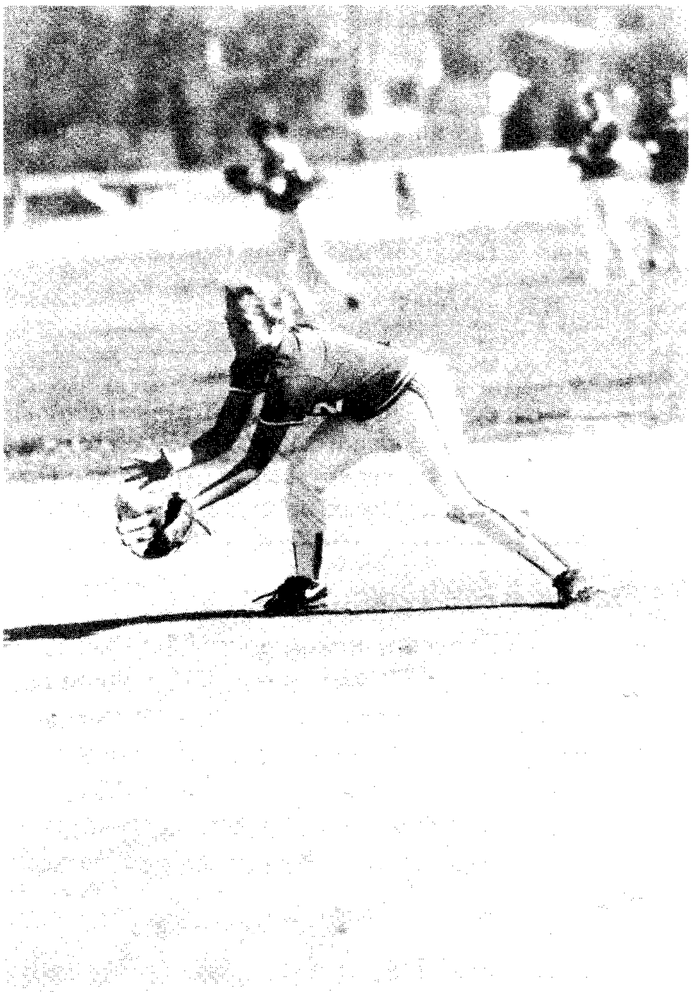
Delay and Stay of Requirements for Total Hydrocarbon Measurement

According to a recent amendment of the Part 503 rule, for incinerators not exceeding 100 ppm_v (parts per million, volume basis) of CO in the exhaust gas, EPA will allow continuous CO monitoring as a surrogate for THC monitoring. Moreover, EPA has determined that operators of biosolids incinerators will not have to monitor for THC or CO until either a permit has been issued or other Federal action has been taken, such as *Federal Register* notification, even if issuance does not occur until after February 19, 1995.

Total Hydrocarbon and Carbon Monoxide Measurement

The THC concentration (or CO) is used to represent all organic compounds in the exit gas covered by the Part 503 rule. EPA does not require that biosolids themselves be monitored for THC (or CO), as is required for metals (see discussions above on pollutant limits for beryllium and mercury, lead, and arsenic, cadmium, chromium, and nickel). Instead, the stack gas must be monitored for THC (or CO) because organic pollutants could be present due to incomplete combustion of organic compounds or the generation of byproducts of combustion.

The Part 503 rule allows a monthly average concentration of up to 100 ppm_v of THC (or CO) in the stack gas. Thus, an incineration facility operator firing biosolids must continuously monitor THC (or CO) levels in the stack gas to ensure that the monthly average concentration of THC (or CO) is at or below the limit. The monthly average THC (or CO) concentration is the arithmetic mean of the hourly averages; the hourly averages must be calculated based on at least two readings taken each hour that the incinerator operates in a day (i.e., in a 24-hour period).



Residue from biosolids incineration is used as water-absorbent surface material on ballfields in Columbus, Ohio.

THC (or CO) must be measured using a flame ionization detector with a sampling line heated to 150°C or higher. The THC (or CO) concentration measurement taken from the stack must be corrected for moisture content and oxygen (as described below) before being compared to the 100 ppm_V limit.

The Agency will be issuing separate guidance on the procedures for the analysis, installation, calibration, and maintenance of THC (or CO) continuous emissions monitoring (CEM) systems.

Correction for 0 Percent Moisture

The THC (or CO) concentration in the stack gas must be corrected for 0 percent moisture, using the first equation in Figure 4-6. This correction is required so that all THC (or CO) emissions can be evaluated on a standardized basis. Once the correction factor for moisture is known, the original THC (or CO) concentration must be multiplied by this correction factor.

Correction to 7 Percent Oxygen

The THC (or CO) concentration in the stack exit gas also must be corrected to 7 percent oxygen, using the second equation in Figure 4-6. This correction is required so that all THC (or CO) emissions can be evaluated on a standardized basis. Seven percent oxygen was chosen as the standard correction because this amount of oxygen, which is representative of 50 percent excess air, is frequently used for operational and measurement purposes. Once the correction factor for oxygen is known, the THC (or CO) concentration (which has already been corrected for moisture) must be multiplied by this value.

After being corrected to 7 percent oxygen and for 0 percent moisture, the THC (or CO) concentration may not be above 100 ppm_V on a monthly average basis. If the monthly average THC (or CO) concentration in the stack gas measures above 100 ppm_V, the biosolids incinerator is in violation until adjustments are made to meet the limits. These adjustments can include more careful control of furnace operations (and improvements of other procedures, if necessary) to reduce the amount of THC (or CO) released from the stack.

Management Practices for Biosolids Incineration

The management practices for biosolids incineration in the Part 503 rule cover:

instrument operation and maintenance;

temperature requirements;

FIGURE 4-6
Equations for Determining Correction Factors for 0 Percent Moisture and to 7 Percent Oxygen for Total Hydrocarbons or Carbon Monoxide (CO)

For the examples below, assume that the original THC (or CO monthly average) is 40 ppm_v .

(1) 0 Percent Moisture

The equation for correcting the THC (or CO) measurement for 0 percent moisture is:

$$\text{Correction factor} = \frac{1}{(1 - X)}$$ (Eq. 7 of Section 503.44)

Where:

X = The decimal fraction of the percent moisture in the biosolids incinerator exit gas in hundredths

Example:

If:

$X = 0.12$

Then:

$$\text{Correction factor for moisture} = \frac{1}{1 - 0.12}$$

Correction factor for moisture = 1.14

Multiply the original THC (or CO) measurement (in this case, 40 ppm_v) by the correction factor for moisture:

40 ppm_v x 1.14 = 45.6 ppm_v

THC (or CO) concentration corrected for 0 percent moisture: 45.6 ppm_v

---

(2) 7 Percent Oxygen:

The equation for correcting the THC (or CO) measurement to 7 percent oxygen is:

$$\text{Correction factor for oxygen} = \frac{14}{(21 - Y)}$$ (Eq. 8 of section 503.44)

Where:

14 = The difference between the percent oxygen in air (21 percent) and 7 percent oxygen

21 = The percent of oxygen in air

Y = The percent oxygen concentration in the biosolids incinerator stack exit gas (dry volume/dry volume)

FIGURE 4-6 (continued)
Equations for Determining Correction Factors for 0 Percent Moisture and to 7 Percent Oxygen for Total Hydrocarbons or Carbon Monoxide (CO)

Example:

If:

Y = 10 percent

Then:

$$\text{Correction factor for oxygen} = \frac{14}{(21 - 10)} = 1.27$$

Finally, multiply the THC or CO monthly average concentration (already corrected for moisture) by the correction factor for oxygen:

45.6 ppm_V x 1.27 = 58 ppm_V (rounded)

Therefore:

The THC or CO monthly average concentration in this example corrected for 0 percent moisture and to 7 percent oxygen is 58 ppm_V

- operation of air pollution control devices; and
- protection of threatened or endangered species.

All but the last of these management practices are necessary to ensure that the limits set for arsenic, beryllium, cadmium, chromium, lead, mercury, nickel, and THC (or CO) (see preceding discussions) are met. The required management practices are described in Figure 4-7 and discussed further below.

Instrument Operation and Maintenance

Biosolids incinerator operators must use instruments to continuously measure and record certain information, including:

- THC (or CO) in the stack exit gas;
- oxygen in the stack exit gas;
- information used to calculate moisture content in the stack exit gas; and
- combustion temperature in the furnace.

Each of the instruments used for these measurements must be installed, calibrated, operated, and maintained according to guidance provided by the permitting authority. Examples of such instruments include extractive or in situ oxygen analyzers, thermocouples to measure the temperature of a saturated stream and combustion temperature, and dewpoint detectors

FIGURE 4-7
Management Practices for Incineration of Biosolids

> Instruments must be used that continuously measure and record THC (or CO) concentrations, oxygen levels, and information needed to calculate moisture content in the stack exit gas, and combustion temperature in the furnace.
>
> These instruments must be installed, calibrated, operated, and maintained according to guidance provided by the permitting authority. Calibration procedures are specified in the Agency's new CEM guidance.
>
> The instrument used for THC (or CO) measurements must:
>
> — use a flame ionization detector;
>
> — have a sampling line heated to 150°C or higher at all times; and
>
> — be calibrated at least once every 24-hour operating period using propane.
>
> The incinerator can be operated within the range of operating conditions set during the performance test and allowed in the permit but it must not be operated above the maximum combustion temperature set by the permitting authority based on performance test conditions.
>
> Conditions for operating the air pollution control devices must be followed; these conditions are also set by the permitting authority based on performance test conditions.
>
> Biosolids may not be incinerated if incineration of biosolids is likely to negatively affect a threatened or endangered species or its critical habitat as listed in Section 4 of the Endangered Species Act. ***Critical habitat*** is any place where a threatened or endangered species lives and grows during any stage of its life cycle.

(known as wet bulb/dry bulb detectors) to obtain information used to determine moisture content.

In addition, the instrument used for THC (or CO) measurements must:

utilize a flame ionization detector;

utilize a sampling line heated to 150°C or higher at all times; and

be calibrated using propane at least once every 24-hour operating period.

Temperature Requirements

The maximum combustion temperature allowed in the incinerator furnace is set by the permitting authority based on performance test data. A limit on combustion temperature is necessary to ensure that the incinerator is operating as it did during the performance test. If biosolids are incinerated at higher temperatures than the allowed maximum temperature, the control efficiency could change and the concentration of metals in the stack gas

Biosolids incinerator ash, called flume sand, is beneficially used as a water-absorbent surface for a horse arena in Columbus, Ohio.

could increase. The incinerator would then be out of compliance until operated below the maximum allowed temperature or until shown to be in compliance with a new set of pollutant limits calculated using control efficiencies relevant to the new set of operating conditions.

Air Pollution Control Devices

Conditions for operating air pollution control devices are determined by the permitting authority from the performance test. These conditions (e.g., gas flow rate and gas temperature) ensure that the APCDs are operating as efficiently as possible. If they are not operating properly, the control efficiency could change, which would affect the ability to meet pollutant limits. Therefore, these values must be within the range established during the performance test. Examples of operating parameters for APCDs that the permitting authority might set are shown in Table 4-4.

TABLE 4-4
Operating Parameters for Air Pollution Control Devices

Based on the results of the performance test, the permitting authority sets permit conditions for certain operating parameters of the APCDs. Examples of important operating parameters are listed below:

Operating Parameter	Air Pollution Control Device	Example Measuring Instrument
Pressure drop	Venturi scrubber, impingement scrubber, mist eliminator,* fabric filter	Differential pressure gauge/transmitter
Liquid flow rate(s)	Venturi scrubber, impingement scrubber, mist eliminator, wet electrostatic precipitator (ESP)	Orifice plate with differential pressure gauge/transmitter
Gas temperature (inlet and/or outlet)	Venturi scrubber, impingement scrubber, dry scrubber, fabric filter, wet ESP	Thermocouple/transmitter
Liquid/reagent flow rate to atomizer	Dry scrubber (spray dryer absorber)	Magnetic flow meter
pH of liquid/reagent to atomizer	Dry scrubber (spray dryer absorber)	pH meter/transmitter
Atomized motor power (for rotary atomizer)	Dry scrubber (spray dryer absorber)	Wattmeter
Compressed air pressure (for dual fluid flow)	Dry scrubber (spray dryer absorber)	Pressure gauge
Compressed airflow rate	Dry scrubber (spray dryer absorber)	Orifice plate with differential pressure gauge/transmitter
Opacity	Fabric filter	Transmissometer
Secondary voltage (for each transformer/rectifier)	Wet ESP	Kilovolt meters/transmitter
Secondary currents (for each transformer/rectifier)	Wet ESP	Milliammeters/transmitter

*Types of mist eliminators include the wet cyclone, vane demister, chevron demister, and mesh pad.

Protection of Threatened or Endangered Species

The final management practice for biosolids incinerators in the Part 503 rule does not allow biosolids to be incinerated if a threatened or endangered animal or plant species or its "critical habitat" is likely to be adversely affected. Threatened and endangered species are listed in the Endangered Species Act. (The Threatened and Endangered Species List can be obtained from the U.S. Fish and Wildlife Service's [FWS's] Publications Office by calling 703-358-1711.)

Critical habitat is defined as any place where a threatened or endangered species lives and grows during any stage of its life cycle. Any direct or indirect action (or the result of any direct or indirect action) in a critical habitat that diminishes the likelihood of survival and recovery of a listed species is considered destruction or adverse modification of a critical habitat. Individuals may contact the Endangered Species Protection Program in Washington, DC, (703-358-2171) or the FWS Field Offices listed in Appendix C for more information about threatened and endangered species in their area. State departments governing fish and wildlife also should be contacted for specific State requirements.

Frequency of Monitoring Requirements for Biosolids Incineration

The person firing biosolids in a biosolids incinerator must monitor at specified intervals for certain metals in the biosolids; for the THC (or CO) concentration, oxygen content, and information needed to determine moisture in the stack exit gas; for combustion temperature in the furnace; and for certain conditions of air pollution control device operation. Representative samples of biosolids and stack gas must be collected and analyzed using the methods listed in the Part 503 rule. These monitoring requirements are summarized in Table 4-5 and are discussed below.

TABLE 4-5
Monitoring Requirements for Biosolids Incineration

Must monitor:

- concentration of metals (arsenic, cadmium, chromium, lead, mercury, and nickel) in biosolids
- concentration of beryllium in the stack gas, unless the permitting authority approves a biosolids method
- concentration of THC (or CO) in stack exit gas
- oxygen concentration in stack exit gas
- information needed to determine moisture content in stack exit gas
- combustion temperature in the furnace
- operating conditions of air pollution control devices (conditions are set by the permitting authority based on performance test data)
- biosolids feed rate

Monitoring for Metals

Biosolids must be monitored for the concentration of metals for which pollutant limits have been set, including arsenic, beryllium, cadmium, chromium, lead, mercury, and nickel. The permitting authority will determine how often the facility operator must monitor for beryllium and mercury. For the other metals (arsenic, cadmium, chromium, lead, and nickel), the minimum frequency for monitoring is based on the amount of biosolids incinerated (see Table 4-6). The greater the amount of biosolids incinerated, the more frequently metals must be monitored.

Continuous Monitoring

As shown in Table 4-6, certain monitoring must be done continuously. Continuous monitoring is required for THC (or CO) concentrations, oxygen

TABLE 4-6
Monitoring Frequency for Biosolids Incinerators

Pollutant/Parameter	Amount of Biosolids Fired (metric tons per 365-day period, dry-weight basis)	Must Monitor at Least
Arsenic, cadmium, chromium, lead, and nickel in biosolids	Greater than zero but less than 290	Once per year
	Equal to or greater than 290 but less than 1,500	Once per quarter (four times per year)
	Equal to or greater than 1,500 but less than 15,000	Once per 60 days (six times per year)
	Equal to or greater than 15,000	Once per month (12 times per year)
Beryllium and mercury in biosolids or stack exit gas	NA	As often as permitting authority requires
THC (or CO) concentration in stack exit gas	NA	Continuously; monthly averages reported, which is the arithmetic mean of hourly averages that include at least 2 readings per hour.
Oxygen concentration in stack exit gas	NA	Continuously
Information needed to determine moisture content in stack exit gas	NA	Continuously
Combustion temperature in furnace	NA	Continuously
Air pollution control device conditions	NA	As often as permitting authority requires

levels, and information used to calculate moisture content in the stack exit gas. Continuous monitoring also is required for combustion temperature in the furnace. Because monitors operating continuously require a certain amount of downtime for periodic calibrating and maintenance, the person operating the incinerator should consult the EPA's THC (or CO) CEM guidance to determine how much downtime is acceptable.

Monitoring Conditions in Air Pollution Control Devices

Certain operating conditions must be monitored in air pollution control devices, as discussed above. The specific conditions that must be monitored are based on the type of APCDs in place and the operating parameters that are important for maintaining the control efficiency demonstrated in the performance test. The ultimate monitoring frequency for APCDs will be specified in the permit.

Recordkeeping Requirements for Biosolids Incineration

The person who incinerates biosolids must develop and keep certain records for a minimum of 5 years. The recordkeeping requirements, which are listed in Table 4-7, include information on the pollutant limits, management practices, and monitoring requirements.

Reporting Requirements for Biosolids Incineration

All Class 1 treatment works, treatment works serving a population of 10,000 or more, and treatment works with a 1 mgd or greater design flow, as described in the first chapter of this guidance, have to report the type of information contained in Table 4-7 every February 19th to the permitting authority.

TABLE 4-7
Recordkeeping Requirements for Biosolids Incineration

Records related to pollutant limits for metals:

- concentrations of arsenic, cadmium, chromium, lead, and nickel in biosolids fed to the incinerator
- information showing how the requirements for beryllium and mercury in the NESHAPs are being met, if applicable
- biosolids feed rate (for each incinerator, dry-weight basis)
- stack height
- dispersion factor
- control efficiency for arsenic, cadmium, chromium, lead, and nickel (for each incinerator)
- RSC for chromium (calculated using the equation in Table 4-3, if applicable)

Records related to the THC (or CO) limit:

- THC (or CO) monthly average concentrations in the stack exit gas
- oxygen concentration in the stack exit gas
- information used to measure moisture content in the stack exit gas

Records related to management practices and monitoring requirements:

- combustion temperatures, including maximum daily combustion temperature, in the furnace
- measurements for required air pollution control device operating conditions
- calibration and maintenance log for instruments used to measure:
  - — THC (or CO) levels in stack exit gas
  - — oxygen levels in stack exit gas
  - — moisture content in stack exit gas
  - — combustion temperatures in furnace

Common Questions and Answers

Q: Incinerator manufacturers have indicated that 15 months is necessary for the delivery of equipment. Add time for design, bid, agency review, and construction, and the total time for new construction could be close to 30 months. Are incinerators going to be penalized for actions beyond their control?

A: The Clean Water Act allows 2 years for an incinerator owner/operator to attain compliance where construction of new pollution control facilities is required to meet Part 503 requirements. The permitting authority has no authority to extend this time frame. Incinerators that are not in compliance at the end of the 2-year period will be in violation. Given the reality of such situations, however, the permitting authority may choose to put the incinerator under an enforceable compliance order that includes a schedule for coming into compliance.

Q: What percent of incinerators currently can meet the 100-ppm$_v$ THC (or CO) operational standard?

A: EPA estimates that 60 to 70 percent of multiple-hearth furnaces and all fluidized-bed incinerators can meet this operational standard. Some incinerator owner/operators may have to add afterburners or improve their operations.

Q: Is EPA planning to provide any training on how to measure THC (or CO)?

A: The THC (and CO) equipment manufacturers are willing to provide such training. EPA does not have any plans to provide it beyond its CEM guidance.

Q: What does a THC (or CO) monitoring system cost?

A: EPA has estimates, from some of the equipment manufacturers, of $150,000 to $750,000 for the complete package, which incudes the monitor, the computer, and the oxygen and moisture measuring instruments (including installation).

Q: If new construction is required to meet the THC (or CO) limit (e.g., an afterburner), can monitoring and modeling for the dispersion factor be delayed until after construction is completed?

A: The Clean Water Act allows 2 years for an incinerator owner/operator to attain compliance where construction of new pollution control facilities is required to meet Part 503 requirements. The 2-year period, however, generally pertains only to requirements for which construction is required—in this case THC (or CO) limits. The permitting authority has some flexibility to work with owner/operators whose facilities are undergoing construction, but the permitting authority cannot extend the compliance dates. One option would be to put the incinerator under a compliance order to install the necessary equipment and have the owner/operator perform the necessary modeling after the installation.

Q: If a facility has multiple incinerator units that share one stack, how many THC (or CO) monitoring devices are required?

A: If physically permissible, only one monitoring system would be necessary. However, such factors as length of run for the sample tubing and the nature of the sensing device can have a significant influence on the determination. Furthermore, some of the analytical determinations that must accompany the THC (or CO) measurements, such as those concerning moisture and temperature, may require separate instrumentation for each stack.