

**Biosolids Business Case  
Evaluation**

**REPORT**

Bellingham Post Point  
Wastewater Treatment Facility

12/4/2012





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# Section 1

## Introduction

To support the sustainable practices currently in place and those planned for the future, the City of Bellingham (City) seeks a long term solution for processing their biosolids. With aging infrastructure, projected population growth, the increasing cost of energy, and new technologies available for biosolids processing, the City has recognized the need to evaluate its current biosolids handling system.

The City currently processes its biosolids at the Post Point Wastewater Treatment Plant (Post Point Plant) using two Multiple Hearth Furnaces (MHFs). As part of the facility planning effort, a preliminary investigation of the current biosolids handling system was prepared by CDM Smith in 2010. The alternatives evaluated in that planning study were: (1) Continued use of the existing MHFs, (2) Installation of a new Fluidized Bed Incineration (FBI) system, (3) Anaerobic digestion, (4) Anaerobic digestion with sludge drying, (5) Anaerobic digestion with sludge drying and gasification, (6) Sludge-to-fertilizer conversion, and (7) Sludge-to-fuel conversion.

The 2010 planning study suggested that the existing MHFs were approaching the end of their useful life and the solids loading capacity of the system would soon be reached. Additionally, significant maintenance costs for the MHFs (including expected repairs to the refractories, hearths, insulation, and shell reinforcements), high fuel usage, and problems procuring equipment parts from the original equipment manufacturer were identified as further deficiencies of this alternative. For these reasons, it was recommended that the existing MHFs be replaced with an alternative biosolids handling strategy. At that time, the best apparent alternative for the Post Point Plant was a new FBI system in lieu of the existing MHF units. The reader is referred to the 2010 planning study for more information on this recommendation.

Since the 2010 planning study, however, the population projections for the City and resulting wastewater flows and sludge loads have significantly changed. CDM Smith has revised the biosolids projections based on the new population projection and the five most recent years of plant data (2007 through 2011). The revised biosolids projections are presented in this report and are analyzed for their impact on the solids handling process at Post Point.

Additionally, at the time of the 2010 planning study, the EPA regulations governing emissions limits from sewage sludge incinerators were being revised and the impact on the Post Point Plant incinerators was unknown. The new CAA 129 emissions guidelines for sewage sludge incinerators are now finalized and the impacts of those regulations on the biosolids handling operation at the Post Point Plant can be clearly defined. This report explains the portions of the new CAA 129 regulations that are applicable to the Post Point Plant, and explore the costs and other impacts of the regulations on the current incineration equipment.

For this analysis, three biosolids handling alternatives were evaluated:

1. Continued Use of the Existing Multiple Hearth Furnaces
2. Installation of a New Fluidized Bed Incinerator

### 3. Digestion and Drying with Cogeneration for Heat and Power Production

These three alternatives are compared using a business case evaluation based on economic, environmental, operational, and social considerations. The objective of this analysis is to help the City select a biosolids handling alternative by providing key information on the three alternatives.

To establish a basis for comparison, the biosolids and energy alternatives will be evaluated against four overall objectives:

- **Economic:** Capital and annual costs will be determined for each biosolids alternative. To help the City plan for the biosolids improvements, implementation timeframes will be developed to allow the City to better understand the budgetary and logistical impacts of the alternatives.
- **Operational:** The handling, operations, and maintenance requirements for each alternative will be evaluated based on criteria outlined by the City. Considering the City's criteria for reliability, flexibility and redundancy will help select an alternative that meets the City's expectations with regards to operational ease and staffing requirements.
- **Environmental:** Maintaining and increasing its sustainability is important to the City of Bellingham. Thus, each option will be evaluated based on its environmental impacts, which includes ease in which permits will be obtained, green energy production and utilization, energy demand for biosolids processing, and greenhouse gas emissions.
- **Social:** Upgrades at wastewater treatment plants need to be conducted in a manner to maintain the way of life for the residents and the City wants to maintain its good neighbor status in the surrounding community. Before proceeding with an implementation strategy, the evaluation will consider social criteria such as aesthetics, acoustics, and the potential for fugitive odor emissions.

## Section 2

# Biosolids Production Projection

Projections of biosolids generation and sludge loading rates at wastewater treatment plants are used to define the process conditions for biosolids handling systems. Specifically, biosolids projections are used to quantify the type of solids that will need to be processed, as well as the rate at which they must be processed. Without projections that are supported by a reasonable level of confidence, it is not possible to accurately evaluate, design, and phase upgrades to an existing biosolids handling system.

Biosolids projections for the Post Point Plant have been developed through the year 2035 for the different loading conditions as defined in **Table 2-1**.

**Table 2-1. Definition of Loading Conditions**

Acronym	Definition
AA	Annual Average, the average daily solids generation rate over the course of a year
MM	Maximum Month, the 30-day period with the highest rolling average of solids generation over the course of a year
PW	Peak Week, the 7-day period with the highest rolling average of solids generation over the course of a year
P3D	Peak 3-Day, the 3-day period with the highest rolling average of solids generation over the course of a year
PD	Peak Day, the day with the highest solids generation over the course of a year

For a more thorough description of how the biosolids projections were generated, please see the 2010 planning study. Briefly, the annual average condition is considered the baseline biosolids load and was used to estimate the peak loading conditions at the Post Point Plant. A model simulation of the Post Point Plant was performed to estimate the biosolids loads from 2007 to 2036. With the annual average and maximum month biosolids load quantified, a peaking factor approach was employed to estimate the peak week, peak 3 day and peak day biosolids loading conditions that could be expected at the Post Point Plant. A peaking factor approach uses the historical ratio of the annual average load to the peak load to estimate the magnitude of future peaks. Historical peaking factors developed from the Post Point Plant's historical flow records are presented in Table 2-2.

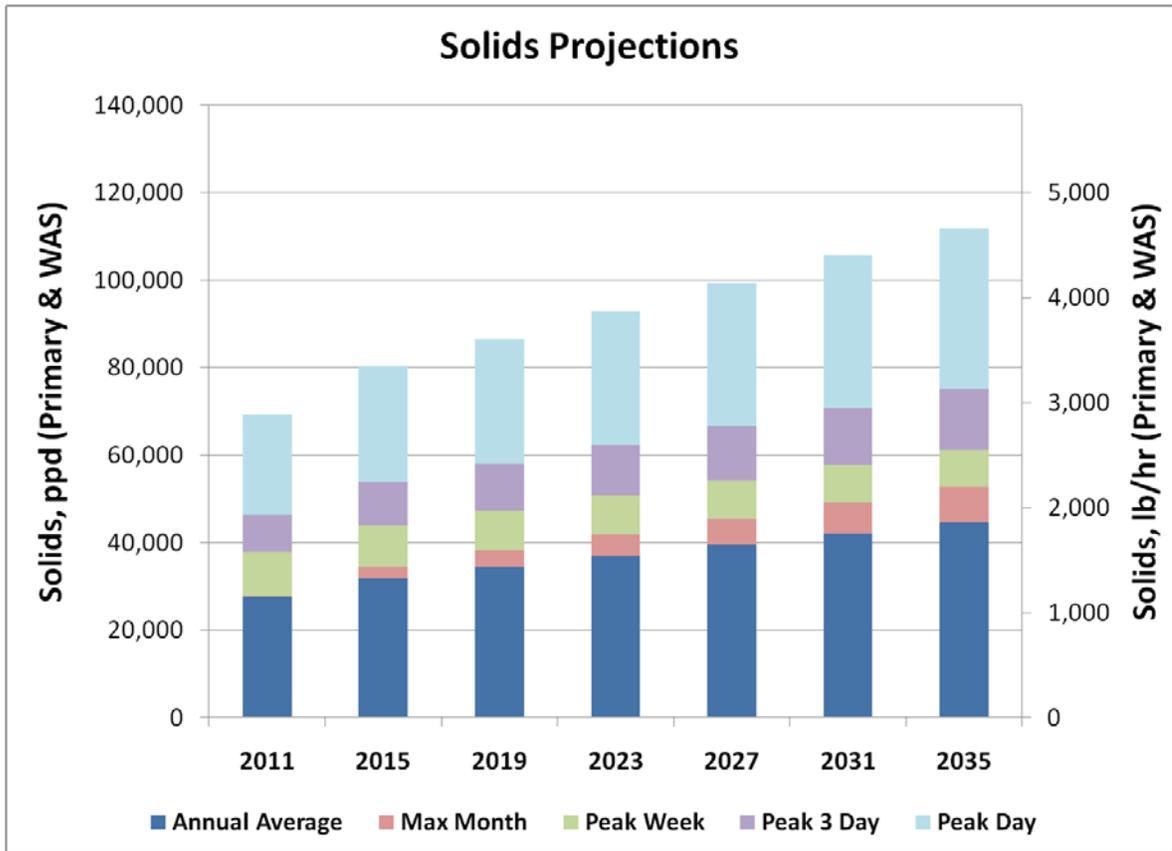
**Table 2-2. Historical Peaking Factors**

Year	Loading Parameter PW/AA	Loading Parameter P3D/AA	Loading Parameter PD/AA
1999	1.50	2.07	3.40
2000	1.40	1.71	2.27
2001	1.31	1.86	3.00
2002	1.38	1.79	2.28
2003	1.30	1.51	2.03
2004	1.28	1.58	2.30
2005	1.33	1.74	2.96
2006	1.49	1.65	2.63
2007	1.68	1.88	2.91
2008	1.28	1.46	2.09
2009	1.26	1.46	2.19
2010	1.31	1.64	2.06
2011	1.32	1.54	2.52

With the annual average and peaking factors quantified, biosolids projections through the year 2035 were developed. A graphical representation of the anticipated biosolids in 3-year increments is shown in **Figure 2-1**. The left y-axis shows the biosolids projections in pounds per day (ppd) and the right y-axis shows the projections in pounds per hour (pph). The colored bands of each bar represent the different peaking conditions for that design year.

The revised solids loading shown in Figure 2-1 are an update to the biosolids production projections presented in the 2010 planning study and include actual process data through 2011. In order to revise the solids projections, the following assumptions/procedures were followed:

- The plant data for three most recent years (2009, 2010, and 2011) were integrated into the master data sheet used for the solids loading analysis.
- The earlier projected data for solids loading for primary and waste activated sludge (WAS) were replaced with the actual data provided by the City for the five most recent years (2007 through 2011). The actual data is now the basis for projection.
- The population projection data as provided in Table 3.2 of the Facility Planning report (Carollo Engineers, 2011) was revised.
- The water consumption per capita per year was assumed unchanged for the planning period.



**Figure 2-1. Biosolids Projections at the Post Point Plant**

The data in **Figure 2-1** are consistently lower than the solids loading from the 2010 planning study. In general, the revised solids loadings are between 7 and 17 percent lower than those from the 2010 planning study, with an average reduction of approximately 12 percent across all years and loading conditions.

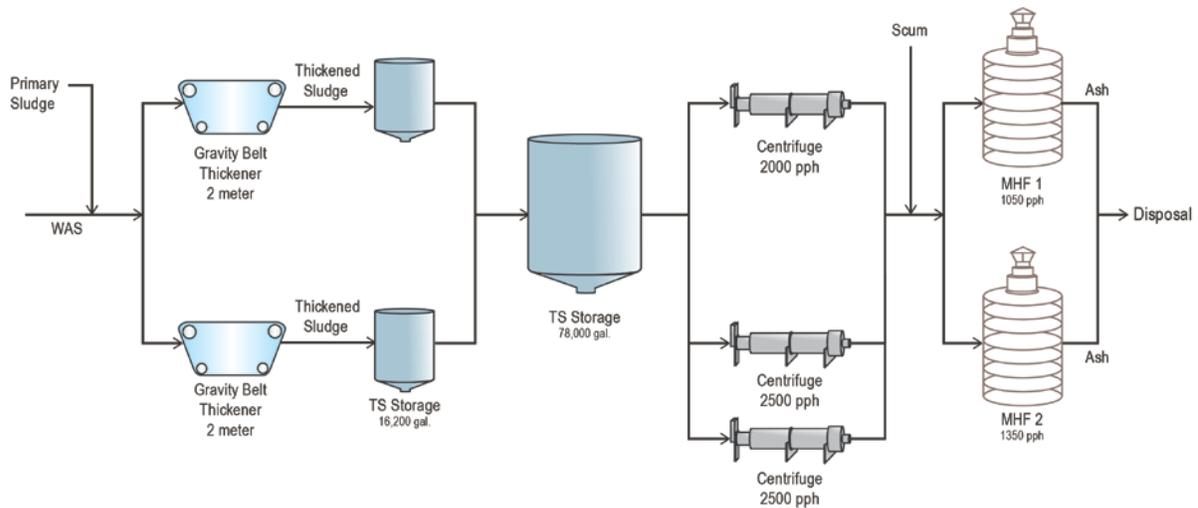


## Section 3

# Existing Biosolids Facility

### 3.1 Background

The Post Point Plant uses a combination of technologies and equipment to handle, process, and dispose of its wastewater biosolids, see **Figure 3-1**. Biosolids handling at the Post Point Plant consists of the following key process areas: 1) sludge thickening, 2) thickened sludge storage 3) dewatering and 4) incineration.



**Figure 3-1. Simplified Process Schematic, Existing Operations**

A more thorough discussion of each of the existing biosolids processes at Post Point is provided in the 2010 planning study prepared by CDM Smith. The following sections provide an update of the biosolids loading projections to each process (where applicable) based on the new population growth data and projected biosolids production within the plant.

### 3.2 Sludge Thickening

Graphs of the projected hydraulic and biosolids loading rates to the gravity belt thickeners (GBTs) have been developed to evaluate the existing thickening capacity. These graphs are shown in **Figures 3-2** and **3-3**. Note that the time interval (x-axis) on Figure 3-2 is varied to show when the peak loading exceed capacity.

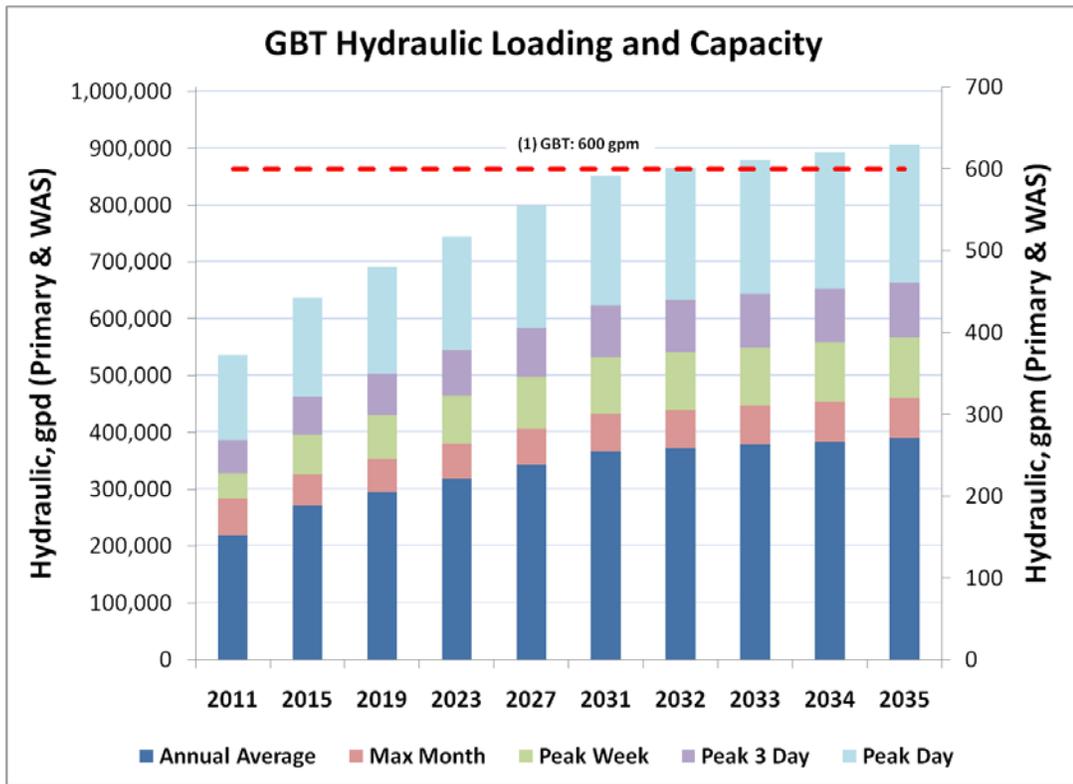


Figure 3-2. Gravity Belt Thickeners Hydraulic Loading and Capacity

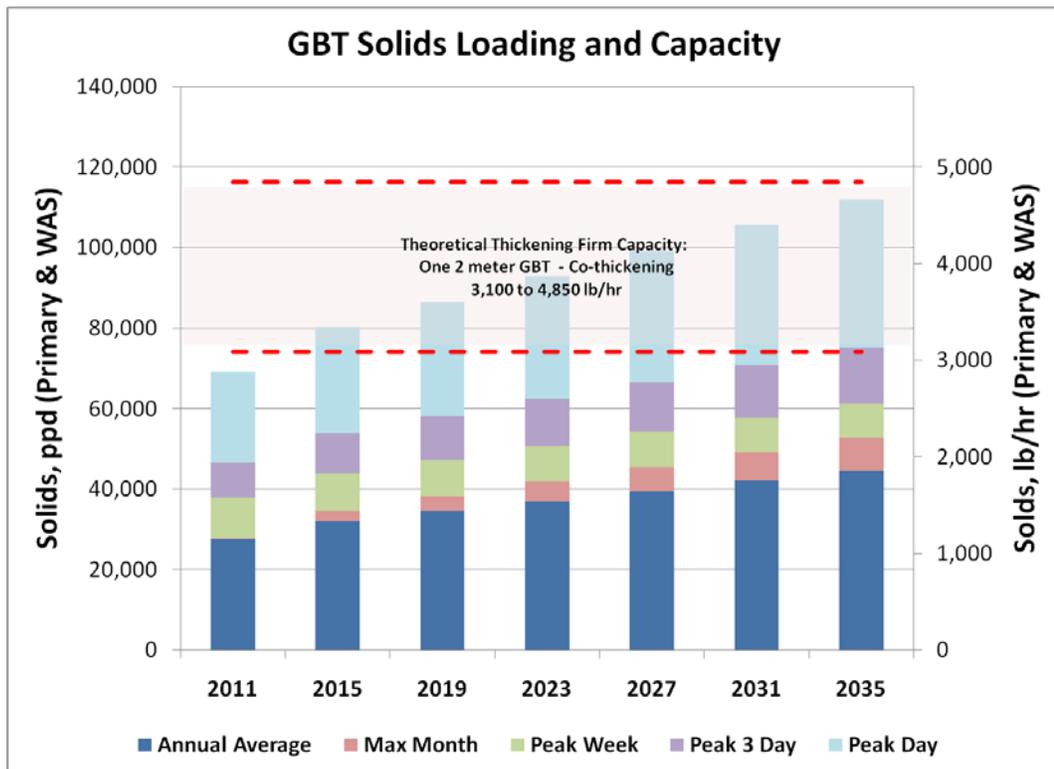


Figure 3-3. Gravity Belt Thickeners Solids Loading and Capacity

Theoretical hydraulic and solids capacities were used for this evaluation. With regards to hydraulic capacity, the vendor estimated that the capacity is likely in excess of 300 gpm per effective meter. With regards to solids capacity, the vendor estimated that the existing unit would meet typical published values. Thus, the theoretical loading capacity in **Figure 3-2** was developed from the vendor's recommendation, whereas the theoretical loading capacities in **Figure 3-3** were from the 2009 WEF Manual of Practice.

The data in **Figure 3-2** are consistently lower than the hydraulic loadings from the 2010 planning study. In general, the revised hydraulic loadings are between 4 and 15 percent lower than those from the 2010 planning study, with an average reduction of approximately 9 percent across all years and loading conditions.

Based on **Figures 3-2** and **3-3**, the existing solids thickening capacity should be sufficient through 2035, but the hydraulic capacity may be limited in terms of firm capacity for peak day loadings. However, the total processing capacity may be sufficient if a slight reduction in performance is acceptable at peak day conditions after approximately 2032.

### 3.3 Dewatering

The Post Point Plant recently installed two new Alfa Laval G2-95 centrifuges. These centrifuges have a rated solids loading capacity of approximately 2,500 dry pounds per hour at 25 percent cake solids production. An additional Sharples DS-705 is available on-site for backup dewatering duty. The DS-705 unit has a rated solids loading capacity of approximately 2,300 dry pounds per hour at 25 percent cake solids. Therefore, the dewatering equipment at the Post Point Plant includes two 2,500 dry lbs per hr centrifuges and one 2,300 dry lbs per hour centrifuge, for a total dewatering capacity of 7,300 dry lbs per hour and a firm capacity of 4,800 dry lbs per hour. A graph of the projected loading rates to the dewatering centrifuges is shown in **Figure 3-4** to evaluate the existing dewatering capacity.

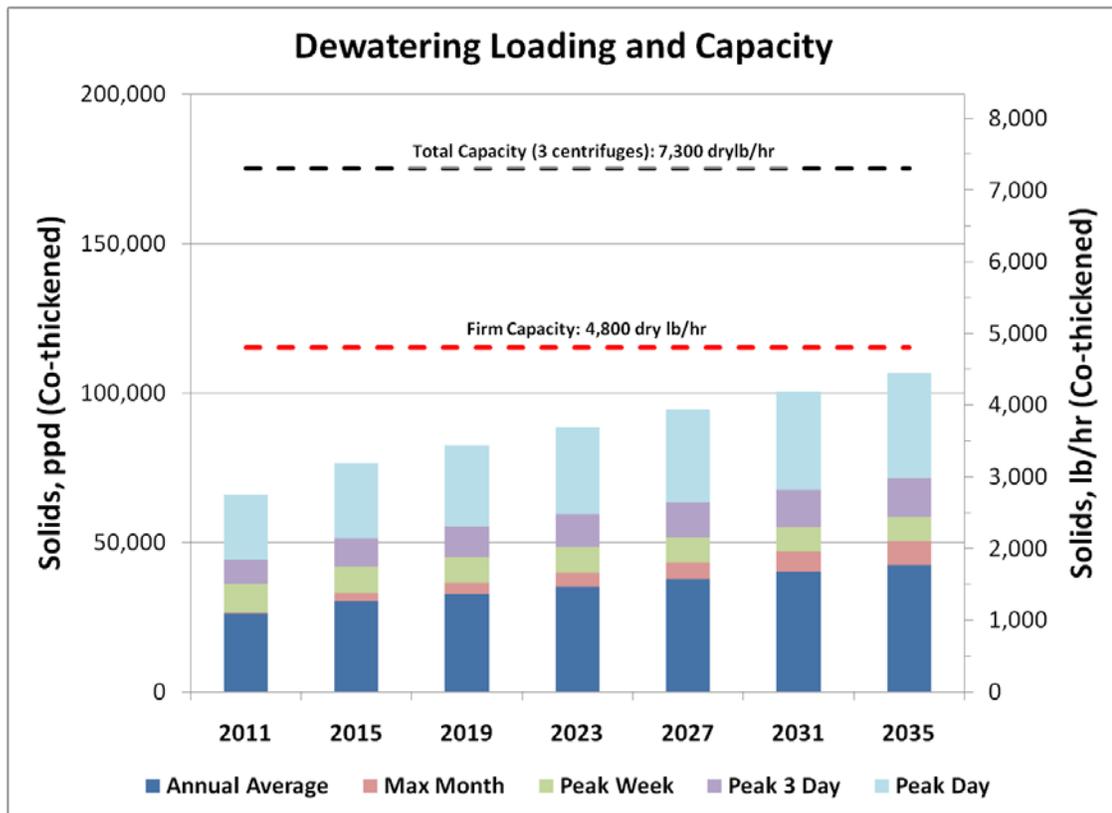


Figure 3-4. Dewatering Loading and Capacity

The horizontal black line shows the total capacity of the dewatering equipment, assuming 24 hour/day and 7 day/week operation. The horizontal red line shows the firm capacity of the dewatering equipment. The firm capacity is the total processing capacity with the largest unit out of service. Assuming the current dewatering equipment is available through 2035, the dewatering firm capacity is sufficient for all peak loading conditions, thus additional dewatering capacity should not be needed. However, the DS-705 may be nearing the end of its useful life. If the DS-705 is decommissioned prior to 2035, the resulting firm capacity of 2,500 dry lbs/hr may be insufficient to directly process the peak day and peak 3-day loadings under current design conditions. However, the presence of thickened sludge storage upstream of the dewatering equipment provides some buffering capacity. Assuming that the entire 110,400 gallons is available, the thickened sludge storage should adequately attenuate the peak day and peak 3-day loadings, and should allow a single G2-95 to handle these loadings through 2035 if the DS-705 was decommissioned.

### 3.4 Incineration

The Post Point Plant employs two multiple hearth furnaces as its primary means of sludge handling. Presently, only one incinerator is operated at a time. Although both are in operation, there is a preference for operating Incinerator 1. As of November 2011, operation of the furnaces has transitioned from a 5 day/week to a 7 day/week operating schedule.

An annual summary of the incinerator operating records from 2006 through 2011 is presented in **Table 3-1**. The current air permit for the incinerators requires that both units achieve 5 percent opacity on their stack emissions, which essentially means that there can be no visible emissions from

the incinerator stacks. To ensure compliance with the opacity requirement, the afterburners on each unit are continuously fired to achieve the 1200°F afterburner exit temperature. Fuel usage in the afterburners is the majority of fuel used by the incinerators.

**Table 3-1. Summary of Incineration Operating Records for 2006 – 2011**

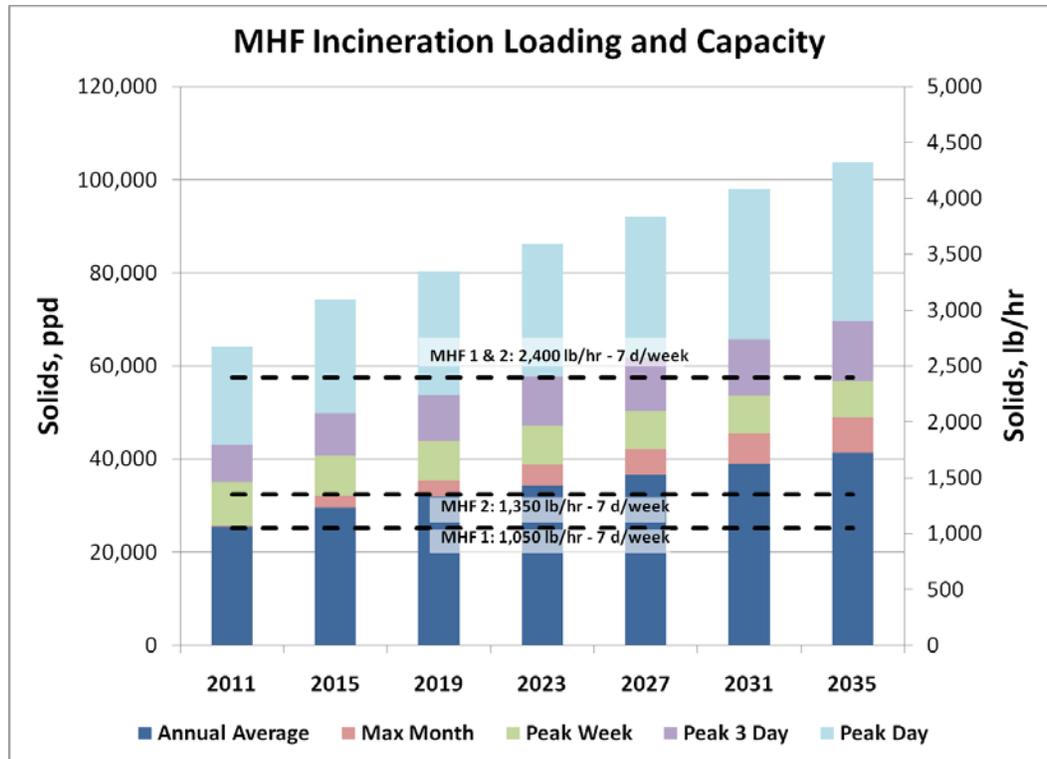
Year		Incinerator 1	Incinerator 2	Total
2006	Operating Hrs <sup>1</sup>	2,200	3,645	5,845
	Sludge Burned			
	Dry lb/yr	3,088,000	5,286,000	8,374,000
	Dry tons/yr	1,540	2,640	4,190
	Avg Feed Rate, Dry lb/hr	1,400	1,430	
	Total Gas Usage, Cuft/yr	5,509,000	16,360,000	21,869,000
	Standby Gas Usage <sup>2</sup> , Cuft/yr	1,392,000	5,837,000	7,229,000
	Standby Gas as % of Total Gas <sup>3</sup>	25%	36%	33%
	Solids Processing Gas per Dry Ton, Cuft/ton	2,670	3,990	3,490
2007	Operating Hrs <sup>1</sup>	4,622	1,273	5,895
	Sludge Burned			
	Dry lb/yr	6,657,000	1,924,000	8,581,000
	Dry tons/yr	3,330	960	4,290
	Avg Feed Rate, Dry lb/hr	1,430	1,480	
	Total Gas Usage, Cuft/yr	11,691,000	5,398,000	17,089,000
	Standby Gas Usage <sup>2</sup> , Cuft/yr	2,974,000	2,013,000	4,987,000
	Standby Gas as % of Total Gas <sup>3</sup>	25%	37%	29%
	Solids Processing Gas per Dry Ton, Cuft/ton	2,620	3,530	2,820
2008	Operating Hrs <sup>1</sup>	3,445	2,317	5,762
	Sludge Burned			
	Dry lb/yr	5,277,000	3,371,000	8,648,000
	Dry tons/yr	2,640	1,690	4,320
	Avg Feed Rate, Dry lb/hr	1,510	1,440	
	Total Gas Usage, Cuft/yr	4,589,000	7,494,000	12,083,000
	Standby Gas Usage <sup>2</sup> , Cuft/yr	1,425,000	2,957,000	4,382,000
	Standby Gas as % of Total Gas <sup>3</sup>	31%	39%	36%
	Solids Processing Gas per Dry Ton, Cuft/ton	1,200	2,680	1,780
2009	Operating Hrs <sup>1</sup>	2,350	3,373	5,723
	Sludge Burned			
	Dry lb/yr	3,662,000	5,301,000	8,963,000
	Dry tons/yr	1,830	2,650	4,480
	Avg Feed Rate, Dry lb/hr	1,560	1,560	
	Total Gas Usage, Cuft/yr	3,976,000	7,317,000	11,293,000
	Standby Gas Usage <sup>2</sup> , Cuft/yr	1,457,000	2,559,000	4,016,000
	Standby Gas as % of Total Gas <sup>3</sup>	37%	35%	36%
	Solids Processing Gas per Dry Ton, Cuft/ton	1,380	1,800	1,620
2010	Operating Hrs <sup>1</sup>	5,404	358	5,762
	Sludge Burned			

Year		Incinerator 1	Incinerator 2	Total
	Dry lb/yr	8,016,000	503,000	8,519,000
	Dry tons/yr	4,010	250	4,260
	Avg Feed Rate, Dry lb/hr	1,480	1,410	
	Total Gas Usage, Cuft/yr	7,071,000	1,253,000	8,324,000
	Standby Gas Usage <sup>2</sup> , Cuft/yr	2,300,000	667,000	2,967,000
	Standby Gas as % of Total Gas <sup>3</sup>	33%	53%	36%
	Solids Processing Gas per Dry Ton, Cuft/ton	1,190	2,340	1,260
2011	Operating Hrs <sup>1</sup>	4,948	1,118	6,066
	Sludge Burned			
	Dry lb/yr	7,341,000	1,314,000	8,655,000
	Dry tons/yr	3,670	660	4,330
	Avg Feed Rate, Dry lb/hr	1,480	1,170	
	Total Gas Usage, Cuft/yr	6,522,000	2,959,000	9,481,000
	Standby Gas Usage <sup>2</sup> , Cuft/yr	2,136,000	1,150,000	3,286,000
	Standby Gas as % of Total Gas <sup>3</sup>	33%	39%	35%
	Solids Processing Gas per Dry Ton, Cuft/ton	1,200	2,740	1,430

## Notes:

1. Operating hours are hours of sludge burning; standby hours are not included.
2. Standby gas usage is required to maintain incinerator in hot standby mode.
3. Solids processing gas per dry ton is the total gas minus the standby gas divided by the dry tons of sludge burned.

Incineration is the primary means of biosolids disposal at the Post Point Plant and thus it must be capable of reliably handling the 2035 sludge loads. As indicated by the 2006 to 2011 data and illustrated in **Figure 3-5**, current average annual loads already exceed the capacity of MHF 1 and peak loads exceed the capacity of the maximum design capacity of both MHFs. The Post Point Plant is only able to continue operating in this manner by operating the MHFs above their design rated capacity and/or utilizing the thickened sludge storage to attenuate peaks in sludge production. As sludge production increases in future years, the Post Point Plant will increasingly need to operate both MHFs in excess of design capacity or rely more heavily on thickened sludge storage to attenuate sludge loading peaks. However, the current thickened sludge storage provides sufficient attenuation capacity to handle all solids loading conditions through 2035, so additional storage should not be necessary. Note that by year 2035, the peak day sludge production will require approximately 81,700 gallons of thickened sludge storage (74 percent of max storage capacity); the peak 3-day sludge production will require approximately 63,700 gallons of thickened sludge storage (58 percent of max storage capacity), assuming both incinerators are operating.



**Figure 3-5. Existing Incineration Loading and Capacity**

Other observations from **Figure 3-5** include the following:

- The larger of the two incinerators (MHF 2) has enough capacity to handle annual average solids loading until between 2019 and 2021, as opposed to 2015 with the earlier projection.
- With both incinerators operating (MHFs 1 & 2) the plant can handle the peak week solids loading for the entire planning period until 2035.
- With both incinerators operating (MHF1 & 2) the plant can handle the peak three day solids loading until 2024 as opposed to 2016 with earlier projection. However, this provides no redundancy in the operations.



## Section 4

# Biosolids Handling Alternatives

### 4.1 Biosolids Handling

As previously stated, sludge incineration has proven to be a reliable biosolids handling approach for the City of Bellingham. However, the age of the existing equipment, its capacity limitations, and new incineration air regulations make it prudent for the City to examine other potential methods for handling wastewater biosolids. It also presents an opportunity to examine ways to capture energy, in the forms of heat and power, from its biosolids process. Several biosolids handling alternatives were evaluated in the 2010 planning study prepared by CDM Smith. This report provides a business case evaluation for three biosolids handling alternatives. The alternatives evaluated in this report are:

- Incineration Using the Existing Multiple Hearth Furnaces
- Incineration Using New Fluidized Bed Incinerators
- Anaerobic Digestion with Biosolids Drying

#### 4.1.1 Prioritized Project Objectives

CDM Smith developed a list of criteria related to the installation and operation of a biosolids handling facility at Post Point Plant. These criteria were grouped into four categories to be consistent with the overall objectives of this study: economic, operational, environmental, and social. The following criteria were prioritized in the evaluation of the alternative biosolids handling alternatives.

##### 4.1.1.1 Operational Considerations:

- **Required Trucking.** The impacts of trucking required to haul the solids from the plant to beneficial use or disposal. The selected solids processing technology determines the amount of trucking required to either dispose of the solids or transport the solids for beneficial use. For example, if the raw sludge is hauled to another solids handling facility for further treatment, the trucking demand would be much higher than if the solids are digested, dewatered, and dried, or incinerated on site. Required trucking for hauling the final product for an incineration process is less than the trucking requirements for hauling dewatered cake produced through a digestion, dewatering, and drying process.
- **Site Space Requirements.** The real estate requirements for the biosolids treatment processes. Each alternative has different space requirements. For example, upgrading the incineration process with a similar technology process will require less space than switching to an anaerobic digestion, dewatering, and drying system.
- **Redundancy.** The importance of system reliability, particularly from redundant units. The reliability consideration not only includes the redundancy of a system, but also the projected length of time that the system may be out of service. Repairs that could be fixed quickly by the local staff rank as preferable to repairs requiring off-site service.

- **Ease of Operation and Maintenance.** Process alternatives vary in their operational complexity. System complexity affects the staffing requirements and training necessary to maintain steady-state or stable operation. This criterion is also used to assess the number of operator hours required, the ability to easily automate the process, and the reliability of the automation system. This objective also considers operational flexibility, which relates to the ability to easily change process modes in response to changing daily or seasonal influent conditions or receiving water requirements. Equipment or process units that are easier to maintain will result in less disruption of the plant by maintaining higher process unit availability and lower cost. Ease of maintenance is measured from the expected frequency of maintenance, the difficulty and hazards inherent in any maintenance event, the ease of accessibility, the labor hours and parts required for a specific maintenance event, the amount of system interference during maintenance, and the requirement for specialized expertise.

#### 4.1.1.2 Environmental Considerations

- **Energy Efficiency.** The importance of improving plant energy efficiency.
- **Ease of Air Permitting.** The ease of obtaining and complying with air permits. This criteria is particularly important given the new air regulations for sewage sludge incinerators. .
- **Carbon Footprint.** The importance of reducing Post Point Plant's overall carbon footprint by increasing energy efficiency and potentially by producing power on-site is a consideration.

#### 4.1.1.3 Economic Considerations

- **Life Cycle Cost.** Life cycle is a measure of the combined costs of capital cost and ongoing expenses such as energy and O&M costs.
- **Capital Cost.** Includes the cost impact on other unit processes such as upgrading existing incinerators with similar or improved incinerators, completely changing the solids treatment processes with anaerobic digestion, etc.

#### 4.1.1.4 Social Considerations

- **Public Acceptance.** This objective refers to the importance of a positive public perception of the Post Point Plant. Public acceptance is influenced by the issues created due to selection of the processes that can potentially generate noise, odor, traffic, and visual impacts such as impacts of buildings, stacks, and other features of neighborhood views.

## 4.2 Incineration Using the Existing Multiple Hearth Furnaces

### 4.2.1 Overview

The Post Point Plant has been incinerating its wastewater biosolids using MHFs for the past 37 years, and the process has proven itself to be reliable. Although MHFs were extensively used for sludge incineration in the past, there has not been a new MHF sludge incinerator installed in the USA for over 20 years. In addition, all the suppliers of MHFs have gone out of business. This is primarily because an MHF needs an afterburner to control emissions of hydrocarbons, carbon monoxide (CO), and odors to meet present-day air pollution control standards. Due to the high fuel usage resulting from a fired afterburner, MHFs are at a significant disadvantage in comparison with FBIs, which can achieve very low emissions of hydrocarbons, CO, and odors while using less fuel. Thus it is unlikely that any new incineration facilities installed throughout North America will be MHFs.

On March 21, 2011, however, the Environmental Protection Agency (EPA) finalized new source performance standards and emissions guidelines for new and existing sewage sludge incineration units. The CAA 129 regulations have two subcategories: multiple hearth incinerators and fluidized bed incinerators. The emissions limits are set for each subcategory based on the best performing existing unit (for existing sources) and single best performing unit (for new sources). Because the emissions profile for FBIs is different from MHFs, the specified limits are calculated based on the performance of both technologies. As a result, standards for FBIs are more stringent (because they are more efficient), and standards for new point sources are more stringent than those for existing sources. This is an important facet of the regulations because it drives MHF owners to consider the economics of continued operation of existing assets versus installing new fluidized bed units. That is, because the existing assets are subject to more lax emissions standards, the cost of rehabilitating and maintaining existing assets should be weighed against substantial upgrades or new equipment, which would be subject to stricter emissions standards.

### 4.2.2 Process Description

The Post Point Plant has two multiple hearth furnace incinerators (MHFs). Both units have seven hearths and an outside diameter of 14 ft - 3 in. MHF 1, which is the older unit, was supplied by Envirotech, BSP Division, in 1973. The more recent unit, MHF 2, was supplied by Enviroquip in 1993.

MHFs consist of a series of stacked hearths. The biosolids are fed at the top of the furnace and move down the unit. Drying occurs on the upper hearths, followed by burning on the middle hearths and cooling of the resultant ash on the bottom hearths. The stacked hearth configuration is thermally efficient in that it allows the hot combustion gases to rise through the furnace and assist in drying the biosolids on the upper hearths. However, the upper drying hearths emit relatively high levels of VOCs, CO, and particulates. Because of these pollutant emissions, most MHFs require the use of a fuel-fired afterburner to meet present day air emission standards. MHF 1 has been modified to include a top hearth afterburner, whereas MHF 2 has a separate downflow afterburner chamber with a gas-fired burner mounted on top of the chamber. The use of a fired afterburner makes MHFs quite inefficient since a significant quantity of fuel is required to raise the flue gas temperature exiting the drying hearths to a minimum afterburner outlet temperature of 1200°F. At the Post Point Plant, the afterburners are used to ensure that the furnaces meet their opacity (visible emission) requirement.

Both incinerators have the same type of air pollution control systems, consisting of a venturi scrubber, followed by a tray scrubber and wet electrostatic precipitator (WESP). Downstream of each WESP is an induced draft (ID) fan which conveys the combustion gases through the system and maintains draft in the MHFs. Incinerator 2 has served primarily as a standby unit that has ensured incineration capacity during maintenance periods or unexpected downtime of the primary operating unit.

This alternative assumed that the existing incinerators would continue sludge service using the current operational regime. In general, no additional upgrades or substantial modifications would be made to the existing equipment, with the exception of maintenance and rehabilitation measures required to maintain functional operation of the incineration system. In the cost estimation and footprint determinations, conservative assumptions were used to convey the maximum expected values. This provides a worse-case scenario for use in planning future biosolids handling strategies.

### 4.2.3 Option for Organic Rankine Cycle

CDM Smith briefly investigated the possibility of using a low temperature Rankine cycle for heat and power production from the incinerator exhaust gas. The low temperature Organic Rankine Cycle uses

an organic fluid with a liquid-vapor phase change at a lower temperature than the water-steam phase change. The lower temperature phase change provides greater power production from lower temperature energy sources. The Organic Rankine Cycle allows for a simpler operation compared to traditional steam cycles by simplifying or reducing system components such as pressure reducing valves, complicated piping, condensers, deaerators, and boiler water treatment. In fact, most Organic Rankine Cycle heat recovery systems are prepackaged skids with two to four process connections. CDM Smith estimates that the Post Point Plant could potentially produce 600 kWe with a packaged Organic Rankine Cycle system.

The Albany, NY County Sewer District Wastewater Treatment Plant is constructing a 1 MWe Organic Rankine Cycle cogeneration system using waste heat from their existing multiple hearth incinerator. The total cost of that system was approximately \$8 million, but the project received external funding which covered nearly \$6 million. Without the extra funding, it is unlikely that the Albany, NY project would have been financially feasible. For the Post Point Plant, it is unlikely that an Organic Rankine Cycle power production system would be cost-effective.

Another important note about potential cogeneration systems coupled with the MHFs is that the new CAA 129 regulations designate any incineration system that undergoes upgrades or modifications that exceed 50% of the original cost of the unit as a *new* system. Further analysis would be required to determine if a new cogeneration system would trigger this reclassification, but this requirement should be kept in mind in future design considerations. If the upgrade caused the existing MHFs to transition from an existing source to a “new” source, more stringent emissions limits would be imposed.

#### 4.2.4 Optional Heat Recovery from Incinerator Exhaust

Waste heat from the incinerators could be recovered using a secondary heat exchanger and intermediate water loop to transfer the heat to the incoming sludge. Experiments have shown that pre-heating sludge to 140 degree F prior to dewatering can increase the solids concentration in the dewatered cake (a 1 percent increase in solids concentration for every 10 degrees has been observed). However, all sludges are different and it is impossible to determine the impact of preheating on the dewatering performance at Post Point. CDM Smith recommends that further study—and possibly demonstration tests—be performed to determine if recovering heat from the incinerators would be an economically and technically viable option.

#### 4.2.5 Capacity

The capacity of the existing incineration system is discussed in **Section 3**.

#### 4.2.6 Space Footprint

The space footprint of this alternative is not expected to change significantly compared to the current operation. The current MHF system footprint is estimated to be approximately 3,300 ft<sup>2</sup>. However, additional equipment may be required to bring the system into accordance with the new CAA 129 air emissions regulations. At the time of this writing, the City was in the process of conducting stack emissions tests to confirm the levels of regulated pollutants in the exhaust gas, thus the type and extent of air pollution controls that will be required are unknown. It is likely that the Post Point Plant is currently in accordance with the regulations. If carbon absorption equipment or caustic tanks are required (see Section 4.2.12), these could probably be located near the existing incinerators and may only require a nominal space footprint. Additional work could be done in the future to determine the exact layout of required air pollution control equipment.

### 4.2.7 Location of the Equipment

As noted previously, it is difficult to determine what additional equipment will be required for this alternative, if any. In general, the bulk of the solids handling and air pollution control equipment will remain in their current locations, and it is expected that additional equipment will not require a significant space footprint.

### 4.2.8 Permitting Issues

One of the main objectives of this report is to assist Post Point Plant in evaluating the impact of the recently issued performance standards and emission guidelines for new and existing sewage sludge incinerators (SSIs) issued by the USEPA on March 21, 2011: Standards of Performance for New Stationary Sources and Emission Guidelines for Existing Sources: Sewage Sludge Incineration (SSI) Units; Final Rule, 40 CFR 60 Subparts LLLL and MMMM. A copy of this rule is included in **Appendix A**. These performance standards and emission guidelines include both multiple hearth and fluidized bed technology, and set emission limits for nine pollutants in accordance with Section 129 of the Clean Air Act. Under this new rule, SSIs must utilize the maximum degree of reduction in controlling their air emissions. This level of control is referred to as the maximum achievable control technology (MACT) standard.

The new regulations are generally structured under what is called the “model rule.” The model rule is organized to address the following items: (1) Emission limits, emission standards, and operating limits, (2) Initial compliance requirements, (3) Continuous compliance requirements, (4) Performance testing, monitoring, and calibration requirements, (5) Increments of progress toward compliance, (6) Operator training and qualification, (7) Recordkeeping and reporting.

#### 4.2.8.1 Emissions Guidelines

The CAA 129 regulations set stringent emission limits for nine pollutants: cadmium (Cd), carbon monoxide (CO), hydrogen chloride (HCl), mercury (Hg), nitrogen oxides (NO<sub>x</sub>), lead (Pb), dioxins/furans on a toxic equivalent basis (PCDD/PCDF TEQ), dioxins/furans on a total mass basis (PCDD/PCDF TMB), particulate matter (PM), and sulfur dioxide (SO<sub>x</sub>). Maximum achievable control technology limits were set for new units and less stringent limits were set for existing units. **Table 4-1** shows a summary of the emissions limits for existing and new MHF units.

**Table 4-1. Emissions Limits for Existing and New Multiple Hearth Incineration Units**

Pollutant	Units @ 7% O <sub>2</sub>	Emissions Limits for Existing MHF	Emissions Limits for New MHF
Cd	mg/dscm	0.095	0.0024
CO	ppmvd	3,800	52
HCl	ppmvd	1.2	1.2
Hg	mg/dscm	0.28	0.15
NO <sub>x</sub>	ppmvd	220	210
Pb	mg/dscm	0.30	0.0035
PCDD/PCDF TEQ	ng/dscm	0.32	0.045
PCDD/PCDF TMB	ng/dscm	5.0	0.0022
PM	mg/dscm	80	60
SO <sub>2</sub>	ppmvd	26	26

In addition to the requirements in **Table 4-1**, existing SSI units are required to conduct Method 22 visible emissions test of the ash handling operations during compliance testing (see 40 CFR part 60, Appendix A-7). A copy of the Method 22 visible emissions testing is included in **Appendix B** of this report. Visible emissions of combustion ash from an ash conveying system (including conveyor transfer points) shall be no more than 5 percent for both new and existing MHF units.

As shown in **Table 4-1**, the SSI MACT Rule has two sets of limits, one for “new” MHF units and one for “existing” MHF units. An existing unit is regulated as a “new” unit under this rule if:

- The cumulative cost of the changes, including any after September 21, 2011, over the life of the unit exceeds 50 percent of the original cost of building and installing the SSI unit (not including the cost of land) updated to current costs (current dollars). (40 CFR 60.4930)

The U.S. EPA has provided the following guidance for calculating this cumulative cost to determine if an SSI Unit is a “new” unit:

- Costs include those associated with sewage sludge feed systems, auxiliary fuel feed system, grate system, flue gas system, waste heat recovery equipment, and bottom ash system, and all ash handling up to truck loading. Costs for air pollution control equipment are excluded. (40 CFR 60.4930)
- Costs are all those over the life of the unit, not just incurred after September 21, 2011. (Response to Comment Document for the SSI MACT Rule)
- Costs exclude routine maintenance, repair, or replacement, as defined in 40 CFR 60.14(e), and as determined by the Administrator. (Response to Comment Document for the SSI MACT Rule)
- In reviewing “routine maintenance, repair or replacement,” EPA determinations exclude repairs that are done infrequently (i.e., once in 15 years) and represent an upgrade or improvement in performance over the original design. (EPA Applicability Determination Index, Control No. 0200060)

It should be noted that the existing MHFs are in need of repair or replacement for the following items: sand seal, center shaft bearings, refractory lining, hearths, insulation, steel shell reinforcement, PLC control system, wet scrubbing system, and others. Most of these items are considered routine maintenance, repair, or replacement, and thus are excluded from the cumulative cost assessment for determination of a “new” unit. The PLC control system may be an exception, and a new PLC may contribute to the cumulative cost assessment. It is CDM Smith’s understanding that the MHFs at Bellingham have not undergone sufficient upgrades or changes to qualify as a “new” incinerator unit. Therefore, the current MHFs will be analyzed as though they are existing units and will be regulated as such.

#### 4.2.8.2 Compliance Requirements

According to CAA 129, sewage sludge incinerators shall be brought into compliance with the new regulations “as expeditiously as practicable after State plan approval, but no later than 3 years after State plan approval or by **May 20, 2016**, whichever is earlier.” Individual States were required to submit State plans to the EPA by March 21, 2012. These State plans were required to contain source emission limits that were equal to, or more stringent than, the Federal limits. The States plans were also required to implement and enforce the emissions limits within 1 year after promulgation of the Federal rules. CDM Smith spoke with the Washington State Department of Ecology Air Control board,

and they indicated that the State intends to implement the Federal Rule as-is, but have not submitted a State plan. Ultimately, this means that the Federal emissions limits and deadlines discussed in this Section will most likely be applicable to Post Point.

To confirm and monitor compliance with the new CAA 129 regulations, existing MHFs require initial and annual emissions performance tests (or continuous emissions monitoring or continuous sampling as an alternative) and annual inspections of air pollution control devices. Stack emissions tests performed within the previous 2 years may be used, provided that the tests were conducted under the same operating conditions as the current operation. Based on conversations between CDM Smith and Post Point Plant personnel, comprehensive stack tests for the incinerators at Post Point are currently ongoing, but the most recent sampling event was conducted in 1993. For that reason, it is difficult to verify to what extent the incinerators are in compliance with the CAA 129 regulations. CDM Smith recommends that Post Point Plant complete comprehensive stack testing on the incinerators as soon as possible to identify any pollution control measures required to bring the solids handling system into accordance with the CAA 129 regulations. Subsequent performance testing shall be performed annually thereafter to monitor compliance with the emissions regulations and inspect the air pollution control system. The CAA 129 regulations provide some flexibility by allowing performance tests every third year if performance tests for a pollutant show that emissions are at or below 75 percent of the emission limit for 2 consecutive years.

Although comprehensive stack tests at Post Point have not been completed, in 2011 Post Point Plant performed CO profiling to assess whether continuous monitoring of CO or total hydrocarbons (THC) would be a better option for the plant. CDM Smith analyzed the data and it appears that CO emissions are well below the applicable CAA 129 regulations. Average CO emissions were 777 ppm<sub>dv</sub> @ 7% O<sub>2</sub>, while the limit for existing MHFs is 3800 ppm<sub>dv</sub> @ 7% O<sub>2</sub>. Thus additional CO control measures are not expected to be required.

If Post Point plant plans to achieve compliance more than 1 year following the effective regulation date, both a final control plan and notification of achievement of final compliance shall be submitted to the regulating authority. Further details on the rules regarding Increments of Progress can be found in 40 CFR Part 60.5085-5160.

#### **4.2.8.3 Operator Training and Qualification**

All SSI units shall be operated by a fully trained and qualified SSI unit operator. The operator shall either be at the facility or capable of being at the facility within 1 hour when the incinerator is in operation. Annual refresher courses are required to maintain operator qualifications. To become a qualified SSI unit operator, an operator must complete a state approved incinerator operator training program and pass a written examination. The SSI Rule does not define who or what organization is providing these training programs.

#### **4.2.8.4 Summary of Requirements and Deadlines**

The following is a summary of the requirements and deadlines discussed above, as well as some other requirements from the CAA 129 regulations.

1. Perform stack performance testing for both incinerators as soon as possible.
2. Identify any pollution control devices required to comply with the relevant emissions limits. The conformance deadline for the air emissions requirements is **May 20, 2016**.

3. Submit stack emissions test report data to EPA using EPA's Electronic Reporting Tool.
4. Repeat performance tests yearly (or less often, as permitted by law).
5. Conduct initial and annual inspections of the air pollution control devices.
6. Complete operator training requirements.
7. Continuously monitor the temperature of the combustion chamber.
8. Prepare a site-specific monitoring plan for each continuous monitoring system and ash handling system.
9. Prepare initial and annual compliance reports and deviation reports.
10. Apply for and obtain a Title V operating permit. These permits ensure compliance with all applicable requirements for regulated SSI units, including all applicable CAA 129 regulations. This permit needs to be obtained prior to **March 20, 2014**.

#### 4.2.8.5 Future Revisions to Emissions Limits

Every 5 years, the regulations regarding emissions limits for SSI units are revisited. It is impossible to forecast what changes will be made and to what extent, but it is conceivable that future revisions to the CAA 129 regulations will add more items to the list of regulated pollutants, or that the current limits will be revised. This aspect of the regulations should be considered in future deliberations regarding the incinerator operation. See Section 4.2.12 for potential economic and process impacts from potential future changes to the SSI emissions limits.

#### 4.2.9 Carbon Footprint

The MHFs are expected to require an average annual natural gas input of approximately 25,000 cubic feet per day of natural gas (250 therms/day). Since the incineration system has transitioned to a 7 day/week operation, it is estimated that natural gas demand for space heating in the solids handling building is now negligible, and will continue as such into the future. Electrical demand for the system is estimated to be 2.5 million kWh per year. Disposal of the ash product at the local landfill is projected to require 3,300 gallons of diesel fuel per year to run the ash hauling trucks and freight trains. Overall, the current MHFs are estimated to emit 1,700 tons of fossil fuel-based carbon dioxide equivalents per year.

#### 4.2.10 O&M Costs

The existing MHFs are becoming increasingly difficult and more costly to repair and maintain. Recently, problems with the sand seal and center shaft bearings on Incinerator 1 resulted in 45 day repair period in which the MHF was not available for operation. It is expected that significant repairs to the refractories, hearths, and insulation and possibly reinforcing of the incinerator's steel shell will be required in the near future. It is noted that the PLC control system on both incinerators is a Texas Instruments processor which is 15 years old and parts for the PLC are no longer available from the original equipment manufacturer (OEM). Availability of parts for the PLC may be a problem in the future.

Additionally, MHF 1 is 39 years old and MHF 2 is 19 years old. By the end of the planning period in 2035, MHFs 1 and 2 will be 62 and 42 years old, respectively. A typical life expectancy of a MHF is

approximately 25 years. Given the age of the MHFs it is expected that maintaining the units will be a continuous and increasingly difficult task for the plant maintenance staff; however, continued operation of these units may be economically preferable to installing a new MHF or FBI unit, as new sewage sludge incinerators are subject to more stringent air emission guidelines (see discussion above). If neither unit is replaced, both incinerators will be well beyond their life expectancy by the end of the planning period. As an incinerator gets older, replacement of major components becomes necessary. Typical maintenance on an old MHF would include replacement of the furnace firebrick and hearths, replacement of the wet scrubbing system due to erosion and corrosion, and replacement of the center shaft drive mechanism.

CDM Smith assumed that maintenance costs required to keep the current MHFs in operation would be consistent throughout the planning period. Other operating costs include natural gas, electricity, dewatering polymer use, and ash hauling. The estimated yearly operating cost for the MHFs is \$1,300,000 per year.

#### 4.2.11 Capital Cost

Capital costs that may be incurred for this alternative consist primarily of additional pollution control features required to comply with the new CAA 129 emissions limits (see discussion above). It is likely that the current pollution control devices are sufficient to achieve compliance with all regulations; however, a discussion of other possible capital costs are included in Section 4.2.12 below.

#### 4.2.12 Additional Considerations

If supplementary equipment or a change in treatment processes is required, other capital or operating costs would likely be incurred. Additionally, EPA is required to reevaluate the CAA 129 regulations every five years, and revise as necessary to protect human health and the environment. While it is impossible to identify exactly which changes, if any, the EPA will institute, possible changes include: eliminating the distinction between “new” and “existing” MHF classifications, changing the cumulative cost assessment that triggers a transition from an existing to a new MHF, or simply revising the air emissions requirements to be more or less stringent. CDM Smith does not expect the EPA to revise the regulations dramatically from their current values, but it is useful to anticipate possible changes and plan for possible “worst-case” scenarios. Therefore, CDM Smith has prepared the following bullets to assist the Post Point Plant in preparing for possible changes that may need to be evaluated in the future:

- If allowable exhaust mercury concentrations are lowered, the recommended treatment approach would most likely include activated carbon absorption. In general, flue gas exiting the wet ESP would be heated using center shaft air and passed through an activated carbon filter. The capital cost of the additional equipment is estimated to be 5-6 million dollars.
- The afterburner could be used to address more stringent requirements for several of the pollutants. For example, if the CO or opacity regulations became more stringent, the afterburner on the MHFs could be fired at a higher temperature—around 1400 F—to achieve the necessary reductions. This would increase natural gas demand an estimated 75% from their current levels. If this is the case, the total cost of natural gas would likely increase from \$80,000/yr to \$140,000/yr (an increase in \$60,000/yr).
- If allowable exhaust SO<sub>2</sub> or HCL concentrations are lowered, a caustic addition system may be required. In general, the required equipment includes a couple large caustic tanks and pumps.

Secondary containment and a loading station would also be required. The capital cost of this equipment is estimated to be around 1 million dollars, and the yearly cost of caustic is anticipated to be around \$100,000 to \$200,000 per year. It should also be noted that alum addition at any point within the wastewater treatment process would critically impact the effectiveness of this treatment technique. Because alum contains sulfur, additional sulfate would be produced during gas treatment, which would increase the required caustic dose.

- The recommended treatment approach for strict metals limits is typically a wet ESP. Because the Post Point plant already has a wet ESP, it is unlikely that allowable metals concentrations will be lowered below the performance of the current system.

It should be noted that the current MHFs are relatively old and maintenance is becoming more difficult in terms of parts availability. A significant cost allowance has been included in the O&M calculations for upkeep on the degrading MHF system, but investment in the current MHFs may become a poor long-term decision. In the event that one or both of the MHFs become irreparably impaired, it is likely that the MHFs would need to be replaced with another biosolids handling technology (e.g., FBI, digestion, gasification, etc). CDM Smith believes that, given the age and operational state of the current MHFs, it is unlikely that the current system will last until year 2035. As the sludge loading increases to the incinerators over the next several years, the capacity of one or both of the incinerators will be exceeded at average annual loadings. This means that both incinerators will need to be operated simultaneously, and if an incinerator went out of service, it would force the remaining incinerator to function beyond its design capacity until the other unit is brought online. Alternatively, raw dewatered sludge would have to be hauled away from the site for disposal, which is a relatively expensive option. Post Point Plant should consider these possibilities, and perhaps set aside a “contingency capital” fund to deal with a situation like the one described above.

### 4.2.13 Life Cycle Costs

As noted above, it is unlikely that the current MHFs will last until year 2035. Therefore, a new solids handling facility will probably need to be installed midway through the study period. To provide a conservative analysis, the life cycle costs for this alternative were calculated assuming that an FBI system would be installed in year 2025 to replace the current MHFs. The capital and O&M costs of the FBI system (described below) were discounted to present day to determine the net present value (life cycle cost). The life cycle cost for this alternative assuming a 1% interest rate through 2035 is approximately \$60,000,000.

## 4.3 Incineration Using a New Fluidized Bed Incinerator

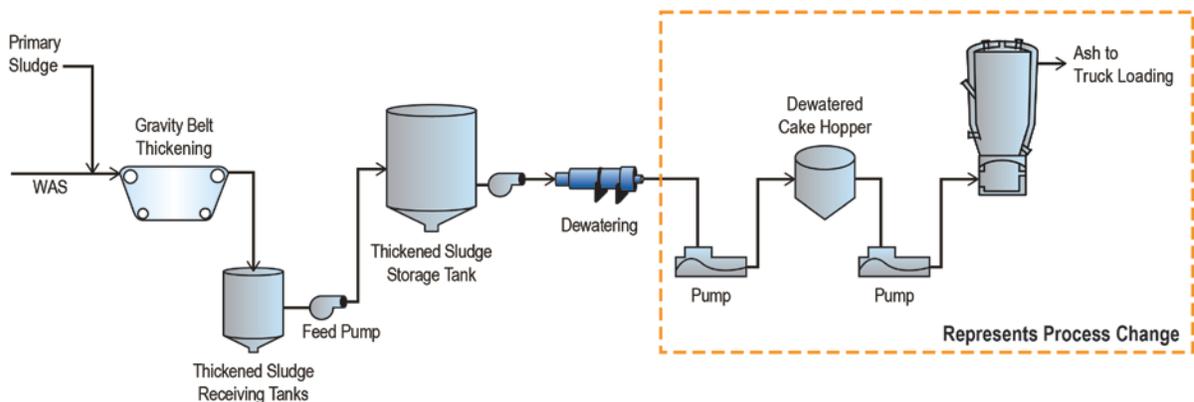
### 4.3.1 Overview

If a new incineration facility was installed, it would likely utilize fluidized bed technology in lieu of the current multiple hearth technology. A Fluidized Bed Incinerator (FBI) can be thought of as a completely mixed process in which drying and combustion take place concurrently and very rapidly. The combustion related components of a FBI system consist of the following items: the reactor, combustion air heat exchanger or preheater, and the fluidizing air blower. Preheated combustion air supplied by the fluidizing air blower is blown into a windbox and distributed through nozzles or tuyeres to the bottom of the bed. The combustion air fluidizes a sand bed. Then fuel (natural gas or fuel oil) and dewatered biosolids are pumped directly into the sand bed to create a hot (1400°F to 1500°F), turbulent suspension of sand, gases, and burning biosolids. In the suspension, the water in the biosolids is evaporated and the combustible matter oxidized in a matter of seconds.

### 4.3.2 Process Description

FBI systems are thermally efficient, as the reactor flue gas is routed to the combustion air preheater to heat the combustion air to 1200°F, while cooling the flue gas to 1000°F. The combustion air preheater makes it possible to burn biosolids with low solids content or low heating value with a minimal use of auxiliary fuel. FBI systems typically use one-third less natural gas to operate than a MHF.

Similar to the current MHF incineration system, an FBI system would require sludge thickening and dewatering. In addition, sludge storage would be required. Utilization of the existing thickened sludge storage would be beneficial and dewatered cake storage would also increase system flexibility. A schematic diagram of a basic FBI system is provided in **Figure 4-1**.



**Figure 4-1. Incineration Schematic for FBI system**

An FBI incineration process would have many of the same benefits as the existing MHFs, including elimination of over 80 percent of the wastewater biosolids and producing a product that is acceptable to landfill. The process is proven at many installations throughout North America and permitting of the process is expected to be easier considering the Post Point Plant's incineration experience.

The incinerator would be a hot windbox FBI which would receive 1200° F preheated combustion air from the primary heat exchanger. Flue gas at 1550° F flows from the incinerator through the primary heat exchanger and is cooled to 1000° F. The flue gas is sent to the air pollution control system, which consists of venturi and impingement tray scrubbers for removal of particulate matter, metals and acid gases and a wet electrostatic precipitator (WESP) for additional removal of fine particulate matter. The exhaust from the WESP is drawn by an induced draft (ID) fan which discharges the cleansed gas to the stack. The stack gas is reheated to 220° F by the addition of the exhaust air from the fin coil heat exchanger. Reheating the stack gas is aesthetically desirable because it eliminates any water vapor plume from the stack. At this time, it appears likely that the existing WESPs and ID fan are adequately sized to handle the flue gas flow from the new FBI. However, a thorough inspection of the WESP and ID fan will have to be made (during the subsequent design phase) before a final determination on the suitability of these components can be made.

Unlike an MHF, all the ash from a FBI is carried out of the incinerator in the flue gas and is removed as a liquid slurry in the venturi scrubber water. The ash-laden scrubber water from the venturi scrubber will be sent to an ash thickener which will concentrate the ash to a 10 percent to 15 percent solids slurry which will then be pumped to a one-meter belt filter press for dewatering. The dewatered ash cake at 35 percent to 40 percent solids would then be discharged to an ash hauling truck.

### 4.3.3 Capacity

New FBI incinerators are typically sized between the maximum week and maximum month condition of the design year. In order to ensure adequate footprint for the components are available and to keep the analysis conservative in nature, CDM Smith has sized the incinerator for peak week conditions at 2,400 dry lb/hr. CDM Smith recommends that this size be revisited in the preliminary design stage to optimize project costs with processing capacity.

### 4.3.4 Space Footprint

A new FBI incinerator would be expected to have a space footprint of 4,100 ft<sup>2</sup>. Some of the existing facilities could be used and CDM Smith estimates that the solids handling facility and maintenance facility combined has more than enough room to accommodate the FBI and accompanying equipment.

### 4.3.5 Location of the New FBI

The size of the new FBI and its accompanying heat exchangers and air pollution control equipment presented some challenges in locating space for the new FBI system. A 2,400 dry lb/hr FBI will have an external freeboard diameter of approximately 20 feet and an overall height of approximately 41 feet. The following alternative locations for the FBI were considered:

1. Remove Incinerator 2 and install FBI in its place
2. Remove Incinerator 1 and install FBI in its place
3. Relocate Maintenance Shop Building and install FBI in its place

The building space required for the FBI has to be free of any building columns over a minimum 20 ft by 20 ft area. Given the space required by the new FBI and its auxiliary components, the building space occupied by Incinerator 2 is not sufficient. In addition, the height of the Solids Handling Building would have to extend over the FBI and the primary heat exchanger.

The building space occupied by Incinerator 1 has been determined to be adequate. However, major structural modifications of the building would be required and the building height around the incinerator would have to be raised. In addition, some of the space in the Maintenance Shop Building would be required to house some of the FBI's auxiliary components such as the fluidizing air blower, purge blower and preheat blower. Another disadvantage of this alternative is that it would require demolishing the incinerator (Incinerator 1) which possesses the better operating characteristics of the two MHFs, namely less fuel usage and less clinker formation. The plant staff has indicated that they would much prefer to demolish Incinerator 2 than Incinerator 1, even though Incinerator 2 is considerably younger than Incinerator 1.

The third alternative, location for the FBI in the Maintenance Shop Building, has ample space for the FBI and its heat exchangers and air pollution control system. In addition, neither of the existing MHFs would have to be demolished. The City could decide if and when either of these units would be removed. Thus, the City could use either unit as a standby unit for the new FBI. An additional benefit of siting the FBI in the Maintenance Shop Building is that there is adequate space to add power production equipment should it be desired in the future. A plan view of the FBI located in place of the existing Maintenance Shop Building is shown in **Figure 4-2**. Note that the existing Maintenance Shop Building would have to be essentially demolished and a new steel frame building erected in its place to house the new FBI system. Relocation of the Maintenance Shop Building has already been included as

an option in the ongoing plans for liquid stream upgrades at the Post Point Plant. Given the advantages of using the Maintenance Shop Building space, this location is recommended for the new FBI.

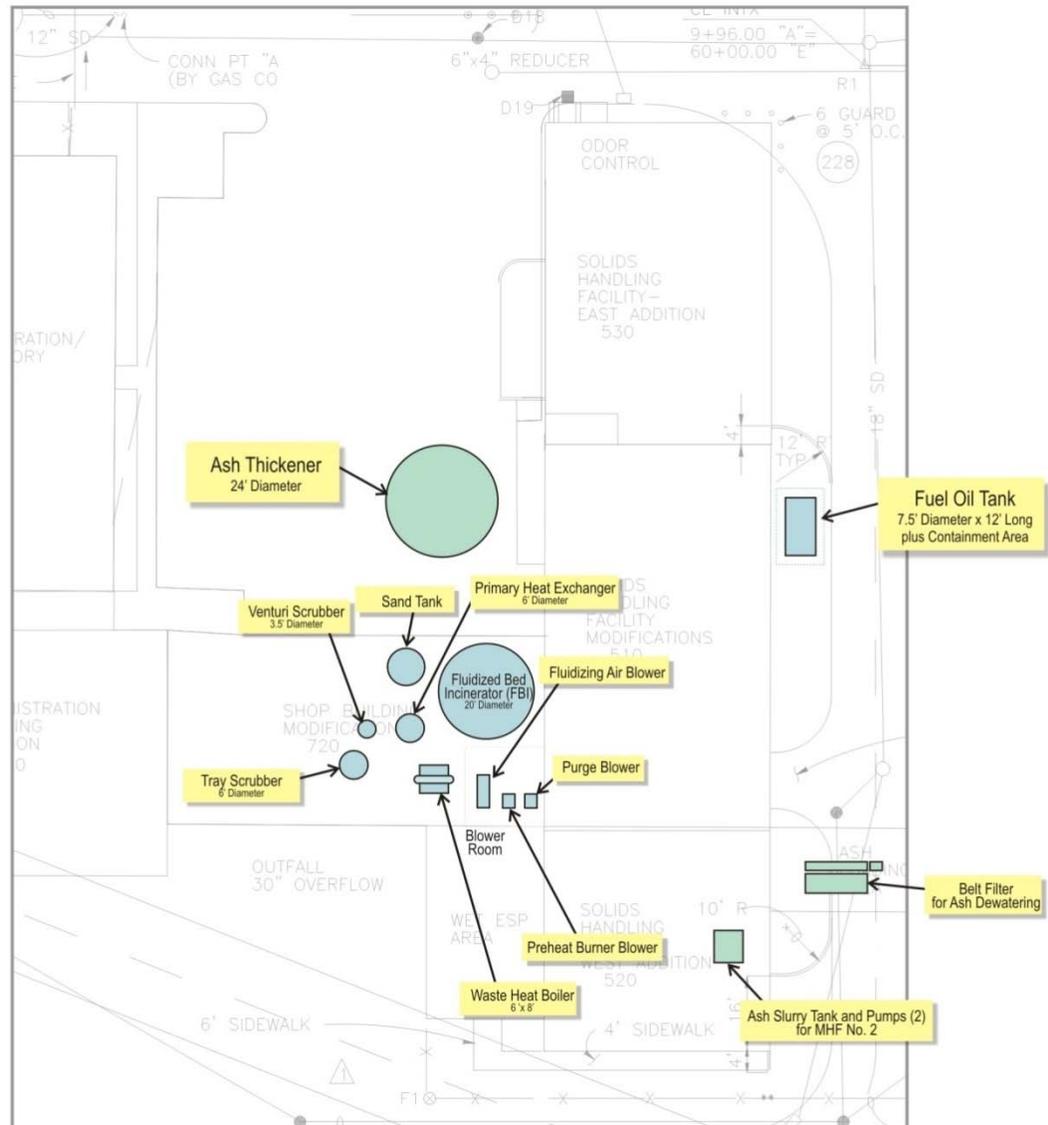


Figure 4-2. FBI Sited in Place of Existing Maintenance Shop Building

#### 4.3.6 Permitting Issues to Consider

Table 4-2 shows a summary of the emissions limits for new FBI units. Note that the emissions limits for new FBI units are far more stringent than those for MHFs, with the exception of the visible emissions of combustion ash from the ash conveying system, which are the same at  $\leq 5$  percent. Other than the numerical limits for the pollutant emissions, permitting regulations for fluidized bed incinerators are similar to those for multiple hearth incinerators (discussed above).

**Table 4-2. Emissions Limits for New Fluidized Bed Incineration Limits**

Pollutant	Units @ 7% O <sub>2</sub>	Emissions Limits for New FBI
Cd	mg/dscm	0.0011
CO	ppmvd	27
HCl	ppmvd	0.24
Hg	mg/dscm	0.0010
NO <sub>x</sub>	ppmvd	30
Pb	mg/dscm	0.00062
PCDD/PCDF TEQ	ng/dscm	0.013
PCDD/PCDF TMB	ng/dscm	0.0044
PM	mg/dscm	9.6
SO <sub>2</sub>	ppmvd	5.3

For new sewage sludge incineration units, compliance dates for emissions limits are within 60 days after the SSI unit reaches the feed rate at which it will operate, or within 180 days after initial startup, whichever is earlier. Operators of the new unit need to be trained within 6 months of the SSI unit startup, or before the employee assumes responsibility for supervising or operating the unit. A notification of construction (including a siting analysis) and notification of initial startup shall also be reported to the regulating authorities.

For other permitting considerations, please see **Appendix A** and the discussion of permitting issues for MHFs (above).

### 4.3.7 Carbon Footprint

A new FBI would be expected to require annual fuel inputs of 3,000 gallons of fuel oil or 4,400 therms of natural gas. If the incinerator is operated 24/7, space heating demands for the solids building are expected to be negligible. Electrical demand for the system will be about 2.4 million kWh per year. Disposal of the ash product at the local landfill is projected to require 5,800 gallons of diesel fuel per year to run the ash hauling trucks and freight trains. Overall, a new incinerator would emit 1,200 tons of fossil fuel-based carbon emissions per year.

### 4.3.8 O&M Costs

Operation and maintenance costs for the new FBI system consist primarily of routine preventative maintenance and scheduled repairs. Other costs include natural gas, electricity, dewatering polymer use, and ash hauling. The estimated yearly operating cost for the new FBI is \$1,100,000 per year.

### 4.3.9 Capital Cost

Capital costs for this alternative consist primarily of the Fluidized Incineration system and air pollution control equipment, ash handling system, and other electrical and mechanical components outside the vendor scope. The estimated capital cost for a new FBI system is approximately \$29,000,000.

### 4.3.10 Life Cycle Cost

The life cycle costs for this alternative assuming a 1% interest rate through 2035 is approximately \$51,000,000.

## 4.4 Anaerobic Digestion with Sludge Drying

### 4.4.1 Overview

There are alternatives to incineration for biosolids handling. For this study, a conceptual analysis of a sludge digestion, dewatering, and drying alternative was performed to give the Post Point plant direction for future planning.

### 4.4.2 Process Description

Anaerobic digestion is the most common method to stabilize wastewater biosolids. Anaerobic digestion relies on anaerobic microorganisms to break down the wastewater biosolids and biodegrade the solid compounds. The byproducts of anaerobic digestion are methane (CH<sub>4</sub>) and carbon dioxide (CO<sub>2</sub>). The CH<sub>4</sub> is often used to produce electrical power and hot water. The hot water is used to heat the sludge fed to the anaerobic digester and to maintain the digester temperature. Excess heat can be used for building heating.

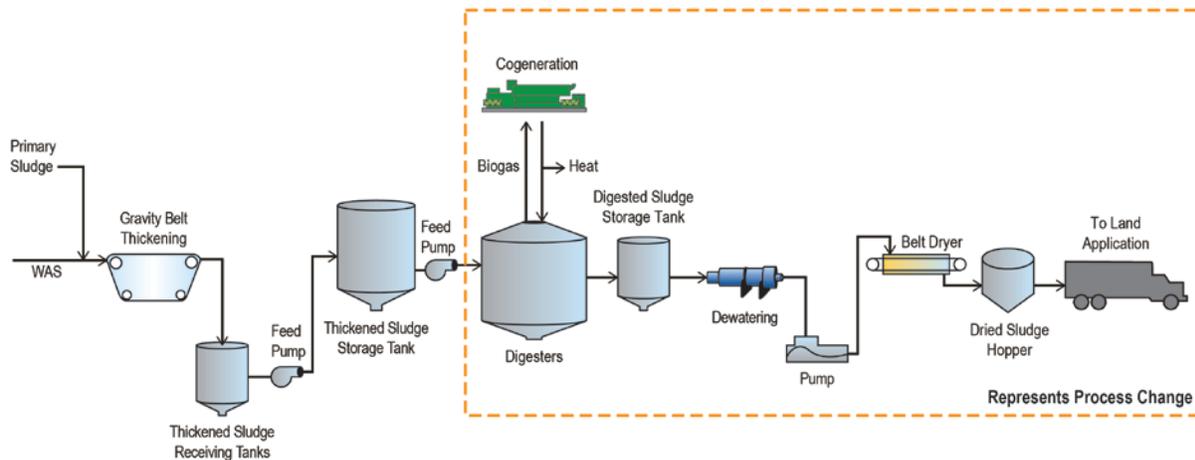
Most anaerobic digesters at municipal wastewater treatment facilities operate in the mesophilic temperature range, between 85 to 100 degrees F. However, thermophilic digestion, which occurs at temperatures between 120 and 135 degrees F, allows for shorter hydraulic residence times and has been shown to increase gas production and sludge dewaterability. Because of the tight space constraints at the Post Point plant, the proposed anaerobic digestion alternative consists of 4 thermophilic digesters operated in parallel. Because the digestion process is coupled with sludge drying, CDM Smith believes that thermophilic digestion is the optimal digestion approach.

Sludge drying is used to remove the water from wastewater biosolids. Typical wastewater sludges are 97 percent water. Dewatering is typically used to mechanically remove a significant portion of the water, leaving an intermediate product with only 75 to 80 percent water to be fed into the sludge dryer. The majority of sludge drying processes also incorporate anaerobic digestion between thickening and dewatering. The reduction in organic matter during digestion makes the dried product more stable and significantly reduces the probability of spontaneous combustion and fire hazards from the product. There is a growing trend of coupling digestion and drying processes with cogeneration. There is at least one United States facility and more than five European facilities that couple the processes. By coupling the processes, the biogas from the digester can be used to fuel the cogeneration facility and/or dryer. Exhaust from the cogeneration facility can be captured and used as a heat input into the dryer. Waste heat from the engine jacket water can be captured into a hot water loop and used to heat the digester and any space heating needs.

The sludge dryer proposed for this alternative is a low temperature belt dryer. Dewatered biosolids are distributed evenly on a belt and fed into a convective dryer where evaporation occurs when biosolids contact the heated air within the dryer chamber.

The dried product from the dryer facility would be classified as Class A biosolids. This classification would allow land application of the product on a larger variety of sources. It would also allow local citizens to purchase the product and apply to their home lawns.

A schematic representation of a sludge digestion and drying process is shown in **Figure 4-3**. Note that the dewatering process may only need to be relocated; otherwise, no changes to the dewatering process may be needed.



**Figure 4-3. Digestion with Drying Process Schematic**

#### 4.4.3 Capacity

The anaerobic digestion system for this alternative is sized to handle the peak week sludge condition of 2,400 dry lb/hr with one of the four digesters out of service. The net hydraulic retention time within the digesters at this condition is 8 days. Digested solids would then be dewatered using the existing dewatering equipment, which has sufficient capacity to handle the sludge loads (as discussed in **Section 2** above). The sludge dryer is designed to process the equivalent of approximately 4,200 dry lb/hr, which will provide Post Point plant with enough drying capacity to handle the peak day solids loading through 2035.

Being conscious of capital cost, only a single drying train has been included in this alternative. In the event of unexpected dryer failure, an additional sludge storage tank is included to store digested sludge until the dryer can be repaired. Unexpected dryer failures can typically be repaired within a couple days, provided the necessary spare parts are kept on-site. The proposed sludge storage tank is the same size as the proposed digesters and, in concert with the existing thickened sludge storage, will be capable of providing sludge storage for the 2035 peak 3-day sludge loading conditions. Additionally, the dryer has been oversized slightly to make up for any unexpected downtime that may be encountered during peak loading conditions.

#### 4.4.4 Space Footprint

Anaerobic digestion is typically carried out in large diameter tanks. For the Post Point Plant, CDM Smith estimates that 1.1 Mgal of tankage would be required, plus another 0.28 Mgal tank for sludge storage after digestion. The total footprint of new anaerobic digestion facilities, including a sludge drying facility and truck loadout area, is 23,000 ft<sup>2</sup>.

#### 4.4.5 Location of New Digesters

Anaerobic digestion would be installed just downstream of the existing gravity belt thickeners and upstream of sludge dewatering, as shown in **Figure 4-4**. The sludge dewatering centrifuges may need to be relocated to facilitate solids transfer from digestion to the dryer. In addition to the digestion

facilities themselves, the process would require a support building to house the pumps, heat exchangers, and piping associated with the process and a new pellet loadout facility adjacent to the dryer building.



Figure 4-4. Anaerobic Digestion with Sludge Drying Location

#### 4.4.6 Permitting Issues to Consider

Permitting this alternative would be easier than either of the incineration alternatives. The primary permitting needs are due to the cogeneration engine air emissions. However, if the biogas was instead conditioned to natural gas quality and used as vehicle fuel, the need for air permits could be circumvented.

#### 4.4.7 Carbon Footprint

A new anaerobic digestion facility with cogeneration and drying would require an estimated 380,000 therms of natural gas per year. The facility would be a net producer of electricity, generating an estimated 4.1 million kWh per year. However, an estimated 7,000 gallons of diesel fuel per year would be required to haul the dewatered biosolids to land application sites. The estimate of diesel fuel is based on application of the dried biosolids within 80 miles of the facility. Overall, a new anaerobic digestion process with drying would emit approximately 770 tons/yr of carbon dioxide equivalents per year.

#### 4.4.8 O&M costs

Operation and maintenance costs for the new digestion system consist primarily of routine preventative maintenance and scheduled repairs. Other costs include natural gas, electricity, dewatering polymer use, and pellet hauling. The estimated yearly operating cost for the new digestion and drying system is \$1,300,000 per year.

#### 4.4.9 Capital Cost

The cost of a new anaerobic digestion facility with cogeneration and sludge drying is expected to be approximately \$21 million. This cost is based on similar projects and does not include site specific considerations that may increase or decrease the facility cost. Further, the cost does not include any modifications to sludge thickening or dewatering that may be required at the Post Point Plant. Due to space constraints around the existing sludge handling building, it is likely that the new digester facilities would be located remotely. This in turn may predicate moving either sludge thickening and/or dewatering to a location adjacent to the new digester facilities. The cost of this relocation is not included in the above costs. Including an allowance of \$5 million dollars to relocate dewatering and construct a new truck loadout facility, the cost of this alternative increases to \$26 million.

#### 4.4.10 Life Cycle Cost

The life cycle cost for this alternative assuming a 1% interest rate through 2035 is approximately \$52,000,000.

### 4.5 Summary of Biosolids and Energy Alternatives

A summary of the important considerations for each of the biosolids and energy alternatives evaluated in this report are provided in **Table 4-3**. Further information for all categories can be found in the Sections above.

**Table 4-3. Summary of Important Considerations for Biosolids and Energy Alternatives**

Consideration	Continued Operation of Existing MHFs	New FBI System	Digestion and Drying with CHP
Footprint	3,300 ft <sup>2</sup>	4,100 ft <sup>2</sup>	30,000 ft <sup>2</sup>
Capital Cost(s)	\$6,000,000 for air emissions treatment, installed as soon as possible <sup>1</sup>  \$29,000,000 (net present cost) for replacement of MHFs in year 2025 <sup>2</sup>	\$29,000,000	\$26,000,000
O&M Cost	\$1,300,000/yr through year 2025, \$1,100,000/yr thereafter	\$1,100,000/yr	\$1,300,000/yr
Net Present Cost (i = 1%)	\$60,000,000	\$51,000,00	\$52,000,000
Unit Cost	\$410/dry ton	\$350/dry ton	\$360/dry ton
Carbon Footprint	1,700 tons/yr of CO <sub>2</sub> e	1,200 tons/yr of CO <sub>2</sub> e	770 tons/yr of CO <sub>2</sub> e
Public Acceptance Issues	Because this alternative is simply a continuation of current practices, public acceptance should not change from current levels.	<u>May present the most challenges in terms of public acceptance.</u> The City of Bellingham has a reputation as a "green" community, and because incineration processes have a negative environmental connotation, significant public backlash could be expected if a new incineration system is pursued.	May be considered the "greenest" alternative, and will most likely rank highest in public acceptance. Anaerobic digestion, when combined with cogeneration equipment, provides a means of heat and electricity production from biosolids. This option is a net producer of electricity and has the lowest expected carbon footprint.
Redundancy and Reliability Issues	A redundant incinerator is provided as long as both MHFs are kept in service throughout the study period. However, a single redundant unit is not sufficient to handle the solids loadings beyond year 2019. If incineration is not available, raw dewatered cake would have to be hauled and disposed, which is typically more difficult and expensive to coordinate with haulers. <u>It is also unlikely that the current MHFs will last until year 2035, thus alternative handling strategies may need to be pursued midway through the study period.</u>	The proposed FBI is capable of processing peak week solids loadings through 2035, which is significantly more capacity than provided by the current incineration system. However, if the incinerator was unavailable for service, raw dewatered cake would have to be hauled and disposed, which is typically more difficult and expensive to coordinate with haulers.	The digester system is designed to process peak loadings in year 2035 with one redundant unit, thus it is unlikely that digestion will become unavailable. If the dryer becomes unavailable, the system could still produce dewatered digester solids. Because the solids are digested, it would be easier to find a hauler and recipient for the biosolids product, compared to the raw dewatered product generated in the incineration alternatives.
Air Permitting Issues	See Section 4.2.8 for a detailed description of air permitting issues. Most importantly, stack testing should be performed to determine what actions, if any, are required to comply with the applicable air emissions standards. There is also <u>significant uncertainty about future regulations.</u> Revisions to the current CAA 129 regulations could force more expensive upgrades in the future.	See Sections 4.2.8 and 4.3.6 for a detailed description of air permitting issues. Note that <u>emissions limits for new FBIs are extremely stringent.</u> However, the new FBI system is guaranteed by the manufacturer to achieve compliance with the current CAA 129 regulations.	Only the CHP engine would need to be permitted for air emissions. The permitting process for this equipment is relatively straightforward and is expected to be much easier compared to the incineration alternatives.

Consideration	Continued Operation of Existing MHFs	New FBI System	Digestion and Drying with CHP
Energy Efficiency	Not expected to produce any electricity and will not improve the energy efficiency of the Post Point plant.	Not expected to produce any electricity and will not significantly improve the energy efficiency of the Post Point plant.	Expected to produce approximately (470 kW) 4.1 million kWh/yr of electricity. This alternative will be a net producer of electricity, thus improving the energy efficiency of the plant.
Mass and Quality of Hauled Material	Approximately 2,000 tons/yr (270 truckloads per year) of ash will be hauled from the Post Point Plant. Because the ash is a low-value byproduct, it will most likely continue to be disposed in a landfill.	Approximately 3,500 tons/yr (470 truckloads per year) of ash will be hauled from the Post Point Plant. Because the ash is a low-value byproduct, it will most likely continue to be disposed in a landfill.	Approximately 3,800 tons/yr (510 loads per year) of dried, Class A solids would be produced. Because the biosolids are a valuable product, it may be possible to distribute the product within the local community. The biosolids could be marketed to produce a revenue stream to offset some of the cost of biosolids handling.

Notes:

<sup>1</sup>It is possible that additional air pollution control equipment will not be required for this alternative. If that is the case, this cost could be excluded from the analysis.

<sup>2</sup>Because it is unlikely that the current MHFs will last until year 2035, it was assumed that an FBI system would be installed in the future to replace the current MHFs.

Regarding the continued use of the existing MHFs, it is important to note that there is some uncertainty about the future of the CAA 129 regulations and how they apply to multiple hearth incinerators. Further, the existing MHFs are relatively old and may not last until year 2035. As noted above, the current average annual sludge loadings are surpassing the capacity of each incinerator, thus the incinerators will either need to be operated above their design capacity, or operated simultaneously, to process the incoming sludge. However, depending on how long the MHFs will last, this option may be the cheapest from a capital cost standpoint and would prevent significant changes to the status quo. This option also has the lowest space footprint.

Although a new FBI system would have a relatively small footprint and the lowest operating costs of the alternatives, the capital and net present costs are the highest. Additionally, the CAA 129 regulations for a new FBI system are extremely stringent, which accounts for the high capital cost. Public acceptance of a new incineration system is also expected to be very low due to the negative environmental connotation of incineration technology.

An anaerobic digestion system coupled with drying and CHP would have the largest footprint and ranks in the middle of the alternatives for costs. However, this option may be considered the “greenest” because of the low carbon footprint and potential to produce heat and electricity as byproducts of the process. The proposed digester system is very robust and offers significant redundancy to prevent downtime of the biosolids processing system. This option would also be the easiest to permit.

Appendix A – USEPA Standards of Performance for New Stationary Sources and Emission Guidelines for Existing Sources: Sewage Sludge Incineration (SSI) Units; Final Rule, 40 CFR 60 Subparts LLLL and MMMM, (“SSI MACT Rule”).

Appendix B – USEPA 40 CFR Part 60, Appendix A-7: Method 22 visible emissions testing

# Appendix A





# FEDERAL REGISTER

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Part II

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40 CFR Part 60

Standards of Performance for New Stationary Sources and Emission  
Guidelines for Existing Sources: Sewage Sludge Incineration Units; Final  
Rule

**ENVIRONMENTAL PROTECTION AGENCY****40 CFR Part 60**

[EPA-HQ-OAR-2009-0559; FRL-9272-9]

RIN 2060-AP90

**Standards of Performance for New Stationary Sources and Emission Guidelines for Existing Sources: Sewage Sludge Incineration Units****AGENCY:** Environmental Protection Agency (EPA).**ACTION:** Final rule.

**SUMMARY:** This action promulgates EPA's new source performance standards and emission guidelines for sewage sludge incineration units located at wastewater treatment facilities designed to treat domestic sewage sludge. This final rule sets limits for nine pollutants under section 129 of the Clean Air Act: Cadmium, carbon monoxide, hydrogen chloride, lead, mercury, nitrogen oxides, particulate matter, polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans, and sulfur dioxide.

**DATES:** The final rule is effective on May 20, 2011. The incorporation by reference of certain publications listed in the rule is approved by the Director of the Federal Register as of May 20, 2011.

**ADDRESSES:** EPA established a single docket under Docket ID No. EPA-HQ-OAR-2009-0559 for this action. This docket includes previous actions including the standards proposed on October 14, 2010 (75 FR 63260) and a supplemental notice issued on November 5, 2010 (75 FR 68296). All documents in the docket are listed on the <http://www.regulations.gov> Web site. Although listed in the index, some information is not publicly available, e.g., confidential business information or other information whose disclosure is restricted by statute. Certain other material, such as copyrighted material, is not placed on the Internet and will be publicly available only in hard copy form. Publicly available docket materials are available either electronically through <http://www.regulations.gov> or in hard copy at EPA's Docket Center, Public Reading Room, EPA West Building, Room 3334, 1301 Constitution Avenue, NW., Washington, DC 20004. This Docket Facility is open from 8:30 a.m. to 4:30 p.m., Monday through Friday, excluding legal holidays. The telephone number for the Public Reading Room is (202) 566-1744, and the telephone number for the EPA Docket Center is (202) 566-1742.

**FOR FURTHER INFORMATION CONTACT:** Ms. Amy Hambrick, Natural Resource and Commerce Group, Sector Policies and Programs Division (E143-03), Environmental Protection Agency, Research Triangle Park, North Carolina 27711; telephone number: (919) 541-0964; fax number: (919) 541-3470; e-mail address: [hambrick.amy@epa.gov](mailto:hambrick.amy@epa.gov).

**SUPPLEMENTARY INFORMATION:**

*Acronyms and Abbreviations.* The following acronyms and abbreviations are used in this document.

7-PAH 7-Polycyclic Aromatic Hydrocarbons  
 ANSI American National Standards Institute  
 As Arsenic  
 ASME American Society of Mechanical Engineers  
 ASTM American Society of Testing and Materials  
 CAA Clean Air Act  
 CASS Continuous Automated Sampling System  
 CBI Confidential Business Information  
 Cd Cadmium  
 CDX Central Data Exchange  
 CEMS Continuous Emissions Monitoring Systems  
 COMS Continuous Opacity Monitoring System  
 The Court U.S. Court of Appeals for the District of Columbia Circuit  
 CPMS Continuous Parametric Monitoring System  
 CFR Code of Federal Regulations  
 CISWI Commercial and Industrial Solid Waste Incineration  
 CO Carbon Monoxide  
 Cr Chromium  
 CWA Clean Water Act  
 EG Emission Guidelines  
 EJ Environmental Justice  
 ERT Electronic Reporting Tool  
 ESP Electrostatic Precipitators  
 FF Fabric Filter  
 FB Fluidized Bed  
 FGR Flue Gas Recirculation  
 HAP Hazardous Air Pollutants  
 HCl Hydrogen Chloride  
 Hg Mercury  
 HMIWI Hospital, Medical and Infectious Waste Incineration  
 ICR Information Collection Request  
 ISTDMS Integrated Sorbent Trap Dioxin Monitoring System  
 ISTMMS Integrated Sorbent Trap Mercury Monitoring System  
 LML Lowest Measured Level  
 MACT Maximum Achievable Control Technology  
 Mg/dscm Milligrams per Dry Standard Cubic Meter  
 MH Multiple Hearth  
 Mn Manganese  
 MWC Municipal Waste Combustion  
 NAAQS National Ambient Air Quality Standards  
 NAICS North American Industrial Classification System  
 Ng/dscm Nanograms per Dry Standard Cubic Meter  
 Ni Nickel  
 NO<sub>x</sub> Nitrogen Oxides

NPRM Notice of Proposed Rulemaking  
 NSPS New Source Performance Standards  
 NTAA National Tribal Air Association  
 NTTAA National Technology Transfer and Advancement Act of 1995  
 OAQPS Office of Air Quality Planning and Standards  
 O&M Operation and Maintenance  
 OMB Office of Management and Budget  
 OP Office of Policy  
 OSWI Other Solid Waste Incineration  
 OTM Other Test Method  
 OW Office of Water  
 Pb Lead  
 PCB Polychlorinated Biphenyls  
 PCDD/PCDF Polychlorinated Dibenzo-P-Dioxins and Polychlorinated Dibenzofurans  
 PM Particulate Matter  
 POM Polycyclic Organic Matter  
 POTW Publicly Owned Treatment Works  
 PPM Parts per Million  
 PPMV Parts per Million by Volume  
 PPMVD Parts per Million of Dry Volume  
 PRA Paperwork Reduction Act  
 PS Performance Specifications  
 RCRA Resource Conservation and Recovery Act  
 RFA Regulatory Flexibility Act  
 RIA Regulatory Impact Analysis  
 RTO Regenerative Thermal Oxidizer  
 SBA Small Business Administration  
 SCR Selective Catalytic Reduction  
 SNCR Selective Non-Catalytic Reduction  
 SO<sub>2</sub> Sulfur Dioxide  
 SSI Sewage Sludge Incineration  
 SSM Startup, Shutdown, and Malfunction  
 TEF Toxic Equivalency Factor  
 TEQ Toxic Equivalency  
 THC Total Hydrocarbons  
 TMB Total Mass Basis  
 TPD Tons per Day  
 TPY Tons per Year  
 TTN Technology Transfer Network  
 UL Upper Limit  
 UMRA Unfunded Mandates Reform Act of 1995  
 UPL Upper Prediction Limit  
 VCS Voluntary Consensus Standards  
 WWW Worldwide Web

*Organization of This Document.* The following outline is provided to aid in locating information in this preamble.

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- G. Executive Order 13045: Protection of Children From Environmental Health and Safety Risks
- H. Executive Order 13211: Actions That Significantly Affect Energy Supply, Distribution, or Use
- I. National Technology Transfer and Advancement Act
- J. Executive Order 12898: Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations

**I. General Information**

*A. Does this action apply to me?*

Categories and entities potentially affected by the final action are those that operate sewage sludge incinerators (SSI). Although there is no specific NAICS code for SSI, these units may be operated by wastewater treatment facilities designed to treat domestic sewage sludge. The following NAICS codes could apply:

Category	NAICS code	Examples of potentially regulated entities
Solid waste combustors and incinerators .....	562213	Municipalities with SSI units.
Sewage treatment facilities .....	221320	

This table is not intended to be exhaustive, but rather provides a general guide for identifying entities likely to be affected by the final action. To determine whether your facility would be affected by the final action, you should examine the applicability criteria in 40 CFR 60.4770 of subpart LLLL and proposed 40 CFR 60.5005 of subpart MMMM. If you have any questions regarding the applicability of the final action to a particular entity, contact the person listed in the preceding **FOR FURTHER INFORMATION CONTACT** section.

*B. Where can I get a copy of this document?*

In addition to being available in the docket, an electronic copy of the final action will also be available on the WWW through the TTN. Following signature, a copy of the final action will be posted on the TTN's policy and guidance page for newly proposed or promulgated rules at the following address: <http://www.epa.gov/ttn/oarpg/>. The TTN provides information and technology exchange in various areas of air pollution control.

*C. Judicial Review*

Under CAA section 307(b)(1), judicial review of this final rule is available only by filing a petition for review in the Court by May 20, 2011. Section 307(d)(7)(B) of the CAA further provides

that “only an objection to this final rule that was raised with reasonable specificity during the period for public comment can be raised during judicial review.” This section also provides a mechanism for EPA to convene a proceeding for reconsideration, “[i]f the person raising an objection can demonstrate to EPA that it was impracticable to raise such objection within [the period for public comment] or if the grounds for such objection arose after the period for public comment (but within the time specified for judicial review) and if such objection is of central relevance to the outcome of this rule.” Any person seeking to make such a demonstration to EPA should submit a Petition for Reconsideration to the Office of the Administrator, Environmental Protection Agency, Room 3000, Ariel Rios Building, 1200 Pennsylvania Ave., NW., Washington, DC 20004, with a copy to both of the contacts listed in the preceding **FOR FURTHER INFORMATION CONTACT** section, and the Associate General Counsel for the Air and Radiation Law Office, Office of General Counsel (Mail Code 2344A), Environmental Protection Agency, 1200 Pennsylvania Ave., NW., Washington, DC 20004. Note, under CAA section 307(b)(2), the requirements established by this final rule may not be challenged separately in any civil or criminal proceedings brought by EPA to enforce these requirements.

**II. Background**

*A. What is the statutory background for this final rule?*

Section 129 of the CAA, entitled, “Solid Waste Combustion,” requires EPA to develop and adopt standards for solid waste incineration units pursuant to CAA sections 111 and 129. Section 129(a)(1)(A) of the CAA requires EPA to establish performance standards, including emission limitations, for “solid waste incineration units.” Section 129 of the CAA defines “solid waste incineration unit” as “a distinct operating unit of any facility which combusts any solid waste material from commercial or industrial establishments or the general public” (section 129(g)(1)). Section 129 of the CAA also provides that “solid waste” shall have the meaning established by EPA pursuant to its authority under the RCRA (section 129(g)(6)). Sections 111(b) and 129(a) of the CAA address emissions from new units (*i.e.*, NSPS), and CAA sections 111(d) and 129(b) address emissions from existing units (*i.e.*, EG). The NSPS are directly enforceable Federal regulations, and under CAA section 129(f)(1), become effective 6 months after promulgation. Unlike the NSPS, the EG are not themselves directly enforceable. Rather, the EG are implemented and enforced through either an EPA-approved state plan or a promulgated Federal plan.

States are required to submit a plan to implement and enforce the EG to EPA for approval not later than 1 year after EPA promulgates the EG (CAA section 129(b)(2)). The state plan must be "at least as protective as" the EG and must ensure compliance with all applicable requirements not later than 3 years after the state plan is approved by EPA, or 5 years after promulgation of the relevant EG, whichever is sooner. EPA's procedures for submitting and approving state plans are set forth in 40 CFR part 60, subpart B. When a state plan is approved by EPA, the plan requirements become federally enforceable, but the state has primary responsibility for implementing and enforcing the plan. However, EPA is required to develop, implement, and enforce a Federal plan for solid waste incineration units located in any state which has not submitted an approvable state plan within 20 years after the date of promulgation of the relevant EG (CAA section 129(b)(3)). The Federal plan must assure that each solid waste incineration unit subject to the Federal plan is in compliance with all provisions of the EG not later than 5 years after the date the relevant guidelines are promulgated. EPA views the Federal plan as a "place-holder" that remains in effect only until such time as a state without an approved plan submits and receives EPA approval of its state plan. Once an applicable state plan has been approved, the requirements of the Federal plan no longer apply to solid waste incineration units covered by that state plan.

The CAA sets forth a two-stage approach to regulating emissions from solid waste incinerator units. The statute also provides EPA with substantial discretion to distinguish among classes, types, and sizes of incineration units within a category while setting standards. In the first stage of setting standards, CAA section 129(a)(2) requires EPA to establish technology-based emission standards that reflect levels of control EPA determines are achievable for new and existing units, after considering costs, nonair quality health and environmental impacts and energy requirements associated with the implementation of the standards. Section 129(a)(5) of the CAA then directs EPA to review those standards and revise them as necessary every 5 years. In the second stage, CAA section 129(h)(3) requires EPA to determine whether further revisions of the standards are necessary in order to provide an ample margin of safety to protect public health.

In setting forth the methodology EPA must use to establish the first-stage

technology-based standards for the standards, CAA section 129(a)(2) provides that standards "applicable to solid waste incineration units promulgated under section 111 and this section shall reflect the maximum degree of reduction in emissions of [certain listed air pollutants] that the Administrator, taking into consideration the cost of achieving such emission reduction and any nonair quality health and environmental impacts and energy requirements, determines is achievable for new and existing units in each category." This level of control is referred to as a MACT standard.

In promulgating a MACT standard, EPA must first calculate the minimum stringency levels for new and existing solid waste incineration units in a category, generally based on levels of emissions control achieved or required to be achieved by the subject units. The minimum level of stringency is called the MACT "floor," and CAA section 129(a)(2) sets forth differing levels of minimum stringency that EPA's standards must achieve, based on whether they regulate new and reconstructed sources, or existing sources. For new and reconstructed sources, CAA section 129(a)(2) provides that the "degree of reduction in emissions that is deemed achievable \* \* \* shall not be less stringent than the emissions control that is achieved in practice by the best controlled similar unit, as determined by the Administrator." Emissions standards for existing units may be less stringent than standards for new units, but "shall not be less stringent than the average emissions limitation achieved by the best performing 12 percent of units in the category."

Maximum Achievable Control Technology analyses involve an assessment of the emissions from the best performing unit or units in a source category. The assessment can be based on actual emissions data, knowledge of the air pollution control in place in combination with actual emissions data, state regulatory requirements that may enable EPA to estimate the actual performance of the regulated units, or other emissions information. For each source category, the assessment involves a review of actual emissions data with an appropriate accounting for emissions variability. Other methods of estimating emissions can also be used, if the methods can be shown to provide reasonable estimates of the actual emissions performance of a source or sources. In addition to the MACT floor limit, EPA must examine whether more stringent "beyond-the-floor" standards should be adopted. In considering

whether such standards are appropriate, EPA must consider the cost of achieving such emission reduction, and any non-air quality health and environmental impacts and energy requirements. The CAA requires that the MACT floor for new sources be no less stringent than the emissions control achieved in practice by the best-controlled similar unit. EPA is also required to consider beyond-the-floor standards for new sources, consistent with the factors described above. Clean Air Act section 129(a)(1) identifies five categories of solid waste incineration units:

- Units that combust municipal waste at a capacity greater than 250 tpd.
- Units that combust municipal waste at a capacity equal to or less than 250 tpd.
- Units that combust hospital, medical, and infectious waste.
- Units that combust commercial or industrial waste.
- Units that combust waste and which are not specifically identified in section 129(a)(1)(A) through (D) are referred to in section 129(a)(1)(E) as "other categories" of solid waste incineration units.

A SSI unit is an incinerator located at a wastewater treatment facility designed to treat domestic sewage sludge that combusts sewage sludge for the purpose of reducing the volume of the sewage sludge by removing combustible matter. Sewage sludge incinerators, by virtue of having not been specifically identified in section 129(a)(1)(A) through (D), have been interpreted to be part of the broader category of "other categories" of solid waste. EPA has issued emission standards for large and small MWC, HMIWI, CISWI, and OSWI units; however, as explained further below, none of those emission standards apply to SSI units.

EPA issued emission standards for OSWI units on December 16, 2005 (70 FR 74870). Based on EPA's interpretation of the CAA at that time, the OSWI standards did not include emission standards for SSI units. EPA received a petition for reconsideration of the OSWI standards on February 14, 2006, regarding the exclusion of certain categories, including SSI.<sup>1</sup> While EPA granted the petition for reconsideration on June 28, 2006, EPA's final review, which became effective January 22, 2007, concluded that no additional changes were necessary to the 2005 OSWI rule (71 FR 36726). That litigation is currently being held in abeyance. EPA currently intends to revise the emission standards for OSWI units in the future,

<sup>1</sup> *Sierra Club v. EPA*; DC Cir. Nos. 06-1066, 07-1063.

and that rulemaking will address all OSWI units except SSI units.

In the OSWI rule issued on December 16, 2005, EPA stated that it had decided not to regulate SSI units under CAA section 129 (70 FR 74870), but rather to regulate SSI units under CAA section 112, pointing to a statement in EPA's 2000 Unified Regulatory Agenda stating that sewage sludge incinerators do not combust waste from a commercial or industrial establishment or the general public. We declined to revise that decision to regulate SSI units under 112 in the response to the petition for reconsideration on this issue for five reasons, including our position that section 129(a)(1)(E) did not require regulation of all "other" solid waste incineration units and that section 129(g)(1)'s enumerated exemptions to the definition of "solid waste incineration unit" were not exclusive, and that section 129(h)(2) gave EPA the discretion to choose whether to regulate incinerators under section 112 or section 129 of the Act. (72 FR 2620). In June 2007, in a separate decision related to EPA's December 1, 2000, emission standards for CISWI units, the Court held that any unit combusting any solid waste must be regulated under section 129 of the CAA. The impact of this decision on EPA's regulation of SSI is explained in detail in the NPRM.<sup>2</sup>

EPA considers SSI units to be "other solid waste incineration units," since that category is intended to encompass all solid waste incineration units that are not included in the first four categories identified in CAA section 129(a) through (d). EPA plans to re-issue emission standards for the remaining OSWI units at a later time. EPA is taking final action on emission standards for SSI units at this time because these emission standards are needed as part of EPA's fulfillment of its obligations under CAA sections 112(c)(3) and (k)(3)(B)(ii) and section 112(c)(6). Clean Air Act section 112(k)(3)(B)(ii) calls for EPA to identify at least 30 HAP which, as the result of emissions from area sources, pose the greatest threat to public health in the largest number of urban areas. EPA must then ensure that sources representing 90 percent of the aggregate area source emissions of each of the 30 identified HAP are subject to standards pursuant to section 112(d).<sup>3</sup> Sewage sludge incineration units are one of the source categories identified for regulation to meet the 90 percent requirement for Cd, Cr, Pb, Mn, Hg, Ni and PCB. EPA is ordered by the Court

to satisfy its obligation under CAA section 112(c)(3) and (k)(3)(B)(ii) by January 16, 2011.<sup>4</sup>

In a notice on April 10, 1998, EPA provided a list of source categories for regulation under CAA section 112(d)(2) or 112(d)(4). Section 112(c)(6) of the CAA requires EPA to identify categories of sources of seven specified pollutants to assure that sources counting for not less than 90 percent of the aggregate emissions of each such pollutant are subject to standards under CAA section 112(d)(2) or 112(d)(4) (63 FR 17838). Sewage sludge incineration units are one of the identified source categories for regulation to meet the 90 percent requirement for Hg. Further information can be found in the Memorandum titled, "Emission Standards for Meeting the Ninety Percent Requirement under Section 112(c)(6) of the Clean Air Act" in the SSI docket (EPA-HQ-OAR-2009-0559). Therefore, EPA is finalizing the SSI standards prior to taking action on the remaining source categories that will be regulated under CAA section 129(a)(1)(E) as OSWI units.

#### *B. What are the primary sources of emissions and what are the emissions?*

Sewage sludge incineration units may be operated by municipalities or other entities. Incineration continues to be used to dispose of sewage sludge. Combustion of solid waste, and specifically sewage sludge, causes the release of a wide array of air pollutants, some of which exist in the waste feed material and are released unchanged during combustion, and some of which are generated as a result of the combustion process itself. The pollutants for which numerical limits must be established, as specified in section 129 of the CAA, include Cd, CO, HCl, Hg, NO<sub>x</sub>, PCDD/PCDF, PM, Pb, and SO<sub>2</sub>; and, where appropriate, numerical limits for opacity must also be established. These emissions come from the SSI unit's stack and fugitive PM emissions, as indicated by the associated visible emissions, also occur from ash handling.

#### *C. What is the relationship of the final standards to other standards for the use or disposal of sewage sludge and associated air emissions?*

Under authority of section 405(d) and (e) of the CWA, as amended 33 U.S.C.A. 1251, (*et seq.*), EPA promulgated regulations on February 19, 1993, at 40 CFR part 503 designed to protect public health and the environment from any reasonably anticipated adverse effects of certain pollutants that may be present in

sewage sludge. The part 503 regulations establish requirements for the final use and disposal of sewage sludge when: (1) The sludge is applied to the land for a beneficial use (*e.g.*, for use in home gardens); (2) the sludge is disposed on land by placing it on surface disposal sites; and (3) the sewage sludge is incinerated. The standards apply to POTW that generate or treat domestic sewage sludge, as well as to any person who uses or disposes of sewage sludge from such treatment works.

The part 503 requirements for firing sewage sludge in a SSI are in subpart E of the regulations. Subpart E includes general requirements; pollutant limits; operational standards; management practices; and monitoring, recordkeeping, and reporting requirements.

These part 503 regulations require that SSI meet the National Emission Standards for Beryllium and Hg in subparts C and E, respectively, of 40 CFR part 61. The regulations also require that the allowable concentration of five other inorganic pollutants be calculated using equations in the regulation. The inorganic pollutants included are Pb, As, Cd, Cr, and Ni. The terms in the equations must be determined on a case-by-case basis, except for the risk-specific concentration for the inhalation exposure pathway to protect individuals when these pollutants are inhaled. The site-specific variables for the equations (incinerator type, dispersion factor, control efficiency, feed rate, and stack height) must be used to calculate allowable daily concentrations of As, Cd, Cr, Pb and Ni in the sewage sludge fed to the incinerator.

Also included in subpart E of part 503 is an operational standard for THC. The value for THC in the final part 503 regulation cannot be exceeded in the exit gas from the SSI stack. Management practices and frequency of monitoring, recordkeeping, and reporting requirements are also included in this subpart.

Under today's final standards, EPA is establishing limits for three of the inorganic pollutants covered by the current part 503 regulations (Cd, Pb and Hg) and the following six additional pollutants: HCl, CO, NO<sub>x</sub>, SO<sub>2</sub>, PM, and total PCDD/PCDF. Besides the pollutants covered here, there are other differences between the part 503 regulations and these final standards. The emission limits for inorganic pollutants under part 503 are risk-based numbers rather than technology-based. Also, part 503 does not distinguish between new and existing units or between incinerator types (*i.e.*, MH or

<sup>2</sup> *NRDC v. EPA*, 489 F. 3d. at 1257–8.

<sup>3</sup> CAA section 112(c)(3) and section 112(k)(3)(B)(ii).

<sup>4</sup> *Sierra Club v. Jackson*; D.DC No. 1:01CV01537.

FB incinerator) for setting emission limits since emission limits are based on risks to a highly exposed individual.

Because both part 503 and these final standards cover the same universe of facilities, there are certain issues that arise in terms of potential impacts to current SSI facilities. First, the regulation of sewage sludge under CAA section 129 will result in stricter emission standards than under the current CWA rule. Additional pollution controls will increase costs for facilities that continue to use the incineration disposal method. If the additional costs are high enough, many entities may choose to adopt alternative disposal methods (e.g., surface disposal in landfills or other beneficial land applications). Consequently, a potential impact of this rule is that some of the estimated 110 facilities that operate SSI as the primary means of disposal could discontinue this practice and would instead landfill or land apply their sewage sludge. Second, one must consider the available capacity of surface disposal sites to receive additional sewage sludge and the potential for added costs if the use of SSI is discontinued. Third, SSI will be subject to two different sets of requirements (numeric standards, operational standards, monitoring, recordkeeping, and reporting) under the two different statutes, creating an additional burden to these facilities unless alternative regulatory approaches

are implemented. EPA plans to evaluate the requirements under both statutes to determine what changes, if any, should be made to the part 503 regulations.

**III. Summary of the Final Standards**

This preamble discusses the final standards as they apply to the owner or operator of a new or existing SSI unit. This preamble also describes the major requirements of the SSI regulations. For a full description of the final requirements and compliance times, see the SSI standards in subparts LLLL and MMMM.

*A. What units are affected by the final standards?*

The final standards and guidelines apply to owners or operators of SSI units (as defined in 40 CFR 60.4780 and 40 CFR 60.5065) located at wastewater treatment facilities designed to treat domestic sewage sludge. A SSI unit is an enclosed device or devices using controlled flame combustion that burns sewage sludge for the purpose of reducing the volume of the sewage sludge by removing combustible matter. A SSI unit also includes, but is not limited to, the sewage sludge feed system, auxiliary fuel feed system, grate system, flue gas system, waste heat recovery equipment, if any, and bottom ash system. The SSI unit includes all ash handling systems connected to the bottom ash handling system. The combustion unit bottom ash system

ends at the truck loading station or similar equipment that transfers the ash to final disposal. The SSI unit does not include air pollution control equipment or the stack. The affected facility is each individual SSI unit. The SSI standards in subparts LLLL and MMMM apply to new and existing SSI units that burn sewage sludge as defined in the subparts. The final standards define two subcategories for new and existing SSI units: MH incinerators and FB incinerators.

The combustion of sewage sludge that is not burned in a SSI unit located at a wastewater treatment facility designed to treat domestic sewage sludge is subject to other section 129 standards, such as the CISWI standards (40 CFR part 60, subparts CCCC and DDDD of this part), the OSWI standards (40 CFR part 60, subparts EEEE and FFFF), the MWC standards (40 CFR part 60, subparts Ea, Eb, Cb, AAAA, and BBBB of this part) or the Hazardous Waste Combustor rule (40 CFR part 63 subpart EEE).

*B. What are the emission limits in the emission guidelines for existing sources?*

The final emission limits for existing sources in the MH incinerator subcategory and FB incinerator subcategory are presented in Table 1 of this preamble. Existing sources may comply with either the PCDD/PCDF TEQ or TMB emission limits.

These standards apply at all times.

TABLE 1—EMISSION LIMITS FOR EXISTING SSI UNITS

Pollutant	Units	Emission limit for MH incinerators	Emission limit for FB incinerators
Cd	mg/dscm @ 7% O <sub>2</sub>	0.095	0.0016
CO	ppmvd @ 7% O <sub>2</sub>	3,800	64
HCl	ppmvd @ 7% O <sub>2</sub>	1.2	0.51
Hg	mg/dscm @ 7% O <sub>2</sub>	0.28	0.037
NO <sub>x</sub>	ppmvd @ 7% O <sub>2</sub>	220	150
Pb	mg/dscm @ 7% O <sub>2</sub>	0.30	0.0074
PCDD/PCDF, TEQ	ng/dscm @ 7% O <sub>2</sub>	0.32	0.10
PCDD/PCDF, TMB	ng/dscm @ 7% O <sub>2</sub>	5.0	1.2
PM	mg/dscm @ 7% O <sub>2</sub>	80	18
SO <sub>2</sub>	ppmvd @ 7% O <sub>2</sub>	26	15

*C. What are the emission limits in the new source performance standards for new sources?*

The final emission limits for new sources in the MH incinerator

subcategory and FB incinerator subcategory are presented in Table 2 of this preamble. Existing sources may comply with either the PCDD/PCDF TEQ or TMB emission limits.

These standards apply at all times.

TABLE 2—EMISSION LIMITS FOR NEW SSI UNITS

Pollutant	Units	Emission limit for MH incinerators	Emission limit for FB incinerators
Cd	mg/dscm @ 7% O <sub>2</sub>	0.0024	0.0011
CO	ppmvd @ 7% O <sub>2</sub>	52	27
HCl	ppmvd @ 7% O <sub>2</sub>	1.2	0.24

TABLE 2—EMISSION LIMITS FOR NEW SSI UNITS—Continued

Pollutant	Units	Emission limit for MH incinerators	Emission limit for FB incinerators
Hg .....	mg/dscm @ 7% O <sub>2</sub> .....	0.15	0.0010
NO <sub>x</sub> .....	ppmvd @ 7% O <sub>2</sub> .....	210	30
Pb .....	mg/dscm @ 7% O <sub>2</sub> .....	0.0035	0.00062
PCDD/PCDF, TMB .....	ng/dscm @ 7% O <sub>2</sub> .....	0.045	0.013
PCDD/PCDF, TEQ .....	ng/dscm @ 7% O <sub>2</sub> .....	0.0022	0.0044
PM .....	mg/dscm @ 7% O <sub>2</sub> .....	60	9.6
SO <sub>2</sub> .....	ppmvd @ 7% O <sub>2</sub> .....	26	5.3

#### D. What are the testing and monitoring requirements?

These final standards require all new and existing SSI units to demonstrate initial and annual compliance with the emission limits using EPA-approved emission test methods. The final standards also provide an option for less frequent testing if sources demonstrate that their emissions of regulated pollutants are below thresholds of the emission limits.

For existing SSI units, the EG requires initial and annual emissions performance tests (or continuous emissions monitoring or continuous sampling as an alternative), bag leak detection systems for FF controlled units, continuous parameter monitoring, and annual inspections of air pollution control devices, if they are used to meet the emission limits. Additionally, existing units are required to conduct Method 22 (*see* 40 CFR part 60, appendix A-7) visible emissions test of the ash handling operations during each compliance test.

For new SSI units, the NSPS requires initial and annual emissions performance tests (or continuous emissions monitoring or continuous sampling as an alternative), bag leak detection systems for FF controlled units, as well as continuous parameter monitoring and annual inspections of air pollution control devices that may be used to meet the emission limits. The final rule requires all new SSI units to install a CO CEMS. Operators of new units are also required to conduct Method 22 visible emissions testing of the ash handling operations during each compliance test.

For existing SSI units, use of Cd, CO, HCl, NO<sub>x</sub>, PM, Pb or SO<sub>2</sub> CEMS; ISTMMS; and ISTDMS (continuous sampling with periodic sample analysis) are approved alternatives to parametric monitoring and annual compliance testing. For new SSI units, CO CEMS are required, and use of Cd, HCl, NO<sub>x</sub>, PM, Pb or SO<sub>2</sub> CEMS; ISTMMS; and ISTDMS (continuous sampling, with periodic sample analysis) are approved

alternatives to parametric monitoring and annual compliance testing.

#### E. What are the other requirements for new and existing SSI units?

Owners or operators of new or existing SSI units are required to meet operator training and qualification requirements, which include: Ensuring that at least one operator or supervisor per facility complete the operator training course, that qualified operator(s) or supervisor(s) complete an annual review or refresher course specified in the regulation, and that they maintain plant-specific information, updated annually, regarding training.

Owners or operators of new SSI units are required to conduct a siting analysis, which includes submitting a report that evaluates site-specific air pollution control alternatives that minimize potential risks to public health or the environment, considering costs, energy impacts, non-air environmental impacts and any other factors related to the practicability of the alternatives.

Owners or operators of new or existing SSI units are required to submit a monitoring plan for any continuous monitoring system or bag leak detection system used to comply with the rule. They must also submit a monitoring plan for their ash handling system that specifies the operating procedures they will follow to ensure that they meet the fugitive emission limit.

#### F. What are the recordkeeping and reporting requirements?

Records of the initial and all subsequent stack or PS tests, deviation reports, operating parameter data, continuous monitoring data, maintenance and inspections of the air pollution control devices, the siting analysis (for new units only), monitoring plan and operator training and qualification must be maintained for 5 years. The results of the stack tests and PS tests and values for operating parameters are required to be included in initial and subsequent compliance reports.

#### G. What are the SSM provisions?

The Court vacated portions of two provisions in EPA's CAA section 112 regulations governing the emissions of HAP during periods of SSM. *Sierra Club v. EPA*, 551 F.3d 1019 (D.C. Cir. 2008), cert. denied, 130 S. Ct. 1735 (U.S. 2010). Specifically, the Court vacated the SSM exemption contained in 40 CFR 63.6(f)(1) and 40 CFR 63.6(h)(1), (the "General Provisions Rule,") that EPA promulgated under section 112 of the CAA. When incorporated into CAA section 112(d) regulations for specific source categories, these two provisions exempt sources from the requirement to comply with the otherwise applicable CAA section 112(d) emission standard during periods of SSM.

While the Court's ruling in *Sierra Club v. EPA* directly affects only the subset of CAA section 112(d) rules that incorporate 40 CFR 63.6(f)(1) and (h)(1) by reference and that contain no other regulatory text exempting or excusing compliance during SSM events, the legality of source category-specific SSM provisions is questionable.

Consistent with *Sierra Club v. EPA*, EPA is requiring that emission limitations in these final standards apply at all times the unit is operating. In establishing these standards, EPA has taken into account startup and shutdown periods and, for the reasons explained below, has not established different standards for those periods.

We are not promulgating a separate emission standard for the source category that applies during periods of startup and shutdown. Based on the information available at this time, we believe that SSI units will be able to meet the emission limits during periods of startup. Units we have information on use natural gas, landfill gas, or distillate oil to start the unit and add waste once the unit has reached combustion temperatures. Emissions from burning natural gas, landfill gas or distillate fuel oil are expected to generally be lower than from burning solid wastes. Emissions during periods of shutdown are also generally lower than emissions during normal operations because the

materials in the incinerator would be almost fully combusted before shutdown occurs. Furthermore, the approach for establishing MACT floors for SSI units ranked individual SSI units based on actual performance for each pollutant and subcategory, with an appropriate accounting of emissions variability. Because we accounted for emissions variability, we believe we have adequately addressed any minor variability that may potentially occur during startup or shutdown.

Periods of startup, normal operations, and shutdown are predictable and routine aspects of a source's operations. However, by contrast, malfunction is defined as a "sudden, infrequent, and not reasonably preventable failure of air pollution control and monitoring equipment, process equipment or a process to operate in a normal or usual manner \* \* \*" (40 CFR 60.2). EPA has determined that malfunctions should not be viewed as a distinct operating mode and, therefore, any emissions that occur at such times do not need to be factored into development of CAA section 129 standards, which, once promulgated, apply at all times. Nothing in CAA section 129 or in case law requires that EPA anticipate and account for the innumerable types of potential malfunction events in setting emission standards.<sup>5</sup>

Further, it is reasonable to interpret CAA section 129 as not requiring EPA to account for malfunctions in setting emissions standards. For example, we note that CAA section 129 uses the concept of "best controlled" or "best performing" sources in defining MACT, the level of stringency that major source standards must meet. Applying the concept of "best controlled" or "best performing" to a source that is malfunctioning presents significant difficulties. The goal of best controlled or best performing sources is to operate in such a way as to avoid malfunctions of their units.

Moreover, even if malfunctions were considered a distinct operating mode, we believe it would be impracticable to take malfunctions into account in setting CAA section 129 standards for SSI. As noted above, by definition, malfunctions are sudden and

unexpected events, and it would be difficult to set a standard that takes into account the myriad different types of malfunctions that can occur across all sources in the category. Moreover, malfunctions can vary in frequency, degree, and duration, further complicating standard setting.

For the SSI standards, malfunctions are required to be reported in deviation reports. We will then review the deviation reports to determine if the deviation is a violation of the standards.

In the event that a source fails to comply with the applicable CAA section 129 standards as a result of a malfunction event, EPA would determine an appropriate response based on, among other things, the good faith efforts of the source to minimize emissions during malfunction periods, including preventative and corrective actions, as well as root cause analyses to ascertain and rectify excess emissions. EPA would also consider whether the source's failure to comply with the CAA section 129 standard was, in fact, "sudden, infrequent, not reasonably preventable" and was not instead "caused in part by poor maintenance or careless operation."<sup>6</sup>

Finally, EPA recognizes that even equipment that is properly designed and maintained can fail and that such failure can sometimes cause an exceedance of the relevant emission standard.<sup>7</sup> EPA is therefore finalizing the proposed affirmative defense to civil penalties for exceedances of emissions limits that are caused by malfunctions, with some revisions to the proposed regulatory provision.<sup>8</sup> Under this provision, the source must prove by a preponderance of the evidence that it has met all of the elements set forth in 40 CFR 60.4860 and in 40 CFR 60.5180. The criteria ensure that the affirmative defense is available only where the event that causes an exceedance of the emission limit meets the narrow definition of malfunction in 40 CFR 60.2 (sudden, infrequent, not reasonable preventable and not caused by poor maintenance and or careless operation). For example, to successfully assert the affirmative

defense, the source must prove by a preponderance of the evidence that excess emissions "[w]ere caused by a sudden, infrequent, and unavoidable failure of air pollution control and monitoring equipment, process equipment, or a process to operate in a normal or usual manner \* \* \*." The criteria also are designed to ensure that steps are taken to correct the malfunction, to minimize emissions in accordance with 40 CFR part 60, subpart LLLL and 40 CFR part 60, subpart MMMM and to prevent future malfunctions. For example, the source must prove by a preponderance of the evidence that "[r]epairs were made as expeditiously as possible when the applicable emission limitations were being exceeded \* \* \*" and that "[a]ll possible steps were taken to minimize the impact of the excess emissions on ambient air quality, the environment and human health \* \* \*." In any judicial or administrative proceeding, the Administrator may challenge the assertion of the affirmative defense and, if the respondent has not met its burden of proving all of the requirements in the affirmative defense, appropriate penalties may be assessed in accordance with section 113 of the CAA (see also 40 CFR 22.77).

#### H. What are the Title V permit requirements?

All new and existing SSI units regulated by the final SSI rule are required to apply for and obtain a Title V permit. These Title V operating permits assure compliance with all applicable requirements for regulated SSI units, including all applicable CAA section 129 requirements.<sup>9</sup>

The permit application deadline for a CAA section 129 source applying for a Title V operating permit depends on when the source first becomes subject to the relevant Title V permits program. If a regulated SSI unit is a new unit and is not subject to an earlier permit application deadline, a complete Title V permit application must be submitted on or before the relevant date below.

- For a SSI unit that commenced operation as a new source on or before the promulgation date of 40 CFR part 60, subpart LLLL, the source must submit a complete Title V permit application no later than 12 months after the promulgation date of 40 CFR part 60, subpart LLLL; or
- For a SSI unit that commences operation as a new source after the promulgation of 40 CFR part 60, subpart LLLL, the source must submit a complete Title V permit application no

<sup>6</sup> 40 CFR 60.2 (definition of malfunction).

<sup>7</sup> See, e.g., State Implementation Plans: Policy Regarding Excessive Emissions During Malfunctions, Startup, and Shutdown (Sept. 20, 1999); Policy on Excess Emissions During Startup, Shutdown, Maintenance, and Malfunctions (Feb. 15, 1983).

<sup>8</sup> See proposed definition 40 CFR 60.4930 and 40 CFR 60.5250 (defining "affirmative defense" to mean, in the context of an enforcement proceeding, a response or defense put forward by a defendant, regarding which the defendant has the burden of proof, and the merits of which are independently and objectively evaluated in a judicial or administrative proceeding).

<sup>9</sup> 40 CFR 70.6(a)(1), 70.2, 71.6(a)(1) and 71.2.

<sup>5</sup> See, *Weyerhaeuser v. Costle*, 590 F.2d 1011, 1058 (DC Cir. 1978) ("In the nature of things, no general limit, individual permit, or even any upset provision can anticipate all upset situations. After a certain point, the transgression of regulatory limits caused by 'uncontrollable acts of third parties,' such as strikes, sabotage, operator intoxication or insanity, and a variety of other eventualities, must be a matter for the administrative exercise of case-by-case enforcement discretion, not for specification in advance by regulation.").

later than 12 months after the date the SSI unit commences operation as a new source.<sup>10</sup>

If the SSI unit is an existing unit and is not subject to an earlier permit application deadline, then the source must submit a complete Title V permit application by the earlier of the following dates:

- Twelve months after the effective date of any applicable EPA-approved CAA section 111(d)/129 plan (*i.e.*, an EPA approved state or tribal plan that implements the SSI EG); or
- Twelve months after the effective date of any applicable Federal plan; or
- Thirty-six months after promulgation of 40 CFR part 60, subpart MMMM.

For any existing SSI unit not subject to an earlier permit application deadline, the application deadline of 36 months after the promulgation of 40 CFR part 60, subpart MMMM, applies regardless of whether or when any applicable Federal plan is effective, or whether or when any applicable state or tribal CAA section 111(d)/129 plan is approved by EPA and becomes effective. (See CAA sections 129(e), 503(c), 503(d), and 502(a) and 40 CFR 70.5(a)(1)(i) and 71.5(a)(1)(i).)

If the SSI unit is subject to Title V as a result of some triggering requirement(s) other than those mentioned above, for example, a SSI unit may be a major source (or part of a major source), then you may be required to apply for a Title V permit prior to the deadlines specified above. If more than one requirement triggers a source's obligation to apply for a Title V permit, the 12-month time frame for filing a Title V permit application is triggered by the requirement which first causes the source to be subject to Title V.<sup>11</sup>

For additional background information on the interface between CAA section 129 and Title V, including EPA's interpretation of section 129(e), information on updating existing Title V permit applications and reopening existing Title V permits, see the final "Federal Plan for Commercial and Industrial Solid Waste Incineration," October 3, 2003 (68 FR 57518), as well as the "Summary of Public Comments and Responses" document in the OSWI docket (EPA-HQ-OAR-2003-0156).

#### *I. What are the applicability dates of the standards?*

New SSI units that commence construction after October 14, 2010, or

that are modified 6 months or more after the date of promulgation, must meet the NSPS emission limits of 40 CFR part 60, subpart LLLL within 6 months after the promulgation date of the standards or upon startup, whichever is later.

Under the final EG, and consistent with CAA section 129 (b)(2) and 40 CFR 60, subpart B, states are required to submit state plans containing the existing source emission limits of subpart MMMM of this part, and other requirements to implement and enforce the EG within 1 year after promulgation of the EG. States must submit state plans to EPA by March 21, 2012. State plans apply to existing SSI in the state (including SSI that are modified prior to and including the date 6 months after promulgation) and must be at least as protective as the EG.

The final EG requires existing SSI to demonstrate compliance with the standards as expeditiously as practicable after approval of a state plan, but no later than 3 years from the date of approval of a state plan or 5 years after promulgation of the EG, whichever is earlier. Consistent with CAA section 129, EPA expects states to require compliance as expeditiously as practicable. However, because we believe that many SSI units will find it necessary to retrofit existing emissions control equipment and/or install additional emissions control equipment in order to meet the final limits, EPA anticipates that states may choose to provide the 3-year compliance period allowed by CAA section 129(f)(2). If EPA does not approve a state plan or issue a Federal plan, then the compliance date is 5 years from the date of the final rule.

EPA intends to develop a Federal plan that will apply to existing SSI units in any state that has not submitted an approved state plan within 2 years after promulgation of the EG. The final EG allows existing SSI units subject to the Federal plan up to 5 years after promulgation of the EG to demonstrate compliance with the standards, as allowed by CAA section 129(b)(3).

#### *J. What are the requirements for submission of emissions test results to EPA?*

EPA must have performance test data to conduct effective reviews of CAA sections 112 and 129 standards, as well as for many other purposes including compliance determinations, emission factor development, and annual emission rate determinations. In conducting these required reviews, EPA has found it ineffective and time consuming, not only for us, but also for regulatory agencies and source owners

and operators to locate, collect, and submit emissions test data because of varied locations for data storage and varied data storage methods. One improvement that has occurred in recent years is the availability of stack test reports in electronic format as a replacement for cumbersome paper copies.

In this final rule, EPA is taking a step to improve data accessibility and increase the ease and efficiency of reporting for sources. Owners and operators of SSI facilities are required to submit, to EPA's ERT database, electronic copies of reports of certain performance tests required under the SSI EG and NSPS. Data entry will be through an electronic emissions test report structure called the Emissions Reporting Tool (ERT) whenever conducting performance tests. The ERT was developed with input from stack testing companies who generally collect and compile performance test data electronically and offices within state and local agencies that perform field test assessments. The ERT is currently available at [http://www.epa.gov/ttn/chief/ert/ert\\_tool.html](http://www.epa.gov/ttn/chief/ert/ert_tool.html), and access to direct data submittal to EPA's electronic emissions database (WebFIRE) will become available by December 31, 2011.

The requirement to submit source test data electronically to EPA would not require any additional performance testing and would apply to those performance tests conducted using test methods that are supported by the ERT. The ERT contains a specific electronic data entry form for most of the commonly used EPA reference methods. The Web site listed below contains a listing of the pollutants and test methods supported by the ERT. In addition, when a facility submits performance test data to WebFIRE, there will be no additional requirements for emissions test data compilation. Moreover, we believe industry will benefit from development of improved emission factors, fewer follow-up information requests, and better regulation development as discussed below. The information to be reported is already required for the existing test methods and is necessary to evaluate the conformance to the test method.

One major advantage of submitting source test data through the ERT is a standardized method to compile and store much of the documentation required to be reported by this rule that also clearly states what testing information would be required. Another important benefit of submitting these data to EPA at the time the source test is conducted is that it should substantially reduce the effort involved

<sup>10</sup> CAA section 503(c) and 40 CFR 70.5(a)(1)(i) and 71.5(a)(1)(i).

<sup>11</sup> CAA section 503(c) and 40 CFR 70.3(a) and (b), 70.5(a)(1)(i), 71.3(a) and (b) and 71.5(a)(1)(i).

in data collection activities in the future. When EPA has source category performance test data in hand, there will likely be fewer or less substantial data collection requests in conjunction with prospective required residual risk assessments or technology reviews. This results in a reduced burden on both affected facilities (in terms of reduced manpower to respond to data collection requests) and EPA (in terms of preparing and distributing data collection requests and assessing the results).

State/local/tribal agencies may also benefit in that their review may be more streamlined and accurate because they would not have to re-enter the data to assess the calculations and verify the data entry. Finally, another benefit of submitting these data to WebFIRE electronically is that these data will greatly improve the overall quality of the existing and new emission factors by supplementing the pool of emissions test data upon which the emission factor is based and by ensuring that data are more representative of current industry operational procedures. A common complaint heard from industry and regulators is that emissions factors are outdated or not representative of a particular source category. Receiving and incorporating data for most performance tests will ensure that emissions factors, when updated, represent accurately the most current range of operational practices. In summary, in addition to supporting regulation development, control strategy development, and other air pollution control activities, receiving test data already collected and using them in the emissions factors development program will save industry, state/local/tribal agencies, and EPA significant time, money, and effort while improving the quality of emission inventories and related regulatory decisions.

As mentioned earlier, the electronic database that will be used is EPA's WebFIRE, which is a Web site accessible through EPA's TTN Web. The WebFIRE Web site was constructed to store emissions test data for use in developing emission factors. A description of the WebFIRE database can be found at <http://cfpub.epa.gov/oarweb/index.cfm?action=fire.main>. The ERT will be able to transmit the electronic report through EPA's CDX network for storage in the WebFIRE database. Although ERT is not the only electronic interface that can be used to submit source test data to the CDX for entry into WebFIRE, it makes

submission of data very straightforward and easy. A description of the ERT can be found at [http://www.epa.gov/ttn/chief/ert/ert\\_tool.html](http://www.epa.gov/ttn/chief/ert/ert_tool.html).

#### IV. Summary of Significant Changes Following Proposal

EPA received over 90 public comments on the proposed rulemaking. Furthermore, we conducted one public hearing to allow the public to comment on the proposed rulemaking. After consideration of public comments received, EPA is making several changes to the standards. Following are the major changes to the standards since the proposal. The rationale for these and any other significant changes can be found in section V of this preamble or in the "Sewage Sludge Incineration (SSI) Rule: Summary of Public Comments and Responses" in the SSI docket (EPA-HQ-OAR-2009-0559).

##### A. Applicability

The final rule clarifies that, if any amount of sewage sludge is burned in an incinerator at a wastewater treatment facility designed to treat domestic sewage sludge, the incinerator is subject to the SSI standards in subparts LLLL and MMMM of this part while burning sewage sludge. The final rule also clarifies that sewage sludge that is not burned in a SSI located at a wastewater treatment facility designed to treat domestic sewage sludge is subject to other section 129 standards, such as the CISWI standards (40 CFR part 60, subparts CCCC and DDDD of this part), the OSWI standards (40 CFR part 60, subparts EEEE and FFFF), the MWC standards (40 CFR part 60, subparts Ea, Eb, Cb, AAAA, and BBBB of this part) or the Hazardous Waste Combustor rule (40 CFR part 63 subpart EEE).

##### B. Subcategories

The proposed NSPS did not subcategorize new sources. In the final NSPS, SSI units at new sources are subcategorized into two subcategories: MH and FB.

##### C. MACT Floor UPL Calculation and EG and NSPS Emission Limits

At proposal, we used a 99 percent UPL calculation to determine variability. For the final rule, for existing FB units, we are using a weighted 99 percent UPL calculation to account for the biasing of emissions data from one facility. The weighted UPL was not used for MH units.

In the proposed rule, two statistical measures, skewness and kurtosis, were examined to determine if the data used to calculate the MACT floor were normally or log-normally distributed. If both the reported values and the natural-log transformed reported values had skewness and kurtosis statistics that indicated neither were normally distributed, the reported dataset was selected as the basis of the floor to be conservative. If the results of the skewness and kurtosis hypothesis tests were mixed for the reported values and the natural log-transformed reported values, the analysis done on the reported data values was chosen to be conservative. We have modified our assumptions when results of the skewness and kurtosis tests do not clearly show whether a normal or log-normal distribution better represents the data, or when there are not enough data to complete the skewness and kurtosis tests. In these cases, we have chosen to use the log-normal results for the final MACT floor calculation.

In the proposed rule, we proposed setting beyond-the-floor emission standards for Hg emissions from existing MH units. In the final rule, we are establishing MACT floor emission limits but are not setting beyond-the-floor standards. Also, we are not finalizing the proposed opacity limits. At proposal, we set emission limits for both PCDD/PCDF TMB and PCDD/PCDF TEQ and required SSI units to meet both limits. In the final standards, we are allowing affected sources to comply with either the PCDD/PCDF TMB or TEQ emission limits.

In the proposed rule, we did not compare the CO span of the test to the measured CO values to determine if the values were consistent. For the final rule, we reviewed the CO values obtained from emission test reports to determine whether the span of the test used was capable of accurately reading the reported value. If the span was inconsistent with the reported value, the CO levels were adjusted to provide a value that was more consistent with the span. We revised the CO limits based on the results of this analysis.

The final emission limits resulting from the revised MACT floor calculations are presented in Tables 3 through 6 of this preamble, and compared to the proposed emission limits.

TABLE 3—FINAL AND PROPOSED EMISSION LIMITS FOR EXISTING FB SSI UNITS

Pollutant	Units	Proposed emission limit	Final emission limit
Cd	mg/dscm @ 7% O <sub>2</sub>	0.0019	0.0016
CO	ppmvd @ 7% O <sub>2</sub>	56	64
HCl	ppmvd @ 7% O <sub>2</sub>	0.49	0.51
Hg	mg/dscm @ 7% O <sub>2</sub>	0.0033	0.037
NO <sub>x</sub>	ppmvd @ 7% O <sub>2</sub>	63	150
Pb	mg/dscm @ 7% O <sub>2</sub>	0.0098	0.0074
PCDD/PCDF, TEQ	ng/dscm @ 7% O <sub>2</sub>	0.056	0.10
PCDD/PCDF, TMB	ng/dscm @ 7% O <sub>2</sub>	0.61	1.2
PM	mg/dscm @ 7% O <sub>2</sub>	12	18
SO <sub>2</sub>	ppmvd @ 7% O <sub>2</sub>	22	15

TABLE 4—FINAL AND PROPOSED EMISSION LIMITS FOR EXISTING MH SSI UNITS

Pollutant	Units	Proposed emission limit	Final emission limit
Cd	mg/dscm @ 7% O <sub>2</sub>	0.095	0.095
CO	ppmvd @ 7% O <sub>2</sub>	3,900	3,800
HCl	ppmvd @ 7% O <sub>2</sub>	1.0	1.2
Hg	mg/dscm @ 7% O <sub>2</sub>	0.02	0.28
NO <sub>x</sub>	ppmvd @ 7% O <sub>2</sub>	210	220
Pb	mg/dscm @ 7% O <sub>2</sub>	0.30	0.30
PCDD/PCDF, TEQ	ng/dscm @ 7% O <sub>2</sub>	0.32	0.32
PCDD/PCDF, TMB	ng/dscm @ 7% O <sub>2</sub>	5.0	5.0
PM	mg/dscm @ 7% O <sub>2</sub>	80	80
SO <sub>2</sub>	ppmvd @ 7% O <sub>2</sub>	26	26

TABLE 5—FINAL AND PROPOSED EMISSION LIMITS FOR NEW FB SSI UNITS

Pollutant	Units	Proposed emission limit	Final emission limit
Cd	mg/dscm @ 7% O <sub>2</sub>	0.00051	0.0011
CO	ppmvd @ 7% O <sub>2</sub>	7.4	27
HCl	ppmvd @ 7% O <sub>2</sub>	0.12	0.24
Hg	mg/dscm @ 7% O <sub>2</sub>	0.0010	0.0010
NO <sub>x</sub>	ppmvd @ 7% O <sub>2</sub>	26	30
Pb	mg/dscm @ 7% O <sub>2</sub>	0.00053	0.00062
PCDD/PCDF, TEQ	ng/dscm @ 7% O <sub>2</sub>	0.0022	0.0044
PCDD/PCDF, TMB	ng/dscm @ 7% O <sub>2</sub>	0.024	0.013
PM	mg/dscm @ 7% O <sub>2</sub>	4.1	9.6
SO <sub>2</sub>	ppmvd @ 7% O <sub>2</sub>	2.0	5.3

TABLE 6—FINAL AND PROPOSED EMISSION LIMITS FOR NEW MH SSI UNITS

Pollutant	Units	Proposed emission limit	Final emission limit
Cd	mg/dscm @ 7% O <sub>2</sub>	0.00051	0.0024
CO	ppmvd @ 7% O <sub>2</sub>	7.4	52
HCl	ppmvd @ 7% O <sub>2</sub>	0.12	1.2
Hg	mg/dscm @ 7% O <sub>2</sub>	0.0010	0.15
NO <sub>x</sub>	ppmvd @ 7% O <sub>2</sub>	26	210
Pb	mg/dscm @ 7% O <sub>2</sub>	0.00053	0.0035
PCDD/PCDF, TEQ	ng/dscm @ 7% O <sub>2</sub>	0.0022	0.0022
PCDD/PCDF, TMB	ng/dscm @ 7% O <sub>2</sub>	0.024	0.045
PM	mg/dscm @ 7% O <sub>2</sub>	4.1	60
SO <sub>2</sub>	ppmvd @ 7% O <sub>2</sub>	2.0	26

#### D. Baseline Emissions, Costs and Impacts Estimation

For the final rule, we have revised the baseline emissions, costs, and impacts to incorporate information provided by commenters. A discussion of the

changes is presented in section V of this preamble. The results of these analyses are summarized in section VI of this preamble.

#### E. Compliance Requirements

For both the standards, the following changes have been made:

- SSI units must submit (at least 60 days before their initial compliance test date) a monitoring plan to establish that

their ash handling system will meet the visible emissions limit on a continuous basis.

- The alternative to test less frequently (every third year) is being revised to be the following:

- If SSI units demonstrate emissions below a specified threshold during two consecutive performance tests, they may test every 3 years instead of annually. Any year that the emission threshold is not met, the SSI must test annually until the threshold is met over a consecutive 2 year period. The alternative in the standards no longer requires that SSI units establish that they meet the lower thresholds for three consecutive years.

- For all pollutants, less frequent testing is allowed if emissions are no greater than an emissions threshold of 75 percent of the emission limit.

- For fugitive emissions from ash handling, less frequent testing is allowed as long as visible emissions of combustion ash occur less than or equal to two percent of each hourly observation period (the standard is five percent of each of three hourly observation periods).

- The final rule removes the requirements in the standards to maintain sludge feed rate and moisture content within specified parameters. However, sludge feed rate and sludge moisture content are still required to be monitored during performance test runs, and daily records of sludge feed rate and sludge moisture content are required to be kept.

- At proposal, operating limits were calculated based on a specified percentage of the average parameter value recorded during pollutant performance tests. In the final standards, operating parameter limits are determined on a site-specific basis as the minimum or maximum operating parameter value for the parameter, as applicable, recorded during pollutant performance tests.

- The proposed standards schedule for conducting annual performance tests was each 10–12 months. This has been changed to specify that performance tests must be conducted on a calendar year basis (no less than nine calendar months and no more than 15 calendar months following the previous performance test); and you must complete five performance tests for each such pollutant in each 5-year calendar period.

- The averaging time for demonstrating compliance with the CO CEMS operating parameters has been changed from a 4-hour rolling averaging period to a 24-hr block averaging period. The averaging times for all other operating parameters, except scrubber

liquid pH, has been changed from a 4-hour rolling averaging period to a 12-hour block averaging period.

- During each compliance test run, SSI units must be operated at a minimum of 85 percent of their maximum permitted capacity.

#### F. Definitions

The following definitions have been revised:

- Process change means a significant permit revision, but only with respect to those pollutant-specific emission units for which the proposed permit revision is applicable, including but not limited to:

- (1) A change in the process employed at the wastewater treatment facility associated with the affected SSI unit (e.g., the addition of tertiary treatment at the facility, which changes the method used for disposing of process solids and processing of the sludge prior to incineration).

- (2) A change in the air pollution control devices used to comply with the emission limits for the affected SSI unit (e.g., change in the sorbent used for activated carbon injection).

- Sewage sludge incineration (SSI) unit means an incineration unit combusting sewage sludge for the purpose of reducing the volume of the sewage sludge by removing combustible matter. Sewage sludge incineration unit designs include fluidized bed and multiple hearth. A SSI unit also includes, but is not limited to, the sewage sludge feed system, auxiliary fuel feed system, grate system, flue gas system, waste heat recovery equipment, if any, and bottom ash system. The SSI unit includes all ash handling systems connected to the bottom ash handling system. The combustion unit bottom ash system ends at the truck loading station or similar equipment that transfers the ash to final disposal. The SSI unit does not include air pollution control equipment or the stack.

#### V. Significant Public Comments and Rationale for Changes to the Proposed Rule

This section contains a brief summary of major comments and responses. EPA received many comments on this subpart covering numerous topics. EPA's responses to all comments, including those below, can be found in the comment response document for SSI units in the docket.

##### A. Legal and Applicability Issues Regulating SSI Under Section 112 vs. Section 129

*Comment:* Many commenters contended that SSI are within the CWA

definition of POTW; therefore, according to CAA section 112(e)(5), EPA must regulate SSI units under CAA section 112(d), and not CAA section 129. The commenters emphasized that SSI units are located within each respective POTW and are wholly integrated into the solids handling and treatment processes at each POTW.

Other commenters stated that SSI units cannot be regulated under CAA section 129 because they are combusting material that is generated by the POTW, which is neither a commercial or industrial establishment nor the general public as required in CAA section 129(g)(1). The commenters added that, based on the proposed definition of solid waste, even if they had a new point of generation within the POTW where they were generating solid waste, the POTW sewage sludge is from a municipal source and does not pass the broad applicability for solid waste incineration under CAA section 129. Another commenter added that CAA section 129(a)(1)(B)–(C) also directs EPA to set standards for solid waste incineration units combusting municipal waste, but to qualify as a unit combusting municipal waste, the unit must first be a solid waste incineration unit. The commenters concluded that this would not include SSI units.

Several commenters stated that EPA's determination to regulate SSI units under CAA section 129 contradicts previous decisions where EPA has stated that regulations were being developed for SSI under CAA section 112. Another commenter stated that EPA's revision to the list of source categories under CAA section 112 to delete SSI units was because there were no major sources in the source category. One commenter added that EPA's decision to regulate SSI units under CAA section 129 is based on an overly broad reading of the NRDC case. The commenter also claimed that SSI units are not within the scope of the definition of "solid waste incineration unit" in section 129 because sewage sludge is not generated by a commercial or industrial establishment or by the general public.

*Response:* EPA disagrees with the commenter's assertion that regulation of SSI units under section 129 is inconsistent with past EPA statements. As explained in the NPRM, EPA issued emissions standards for POTW in 1999 pursuant to section 112(d), and those emissions standards did not include standards for SSI units. In the proposed POTW emissions standards, EPA stated that "[s]ewage sludge incineration will be regulated under section 129 of the CAA[.]" See 63 FR 66087 (December 1,

1998). EPA also explained in the NPRM for today's action that the EPA's statements regarding SSI units during its promulgation of emissions standards for OSWI units are squarely in conflict with the Court's decision in *NRDC v. EPA*, 489 F.3d 1250 (D.C. Cir. 2007), which states in pertinent part that any unit that combusts any solid waste at all is subject to CAA section 129. The commenter does not appear to disagree with that conclusion, but instead simply argues that EPA cannot regulate SSI units under section 129 because it previously stated that it would regulate them under section 112. However, the *NRDC* decision precludes EPA from doing so. Additionally, section 112(c)(6) requires that EPA promulgate emission standards assuring that sources accounting for not less than 90 percent of the aggregate emissions of each of the HAP identified in section 112(c)(6) are subject to emission standards. EPA has determined that section 129 source categories can be included to meet our 90 percent obligations. Therefore, EPA has included SSI units in the section 112(c)(6) list of sources because SSI units are needed to meet our 90 percent requirement for mercury. This decision is documented in the memorandum "Emission Standards for Meeting the Ninety Percent Requirement under Section 112(c)(6) of the Clean Air Act" in the SSI docket (EPA-HQ-OAR-2009-0559).

Moreover, section 112(e)(5) does not require EPA to issue emissions standards for SSI units under section 112(d). Rather, it simply governs the schedule for the issuance of section 112(d) emissions standards for POTW. Section 112(e), titled "Schedule for Standards and Review," generally requires EPA to establish emissions standards for initially listed source categories as expeditiously as practicable, with certain specific deadlines in section 112(e)(1). Section 112(e) further describes how EPA shall prioritize source categories for regulation, and requires EPA to establish a schedule for issuance of emissions standards for section 112 listed source categories. Finally, Congress specified a different schedule for POTW in section 112(e)(5), stating that emissions standards shall be issued no later than November 15, 1995. Thus, section 112(e)(5) does not require EPA to regulate SSI units under section 112(d), but rather simply identifies the date by which EPA must issue emissions standards for POTW.

Additionally, the commenter's interpretation of section 112(e)(5) would conflict with section 129(g) and with the DC Circuit's interpretation of section

129(g) as explained in *NRDC v. EPA*. Section 129(g) defines "solid waste incineration unit" to include any unit combusting any solid waste, and the Court in *NRDC v. EPA* rejected EPA's position that it could choose to regulate certain units, combusting solid waste, under section 112 instead of under section 129. Since SSI units do combust solid waste, EPA does not have the discretion under section 129 to create an exemption for SSI units from the statutory definition of solid waste. The court noted that section 129(g) itself specifies certain units that combust solid waste but are exempt from the definition, and noted that where Congress created such enumerated exemptions, the EPA lacks discretion to create additional ones.

EPA also disagrees with the commenter that SSI units do not combust waste from the general public. Sewage sludge clearly originates from the general public, including residential and commercial facilities. Simply because the waste is treated at a POTW prior to combustion does not change the original source of the sewage sludge. The commenter refers to a statement in EPA's 2000 Unified Regulatory Agenda to support its argument. However, the Regulatory Agenda did not represent an Agency interpretation following a notice and comment process. Moreover, as explained above, EPA's position regarding the section of the Act under which SSI units must be regulated has changed since 2000, in light of the DC Circuit's decision in *NRDC v. EPA*. Finally, EPA notes that its final action on reconsideration of the OSWI rule did not refer to the source of sewage sludge as a basis for concluding that regulation under section 129 was not required. Instead, as explained above, it referred to discretion the Agency believed it had at the time to choose to regulate certain solid waste incinerators under section 112—discretion the Agency no longer believes it has.

The commenter's reference to statements made in other **Federal Register** notices that pre-date the *NRDC* decision similarly fail to support its argument that EPA must regulate SSI units under section 112. Specifically, commenters refer to EPA's inclusion of SSI on the list of area source categories listed under section 112(c)(3) and (k)(3)(B)(ii) of the Act. *See* 67 FR 70427 (Nov. 22, 2002). However, that listing does not lead to the conclusion that SSI must be regulated under section 112. First, as explained above, EPA's interpretation of its authority to regulate SSI has changed following the issuance of the DC Circuit's decision in *NRDC v. EPA*, which occurred after the 2002

listing referred to by the commenter. Additionally, that listing included source categories that would clearly be regulated under section 129, such as medical waste incinerators and municipal waste combustors, *Id.* at 70428, because EPA's regulation of incinerator source categories under section 129 serves towards meeting its statutory obligations under section 112(c)(3) and (k)(3)(B)(ii). Therefore, the inclusion of SSI on that list does not indicate that such units must be regulated under section 112.

EPA further disagrees that regulation of SSI units under section 129 is unnecessary because SSI units are already regulated under section 405 of the CWA and that section 129 regulation will therefore provide no public health or environmental benefit. As explained in section VI of this preamble, today's action will benefit public health and the environment by achieving reductions of the section 129 pollutants from SSI units beyond those required by regulations issued pursuant to the CWA. Today's action must be undertaken to comply with the Clean Air Act and the court decision in *NRDC v. EPA*. EPA further notes that section 405 of the CWA expressly provides that nothing in that section is intended to waive more stringent requirements of any other law. Therefore, Congress clearly did not intend for regulation of SSI units under the CWA to preclude any other regulations, including regulation under CAA section 129. *Overlap with Other Standards*

*Comment:* Several commenters expressed concern that other types of solid waste incineration units could be considered SSI units and subject to the SSI standards if they combust any amount of sewage sludge. Some commenters added that the definition of a SSI does not have a *de minimis* level of sewage sludge burned. Other commenters requested clarification on whether SSI units burning non-sludge industrial waste would be subject to both SSI and CISWI. Some commenters suggested that SSI units be consistent with the MWC standards and provide an exemption for co-fired combustors firing 30 percent or less by weight of sewage sludge.

Commenters suggested that the SSI standards provide exclusions for all solid waste incineration units that meet the applicability requirements of other CAA section 129 standards, including MWCs regulated under Subparts Ea, Eb, Ec, Ee, EeA, EeB, EeC, EeD, EeE, EeF, EeG, EeH, EeI, EeJ, EeK, EeL, EeM, EeN, EeO, EeP, EeQ, EeR, EeS, EeT, EeU, EeV, EeW, EeX, EeY, EeZ, EeAA, EeAB, EeAC, EeAD, EeAE, EeAF, EeAG, EeAH, EeAI, EeAJ, EeAK, EeAL, EeAM, EeAN, EeAO, EeAP, EeAQ, EeAR, EeAS, EeAT, EeAU, EeAV, EeAW, EeAX, EeAY, EeAZ, EeBA, EeBB, EeBC, EeBD, EeBE, EeBF, EeBG, EeBH, EeBI, EeBJ, EeBK, EeBL, EeBM, EeBN, EeBO, EeBP, EeBQ, EeBR, EeBS, EeBT, EeBU, EeBV, EeBW, EeBX, EeBY, EeBZ, EeCA, EeCB, EeCC, EeCD, EeCE, EeCF, EeCG, EeCH, EeCI, EeCJ, EeCK, EeCL, EeCM, EeCN, EeCO, EeCP, EeCQ, EeCR, EeCS, EeCT, EeCU, EeCV, EeCW, EeCX, EeCY, EeCZ, EeDA, EeDB, EeDC, EeDD, EeDE, EeDF, EeDG, EeDH, EeDI, EeDJ, EeDK, EeDL, EeDM, EeDN, EeDO, EeDP, EeDQ, EeDR, EeDS, EeDT, EeDU, EeDV, EeDW, EeDX, EeDY, EeDZ, EeEA, EeEB, EeEC, EeED, EeEE, EeEF, EeEG, EeEH, EeEI, EeEJ, EeEK, EeEL, EeEM, EeEN, EeEO, EeEP, EeEQ, EeER, EeES, EeET, EeEU, EeEV, EeEW, EeEX, EeEY, EeEZ, EeFA, EeFB, EeFC, EeFD, EeFE, EeFF, EeFG, EeFH, EeFI, EeFJ, EeFK, EeFL, EeFM, EeFN, EeFO, EeFP, EeFQ, EeFR, EeFS, EeFT, EeFU, EeFV, EeFW, EeFX, EeFY, EeFZ, EeGA, EeGB, EeGC, EeGD, EeGE, EeGF, EeGG, EeGH, EeGI, EeGJ, EeGK, EeGL, EeGM, EeGN, EeGO, EeGP, EeGQ, EeGR, EeGS, EeGT, EeGU, EeGV, EeGW, EeGX, EeGY, EeGZ, EeHA, EeHB, EeHC, EeHD, EeHE, EeHF, EeHG, EeHH, EeHI, EeHJ, EeHK, EeHL, EeHM, EeHN, EeHO, EeHP, EeHQ, EeHR, EeHS, EeHT, EeHU, EeHV, EeHW, EeHX, EeHY, EeHZ, EeIA, EeIB, EeIC, EeID, EeIE, EeIF, EeIG, EeIH, EeII, EeIJ, EeIK, EeIL, EeIM, EeIN, EeIO, EeIP, EeIQ, EeIR, EeIS, EeIT, EeIU, EeIV, EeIW, EeIX, EeIY, EeIZ, EeJA, EeJB, EeJC, EeJD, EeJE, EeJF, EeJG, EeJH, EeJI, EeJJ, EeJK, EeJL, EeJM, EeJN, EeJO, EeJP, EeJQ, EeJR, EeJS, EeJT, EeJU, EeJV, EeJW, EeJX, EeJY, EeJZ, EeKA, EeKB, EeKC, EeKD, EeKE, EeKF, EeKG, EeKH, EeKI, EeKJ, EeKK, EeKL, EeKM, EeKN, EeKO, EeKP, EeKQ, EeKR, EeKS, EeKT, EeKU, EeKV, EeKW, EeKX, EeKY, EeKZ, EeLA, EeLB, EeLC, EeLD, EeLE, EeLF, EeLG, EeLH, EeLI, EeLJ, EeLK, EeLL, EeLM, EeLN, EeLO, EeLP, EeLQ, EeLR, EeLS, EeLT, EeLU, EeLV, EeLW, EeLX, EeLY, EeLZ, EeMA, EeMB, EeMC, EeMD, EeME, EeMF, EeMG, EeMH, EeMI, EeMJ, EeMK, EeML, EeMN, EeMO, EeMP, EeMQ, EeMR, EeMS, EeMT, EeMU, EeMV, EeMW, EeMX, EeMY, EeMZ, EeNA, EeNB, EeNC, EeND, EeNE, EeNF, EeNG, EeNH, EeNI, EeNJ, EeNK, EeNL, EeNM, EeNN, EeNO, EeNP, EeNQ, EeNR, EeNS, EeNT, EeNU, EeNV, EeNW, EeNX, EeNY, EeNZ, EeOA, EeOB, EeOC, EeOD, EeOE, EeOF, EeOG, EeOH, EeOI, EeOJ, EeOK, EeOL, EeOM, EeON, EeOO, EeOP, EeOQ, EeOR, EeOS, EeOT, EeOU, EeOV, EeOW, EeOX, EeOY, EeOZ, EePA, EePB, EePC, EePD, EePE, EePF, EePG, EePH, EePI, EePJ, EePK, EePL, EePM, EePN, EePO, EePP, EePQ, EePR, EePS, EePT, EePU, EePV, EePW, EePX, EePY, EePZ, EeQA, EeQB, EeQC, EeQD, EeQE, EeQF, EeQG, EeQH, EeQI, EeQJ, EeQK, EeQL, EeQM, EeQN, EeQO, EeQP, EeQQ, EeQR, EeQS, EeQT, EeQU, EeQV, EeQW, EeQX, EeQY, EeQZ, EeRA, EeRB, EeRC, EeRD, EeRE, EeRF, EeRG, EeRH, EeRI, EeRJ, EeRK, EeRL, EeRM, EeRN, EeRO, EeRP, EeRQ, EeRR, EeRS, EeRT, EeRU, EeRV, EeRW, EeRX, EeRY, EeRZ, EeSA, EeSB, EeSC, EeSD, EeSE, EeSF, EeSG, EeSH, EeSI, EeSJ, EeSK, EeSL, EeSM, EeSN, EeSO, EeSP, EeSQ, EeSR, EeSS, EeST, EeSU, EeSV, EeSW, EeSX, EeSY, EeSZ, EeTA, EeTB, EeTC, EeTD, EeTE, EeTF, EeTG, EeTH, EeTI, EeTJ, EeTK, EeTL, EeTM, EeTN, EeTO, EeTP, EeTQ, EeTR, EeTS, EeTT, EeTU, EeTV, EeTW, EeTX, EeTY, EeTZ, EeUA, EeUB, EeUC, EeUD, EeUE, EeUF, EeUG, EeUH, EeUI, EeUJ, EeUK, EeUL, EeUM, EeUN, EeUO, EeUP, EeUQ, EeUR, EeUS, EeUT, EeUU, EeUV, EeUW, EeUX, EeUY, EeUZ, EeVA, EeVB, EeVC, EeVD, EeVE, EeVF, EeVG, EeVH, EeVI, EeVJ, EeVK, EeVL, EeVM, EeVN, EeVO, EeVP, EeVQ, EeVR, EeVS, EeVT, EeVU, EeVV, EeVW, EeVX, EeVY, EeVZ, EeWA, EeWB, EeWC, EeWD, EeWE, EeWF, EeWG, EeWH, EeWI, EeWJ, EeWK, EeWL, EeWM, EeWN, EeWO, EeWP, EeWQ, EeWR, EeWS, EeWT, EeWU, EeWV, EeWW, EeWX, EeWY, EeWZ, EeXA, EeXB, EeXC, EeXD, EeXE, EeXF, EeXG, EeXH, EeXI, EeXJ, EeXK, EeXL, EeXM, EeXN, EeXO, EeXP, EeXQ, EeXR, EeXS, EeXT, EeXU, EeXV, EeXW, EeXX, EeXY, EeXZ, EeYA, EeYB, EeYC, EeYD, EeYE, EeYF, EeYG, EeYH, EeYI, EeYJ, EeYK, EeYL, EeYM, EeYN, EeYO, EeYP, EeYQ, EeYR, EeYS, EeYT, EeYU, EeYV, EeYW, EeYX, EeYY, EeYZ, EeZA, EeZB, EeZC, EeZD, EeZE, EeZF, EeZG, EeZH, EeZI, EeZJ, EeZK, EeZL, EeZM, EeZN, EeZO, EeZP, EeZQ, EeZR, EeZS, EeZT, EeZU, EeZV, EeZW, EeZX, EeZY, EeZZ.

Several commenters contended that EPA should exempt incineration units subject to hazardous waste combustor regulations and/or hazardous waste management permits under the Solid Waste Disposal Act. The commenters added that CAA section 129(g)(1) states that a solid waste incineration unit does not include incinerators or other units required to have a permit under section 3005 of the SWDA. Other commenters requested EPA include an exemption for hazardous waste combustion units that are affected sources under 40 CFR part 63 subpart EEE.

*Response:* Section 129 defines solid waste incineration unit to include any unit combusting any solid waste. Therefore, EPA is not setting *de minimus* levels for solid waste burned in incinerators. An incinerator located at a wastewater treatment facility designed to treat domestic sewage sludge that combusts any amount of sewage sludge is subject to the final SSI standards. We have clarified that the final standards and guidelines do not apply to sewage sludge that is not burned in a SSI located at a wastewater treatment facility designed to treat domestic sewage sludge. Sewage sludge that is not burned in a SSI located at a wastewater treatment facility designed to treat domestic sewage sludge is subject to other section 129 standards, such as the CISWI standards (40 CFR part 60, subparts CCCC and DDDD of this part), the OSWI standards (40 CFR part 60, subparts EEEE and FFFF), the MWC standards (40 CFR part 60, subparts Ea, Eb, Cb, AAAA, and BBBB of this part) or the Hazardous Waste Combustor rule (40 CFR part 63 subpart EEE).

Hazardous waste combustion units that are required to have a permit under CAA section 3005 or the Solid Waste Disposal Act are exempt from CAA section 129 standards per CAA section 129(g)(1), therefore we do not believe an exemption is needed for this rule.

*Comment:* Several commenters objected to EPA issuing the proposed SSI standards prior to making determinations regarding the definition of non-hazardous solid waste.

*Response:* EPA is not making determination in this rule about the definition of non-hazardous solid waste. Section 129 of the CAA states that "solid waste" shall have meaning promulgated by the Administrator under RCRA. Therefore, today's action is consistent with using the definition of non-hazardous secondary materials promulgated RCRA rule, elsewhere in today's **Federal Register**.

*Comment:* Several commenters contended that sewage sludge is not a

solid waste, as the CAA defines solid waste by referencing the definition of solid waste under RCRA. The commenters added that RCRA excludes sewage sludge in what is commonly referred to as the domestic sewage exclusion (DSE). The exclusion explicitly states that solid waste does not include solid or dissolved material in domestic sewage.

*Response:* This comment is not relevant to EPA's establishment of emissions standards for SSI units. Rather, it is relevant to EPA's proposed Identification of Non-Hazardous Secondary Materials That Are Solid Waste rule, and is addressed in EPA's final action on that proposed rule.

#### B. Subcategories

*Comment:* Many commenters agreed with the development of separate EG for existing MH and FB units. The commenters also requested adding the same subcategories for the NSPS. The commenters added that it was inappropriate to consider the best performing FB SSI as the best performing similar source for the MH SSI new source category. They also stated that, as proposed, the NSPS standards would discourage a POTW's ability to modify existing MH units, including modifications to improve combustion efficiency or boost steam output for electricity generation. Some commenters stated that, by using the best performing FB unit as the basis for the NSPS for MH units, EPA was effectively setting a beyond-the-floor MACT limit for SSI units without considering any criteria that the statute requires. Other commenters agreed with the decision to use the best-performing FB unit as the best similar source for the MH SSI source category.

Other commenters requested further subcategorization based on size of the SSI unit, type of sewage sludge incinerated, limited use units, and distance over which the SSI would need to transport its sludge for disposal.

*Response:* We have considered the commenters' concerns and are setting separate standards for FB and MH units at new sources in the final rule. As discussed in the NPRM, there are two types of incinerators currently used to combust sewage sludge: MH and FB incinerators. The differences between the two combustor designs result in significant differences in emissions, size of the flue gas stream, ability to handle variability in the feeds, control of temperature and other process variables, auxiliary fuel use and other characteristics. To reflect the differences in their combustion mechanisms, two subcategories, FB and MH, were

developed in the NPRM for new and existing SSI sources.

At proposal for the MH new source subcategory, we considered the best-performing FB incinerator to be the best-performing similar source because we were not aware of any new MH sources that have been constructed in the last 20 years, and information provided by the industry indicates that future units that will be constructed are likely to be FB incinerators.

We have re-evaluated our decision. Although few MH units have been constructed over the last 20 years, there is no technical reason that would preclude a source from constructing a MH unit. The same design differences that distinguish existing FB and MH units also apply to new units, and provide a similar basis for subcategorizing between the two types of units. Therefore, we are setting separate standards for MH units at new and reconstructed sources. Such subcategorization is appropriate based on the differences between FB and MH units described above, and will also serve to ensure that MH units do not avoid making modifications that may require them to meet standards based on FB units. We are not subcategorizing SSI units on any other basis because we do not have data to support distinguishing units based on class, type, or size. Without such information, we do not have a basis for concluding that these types of units should be placed in a different subcategory.

#### C. MACT Floor Analysis

##### Pollutant-by-Pollutant Approach

*Comment:* Many commenters objected to setting the MACT floors using a pollutant by pollutant approach because none of the facilities in EPA's database can simultaneously meet all the proposed standards. One commenter stated that EPA's MACT Floor methodology is supposed to involve "review of actual emissions data with an appropriate accounting for emissions variability". However, the commenter contended that EPA fails to follow this guidance in a practical manner in establishing MACT Floors for SSI units and that this results in unrealistically stringent limits that are not achievable for any SSI. Several commenters noted that this was especially true for the new source standards. Several commenters added that EPA's pollutant-by-pollutant basis violates the statute and its own views of the statute. One commenter stated that if EPA cannot demonstrate that the top performers can simultaneously meet all standards, EPA has improperly circumvented the

section 129 for establishing “beyond-the-floor” standards because the “floor standards would force industry-wide technological upgrades without consideration of the factors (cost and energy in particular) which Congress mandated for consideration when establishing beyond-the-floor standards.”

Many commenters specifically mentioned that EPA’s pollutant-by-pollutant, lowest emission methodology for setting the CO and NO<sub>x</sub> standards is flawed because EPA did not take into account the inherent conflict in complying with two standards. The commenters noted that CO and NO<sub>x</sub> emissions are inversely proportional. The commenters explained that decreases in CO tend to elevate NO<sub>x</sub> and vice versa. The commenters added that high temperature combustion with long residence times and high oxygen concentration results in very low CO emissions, and that those same operating conditions favor high NO<sub>x</sub> emissions. The commenters added that the conditions used to minimize CO (*i.e.*, high temperature afterburners) consume more fuel and produce more CO<sub>2</sub> emissions.

One commenter noted that the SSI unit with the most advanced control technologies, and those EPA indicated were costed in the impacts analysis, would not meet the emission limits for all of the pollutants all of the time. The commenter provided an example showing that of 11 of 30 test data points from the SSI unit in EPA’s database would not comply with the Cd standard, 28 of 30 data points would not comply with the Pb standard, 22 of 30 would not comply with the HCl standard, six of six data points would not comply with the PCDD/PCDF/TMB or TEQ, 86 of 105 would not comply with the CO standard, and eight of 15 would not comply with the NO<sub>x</sub> standard. The commenter concluded that data variability has not been appropriately accounted for and that EPA’s method of establishing the MACT floor based on the best performing unit for each pollutant is not reasonable.

*Response:* We disagree with the commenters who object to setting MACT floors on a pollutant-by-pollutant basis. EPA previously has explained that although CAA section 129 does not unambiguously declare that MACT floors must be established on a pollutant-by-pollutant basis, applying the requirement to set MACT floors based on what has been achieved by the best-performing sources for each of the pollutants covered by CAA section 129 is a reasonable interpretation of EPA’s

obligation under that provision (62 FR 48363–64).

EPA interprets the provision in CAA section 129(a)(2) to support establishing emissions standards based on the actual emissions of “the best controlled similar unit” or “best-performing 12 percent of units in the category” for each covered pollutant. Even if we were to conclude that the commenters’ interpretation is equally reasonable under the statute, which we do not, the commenters’ interpretation is certainly not compelled by the statute. We maintain that our interpretation is reasonable under the statute and appropriate given the problems associated with implementing the commenters’ approach.

The rest of CAA section 129 requires EPA to “establish performance standards and other requirements pursuant to section [111] of this title and this section [129] for each category of solid waste incineration units.” Pursuant to CAA section 129(a)(2), those standards “shall reflect the *maximum degree of reduction* in emissions of air pollutants listed under section (a)(4)\* \* \*.” (emphasis added). Subsection (a)(4) then states: “The performance standards promulgated under section [111] of this title and this section [129] and applicable to solid waste incineration units shall specify numerical emissions limitations for the following substances or mixtures: PM (total and fine), opacity (as appropriate), sulfur dioxide, hydrogen chloride, oxides of nitrogen, carbon monoxide, lead, Cd, mercury, and dioxins and dibenzofurans.” Thus, the statute requires EPA to set individual numeric performance standards based on the maximum degree of reduction in emissions actually achieved for each of nine listed pollutants. Based on this, EPA believes—and has long believed—the statute supports, if not requires, that MACT floors be derived for each pollutant based on the emission levels achieved for each pollutant. Moreover, although the provisions do not state whether there is to be a separate floor for each pollutant, the fact that Congress singled out these pollutants suggests that the floor level of control need not be limited by the performance of devices that only control some of these pollutants well.

Looking at the statute as a whole, EPA declared in the 1997 rulemaking for medical waste incinerators “The EPA does not agree that the MACT floors are to be based upon one overall unit” (62 FR 48364). Pointing for instance to subsection 129(a)(4), EPA explained:

This provision certainly appears to direct maximum reduction of each specified

pollutant. Moreover, although the provisions do not state whether there is to be a separate floor for each pollutant, the fact that Congress singled out these pollutants suggests that the floor level of control need not be limited by the performance of devices that only control some of these pollutants well.

*Id.*

Since 1997, the courts have consistently repeated that EPA must set emission standards based on the best-performing source for each pollutant. *See, e.g., Cement Kiln*, 255 F.3d 855, 858 (DC Cir.) (“[T]he Agency first sets emission floors for each pollutant and source category \* \* \*”). Accordingly, EPA’s pollutant-by-pollutant approach has, as outlined above, been in place since 1997 for medical waste incinerators, and even earlier for other types of incinerators regulated under section 129. *See, e.g., 59 FR 48198* (September 20, 1994) (municipal waste combustors). In addition, such an approach has been upheld in other contexts. *See, e.g., Chemical Mfrs. Ass’n v. EPA*, 870 F.2d 177, 239 (5th Cir. 1989) (concluding that basing CWA best available technology standards on a pollutant-by-pollutant basis was a rational interpretation of EPA’s obligations under that similar statute). We note that the CAA MACT provisions were fashioned on that CWA program. S. Rep. No. 228, 101st Cong. 2d sess. 133–34.

Further, utilizing the single-unit theory would likely result in EPA setting the standards at levels that could, for some pollutants, actually be based on emissions limitations achieved by the worst-performing unit, rather than the *best*-performing unit, as required by the statute. *See* 61 FR 173687 (April 19, 1996); 62 FR 48363–64 (September 15, 1997). For example, if the best performing 12 percent of facilities for metals did not control CDD/CDF as well as a different 12 percent of facilities, the floor for PCDD/PCDF and metals would end up not reflecting best performance. Moreover, a single-unit approach would require EPA to make value judgments as to which pollutant reductions are most critical in working to identify the single unit that reduces emissions of the nine pollutants on an overall best-performing basis. Such value judgments are antithetical to the command of the statute at the MACT floor stage. It would essentially require EPA to prioritize the nine pollutants based on the relative risk to human health of each pollutant, a criterion that has no place in the establishment of MACT floors. *Sierra Club v. EPA (Copper Smelters)*, 353 F.3d 976, 979–80 (DC Cir. 2004).

The fact that the statute does not contain the phrase “for each pollutant” does not compel any inference that Congress was *sub silentio* mandating a different result when it left the provision ambiguous on this issue. The argument that MACT floors set pollutant-by-pollutant are based on the performance of a hypothetical facility, so that the limitations are not based on those achieved in practice, just re-opens the question of whether CAA section 129(a)(2) refers to whole facilities or individual pollutants. All of the emission limitations in this rule reflect actual performance and are achieved in practice.

An interpretation that the floor level of control must be limited by the performance of devices that only control some of these pollutants effectively “guts the standards” by including worse performers in the averaging process, whereas EPA’s interpretation promotes the evident Congressional objective of having the floor reflect the average performance of best performing sources. Since Congress has not spoken to the precise question at issue, and EPA’s interpretation effectuates statutory goals and policies in a reasonable manner, its interpretation must be upheld. See *Chevron v. NRDC*, 467 U.S. 837 (1984).

Commenters made much of the fact that no single facility is presently achieving all of the nine pollutant limits proposed. However, the available information compared to the final standards disputes this assertion. For the final standards, based on the data we have, our estimate of baseline emissions, and the revised emission limits, we are estimating that 155 of 204 existing SSI units can meet standards for all nine pollutants, without installing additional pollution control. We cannot make this assessment for new sources, because none have been constructed. However, we are not aware of any technical reason that new units could not install the most advanced pollution control techniques or reduce the pollutant concentrations in the sludge to meet the new source standards.

We recognize that the pollutant-by-pollutant approach for determining the MACT floor can, as it does in this case, increase the overall cost of the regulation compared to what would result under a unit-based methodology. We interpret CAA section 129 to require that the MACT floor be determined in this manner, and we believe that Congress did, in fact, intend that sources subject to regulations developed under CAA section 129 meet emissions limits that are achieved by the best controlled unit for each pollutant, as

long as the control systems are compatible with each other. To our knowledge, there is no technical reason why these air pollution control systems cannot be combined.

Regarding the inverse relationship between CO and NO<sub>x</sub> with regard to combustion control, it is incumbent upon the SSI facility to determine whether combustion conditions can be adjusted to meet both standards and, if not, install NO<sub>x</sub> controls as necessary (e.g., SNCR systems, SCR systems, FGR, or low NO<sub>x</sub> burners). In the proposed rule, we conjectured reasons why SCR and SNCR were not used or may not be able to be used at SSI units. While we are not aware of any SSI unit that currently uses SNCR or SCR, we also do not know of technical reason why they could not be used. Given the limited data available on SSI units with FGR, we could not definitely determine how effective the technology was on SSI units. However, we also do not know of a technical reason why they could not be used, if necessary, to meet NO<sub>x</sub> limits, and commenters did not provide any reasons they could not be used.

#### Dataset for the MACT Floor Analysis

*Comment:* Many commenters urged EPA to collect more information to set the standards. Many commenters contended that EPA does not have sufficient actual emission data from enough SSI units to properly set the MACT floor. Some commenters contended that the floor-setting provision in section 129 requires them to set the existing floor standards “based on the best performing 12 percent of sources in the category” and not just based on the sources for which they have information. The commenters contended that EPA did not have emissions data from the best-performing 12 percent of sources or even from 12 percent of sources. Additionally, the commenters stated that there is no evidence that the sources for which EPA collected data are among the top 12%. One commenter added that EPA is using actual data from as little as 4.3 percent of a subcategory (7 of 163 MH units for HCl) to determine how the top 12 percent perform.

Some commenters contended that EPA chose to limit its ICR to just nine entities because collecting information from ten or more entities would have triggered the PRA obligations and a more rigorous OMB review. The commenters concluded that EPA’s plan to circumvent the PRA and OMB review resulted in an inadequate dataset for this rulemaking that leaves EPA unable to reliably take the first necessary step in a section 129 rulemaking: To

determine which of the SSI units are the best performing sources.

Some commenters also contended that EPA targeted its ICR to the nine POTW expected to have the lowest emissions based on the type of unit and the installed air pollution controls. The commenters contended that EPA’s targeted approach to collecting data from expected top performers undermines its ability to presume the data is a random sample representative of the entire source category or subcategory. The commenters stated that if the data gathered are not representative at the outset, then the data cannot reliably be used in a statistical equation to predict the emissions data across the source category or subcategory.

Some commenters noted that in the past, EPA has used permit or other regulatory limits, emission levels, feed rate control, and other information to establish MACT standards. Despite this flexibility, the commenters stated that EPA is proposing to use an “actual emissions” method in the SSI rule, even though it does not have actual emissions for each of the regulated pollutants from at least 12% of the units.

Another commenter stated that EPA used emission data from state databases for an additional nine MHs. The commenter stated that EPA was instructed by the Court to collect data from the best-performing 12% of existing sources, and EPA needs to justify that the emissions data from the state databases for the additional nine MHs were the 12% best performing MHs.

*Response:* As explained in the preamble to the proposed rule, EPA requested several SSI to conduct emissions testing and provide the results to EPA for purposes of this rulemaking. Specifically, EPA collected information on the best-performing sources to establish MACT floor standards for SSI. Therefore, EPA sent emissions tests requests under section 114 of the CAA to nine entities that own and operate SSI units. EPA identified SSI units that were expected to be the best-controlled sources and the best performers for further emissions testing. The Agency acknowledges that this selection methodology targets identifying the best-performing sources rather than selecting a representative sample of sources. However, given the court-ordered deadline for EPA to issue the final SSI rule, it was not possible to undertake the time-consuming process of sending an ICR to all the affected SSI units consistent with the requirements of the PRA.

To select the surveyed owners, EPA reviewed the inventory of SSI units for the control devices being operated, and identified a subset of units expected to have the lowest emissions based on the type of unit and the installed air pollution controls. These controls generally achieve the most reductions possible for the CAA section 129 pollutants, and thereby allow EPA to identify for each pollutant the units with the lowest emissions. For example, units were selected that operated more than one of the following technologies: Activated carbon injection to reduce Hg and dioxins/furans; RTOs or afterburners to reduce CO and organics; wet ESP to reduce fine particulate; high efficiency scrubbers such as packed bed scrubbers and impingement tray scrubbers to reduce PM, Cd, Pb, particulate Hg, and acid gases such as HCl and SO<sub>2</sub>; and units with multiple control devices that could reduce PM, Cd, Pb, particulate Hg, such as venturi scrubber in combination with impingement scrubbers and wet ESPs or with another particulate control device. The 9 owners or operators selected were from different states in different regions of the country, providing a wide spectrum of sources for sludge generated.

Six of the nine ICR recipients operate MH units, resulting in 13 MH units surveyed. Three of the nine operate FB units, resulting in 7 FB units surveyed. Some owners of multiple units at a facility provided information for less than the total number they operated, *e.g.* 1 unit instead of 2, because not all units were in operation during the test period. Of those 20 units from the nine surveyed municipalities, EPA collected data from 17 units that were in operation (11 MH units and 6 FB units). While testing was being undertaken, the EPA also collected emission test information for 9 MH SSI units collected from state environmental agencies public databases. For some pollutants, the emissions from these supplemental test reports were lower than those from the nine ICR sources. The EPA concluded that it was appropriate to use all the emissions information from these test reports in the MACT floor analysis. The EPA also collected many test reports that were older than 15 years. The older reports were determined to not be appropriate for this rulemaking because they were unlikely to represent current emissions performance, due to their age and because they pre-dated required compliance with the CWA part 503 standard. In total, emissions information were collected from 6 FB units and 20

MH units from facilities responding to the ICR and additional test reports provided by state environmental agencies.

As discussed in the NPRM and background documentation, the EPA conducted a statistical analysis to verify the minimum number of observations needed to accurately characterize the distribution of the best-performing 12 percent of units in each subcategory. The results showed that the data utilized by EPA meets or exceeds the number of observations necessary to provide an accurate representation of that data distributed from the best-performing 12 percent of the source population. The EPA maintains that the emissions information that we have collected is adequate to determine the MACT floor for the best-performing sources. The EPA disagrees with the commenters' recommendation to use other types of data, such as permits, other regulatory limits, or feed rate controls with the emissions information to calculate the MACT floor. The other types of data mentioned do not represent the actual emissions or operation of the unit but are potential values in their permits or limits. Most units are typically operating at lower than permitted levels or emission limits.

Additionally, it would be difficult to incorporate such data into the EPA's UPL calculation because the UPL calculation is based on emission test runs of actual data, rather than limits based on permits. The permit or emission limits would be on a different basis and potentially skew the MACT floor UPL calculation.

The EPA has also updated the inventory of sources based on additional data provided in the comment letters. The inventory now contains 204 SSI units, 60 FB units and 144 MH units. Given this change in population, 12 percent of each subcategory are equal to 8 FB units and 18 MH units. Although we do not have any more emissions information than at proposal, the change in inventory results in more than 12 percent of MH units with data for PM and Hg. For these pollutants, we determined the MACT floor based on the best-performing 12 percent of emissions data, as documented in the memorandum "Revised MACT Floor Analysis for the Sewage Sludge Incinerator Source Category" in the SSI docket (EPA-HQ-OAR-2009-0559). EPA solicited additional emission test reports in the NPRM. Although many commenters summarized the results of their most recent emission tests when comparing their site-specific emissions to EPA's baseline emissions, none of the commenters actually provided the

emissions test reports. The emission test reports are necessary for the EPA to review the test methods and procedures to ensure consistency with other emissions data, and to verify the tests represent a valid test result that can be used in the MACT floor analysis. Additionally, the test reports provide information necessary to correct the emissions measured into the units used for the MACT floor analysis. Therefore, these additional test result summaries, without background documentation, could not be used in the MACT floor UPL calculation.

*Comment:* One commenter stated that, to fill the data gap caused by the lack of actual emissions data from the required number of units in each subcategory, EPA applied statistical analysis to single test run results. Several commenters contended that, in order to enhance the data available for MACT development, EPA counted each test run as a separate data point.

Some commenters stated that basing a MACT Analysis on test runs, instead of tests, is improper. The commenters noted that CAA section 129 states that MACT standards for existing sources must be as stringent as the "emissions limitation achieved by the best performing 12 percent of units in, the category." The commenters added that, assuming that EPA equates the term "emissions limitation" with the concept of emission level (as often stated by EPA), this clause means that EPA must use the emission levels that have been achieved to set the MACT floors. The commenters contended that, under the MACT program, it takes a "minimum" of three test runs to make up a valid emissions level test. The commenter stated that a test run is not an accurate measure of the performance of the unit and should not be used as if it were. Commenters added that EPA should use the results of the test for each unit (comprised of at least three test runs) to represent what is being achieved by a unit.

Several commenters contended that EPA must go back and reset the process based on 12% of MH and 12% of FBI sources (not individual incinerators). The commenters added that it is important that individual sources, not units, be utilized because the composition of the sludge varies greatly from source to source and utilizing multiple units at one source skews the data development process and ultimately provides the basis for a flawed MACT standard at best.

*Response:* We disagree with the commenters. The 99 percent UPL values were calculated for each pollutant and for each subcategory using the test run

data for those units in the best-performing 12 percent. Consistent with EPA's procedures on other MACT standards, such as HMIWI, CISWI, and boilers, the MACT floor emission limits were calculated on a run basis since compliance is based on the average of a 3-run test. The 99 percent UPL represents the value which one can expect the mean of future 3-run performance tests form the best-performing 12 percent of sources to fall below, with 99 percent confidence, based upon the results of the independent sample observations from the same best-performing sources.

Variability Calculation

For the final rule, as in the NPRM, we are incorporating variability in the MACT floor calculation for this source category using the 99 percent UPL. We are also following the same procedures for establishing limits and incorporating non-detect values as discussed in the NPRM. We have made three revisions to the variability calculation for the final rule. First, we revised the MACT floor variability calculation to incorporate weighted UPL's for existing FB units. Second, we selected log-normal results when it is not clear that data are normally distributed. Lastly, we revised the CO limits based on an analysis of the span of the test. The weighted UPL's and log-normal results are discussed in

responses to comments. The revision to the CO limits based on reviewing the CO span was done to correct errors in the CO values provided in test reports and to be consistent with the calculation methods used in the CISWI and boilers rules.

Carbon monoxide values obtained from emission test reports were reviewed to determine whether the span of the test used was capable of accurately reading the reported value. If the span was inconsistent with the reported value, the CO levels were adjusted to provide a value that was more consistent with the span. EPA Method 10 is structured such that measurement data quality relative to the calibration span of the instrument can be assessed. For a measurement made using an instrumental test method, the equivalent of the method detection level can be assessed using: a square root formula, the reported calibration span value, and the allowable data quality criteria (*i.e.* the allowable calibration error, bias, and drift values). The estimated CO measurement error resulting from the square root formula was adjusted by a factor of three to be consistent with the methodology EPA applied for non-detect data (where limits no less than three times the method detection level were established).

In order to develop a basis for measurement error, instrument calibration spans in available test reports were reviewed. Where no span values could be found, it was assumed that if the test was conducted on or before May, 2008, the associated CO span would be 1000 ppm, and tests conducted after May 2008 would have a CO span of 100 ppm. This assumption was made because, before revisions were made to Method 10 in May of 2008, it was common that units were using the prescriptive span guidance that was listed in the old method. The current version of EPA Method 10 does not include these span requirements but instead requires the tester to choose calibration ranges that reflect the range of expected emission concentrations at the unit. In cases where the reported emission concentrations were lower than their corresponding measurement errors, the default measurement errors were used in lieu of the reported concentration.

These revisions are further documented in the memorandum "Revised MACT Floor Analysis for the Sewage Sludge Incinerator Source Category" in the SSI docket (EPA-HQ-OAR-2009-0559). Table 7 of this preamble shows the revised results of the MACT floor analysis for existing sources, and Table 8 of this preamble shows the results for new sources.

TABLE 7—SUMMARY OF MACT FLOOR ANALYSIS FOR EXISTING SSI UNITS

Pollutant	Units	MACT floor emission limit for FB incinerators <sup>a</sup>	MACT floor emission limit for MH incinerators <sup>a</sup>
Cd	mg/dscm@7% O <sub>2</sub>	0.0016	0.095
CO	ppmvd@7% O <sub>2</sub>	64	3,800
HCl	ppmvd@7% O <sub>2</sub>	<sup>b</sup> 0.51	1.2
Hg	mg/dscm@7% O <sub>2</sub>	0.037	<sup>b</sup> 0.28
NO <sub>x</sub>	ppmvd@7% O <sub>2</sub>	150	220
Pb	mg/dscm@7% O <sub>2</sub>	0.0074	0.30
PCDD/PCDF TEQ	ng/dscm@7% O <sub>2</sub>	0.1	0.32
PCDD/PCDF TMB	ng/dscm@7% O <sub>2</sub>	1.2	5.0
PM	mg/dscm@7% O <sub>2</sub>	18	80
SO <sub>2</sub>	ppmvd@7% O <sub>2</sub>	15	26

<sup>a</sup>Limits were rounded up to two significant figures.  
<sup>b</sup>Limits represent three times the detection level.

TABLE 8—SUMMARY OF MACT FLOOR ANALYSIS FOR NEW SSI UNITS

Pollutant	Units	MACT floor emission limit for FB incinerators <sup>a</sup>	MACT floor emission limit for MH incinerators <sup>a</sup>
Cd	mg/dscm@7% O <sub>2</sub>	0.0011	0.0024
CO	ppmvd@7% O <sub>2</sub>	27	52
HCl	ppmvd@7% O <sub>2</sub>	0.24	<sup>c</sup> 1.2
Hg	mg/dscm@7% O <sub>2</sub>	0.0010	<sup>b</sup> 0.15
NO <sub>x</sub>	ppmvd@7% O <sub>2</sub>	30	210
Pb	mg/dscm@7% O <sub>2</sub>	0.00062	0.0035
CDD/CDF TEQ	ng/dscm@7% O <sub>2</sub>	0.0044	0.0022
CDD/CDF TMB	ng/dscm@7% O <sub>2</sub>	0.013	0.045

TABLE 8—SUMMARY OF MACT FLOOR ANALYSIS FOR NEW SSI UNITS—Continued

Pollutant	Units	MACT floor emission limit for FB incinerators <sup>a</sup>	MACT floor emission limit for MH incinerators <sup>a</sup>
PM .....	mg/dscm@7% O <sub>2</sub> .....	9.6	60
SO <sub>2</sub> .....	ppmvd@7% O <sub>2</sub> .....	5.3	26 <sup>c</sup>

<sup>a</sup>Limits were rounded up to two significant figures.

<sup>b</sup>Limits represent three times the detection level.

<sup>c</sup>Limits defaulted to EG limits since NSPS limits were less stringent than EG.

*Comment:* One commenter contended that because CAA section 129 unambiguously requires EPA to set floors reflecting the “average” emission level achieved by the best sources, setting floors that instead reflect a UPL for those sources is unlawful. The commenter, added that by claiming that it can use the UPL for all sources in the top twelve percent, EPA misreads its authority to consider variability under the CAA and relevant case law. The commenter explained that, although EPA may consider variability in estimating an individual source’s actual performance over time, nothing in the CAA or the case law even suggests that EPA may account for differences in performance between sources except as section 129 provides, by averaging the emission levels achieved by the sources in the top twelve percent.

*Response:* In assessing sources’ performance, EPA may consider variability both in identifying which performers are “best” and in assessing their level of performance. *Sierra Club v. EPA (Brick MACT)*, 479 F. 3d 875, 881–82 (D.C. Cir. 2007); see also *Mossville Environmental Action Now v. EPA*, 370 F.3d 1232, 1241–42 (D.C. Cir 2004) (EPA must exercise its judgment, based on an evaluation of the relevant factors and available data, to determine the level of emissions control that has been achieved by the best performing sources considering these sources’ operating variability). The *Brick MACT* decision indicated that floors for existing sources must reflect the average emission limitation achieved by the best-performing 12 percent of existing sources. The *Brick MACT* decision also reiterated that EPA may account for variability in setting floors; however, the Court found that EPA erred in assessing variability because it relied on data from the worst performers to estimate best performers’ variability. The Court held that “EPA may not use emission levels of the worst performers to estimate variability of the best performers without a demonstrated relationship between the two.” 479 F. 3d at 882.

In determining the MACT floor limits, we first determine the floor, which, for

existing sources, is the emissions limitation achieved in practice by the average of the top 12 percent of existing sources, or the level achieved in practice by the best controlled similar source for new sources. In this rule, EPA is using lowest emissions limitation as the measure of best performance. We then assess variability of the best performers by using a statistical formula designed to estimate a MACT floor level based on the average of the best performing sources using the expected distribution of future compliance tests. We used the UPL to perform this calculation, as explained below.

Variability can be accounted for using different statistical methods. For example, recent standards have used the UL or the UPL to determine the MACT floor emission limits. A UL is based on the distribution of the available emission observations (e.g., test runs), and does not embody a predictive aspect that a UPL does. A prediction interval (e.g., a UPL) for a future observation is an interval that will, with a specified degree of confidence, contain the next (or some other pre-specified) randomly selected observation from a population. In other words, the prediction interval estimates what future values will be, based on present or past background samples taken. Given this definition, the UPL represents the value the mean of three future test run observations (three-run average) can be expected to fall below, based on the results of the independent sample of size (n) from the same population. Therefore, should a future test condition be selected randomly from any of these sources (i.e., average of three runs), we can be 99 percent confident that the reported level will fall below a MACT floor emission limit calculated using a UPL. The UPL is an appropriate statistical tool to use in determining variability in the SSI data. For this source category, where there is a limited sampling of the source category and we do not have test data from all of the SSI units in the best performing 12% for each subcategory,

the predictive aspect of the UPL calculation is especially important.

Because the UPL represents the value which we can expect the mean (i.e., average) of three future observations (3-run average) to fall below, based upon the results of the independent sample size from the same population, the UPL reflects average emissions. The UPL is also consistent with other recent rulemakings.

*Comment:* Several commenters asserted that, in setting MACT standards for existing units, EPA pooled and utilized data from all available test runs for the best performing units without regard to the number of data points available for each unit. The commenters added that, for all pollutants, the number of test runs varies from unit to unit. One commenter stated that using data this way biases the statistical results, and ultimately, the standards by over-weighting the performance of the units that have more data. The commenter suggested that EPA should employ an alternate methodology which determines the emissions limitation achieved for each best performing unit first, and then averages these limitations to determine the least stringent standard, or MACT floor.

*Response:* The SSI emissions database for fluidized bed units contains data from six units at four facilities. The entities surveyed were requested to provide recent (within the previous 5 years) emissions test reports. Most survey recipients provided only the most recent report. One facility, with three units, provided results of emissions test conducted for compliance reports spanning a 10-year period. This facility also uses the most advanced pollution controls on their fluidized bed units in the subcategory. This facility constitutes 70 percent of the Cd and Pb data, 90 percent of the CO and Hg data, and 75 percent of the HCl data and PM data. As a result, the existing source MACT floors calculated using the UPL methodology, and all the test run data from the one facility, effectively result in calculating more stringent limits more akin to a new source MACT floor than an existing

source MACT floor, because it is based primarily on only the emissions performance of the best-performing single source, rather than the average of the best-performing 12 percent of sources. In order to adequately incorporate the emissions from the best-performing SSI units in the fluidized bed subcategory, a weighted UPL was used for calculating the existing source MACT floors for the final rule. The weighted UPL is calculated from a weighted mean and weighted variance as described below.

There are many different types of weighting procedures. We have chosen the most straightforward methodology, to base it on the number of data points (*i.e.*, test runs) from each SSI unit.<sup>12</sup> This weighting scheme ensures that no facility in the MACT best performers pool is over-represented in the computation of the MACT floor. The first step in weighting procedure is to assign a weighting factor to each test run by multiplying each observation for source *i* and run *j* with a weight term,  $w_{ij}$ , as shown in Equation 1 of this preamble:

$$w_{ij} = \left( \frac{1}{M_i} \right) \times \left( \frac{1}{N} \right) \quad (\text{Eq. 1})$$

Where:

$M_i$  = Number of observations (*i.e.*, runs) for source *i* and

$N$  = Number of best performing sources in the MACT pool.

The second step is to calculate the mean and total variance for the weighted data from the weight terms using Equations 2 and 3 of this preamble:

$$\text{Weighted Mean: } \bar{x}^{\text{weighted}} = \frac{\sum_{i=1}^N \sum_{j=1}^{M_i} w_{ij} x_{ij}}{\sum_{i=1}^N \sum_{j=1}^{M_i} w_{ij}} \quad \text{Equation 2}$$

$$\text{Weighted Variance: } v^{\text{weighted}} = \frac{\sum_{i=1}^N \sum_{j=1}^{M_i} w_{ij} (x_{ij} - \bar{x}_U^{\text{weighted}})^2}{(K-1) \sum_{i=1}^N \sum_{j=1}^{M_i} w_{ij}} \quad \text{Equation 3}$$

Where:

$$K = \sum_{i=1}^N M_i$$

is the total number of observations in the MACT best performers pool.

When the weights are equal to one, the above equations reduce to those for un-weighted data, as expected. As

shown in Equation 4 of this preamble, the weighted mean and weighted variance are then used in the UPL calculation (discussed in the NPRM) instead of the simple (*i.e.*, un-weighted) mean and variance.

$$UPL = \bar{x}^{\text{weighted}} + t(0.99, n_i - 1) \times \sqrt{(v^{\text{weighted}}) \times \left( \frac{1}{n_i} + \frac{1}{m_i} \right)} \quad \text{Equation 4}$$

For multiple hearth units, there are more emissions data from a larger number of facilities/units. For example, we have data on Cd and Pb from 11 facilities with 14 units, Hg from 11 facilities with 18 units. The MACT floor calculations are not skewed by one or two units or facilities. Consequently, the MACT floor for existing multiple hearth units does not need to be calculated using a weighted UPL.

The revisions to the MACT floor methodology are discussed in detail in the memorandum "Revised MACT Floor Analysis for the Sewage Sludge

Incinerator Source Category" in the SSI docket (EPA-HQ-OAR-2009-0559).

*Comment:* One commenter contended that EPA should determine the MACT floor emission limits to be consistent with EPA's Guidance for Data Quality Assessment Manual, which holds that it is more likely that environmental data are distributed log-normally. The commenter considered it reasonable to believe that environmental emission distributions are non-normal, since frequency plots typically show many readings approaching zero and fewer large readings forming an elongated tail to the right. The commenter concluded

that normal distributions may exist for certain pollutants where the entire dataset is many standard deviations away from zero, and values are controlled by an air pollution control process with set points and feedback and control loops.

*Response:* We have reviewed the document referenced and agree with the commenter that the referenced document shows that environmental data are more likely to be log-normally distributed than normally distributed. In the proposed rule, two statistical measures, skewness and kurtosis, were examined to determine if the data used

<sup>12</sup> Heckert, N. A. and Filliben, James J. (2003). "NIST Handbook 148: DATAPLOT Reference

Manual, Volume I: Commands", National Institute of Standards and Technology Handbook Series,

June 2003. [Available at <http://www.itl.nist.gov/div898/software/dataplot/document.html>]

to calculate the MACT floor were normally or log-normally distributed. If both the reported values and the natural-log transformed reported values had skewness and kurtosis statistics that indicated neither were normally distributed, the reported dataset was selected as the basis of the floor to be conservative. If the results of the skewness and kurtosis hypothesis tests were mixed for the reported values and the natural log-transformed reported values, the analysis done on the reported data values was chosen to be conservative.

Based on "Guidance for Data Quality Assessment: Practical Methods for Data Analysis" EPA/600/R-96/084, July 2000, we have modified our assumptions when results of the skewness and kurtosis tests do not clearly show whether a normal or log-normal distribution better represents the data, or when there are not enough data to complete the skewness and kurtosis tests. In these cases, we have chosen to use the log-normal results for the final MACT floor calculation.

*Comment:* Some commenters contended that EPA incorrectly presumes that stack test results account for the full variability of a SSI's performance. Several commenters stated that emissions from SSI units are affected not just by control technology but also by other factors including the contents of the sludge that a unit is burning. Many commenters urged EPA to determine the MACT floor limits by incorporating the variability of the sludge contents. The commenters added that the methodology in developing the proposed standards does not take into account that Hg, Cd, Pb, HC1 and SO<sub>2</sub> emissions are a function of the sludge content of Hg, Cd, Pb, chlorine and sulfur. The commenters expressed concern that the limits were based on test results obtained with sludge containing very low concentration of metals, chlorides, and sulfur. The commenter explained that if the sludge burned during an emissions test was not at or near the maximum constituent concentration level (e.g., due to seasonal variability), a new source emission limit based on these data could not be achieved over the full range of expected normal operating conditions confronted by the best performing source.

The commenters contended that EPA must consider all available data (including Part 503 data) for the best performing source and use that to establish a variability factor applied to the stack test data. The commenters added that EPA's request for metals data during the stack test is insufficient to account for the full intra-source

variability. The commenters added that variability for the compounds not regulated by Part 503 must also be accounted for as well before setting the new source limit.

The commenters explained that POTW, and their SSI units, are statutorily obligated to manage all of the sewage that enters into the sanitary sewer system, resulting in highly variable and often unpredictable spikes in concentrations. The commenters continued that POTW inlet concentrations also vary based on the nature and type of dischargers. The commenters explained that POTW treat wastewater from residential, commercial and industrial dischargers in varying degrees, and pretreatment opportunities also vary because POTW authority to control discharges into the sewer system is limited and the way that authority is exercised varies. The commenters also noted that the nature of sewage entering the POTW changes over time as the character of a community changes, the age of the population changes, and commercial and industrial dischargers come and go. The commenters added that without the use of long-term data to support the level of emission standards, this variability makes numeric technology-based limits impractical and infeasible. The commenters also explained that POTW also face significant regional and seasonal variability that is not captured by EPA's dataset. The commenters stated that initial high flow periods in the spring often scour the sewers and dislodge heavier material that has settled in the sewer system during low-flow periods, which often results in a spike in metals concentrations (e.g., Hg, Cd, Pb) in the sewage sludge. The commenters noted that the ICR stack tests in January and February that were used for the EPA database would not have captured these events. The commenter also noted that northern cities that use salt for de-icing roadways experience significant increases in chlorides during the winter months, and high chloride concentrations are known to improve the effectiveness of Hg control at existing wet scrubbers.

*Response:* The variability analysis is based on emissions information gathered from nine different facilities located in nine different states. The facilities we collected emissions information from are located in a mix of northern, southern, eastern, and western states. Each facility has its own unique sludge characteristics from different residential and commercial populations. We agree that the emissions data represents a "point in time". However, combined together, they represent

sufficient variation in regions, climates and populations that adequately incorporates variability in wastewater treatment systems across the U.S. We have also incorporated variability using the UPL. The variability analysis based on the emissions data collected adequately characterizes the potential differences in sludge contents and regional differences. Because we have a mixture of southern and northern states in the emissions database, we believe that it also adequately considers differences between cold and warm weather climates. Additionally, we did not have sufficient information at proposal to consider if it were appropriate to incorporate variability based on sludge content. We requested additional information in the NPRM, but did not receive adequate sampling data from the best-performing sources.

*Comment:* Some commenters claimed that EPA's identification of the relevant best performing units for both existing and new unit standards is both unlawful and arbitrary, and EPA may not use sources' control technology as a proxy for their actual performance unless "pollution control technology is the only factor determining emission levels." *Cement Kiln Recycling Coalition v. EPA*, 255 F.3d 855, 863 (DC Cir. 2001). The commenters stated that, in *Cement Kiln Recycling Coalition v. EPA*, 255 F.3d 855 (DC Cir 2001) ("CKRC"), the Court considered Sierra Club's challenge that EPA could not set the floors based solely on the performance of one method: Add-on technology. The commenters added that the Court remanded the rule because EPA did not consider all of the ways facilities control emissions. The commenters stated that this requirement is consistent with doing a more complete study as required by section 111 and is antithetical to a methodology based solely on emission levels since setting the floor in this fashion does not require EPA to examine all methods of control. The commenters concluded that EPA's performance data approach in this rule may violate CKRC because EPA did not check for all methods that sources use to reduce pollution.

*Response:* EPA disagrees with the commenter who alleges that EPA has not properly identified the best performing SSI units for purposes of calculating MACT floor limits. As explained above, EPA targeted its emissions testing requests to units it believed had the lowest emissions, while accounting for factors such as sludge content and seasonal variation by selecting units in different geographic areas of the country.

EPA further notes that SSI units currently employ non-technology measures (pollution prevention) to reduce emissions to comply with CWA regulations at 40 CFR part 503. These regulations establish daily average concentration limits for Pb, Cd, and other metals in sewage sludge that is disposed of by incineration. Part 503 also requires that SSI meet the National Emission Standards for Beryllium and Hg in subparts C and E, respectively, of 40 CFR part 61. In order to meet the 40 CFR part 503 standards, facilities are already incorporating management practices and measures to reduce waste and limit the concentration of pollutants in the sludge sent to SSI units, such as segregating contaminated and uncontaminated wastes and establishing discharge limits or pre-treatment standards for non-domestic users discharging wastewater to POTW. Thus, the facilities from which EPA received emissions test results are already applying non-technology measures to reduce emissions.

*Comment:* One commenter suggested that if EPA employs the statistical limit to set MACT floor emission limits, it should use the 99.9 percent limit. The commenter stated that the 99.9 percent UPL represents a 0.1 percent probability of a failure for individual tests, or a one percent per unit non-compliance probability per annual performance test program. The commenter concluded that this value better encompasses unit emissions variability and represents a manageable risk to the responsible facility operator.

*Response:* We disagree with the commenters. For the final standards, we maintain the use of 99 percent UPL is appropriate and sufficiently addresses variability in the emissions information. Our analysis of variability is explained in detail in the memorandum "Revised MACT Floor Analysis for the Sewage Sludge Incinerator Source Category" in the SSI docket (EPA-HQ-OAR-2009-0559).

*Comment:* Several commenters opposed an opacity limit of zero percent because opacity is a subjective measurement and no unit can meet opacity limits of zero at all times. Another commenter suggested that control and monitoring of PM is sufficient.

*Response:* We agree that a no visible emissions (zero opacity) limit for combustion processes is impractical for both compliance and enforcement purposes. We also believe that a measurable opacity may or may not be indicative of compliance with a PM emissions limit when applied to multiple sources within the category.

That is, an opacity limit applied to one facility could very readily correspond to a PM emissions level different than that same opacity limit applied to another facility and one or both may be emitting above the PM limit. That opacity limits do not apply very well when wet control devices are used further confounds the benefit of such regulatory limits. We also agree that there are both CEMS and site-specific parametric monitoring approaches applicable to various control devices that can be more closely aligned with PM control and compliance with the PM emissions limit than would an opacity limit and opacity monitoring. Instead of establishing opacity limits that may or may not assure compliance with PM emissions limits, the final rules include rigorous requirements for establishing site-specific operating limits derived from the results of performance testing. The rules also include a requirement that sources update those enforceable operating limits with each repeated performance test. Re-establishing operating limits periodically will assure that the monitoring will continue to indicate compliance with the PM emissions limits. The rules also provide the source the option of apply CEMS to monitor directly the pollutant of interest in lieu of parametric monitoring. We believe that continuous compliance with operating limits and periodic stack testing to verify the operating limits plus the CEMS option will ensure that sources demonstrate continuous compliance with the PM emission limits more effectively than would periodic or continuous monitoring of a broadly applicable opacity limit.

#### Format of the Standards

*Comment:* Several commenters requested that EPA develop emission limits for some pollutants in different units or to provide a control efficiency alternative. The commenters expressed concern that the use of concentration limits would not reflect the variability of the unique sludge characteristics of each SSI unit, and may unfairly penalize units with very low or very high feed concentrations of certain pollutants, such as Hg, Cd, or Pb. Some commenters suggested establishing limits similar to the EPA 503 regulations, which provided emission limits based on control efficiencies coupled with feed concentration limits.

*Response:* We did not have sufficient data to set alternative control efficiency standards or standards in other units at proposal. We requested additional information in the proposal. However, sufficient data were not provided in

response to our request for alternative formats to be developed.

#### D. Baseline Emissions

*Comment:* Commenters stated that EPA overestimated baseline emissions because EPA used incorrect air flow rate parameters, pollution control device efficiencies, sludge feed rates, and operating hours. Many commenters provided stack test data, emission estimates, and corrections to the EPA's SSI inventory database. Other commenters noted that EPA used uncorrected flue gas flow rates and flow rate factors in combination with pollutant concentrations corrected to seven percent oxygen.

*Response:* We have incorporated corrections to the inventory and calculation inputs provided by the commenters where applicable. In some cases, commenters did not provide information sufficient for us to revise the inventory or calculation inputs for the commenter's facility. For example, commenters may have provided an average concentration for a pollutant, but did not provide run-specific information that would allow us to convert the concentration information provided to standardized units (7 percent oxygen). Other commenters may have provided emission rates in pounds per hour, but did not provide vent gas flow rate, oxygen content, or moisture content to convert to concentration units. None of the commenters provided test reports that would have include this information.

We have also revised the calculation of baseline emissions by revising the defaults assigned to SSI units where information was not available. Defaults were necessary to be assigned because, even after new data were received in comments, a significant number of units did not have data on sludge capacity, flue gas flow rates, etc. A detailed discussion of the methodology used to estimate baseline emissions for the final standards is presented in the memorandum "Revised Estimation of Baseline Emissions from Existing Sewage Sludge Incineration Units" (EPA-HQ-OAR-2009-0559). The revisions to the inventory and other corrections resulted in the final rule baseline emissions shown in Table 9 of this preamble. The table shows a range of emissions for each pollutant. The lower bound represents an estimation of actual emissions based on the actual dry sludge feed rates commenters indicated their units were running. The upper bound represents an estimation of potential emissions if the sludge feed rate was at the dry sludge capacity of each unit. We estimated the potential

emissions because the amount of wastewater treated (and sludge produced) may vary significantly based on changes in population or sources of wastewater. Facilities have the potential to burn up to their units permitted capacity although they may not be doing so currently.

TABLE 9—ESTIMATED BASELINE EMISSIONS FOR EXISTING SSI UNITS

Pollutant	Range of baseline emissions by subcategory (TPY)		Range of total baseline emissions (TPY)
	FB	MH	
Cd	0.0022–0.0015	0.91–1.2	0.91–1.2
CO	73–100	8,400–11,500	8,500–11,600
HCl	1.6–2.2	26–41	28–43
Hg	0.040–0.058	0.85–1.15	0.9–1.2
NO <sub>x</sub>	320–480	2,100–2,800	2,400–3,300
Pb	0.0056–0.0077	2.4–3.1	2.4–3.1
PCDD/PCDF TEQ <sup>a</sup>	0.00012–0.00016	0.00076–0.0010	0.0009–0.0012
PCDD/PCDF TMB <sup>a</sup>	0.0014–0.0020	0.011–0.015	0.013–0.017
PM	25–37	310–410	330–450
SO <sub>2</sub>	43–57	660–1,020	700–1,100

<sup>a</sup>Baseline emissions are in pounds per year for PCDD/PCDF.

E. Beyond-the-Floor Analysis

*Comment:* Several commenters requested that EPA reconsider the beyond-the-floor Hg limit for MH units because baseline Hg emissions were overstated and costs for Hg control were understated. Many of the commenters contended that carbon injection is an unproven technology for SSI units, and is currently used at only one facility with FB units. The commenters added that the facility is undergoing significant issues with the technology.

Commenters also contended that Hg removal using carbon injection cannot be accomplished with existing PM controls, such as venturi scrubbers, and that FFs would be necessary. The commenters added that the high moisture content in the form of liquid droplets from the incinerator will plug FFs, and additional equipment may be

necessary to keep the temperature above the dew point, such as an afterburner.

*Response:* We have revised the beyond-the-floor analysis to incorporate changes made to the baseline emissions, new facility specific data and inputs provided by commenters, and revised control options. We analyzed several beyond-the-floor controls for the final rule. First, we evaluated the use of an afterburner for control of CO at MH units. We then evaluated whether additional control of Hg should be required at MH units. We have reviewed the commenters concerns regarding Hg control technologies and agree that applying carbon injection to existing scrubbers has not been demonstrated to be effective at removing Hg. For combustion sources that are not SSI, such as boilers, carbon injection in combination with a FF has proven to be highly effective in removing Hg.

However, for high moisture flue gas streams, such as emitted from SSI units, the use of FFs is problematic due to plugging/fouling. In order to use carbon injection with a FF with high moisture streams, a waste heat boiler, RTO, or afterburner is necessary to maintain a high enough temperature to keep the stream above the dew point prior to sending the stream to the FF.

Therefore, we next evaluated the combination of using an afterburner, carbon injection, and FF for additional control of Hg at MH units. Additional equipment may also be necessary to reduce the temperature of the flue gas to prevent damage to the fabric filter bags. Sufficient information was not collected to estimate this cost. Table 10 of this preamble summarizes the cost for existing SSI units to apply different controls that were analyzed.

TABLE 10—COSTS EXPECTED FOR EXISTING SSI UNITS TO APPLY MACT CONTROLS ANALYZED [2008\$]

Control analyzed	Total capital costs (million \$)	Total annualized costs (million \$/yr) <sup>a</sup>
1—MACT Floor	55	18
2—MACT Floor + Afterburner for MH units	155	46
3—MACT Floor + Afterburner and Activated carbon injection and FF for MH units	490	138

<sup>a</sup>Calculated using a seven percent discount factor.

Table 11 of this preamble summarizes the emission reductions of each pollutant for various controls analyzed.

TABLE 11—SUMMARY OF EMISSION REDUCTIONS FOR EXISTING UNITS TO APPLY THE MACT CONTROLS ANALYZED

Pollutant	Emission Reductions for MACT Controls Analyzed (TPY)		
	MACT floor	MACT floor + afterburner for MH units	MACT floor + afterburner + ACI and FF for MH units
Cd .....	0.5–0.6	0.5–0.6	0.87–1.1
CO .....	0	6,900–9,300	6,900–9,300
HCl .....	19–30	19–30	19–30
Hg .....	0.0022–0.0025	0.0022–0.0025	0.67–0.89
NO <sub>x</sub> .....	6.8–16	6.8–16	6.8–16
Pb .....	1.2–1.5	1.2–1.5	2.3–2.9
PCDD/PCDF TEQ .....	0	0	0.0000003–0.0000004
PCDD/PCDF TMB .....	0	0	0.0000005–0.0000007
PM .....	58–70	58–70	300–400
SO <sub>2</sub> .....	430–700	430–700	430–700

The results provided in Tables 10 and 11 of this preamble were calculated using data gathered for each source (*e.g.*, emissions, vent gas flow rates, controls currently used), as well as default values for emissions, sludge capacity, and vent gas flow rate for sources where data were unavailable. We estimate that requiring the use of an afterburner for MH units not already having an afterburner could require as much as 1,010 million cubic feet of natural gas a year to be burned, resulting in NO<sub>x</sub> and CO emissions of 51 and 43 TPY, respectively. We estimate that applying activated carbon injection with a FF and an afterburner or RTO to all MH units to control Hg and PCDD/PCDF would result in total annualized costs of \$138 million dollars (using a discount rate of seven percent) and would achieve Hg reductions of 0.67–0.89 TPY. The incremental cost-effectiveness of adding afterburners/RTO, activated carbon injection, and FFs to all MH units is estimated to be \$80,000 to \$100,000 per pound of Hg removed. Costs would increase if equipment necessary to cool the flue gas is also necessary. Therefore, given these factors, we are not finalizing any beyond-the-floor requirements for SSI units.

We also analyzed going beyond-the-floor to require packed bed scrubbers for additional HCl and SO<sub>2</sub> reduction, a wet ESP for additional PM, Cd and Pb reduction, and SNCR for additional NO<sub>x</sub> reduction. We determined that it was not appropriate to go beyond-the-floor to achieve greater reduction of HCl, SO<sub>2</sub>, PM, Cd, Pb, and NO<sub>x</sub> considering the cost and secondary impacts incurred. Our beyond-the-floor analyses for the final standards are documented in the memorandum “Revised Analysis of Beyond the Maximum Achievable Control Technology (MACT) Floor Controls for Existing SSI Units” (EPA–HQ–OAR–2009–0559).

#### F. Cost and Economic Impacts

*Comment:* Commenters contended that EPA had underestimated the cost of the proposed rule for the beyond-the-floor option of Hg control as well as for the MACT floor for other pollutants because it only has information for less than 12 percent of the SSI units. The commenters added that EPA used information from these limited sources and applied it to remaining sources for which they did not have. The commenters contended that this results in inaccurate determinations of which units could meet the proposed emission limits and which could not. The commenters contended that EPA overestimated the number of sources that could meet the proposed standards resulting in a significant underestimation of controls.

Some commenters also contended that EPA's choices of controls to cost for compliance with the proposed standards were inappropriate for SSI units. Many commenters stated that the high moisture content of flue gas streams in some applications may mean that FFs would not be an appropriate control for PM, Cd, or Pb.

*Response:* EPA is not prescribing a specific control technology or method. A source is required to meet the final emissions limits in these standards, and has the flexibility to use the control method or technology that is best suited for their individual facility. EPA's costs are estimated based on technologies we believe may be appropriate for the sources to meet the emissions limits.

At proposal, and for the final standards, we estimated costs and emissions reductions based on the best available information to us. We acknowledge that the inventory database did not have complete information for all 204 SSI units. Consequently, we developed defaults for flue gas flow rate, hours of operation, sludge capacity, and other inputs for the

proposed rule. We have updated our analyses using data provided by the commenters as summarized in section IV. Summary of Significant Changes Following Proposal and the memorandum titled, “Post-Proposal SSI Database Revisions and Data Gap Filling Methodology” in the docket (EPA–HQ–OAR–2009–0559). However, for a number of inputs, we are still assigning default values where data were not available for each SSI. For the final rule, we have correlated some of the defaults to populations served by the facilities in order to better estimate costs and emission reductions more specifically to each facility. Sources will have the best idea of the costs of controls for their site specific conditions. For some sources, the costs and emission reductions estimated by EPA may be higher than what the source estimates, and for others they will be less. EPA's estimates are estimates based on the best information available to us. We also note that the MACT floor costs and emission reductions, and determination of the number of sources estimated to require control, estimated for the final rule are also based on the revised MACT floor limits.

For the final standards we have also revised the types of controls costed to meet the MACT floor limits. For SSI that we estimate will need further control of PM, Cd, or Pb to meet the MACT floor, we have costed out wet ESP as a more appropriate PM control for high moisture streams. We have also costed out SNCR for SSI that we estimate will need further control of NO<sub>x</sub> to meet the MACT floor limits. As at proposal, we have costed out packed scrubbers for SSI that we estimate will need further control of HCl or SO<sub>2</sub>. At the MACT floor level, we do not estimate that any SSI will need to add control for Hg, PCDD/PCDF, or CO. A detailed discussion of the costs and emissions reductions estimates for the final

standards is provided in the memorandum "Revised Cost and Emission Reduction of the MACT Floor Level of Control" in the SSI docket (EPA-HQ-OAR-2009-0559).

*Comment:* Commenters contended that EPA had incorrectly calculated the costs of the landfilling alternative because it used dry tons of sewage sludge instead of wet tons. The commenters added that wet tons is the appropriate basis of the sludge because even after the dewatering process, the sludge contains 70 to 80 percent moisture. Many of the commenters provided estimates for landfilling sludge from their specific unit. The commenters added that because of the error, EPA has significantly underestimated the impacts from transporting sludge by truck. Other commenters added that EPA had not evaluated the negative social impact of hauling sludge to a landfill. Some commenters added that EPA did not consider the additional costs for specific state landfilling regulations.

Several commenters contended that EPA incorrectly estimated the on-site sludge storage requirements because calculations were not done on a wet basis. Commenters added that the cost of the storage units would be significant and would need to include odor control as well as a settling basin.

Other commenters expressed concern regarding the availability of landfills to POTW needing disposal sites. The commenters contended there was insufficient landfill capacity to handle the influx of sewage sludge.

*Response:* We have revised our costs and impacts of the landfill alternative based on comments received on the proposal and corrections made to the analysis. Table 14 of this preamble summarizes the revised costs and impacts of this alternative if small entities choose to landfill rather than incinerate sewage sludge. A detailed discussion of the landfilling alternative analysis is provided in the memorandum "Revised Cost and Emission Reduction of the MACT Floor Level of Control" in the SSI docket (EPA-HQ-OAR-2009-0559).

Based on the revised impacts, it is unlikely that many sources will find landfilling an appropriate alternative. The selection of a management option for sewage sludge is often a local decision that is based on environmental protection concerns, community needs, geographic constraints, and economic conditions. Given a full evaluation of these factors, for some sources, landfilling or land treatment may be a better management option than incineration.

### G. Startup, Shutdown, and Malfunction

*Comment:* Numerous commenters disagreed with EPA's proposed language requiring facilities to meet the proposed SSI standards "at all times" because it would be difficult to comply with certain proposed emission limits during startup and shutdown. Many of these commenters were specifically concerned about not being able to meet the proposed CO concentration limit upon startup of a SSI because when a heat up burner system is fired into a cold vessel, the flame tip is quenched before the combustion is completed creating a small flow of CO. One commenter contended that EPA is proposing a new source CO standard without any evidence that it can be achieved during startup, shutdown, or malfunction. This commenter provided an example of CO data from one hazardous waste combustor that averaged 2.2 ppmv during normal operations but averaged 48.6 ppmv during startup, 40.5 ppmv during shutdown, and 815.5 during malfunctions. The commenters stated that absolute pollutant levels tend to increase during startup and shutdown due to incomplete combustion that is unavoidable at lower temperatures, and noted that the influence of unstable combustion may be more pronounced during shutdowns as the incinerator combusts the remaining sewage sludge for 30 minutes or more. The commenters recommended that EPA account for situations where higher emissions occur during the time it takes to bring control equipment from startup to steady-state operations.

*Response:* At this time, we are not promulgating a separate emission standard for the source category that applies during periods of startup and shutdown. We do not have data that would allow us to set a separate standard during periods of startup and shutdown. We requested information in the NPRM. However, no data were provided. Based on the information available at this time, we believe that SSI units will be able to meet the emission limits during periods of startup. Units we have information on use natural gas, landfill gas, or distillate oil to start the unit and add waste once the unit has reached combustion temperatures. Emissions from burning natural gas, landfill gas or distillate fuel oil are expected to generally be lower than from burning solid wastes. Emissions during periods of shutdown are also generally lower than emissions during normal operations because the materials in the incinerator would be almost fully combusted before

shutdown occurs. Furthermore, the approach for establishing MACT floors for SSI units ranked individual SSI units based on actual performance for each pollutant and subcategory, with an appropriate accounting of emissions variability. Because we accounted for emissions variability, we believe we have adequately addressed any minor variability that may potentially occur during startup or shutdown.

Periods of startup, normal operations, and shutdown are all predictable and routine aspects of a source's operations. However, by contrast, EPA has determined that malfunctions should not be viewed as a distinct operating mode and, therefore, any emissions that occur at such times were not needed to be factored into development of CAA section 129 standards, which, once promulgated, apply at all times. We note that continuous compliance is demonstrated using continuous parametric monitoring, except for CO from new sources. CO CEMS are required for new source using a 24-hour block average.

*Comment:* Some commenters argued that EPA incorrectly claims that its authority to prescribe unique standards for SSM periods is constrained by *Sierra Club v. EPA*, 551 F.3d 1019 (DC Cir. 2008). These commenters stated that EPA has failed to account adequately for emissions that occur during SSM periods. One commenter contended that the *Sierra Club* decision interpreted CAA section 112, not CAA section 129 (which incorporates, by reference, CAA section 111), and pointed out that this interpretation is not merely a technical distinction. The commenter pointed out that since 1977, EPA has exempted emissions during SSM events from compliance with NSPS under CAA section 111 (referenced 40 CFR 60.8(c)). The commenter argued that Congress enacted the continuous basis language in section 302(k) knowing that EPA's emissions standards under section 111 exempted SSM periods, and pointed out that there is nothing in the legislative history of the 1977 amendments to the CAA that suggests congress intended to overturn that practice.

*Response:* As explained above, EPA believes the reasoning in the DC Circuit's decision in *Sierra Club v. EPA* applies equally to section 129. Additionally, EPA explains above the reasons it is not establishing different emissions standards for periods of startup, shutdown, and malfunction.

### H. Compliance Requirements

*Comment:* Several commenters indicated that the proposed operating parameter ranges for minimum pressure

drop across a wet scrubber, minimum scrubber liquid flow rate, minimum scrubber liquid pH, and minimum combustion temperature (or minimum afterburner temperature) would not be achievable. They explained that these ranges are too narrow and that they will be inconsistent with the operating standards already required by 40 CFR part 60 subpart O, 40 CFR part 503, and state permits. Two commenters agreed with the proposed operating parameter ranges.

*Response:* The EPA reviewed the information provided by the commenters and determined that proposed procedure for establishing the operating ranges (*i.e.*, calculated as the average of three test runs and as 90 percent of the minimum value recorded during the applicable performance tests) may be too restrictive on control device operations in terms of energy or other operating needs. We determined that the operating limits should be more appropriately based on values recorded during the performance test runs. The final rule requires that operating limits be established on a site-specific basis as the minimum (or maximum, as appropriate) operating parameter value measured during the performance test. This approach has been incorporated into the final rule for all operating parameters and will result in achievable operating ranges that will ensure that the control devices used for compliance will be operated to achieve continuous compliance with the emissions limits.

*Comment:* Many commenters argued that the proposed operating range for sludge feed rate would not be achievable, that it results in the EPA changing the current state-permitted maximum sludge feed rate, and that it could force SSI units to conduct performance tests at maximum rated capacity. They explained that the proposed approach fails to take into account the normal feed condition and rate variation that occur on a daily and seasonal basis. A few commenters suggested that charging a SSI at 75 percent to 90 percent of its rated capacity results in a steadier state of control and more efficient combustion of the sludge.

Many commenters indicated that the proposed operating range for sludge moisture content would not be achievable and that EPA does not need sludge moisture content to determine whether SSI units are in compliance with their emission limits. They explained that sludge moisture is very sensitive to the type of dewatering equipment used, seasonal changes in the sewage or sludge received by a SSI, temperature changes, the biological

systems that treat the sewage, and to operational changes, and that these changes cannot always be anticipated and are not always immediately correctable.

*Response:* The EPA reviewed its decision at proposal to require that SSI units maintain the sludge feed rate and sludge moisture content of the incinerated sludge within specified ranges. We determined that the operating limit for temperature of the combustion chamber (or afterburner temperature) is sufficient to ensure good combustion practice, and that moisture content is not needed to establish that SSI units are in compliance with their emission limits. If a SSI has a higher moisture content, the SSI will need to use more fuel to comply with their operating limit for temperature of the combustion chamber. We are no longer requiring that SSI units maintain sludge moisture content within specified ranges. We are also no longer requiring SSI units to maintain sludge feed rates within specified ranges due to the seasonal variability at wastewater treatment plants. Sludge feed rate information is necessary during performance test runs to establish that SSI units are in compliance with the new requirement that they conduct performance tests at 85 percent capacity. We are retaining the requirement to keep daily records of sludge feed rates and moisture contents, as SSI units should already be keeping records of these parameters, and this information will be useful in establishing representative operating limitations for a SSI unit.

EPA added a requirement that performance tests be conducted at 85 percent of the permitted maximum capacity. This level has been selected based on the performance test operating information provided by the commenters and previous EPA standards.

*Comment:* A few commenters indicated that the 4-hour rolling averaging period selected in the proposed rule for determining compliance with the operating parameters and CO limit was more burdensome and difficult to achieve. They explained that the recordkeeping and compliance burden is less if the averaging period for CEMS and CPMS are both based on a 24-hour block average. They also explained that the proposed CO limit on a 4-hour rolling average basis would be unachievable with MH incinerators and difficult to achieve with FB incinerators.

*Response:* The EPA has determined that a 24-hour block averaging period for compliance with the CO CEMS

requirement for new sources will provide a sufficient indication of compliance and will allow more flexibility for facilities. Additionally, the proposed CO emission guidelines limit of 7.4 ppm for existing fluidized bed SSI units has changed in the final guidelines to 27 ppm, and this change is discussed in Section IV of this preamble. We have also revised the averaging periods for all other operating parameters, except scrubber liquid pH, to be on a 12-hour block average instead of a 4-hour rolling average basis in order to relate the averaging time for operating limits to the duration of the performance tests (*e.g.*, a three run test of 4 hour test runs would equal a 12-hour averaging time). For scrubber liquid pH, we chose 3-hour averages to be consistent with the performance test duration for acid gas scrubbers.

In the final rule, we are also not incorporating the alternative THC compliance requirement. Section 129 requires that limits be set for each of the 9 regulated pollutants. Surrogates, such as THC, cannot be used in place of the regulated pollutants.

*Comment:* Many commenters disagreed with the requirement in the proposed rule for annual testing, and argued that annual testing of each SSI is not needed to demonstrate compliance, too costly, and inconsistent with current Title V permits. They also argued that Method 22 compliance testing for fugitive ash emissions is not feasible or difficult to conduct due to space constraints, and that many FB incinerators utilize wet ash removal systems that do not require annual testing. They explained that the cost for emissions testing may be significantly higher than the proposed cost of \$61,000 per unit. They further explained that Title V permits require facilities to test each of its SSI units once per 5 years. They pointed out that current management practices and strict health-based sludge content limits under the CWA section 405 and the CAA 40 CFR part 503 regulations will help ensure that SSI units are in compliance with their emission limits. One commenter pointed out that the proposed compliance schedule of every 10 to 12 months will essentially shorten the testing year by one month each year.

*Response:* The proposed standards included provisions for less frequent testing. In the final standards, EPA has revised these provisions, making it easier for facilities to qualify for less frequent testing, allowing less frequent testing for more pollutants, and ensuring that facilities that do less frequent testing are well below their emission limits. In the final standards,

owners or operators are required to establish that emissions of a given pollutant are under a specified threshold for two consecutive years, rather than 3 years as proposed, to qualify for less frequent testing for that pollutant. We have also extended the option to do less frequent testing to PCDD/PCDF and fugitive ash emissions testing. The threshold is 75 percent of the emission limit for each of the nine regulated pollutants. In order to allow a decrease in testing frequency, EPA must have assurance that SSI units can meet a more stringent threshold than the limits. This is particularly necessary because of the variability in sludge that may occur at wastewater treatment facilities. Additionally, in the final standards we are also providing assurance that the SSI unit is being operated properly and emission limits are being met continuously by requiring stringent parametric monitoring requirements. Specifically, exceedances of the minimum or maximum values established during the performance tests are considered deviations. For fugitive emissions from ash handling, owners or operators must demonstrate that visible emissions occur no more than 2 percent of the time during each Method 22 1-hour observation period. This allowance for fugitive ash emissions has been included in the final standards with a new requirement that all facilities must submit a monitoring plan at least 60 days before their initial compliance test to establish that their ash handling system will continuously meet the visible emissions limit.

Additionally, to allow facilities more flexibility regarding their test dates, to ensure that facilities are not forced to test at intervals less than 12 months, and to ensure that facilities are testing once per year, we have revised the testing schedule provisions. In the final standards, performance tests (except for pollutants that qualify for less frequent testing) must be conducted on a calendar year basis (no less than nine calendar months and no more than 15 calendar months following the previous performance test); and facilities must complete five performance tests per pollutant in each 5-year calendar period.

*Comment:* Many commenters requested that the definition of “process change” be revised to exclude the provision that a process change include an increase in the allowable wastewater received from an industrial source. They pointed out that any such increase would trigger a performance test, as required by the proposed standards, and that such increases did not warrant a re-test. They explained that industrial

discharges often constitute only a small percentage of total influent flow (e.g., 3.5 percent, four to eight percent), that such discharges are sometimes from sources that do not discharge the pollutants regulated by the proposed NSPS and guidelines (e.g., food processing facilities), that some merchant SSI facilities regularly receive variable amounts of sludge from other regional wastewater treatment plants and POTW, and that it is difficult for impossible to anticipate some industrial load changes ahead of time. Several commenters argued that this proposed requirement would be redundant to the National Pretreatment Regulations at 40 CFR part 403, which are incorporated into their SSI’s National Pollutant Discharge Elimination System (NPDES) permit, which require them to establish local limits on industrial discharges to prevent interference with sludge processes, use, and disposal. The commenters anticipate that they would establish similar limits to prevent noncompliance with the final emission limits. A few commenters suggested that the proposed provision for industrial discharges is vague and open to interpretation.

*Response:* The EPA reviewed the definition of “process change” and agrees with the commenters that there are some situations where an increase in the allowable wastewater received from an industrial source should not trigger a performance test. We have revised the definition of “process change” to more specifically and clearly identify the type of process change that will trigger a performance test. The revised definition identifies a “process change” as pollutant-specific and as including only situations where the SSI has undergone a significant permit revision. This revision will ensure that facilities retest whenever they have a significant change in the process that could trigger higher emissions of a given pollutant.

*Comment:* Several commenters requested EPA clarify what equipment are included as part of the SSI unit. The commenters stated that the proposed rules do not specify the equipment and without clarification, a SSI unit could be interpreted inconsistently or over-broadly. Commenters requested clarification regarding whether the “modification” (which refers to an “SSI unit”) applies to the multiple hearth or fluid bed “reactor” or whether it includes the entire system including all air emission controls and auxiliary equipment.

*Response:* We agree that the definition of the SSI unit in the proposed rule was unclear as to what equipment constitutes the SSI unit. We have

revised the definition of SSI unit in the final rule. A SSI unit means an incineration unit combusting sewage sludge for the purpose of reducing the volume of the sewage sludge by removing combustible matter. Sewage sludge incineration unit designs include fluidized bed and multiple hearth. We have clarified that a SSI unit also includes, but is not limited to, the sewage sludge feed system, auxiliary fuel feed system, grate system, flue gas system, waste heat recovery equipment, if any, and bottom ash system. The SSI unit includes all ash handling systems connected to the bottom ash handling system. The combustion unit bottom ash system ends at the truck loading station or similar equipment that transfers the ash to final disposal. The SSI unit does not include air pollution control equipment or the stack.

## VI. Impacts of the Final Action

As discussed in sections IV and V of this preamble, we have made several revisions to the impacts analyses for the final rules. We have incorporated revisions to the variability calculation. These revisions include: incorporating weighted UPL’s for existing FB units, selecting log-normal results when it is not clear that data are normally distributed, and revising CO limits based on an analysis of the span of the test. The result of these changes increased UPL values for most pollutants.

Additionally, we have incorporated corrections to the inventory and calculation inputs provided by the commenters where applicable. We have also revised the calculation of baseline emissions by revising the defaults assigned to SSI units where information was not available. These changes resulted in decreasing the baseline emissions for each of the pollutants. The combination of increase UPL and decreased baseline emissions resulted in less SSI units estimated to need additional control to meet the MACT floor limits.

For the final rules, we also selected the MACT floor level of control for both subcategories instead of selecting a beyond-the-floor requirement.

For the final rules we have also revised the types of controls costed to meet the MACT floor limits. For SSI that we estimate will need further control of PM, Cd, or Pb to meet the MACT floor, we have costed out wet ESP as a more appropriate PM control for high moisture streams. We have also costed out SNCR for SSI that we estimate will need further control of NO<sub>x</sub> to meet the MACT floor limits. As at proposal, we have costed out packed-bed scrubbers

for SSI that we estimate will need further control of HCl or SO<sub>2</sub>.

*A. Impacts of the Final Action for Existing Units*

1. What are the primary air impacts?

We have estimated the potential emission reductions that may be

realized through implementation of the final emission limits. As discussed in section V of this preamble, we have revised the estimation of baseline emissions and emission reductions to present a range to show the variability in the emission calculations between estimated actual and estimated potential sludge feed rates. Table 12 of this

preamble summarizes the emission reductions for MACT compliance for each pollutant. The analysis is documented in the memorandum “Revised Analysis of Beyond the Maximum Achievable Control Technology (MACT) Floor Controls for Existing SSI Units” in the SSI docket (EPA-HQ-OAR-2009-0559).

TABLE 12—PROJECTED EMISSION REDUCTIONS FOR EXISTING SSI UNITS COMPLYING WITH THE PROPOSED EMISSION LIMITS

Pollutant	Range of reductions achieved through meeting MACT by subcategory (TPY)		Range of total reductions (TPY)
	FB	MH	
Cd	0	0.5–0.6	0.5–0.6
CO	0	0	0
HCl	0.73–0.94	18–29	19–30
Hg	0.0005–0.0006	0.0017–0.0019	0.0022–0.0025
NO <sub>x</sub>	6.8–16	0	6.8–16
Pb	0	1.2–1.5	1.2–1.5
PCDD/PCDF TEQ	0	0	0
PCDD/PCDF TMB	0	0	0
PM	0	58–70	58–70
SO <sub>2</sub>	17–21	420–680	430–700

2. What are the water and solid waste impacts?

We anticipate affected sources will need to apply additional controls to meet the proposed emission limits. These controls may utilize water, such as wet scrubbers, which would need to be treated. We estimate an annual requirement of 234 million gallons per year of additional wastewater will be generated as a result of operating additional controls or increased sorbents.

The analysis is documented in the memorandum “Revised Secondary Impacts for the Sewage Sludge Incineration Source Category” in the SSI docket (EPA-HQ-OAR-2009-0559).

3. What are the energy impacts?

The energy impacts associated with meeting the proposed emission limits consist primarily of additional electricity needs to run added or improved air pollution control devices. For example, increased scrubber pump horsepower may cause slight increases in electricity consumption; sorbent injection controls would likewise require electricity to power pumps and motors. We anticipate that an additional 5,420 megawatt-hours per year will be required for the additional and improved control devices. The analysis is documented in the memorandum “Revised Secondary Impacts for the Sewage Sludge Incineration Source Category” in the SSI docket (EPA-HQ-OAR-2009-0559).

4. What are the secondary air impacts?

For SSI units adding controls to meet the final emission limits, we anticipate very minor secondary air impacts. The combustion of fuel needed to generate additional electricity will yield slight increases in emissions, including NO<sub>x</sub>, CO, PM and SO<sub>2</sub> and an increase in CO<sub>2</sub> emissions. Since NO<sub>x</sub> and SO<sub>2</sub> are covered by capped emissions trading programs, and methodological limitations prevent us from quantifying the change in CO and PM, we do not estimate an increase in secondary air impacts for this rule from additional electricity demand.

5. What are the cost and economic impacts?

We have estimated compliance costs for all existing units to add the necessary controls, monitoring equipment, inspections, recordkeeping, and reporting requirements to comply with Option 1 (i.e., the selected SSI standards). Based on this analysis, we anticipate an overall total capital investment of \$55 million with an associated total annualized cost of \$18 million, in 2008 dollars (and using a discount rate of seven percent), as shown in Table 13 of this preamble. We anticipate that owner/operators will need to install one or more air pollution control devices for 43 of the 204 affected units to meet the final emission limits. The analysis is documented in the memorandum “Revised Analysis of Beyond the Maximum Achievable Control Technology (MACT) Floor

Controls for Existing SSI Units” in the SSI docket (EPA-HQ-OAR-2009-0559).

TABLE 13—SUMMARY OF COSTS FOR EXISTING SSI IF ALL ENTITIES COMPLY WITH PROPOSED EMISSION LIMITS

[Millions of 2008\$]		
Sub-category	Capital cost (\$million)	Annualized cost (\$million/yr) <sup>a</sup>
FB	10.1	3.1
MH	45.0	14.7
Total	55.0	17.8

<sup>a</sup> Calculated using a discount factor of seven percent.

*Analysis of Alternative Sewage Sludge Disposal.* At proposal, we evaluated landfilling as an alternative disposal method. We have revised our costs and impacts of this alternative based on comments received on the proposal and corrections made to the analysis. Table 14 of this preamble summarizes the revised costs and impacts of this alternative if small entities choose to landfill rather than incinerate sewage sludge. A detailed discussion of the landfilling alternative analysis is provided in the memorandum “Revised Cost and Emission Reduction of the MACT Floor Level of Control” in the SSI docket (EPA-HQ-OAR-2009-0559).

Based on the revised impacts, it is unlikely that many sources will find landfilling an appropriate alternative. However, the selection of a management option for sewage sludge is often a local

decision that is based on environmental protection concerns, community needs, geographic constraints, and economic conditions. Given a full evaluation of these factors, for some sources, landfilling or land treatment may be a better management option than incineration.

**TABLE 14—SUMMARY OF REVISED COSTS FOR SMALL ENTITIES THAT LANDFILL IN LIEU OF INCINERATION**  
[Millions of 2008\$]

Sub-category	Capital cost (\$million)	Annualized cost (\$million/yr) <sup>a</sup>
FB .....	278	38
MH .....	313	42.7
Total	591	80.7

<sup>a</sup> Calculated using a discount factor of seven percent.

**B. Impacts of the Final Action for New Units**

As discussed in the proposal, based on trends of SSI units constructed and replaced, technical advantages of FB incinerators, and information provided by the industry on likely units constructed, we believe that new SSI units constructed are likely to be FB incinerators.

1. What are the primary air impacts?

We have estimated the potential emission reductions that may be realized through implementation of the final emission limits on two new FB incinerators potentially being constructed in the next 5 years. Table 15 of this preamble summarizes these emission reductions for MACT compliance for each pollutant from two new FB incinerators. The analysis is documented in the memorandum “Revised Estimation of Impacts for New Units Constructed Within 5 Years After Promulgation of the SSI NSPS” in the SSI docket (EPA–HQ–OAR–2009–0559).

**TABLE 15—EMISSION REDUCTIONS FOR TWO NEW SSI UNITS (I.E., FLUIDIZED BED INCINERATORS) CONSTRUCTED**

Pollutant	Emission reduction (TPY)
Cd .....	0
CDD/CDF, TEQ .....	0.0000000033
CDD/CDF, TMB .....	0.000000051
CO .....	0.26
HCl .....	0
Hg .....	0.0026
NO <sub>x</sub> .....	14
Pb .....	0.00053
PM .....	0
PM <sub>2.5</sub> .....	0
SO <sub>2</sub> .....	0

2. What are the water and solid waste impacts?

We anticipate affected sources would need to apply controls in addition to what they would have planned to include in the absence of this rule to meet the final emission limits. These controls may utilize water, such as wet scrubbers, which would need to be treated. We estimate an annual requirement of 8.6 million gallons per year of additional wastewater will be generated as a result of operating additional controls or increased sorbents for the two new units expected to come on-line in the next 5 years. The analysis is documented in the memorandum “Revised Analysis of Secondary Impacts for the Sewage Sludge Incineration Source Category” in the SSI docket (EPA–HQ–OAR–2009–0559).

Likewise, the application of PM controls results in particulate collected that would require disposal. Furthermore, activated carbon injection may be used by some sources, which would result in solid waste needing disposal. The annual amounts of solid waste that will require disposal are anticipated to be approximately 34 TPY from activated carbon injection for the two units.

3. What are the energy impacts?

The energy impacts associated with meeting the final emission limits would consist primarily of additional electricity needs to run added or improved air pollution control devices. For example, increased scrubber pump horsepower may cause slight increases in electricity consumption. Sorbent injection controls would likewise require electricity to power pumps and motors. By our estimate, we anticipate that an additional 300 megawatt-hours per year will be required for the additional and improved control devices for the two new units modeled to come on-line in the next 5 years. The analysis is documented in the memorandum “Revised Analysis of Secondary Impacts for the Sewage Sludge Incineration Source Category Analysis of New Units for the Sewage Sludge Incineration Source Category” in the SSI docket (EPA–HQ–OAR–2009–0559).

4. What are the secondary air impacts?

For SSI units adding controls to meet the final emission limits, we anticipate very minor secondary air impacts. The analysis is documented in the memorandum “Revised Analysis of Secondary Impacts for the Sewage Sludge Incineration Source Category.”

5. What are the cost impacts?

We have estimated compliance costs for new SSI units coming on-line in the next 5 years. This analysis is based on a model plant, the assumption that two new units will come on-line and will add the necessary controls, monitoring equipment, inspections, recordkeeping, and reporting requirements to comply with the final SSI standards. Based on this analysis, we anticipate an overall total capital investment of \$8 million (2008\$) with an associated total annualized cost of \$2 million (2008\$ and using a seven percent discount rate). This analysis assumes that new SSI units constructed are only FB incinerators.

**VII. Statutory and Executive Order Reviews**

*A. Executive Order 12866 and 13563: Regulatory Planning and Review*

Under Executive Order (EO) 12866 (58 FR 51735, October 4, 1993) and EO 13563 (76 FR 3821, January 21, 2011), this action is a “significant regulatory action” because it was likely to have an annual effect on the economy of \$100 million or more based on the proposed standards. However, the cost of the final standards are no longer likely to have an annual effect on the economy of \$100 million or more. Despite the change in costs, EPA submitted this action to the Office of Management and Budget (OMB) for review under EOs 12866 and 13563 and any changes made in response to OMB recommendations have been documented in the docket for this action. Although EPA prepared a RIA of the potential costs and benefits associated with the proposed standards we are simply updating the RIA rather than revising it.

A RIA was prepared in September of 2010 for the proposed Standards of Performance for New Stationary Sources and Emission Guidelines for Existing Sources: Sewage Sludge Incineration Units. However, based on the lower costs associated with the selected alternative in this final action we are providing an update of the RIA rather than completely revising the RIA. Within this update, we are providing updated costs and benefits of the controls analyzed and have provided a comparison of the selected controls with the alternatives.<sup>13</sup> While the characteristics of the controls analyzed have changed, we have also provided a comparison of the costs and benefits of

<sup>13</sup> In the RIA, the controls analyzed are referred to as Option 1 (MACT floor), Option 2 (MACT floor, plus afterburner for MH units), and Option 3 (MACT floor, plus afterburner and activated carbon injection and fabric filter for MH units).

the proposed controls analyzed with the selected alternative in this final action. A summary of the differences are presented below.

- Costs for the selected controls analyzed for promulgation are 80% lower and benefits are 81% lower than they were for the selected controls analyzed for proposal.
- Because the regulated sewage sludge incineration is a government provided service that does not involve a market, no price, quantity, or employment impacts were estimated for the proposal RIA. The economic impact

analysis focused on the comparison of control cost to total governmental revenue. Because the costs are 80% lower for the selected controls analyzed for promulgation compared to the proposed controls analyzed, the control costs are expected to be a smaller portion of government revenues for the selected controls for promulgation than they were for the proposed controls.

- Because of insufficient information, employment changes due to the requirements for operating and maintaining control equipment were not estimated. Also, we did not have the

information needed to estimate any labor changes related to governmental decisions to switch from incineration to landfilling.

- Monetized benefits are greater than costs for the selected option by \$3 million to \$34 million at three percent and \$1 million to \$29 million at seven percent. The benefits from reducing exposure to HAP, direct exposure to NO<sub>x</sub> and SO<sub>2</sub>, ecosystem effects, and visibility impairment have not been monetized, including reducing 19 tons of HCl, 4 pounds of Hg, 2,400 pounds of Pb, and 1,000 pounds of Cd.

**NET BENEFITS FOR FINAL SEWAGE SLUDGE INCINERATORS NSPS AND EG**  
[Millions of \$2008]

MACT floor (selected)	3% Discount rate	7% Discount rate
Monetized Benefits .....	\$21 to \$52 .....	\$19 to \$47.
Costs .....	\$18 to \$18 .....	\$18 to \$18.
Net Benefits .....	\$3 to \$34 .....	\$1 to \$29.

**MONETIZED BENEFITS FOR FINAL SEWAGE SLUDGE INCINERATORS NSPS AND EG**

Total monetized benefits for final controls analyzed (millions of 2008\$)	3% Discount rate	7% Discount rate
MACT Floor (Selected) .....	\$21 to \$52 .....	\$19 to \$47.
MACT Floor + Afterburner for MH units .....	\$20 to \$50 .....	\$18 to \$45.
MACT Floor + Afterburner and Activated carbon injection and fabric filter for MH units .....	\$55 to \$140 .....	\$50 to \$130.

Monetized benefits changes for MACT floor (millions of 2008\$)	3% Discount rate	7% Discount rate
Proposal (MACT Floor, all comply) .....	\$110 to \$270 .....	\$100 to \$250.
Final (MACT Floor) .....	\$21 to \$52 .....	\$19 to \$47.
% Change .....	-81% .....	-81%.

Monetized benefits changes for selected controls analyzed (millions of 2008\$)	3% Discount rate	7% Discount rate
Proposal (BTF Option 2, all comply) .....	\$110 to \$270 .....	\$100 to \$250.
Final (MACT Floor) .....	\$21 to \$52 .....	\$19 to \$47.
% Change .....	-81% .....	-81%.

**COSTS FOR FINAL SEWAGE SLUDGE INCINERATORS NSPS AND EG**

Total costs for final controls analyzed (millions of 2008\$)	3% or 7% Discount rate
MACT Floor (selected) .....	\$18
MACT Floor + Afterburner for MH units .....	46
MACT Floor + Afterburner and activated carbon injection + fabric filter for MH units .....	138

Costs changes for MACT floor (millions of 2008\$)	3% or 7% Discount rate
Proposal (MACT Floor, all comply) .....	\$63
Final (MACT Floor) .....	\$18
% Change .....	-71%

Cost changes for selected controls analyzed (millions of 2008\$)	3% or 7% Discount rate
Proposal (BTF Option 2, all comply) .....	\$92
Final (MACT Floor) .....	\$18

Cost changes for selected controls analyzed (millions of 2008\$)	3% or 7% Discount rate
% Change .....	-80%

**B. Paperwork Reduction Act**

The information collection requirements in this rule have been submitted for approval to the OMB under the Paperwork Reduction Act, 44 U.S.C. 3501 *et seq.* The information collection requirements are not enforceable until OMB approves them. The ICR documents prepared by EPA have been assigned EPA ICR number 2369.02 for subpart LLLL, and 2403.02 for subpart MMMM.

The recordkeeping and reporting requirements in this rule are based on the information collection requirements in CAA section 129 and EPA's NSPS General Provisions (40 CFR part 60, subpart A). The recordkeeping and reporting requirements in the General Provisions are mandatory pursuant to CAA section 114 (42 U.S.C. 7414). All information other than emissions data submitted to EPA pursuant to the information collection requirements for which a claim of confidentiality is made is safeguarded according to CAA section 114(c) and EPA's implementing regulations at 40 CFR part 2, subpart B.

The requirements in this action result in industry recordkeeping and reporting burden associated with review of the amendments for all SSI and initial and annual compliance with the emission limits using EPA approved emissions test methods. The burden also includes continuous parameter monitoring and annual inspections of air pollution control devices that may be used to meet the emission limits. Operators are required to obtain qualification and complete annual training. New units are also required to submit a report prior to construction, including a siting analysis.

When a malfunction occurs, sources must report them according to the applicable reporting requirements of Subparts LLLL and MMMM. An affirmative defense to civil penalties for exceedances of emission limits that are caused by malfunctions is available to a source if it can demonstrate that certain criteria and requirements are satisfied. The criteria ensure that the affirmative defense is available only where the event that causes an exceedance of the emission limit meets the narrow definition of malfunction in 40 CFR 60.2 (sudden, infrequent, not reasonably preventable and not caused by poor maintenance and or careless operation) and where the source took necessary actions to minimize emissions. In

addition, the source must meet certain notification and reporting requirements. For example, the source must prepare a written root cause analysis and submit a written report to the Administrator documenting that it has met the conditions and requirements for assertion of the affirmative defense.

To provide the public with an estimate of the relative magnitude of the burden associated with an assertion of the affirmative defense position adopted by a source, EPA provides an administrative adjustment to this ICR that shows what the notification, recordkeeping and reporting requirements associated with the assertion of the affirmative defense might entail. EPA's estimate for the required notification, reports and records, including the root cause analysis, totals \$3,141 and is based on the time and effort required of a source to review relevant data, interview plant employees, and document the events surrounding a malfunction that has caused an exceedance of an emission limit. The estimate also includes time to produce and retain the record and reports for submission to EPA. EPA provides this illustrative estimate of this burden because these costs are only incurred if there has been a violation and a source chooses to take advantage of the affirmative defense.

The annual average burden associated with the emission guidelines over the first 3 years following promulgation is estimated to be \$9.6 million. This includes 39,350 hours at a total annual labor cost of \$2.2 million and total annualized capital/startup and operation and maintenance costs of \$7.4 million per year, associated with the monitoring requirements, storage of data and reports and photocopying and postage over the 3-year period of the ICR. The annual inspection costs are included under the recordkeeping and reporting labor costs

The annual average burden associated with the NSPS over the first 3 years following promulgation is estimated to involve 701 hours at a total annual labor cost of \$40,000. The total annualized capital/startup costs are estimated at \$232,000 per year. This gives a cumulative annual burden of \$272,000 per year for the NSPS. Burden is defined at 5 CFR 1320.3(b).

An Agency may not conduct or sponsor, and a person is not required to respond to a collection of information

unless it currently displays a valid OMB control number. The OMB control numbers for EPA's regulations in 40 CFR are listed in 40 CFR part 9. When this ICR is approved by OMB, the Agency will publish a technical amendment to 40 CFR part 9 in the **Federal Register** to display the OMB control number for the approved information collection requirements contained in this final.

**C. Regulatory Flexibility Act**

The RFA generally requires an agency to prepare a regulatory flexibility analysis of any rule subject to notice and comment rulemaking requirements under the Administrative Procedures Act or any other statute unless the agency certifies that the rule will not have a significant economic impact on a substantial number of small entities. Small entities include small businesses, small organizations, and small governmental jurisdictions.

For purposes of assessing the impacts of this action on small entities, a small entity is defined as follows: (1) A small business as defined by the SBA regulations at 13 CFR 121.201; (2) a small governmental jurisdiction that is a government of a city, county, town, school district, or special district with a population of less than 50,000; or (3) a small organization that is any not-for-profit enterprise that is independently-owned and operated and is not dominant in its field.

In the proposal, we certified that there would not be a significant economic impact on a substantial number of small entities. The economic analysis conducted at proposal identified 18 small entities none of which had cost-revenue-ratios greater than one percent. The cost analysis for the final standards showed a significant decrease (35 to 98 percent) in all costs for 11 of the 18 small entities. The cost-revenue-ratios were again estimated using the costs for the final rule and the same revenue estimates used in the proposal screening analysis. The revenue estimates were obtained using census average per capita revenue numbers (\$1,696 for entities with populations between 10 thousand and 25 thousand and \$1,677 for entities with populations between 25 thousand and 50 thousand) The resulting cost-revenue-ratios ranged between 0.04% and 0.5. Thus all cost-revenue-ratios were well below 1%. Therefore, we consider the final rule to

have no significant impact on a substantial number of small entities.

After considering the economic impacts of this final rule on small entities, I certify that this action will not have a significant economic impact on a substantial number of small entities. None of the 18 small entities has cost-revenue-ratios greater than one percent. Thus, this is not considered to be a significant impact.

Although the final rule will not have a significant economic impact on a substantial number of small entities, EPA nonetheless has tried to reduce the impact of this rule on small entities by allowing optional CEMS instead of requiring them, allowing information from tests conducted in recent years to show compliance rather than require all new testing and allowing reduced testing with continued compliance.

#### *D. Unfunded Mandates Reform Act*

This rule does not contain a Federal mandate that may result in expenditures of \$100 million or more for state, local, and tribal governments, in the aggregate, or the private sector in any 1 year. Thus, this final rule is not subject to the requirements of sections 202 or 205 of UMRA.

At proposal, EPA prepared under section 202 of the UMRA a written statement that is summarized in section VIII.D of the proposal preamble (75 FR 63260, October 14, 2010). A copy of the UMRA written statement can be found in the docket.

At proposal, the estimated costs were higher than the estimated costs of the final rule. At proposal, EPA prepared an RIA, including EPA's assessment of costs and benefits, which is detailed in the "Regulatory Impact Analysis: Standards of Performance for New Stationary Sources and Emission Guidelines for Existing Sources: Sewage Sludge Incineration Units" in the docket. Based on estimated compliance costs associated with the final rule and the predicted change in prices and production in the affected industries, the estimated social costs of the final rule are \$55 million (\$).

At proposal, EPA consulted with governmental entities expected to be affected by the proposed rule, consistent with the intergovernmental consultation provisions of section 204 of the UMRA. Those consultations are discussed in section VIII.D of the proposal preamble (75 FR 63260).

This final rule is not subject to the requirements of section 203 of UMRA because it contains no regulatory requirements that might significantly or uniquely affect small governments. Because this final rule's requirements

apply equally to SSI units owned and/or operated by governments or SSI units owned and/or operated by private entities, there would be no requirements that uniquely apply to such government or impose any disproportionate impacts on them.

#### *E. Executive Order 13132: Federalism*

This action does not have federalism implications. It will not have substantial direct effects on the states, on the relationship between the national government and the states, or on the distribution of power and responsibilities among the various levels of government, as specified in Executive Order 13132.

Under Executive Order 13132, EPA may not issue an action that has federalism implications, that imposes substantial direct compliance costs, and that is not required by statute, unless the Federal government provides the funds necessary to pay the direct compliance costs incurred by state and local governments, or EPA consults with state and local officials early in the process of developing the proposed action.

EPA's proposed action estimated expenditures of greater than \$100 million to state and local governments and therefore as specified by the Executive Order, EPA consulted with elected state and local government officials, or their representative national organizations, when developing regulations and policies that impose substantial compliance costs on state and local governments. Pursuant to Agency policy, EPA conducted a briefing for the "Big 10" intergovernmental organizations representing elected state and local government officials, as discussed in section VIII.D of the proposal preamble (75 FR 63260) to formally request their comments and input on the action. The Big 10 provided EPA with feedback on the proposed standards and EG for SSI units.

EPA has concluded that this final rule will not have federalism implications, as defined by Agency guidance for implementing the Executive Order, due to the final rule's direct compliance costs on state or local governments resulting in expenditures of less than \$100 million.

In the spirit of Executive Order 13132 and consistent with EPA policy to promote communications between EPA and state and local governments, EPA specifically solicited comment on the proposed rule from state and local officials.

#### *F. Executive Order 13175: Consultation and Coordination With Indian Tribal Governments*

During proposal EPA was not aware of any SSI owned or operated by an Indian tribe or tribal governments, thus, Executive Order 13175 did not appear to have implications. However as specified in Executive Order 13175, (65 FR 67249, November 9, 2000), EPA has attempted to outreach and discuss possible SSI implications with tribal contacts.

EPA presented information on the SSI proposal and specifically solicited additional comment on the proposed action from tribal contacts in the proposal period via the NTAA conference calls.

EPA has received coordinated comments from the NTAA; those comments can be reviewed in the public docket, document number EPA-HQ-OAR-2009-0559-0130.1. Commenters expressed that SSI units located in proximity to Indian country units, obtaining Title V permits, may trigger tribal consultation with regard to potential impact from the SSI unit. Commenters are dismayed, as they believe EPA failed to consult with Indian tribes regarding the standards and have failed to fully assess the potential impacts of SSI units on tribal communities. Lastly, commenters recommended that EPA provide a map overlay that accounts for both SSI units and tribal lands so tribes can acquire a better understanding on how they might be affected by such sites and these standards in general.

EPA participated on two NTAA conference calls to discuss the rule development process, first to provide general information on the development of the SSI standards and second providing more specific background information on the purpose of the rulemaking, number and locations of units, and unit types. EPA allowed time for clarifying questions and requested information if any NTAA members were aware of any type of incinerator burning sewage sludge in Indian Country. EPA will provide a map overlay for the SSI docket so that tribes can acquire a better understanding on how they might be affected by SSI sites and the standards in general.

#### *G. Executive Order 13045: Protection of Children From Environmental Health and Safety Risks*

EPA interprets Executive Order 13045 (62 FR 19885, April 23, 1997) as applying to those regulatory actions that concern health or safety risks, such that the analysis required under section 5-501 of the Executive Order has the

potential to influence the regulation. This final action is not subject to Executive Order 13045 because it is based solely on technology performance. We note however, that reductions in air emissions by these facilities will improve air quality, with expected positive impacts for children's health.

#### *H. Executive Order 13211: Actions That Significantly Affect Energy Supply, Distribution, or Use*

This action is not subject to Executive Order 13211 (66 FR 28355, May 22, 2001), because it is not a significant regulatory action under Executive Orders 12866 and 13563.

#### *I. National Technology Transfer and Advancement Act*

Section 12(d) of the NTTAA of 1995, Public Law 104-113, 12(d) (15 U.S.C. 272 note) directs EPA to use voluntary consensus standards (VCS) in its regulatory activities unless to do so would be inconsistent with applicable law or otherwise impractical. Voluntary consensus standards are technical standards (e.g., materials specifications, test methods, sampling procedures, and business practices) that are developed or adopted by VCS bodies. The NTTAA directs EPA to provide Congress, through OMB, explanations when the Agency decides not to use available and applicable VCS.

EPA conducted searches for the "Standards of Performance for New Stationary Sources and Emission Guidelines for Existing Sources: Sewage Sludge Incineration Units" through the Enhanced National Standards Service Network Database managed by the ANSI. We also contacted VCS organizations, accessed, and searched their data bases.

This rulemaking involves technical standards. EPA has decided to use ANSI/ASME PTC 19.10-1981, "Flue and Exhaust Gas Analyses," for its manual methods of measuring the oxygen or carbon dioxide content of the exhaust gas. These parts of ASME PTC 19.10-1981 are acceptable alternatives to EPA Methods 6, 7. This standard is available from the ASME, Three Park Avenue, New York, NY 10016-5990.

Another VCS, ASTM D6784-02 (Reapproved 2008), "Standard Test Method for Elemental, Oxidized, Particle-Bound and Total Mercury Gas Generated From Coal-Fired Stationary Sources (Ontario Hydro Method)" is an acceptable alternative to Method 29 and 30B. EPA has also decided to use EPA Methods 5, 6, 6C, 7, 7E, 9, 10, 10A, 10B, 22, 23, 26A, 29 and 30B. No VCS were found for EPA Method 9 and 22.

During the search, if the title or abstract (if provided) of the VCS described technical sampling and analytical procedures that are similar to EPA's reference method, EPA ordered a copy of the standard and reviewed it as a potential equivalent method. All potential standards were reviewed to determine the practicality of the VCS for this rule. This review requires significant method validation data that meet the requirements of EPA Method 301 for accepting alternative methods or scientific, engineering and policy equivalence to procedures in EPA reference methods. EPA may reconsider determinations of impracticality when additional information is available for particular VCS.

The search identified other VCS that were potentially applicable for this rule in lieu of EPA reference methods. After reviewing the available standards, EPA determined that candidate VCS (ASME B133.9-1994 (2001), ISO 9096:1992 (2003), ANSI/ASME PTC PTC-38-1980 (1985), ASTM D3685/D3685M-98 (2005), CAN/CSA Z223.1-M1977, ANSI/ASME PTC 19.10-1981, ISO 10396:1993 (2007), ISO 12039:2001, ASTM D5835-95 (2007), ASTM D6522-00 (2005), CAN/CSA Z223.2-M86 (1999), ISO 7934:1998, ISO 11632:1998, ASTM D1608-98 (2003), ISO 11564:1998, CAN/CSA Z223.24-MI983, CAN/CSA Z223.21-MI978, ASTM D3162-94 (2005), EN 1948-3 (1996), EN 1911-1.2,3 (1998), ASTM D6735-01, EN 13211:2001, CAN/CSA Z223.26-MI987) identified for measuring emissions of pollutants or their surrogates subject to emission standards in the rule would not be practical due to lack of equivalency, documentation, validation data, and other important technical and policy considerations.

Under 40 CFR 60.13(i) of the NSPS General Provisions, a source may apply to EPA for permission to use alternative test methods or alternative monitoring requirements in place of any required testing methods, performance specifications, or procedures in the final rule and any amendments.

#### *J. Executive Order 12898: Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations*

Executive Order 12898 (59 FR 7629, February 16, 1994) establishes Federal executive policy on environmental justice. Its main provision directs Federal agencies, to the greatest extent practicable and permitted by law, to make environmental justice part of their mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or

environmental effects of their programs, policies and activities on minority populations and low-income populations in the United States.

EPA has determined that this final rule will not have disproportionately high and adverse human health or environmental effects on minority or low-income populations because it increases the level of environmental protection for all affected populations without having any disproportionately high and adverse human health or environmental effects on any population, including any minority or low-income populations. Additionally, the Agency has reviewed this final rule to determine if there was existing disproportionately high and adverse human health or environmental effects on minority or low-income populations that could be mitigated by this rulemaking. An analysis of demographic data showed that the average of populations in close proximity to the sources, and thus most likely to be effected by the sources, were similar in demographic composition to national averages. The results of the demographic analysis are presented in "Review of Environmental Justice Impacts," June 2010, a copy of which is available in the SSI docket (EPA-HQ-OAR-2009-0559).

This final action establishes national emission standards for new and existing SSI units. The EPA estimates that there are approximately 204 such units covered by this rule. The final rule will reduce emissions of many of the listed HAP emitted from this source. This includes emissions of Cd, HCl, Pb, and Hg. Adverse health effects from these pollutants include cancer, irritation of the lungs, skin and mucus membranes, effects on the central nervous system and damage to the kidneys and acute health disorders. The rule will also result in substantial reductions of criteria pollutants such as CO, NO<sub>x</sub>, PM and PM<sub>2.5</sub> and SO<sub>2</sub>. Sulfur dioxide and NO<sub>x</sub> are precursors for the formation of PM<sub>2.5</sub> and ozone. Reducing these emissions will reduce ozone and PM<sub>2.5</sub> formation and associated health effects, such as adult premature mortality, chronic and acute bronchitis, asthma and other respiratory and cardiovascular diseases. For additional information, please refer to the RIA contained in the docket for this rulemaking. In EPA's July 2010 "Interim Guidance on Considering Environmental Justice During the Development of an Action," EPA defines "environmental justice" as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development,

implementation, and enforcement of environmental laws, regulations, and policies.

To help achieve EPA's goal for Environmental Justice (*i.e.*, the fair treatment and meaningful involvement of all people), EPA places particular emphasis on the public health of and environmental conditions affecting minority, low-income, and indigenous populations. In recognizing that these populations frequently bear a disproportionate burden of environmental harms and risks, EPA works to protect them from adverse public health and environmental effects of its programs. EPA looks at the vulnerabilities of these populations because they have historically been exposed to a combination of physical, chemical, biological, social, and cultural factors that have imposed greater environmental burdens on them than those imposed on the general population.

To promote meaningful involvement, EPA has developed a communication and outreach strategy to ensure that interested communities have access to this final rule, are aware of its content and have an opportunity to comment during the comment period. During the comment period, EPA publicized the rulemaking via environmental newsletters, tribal newsletters, environmental justice listservs, and the Internet, including the OPEI Rulemaking Gateway Web site (<http://yosemite.epa.gov/opei/RuleGate.nsf/>). EPA will also provide general rulemaking fact sheets (*e.g.*, why is this important for my community) for environmental justice community groups and conduct conference calls with interested communities. In addition, state and Federal permitting requirements will provide state and local governments and members of affected communities the opportunity to provide comments on the permit conditions associated with permitting the sources affected by this rulemaking.

#### J. Congressional Review Act

The Congressional Review Act, 5 U.S.C. 801 *et seq.*, as added by the Small Business Regulatory Enforcement Fairness Act of 1996, generally provides that before a rule may take effect, the agency promulgating the rule must submit a rule report, which includes a copy of the rule, to each House of the Congress and to the Comptroller General of the United States. EPA will submit a report containing this rule and other required information to the U.S. Senate, the U.S. House of Representatives, and the Comptroller General of the United States prior to publication of the rule in

the **Federal Register**. A major rule cannot take effect until 60 days after it is published in the **Federal Register**. This action is not a "major rule" as defined by 5 U.S.C. 804(2). This rule will be effective May 20, 2011.

#### List of Subjects in 40 CFR Part 60

Environmental protection, Administrative practice and procedure, Air pollution control, Incorporation by reference, Intergovernmental relations, Reporting and recordkeeping requirements.

Dated: February 21, 2011.

**Lisa Jackson**,  
*Administrator*.

For the reasons stated in the preamble, title 40, chapter I, part 60 of the Code of Federal Regulations, is amended as follows:

#### PART 60—[AMENDED]

■ 1. The authority citation for part 60 continues to read as follows:

**Authority:** 42 U.S.C. 7401, *et seq.*

■ 2. Section 60.17 is amended by:

- a. Adding paragraph (a)(93);
- b. Revising paragraph (h)(4); and
- c. Adding paragraph (o) to read as follows:

#### § 60.17 Incorporations by reference.

\* \* \* \* \*

(a) \* \* \*  
(93) ASTM D6784–02 (Reapproved 2008) Standard Test Method for Elemental, Oxidized, Particle-Bound and Total Mercury in Flue Gas Generated from Coal-Fired Stationary Sources (Ontario Hydro Method), approved April 1, 2008, IBR approved for §§ 60.2165(j), 60.2730(j), tables 1, 5, 6 and 8 to subpart CCCC, tables 2, 6, 7, and 9 to subpart DDDD, § 60.4900(b)(4)(v), 60.5220(b)(4)(v), tables 1 and 2 to subpart LLLL, and tables 2 and 3 to subpart MMMM.

\* \* \* \* \*

(h) \* \* \*  
(4) ANSI/ASME PTC 19.10–1981, Flue and Exhaust Gas Analyses [Part 10, Instruments and Apparatus], IBR approved for § 60.56c(b)(4), § 60.63(f)(2) and (f)(4), § 60.106(e)(2), § 60.104a(d)(3), (d)(5), (d)(6), (h)(3), (h)(4), (h)(5), (i)(3), (i)(4), (i)(5), (j)(3), and (j)(4), § 60.105a(d)(4), (f)(2), (f)(4), (g)(2), and (g)(4), § 60.106a(a)(1)(iii), (a)(2)(iii), (a)(2)(v), (a)(2)(viii), (a)(3)(ii), and (a)(3)(v), and § 60.107a(a)(1)(ii), (a)(1)(iv), (a)(2)(ii), (c)(2), (c)(4), and (d)(2), tables 1 and 3 of subpart EEEE, tables 2 and 4 of subpart FFFF, table 2 of subpart JJJJ, § 60.4415(a)(2) and (a)(3), 60.2145(s)(1)(i) and (ii), 60.2145(t)(1)(ii), 60.2145(t)(5)(i),

60.2710(s)(1)(i) and (ii), 60.2710(t)(1)(ii), 60.2710(t)(5)(i), 60.2710(w)(3), 60.2730(q)(3), 60.4900(b)(4)(vii) and (viii), 60.4900(b)(5)(i), 60.5220(b)(4)(vii) and (viii), 60.5220(b)(5)(i), tables 1 and 2 to subpart LLLL, and tables 2 and 3 to subpart MMMM.

\* \* \* \* \*

(o) The following material is available from the U.S. Environmental Protection Agency, 1200 Pennsylvania Avenue, NW., Washington, DC 20460, (202) 272–0167, <http://www.epa.gov>.

(1) Office of Air Quality Planning and Standards (OAQPS) Fabric Filter Bag Leak Detection Guidance, EPA–454/R–98–015, September 1997, IBR approved for §§ 60.2145(r)(2), 60.2710(r)(2), 60.4905(b)(3)(i)(B), and 60.5225(b)(3)(i)(B).

(2) [Reserved]

■ 3. Part 60 is amended by adding subparts LLLL and MMMM to read as follows:

#### Subpart LLLL—Standards of Performance for New Sewage Sludge Incineration Units

Sec.

#### Introduction

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- 60.4855 How do I establish operating limits if I do not use a wet scrubber, fabric filter, electrostatic precipitator, or activated carbon injection, or if I limit emissions in some other manner, to comply with the emission limits?
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**Initial Compliance Requirements**

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**Continuous Compliance Requirements**

- 60.4885 How and when do I demonstrate continuous compliance with the emission limits and standards?
- 60.4890 How do I demonstrate continuous compliance with my operating limits?
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**Performance Testing, Monitoring, and Calibration Requirements**

- 60.4900 What are the performance testing, monitoring, and calibration requirements for compliance with the emission limits and standards?
- 60.4905 What are the monitoring and calibration requirements for compliance with my operating limits?

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- 60.4910 What records must I keep?
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**Title V Operating Permits**

- 60.4920 Am I required to apply for and obtain a Title V operating permit for my unit?
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**Definitions**

- 60.4930 What definitions must I know?

**Tables**

Table 1 to Subpart LLLL of Part 60—Emission Limits and Standards for Fluidized Bed New Sewage Sludge Incineration Units

Table 2 to Subpart LLLL of Part 60—Emission Limits and Standards for New Multiple Hearth Sewage Sludge Incineration Units

Table 3 to Subpart LLLL of Part 60—Operating Parameters for New Sewage Sludge Incineration Units

Table 4 to Subpart LLLL of Part 60—Toxic Equivalency Factors

Table 5 to Subpart LLLL of Part 60—Summary of Reporting Requirements for New Sewage Sludge Incineration Units

**Introduction****§ 60.4760 What does this subpart do?**

This subpart establishes new source performance standards for sewage sludge incineration (SSI) units. To the extent any requirement of this subpart is inconsistent with the requirements of subpart A of this part, the requirements of this subpart will apply.

**§ 60.4765 When does this subpart become effective?**

This subpart takes effect on *September 21, 2011*. Some of the requirements in this subpart apply to planning a SSI unit and must be completed even before construction is initiated on a SSI unit (*i.e.*, the preconstruction requirements in §§ 60.4800 and 60.4805). Other requirements such as the emission limits, emission standards, and operating limits apply after the SSI unit begins operation.

**Applicability and Delegation of Authority****§ 60.4770 Does this subpart apply to my sewage sludge incineration unit?**

Yes, your SSI unit is an affected source if it meets all the criteria specified in paragraphs (a) through (c) of this section.

(a) Your SSI unit is a SSI unit for which construction commenced after October 14, 2010 or for which modification commenced after September 21, 2011.

(b) Your SSI unit is a SSI unit as defined in § 60.4930.

(c) Your SSI unit is not exempt under § 60.4780.

**§ 60.4775 What is a new sewage sludge incineration unit?**

(a) A new SSI unit is a SSI unit that meets either of the two criteria specified in paragraph (a)(1) or (a)(2) of this section.

(1) Commenced construction after October 14, 2010.

(2) Commenced modification after September 21, 2011.

(b) Physical or operational changes made to your SSI unit to comply with the emission guidelines in subpart

MMMM of this part (Emission Guidelines and Compliance Times for Existing Sewage Sludge Incineration Units) do not qualify as a modification under this subpart.

**§ 60.4780 What sewage sludge incineration units are exempt from this subpart?**

This subpart exempts combustion units that incinerate sewage sludge and are not located at a wastewater treatment facility designed to treat domestic sewage sludge. These units may be subject to another subpart of this part (*e.g.*, subpart CCCC of this part). The owner or operator of such a combustion unit must notify the Administrator of an exemption claim under this section.

**§ 60.4785 Who implements and enforces this subpart?**

(a) This subpart can be implemented and enforced by the Administrator, as defined in § 60.2, or a delegated authority such as your state, local, or tribal agency. If the Administrator has delegated authority to your state, local, or tribal agency, then that agency (as well as the Administrator) has the authority to implement and enforce this subpart. You should contact your EPA Regional Office to find out if this subpart is delegated to your state, local, or tribal agency.

(b) In delegating implementation and enforcement authority of this subpart to a state, local, or tribal agency, the authorities contained in paragraph (c) of this section are retained by the Administrator and are not transferred to the state, local, or tribal agency.

(c) The authorities that will not be delegated to state, local, or tribal agencies are specified in paragraphs (c)(1) through (c)(8) of this section.

(1) Approval of alternatives to the emission limits and standards in Tables 1 and 2 to this subpart and operating limits established under § 60.4850.

(2) Approval of major alternatives to test methods.

(3) Approval of major alternatives to monitoring.

(4) Approval of major alternatives to recordkeeping and reporting.

(5) The requirements in § 60.4855.

(6) The requirements in § 60.4835(b)(2).

(7) Performance test and data reduction waivers under § 60.8(b).

(8) Preconstruction siting analysis in § 60.4800 and § 60.4805.

**§ 60.4790 How are these new source performance standards structured?**

These new source performance standards contain the nine major

components listed in paragraphs (a) through (i) of this section.

- (a) Preconstruction siting analysis.
- (b) Operator training and qualification.
- (c) Emission limits, emission standards, and operating limits.
- (d) Initial compliance requirements.
- (e) Continuous compliance requirements.
- (f) Performance testing, monitoring, and calibration requirements.
- (g) Recordkeeping and reporting.
- (h) Definitions.
- (i) Tables.

**§ 60.4795 Do all nine components of these new source performance standards apply at the same time?**

No. You must meet the preconstruction siting analysis requirements before you commence construction of the SSI unit. The operator training and qualification, emission limits, emission standards, operating limits, performance testing, and compliance, monitoring, and most recordkeeping and reporting requirements are met after the SSI unit begins operation.

**Preconstruction Siting Analysis**

**§ 60.4800 Who must prepare a siting analysis?**

(a) You must prepare a siting analysis if you plan to commence construction of a SSI unit after October 14, 2010.

(b) You must prepare a siting analysis if you are required to submit an initial application for a construction permit under 40 CFR part 51, subpart I, or 40 CFR part 52, as applicable, for the modification of your SSI unit.

**§ 60.4805 What is a siting analysis?**

(a) The siting analysis must consider air pollution control alternatives that minimize, on a site-specific basis, to the maximum extent practicable, potential risks to public health or the environment, including impacts of the affected SSI unit on ambient air quality, visibility, soils, and vegetation. In considering such alternatives, the analysis may consider costs, energy impacts, nonair environmental impacts, or any other factors related to the practicability of the alternatives.

(b) Analyses of your SSI unit's impacts that are prepared to comply with state, local, or other Federal regulatory requirements may be used to satisfy the requirements of this section, provided they include the consideration of air pollution control alternatives specified in paragraph (a) of this section.

(c) You must complete and submit the siting requirements of this section as

required under § 60.4915(a)(3) prior to commencing construction.

**Operator Training and Qualification**

**§ 60.4810 What are the operator training and qualification requirements?**

(a) A SSI unit cannot be operated unless a fully trained and qualified SSI unit operator is accessible, either at the facility or can be at the facility within 1 hour. The trained and qualified SSI unit operator may operate the SSI unit directly or be the direct supervisor of one or more other plant personnel who operate the unit. If all qualified SSI unit operators are temporarily not accessible, you must follow the procedures in § 60.4835.

(b) Operator training and qualification must be obtained through a state-approved program or by completing the requirements included in paragraph (c) of this section.

(c) Training must be obtained by completing an incinerator operator training course that includes, at a minimum, the three elements described in paragraphs (c)(1) through (c)(3) of this section.

(1) Training on the 10 subjects listed in paragraphs (c)(1)(i) through (c)(1)(x) of this section.

(i) Environmental concerns, including types of emissions.

(ii) Basic combustion principles, including products of combustion.

(iii) Operation of the specific type of incinerator to be used by the operator, including proper startup, sewage sludge feeding, and shutdown procedures.

(iv) Combustion controls and monitoring.

(v) Operation of air pollution control equipment and factors affecting performance (if applicable).

(vi) Inspection and maintenance of the incinerator and air pollution control devices.

(vii) Actions to prevent malfunctions or to prevent conditions that may lead to malfunctions.

(viii) Bottom and fly ash characteristics and handling procedures.

(ix) Applicable Federal, State, and local regulations, including Occupational Safety and Health Administration workplace standards.

(x) Pollution prevention.

(2) An examination designed and administered by the state-approved program.

(3) Written material covering the training course topics that may serve as reference material following completion of the course.

**§ 60.4815 When must the operator training course be completed?**

The operator training course must be completed by the later of the two dates

specified in paragraphs (a) and (b) of this section.

(a) Six months after your SSI unit startup.

(b) The date before an employee assumes responsibility for operating the SSI unit or assumes responsibility for supervising the operation of the SSI unit.

**§ 60.4820 How do I obtain my operator qualification?**

(a) You must obtain operator qualification by completing a training course that satisfies the criteria under § 60.4810(b).

(b) Qualification is valid from the date on which the training course is completed and the operator successfully passes the examination required under § 60.4810(c)(2).

**§ 60.4825 How do I maintain my operator qualification?**

To maintain qualification, you must complete an annual review or refresher course covering, at a minimum, the five topics described in paragraphs (a) through (e) of this section.

(a) Update of regulations.

(b) Incinerator operation, including startup and shutdown procedures, sewage sludge feeding, and ash handling.

(c) Inspection and maintenance.

(d) Prevention of malfunctions or conditions that may lead to malfunction.

(e) Discussion of operating problems encountered by attendees.

**§ 60.4830 How do I renew my lapsed operator qualification?**

You must renew a lapsed operator qualification before you begin operation of a SSI unit by one of the two methods specified in paragraphs (a) and (b) of this section.

(a) For a lapse of less than 3 years, you must complete a standard annual refresher course described in § 60.4825.

(b) For a lapse of 3 years or more, you must repeat the initial qualification requirements in § 60.4820(a).

**§ 60.4835 What if all the qualified operators are temporarily not accessible?**

If a qualified operator is not at the facility and cannot be at the facility within 1 hour, you must meet the criteria specified in either paragraph (a) or (b) of this section, depending on the length of time that a qualified operator is not accessible.

(a) When a qualified operator is not accessible for more than 8 hours, the SSI unit may be operated for less than 2 weeks by other plant personnel who are familiar with the operation of the SSI unit and who have completed a review

of the information specified in § 60.4840 within the past 12 months. However, you must record the period when a qualified operator was not accessible and include this deviation in the annual report as specified under § 60.4915(d).

(b) When a qualified operator is not accessible for 2 weeks or more, you must take the two actions that are described in paragraphs (b)(1) and (b)(2) of this section.

(1) Notify the Administrator of this deviation in writing within 10 days. In the notice, state what caused this deviation, what you are doing to ensure that a qualified operator is accessible, and when you anticipate that a qualified operator will be accessible.

(2) Submit a status report to the Administrator every 4 weeks outlining what you are doing to ensure that a qualified operator is accessible, stating when you anticipate that a qualified operator will be accessible, and requesting approval from the Administrator to continue operation of the SSI unit. You must submit the first status report 4 weeks after you notify the Administrator of the deviation under paragraph (b)(1) of this section.

(i) If the Administrator notifies you that your request to continue operation of the SSI unit is disapproved, the SSI unit may continue operation for 30 days, and then must cease operation.

(ii) Operation of the unit may resume if a qualified operator is accessible as required under § 60.4810(a). You must notify the Administrator within 5 days of having resumed operations and of having a qualified operator accessible.

**§ 60.4840 What site-specific documentation is required and how often must it be reviewed by qualified operators and plant personnel?**

(a) You must maintain at the facility the documentation of the operator training procedures specified under § 60.4910(c)(1) and make the documentation readily accessible to all SSI unit operators.

(b) You must establish a program for reviewing the information listed in § 60.4910(c)(1) with each qualified incinerator operator and other plant personnel who may operate the unit according to the provisions of § 60.4835(a), according to the following schedule:

(1) The initial review of the information listed in § 60.4910(c)(1) must be conducted within 6 months after the effective date of this subpart or prior to an employee's assumption of responsibilities for operation of the SSI unit, whichever date is later.

(2) Subsequent annual reviews of the information listed in § 60.4910(c)(1)

must be conducted no later than 12 months following the previous review.

**Emission Limits, Emission Standards, and Operating Limits and Requirements**

**§ 60.4845 What emission limits and standards must I meet and by when?**

You must meet the emission limits and standards specified in Table 1 or 2 to this subpart within 60 days after your SSI unit reaches the feed rate at which it will operate or within 180 days after its initial startup, whichever comes first. The emission limits and standards apply at all times the unit is operating, and during periods of malfunction. The emission limits and standards apply to emissions from a bypass stack or vent while sewage sludge is in the combustion chamber (*i.e.*, until the sewage sludge feed to the combustor has been cut off for a period of time not less than the sewage sludge incineration residence time).

**§ 60.4850 What operating limits and requirements must I meet and by when?**

You must meet, as applicable, the operating limits and requirements specified in paragraphs (a) through (d) and (h) of this section, according to the schedule specified in paragraph (e) of this section. The operating parameters for which you will establish operating limits for a wet scrubber, fabric filter, electrostatic precipitator, or activated carbon injection are listed in Table 3 to this subpart. You must comply with the operating requirements in paragraph (f) of this section and the requirements in paragraph (g) of this section for meeting any new operating limits, re-established in § 60.4890. The operating limits apply at all times that sewage sludge is in the combustion chamber (*i.e.*, until the sewage sludge feed to the combustor has been cut off for a period of time not less than the sewage sludge incineration residence time).

(a) You must meet a site-specific operating limit for minimum operating temperature of the combustion chamber (or afterburner combustion chamber) that you establish in § 60.4890(a)(2)(i).

(b) If you use a wet scrubber, electrostatic precipitator, or activated carbon injection to comply with an emission limit, you must meet the site-specific operating limits that you establish in § 60.4870 for each operating parameter associated with each air pollution control device.

(c) If you use a fabric filter to comply with the emission limits, you must install the bag leak detection system specified in §§ 60.4880(b) and 60.4905(b)(3)(i) and operate the bag leak detection system such that the alarm

does not sound more than 5 percent of the operating time during a 6-month period. You must calculate the alarm time as specified in § 60.4870.

(d) You must meet the operating requirements in your site-specific fugitive emission monitoring plan, submitted as specified in § 60.4880(d) to ensure that your ash handling system will meet the emission standard for fugitive emissions from ash handling.

(e) You must meet the operating limits and requirements specified in paragraphs (a) through (d) of this section 60 days after your SSI unit reaches the feed rate at which it will operate, or within 180 days after its initial startup, whichever comes first.

(f) You must monitor the feed rate and moisture content of the sewage sludge fed to the sewage sludge incinerator, as specified in paragraphs (f)(1) and (f)(2) of this section.

(1) Continuously monitor the sewage sludge feed rate and calculate a daily average for all hours of operation during each 24-hour period. Keep a record of the daily average feed rate, as specified in § 60.4910(f)(3)(ii).

(2) Take at least one grab sample per day of the sewage sludge fed to the sewage sludge incinerator. If you take more than one grab sample in a day, calculate the daily average for the grab samples. Keep a record of the daily average moisture content, as specified in § 60.4910(f)(3)(ii).

(g) For the operating limits and requirements specified in paragraphs (a) through (d) and (h) of this section, you must meet any new operating limits and requirements, re-established according to § 60.4890(d).

(h) If you use an air pollution control device other than a wet scrubber, fabric filter, electrostatic precipitator, or activated carbon injection to comply with the emission limits in Table 1 or 2 to this subpart, you must meet any site-specific operating limits or requirements that you establish as required in § 60.4855.

**§ 60.4855 How do I establish operating limits if I do not use a wet scrubber, fabric filter, electrostatic precipitator, or activated carbon injection, or if I limit emissions in some other manner, to comply with the emission limits?**

If you use an air pollution control device other than a wet scrubber, fabric filter, electrostatic precipitator, or activated carbon injection, or limit emissions in some other manner (*e.g.*, materials balance) to comply with the emission limits in § 60.4845, you must meet the requirements in paragraphs (a) and (b) of this section.

(a) Meet the applicable operating limits and requirements in § 60.4850,

and establish applicable operating limits according to § 60.4870.

(b) Petition the Administrator for specific operating parameters, operating limits, and averaging periods to be established during the initial performance test and to be monitored continuously thereafter.

(1) You are responsible for submitting any supporting information in a timely manner to enable the Administrator to consider the application prior to the performance test. You must not conduct the initial performance test until after the petition has been approved by the Administrator, and you must comply with the operating limits as written, pending approval by the Administrator. Neither submittal of an application, nor the Administrator's failure to approve or disapprove the application relieves you of the responsibility to comply with any provision of this subpart.

(2) Your petition must include the five items listed in paragraphs (b)(2)(i) through (b)(2)(v) of this section.

(i) Identification of the specific parameters you propose to monitor.

(ii) A discussion of the relationship between these parameters and emissions of regulated pollutants, identifying how emissions of regulated pollutants change with changes in these parameters, and how limits on these parameters will serve to limit emissions of regulated pollutants.

(iii) A discussion of how you will establish the upper and/or lower values for these parameters that will establish the operating limits on these parameters, including a discussion of the averaging periods associated with those parameters for determining compliance.

(iv) A discussion identifying the methods you will use to measure and the instruments you will use to monitor these parameters, as well as the relative accuracy and precision of these methods and instruments.

(v) A discussion identifying the frequency and methods for recalibrating the instruments you will use for monitoring these parameters.

**§ 60.4860 Do the emission limits, emission standards, and operating limits apply during periods of startup, shutdown, and malfunction?**

The emission limits and standards apply at all times and during periods of malfunction. The operating limits apply at all times that sewage sludge is in the combustion chamber (*i.e.*, until the sewage sludge feed to the combustor has been cut off for a period of time not less than the sewage sludge incineration residence time).

**§ 60.4861 How do I establish an affirmative defense for exceedance of an emission limit or standard during malfunction?**

In response to an action to enforce the numerical emission standards set forth in paragraph § 60.4845, you may assert an affirmative defense to a claim for civil penalties for exceedances of emission limits that are caused by malfunction, as defined in § 60.2. Appropriate penalties may be assessed, however, if you fail to meet your burden of proving all of the requirements in the affirmative defense. The affirmative defense shall not be available for claims for injunctive relief.

(a) To establish the affirmative defense in any action to enforce such a limit, you must timely meet the notification requirements in paragraph (b) of this section, and must prove by a preponderance of evidence that the conditions in paragraphs (a)(1) through (a)(9) of this section are met.

(1) The excess emissions meet:

(i) Were caused by a sudden, infrequent, and unavoidable failure of air pollution control and monitoring equipment, process equipment, or a process to operate in a normal or usual manner, and

(ii) Could not have been prevented through careful planning, proper design or better operation and maintenance practices, and

(iii) Did not stem from any activity or event that could have been foreseen and avoided, or planned for, and

(iv) Were not part of a recurring pattern indicative of inadequate design, operation, or maintenance, and (2) Repairs were made as expeditiously as possible when the applicable emission limits were being exceeded. Off-shift and overtime labor were used, to the extent practicable to make these repairs, and

(3) The frequency, amount and duration of the excess emissions (including any bypass) were minimized to the maximum extent practicable during periods of such emissions, and

(4) If the excess emissions resulted from a bypass of control equipment or a process, then the bypass was unavoidable to prevent loss of life, personal injury, or severe property damage, and

(5) All possible steps were taken to minimize the impact of the excess emissions on ambient air quality, the environment and human health, and

(6) All emissions monitoring and control systems were kept in operation if at all possible consistent with safety and good air pollution control practices, and

(7) All of the actions in response to the excess emissions were documented

by properly signed, contemporaneous operating logs, and

(8) At all times, the affected facility was operated in a manner consistent with good practices for minimizing emissions, and

(9) A written root cause analysis has been prepared the purpose of which is to determine, correct, and eliminate the primary causes of the malfunction and the excess emissions resulting from the malfunction event at issue. The analysis shall also specify, using best monitoring methods and engineering judgment, the amount of excess emissions that were the result of the malfunction.

(b) The owner or operator of the SSI unit experiencing an exceedance of its emission limit(s) during a malfunction, shall notify the Administrator by telephone or facsimile (fax) transmission as soon as possible, but no later than 2 business days after the initial occurrence of the malfunction, if it wishes to avail itself of an affirmative defense to civil penalties for that malfunction. The owner or operator seeking to assert an affirmative defense shall also submit a written report to the Administrator within 45 days of the initial occurrence of the exceedance of the standard in § 60.4845 to demonstrate, with all necessary supporting documentation, that it has met the requirements set forth in paragraph (a) of this section. The owner or operator may seek an extension of this deadline for up to 30 additional days by submitting a written request to the Administrator before the expiration of the 45 day period. Until a request for an extension has been approved by the Administrator, the owner or operator is subject to the requirement to submit such report within 45 days of the initial occurrence of the exceedance.

**Initial Compliance Requirements**

**§ 60.4865 How and when do I demonstrate initial compliance with the emission limits and standards?**

To demonstrate initial compliance with the emission limits and standards in Table 1 or 2 to this subpart, use the procedures specified in paragraph (a) of this section for particulate matter, hydrogen chloride, dioxins/furans (total mass basis or toxic equivalency basis), mercury, nitrogen oxides, sulfur dioxide, cadmium, lead, and fugitive emissions from ash handling, and follow the procedures specified in paragraph (b) of this section for carbon monoxide. In lieu of using the procedures specified in paragraph (a) of this section, you also have the option to demonstrate initial compliance using the procedures specified in paragraph (b) of this section for particulate matter,

hydrogen chloride, dioxins/furans (total mass basis or toxic equivalency basis), mercury, nitrogen oxides, sulfur dioxide, cadmium, and lead. You must meet the requirements of paragraphs (a) or (b) of this section, as applicable, and paragraphs (c) and (d) of this section, according to the performance testing, monitoring, and calibration requirements in § 60.4900(a) and (b). Except as provided in paragraph (e) of this section, within 60 days after your SSI unit reaches the feed rate at which it will operate, or within 180 days after its initial startup, whichever comes first, you must demonstrate that your SSI unit meets the emission limits and standards specified in Table 1 or 2 to this subpart.

(a) Demonstrate initial compliance using the performance test required in § 60.8. You must demonstrate that your SSI unit meets the emission limits and standards specified in Table 1 or 2 to this subpart for particulate matter, hydrogen chloride, dioxins/furans (total mass basis or toxic equivalency basis), mercury, nitrogen oxides, sulfur dioxide, cadmium, lead, and fugitive emissions from ash handling using the performance test. The initial performance test must be conducted using the test methods, averaging methods, and minimum sampling volumes or durations specified in Table 1 or 2 to this subpart and according to the testing, monitoring, and calibration requirements specified in § 60.4900(a).

(b) Demonstrate initial compliance using a continuous emissions monitoring system or continuous automated sampling system. The option to use a continuous emissions monitoring system for hydrogen chloride, dioxins/furans, cadmium, or lead takes effect on the date a final performance specification applicable to hydrogen chloride, dioxins/furans, cadmium, or lead is published in the **Federal Register**. The option to use a continuous automated sampling system for dioxins/furans takes effect on the date a final performance specification for such a continuous automated sampling system is published in the **Federal Register**. Collect data as specified in § 60.4900(b)(6) and use the following procedures:

(1) To demonstrate initial compliance with the carbon monoxide emission limit specified in Table 1 or 2 to this subpart, you must use the carbon monoxide continuous emissions monitoring system specified in § 60.4900(b). For determining compliance with the carbon monoxide concentration limit using carbon monoxide CEMS, the correction to 7 percent oxygen does not apply during periods of startup or shutdown. Use the

measured carbon monoxide concentration without correcting for oxygen concentration in averaging with other carbon monoxide concentrations (corrected to 7 percent oxygen) to determine the 24-hour average value.

(2) To demonstrate initial compliance with the emission limits specified in Table 1 or 2 to this subpart for particulate matter, hydrogen chloride, dioxins/furans (total mass basis or toxic equivalency basis), mercury, nitrogen oxides, sulfur dioxide, cadmium, and lead, you may substitute the use of a continuous monitoring system in lieu of conducting the initial performance test required in paragraph (a) of this section, as follows:

(i) You may substitute the use of a continuous emissions monitoring system for any pollutant specified in paragraph (b)(2) of this section in lieu of conducting the initial performance test for that pollutant in paragraph (a) of this section.

(ii) You may substitute the use of a continuous automated sampling system for mercury or dioxins/furans in lieu of conducting the initial mercury or dioxin/furan performance test in paragraph (a) of this section.

(3) If you use a continuous emissions monitoring system to demonstrate compliance with an applicable emission limit in Table 1 or 2 to this subpart, as described in paragraph (b)(1) or (b)(2) of this section, you must use the continuous emissions monitoring system and follow the requirements specified in § 60.4900(b). You must measure emissions according to § 60.13 to calculate 1-hour arithmetic averages, corrected to 7 percent oxygen (or carbon dioxide). You must demonstrate initial compliance using a 24-hour block average of these 1-hour arithmetic average emission concentrations, calculated using Equation 19–19 in section 12.4.1 of Method 19 of 40 CFR part 60, appendix A–7.

(4) If you use a continuous automated sampling system to demonstrate compliance with an applicable emission limit in Table 1 or 2 to this subpart, as described in paragraph (b)(2) of this section, you must:

(i) Use the continuous automated sampling system specified in § 60.58b(p) and (q), and measure and calculate average emissions corrected to 7 percent oxygen (or carbon dioxide) according to § 60.58b(p) and your monitoring plan.

(A) Use the procedures specified in § 60.58b(p) to calculate 24-hour block averages to determine compliance with the mercury emission limit in Table 1 or 2 to this subpart.

(B) Use the procedures specified in § 60.58b(p) to calculate 2-week block

averages to determine compliance with the dioxin/furan (total mass basis or toxic equivalency basis) emission limits in Table 1 or 2 to this subpart.

(ii) Comply with the provisions in § 60.58b(q) to develop a monitoring plan. For mercury continuous automated sampling systems, you must use Performance Specification 12B of appendix B of part 75 and Procedure 5 of appendix F of this part.

(5) Except as provided in paragraph (e) of this section, you must complete your initial performance evaluations required under your monitoring plan for any continuous emissions monitoring system and continuous automated sampling systems according to the provisions of § 60.4880. Your performance evaluation must be conducted using the procedures and acceptance criteria specified in § 60.4880(a)(3).

(c) To demonstrate initial compliance with the dioxins/furans toxic equivalency emission limit in Table 1 or 2 to this subpart, determine dioxins/furans toxic equivalency as follows:

(1) Measure the concentration of each dioxin/furan tetra- through octachlorinated-isomer emitted using Method 23 at 40 CFR part 60, appendix A–7.

(2) Multiply the concentration of each dioxin/furan (tetra- through octachlorinated) isomer by its corresponding toxic equivalency factor specified in Table 4 to this subpart.

(3) Sum the products calculated in accordance with paragraph (c)(2) of this section to obtain the total concentration of dioxins/furans emitted in terms of toxic equivalency.

(d) Submit an initial compliance report, as specified in § 60.4915(c).

(e) If you demonstrate initial compliance using the performance test specified in paragraph (a) of this section, then the provisions of this paragraph (e) apply. If a force majeure is about to occur, occurs, or has occurred for which you intend to assert a claim of force majeure, you must notify the Administrator in writing as specified in § 60.4915(g). You must conduct the initial performance test as soon as practicable after the force majeure occurs. The Administrator will determine whether or not to grant the extension to the initial performance test deadline, and will notify you in writing of approval or disapproval of the request for an extension as soon as practicable. Until an extension of the performance test deadline has been approved by the Administrator, you remain strictly subject to the requirements of this subpart.

**§ 60.4870 How do I establish my operating limits?**

(a) You must establish the site-specific operating limits specified in paragraphs (b) through (h) of this section or established in § 60.4855, as applicable, during your initial performance tests required in § 60.4865. You must meet the requirements in § 60.4890(d) to confirm these operating limits or re-establish new operating limits using operating data recorded during any performance tests or performance evaluations required in § 60.4885. You must follow the data measurement and recording frequencies and data averaging times specified in Table 3 to this subpart or as established in § 60.4855, and you must follow the testing, monitoring, and calibration requirements specified in §§ 60.4900 and 60.4905 or established in § 60.4855. You are not required to establish operating limits for the operating parameters listed in Table 3 to this subpart for a control device if you use a continuous monitoring system to demonstrate compliance with the emission limits in Table 1 or 2 to this subpart for the applicable pollutants, as follows:

(1) For a scrubber designed to control emissions of hydrogen chloride or sulfur dioxide, you are not required to establish an operating limit and monitor, scrubber liquid flow rate or scrubber liquid pH if you use the continuous monitoring system specified in §§ 60.4865(b) and 60.4885(b) to demonstrate compliance with the emission limit for hydrogen chloride or sulfur dioxide.

(2) For a scrubber designed to control emissions of particulate matter, cadmium, and lead, you are not required to establish an operating limit and monitor pressure drop across the scrubber or scrubber liquid flow rate if you use the continuous monitoring system specified in §§ 60.4865(b) and 60.4885(b) to demonstrate compliance with the emission limit for particulate matter, cadmium, and lead.

(3) For an electrostatic precipitator designed to control emissions of particulate matter, cadmium, and lead, you are not required to establish an operating limit and monitor secondary voltage of the collection plates, secondary amperage of the collection plates, or effluent water flow rate at the outlet of the electrostatic precipitator if you use the continuous monitoring system specified in §§ 60.4865(b) and 60.4885(b) to demonstrate compliance with the emission limit for particulate matter, cadmium, and lead.

(4) For an activated carbon injection system designed to control emissions of

mercury, you are not required to establish an operating limit and monitor sorbent injection rate and carrier gas flow rate (or carrier gas pressure drop) if you use the continuous monitoring system specified in §§ 60.4865(b) and 60.4885(b) to demonstrate compliance with the emission limit for mercury.

(5) For an activated carbon injection system designed to control emissions of dioxins/furans, you are not required to establish an operating limit and monitor sorbent injection rate and carrier gas flow rate (or carrier gas pressure drop) if you use the continuous monitoring system specified in §§ 60.4865(b) and 60.4885(b) to demonstrate compliance with the emission limit for dioxins/furans (total mass basis or toxic equivalency basis).

(b) Minimum pressure drop across each wet scrubber used to meet the particulate matter, lead, and cadmium emission limits in Table 1 or 2 to this subpart, equal to the lowest 4-hour average pressure drop across each such wet scrubber measured during the most recent performance test demonstrating compliance with the particulate matter, lead, and cadmium emission limits.

(c) Minimum scrubber liquid flow rate (measured at the inlet to each wet scrubber), equal to the lowest 4-hour average liquid flow rate measured during the most recent performance test demonstrating compliance with all applicable emission limits.

(d) Minimum scrubber liquid pH for each wet scrubber used to meet the sulfur dioxide or hydrogen chloride emission limits in Table 1 or 2 to this subpart, equal to the lowest 1-hour average scrubber liquid pH measured during the most recent performance test demonstrating compliance with the sulfur dioxide and hydrogen chloride emission limits.

(e) Minimum combustion chamber operating temperature (or minimum afterburner temperature), equal to the lowest 4-hour average combustion chamber operating temperature (or afterburner temperature) measured during the most recent performance test demonstrating compliance with all applicable emission limits.

(f) Minimum power input to the electrostatic precipitator collection plates, equal to the lowest 4-hour average power measured during the most recent performance test demonstrating compliance with the particulate matter, lead, and cadmium emission limits. Power input must be calculated as the product of the secondary voltage and secondary amperage to the electrostatic precipitator collection plates. Both the secondary voltage and secondary

amperage must be recorded during the performance test.

(g) Minimum effluent water flow rate at the outlet of the electrostatic precipitator, equal to the lowest 4-hour average effluent water flow rate at the outlet of the electrostatic precipitator measured during the most recent performance test demonstrating compliance with the particulate matter, lead, and cadmium emission limits.

(h) For activated carbon injection, establish the site-specific operating limits specified in paragraphs (h)(1) through (h)(3) of this section.

(1) Minimum mercury sorbent injection rate, equal to the lowest 4-hour average mercury sorbent injection rate measured during the most recent performance test demonstrating compliance with the mercury emission limit.

(2) Minimum dioxin/furan sorbent injection rate, equal to the lowest 4-hour average dioxin/furan sorbent injection rate measured during the most recent performance test demonstrating compliance with the dioxin/furan (total mass basis or toxic equivalency basis) emission limit.

(3) Minimum carrier gas flow rate or minimum carrier gas pressure drop, as follows:

(i) Minimum carrier gas flow rate, equal to the lowest 4-hour average carrier gas flow rate measured during the most recent performance test demonstrating compliance with the applicable emission limit.

(ii) Minimum carrier gas pressure drop, equal to the lowest 4-hour average carrier gas flow rate measured during the most recent performance test demonstrating compliance with the applicable emission limit.

**§ 60.4875 By what date must I conduct the initial air pollution control device inspection and make any necessary repairs?**

(a) You must conduct an air pollution control device inspection according to § 60.4900(c) within 60 days of installing an air pollution control device or within 180 days of startup of the SSI unit using the air pollution control device, whichever comes first.

(b) Within 10 operating days following the air pollution control device inspection under paragraph (a) of this section, all necessary repairs must be completed unless you obtain written approval from the Administrator establishing a date whereby all necessary repairs of the SSI unit must be completed.

**§ 60.4880 How do I develop a site-specific monitoring plan for my continuous monitoring, bag leak detection, and ash handling systems, and by what date must I conduct an initial performance evaluation?**

You must develop and submit to the Administrator for approval a site-specific monitoring plan for each continuous monitoring system required under this subpart, according to the requirements in paragraphs (a) through (d) of this section. This requirement also applies to you if you petition the Administrator for alternative monitoring parameters under § 60.13(i) and paragraph (e) of this section. If you use a continuous automated sampling system to comply with the mercury or dioxin/furan (total mass basis or toxic equivalency basis) emission limit, you must develop your monitoring plan as specified in § 60.58b(q), and you are not required to meet the requirements in paragraphs (a) and (b) of this section. You must also submit a site-specific monitoring plan for your ash handling system, as specified in paragraph (d) of this section. You must submit and update your monitoring plans as specified in paragraphs (f) through (h) of this section.

(a) For each continuous monitoring system, your monitoring plan must address the elements and requirements specified in paragraphs (a)(1) through (a)(8) of this section. You must operate and maintain the continuous monitoring system in continuous operation according to the site-specific monitoring plan.

(1) Installation of the continuous monitoring system sampling probe or other interface at a measurement location relative to each affected process unit such that the measurement is representative of control of the exhaust emissions (*e.g.*, on or downstream of the last control device).

(2) Performance and equipment specifications for the sample interface, the pollutant concentration or parametric signal analyzer and the data collection and reduction systems.

(3) Performance evaluation procedures and acceptance criteria (*e.g.*, calibrations).

(i) For continuous emissions monitoring systems, your performance evaluation and acceptance criteria must include, but is not limited to, the following:

(A) The applicable requirements for continuous emissions monitoring systems specified in § 60.13.

(B) The applicable performance specifications (*e.g.*, relative accuracy tests) in appendix B of this part.

(C) The applicable procedures (*e.g.*, quarterly accuracy determinations and

daily calibration drift tests) in appendix F of this part.

(D) A discussion of how the occurrence and duration of out-of-control periods will affect the suitability of CEMS data, where out-of-control has the meaning given in section (a)(7)(i) of this section.

(ii) For continuous parameter monitoring systems, your performance evaluation and acceptance criteria must include, but is not limited to the following:

(A) If you have an operating limit that requires the use of a flow monitoring system, you must meet the requirements in paragraphs (a)(3)(ii)(A)(1) through (4) of this section.

(1) Install the flow sensor and other necessary equipment in a position that provides a representative flow.

(2) Use a flow sensor with a measurement sensitivity of no greater than 2 percent of the expected process flow rate.

(3) Minimize the effects of swirling flow or abnormal velocity distributions due to upstream and downstream disturbances.

(4) Conduct a flow monitoring system performance evaluation in accordance with your monitoring plan at the time of each performance test but no less frequently than annually.

(B) If you have an operating limit that requires the use of a pressure monitoring system, you must meet the requirements in paragraphs (a)(3)(ii)(B)(1) through (6) of this section.

(1) Install the pressure sensor(s) in a position that provides a representative measurement of the pressure (*e.g.*, particulate matter scrubber pressure drop).

(2) Minimize or eliminate pulsating pressure, vibration, and internal and external corrosion.

(3) Use a pressure sensor with a minimum tolerance of 1.27 centimeters of water or a minimum tolerance of 1 percent of the pressure monitoring system operating range, whichever is less.

(4) Perform checks at least once each process operating day to ensure pressure measurements are not obstructed (*e.g.*, check for pressure tap pluggage daily).

(5) Conduct a performance evaluation of the pressure monitoring system in accordance with your monitoring plan at the time of each performance test but no less frequently than annually.

(6) If at any time the measured pressure exceeds the manufacturer's specified maximum operating pressure range, conduct a performance evaluation of the pressure monitoring system in accordance with your monitoring plan and confirm that the

pressure monitoring system continues to meet the performance requirements in your monitoring plan. Alternatively, install and verify the operation of a new pressure sensor.

(C) If you have an operating limit that requires a pH monitoring system, you must meet the requirements in paragraphs (a)(3)(ii)(C)(1) through (4) of this section.

(1) Install the pH sensor in a position that provides a representative measurement of scrubber effluent pH.

(2) Ensure the sample is properly mixed and representative of the fluid to be measured.

(3) Conduct a performance evaluation of the pH monitoring system in accordance with your monitoring plan at least once each process operating day.

(4) Conduct a performance evaluation (including a two-point calibration with one of the two buffer solutions having a pH within 1 of the pH of the operating limit) of the pH monitoring system in accordance with your monitoring plan at the time of each performance test but no less frequently than quarterly.

(D) If you have an operating limit that requires the use of a temperature measurement device, you must meet the requirements in paragraphs (a)(3)(ii)(D)(1) through (4) of this section.

(1) Install the temperature sensor and other necessary equipment in a position that provides a representative temperature.

(2) Use a temperature sensor with a minimum tolerance of 2.8 degrees Celsius (5 degrees Fahrenheit), or 1.0 percent of the temperature value, whichever is larger, for a noncryogenic temperature range.

(3) Use a temperature sensor with a minimum tolerance of 2.8 degrees Celsius (5 degrees Fahrenheit), or 2.5 percent of the temperature value, whichever is larger, for a cryogenic temperature range.

(4) Conduct a temperature measurement device performance evaluation at the time of each performance test but no less frequently than annually.

(E) If you have an operating limit that requires a secondary electric power monitoring system for an electrostatic precipitator, you must meet the requirements in paragraphs (a)(3)(ii)(E)(1) and (2) of this section.

(1) Install sensors to measure (secondary) voltage and current to the electrostatic precipitator collection plates.

(2) Conduct a performance evaluation of the electric power monitoring system in accordance with your monitoring plan at the time of each performance

test but no less frequently than annually.

(F) If you have an operating limit that requires the use of a monitoring system to measure sorbent injection rate (*e.g.*, weigh belt, weigh hopper, or hopper flow measurement device), you must meet the requirements in paragraphs (a)(3)(ii)(F)(1) and (2) of this section.

(1) Install the system in a position(s) that provides a representative measurement of the total sorbent injection rate.

(2) Conduct a performance evaluation of the sorbent injection rate monitoring system in accordance with your monitoring plan at the time of each performance test but no less frequently than annually.

(4) Ongoing operation and maintenance procedures in accordance with the general requirements of § 60.11(d).

(5) Ongoing data quality assurance procedures in accordance with the general requirements of § 60.13.

(6) Ongoing recordkeeping and reporting procedures in accordance with the general requirements of § 60.7(b), (c), (c)(1), (c)(4), (d), (e), (f) and (g).

(7) Provisions for periods when the continuous monitoring system is out of control, as follows:

(i) A continuous monitoring system is out of control if the conditions of paragraph (a)(7)(i)(A) or (a)(7)(i)(B) of this section are met.

(A) The zero (low-level), mid-level (if applicable), or high-level calibration drift exceeds two times the applicable calibration drift specification in the applicable performance specification or in the relevant standard.

(B) The continuous monitoring system fails a performance test audit (*e.g.*, cylinder gas audit), relative accuracy audit, relative accuracy test audit, or linearity test audit.

(ii) When the continuous monitoring system is out of control as specified in paragraph (a)(7)(i) of this section, you must take the necessary corrective action and must repeat all necessary tests that indicate that the system is out of control. You must take corrective action and conduct retesting until the performance requirements are below the applicable limits. The beginning of the out-of-control period is the hour you conduct a performance check (*e.g.*, calibration drift) that indicates an exceedance of the performance requirements established under this part. The end of the out-of-control period is the hour following the completion of corrective action and successful demonstration that the system is within the allowable limits.

(8) Schedule for conducting initial and periodic performance evaluations.

(b) If a bag leak detection system is used, your monitoring plan must include a description of the following items:

(1) Installation of the bag leak detection system in accordance with paragraphs (b)(1)(i) and (ii) of this section.

(i) Install the bag leak detection sensor(s) in a position(s) that will be representative of the relative or absolute particulate matter loadings for each exhaust stack, roof vent, or compartment (*e.g.*, for a positive pressure fabric filter) of the fabric filter.

(ii) Use a bag leak detection system certified by the manufacturer to be capable of detecting particulate matter emissions at concentrations of 10 milligrams per actual cubic meter or less.

(2) Initial and periodic adjustment of the bag leak detection system, including how the alarm set-point will be established. Use a bag leak detection system equipped with a system that will sound an alarm when the system detects an increase in relative particulate matter emissions over a preset level. The alarm must be located where it is observed readily and any alert is detected and recognized easily by plant operating personnel.

(3) Evaluations of the performance of the bag leak detection system, performed in accordance with your monitoring plan and consistent with the guidance provided in Fabric Filter Bag Leak Detection Guidance, EPA-454/R-98-015, September 1997 (incorporated by reference, see § 60.17).

(4) Operation of the bag leak detection system, including quality assurance procedures.

(5) Maintenance of the bag leak detection system, including a routine maintenance schedule and spare parts inventory list.

(6) Recordkeeping (including record retention) of the bag leak detection system data. Use a bag leak detection system equipped with a device to continuously record the output signal from the sensor.

(c) You must conduct an initial performance evaluation of each continuous monitoring system and bag leak detection system, as applicable, in accordance with your monitoring plan and § 60.13(c). For the purposes of this subpart, the provisions of § 60.13(c) also apply to the bag leak detection system. You must conduct the initial performance evaluation of each continuous monitoring system within 60 days of installation of the monitoring system.

(d) You must submit a monitoring plan specifying the ash handling system operating procedures that you will follow to ensure that you meet the fugitive emissions limit specified in Table 1 or 2 to this subpart.

(e) You may submit an application to the Administrator for approval of alternate monitoring requirements to demonstrate compliance with the standards of this subpart, subject to the provisions of paragraphs (e)(1) through (e)(6) of this section.

(1) The Administrator will not approve averaging periods other than those specified in this section, unless you document, using data or information, that the longer averaging period will ensure that emissions do not exceed levels achieved over the duration of three performance test runs.

(2) If the application to use an alternate monitoring requirement is approved, you must continue to use the original monitoring requirement until approval is received to use another monitoring requirement.

(3) You must submit the application for approval of alternate monitoring requirements no later than the notification of performance test. The application must contain the information specified in paragraphs (e)(3)(i) through (e)(3)(iii) of this section:

(i) Data or information justifying the request, such as the technical or economic infeasibility, or the impracticality of using the required approach.

(ii) A description of the proposed alternative monitoring requirement, including the operating parameter to be monitored, the monitoring approach and technique, the averaging period for the limit, and how the limit is to be calculated.

(iii) Data or information documenting that the alternative monitoring requirement would provide equivalent or better assurance of compliance with the relevant emission standard.

(4) The Administrator will notify you of the approval or denial of the application within 90 calendar days after receipt of the original request, or within 60 calendar days of the receipt of any supplementary information, whichever is later. The Administrator will not approve an alternate monitoring application unless it would provide equivalent or better assurance of compliance with the relevant emission standard. Before disapproving any alternate monitoring application, the Administrator will provide the following:

(i) Notice of the information and findings upon which the intended disapproval is based.

(ii) Notice of opportunity for you to present additional supporting information before final action is taken on the application. This notice will specify how much additional time is allowed for you to provide additional supporting information.

(5) You are responsible for submitting any supporting information in a timely manner to enable the Administrator to consider the application prior to the performance test. Neither submittal of an application, nor the Administrator's failure to approve or disapprove the application relieves you of the responsibility to comply with any provision of this subpart.

(6) The Administrator may decide at any time, on a case-by-case basis, that additional or alternative operating limits, or alternative approaches to establishing operating limits, are necessary to demonstrate compliance with the emission standards of this subpart.

(f) You must submit your monitoring plans required in paragraphs (a) and (b) of this section at least 60 days before your initial performance evaluation of your continuous monitoring system(s).

(g) You must submit your monitoring plan for your ash handling system, as required in paragraph (d) of this section, at least 60 days before your initial compliance test date.

(h) You must update and resubmit your monitoring plan if there are any changes or potential changes in your monitoring procedures or if there is a process change, as defined in § 60.4930.

### Continuous Compliance Requirements

#### § 60.4885 How and when do I demonstrate continuous compliance with the emission limits and standards?

To demonstrate continuous compliance with the emission limits and standards specified in Table 1 or 2 to this subpart, use the procedures specified in paragraph (a) of this section for particulate matter, hydrogen chloride, dioxins/furans (total mass basis or toxic equivalency basis), mercury, nitrogen oxides, sulfur dioxide, cadmium, lead, and fugitive emissions from ash handling, and follow the procedures specified in paragraph (b) of this section for carbon monoxide. In lieu of using the procedures specified in paragraph (a) of this section, you also have the option to demonstrate continuous compliance using the procedures specified in paragraph (b) of this section for particulate matter, hydrogen chloride, dioxins/furans (total mass basis or toxic equivalency basis), mercury, nitrogen oxides, sulfur dioxide, cadmium, and lead. You must meet the requirements of

paragraphs (a) and (b) of this section, as applicable, and paragraphs (c) through (e) of this section, according to the performance testing, monitoring, and calibration requirements in § 60.4900(a) and (b). You may also petition the Administrator for alternative monitoring parameters as specified in paragraph (f) of this section.

(a) Demonstrate continuous compliance using a performance test. Except as provided in paragraphs (a)(3) and (e) of this section, following the date that the initial performance test for each pollutant in Table 1 or 2 to this subpart except carbon monoxide is completed, you must conduct a performance test for each such pollutant on an annual basis (between 11 and 13 calendar months following the previous performance test). The performance test must be conducted using the test methods, averaging methods, and minimum sampling volumes or durations specified in Table 1 or 2 to this subpart and according to the testing, monitoring, and calibration requirements specified in § 60.4900(a).

(1) You may conduct a repeat performance test at any time to establish new values for the operating limits to apply from that point forward. The Administrator may request a repeat performance test at any time.

(2) You must repeat the performance test within 60 days of a process change, as defined in § 60.4930.

(3) Except as specified in paragraphs (a)(1) and (2) of this section, you can conduct performance tests less often for a given pollutant, as specified in paragraphs (a)(3)(i) through (iii) of this section.

(i) You can conduct performance tests less often if your performance tests for the pollutant for at least 2 consecutive years show that your emissions are at or below 75 percent of the emission limit specified in Table 2 or 3 to this subpart, and there are no changes in the operation of the affected source or air pollution control equipment that could increase emissions. In this case, you do not have to conduct a performance test for that pollutant for the next 2 years. You must conduct a performance test during the third year and no more than 37 months after the previous performance test.

(ii) If your SSI unit continues to meet the emission limit for the pollutant, you may choose to conduct performance tests for the pollutant every third year if your emissions are at or below 75 percent of the emission limit, and if there are no changes in the operation of the affected source or air pollution control equipment that could increase emissions, but each such performance

test must be conducted no more than 37 months after the previous performance test.

(iii) If a performance test shows emissions exceeded 75 percent of the emission limit for a pollutant, you must conduct annual performance tests for that pollutant until all performance tests over 2 consecutive years show compliance.

(b) Demonstrate continuous compliance using a continuous emissions monitoring system or continuous automated sampling system. The option to use a continuous emissions monitoring system for hydrogen chloride, dioxins/furans, cadmium, or lead takes effect on the date a final performance specification applicable to hydrogen chloride, dioxins/furans, cadmium, or lead is published in the **Federal Register**. The option to use a continuous automated sampling system for dioxins/furans takes effect on the date a final performance specification for such a continuous automated sampling system is published in the **Federal Register**. Collect data as specified in § 60.4900(b)(6) and use the following procedures:

(1) To demonstrate continuous compliance with the carbon monoxide emission limit, you must use the carbon monoxide continuous emissions monitoring system specified in § 60.4900(b). For determining compliance with the carbon monoxide concentration limit using carbon monoxide CEMS, the correction to 7 percent oxygen does not apply during periods of startup or shutdown. Use the measured carbon monoxide concentration without correcting for oxygen concentration in averaging with other carbon monoxide concentrations (corrected to 7 percent oxygen) to determine the 24-hour average value.

(2) To demonstrate continuous compliance with the emission limits for particulate matter, hydrogen chloride, dioxins/furans (total mass basis or toxic equivalency basis), mercury, nitrogen oxides, sulfur dioxide, cadmium, and lead, you may substitute the use of a continuous monitoring system in lieu of conducting the annual performance test required in paragraph (a) of this section, as follows:

(i) You may substitute the use of a continuous emissions monitoring system for any pollutant specified in paragraph (b)(2) of this section in lieu of conducting the annual performance test for that pollutant in paragraph (a) of this section.

(ii) You may substitute the use of a continuous automated sampling system for mercury or dioxins/furans in lieu of

conducting the annual mercury or dioxin/furan performance test in paragraph (a) of this section.

(3) If you use a continuous emissions monitoring system to demonstrate compliance with an applicable emission limit in either paragraph (b)(1) or (b)(2) of this section, you must use the continuous emissions monitoring system and follow the requirements specified in § 60.4900(b). You must measure emissions according to § 60.13 to calculate 1-hour arithmetic averages, corrected to 7 percent oxygen (or carbon dioxide). You must demonstrate initial compliance using a 24-hour block average of these 1-hour arithmetic average emission concentrations, calculated using Equation 19–19 in section 12.4.1 of Method 19 of 40 CFR part 60, appendix A–7.

(4) If you use a continuous automated sampling system to demonstrate compliance with an applicable emission limit in paragraph (b)(2) of this section, you must:

(i) Use the continuous automated sampling system specified in § 60.58b(p) and (q), and measure and calculate average emissions corrected to 7 percent oxygen (or carbon dioxide) according to § 60.58b(p) and your monitoring plan.

(A) Use the procedures specified in § 60.58b(p) to calculate 24-hour averages to determine compliance with the mercury emission limit in Table 1 or 2 to this subpart.

(B) Use the procedures specified in § 60.58b(p) to calculate 2-week averages to determine compliance with the dioxin/furan emission limit (total mass basis or toxic equivalency basis) in Table 1 or 2 to this subpart.

(ii) Update your monitoring plan as specified in § 60.4880(e). For mercury continuous automated sampling systems, you must use Performance Specification 12B of appendix B of part 75 and Procedure 5 of appendix F of this part.

(5) Except as provided in paragraph (e) of this section, you must complete your periodic performance evaluations required under your monitoring plan for any continuous emissions monitoring system and continuous automated sampling systems, according to the schedule specified in your monitoring plan. If you were previously determining compliance by conducting an annual performance test (or according to the less frequent testing for a pollutant as provided in paragraph (a)(3) of this section), you must complete the initial performance evaluation required in your monitoring plan in § 60.4880 for the continuous monitoring system prior to using the continuous emissions monitoring

system to demonstrate compliance or continuous automated sampling system. Your performance evaluation must be conducted using the procedures and acceptance criteria specified in § 60.4880(a)(3).

(c) To demonstrate compliance with the dioxins/furans toxic equivalency emission limit in paragraph (a) or (b) of this section, you must determine dioxins/furans toxic equivalency as follows:

(1) Measure the concentration of each dioxin/furan tetra- through octa-chlorinated isomer emitted using EPA Method 23.

(2) For each dioxin/furan (tetra-through octa-chlorinated) isomer measured in accordance with paragraph (c)(1) of this section, multiply the isomer concentration by its corresponding toxic equivalency factor specified in Table 4 to this subpart.

(3) Sum the products calculated in accordance with paragraph (c)(2) of this section to obtain the total concentration of dioxins/furans emitted in terms of toxic equivalency.

(d) You must submit the annual compliance report specified in § 60.4915(d). You must submit the deviation report specified in § 60.4915(e) for each instance that you did not meet each emission limit in Table 1 or 2 to this subpart.

(e) If you demonstrate continuous compliance using a performance test, as specified in paragraph (a) of this section, then the provisions of this paragraph (e) apply. If a force majeure is about to occur, occurs, or has occurred for which you intend to assert a claim of force majeure, you must notify the Administrator in writing as specified in § 60.4915(g). You must conduct the performance test as soon as practicable after the force majeure occurs. The Administrator will determine whether or not to grant the extension to the performance test deadline, and will notify you in writing of approval or disapproval of the request for an extension as soon as practicable. Until an extension of the performance test deadline has been approved by the Administrator, you remain strictly subject to the requirements of this subpart.

(f) After any initial requests in § 60.4880 for alternative monitoring requirements for initial compliance, you may subsequently petition the Administrator for alternative monitoring parameters as specified in §§ 60.13(i) and 60.4880(e).

#### **§ 60.4890 How do I demonstrate continuous compliance with my operating limits?**

You must continuously monitor your operating parameters as specified in paragraph (a) of this section and meet the requirements of paragraphs (b) and (c) of this section, according to the monitoring and calibration requirements in § 60.4905. You must confirm and re-establish your operating limits as specified in paragraph (d) of this section.

(a) You must continuously monitor the operating parameters specified in paragraphs (a)(1) and (a)(2) of this section using the continuous monitoring equipment and according to the procedures specified in § 60.4905 or established in § 60.4855. To determine compliance, you must use the data averaging period specified in Table 3 to this subpart (except for alarm time of the baghouse leak detection system) unless a different averaging period is established under § 60.4855.

(1) You must demonstrate that the SSI unit meets the operating limits established according to §§ 60.4855 and 60.4870 and paragraph (d) of this section for each applicable operating parameter.

(2) You must demonstrate that the SSI unit meets the operating limit for bag leak detection systems as follows:

(i) For a bag leak detection system, you must calculate the alarm time as follows:

(A) If inspection of the fabric filter demonstrates that no corrective action is required, no alarm time is counted.

(B) If corrective action is required, each alarm time shall be counted as a minimum of 1 hour.

(C) If you take longer than 1 hour to initiate corrective action, each alarm time (*i.e.*, time that the alarm sounds) is counted as the actual amount of time taken by you to initiate corrective action.

(ii) Your maximum alarm time is equal to 5 percent of the operating time during a 6-month period, as specified in § 60.4850(c).

(b) Operation above the established maximum, below the established minimum, or outside the allowable range of the operating limits specified in paragraph (a) of this section constitutes a deviation from your operating limits established under this subpart, except during performance tests conducted to determine compliance with the emission and operating limits or to establish new operating limits. You must submit the deviation report specified in § 60.4915(e) for each instance that you did not meet one of

your operating limits established under this subpart.

(c) You must submit the annual compliance report specified in § 60.4915(d) to demonstrate continuous compliance.

(d) You must confirm your operating limits according to paragraph (d)(1) of this section or re-establish operating limits according to paragraph (d)(2) of this section. Your operating limits must be established so as to assure ongoing compliance with the emission limits. These requirements also apply to your operating requirements in your fugitive emissions monitoring plan specified in § 60.4850(d).

(1) Your operating limits must be based on operating data recorded during any performance test required in § 60.4885(a) or any performance evaluation required in § 60.4885(b)(5).

(2) You may conduct a repeat performance test at any time to establish new values for the operating limits to apply from that point forward.

**§ 60.4895 By what date must I conduct annual air pollution control device inspections and make any necessary repairs?**

(a) You must conduct an annual inspection of each air pollution control device used to comply with the emission limits, according to § 60.4900(c), no later than 12 months following the previous annual air pollution control device inspection.

(b) Within 10 operating days following an air pollution control device inspection, all necessary repairs must be completed unless you obtain written approval from the Administrator establishing a date whereby all necessary repairs of the affected SSI unit must be completed.

**Performance Testing, Monitoring, and Calibration Requirements**

**§ 60.4900 What are the performance testing, monitoring, and calibration requirements for compliance with the emission limits and standards?**

You must meet, as applicable, the performance testing requirements specified in paragraph (a) of this section, the monitoring requirements specified in paragraph (b) of this section, the air pollution control device inspections requirements specified in paragraph (c) of this section, and the bypass stack provisions specified in paragraph (d) of this section.

(a) *Performance testing requirements.*

(1) All performance tests must consist of a minimum of three test runs conducted under conditions representative of normal operations, as specified in § 60.8(c). Emissions in excess of the emission limits or standards during periods of startup, shutdown, and malfunction are considered deviations from the applicable emission limits or standards.

(2) You must document that the dry sludge burned during the performance test is representative of the sludge burned under normal operating conditions by:

(i) Maintaining a log of the quantity of sewage sludge burned during the performance test by continuously monitoring and recording the average hourly rate that sewage sludge is fed to the incinerator.

(ii) Maintaining a log of the moisture content of the sewage sludge burned during the performance test by taking grab samples of the sewage sludge fed to the incinerator for each 8 hour period that testing is conducted.

(3) All performance tests must be conducted using the test methods, minimum sampling volume, observation period, and averaging methods specified in Table 1 or 2 to this subpart.

(4) Method 1 at 40 CFR part 60, appendix A-1 must be used to select the sampling location and number of traverse points.

(5) Method 3A or 3B at 40 CFR part 60, appendix A-2 must be used for gas composition analysis, including measurement of oxygen concentration. Method 3A or 3B at 40 CFR part 60, appendix A-2 must be used simultaneously with each method.

(6) All pollutant concentrations must be adjusted to 7 percent oxygen using Equation 1 of this section:

$$C_{adj} = C_{meas} (20.9 - 7) / (20.9 - \%O_2) \quad (\text{Eq. 1})$$

Where:

$C_{adj}$  = Pollutant concentration adjusted to 7 percent oxygen.

$C_{meas}$  = Pollutant concentration measured on a dry basis.

$(20.9 - 7)$  = 20.9 percent oxygen - 7 percent oxygen (defined oxygen correction basis).

20.9 = Oxygen concentration in air, percent.

$\%O_2$  = Oxygen concentration measured on a dry basis, percent.

(7) Performance tests must be conducted and data reduced in accordance with the test methods and procedures contained in this subpart unless the Administrator does one of the following.

(i) Specifies or approves, in specific cases, the use of a method with minor changes in methodology.

(ii) Approves the use of an equivalent method.

(iii) Approves the use of an alternative method the results of which he has determined to be adequate for indicating whether a specific source is in compliance.

(iv) Waives the requirement for performance tests because you have demonstrated by other means to the Administrator's satisfaction that the affected SSI unit is in compliance with the standard.

(v) Approves shorter sampling times and smaller sample volumes when necessitated by process variables or other factors. Nothing in this paragraph is construed to abrogate the Administrator's authority to require testing under section 114 of the Clean Air Act.

(8) You must provide the Administrator at least 30 days prior notice of any performance test, except as specified under other subparts, to afford the Administrator the opportunity to have an observer present. If after 30 days notice for an initially scheduled performance test, there is a delay (due to operational problems, *etc.*) in conducting the scheduled performance test, you must notify the Administrator as soon as possible of any delay in the

original test date, either by providing at least 7 days prior notice of the rescheduled date of the performance test, or by arranging a rescheduled date with the Administrator by mutual agreement.

(9) You must provide, or cause to be provided, performance testing facilities as follows:

(i) Sampling ports adequate for the test methods applicable to the SSI unit, as follows:

(A) Constructing the air pollution control system such that volumetric flow rates and pollutant emission rates can be accurately determined by applicable test methods and procedures.

(B) Providing a stack or duct free of cyclonic flow during performance tests, as demonstrated by applicable test methods and procedures.

(ii) Safe sampling platform(s).

(iii) Safe access to sampling platform(s).

(iv) Utilities for sampling and testing equipment.

(10) Unless otherwise specified in this subpart, each performance test must consist of three separate runs using the applicable test method. Each run must be conducted for the time and under the conditions specified in the applicable standard. Compliance with each emission limit must be determined by calculating the arithmetic mean of the three runs. In the event that a sample is accidentally lost or conditions occur in which one of the three runs must be discontinued because of forced shutdown, failure of an irreplaceable portion of the sample train, extreme meteorological conditions, or other circumstances, beyond your control, compliance may, upon the Administrator's approval, be determined using the arithmetic mean of the results of the two other runs.

(11) During each test run specified in paragraph (a)(1) of this section, you must operate your sewage sludge incinerator at a minimum of 85 percent of your maximum permitted capacity.

(b) *Continuous monitor requirements.* You must meet the following requirements, as applicable, when using a continuous monitoring system to demonstrate compliance with the emission limits in Table 1 or 2 to this subpart. The option to use a continuous emissions monitoring system for hydrogen chloride, dioxins/furans, cadmium, or lead takes effect on the date a final performance specification applicable to hydrogen chloride, dioxins/furans, cadmium, or lead is published in the **Federal Register**. If you elect to use a continuous emissions monitoring system instead of conducting annual performance testing, you must meet the requirements of paragraphs (b)(1) through (b)(6) of this section. If you elect to use a continuous automated sampling system instead of conducting annual performance testing, you must meet the requirements of paragraph (b)(7) of this section. The option to use a continuous automated sampling system for dioxins/furans takes effect on the date a final performance specification for such a continuous automated sampling system is published in the **Federal Register**.

(1) You must notify the Administrator one month before starting use of the continuous monitoring system.

(2) You must notify the Administrator one month before stopping use of the continuous monitoring system, in which case you must also conduct a performance test prior to ceasing operation of the system.

(3) You must install, operate, calibrate, and maintain an instrument for continuously measuring and recording the emissions to the

atmosphere in accordance with the following:

(i) Section 60.13 of subpart A of this part.

(ii) The following performance specifications of appendix B of this part, as applicable:

(A) For particulate matter, Performance Specification 11 of appendix B of this part.

(B) For hydrogen chloride, Performance Specification 15 of appendix B of this part.

(C) For carbon monoxide, Performance Specification 4B of appendix B of this part with the modifications shown in Tables 1 and 2 to this subpart.

(D) [Reserved]

(E) For mercury, Performance Specification 12A of appendix B of this part.

(F) For nitrogen oxides, Performance Specification 2 of appendix B of this part.

(G) For sulfur dioxide, Performance Specification 2 of appendix B of this part.

(iii) For continuous emissions monitoring systems, the quality assurance procedures (e.g., quarterly accuracy determinations and daily calibration drift tests) of appendix F of this part specified in paragraphs (b)(3)(iii)(A) through (b)(3)(iii)(G) of this section. For each pollutant, the span value of the continuous emissions monitoring system is two times the applicable emission limit, expressed as a concentration.

(A) For particulate matter, Procedure 2 in appendix F of this part.

(B) For hydrogen chloride, Procedure 1 in appendix F of this part except that the Relative Accuracy Test Audit requirements of Procedure 1 shall be replaced with the validation requirements and criteria of sections 11.1.1 and 12.0 of Performance Specification 15 of appendix B of this part.

(C) For carbon monoxide, Procedure 1 in appendix F of this part.

(D) [Reserved]

(E) For mercury, Procedures 5 in appendix F of this part.

(F) For nitrogen oxides, Procedure 1 in appendix F of this part.

(G) For sulfur dioxide, Procedure 1 in appendix F of this part.

(iv) If your monitoring system has a malfunction or out-of-control period, you must complete repairs and resume operation of your monitoring system as expeditiously as possible.

(4) During each relative accuracy test run of the continuous emissions monitoring system using the performance specifications in paragraph

(b)(3)(ii) of this section, emission data for each regulated pollutant and oxygen (or carbon dioxide as established in paragraph (b)(5) of this section) must be collected concurrently (or within a 30- to 60-minute period) by both the continuous emissions monitoring systems and the test methods specified in paragraphs (b)(4)(i) through (b)(4)(viii) of this section. Relative accuracy testing must be at representative operating conditions while the SSI unit is charging sewage sludge.

(i) For particulate matter, Method 5 at 40 CFR part 60, appendix A-3 or Method 26A or 29 at 40 CFR part 60, appendix A-8 shall be used.

(ii) For hydrogen chloride, Method 26 or 26A at 40 CFR part 60, appendix A-8, shall be used as specified in Tables 2 and 3 to this subpart.

(iii) For carbon monoxide, Method 10, 10A, or 10B at 40 CFR part 60, appendix A-4, shall be used.

(iv) For dioxins/furans, Method 23 at 40 CFR part 60, appendix A-7, shall be used.

(v) For mercury, cadmium, and lead, Method 29 at 40 CFR part 60, appendix A-8 shall be used. Alternatively for mercury, Method 30B at 40 CFR part 60, appendix A-8 or ASTM D6784-02 (Reapproved 2008) (incorporated by reference, see § 60.17), may be used.

(vi) For nitrogen oxides, Method 7 or 7E at 40 CFR part 60, appendix A-4, shall be used.

(vii) For sulfur dioxide, Method 6 or 6C at 40 CFR part 60, appendix A-4, or as an alternative ANSI/ASME PTC 19.10-1981 (incorporated by reference, see § 60.17) must be used. For sources that have actual inlet emissions less than 100 parts per million dry volume, the relative accuracy criterion for inlet sulfur dioxide continuous emissions monitoring system should be no greater than 20 percent of the mean value of the method test data in terms of the units of the emission standard, or 5 parts per million dry volume absolute value of the mean difference between the method and the continuous emissions monitoring system, whichever is greater.

(viii) For oxygen (or carbon dioxide as established in (b)(5) of this section), Method 3A or 3B at 40 CFR part 60, appendix A-2, or as an alternative ANSI/ASME PTC 19.10-1981 (incorporated by reference, see § 60.17), as applicable, must be used.

(5) You may request that compliance with the emission limits be determined using carbon dioxide measurements corrected to an equivalent of 7 percent oxygen. If carbon dioxide is selected for use in diluent corrections, the relationship between oxygen and carbon

dioxide levels must be established during the initial performance test according to the procedures and methods specified in paragraphs (b)(5)(i) through (b)(5)(iv) of this section. This relationship may be re-established during subsequent performance tests.

(i) The fuel factor equation in Method 3B at 40 CFR part 60, appendix A-2 must be used to determine the relationship between oxygen and carbon dioxide at a sampling location. Method 3A or 3B at 50 CFR part 60, appendix A-2, or as an alternative ANSI/ASME PTC 19.10-1981 (incorporated by reference, see § 60.17), as applicable, must be used to determine the oxygen concentration at the same location as the carbon dioxide monitor.

(ii) Samples must be taken for at least 30 minutes in each hour.

(iii) Each sample must represent a 1-hour average.

(iv) A minimum of three runs must be performed.

(6) You must operate the continuous monitoring system and collect data with the continuous monitoring system as follows:

(i) You must collect data using the continuous monitoring system at all times the affected SSI unit is operating and at the intervals specified in paragraph (b)(6)(ii) of this section, except for periods of monitoring system malfunctions that occur during periods specified in § 60.4880(a)(7)(i), repairs associated with monitoring system malfunctions, and required monitoring system quality assurance or quality control activities (including, as applicable, calibration checks and required zero and span adjustments). Any such periods that you do not collect data using the continuous monitoring system constitute a deviation from the monitoring requirements and must be reported in a deviation report.

(ii) You must collect continuous emissions monitoring system data in accordance with § 60.13(e)(2).

(iii) Any data collected during monitoring system malfunctions, repairs associated with monitoring system malfunctions, or required monitoring system quality assurance or control activities conducted during monitoring system malfunctions must not be included in calculations used to report emissions or operating levels. Any such periods must be reported in a deviation report.

(iv) Any data collected during periods when the monitoring system is out of control as specified in § 60.4880(a)(7)(i), repairs associated with periods when the monitoring system is out of control, or required monitoring system quality

assurance or control activities conducted during out-of-control periods must not be included in calculations used to report emissions or operating levels. Any such periods that do not coincide with a monitoring system malfunction constitute a deviation from the monitoring requirements and must be reported in a deviation report.

(v) You must use all the data collected during all periods except those periods specified in paragraphs (b)(6)(iii) and (b)(6)(iv) of this section in assessing the operation of the control device and associated control system.

(7) If you elect to use a continuous automated sampling system instead of conducting annual performance testing, you must:

(i) Install, calibrate, maintain, and operate a continuous automated sampling system according to the site-specific monitoring plan developed in § 60.58b(p)(1) through (p)(6), (p)(9), (p)(10), and (q).

(ii) Collect data according to § 60.58b(p)(5) and paragraph (b)(6) of this section.

(c) *Air pollution control device inspections.* You must conduct air pollution control device inspections that include, at a minimum, the following:

(1) Inspect air pollution control device(s) for proper operation.

(2) Generally observe that the equipment is maintained in good operating condition.

(3) Develop a site-specific monitoring plan according to the requirements in § 60.4880. This requirement also applies to you if you petition the EPA Administrator for alternative monitoring parameters under § 60.13(i).

(d) *Bypass stack.* Use of the bypass stack at any time that sewage sludge is being charged to the SSI unit is an emissions standards deviation for all pollutants listed in Table 1 or 2 to this subpart. The use of the bypass stack during a performance test invalidates the performance test.

#### **§ 60.4905 What are the monitoring and calibration requirements for compliance with my operating limits?**

(a) You must install, operate, calibrate, and maintain the continuous parameter monitoring systems according to the requirements in paragraphs (a)(1) and (2) of this section.

(1) Meet the following general requirements for flow, pressure, pH, and operating temperature measurement devices:

(i) You must collect data using the continuous monitoring system at all times the affected SSI unit is operating and at the intervals specified in

paragraph (a)(1)(ii) of this section, except for periods of monitoring system malfunctions that occur during periods specified in § 60.4880(a)(7)(i), repairs associated with monitoring system malfunctions, and required monitoring system quality assurance or quality control activities (including, as applicable, calibration checks and required zero and span adjustments). Any such periods that you do not collect data using the continuous monitoring system constitute a deviation from the monitoring requirements and must be reported in a deviation report.

(ii) You must collect continuous parameter monitoring system data in accordance with § 60.13(e)(2).

(iii) Any data collected during monitoring system malfunctions, repairs associated with monitoring system malfunctions, or required monitoring system quality assurance or control activities conducted during monitoring system malfunctions must not be included in calculations used to report emissions or operating levels. Any such periods must be reported in your annual deviation report.

(iv) Any data collected during periods when the monitoring system is out of control as specified in § 60.4880(a)(7)(i), repairs associated with periods when the monitoring system is out of control, or required monitoring system quality assurance or control activities conducted during out-of-control periods must not be included in calculations used to report emissions or operating levels. Any such periods that do not coincide with a monitoring system malfunction, as defined in § 60.4930, constitute a deviation from the monitoring requirements and must be reported in a deviation report.

(v) You must use all the data collected during all periods except those periods specified in paragraphs (a)(1)(iii) and (a)(1)(iv) of this section in assessing the operation of the control device and associated control system.

(vi) Record the results of each inspection, calibration, and validation check.

(2) Operate and maintain your continuous monitoring system according to your monitoring plan required under § 60.4880. Additionally:

(i) For carrier gas flow rate monitors (for activated carbon injection), during the performance test conducted pursuant to § 60.4885, you must demonstrate that the system is maintained within  $\pm 5$  percent accuracy, according to the procedures in appendix A to part 75 of this chapter.

(ii) For carrier gas pressure drop monitors (for activated carbon

injection), during the performance test conducted pursuant to § 60.4885, you must demonstrate that the system is maintained within  $\pm 5$  percent accuracy.

(b) You must operate and maintain your bag leak detection system in continuous operation according to your monitoring plan required under § 60.4880. Additionally:

(1) For positive pressure fabric filter systems that do not duct all compartments of cells to a common stack, a bag leak detection system must be installed in each baghouse compartment or cell.

(2) Where multiple bag leak detectors are required, the system's instrumentation and alarm may be shared among detectors.

(3) You must initiate procedures to determine the cause of every alarm within 8 hours of the alarm, and you must alleviate the cause of the alarm within 24 hours of the alarm by taking whatever corrective action(s) are necessary. Corrective actions may include, but are not limited to the following:

(i) Inspecting the fabric filter for air leaks, torn or broken bags or filter media, or any other condition that may cause an increase in particulate matter emissions.

(ii) Sealing off defective bags or filter media.

(iii) Replacing defective bags or filter media or otherwise repairing the control device.

(iv) Sealing off a defective fabric filter compartment.

(v) Cleaning the bag leak detection system probe or otherwise repairing the bag leak detection system.

(vi) Shutting down the process producing the particulate matter emissions.

(c) You must operate and maintain the continuous parameter monitoring systems specified in paragraphs (a) and (b) of this section in continuous operation according to your monitoring plan required under § 60.4880.

(d) If your SSI unit has a bypass stack, you must install, calibrate (to manufacturers' specifications), maintain, and operate a device or method for measuring the use of the bypass stack including date, time, and duration.

### Recordkeeping and Reporting

#### § 60.4910 What records must I keep?

You must maintain the items (as applicable) specified in paragraphs (a) through (n) of this section for a period of at least 5 years. All records must be available on site in either paper

copy or computer-readable format that can be printed upon request, unless an alternative format is approved by the Administrator.

(a) *Date*. Calendar date of each record.

(b) *Siting*. All documentation produced as a result of the siting requirements of §§ 60.4800 and 60.4805.

(c) *Operator Training*. Documentation of the operator training procedures and records specified in paragraphs (c)(1) through (c)(4) of this section. You must make available and readily accessible at the facility at all times for all SSI unit operators the documentation specified in paragraph (c)(1) of this section.

(1) Documentation of the following operator training procedures and information:

(i) Summary of the applicable standards under this subpart.

(ii) Procedures for receiving, handling, and feeding sewage sludge.

(iii) Incinerator startup, shutdown, and malfunction preventative and corrective procedures.

(iv) Procedures for maintaining proper combustion air supply levels.

(v) Procedures for operating the incinerator and associated air pollution control systems within the standards established under this subpart.

(vi) Monitoring procedures for demonstrating compliance with the incinerator operating limits.

(vii) Reporting and recordkeeping procedures.

(viii) Procedures for handling ash.

(ix) A list of the materials burned during the performance test, if in addition to sewage sludge.

(x) For each qualified operator and other plant personnel who may operate the unit according to the provisions of § 60.4835(a), the phone and/or pager number at which they can be reached during operating hours.

(2) Records showing the names of SSI unit operators and other plant personnel who may operate the unit according to the provisions of § 60.4835(a), as follows:

(i) Records showing the names of SSI unit operators and other plant personnel who have completed review of the information in paragraph (c)(1) of this section as required by § 60.4840(b), including the date of the initial review and all subsequent annual reviews.

(ii) Records showing the names of the SSI operators who have completed the operator training requirements under § 60.4810, met the criteria for qualification under § 60.4820, and maintained or renewed their qualification under § 60.4825 or § 60.4830. Records must include documentation of training, including the dates of their initial qualification

and all subsequent renewals of such qualifications.

(3) Records showing the periods when no qualified operators were accessible for more than 8 hours, but less than 2 weeks, as required in § 60.4835(a).

(4) Records showing the periods when no qualified operators were accessible for 2 weeks or more along with copies of reports submitted as required in § 60.4835(b).

(d) *Air pollution control device inspections*. Records of the results of initial and annual air pollution control device inspections conducted as specified in §§ 60.4875 and 60.4900(c), including any required maintenance and any repairs not completed within 10 days of an inspection or the timeframe established by the Administrator.

(e) *Performance test reports*.

(1) The results of the initial, annual, and any subsequent performance tests conducted to determine compliance with the emission limits and standards and/or to establish operating limits, as applicable.

(2) Retain a copy of the complete performance test report, including calculations.

(3) Keep a record of the hourly dry sludge feed rate measured during performance test runs, as specified in § 60.4900(a)(2)(i).

(4) Keep any necessary records to demonstrate that the performance test was conducted under conditions representative of normal operations, including a record of the moisture content measured as required in § 60.4900(a)(2)(ii) for each grab sample taken of the sewage sludge burned during the performance test.

(f) *Continuous monitoring data*. Records of the following data, as applicable:

(1) For continuous emissions monitoring systems, all 1-hour average concentrations of particulate matter, hydrogen chloride, carbon monoxide, dioxins/furans total mass basis, mercury, nitrogen oxides, sulfur dioxide, cadmium, and lead emissions.

(2) For continuous automated sampling systems, all average concentrations measured for mercury and dioxins/furans total mass basis at the frequencies specified in your monitoring plan.

(3) For continuous parameter monitoring systems:

(i) All 1-hour average values recorded for the following operating parameters, as applicable:

(A) Combustion chamber operating temperature (or afterburner temperature).

(B) If a wet scrubber is used to comply with the rule, pressure drop across each wet scrubber system, liquid flow rate to each wet scrubber used to comply with the emission limit in Table 1 or 2 to this subpart for particulate matter, cadmium, or lead, and scrubber liquid flow rate and scrubber liquid pH for each wet scrubber used to comply with an emission limit in Table 1 or 2 to this subpart for sulfur dioxide or hydrogen chloride.

(C) If an electrostatic precipitator is used to comply with the rule, secondary voltage and secondary amperage of the electrostatic precipitator collection plates, and effluent water flow rate at the outlet of the wet electrostatic precipitator.

(D) If activated carbon injection is used to comply with the rule, sorbent flow rate and carrier gas flow rate or pressure drop, as applicable.

(ii) All daily average values recorded for the feed rate and moisture content of the sewage sludge fed to the sewage sludge incinerator, monitored and calculated as specified in § 60.4850(f).

(iii) If a fabric filter is used to comply with the rule, the date, time, and duration of each alarm and the time corrective action was initiated and completed, and a brief description of the cause of the alarm and the corrective action taken. You must also record the percent of operating time during each 6-month period that the alarm sounds, calculated as specified in § 60.4890.

(iv) For other control devices for which you must establish operating limits under § 60.4855, you must maintain data collected for all operating parameters used to determine compliance with the operating limits, at the frequencies specified in your monitoring plan.

(g) *Other records for continuous monitoring systems.* You must keep the following records, as applicable:

(1) Keep records of any notifications to the Administrator in § 60.4915(h)(1) of starting or stopping use of a continuous monitoring system for determining compliance with any emissions limit.

(2) Keep records of any requests under § 60.4900(b)(5) that compliance with the emission limits be determined using carbon dioxide measurements corrected to an equivalent of 7 percent oxygen.

(3) If activated carbon injection is used to comply with the rule, the type of sorbent used and any changes in the type of sorbent used.

(h) *Deviation Reports.* Records of any deviation reports submitted under § 60.4915(e) and (f).

(i) *Equipment specifications and operation and maintenance*

*requirements.* Equipment specifications and related operation and maintenance requirements received from vendors for the incinerator, emission controls, and monitoring equipment.

(j) *Inspections, calibrations, and validation checks of monitoring devices.* Records of inspections, calibrations, and validations checks of any monitoring devices as required under §§ 60.4900 and 60.4905.

(k) *Monitoring plan and performance evaluations for continuous monitoring systems.* Records of the monitoring plans required under § 60.4880, and records of performance evaluations required under § 60.4885(b)(5).

(l) *Less frequent testing.* If, consistent with 60.4885(a)(3), you elect to conduct performance tests less frequently than annually, you must keep annual records that document that your emissions in the 2 previous consecutive years were at or below 75 percent of the applicable emission limit in Table 1 or 2 to this subpart, and document that there were no changes in source operations or air pollution control equipment that would cause emissions of the relevant pollutant to increase within the past 2 years.

(m) *Use of bypass stack.* Records indicating use of the bypass stack, including dates, times, and durations as required under § 60.4905(d).

(n) If a malfunction occurs, you must keep a record of the information submitted in your annual report in § 60.4915(d)(16).

#### **§ 60.4915 What reports must I submit?**

You must submit the reports specified in paragraphs (a) through (j) of this section. See Table 5 to this subpart for a summary of these reports.

(a) *Notification of construction.* You must submit a notification prior to commencing construction that includes the four items listed in paragraphs (a)(1) through (a)(4) of this section:

(1) A statement of intent to construct.

(2) The anticipated date of commencement of construction.

(3) All documentation produced as a result of the siting requirements of § 60.4805.

(4) Anticipated date of initial startup.

(b) *Notification of initial startup.* You must submit the information specified in paragraphs (b)(1) through (b)(5) of this section prior to initial startup:

(1) The maximum design dry sludge burning capacity.

(2) The anticipated and permitted maximum dry sludge feed rate.

(3) If applicable, the petition for site-specific operating limits specified in § 60.4855.

(4) The anticipated date of initial startup.

(5) The site-specific monitoring plan required under § 60.4880, at least 60 days before your initial performance evaluation of your continuous monitoring system.

(6) The site-specific monitoring plan for your ash handling system required under § 60.4880, at least 60 days before your initial performance test to demonstrate compliance with your fugitive ash emission limit.

(c) *Initial compliance report.* You must submit the following information no later than 60 days following the initial performance test.

(1) Company name, physical address, and mailing address.

(2) Statement by a responsible official, with that official's name, title, and signature, certifying the accuracy of the content of the report.

(3) Date of report.

(4) The complete test report for the initial performance test results obtained by using the test methods specified in Table 1 or 2 to this subpart.

(5) If an initial performance evaluation of a continuous monitoring system was conducted, the results of that initial performance evaluation.

(6) The values for the site-specific operating limits established pursuant to §§ 60.4850 and 60.4855 and the calculations and methods, as applicable, used to establish each operating limit.

(7) If you are using a fabric filter to comply with the emission limits, documentation that a bag leak detection system has been installed and is being operated, calibrated, and maintained as required by § 60.4850(b).

(8) The results of the initial air pollution control device inspection required in § 60.4875, including a description of repairs.

(d) *Annual compliance report.* You must submit an annual compliance report that includes the items listed in paragraphs (d)(1) through (d)(16) of this section for the reporting period specified in paragraph (d)(3) of this section. You must submit your first annual compliance report no later than 12 months following the submission of the initial compliance report in paragraph (c) of this section. You must submit subsequent annual compliance reports no more than 12 months following the previous annual compliance report. (You may be required to submit these reports (or additional compliance information) more frequently by the title V operating permit required in § 60.4920.)

(1) Company name, physical address, and mailing address.

(2) Statement by a responsible official, with that official's name, title, and

signature, certifying the accuracy of the content of the report.

(3) Date of report and beginning and ending dates of the reporting period.

(4) If a performance test was conducted during the reporting period, the results of that performance test.

(i) If operating limits were established during the performance test, include the value for each operating limit and, as applicable, the method used to establish each operating limit, including calculations.

(ii) If activated carbon is used during the performance test, include the type of activated carbon used.

(5) For each pollutant and operating parameter recorded using a continuous monitoring system, the highest average value and lowest average value recorded during the reporting period, as follows:

(i) For continuous emission monitoring systems and continuous automated sampling systems, report the highest and lowest 24-hour average emission value.

(ii) For continuous parameter monitoring systems, report the following values:

(A) For all operating parameters except scrubber liquid pH, the highest and lowest 12-hour average values.

(B) For scrubber liquid pH, the highest and lowest 3-hour average values.

(6) If there are no deviations during the reporting period from any emission limit, emission standard, or operating limit that applies to you, a statement that there were no deviations from the emission limits, emission standard, or operating limits.

(7) Information for bag leak detection systems recorded under § 60.4910(f)(3)(iii).

(8) If a performance evaluation of a continuous monitoring system was conducted, the results of that performance evaluation. If new operating limits were established during the performance evaluation, include your calculations for establishing those operating limits.

(9) If you elect to conduct performance tests less frequently as allowed in § 60.4885(a)(3) and did not conduct a performance test during the reporting period, you must include the dates of the last two performance tests, a comparison of the emission level you achieved in the last two performance tests to the 75 percent emission limit threshold specified in § 60.4885(a)(3), and a statement as to whether there have been any process changes and whether the process change resulted in an increase in emissions.

(10) Documentation of periods when all qualified SSI unit operators were

unavailable for more than 8 hours, but less than 2 weeks.

(11) Results of annual air pollution control device inspections recorded under § 60.4910(d) for the reporting period, including a description of repairs.

(12) If there were no periods during the reporting period when your continuous monitoring systems had a malfunction, a statement that there were no periods during which your continuous monitoring systems had a malfunction.

(13) If there were no periods during the reporting period when a continuous monitoring system was out of control, a statement that there were no periods during which your continuous monitoring system was out of control.

(14) If there were no operator training deviations, a statement that there were no such deviations during the reporting period.

(15) If you did not make revisions to your site-specific monitoring plan during the reporting period, a statement that you did not make any revisions to your site-specific monitoring plan during the reporting period. If you made revisions to your site-specific monitoring plan during the reporting period, a copy of the revised plan.

(16) If you had a malfunction during the reporting period, the compliance report must include the number, duration, and a brief description for each type of malfunction that occurred during the reporting period and that caused or may have caused any applicable emission limitation to be exceeded. The report must also include a description of actions taken by an owner or operator during a malfunction of an affected source to minimize emissions in accordance with § 60.11(d), including actions taken to correct a malfunction.

(e) *Deviation reports.*

(1) You must submit a deviation report if:

(i) Any recorded operating parameter level, based on the averaging time specified in Table 3 to this subpart, is above the maximum operating limit or below the minimum operating limit established under this subpart.

(ii) The bag leak detection system alarm sounds for more than 5 percent of the operating time for the 6-month reporting period.

(iii) Any recorded 24-hour block average emissions level is above the emission limit, if a continuous monitoring system is used to comply with an emission limit.

(iv) There are visible emissions of combustion ash from an ash conveying

system for more than 5 percent of the hourly observation period.

(v) A performance test was conducted that deviated from any emission limit in Table 1 or 2 to this subpart.

(vi) A continuous monitoring system was out of control.

(vii) You had a malfunction (*e.g.*, continuous monitoring system malfunction) that caused or may have caused any applicable emission limit to be exceeded.

(2) The deviation report must be submitted by August 1 of that year for data collected during the first half of the calendar year (January 1 to June 30), and by February 1 of the following year for data you collected during the second half of the calendar year (July 1 to December 31).

(3) For each deviation where you are using a continuous monitoring system to comply with an associated emission limit or operating limit, report the items described in paragraphs (e)(3)(i) through (e)(3)(viii) of this section.

(i) Company name, physical address, and mailing address.

(ii) Statement by a responsible official, with that official's name, title, and signature, certifying the accuracy of the content of the report.

(iii) The calendar dates and times your unit deviated from the emission limits, emission standards, or operating limits requirements.

(iv) The averaged and recorded data for those dates.

(v) Duration and cause of each deviation from the following:

(A) Emission limits, emission standards, operating limits, and your corrective actions.

(B) Bypass events and your corrective actions.

(vi) Dates, times, and causes for monitor downtime incidents.

(vii) A copy of the operating parameter monitoring data during each deviation and any test report that documents the emission levels.

(viii) If there were periods during which the continuous monitoring system malfunctioned or was out of control, you must include the following information for each deviation from an emission limit or operating limit:

(A) The date and time that each malfunction started and stopped.

(B) The date, time, and duration that each continuous monitoring system was inoperative, except for zero (low-level) and high-level checks.

(C) The date, time, and duration that each continuous monitoring system was out of control, including start and end dates and hours and descriptions of corrective actions taken.

(D) The date and time that each deviation started and stopped, and

whether each deviation occurred during a period of malfunction, during a period when the system as out of control, or during another period.

(E) A summary of the total duration of the deviation during the reporting period, and the total duration as a percent of the total source operating time during that reporting period.

(F) A breakdown of the total duration of the deviations during the reporting period into those that are due to control equipment problems, process problems, other known causes, and other unknown causes.

(G) A summary of the total duration of continuous monitoring system downtime during the reporting period, and the total duration of continuous monitoring system downtime as a percent of the total operating time of the SSI unit at which the continuous monitoring system downtime occurred during that reporting period.

(H) An identification of each parameter and pollutant that was monitored at the SSI unit.

(I) A brief description of the SSI unit.

(J) A brief description of the continuous monitoring system.

(K) The date of the latest continuous monitoring system certification or audit.

(L) A description of any changes in continuous monitoring system, processes, or controls since the last reporting period.

(4) For each deviation where you are not using a continuous monitoring system to comply with the associated emission limit or operating limit, report the following items:

(i) Company name, physical address, and mailing address.

(ii) Statement by a responsible official with that official's name, title, and signature, certifying the accuracy of the content of the report.

(iii) The total operating time of each affected SSI during the reporting period.

(iv) The calendar dates and times your unit deviated from the emission limits, emission standards, or operating limits requirements.

(v) The averaged and recorded data for those dates.

(vi) Duration and cause of each deviation from the following:

(A) Emission limits, emission standard, and operating limits, and your corrective actions.

(B) Bypass events and your corrective actions.

(vii) A copy of any performance test report that showed a deviation from the emission limits or standard.

(viii) A brief description of any malfunction reported in paragraph (e)(1)(vii) of this section, including a description of actions taken during the

malfunction to minimize emissions in accordance with 60.11(d) and to correct the malfunction.

(f) *Qualified operator deviation.*

(1) If all qualified operators are not accessible for 2 weeks or more, you must take the two actions in paragraphs (f)(1)(i) and (f)(1)(ii) of this section.

(i) Submit a notification of the deviation within 10 days that includes the three items in paragraphs (f)(1)(i)(A) through (f)(1)(i)(C) of this section.

(A) A statement of what caused the deviation.

(B) A description of actions taken to ensure that a qualified operator is accessible.

(C) The date when you anticipate that a qualified operator will be available.

(ii) Submit a status report to the Administrator every 4 weeks that includes the three items in paragraphs (f)(1)(ii)(A) through (f)(1)(ii)(C) of this section.

(A) A description of actions taken to ensure that a qualified operator is accessible.

(B) The date when you anticipate that a qualified operator will be accessible.

(C) Request for approval from the Administrator to continue operation of the SSI unit.

(2) If your unit was shut down by the Administrator, under the provisions of § 60.4835(b)(2)(i), due to a failure to provide an accessible qualified operator, you must notify the Administrator within 5 days of meeting § 60.4835(b)(2)(ii) that you are resuming operation.

(g) *Notification of a force majeure.* If a force majeure is about to occur, occurs, or has occurred for which you intend to assert a claim of force majeure:

(1) You must notify the Administrator, in writing as soon as practicable following the date you first knew, or through due diligence should have known that the event may cause or caused a delay in conducting a performance test beyond the regulatory deadline, but the notification must occur before the performance test deadline unless the initial force majeure or a subsequent force majeure event delays the notice, and in such cases, the notification must occur as soon as practicable.

(2) You must provide to the Administrator a written description of the force majeure event and a rationale for attributing the delay in conducting the performance test beyond the regulatory deadline to the force majeure; describe the measures taken or to be taken to minimize the delay; and identify a date by which you propose to conduct the performance test.

(h) *Other notifications and reports required.* You must submit other notifications as provided by § 60.7 and as follows:

(1) You must notify the Administrator 1 month before starting or stopping use of a continuous monitoring system for determining compliance with any emission limit.

(2) You must notify the Administrator at least 30 days prior to any performance test conducted to comply with the provisions of this subpart, to afford the Administrator the opportunity to have an observer present.

(3) As specified in § 60.4900(a)(8), you must notify the Administrator at least 7 days prior to the date of a rescheduled performance test for which notification was previously made in paragraph (h)(2) of this section.

(i) *Report submission form.*

(1) Submit initial, annual, and deviation reports electronically or in paper format, postmarked on or before the submittal due dates.

(2) As of January 1, 2012 and within 60 days after the date of completing each performance test, as defined in § 63.2, conducted to demonstrate compliance with this subpart, you must submit relative accuracy test audit (*i.e.*, reference method) data and performance test (*i.e.*, compliance test) data, except opacity data, electronically to EPA's Central Data Exchange (CDX) by using the Electronic Reporting Tool (ERT) (*see* [http://www.epa.gov/ttn/chief/ert/ert\\_tool.html/](http://www.epa.gov/ttn/chief/ert/ert_tool.html/)) or other compatible electronic spreadsheet. Only data collected using test methods compatible with ERT are subject to this requirement to be submitted electronically into EPA's WebFIRE database.

(j) *Changing report dates.* If the Administrator agrees, you may change the semi-annual or annual reporting dates. See § 60.19(c) for procedures to seek approval to change your reporting date.

## Title V Operating Permits

### § 60.4920 Am I required to apply for and obtain a title V operating permit for my unit?

Yes, if you are subject to this subpart, you are required to apply for and obtain a Title V operating permit unless you meet the relevant requirements for an exemption specified in § 60.4780.

### § 60.4925 When must I submit a title V permit application for my new SSI unit?

(a) If your new SSI unit subject to this subpart is not subject to an earlier permit application deadline, a complete Title V permit application must be submitted on or before one of the dates specified in paragraph (a)(1) or (a)(2) of

this section. (See section 503(c) of the Clean Air Act and 40 CFR 70.5(a)(1)(i) and 40 CFR 71.5(a)(1)(i)).

(1) For a SSI unit that commenced operation as a new SSI unit as of March 21, 2011, then a complete title V permit application must be submitted not later than March 21, 2012.

(2) For a SSI unit that does not commence operation as a new SSI unit until after March 21, 2011, then a complete title V permit application must be submitted not later than 12 months after the date the unit commences operation as a new source.

(b) If your new SSI unit subject to this subpart is subject to title V as a result of some triggering requirement(s) other than this subpart (for example, a unit subject to this subpart may be a major source or part of a major source), then your unit may be required to apply for a title V permit prior to the deadlines specified in paragraph (a) of this section. If more than one requirement triggers a source's obligation to apply for a title V permit, the 12-month timeframe for filing a title V permit application is triggered by the requirement that first causes the source to be subject to title V. (See section 503(c) of the Clean Air Act and 40 CFR 70.3(a) and (b), 40 CFR 70.5(a)(1)(i), 40 CFR 71.3(a) and (b), and 40 CFR 71.5(a)(1)(i).)

(c) A "complete" title V permit application is one that has been determined or deemed complete by the relevant permitting authority under section 503(d) of the Clean Air Act and 40 CFR 70.5(a)(2) or 40 CFR 71.5(a)(2). You must submit a complete permit application by the relevant application deadline in order to operate after this date in compliance with Federal law. (See sections 503(d) and 502(a) of the Clean Air Act and 40 CFR 70.7(b) and 40 CFR 71.7(b).)

## Definitions

### § 60.4930 What definitions must I know?

Terms used but not defined in this subpart are defined in the Clean Air Act and § 60.2.

*Affected source* means a sewage sludge incineration unit as defined in § 60.4930.

*Affirmative defense* means, in the context of an enforcement proceeding, a response or defense put forward by a defendant, regarding which the defendant has the burden of proof, and the merits of which are independently and objectively evaluated in a judicial or administrative proceeding.

*Auxiliary fuel* means natural gas, liquefied petroleum gas, fuel oil, or diesel fuel.

*Bag leak detection system* means an instrument that is capable of monitoring

particulate matter loadings in the exhaust of a fabric filter (*i.e.*, baghouse) in order to detect bag failures. A bag leak detection system includes, but is not limited to, an instrument that operates on triboelectric, light scattering, light transmittance, or other principle to monitor relative particulate matter loadings.

*Bypass stack* means a device used for discharging combustion gases to avoid severe damage to the air pollution control device or other equipment.

*Calendar year* means 365 consecutive days starting on January 1 and ending on December 31.

*Continuous automated sampling system* means the total equipment and procedures for automated sample collection and sample recovery/analysis to determine a pollutant concentration or emission rate by collecting a single integrated sample(s) or multiple integrated sample(s) of the pollutant (or diluent gas) for subsequent on- or off-site analysis; integrated sample(s) collected are representative of the emissions for the sample time as specified by the applicable requirement.

*Continuous emissions monitoring system* means a monitoring system for continuously measuring and recording the emissions of a pollutant from an affected facility.

*Continuous monitoring system (CMS)* means a continuous emissions monitoring system, continuous automated sampling system, continuous parameter monitoring system, or other manual or automatic monitoring that is used for demonstrating compliance with an applicable regulation on a continuous basis as defined by this subpart. The term refers to the total equipment used to sample and condition (if applicable), to analyze, and to provide a permanent record of emissions or process parameters.

*Continuous parameter monitoring system* means a monitoring system for continuously measuring and recording operating conditions associated with air pollution control device systems (*e.g.*, operating temperature, pressure, and power).

*Deviation* means any instance in which an affected source subject to this subpart, or an owner or operator of such a source:

(1) Fails to meet any requirement or obligation established by this subpart, including but not limited to any emission limit, operating limit, or operator qualification and accessibility requirements.

(2) Fails to meet any term or condition that is adopted to implement an applicable requirement in this subpart and that is included in the operating

permit for any affected source required to obtain such a permit.

*Dioxins/furans* means tetra- through octachlorinated dibenzo-p-dioxins and dibenzofurans.

*Electrostatic precipitator or wet electrostatic precipitator* means an air pollution control device that uses both electrical forces and, if applicable, water to remove pollutants in the exit gas from a sewage sludge incinerator stack.

*Existing sewage sludge incineration unit* means a sewage sludge incineration unit the construction of which is commenced on or before October 14, 2010.

*Fabric filter* means an add-on air pollution control device used to capture particulate matter by filtering gas streams through filter media, also known as a baghouse.

*Fluidized bed incinerator* means an enclosed device in which organic matter and inorganic matter in sewage sludge are combusted in a bed of particles suspended in the combustion chamber gas.

*Malfunction* means any sudden, infrequent, and not reasonably preventable failure of air pollution control and monitoring equipment, process equipment, or a process to operate in a normal or usual manner. Failures that are caused, in part, by poor maintenance or careless operation are not malfunctions.

*Modification* means a change to an existing SSI unit later than September 21, 2011 and that meets one of two criteria:

(1) The cumulative cost of the changes over the life of the unit exceeds 50 percent of the original cost of building and installing the SSI unit (not including the cost of land) updated to current costs (current dollars). To determine what systems are within the boundary of the SSI unit used to calculate these costs, see the definition of SSI unit.

(2) Any physical change in the SSI unit or change in the method of operating it that increases the amount of any air pollutant emitted for which section 129 or section 111 of the Clean Air Act has established standards.

*Modified sewage sludge incineration (SSI) unit* means an existing SSI unit that undergoes a modification, as defined in this section.

*Multiple hearth incinerator* means a circular steel furnace that contains a number of solid refractory hearths and a central rotating shaft; rabble arms that are designed to slowly rake the sludge on the hearth are attached to the rotating shaft. Dewatered sludge enters at the top and proceeds downward through the

furnace from hearth to hearth, pushed along by the rabble arms.

*New sewage sludge incineration unit* means a SSI unit the construction of which is commenced after October 14, 2010 which would be applicable to such unit or a modified solid waste incineration unit.

*Operating day* means a 24-hour period between 12:00 midnight and the following midnight during which any amount of sewage sludge is combusted at any time in the SSI unit.

*Particulate matter* means filterable particulate matter emitted from SSI units as measured by Method 5 at 40 CFR part 60, appendix A-3 or Methods 26A or 29 at 40 CFR part 60, appendix A-8.

*Power input to the electrostatic precipitator* means the product of the test-run average secondary voltage and the test-run average secondary amperage to the electrostatic precipitator collection plates.

*Process change* means a significant permit revision, but only with respect to those pollutant-specific emission units for which the proposed permit revision is applicable, including but not limited to:

(1) A change in the process employed at the wastewater treatment facility associated with the affected SSI unit (e.g., the addition of tertiary treatment at the facility, which changes the method used for disposing of process solids and processing of the sludge prior to incineration).

(2) A change in the air pollution control devices used to comply with the emission limits for the affected SSI unit (e.g., change in the sorbent used for activated carbon injection).

*Sewage sludge* means solid, semi-solid, or liquid residue generated during

the treatment of domestic sewage in a treatment works. Sewage sludge includes, but is not limited to, domestic septage; scum or solids removed in primary, secondary, or advanced wastewater treatment processes; and a material derived from sewage sludge. Sewage sludge does not include ash generated during the firing of sewage sludge in a sewage sludge incineration unit or grit and screenings generated during preliminary treatment of domestic sewage in a treatment works.

*Sewage sludge feed rate* means the rate at which sewage sludge is fed into the incinerator unit.

*Sewage sludge incineration (SSI) unit* means an incineration unit combusting sewage sludge for the purpose of reducing the volume of the sewage sludge by removing combustible matter. Sewage sludge incineration unit designs include fluidized bed and multiple hearth. A SSI unit also includes, but is not limited to, the sewage sludge feed system, auxiliary fuel feed system, grate system, flue gas system, waste heat recovery equipment, if any, and bottom ash system. The SSI unit includes all ash handling systems connected to the bottom ash handling system. The combustion unit bottom ash system ends at the truck loading station or similar equipment that transfers the ash to final disposal. The SSI unit does not include air pollution control equipment or the stack.

*Shutdown* means the period of time after all sewage sludge has been combusted in the primary chamber.

*Solid waste* means any garbage, refuse, sewage sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid, or contained

gaseous material resulting from industrial, commercial, mining, agricultural operations, and from community activities, but does not include solid or dissolved material in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial discharges which are point sources subject to permits under section 402 of the Federal Water Pollution Control Act, as amended (33 U.S.C. 1342), or source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954, as amended (42 U.S.C. 2014).

*Standard conditions*, when referring to units of measure, means a temperature of 68 °F (20 °C) and a pressure of 1 atmosphere (101.3 kilopascals).

*Startup* means the period of time between the activation, including the firing of fuels (e.g., natural gas or distillate oil), of the system and the first feed to the unit.

*Toxic equivalency* means the product of the concentration of an individual dioxin isomer in an environmental mixture and the corresponding estimate of the compound-specific toxicity relative to tetrachlorinated dibenzo-p-dioxin, referred to as the toxic equivalency factor for that compound. Table 4 to this subpart lists the toxic equivalency factors.

*Wet scrubber* means an add-on air pollution control device that utilizes an aqueous or alkaline scrubbing liquid to collect particulate matter (including nonvaporous metals and condensed organics) and/or to absorb and neutralize acid gases.

*You* means the owner or operator of a SSI unit that meets the criteria in § 60.4770.

TABLE 1 TO SUBPART LLLL OF PART 60—EMISSION LIMITS AND STANDARDS FOR NEW FLUIDIZED BED SEWAGE SLUDGE INCINERATION UNITS

For the air pollutant	You must meet this emission limit <sup>a</sup>	Using these averaging methods and minimum sampling volumes or durations	And determining compliance using this method
Particulate matter .....	9.6 milligrams per dry standard cubic meter.	3-run average (collect a minimum volume of 1 dry standard cubic meters per run).	Performance test (Method 5 at 40 CFR part 60, appendix A-3; Method 26A or Method 29 at 40 CFR part 60, appendix A-8).
Hydrogen chloride .....	0.24 parts per million by dry volume.	3-run average (Collect a minimum volume of 1 dry standard cubic meters per run).	Performance test (Method 26A at 40 CFR part 60, appendix A-8).

TABLE 1 TO SUBPART LLLL OF PART 60—EMISSION LIMITS AND STANDARDS FOR NEW FLUIDIZED BED SEWAGE SLUDGE INCINERATION UNITS—Continued

For the air pollutant	You must meet this emission limit <sup>a</sup>	Using these averaging methods and minimum sampling volumes or durations	And determining compliance using this method
Carbon monoxide .....	27 parts per million by dry volume	24-hour block average (using 1-hour averages of data). For determining compliance with the carbon monoxide concentration limit using carbon monoxide CEMS, the correction to 7 percent oxygen does not apply during periods of startup or shutdown. Use the measured carbon monoxide concentration without correcting for oxygen concentration in averaging with other carbon monoxide concentrations (corrected to 7 percent oxygen) to determine the 24-hour average value.	Continuous emissions monitoring system. (Performance Specification 4B of this part, using a low-range span of 100 ppm and a high-range span of 1000 ppm, and a RA of 0.5 ppm instead of 5 ppm specified in section 13.2. For the cylinder gas audit of Procedure 1, +/- 15% or 0.5 whichever is greater).
Dioxins/furans (total mass basis); or Dioxins/furans (toxic equivalency basis) <sup>b</sup>	0.013 nanograms per dry standard cubic meter (total mass basis); or 0.0044 nanograms per dry standard cubic meter (toxic equivalency basis).	3-run average (collect a minimum volume of 3 dry standard cubic meters per run).	Performance test (Method 23 at 40 CFR part 60, appendix A-7).
Mercury .....	0.0010 milligrams per dry standard cubic meter.	3-run average (For Method 29 and ASTM D6784-02 (Reapproved 2008), <sup>c</sup> collect a minimum volume of 3 dry standard cubic meters per run. For Method 30B, collect a minimum sample as specified in Method 30B at 40 CFR part 60, appendix A-8).	Performance test (Method 29 at 40 CFR part 60, appendix A-8; Method 30B at 40 CFR part 60, appendix A-8; or ASTM D6784-02 (Reapproved 2008). <sup>c</sup>
Oxides of nitrogen .....	30 parts per million by dry volume	3-run average (Collect sample for a minimum duration of one hour per run).	Performance test (Method 7 or 7E at 40 CFR part 60, appendix A-4).
Sulfur dioxide .....	5.3 parts per million by dry volume.	3-run average (For Method 6, collect a minimum volume of 100 liters per run. For Method 6C, sample for a minimum duration of one hour per run).	Performance test (Method 6 or 6C at 40 CFR part 40, appendix A-4; or ANSI/ASME PTC 19.10-1981. <sup>c</sup>
Cadmium .....	0.0011 milligrams per dry standard cubic meter.	3-run average (collect a minimum volume of 1 dry standard cubic meters per run).	Performance test (Method 29 at 40 CFR part 60, appendix A-8). Use GFAAS or ICP/MS for the analytical finish.
Lead .....	0.00062 milligrams per dry standard cubic meter.	3-run average (collect a minimum volume of 3 dry standard cubic meters per run).	Performance test (Method 29 at 40 CFR part 60, appendix A-8. Use GFAAS or ICP/MS for the analytical finish.
Fugitive emissions from ash handling.	Visible emissions of combustion ash from an ash conveying system (including conveyor transfer points) for no more than 5 percent of the hourly observation period.	Three 1-hour observation periods	Visible emission test (Method 22 of appendix A-7 of this part).

<sup>a</sup> All emission limits are measured at 7 percent oxygen, dry basis at standard conditions.

<sup>b</sup> You have the option to comply with either the dioxin/furan emission limit on a total mass basis or the dioxin/furan emission limit on a toxic equivalency basis.

<sup>c</sup> Incorporated by reference, see § 60.17.

TABLE 2 TO SUBPART LLLL OF PART 60—EMISSION LIMITS AND STANDARDS FOR NEW MULTIPLE HEARTH SEWAGE SLUDGE INCINERATION UNITS

For the air pollutant	You must meet this emission limit <sup>a</sup>	Using these averaging methods and minimum sampling volumes or durations	And determining compliance using this method
Particulate matter .....	60 milligrams per dry standard cubic meter.	3-run average (collect a minimum volume of 0.75 dry standard cubic meters per run).	Performance test (Method 5 at 40 CFR part 60, appendix A-3; Method 26A or Method 29 at 40 CFR part 60, appendix A-8).
Hydrogen chloride .....	1.2 parts per million by dry volume.	3-run average (For Method 26, collect a minimum volume of 200 liters per run. For Method 26A, collect a minimum volume of 1 dry standard cubic meters per run).	Performance test (Method 26 or 26A at 40 CFR part 60, appendix A-8).
Carbon monoxide .....	52 parts per million by dry volume	24-hour block average (using 1-hour averages of data).	Continuous emissions monitoring system. (Performance Specification 4B of this part, using a low-range span of 100 ppm and a high-range span of 1000 ppm, and a relative accuracy of 0.5 ppm instead of 5 ppm specified in section 13.2. For the cylinder gas audit of Procedure 1, +/- 15% or 0.5 whichever is greater).
Dioxins/furans (total mass basis); or Dioxins/furans (toxic equivalency basis) <sup>b</sup>	0.045 nanograms per dry standard cubic meter (total mass basis); or 0.0022 nanograms per dry standard cubic meter (toxic equivalency basis).	3-run average (collect a minimum volume of 3 dry standard cubic meters per run).	Performance test (Method 23 at 40 CFR part 60, appendix A-7).
Mercury .....	0.15 milligrams per dry standard cubic meter.	3-run average (For Method 29 and ASTM D6784-02 (Reapproved 2008), <sup>c</sup> collect a minimum volume of 1 dry standard cubic meters per run. For Method 30B, collect a minimum sample as specified in Method 30B at 40 CFR part 60, appendix A-8).	Performance test (Method 29 at 40 CFR part 60, appendix A-8; Method 30B at 40 CFR part 60, appendix A-8; or ASTM D6784-02 (Reapproved 2008). <sup>c</sup>
Oxides of nitrogen .....	210 parts per million by dry volume.	3-run average (Collect sample for a minimum duration of one hour per run).	Performance test (Method 7 or 7E at 40 CFR part 60, appendix A-4).
Sulfur dioxide .....	26 parts per million by dry volume	3-run average (For Method 6, collect a minimum volume of 200 liters per run. For Method 6C, collect sample for a minimum duration of one hour per run).	Performance test (Method 6 or 6C at 40 CFR part 40, appendix A-4; or ANSI/ASME PTC 19.10-1981. <sup>c</sup>
Cadmium .....	0.0024 milligrams per dry standard cubic meter.	3-run average (collect a minimum volume of 1 dry standard cubic meters per run).	Performance test (Method 29 at 40 CFR part 60, appendix A-8). Use GFAAS or ICP/MS for the analytical finish.
Lead .....	0.0035 milligrams per dry standard cubic meter.	3-run average (collect a minimum volume of 1 dry standard cubic meters per run).	Performance test (Method 29 at 40 CFR part 60, appendix A-8). Use GFAAS or ICP/MS for the analytical finish.
Fugitive emissions from ash handling.	Visible emissions of combustion ash from an ash conveying system (including conveyor transfer points) for no more than 5 percent of the hourly observation period.	Three 1-hour observation periods	Visible emission test (Method 22 of appendix A-7 of this part).

<sup>a</sup> All emission limits are measured at 7 percent oxygen, dry basis at standard conditions.

<sup>b</sup> You have the option to comply with either the dioxin/furan emission limit on a total mass basis or the dioxin/furan emission limit on a toxic equivalency basis.

<sup>c</sup> Incorporated by reference, see § 60.17.

TABLE 3 TO SUBPART LLLL OF PART 60—OPERATING PARAMETERS FOR NEW SEWAGE SLUDGE INCINERATION UNITS<sup>A</sup>

For these operating parameters	You must establish these operating limits	And monitor using these minimum frequencies		
		Data measurement	Data recording <sup>b</sup>	Data averaging period for compliance
<b>All sewage sludge incineration units</b>				
Combustion chamber operating temperature or afterburner temperature.	Minimum combustion chamber operating temperature or afterburner temperature.	Continuous .....	Every 15 minutes ...	12-hour block.
Fugitive emissions from ash handling	Site-specific operating requirements	Not applicable .....	Not applicable .....	Not applicable.
<b>Scrubber</b>				
Pressure drop across each wet scrubber.	Minimum pressure drop .....	Continuous .....	Every 15 minutes ...	12-hour block.
Scrubber liquid flow rate .....	Minimum flow rate .....	Continuous .....	Every 15 minutes ...	12-hour block.
Scrubber liquid pH .....	Minimum pH .....	Continuous .....	Every 15 minutes ...	3-hour block.
<b>Fabric Filter</b>				
Alarm time of the bag leak detection system alarm.	Maximum alarm time of the bag leak detection system alarm (this operating limit is provided in § 60.4850 and is not established on a site-specific basis).			
<b>Electrostatic precipitator</b>				
Secondary voltage of the electrostatic precipitator collection plates.	Minimum power input to the electrostatic precipitator collection plates.	Continuous .....	Hourly .....	12-hour block.
Secondary amperage of the electrostatic precipitator collection plates. Effluent water flow rate at the outlet of the electrostatic precipitator.	Minimum effluent water flow rate at the outlet of the electrostatic precipitator.	Hourly .....	Hourly .....	12-hour block.
<b>Activated carbon injection</b>				
Mercury sorbent injection rate .....	Minimum mercury sorbent injection rate.	Hourly .....	Hourly .....	12-hour block.
Dioxin/furan sorbent injection rate .....	Minimum dioxin/furan sorbent injection rate.			
Carrier gas flow rate or carrier gas pressure drop.	Minimum carrier gas flow rate or minimum carrier gas pressure drop.	Continuous .....	Every 15 minutes ...	12-hour block.

<sup>a</sup> As specified in § 60.4870, you may use a continuous emissions monitoring system or continuous automated sampling system in lieu of establishing certain operating limits.

<sup>b</sup> This recording time refers to the minimum frequency that the continuous monitor or other measuring device initially records data. For all data recorded every 15 minutes, you must calculate hourly arithmetic averages. For all parameters, you use hourly averages to calculate the 12-hour or 3-hour block average specified in this table for demonstrating compliance. You maintain records of 1-hour averages.

TABLE 4 TO SUBPART LLLL OF PART 60—TOXIC EQUIVALENCY FACTORS

Dioxin/furan isomer	Toxic equivalency factor
2,3,7,8-tetrachlorinated dibenzo-p-dioxin .....	1
1,2,3,7,8-pentachlorinated dibenzo-p-dioxin .....	1
1,2,3,4,7,8-hexachlorinated dibenzo-p-dioxin .....	0.1
1,2,3,7,8,9-hexachlorinated dibenzo-p-dioxin .....	0.1
1,2,3,6,7,8-hexachlorinated dibenzo-p-dioxin .....	0.1
1,2,3,4,6,7,8-heptachlorinated dibenzo-p-dioxin .....	0.01
octachlorinated dibenzo-p-dioxin .....	0.0003
2,3,7,8-tetrachlorinated dibenzofuran .....	0.1
2,3,4,7,8-pentachlorinated dibenzofuran .....	0.3
1,2,3,7,8-pentachlorinated dibenzofuran .....	0.03
1,2,3,4,7,8-hexachlorinated dibenzofuran .....	0.1
1,2,3,6,7,8-hexachlorinated dibenzofuran .....	0.1
1,2,3,7,8,9-hexachlorinated dibenzofuran .....	0.1
2,3,4,6,7,8-hexachlorinated dibenzofuran .....	0.1
1,2,3,4,6,7,8-heptachlorinated dibenzofuran .....	0.01
1,2,3,4,7,8,9-heptachlorinated dibenzofuran .....	0.01
octachlorinated dibenzofuran .....	0.0003

TABLE 5 TO SUBPART LLLL OF PART 60—SUMMARY OF REPORTING REQUIREMENTS FOR NEW SEWAGE SLUDGE INCINERATION UNITS<sup>A</sup>

Report	Due date	Contents	Reference
Notification of construction .....	Prior to commencing construction.	<ol style="list-style-type: none"> <li>1. Statement of intent to construct .....</li> <li>2. Anticipated date of commencement of construction.</li> <li>3. Documentation for siting requirements.</li> <li>4. Anticipated date of initial startup.</li> </ol>	§ 60.4915(a).
Notification of initial startup ....	Prior to initial startup .....	<ol style="list-style-type: none"> <li>1. Maximum design dry sewage sludge burning capacity</li> <li>2. Anticipated and permitted maximum feed rate.</li> <li>3. If applicable, the petition for site-specific operating limits.</li> <li>4. Anticipated date of initial startup.</li> <li>5. Site-specific monitoring plan.</li> <li>6. The site-specific monitoring plan for your ash handling system.</li> </ol>	§ 60.4915(b).
Initial compliance report .....	No later than 60 days following the initial performance test.	<ol style="list-style-type: none"> <li>1. Company name and address .....</li> <li>2. Statement by a responsible official, with that official's name, title, and signature, certifying the accuracy of the content of the report.</li> <li>3. Date of report.</li> <li>4. Complete test report for the initial performance test.</li> <li>5. Results of CMS<sup>b</sup> performance evaluation.</li> <li>6. The values for the site-specific operating limits and the calculations and methods, as applicable, used to establish each operating limit.</li> <li>7. Documentation of installation of bag leak detection system for fabric filter.</li> <li>8. Results of initial air pollution control device inspection, including a description of repairs.</li> </ol>	§ 60.4915(c).
Annual compliance report .....	No later than 12 months following the submission of the initial compliance report; subsequent reports are to be submitted no more than 12 months following the previous report.	<ol style="list-style-type: none"> <li>1. Company name and address .....</li> <li>2. Statement and signature by responsible official.</li> <li>3. Date and beginning and ending dates of report.</li> <li>4. If a performance test was conducted during the reporting period, the results of the test, including any new operating limits and associated calculations and the type of activated carbon used, if applicable.</li> <li>5. For each pollutant and operating parameter recorded using a CMS, the highest recorded 3-hour average and the lowest recorded 3-hour average, as applicable.</li> <li>6. If no deviations from emission limits, emission standards, or operating limits occurred, a statement that no deviations occurred.</li> <li>7. If a fabric filter is used, the date, time, and duration of alarms.</li> <li>8. If a performance evaluation of a CMS was conducted, the results, including any new operating limits and their associated calculations.</li> <li>9. If you met the requirements of § 60.4885(a)(3) and did not conduct a performance test, include the dates of the last three performance tests, a comparison to the 50 percent emission limit threshold of the emission level achieved in the last three performance tests, and a statement as to whether there have been any process changes.</li> <li>10. Documentation of periods when all qualified SSI unit operators were unavailable for more than 8 hours but less than 2 weeks.</li> <li>11. Results of annual air pollution control device inspections, including description of repairs.</li> <li>12. If there were no periods during which your CMSs had malfunctions, a statement that there were no periods during which your CMSs had malfunctions.</li> <li>13. If there were no periods during which your CMSs were out of control, a statement that there were no periods during which your CMSs were out of control.</li> <li>14. If there were no operator training deviations, a statement that there were no such deviations.</li> <li>15. Information on monitoring plan revisions, including a copy of any revised monitoring plan.</li> </ol>	§§ 60.4915(d).

TABLE 5 TO SUBPART LLLL OF PART 60—SUMMARY OF REPORTING REQUIREMENTS FOR NEW SEWAGE SLUDGE INCINERATION UNITS <sup>A</sup>—Continued

Report	Due date	Contents	Reference
Deviation report (deviations from emission limits, emission standards, or operating limits, as specified in § 60.4915(e)(1)).	By August 1 of a calendar year for data collected during the first half of the calendar year; by February 1 of a calendar year for data collected during the second half of the calendar year.	<p><i>If using a CMS:</i> 1. Company name and address .....                      2. Statement by a responsible official.                      3. The calendar dates and times your unit deviated from the emission limits or operating limits.                      4. The averaged and recorded data for those dates.                      5. Duration and cause of each deviation.                      6. Dates, times, and causes for monitor downtime incidents.                      7. A copy of the operating parameter monitoring data during each deviation and any test report that documents the emission levels.                      8. For periods of CMS malfunction or when a CMS was out of control, you must include the information specified in § 60.4915(e)(3)(viii).</p> <p><i>If not using a CMS:</i> .....                      1. Company name and address .....                      2. Statement by a responsible official.                      3. The total operating time of each affected SSI.                      4. The calendar dates and times your unit deviated from the emission limits, emission standard, or operating limits.                      5. The averaged and recorded data for those dates.                      6. Duration and cause of each deviation.                      7. A copy of any performance test report that showed a deviation from the emission limits or standards.                      8. A brief description of any malfunction, a description of actions taken during the malfunction to minimize emissions, and corrective action taken.</p>	§ 60.4915(e).
Notification of qualified operator deviation (if all qualified operators are not accessible for 2 weeks or more).	Within 10 days of deviation	1. Statement of cause of deviation .....	§ 60.4915(f).
Notification of status of qualified operator deviation.	Every 4 weeks following notification of deviation.	1. Description of actions taken to ensure that a qualified operator is accessible. 2. The date when you anticipate that a qualified operator will be accessible. 3. Request for approval to continue operation.	§ 60.4915(f).
Notification of resumed operation following shutdown (due to qualified operator deviation and as specified in § 60.4835(b)(2)(i)).	Within 5 days of obtaining a qualified operator and resuming operation.	1. Notification that you have obtained a qualified operator and are resuming operation.	§ 60.4915(f).
Notification of a force majeure	As soon as practicable following the date you first knew, or through due diligence should have known that the event may cause or caused a delay in conducting a performance test beyond the regulatory deadline; the notification must occur before the performance test deadline unless the initial force majeure or a subsequent force majeure event delays the notice, and in such cases, the notification must occur as soon as practicable.	1. Description of the force majeure event ..... 2. Rationale for attributing the delay in conducting the performance test beyond the regulatory deadline to the force majeure. 3. Description of the measures taken or to be taken to minimize the delay. 4. Identification of the date by which you propose to conduct the performance test.	§ 60.4915(g).
Notification of intent to start or stop use of a CMS.	1 month before starting or stopping use of a CMS.	1. Intent to start or stop use of a CMS .....	§ 60.4915(h).
Notification of intent to conduct a performance test.	At least 30 days prior to the performance test.	1. Intent to conduct a performance test to comply with this subpart.	
Notification of intent to conduct a rescheduled performance test.	At least 7 days prior to the date of a rescheduled performance test.	1. Intent to conduct a rescheduled performance test to comply with this subpart.	

<sup>a</sup> This table is only a summary, see the referenced sections of the rule for the complete requirements.

<sup>b</sup> CMS means continuous monitoring system.

## Subpart M—Emission Guidelines and Compliance Times for Existing Sewage Sludge Incineration Units

Sec.

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#### Introduction

##### 60.5000 What is the purpose of this subpart?

This subpart establishes emission guidelines and compliance schedules for the control of emissions from sewage sludge incineration (SSI) units. The pollutants addressed by these emission guidelines are listed in Tables 2 and 3 to this subpart. These emission guidelines are developed in accordance with sections 111(d) and 129 of the Clean Air Act and subpart B of this part. To the extent any requirement of this subpart is inconsistent with the requirements of subpart A of this part, the requirements of this subpart will apply.

##### § 60.5005 Am I affected by this subpart?

(a) If you are the Administrator of an air quality program in a state or United States protectorate with one or more SSI units that commenced construction on or before October 14, 2010, you must submit a state plan to U.S. Environmental Protection Agency (EPA) that implements the emission guidelines contained in this subpart.

(b) You must submit the state plan to EPA by March 21, 2012.

**§ 60.5010 Is a state plan required for all states?**

No. You are not required to submit a state plan if there are no SSI units for which construction commenced on or before October 14, 2010 in your state, and you submit a negative declaration letter in place of the state plan.

**§ 60.5015 What must I include in my state plan?**

(a) You must include the nine items described in paragraphs (a)(1) through (a)(9) of this section in your state plan.

(1) Inventory of affected SSI units, including those that have ceased operation but have not been dismantled.

(2) Inventory of emissions from affected SSI units in your state.

(3) Compliance schedules for each affected SSI unit.

(4) Emission limits, emission standards, operator training and qualification requirements, and operating limits for affected SSI units that are at least as protective as the emission guidelines contained in this subpart.

(5) Performance testing, recordkeeping, and reporting requirements.

(6) Certification that the hearing on the state plan was held, a list of witnesses and their organizational affiliations, if any, appearing at the hearing, and a brief written summary of each presentation or written submission.

(7) Provision for state progress reports to EPA.

(8) Identification of enforceable state mechanisms that you selected for implementing the emission guidelines of this subpart.

(9) Demonstration of your state's legal authority to carry out the sections 111(d) and 129 state plan.

(b) Your state plan may deviate from the format and content of the emission guidelines contained in this subpart. However, if your state plan does deviate in content, you must demonstrate that your state plan is at least as protective as the emission guidelines contained in this subpart. Your state plan must address regulatory applicability, increments of progress for retrofit, operator training and qualification, emission limits and standards, performance testing, operating limits, monitoring, and recordkeeping and reporting.

(c) You must follow the requirements of subpart B of this part (Adoption and Submittal of state plans for Designated Facilities) in your state plan.

**§ 60.5020 Is there an approval process for my state plan?**

Yes. The EPA will review your state plan according to § 60.27.

**§ 60.5025 What if my state plan is not approvable?**

If you do not submit an approvable state plan (or a negative declaration letter) by March 21, 2013, EPA will develop a Federal plan according to § 60.27 to implement the emission guidelines contained in this subpart. Owners and operators of SSI units not covered by an approved state plan must comply with the Federal plan. The Federal plan is an interim action and will be automatically withdrawn when your state plan is approved.

**§ 60.5030 Is there an approval process for a negative declaration letter?**

No. The EPA has no formal review process for negative declaration letters. Once your negative declaration letter has been received, EPA will place a copy in the public docket and publish a notice in the **Federal Register**. If, at a later date, a SSI unit for which construction commenced on or before October 14, 2010 is found in your state, the Federal plan implementing the emission guidelines contained in this subpart would automatically apply to that SSI unit until your state plan is approved.

**§ 60.5035 What compliance schedule must I include in my state plan?**

(a) For SSI units that commenced construction on or before October 14, 2010, your state plan must include compliance schedules that require SSI units to achieve final compliance as expeditiously as practicable after approval of the state plan but not later than the earlier of the two dates specified in paragraphs (a)(1) and (a)(2) of this section.

(1) March 21, 2016.

(2) Three years after the effective date of state plan approval.

(b) For compliance schedules that extend more than 1 year following the effective date of state plan approval, state plans must include dates for enforceable increments of progress as specified in § 60.5090.

**§ 60.5040 Are there any state plan requirements for this subpart that apply instead of the requirements specified in subpart B?**

Yes. Subpart B establishes general requirements for developing and processing section 111(d) state plans. This subpart applies instead of the requirements in subpart B of this part, as specified in paragraphs (a) and (b) of this section:

(a) State plans developed to implement this subpart must be as protective as the emission guidelines contained in this subpart. State plans must require all SSI units to comply by the dates specified in § 60.5035. This applies instead of the option for case-by-case less stringent emission standards and longer compliance schedules in § 60.24(f).

(b) State plans developed to implement this subpart are required to include two increments of progress for the affected SSI units. These two minimum increments are the final control plan submittal date and final compliance date in § 60.21(h)(1) and (5). This applies instead of the requirement of § 60.24(e)(1) that would require a state plan to include all five increments of progress for all SSI units.

**§ 60.5045 In lieu of a state plan submittal, are there other acceptable option(s) for a state to meet its section 111(d)/129 (b)(2) obligations?**

Yes, a state may meet its Clean Air Act section 111(d)/129 obligations by submitting an acceptable written request for delegation of the Federal plan that meets the requirements of this section. This is the only other option for a state to meet its section 111(d)/129 obligations.

(a) An acceptable Federal plan delegation request must include the following:

(1) A demonstration of adequate resources and legal authority to administer and enforce the Federal plan.

(2) The items under § 60.5015(a)(1), (a)(2), and (a)(7).

(3) Certification that the hearing on the state delegation request, similar to the hearing for a state plan submittal, was held, a list of witnesses and their organizational affiliations, if any, appearing at the hearing, and a brief written summary of each presentation or written submission.

(4) A commitment to enter into a Memorandum of Agreement with the Regional Administrator that sets forth the terms, conditions, and effective date of the delegation and that serves as the mechanism for the transfer of authority. Additional guidance and information is given in EPA's Delegation Manual, Item 7-139, Implementation and Enforcement of 111(d)(2) and 111(d)/(2)/129 (b)(3) Federal plans.

(b) A state with an already approved SSI Clean Air Act section 111(d)/129 state plan is not precluded from receiving EPA approval of a delegation request for the revised Federal plan, provided the requirements of paragraph (a) of this section are met, and at the time of the delegation request, the state

also requests withdrawal of EPA's previous state plan approval.

(c) A state's Clean Air Act section 111(d)/129 obligations are separate from its obligations under title V of the Clean Air Act.

**§ 60.5050 What authorities will not be delegated to state, local, or tribal agencies?**

The authorities that will not be delegated to state, local, or tribal agencies are specified in paragraphs (a) through (g) of this section.

(a) Approval of alternatives to the emission limits and standards in Tables 2 and 3 to this subpart and operating limits established under § 60.5175 or § 60.5190.

(b) Approval of major alternatives to test methods.

(c) Approval of major alternatives to monitoring.

(d) Approval of major alternatives to recordkeeping and reporting.

(e) The requirements in § 60.5175.

(f) The requirements in § 60.5155(b)(2).

(g) Performance test and data reduction waivers under § 60.8(b).

**§ 60.5055 Does this subpart directly affect SSI unit owners and operators in my state?**

(a) No. This subpart does not directly affect SSI unit owners and operators in your state. However, SSI unit owners and operators must comply with the state plan you develop to implement the emission guidelines contained in this subpart. States may choose to incorporate the model rule text directly in their state plan.

(b) If you do not submit an approvable plan to implement and enforce the guidelines contained in this subpart by March 21, 2012, EPA will implement and enforce a Federal plan, as provided in § 60.5025, to ensure that each unit within your state that commenced construction on or before October 14, 2010 reaches compliance with all the provisions of this subpart by the dates specified in § 60.5035.

**Applicability of State Plans**

**§ 60.5060 What SSI units must I address in my state plan?**

(a) Your state plan must address SSI units that meet all three criteria described in paragraphs (a)(1) through (3) of this section.

(1) SSI units in your state that commenced construction on or before October 14, 2010.

(2) SSI units that meet the definition of a SSI unit as defined in § 60.5250.

(3) SSI units not exempt under § 60.5065.

(b) If the owner or operator of a SSI unit makes changes that meet the

definition of modification after September 21, 2011, the SSI unit becomes subject to subpart LLLL of this part and the state plan no longer applies to that unit.

(c) If the owner or operator of a SSI unit makes physical or operational changes to a SSI unit for which construction commenced on or before September 21, 2011 primarily to comply with your state plan, subpart LLLL of this part does not apply to that unit. Such changes do not qualify as modifications under subpart LLLL of this part.

**§ 60.5065 What SSI units are exempt from my state plan?**

This subpart exempts combustion units that incinerate sewage sludge and are not located at a wastewater treatment facility designed to treat domestic sewage sludge. These units may be subject to another subpart of this part (e.g., subpart CCCC of this part). The owner or operator of such a combustion unit must notify the Administrator of an exemption claim under this section.

**Use of Model Rule**

**§ 60.5070 What is the "model rule" in this subpart?**

(a) The model rule is the portion of these emission guidelines (§§ 60.5085 through 60.5250) that addresses the regulatory requirements applicable to SSI units. The model rule provides these requirements in regulation format. You must develop a state plan that is at least as protective as the model rule. You may use the model rule language as part of your state plan. Alternative language may be used in your state plan if you demonstrate that the alternative language is at least as protective as the model rule contained in this subpart.

(b) In the model rule of §§ 60.5085 through 60.5250, "you" and "Administrator" have the meaning specified in § 60.5250.

**§ 60.5075 How does the model rule relate to the required elements of my state plan?**

Use the model rule to satisfy the state plan requirements specified in § 60.5015(a)(3) through (a)(5).

**§ 60.5080 What are the principal components of the model rule?**

The model rule contains the nine major components listed in paragraphs (a) through (i) of this section.

(a) Increments of progress toward compliance.

(b) Operator training and qualification.

(c) Emission limits, emission standards, and operating limits.

(d) Initial compliance requirements.

(e) Continuous compliance requirements.

(f) Performance testing, monitoring, and calibration requirements.

(g) Recordkeeping and reporting.

(h) Definitions.

(i) Tables.

**Model Rule—Increments of Progress**

**§ 60.5085 What are my requirements for meeting increments of progress and achieving final compliance?**

If you plan to achieve compliance more than 1 year following the effective date of state plan approval, you must meet the two increments of progress specified in paragraphs (a) and (b) of this section.

(a) Submit a final control plan.

(b) Achieve final compliance.

**§ 60.5090 When must I complete each increment of progress?**

Table 1 to this subpart specifies compliance dates for each increment of progress.

**§ 60.5095 What must I include in the notifications of achievement of increments of progress?**

Your notification of achievement of increments of progress must include the three items specified in paragraphs (a) through (c) of this section.

(a) Notification that the increment of progress has been achieved.

(b) Any items required to be submitted with each increment of progress.

(c) Signature of the owner or operator of the SSI unit.

**§ 60.5100 When must I submit the notifications of achievement of increments of progress?**

Notifications for achieving increments of progress must be postmarked no later than 10 business days after the compliance date for the increment.

**§ 60.5105 What if I do not meet an increment of progress?**

If you fail to meet an increment of progress, you must submit a notification to the Administrator postmarked within 10 business days after the date for that increment of progress in Table 1 to this subpart. You must inform the Administrator that you did not meet the increment, and you must continue to submit reports each subsequent calendar month until the increment of progress is met.

**§ 60.5110 How do I comply with the increment of progress for submittal of a control plan?**

For your control plan increment of progress, you must satisfy the two

requirements specified in paragraphs (a) and (b) of this section.

(a) Submit the final control plan that includes the four items described in paragraphs (a)(1) through (a)(4) of this section.

(1) A description of the devices for air pollution control and process changes that you will use to comply with the emission limits and standards and other requirements of this subpart.

(2) The type(s) of waste to be burned, if waste other than sewage sludge is burned in the unit.

(3) The maximum design sewage sludge burning capacity.

(4) If applicable, the petition for site-specific operating limits under § 60.5175.

(b) Maintain an onsite copy of the final control plan.

**§ 60.5115 How do I comply with the increment of progress for achieving final compliance?**

For the final compliance increment of progress, you must complete all process changes and retrofit construction of control devices, as specified in the final control plan, so that, if the affected SSI unit is brought online, all necessary process changes and air pollution control devices would operate as designed.

**§ 60.5120 What must I do if I close my SSI unit and then restart it?**

(a) If you close your SSI unit but will restart it prior to the final compliance date in your state plan, you must meet the increments of progress specified in § 60.5085.

(b) If you close your SSI unit but will restart it after your final compliance date, you must complete emission control retrofits and meet the emission limits, emission standards, and operating limits on the date your unit restarts operation.

**§ 60.5125 What must I do if I plan to permanently close my SSI unit and not restart it?**

If you plan to close your SSI unit rather than comply with the state plan, submit a closure notification, including the date of closure, to the Administrator by the date your final control plan is due.

**Model Rule—Operator Training and Qualification**

**§ 60.5130 What are the operator training and qualification requirements?**

(a) A SSI unit cannot be operated unless a fully trained and qualified SSI unit operator is accessible, either at the facility or can be at the facility within 1 hour. The trained and qualified SSI unit operator may operate the SSI unit

directly or be the direct supervisor of one or more other plant personnel who operate the unit. If all qualified SSI unit operators are temporarily not accessible, you must follow the procedures in § 60.5155.

(b) Operator training and qualification must be obtained through a state-approved program or by completing the requirements included in paragraph (c) of this section.

(c) Training must be obtained by completing an incinerator operator training course that includes, at a minimum, the three elements described in paragraphs (c)(1) through (c)(3) of this section.

(1) Training on the 10 subjects listed in paragraphs (c)(1)(i) through (c)(1)(x) of this section.

(i) Environmental concerns, including types of emissions.

(ii) Basic combustion principles, including products of combustion.

(iii) Operation of the specific type of incinerator to be used by the operator, including proper startup, sewage sludge feeding, and shutdown procedures.

(iv) Combustion controls and monitoring.

(v) Operation of air pollution control equipment and factors affecting performance (if applicable).

(vi) Inspection and maintenance of the incinerator and air pollution control devices.

(vii) Actions to prevent malfunctions or to prevent conditions that may lead to malfunctions.

(viii) Bottom and fly ash characteristics and handling procedures.

(ix) Applicable Federal, State, and local regulations, including Occupational Safety and Health Administration workplace standards.

(x) Pollution prevention.

(2) An examination designed and administered by the state-approved program.

(3) Written material covering the training course topics that may serve as reference material following completion of the course.

**§ 60.5135 When must the operator training course be completed?**

The operator training course must be completed by the later of the three dates specified in paragraphs (a) through (c) of this section.

(a) The final compliance date (Increment 2).

(b) Six months after your SSI unit startup.

(c) Six months after an employee assumes responsibility for operating the SSI unit or assumes responsibility for supervising the operation of the SSI unit.

**§ 60.5140 How do I obtain my operator qualification?**

(a) You must obtain operator qualification by completing a training course that satisfies the criteria under § 60.5130(b).

(b) Qualification is valid from the date on which the training course is completed and the operator successfully passes the examination required under § 60.5130(c)(2).

**§ 60.5145 How do I maintain my operator qualification?**

To maintain qualification, you must complete an annual review or refresher course covering, at a minimum, the five topics described in paragraphs (a) through (e) of this section.

(a) Update of regulations.

(b) Incinerator operation, including startup and shutdown procedures, sewage sludge feeding, and ash handling.

(c) Inspection and maintenance.

(d) Prevention of malfunctions or conditions that may lead to malfunction.

(e) Discussion of operating problems encountered by attendees.

**§ 60.5150 How do I renew my lapsed operator qualification?**

You must renew a lapsed operator qualification before you begin operation of a SSI unit by one of the two methods specified in paragraphs (a) and (b) of this section.

(a) For a lapse of less than 3 years, you must complete a standard annual refresher course described in § 60.5145.

(b) For a lapse of 3 years or more, you must repeat the initial qualification requirements in § 60.5140(a).

**§ 60.5155 What if all the qualified operators are temporarily not accessible?**

If a qualified operator is not at the facility and cannot be at the facility within 1 hour, you must meet the criteria specified in either paragraph (a) or (b) of this section, depending on the length of time that a qualified operator is not accessible.

(a) When a qualified operator is not accessible for more than 8 hours, the SSI unit may be operated for less than 2 weeks by other plant personnel who are familiar with the operation of the SSI unit and who have completed a review of the information specified in § 60.5160 within the past 12 months. However, you must record the period when a qualified operator was not accessible and include this deviation in the annual report as specified under § 60.5235(d).

(b) When a qualified operator is not accessible for 2 weeks or more, you must take the two actions that are

described in paragraphs (b)(1) and (b)(2) of this section.

(1) Notify the Administrator of this deviation in writing within 10 days. In the notice, state what caused this deviation, what you are doing to ensure that a qualified operator is accessible, and when you anticipate that a qualified operator will be accessible.

(2) Submit a status report to the Administrator every 4 weeks outlining what you are doing to ensure that a qualified operator is accessible, stating when you anticipate that a qualified operator will be accessible, and requesting approval from the Administrator to continue operation of the SSI unit. You must submit the first status report 4 weeks after you notify the Administrator of the deviation under paragraph (b)(1) of this section.

(i) If the Administrator notifies you that your request to continue operation of the SSI unit is disapproved, the SSI unit may continue operation for 30 days, and then must cease operation.

(ii) Operation of the unit may resume if a qualified operator is accessible as required under § 60.5130(a). You must notify the Administrator within 5 days of having resumed operations and of having a qualified operator accessible.

**§ 60.5160 What site-specific documentation is required and how often must it be reviewed by qualified operators and plant personnel?**

(a) You must maintain at the facility the documentation of the operator training procedures specified under § 60.5230(c)(1) and make the documentation readily accessible to all SSI unit operators.

(b) You must establish a program for reviewing the information listed in § 60.5230(c)(1) with each qualified incinerator operator and other plant personnel who may operate the unit according to the provisions of § 60.5155(a), according to the following schedule:

(1) The initial review of the information listed in § 60.5230(c)(1) must be conducted within 6 months after the effective date of this subpart or prior to an employee's assumption of responsibilities for operation of the SSI unit, whichever date is later.

(2) Subsequent annual reviews of the information listed in § 60.5230(c)(1) must be conducted no later than 12 months following the previous review.

**Model Rule—Emission Limits, Emission Standards, and Operating Limits and Requirements**

**§ 60.5165 What emission limits and standards must I meet and by when?**

You must meet the emission limits and standards specified in Table 2 or 3 to this subpart by the final compliance date under the approved state plan, Federal plan, or delegation, as applicable. The emission limits and standards apply at all times the unit is operating and during periods of malfunction. The emission limits and standards apply to emissions from a bypass stack or vent while sewage sludge is in the combustion chamber (*i.e.*, until the sewage sludge feed to the combustor has been cut off for a period of time not less than the sewage sludge incineration residence time).

**§ 60.5170 What operating limits and requirements must I meet and by when?**

You must meet, as applicable, the operating limits and requirements specified in paragraphs (a) through (d) and (h) of this section, according to the schedule specified in paragraph (e) of this section. The operating parameters for which you will establish operating limits for a wet scrubber, fabric filter, electrostatic precipitator, or activated carbon injection are listed in Table 4 to this subpart. You must comply with the operating requirements in paragraph (f) of this section and the requirements in paragraph (g) of this section for meeting any new operating limits, re-established in § 60.5210. The operating limits apply at all times that sewage sludge is in the combustion chamber (*i.e.*, until the sewage sludge feed to the combustor has been cut off for a period of time not less than the sewage sludge incineration residence time).

(a) You must meet a site-specific operating limit for minimum operating temperature of the combustion chamber (or afterburner combustion chamber) that you establish in § 60.5190.

(b) If you use a wet scrubber, electrostatic precipitator, activated carbon injection, or afterburner to comply with an emission limit, you must meet the site-specific operating limits that you establish in § 60.5190 for each operating parameter associated with each air pollution control device.

(c) If you use a fabric filter to comply with the emission limits, you must install the bag leak detection system specified in §§ 60.5200(b) and 60.5225(b)(3)(i) and operate the bag leak detection system such that the alarm does not sound more than 5 percent of the operating time during a 6-month

period. You must calculate the alarm time as specified in § 60.5210(a)(2)(i).

(d) You must meet the operating requirements in your site-specific fugitive emission monitoring plan, submitted as specified in § 60.5200(d) to ensure that your ash handling system will meet the emission standard for fugitive emissions from ash handling.

(e) You must meet the operating limits and requirements specified in paragraphs (a) through (d) of this section by the final compliance date under the approved state plan, Federal plan, or delegation, as applicable.

(f) You must monitor the feed rate and moisture content of the sewage sludge fed to the sewage sludge incinerator, as specified in paragraphs (f)(1) and (f)(2) of this section.

(1) Continuously monitor the sewage sludge feed rate and calculate a daily average for all hours of operation during each 24-hour period. Keep a record of the daily average feed rate, as specified in § 60.5230(f)(3)(ii).

(2) Take at least one grab sample per day of the sewage sludge fed to the sewage sludge incinerator. If you take more than one grab sample in a day, calculate the daily average for the grab samples. Keep a record of the daily average moisture content, as specified in § 60.5230(f)(3)(ii).

(g) For the operating limits and requirements specified in paragraphs (a) through (d) and (h) of this section, you must meet any new operating limits and requirements, re-established according to § 60.5210(d).

(h) If you use an air pollution control device other than a wet scrubber, fabric filter, electrostatic precipitator, or activated carbon injection to comply with the emission limits in Table 2 or 3 to this subpart, you must meet any site-specific operating limits or requirements that you establish as required in § 60.5175.

**§ 60.5175 How do I establish operating limits if I do not use a wet scrubber, fabric filter, electrostatic precipitator, activated carbon injection, or afterburner, or if I limit emissions in some other manner, to comply with the emission limits?**

If you use an air pollution control device other than a wet scrubber, fabric filter, electrostatic precipitator, activated carbon injection, or afterburner, or limit emissions in some other manner (*e.g.*, materials balance) to comply with the emission limits in § 60.5165, you must meet the requirements in paragraphs (a) and (b) of this section.

(a) Meet the applicable operating limits and requirements in § 60.4850, and establish applicable operating limits according to § 60.5190.

(b) Petition the Administrator for specific operating parameters, operating limits, and averaging periods to be established during the initial performance test and to be monitored continuously thereafter.

(1) You are responsible for submitting any supporting information in a timely manner to enable the Administrator to consider the application prior to the performance test. You must not conduct the initial performance test until after the petition has been approved by the Administrator, and you must comply with the operating limits as written, pending approval by the Administrator. Neither submittal of an application, nor the Administrator's failure to approve or disapprove the application relieves you of the responsibility to comply with any provision of this subpart.

(2) Your petition must include the five items listed in paragraphs (b)(2)(i) through (b)(2)(v) of this section.

(i) Identification of the specific parameters you propose to monitor.

(ii) A discussion of the relationship between these parameters and emissions of regulated pollutants, identifying how emissions of regulated pollutants change with changes in these parameters, and how limits on these parameters will serve to limit emissions of regulated pollutants.

(iii) A discussion of how you will establish the upper and/or lower values for these parameters that will establish the operating limits on these parameters, including a discussion of the averaging periods associated with those parameters for determining compliance.

(iv) A discussion identifying the methods you will use to measure and the instruments you will use to monitor these parameters, as well as the relative accuracy and precision of these methods and instruments.

(v) A discussion identifying the frequency and methods for recalibrating the instruments you will use for monitoring these parameters.

**§ 60.5180 Do the emission limits, emission standards, and operating limits apply during periods of startup, shutdown, and malfunction?**

The emission limits and standards apply at all times and during periods of malfunction. The operating limits apply at all times that sewage sludge is in the combustion chamber (*i.e.*, until the sewage sludge feed to the combustor has been cut off for a period of time not less than the sewage sludge incineration residence time). For determining compliance with the CO concentration limit using CO CEMS, the correction to 7 percent oxygen does not apply during

periods of startup or shutdown. Use the measured CO concentration without correcting for oxygen concentration in averaging with other CO concentrations (corrected to 7 percent O<sub>2</sub>) to determine the 24-hour average value.

**§ 60.5181 How do I establish an affirmative defense for exceedance of an emission limit or standard during malfunction?**

In response to an action to enforce the numerical emission standards set forth in paragraph § 60.5165, you may assert an affirmative defense to a claim for civil penalties for exceedances of emission limits that are caused by malfunction, as defined in § 60.2.

Appropriate penalties may be assessed however, if you fail to meet your burden of proving all of the requirements in the affirmative defense. The affirmative defense shall not be available for claims for injunctive relief.

(a) To establish the affirmative defense in any action to enforce such a limit, you must timely meet the notification requirements in paragraph (b) of this section, and must prove by a preponderance of evidence that the conditions in paragraphs (a)(1) through (a)(9) of this section are met.

(1) The excess emissions:  
(i) Were caused by a sudden, infrequent, and unavoidable failure of air pollution control and monitoring equipment, process equipment, or a process to operate in a normal or usual manner, and (ii) Could not have been prevented through careful planning, proper design or better operation and maintenance practices, and (iii) Did not stem from any activity or event that could have been foreseen and avoided, or planned for, and

(iv) Were not part of a recurring pattern indicative of inadequate design, operation, or maintenance, and

(2) Repairs were made as expeditiously as possible when the applicable emission limits were being exceeded. Off-shift and overtime labor were used, to the extent practicable to make these repairs, and (3) The frequency, amount and duration of the excess emissions (including any bypass) were minimized to the maximum extent practicable during periods of such emissions, and (4) If the excess emissions resulted from a bypass of control equipment or a process, then the bypass was unavoidable to prevent loss of life, personal injury, or severe property damage, and

(5) All possible steps were taken to minimize the impact of the excess emissions on ambient air quality, the environment and human health, and

(6) All emissions monitoring and control systems were kept in operation

if at all possible consistent with safety and good air pollution control practices, and

(7) All of the actions in response to the excess emissions were documented by properly signed, contemporaneous operating logs, and

(8) At all times, the affected facility was operated in a manner consistent with good practices for minimizing emissions, and

(9) A written root cause analysis has been prepared the purpose of which is to determine, correct, and eliminate the primary causes of the malfunction and the excess emissions resulting from the malfunction event at issue. The analysis shall also specify, using best monitoring methods and engineering judgment, the amount of excess emissions that were the result of the malfunction.

(b) The owner or operator of the SSI unit experiencing an exceedance of its emission limit(s) during a malfunction, shall notify the Administrator by telephone or facsimile (fax) transmission as soon as possible, but no later than 2 business days after the initial occurrence of the malfunction, if it wishes to avail itself of an affirmative defense to civil penalties for that malfunction. The owner or operator seeking to assert an affirmative defense shall also submit a written report to the Administrator within 45 days of the initial occurrence of the exceedance of the standard in § 60.5165 to demonstrate, with all necessary supporting documentation, that it has met the requirements set forth in paragraph (a) of this section. The owner or operator may seek an extension of this deadline for up to 30 additional days by submitting a written request to the Administrator before the expiration of the 45 day period. Until a request for an extension has been approved by the Administrator, the owner or operator is subject to the requirement to submit such report within 45 days of the initial occurrence of the exceedance.

**Model Rule—Initial Compliance Requirements**

**§ 60.5185 How and when do I demonstrate initial compliance with the emission limits and standards?**

To demonstrate initial compliance with the emission limits and standards in Table 2 or 3 to this subpart, use the procedures specified in paragraph (a) of this section. In lieu of using the procedures specified in paragraph (a) of this section, you have the option to demonstrate initial compliance using the procedures specified in paragraph (b) of this section for particulate matter, hydrogen chloride, carbon monoxide, dioxins/furans (total mass basis or toxic

equivalency basis), mercury, nitrogen oxides, sulfur dioxide, cadmium, lead, and fugitive emissions from ash handling. You must meet the requirements of paragraphs (a) and (b) of this section, as applicable, and paragraphs (c) through (e) of this section, according to the performance testing, monitoring, and calibration requirements in § 60.5220(a) and (b).

(a) Demonstrate initial compliance using the performance test required in § 60.8. You must demonstrate that your SSI unit meets the emission limits and standards specified in Table 2 or 3 to this subpart for particulate matter, hydrogen chloride, carbon monoxide, dioxins/furans (total mass basis or toxic equivalency basis), mercury, nitrogen oxides, sulfur dioxide, cadmium, lead, and fugitive emissions from ash handling using the performance test. The initial performance test must be conducted using the test methods, averaging methods, and minimum sampling volumes or durations specified in Table 2 or 3 to this subpart and according to the testing, monitoring, and calibration requirements specified in § 60.5220(a).

(1) Except as provided in paragraph (e) of this section, you must demonstrate that your SSI unit meets the emission limits and standards specified in Table 2 or 3 to this subpart by your final compliance date (see Table 1 to this subpart).

(2) You may use the results from a performance test conducted within the 2 previous years that was conducted under the same conditions and demonstrated compliance with the emission limits and standards in Table 2 or 3 to this subpart, provided no process changes have been made since you conducted that performance test. However, you must continue to meet the operating limits established during the most recent performance test that demonstrated compliance with the emission limits and standards in Table 2 or 3 to this subpart. The performance test must have used the test methods specified in Table 2 or 3 to this subpart.

(b) Demonstrate initial compliance using a continuous emissions monitoring system or continuous automated sampling system. The option to use a continuous emissions monitoring system for hydrogen chloride, dioxins/furans, cadmium, or lead takes effect on the date a final performance specification applicable to hydrogen chloride, dioxins/furans, cadmium, or lead is published in the **Federal Register**. The option to use a continuous automated sampling system for dioxins/furans takes effect on the date a final performance specification

for such a continuous automated sampling system is published in the **Federal Register**. Collect data as specified in § 60.5220(b)(6) and use the following procedures:

(1) To demonstrate initial compliance with the emission limits specified in Table 2 or 3 to this subpart for particulate matter, hydrogen chloride, carbon monoxide, dioxins/furans (total mass basis or toxic equivalency basis), mercury, nitrogen oxides, sulfur dioxide, cadmium, and lead, you may substitute the use of a continuous monitoring system in lieu of conducting the initial performance test required in paragraph (a) of this section, as follows:

(i) You may substitute the use of a continuous emissions monitoring system for any pollutant specified in paragraph (b)(1) of this section in lieu of conducting the initial performance test for that pollutant in paragraph (a) of this section. For determining compliance with the carbon monoxide concentration limit using carbon monoxide CEMS, the correction to 7 percent oxygen does not apply during periods of startup or shutdown. Use the measured carbon monoxide concentration without correcting for oxygen concentration in averaging with other carbon monoxide concentrations (corrected to 7 percent oxygen) to determine the 24-hour average value.

(ii) You may substitute the use of a continuous automated sampling system for mercury or dioxins/furans in lieu of conducting the annual mercury or dioxin/furan performance test in paragraph (a) of this section.

(2) If you use a continuous emissions monitoring system to demonstrate compliance with an applicable emission limit in Table 2 or 3 to this subpart, as described in paragraph (b)(1) of this section, you must use the continuous emissions monitoring system and follow the requirements specified in § 60.5220(b). You must measure emissions according to § 60.13 to calculate 1-hour arithmetic averages, corrected to 7 percent oxygen (or carbon dioxide). You must demonstrate initial compliance using a 24-hour block average of these 1-hour arithmetic average emission concentrations, calculated using Equation 19–19 in section 12.4.1 of Method 19 of 40 CFR part 60, appendix A–7.

(3) If you use a continuous automated sampling system to demonstrate compliance with an applicable emission limit in Table 2 or 3 to this subpart, as described in paragraph (b)(1) of this section, you must:

(i) Use the continuous automated sampling system specified in § 60.58b(p) and (q), and measure and calculate

average emissions corrected to 7 percent oxygen (or carbon dioxide) according to § 60.58b(p) and your monitoring plan.

(A) Use the procedures specified in § 60.58b(p) to calculate 24-hour block averages to determine compliance with the mercury emission limit in Table 2 to this subpart.

(B) Use the procedures specified in § 60.58b(p) to calculate 2-week block averages to determine compliance with the dioxin/furan (total mass basis or toxic equivalency basis) emission limit in Table 2 to this subpart.

(ii) Comply with the provisions in § 60.58b(q) to develop a monitoring plan. For mercury continuous automated sampling systems, you must use Performance Specification 12B of appendix B of part 75 and Procedure 5 of appendix F of this part.

(4) Except as provided in paragraph (e) of this section, you must complete your initial performance evaluations required under your monitoring plan for any continuous emissions monitoring systems and continuous automated sampling systems by your final compliance date (see Table 1 to this subpart). Your performance evaluation must be conducted using the procedures and acceptance criteria specified in § 60.5200(a)(3).

(c) To demonstrate initial compliance with the dioxins/furans toxic equivalency emission limit in Table 2 or 3 to this subpart, determine dioxins/furans toxic equivalency as follows:

(1) Measure the concentration of each dioxin/furan tetra- through octachlorinated-isomer emitted using EPA Method 23 at 40 CFR part 60, appendix A–7.

(2) Multiply the concentration of each dioxin/furan (tetra- through octachlorinated) isomer by its corresponding toxic equivalency factor specified in Table 5 to this subpart. (3) Sum the products calculated in accordance with paragraph (c)(2) of this section to obtain the total concentration of dioxins/furans emitted in terms of toxic equivalency.

(d) Submit an initial compliance report, as specified in § 60.5235(b).

(e) If you demonstrate initial compliance using the performance test specified in paragraph (a) of this section, then the provisions of this paragraph (e) apply. If a force majeure is about to occur, occurs, or has occurred for which you intend to assert a claim of force majeure, you must notify the Administrator in writing as specified in § 60.5235(g). You must conduct the initial performance test as soon as practicable after the force majeure occurs. The Administrator will determine whether or not to grant the extension to the initial performance test

deadline, and will notify you in writing of approval or disapproval of the request for an extension as soon as practicable. Until an extension of the performance test deadline has been approved by the Administrator, you remain strictly subject to the requirements of this subpart.

**§ 60.5190 How do I establish my operating limits?**

(a) You must establish the site-specific operating limits specified in paragraphs (b) through (h) of this section or established in § 60.5175, as applicable, during your initial performance tests required in § 60.5185. You must meet the requirements in § 60.5210(d) to confirm these operating limits or re-establish-re-establish new operating limits using operating data recorded during any performance tests or performance evaluations required in § 60.5205. You must follow the data measurement and recording frequencies and data averaging times specified in Table 4 to this subpart or as established in § 60.5175, and you must follow the testing, monitoring, and calibration requirements specified in §§ 60.5220 and 60.5225 or established in § 60.5175. You are not required to establish operating limits for the operating parameters listed in Table 4 to this subpart for a control device if you use a continuous monitoring system to demonstrate compliance with the emission limits in Table 2 or 3 to this subpart for the applicable pollutants, as follows:

(1) For a scrubber designed to control emissions of hydrogen chloride or sulfur dioxide, you are not required to establish an operating limit and monitor scrubber liquid flow rate or scrubber liquid pH if you use the continuous monitoring system specified in §§ 60.4865(b) and 60.4885(b) to demonstrate compliance with the emission limit for hydrogen chloride or sulfur dioxide.

(2) For a scrubber designed to control emissions of particulate matter, cadmium, and lead, you are not required to establish an operating limit and monitor pressure drop across the scrubber or scrubber liquid flow rate if you use the continuous monitoring system specified in §§ 60.4865(b) and 60.4885(b) to demonstrate compliance with the emission limit for particulate matter, cadmium, and lead.

(3) For an electrostatic precipitator designed to control emissions of particulate matter, cadmium, and lead, you are not required to establish an operating limit and monitor secondary voltage of the collection plates, secondary amperage of the collection

plates, or effluent water flow rate at the outlet of the electrostatic precipitator if you use the continuous monitoring system specified in §§ 60.4865(b) and 60.4885(b) to demonstrate compliance with the emission limit for particulate matter, lead, and cadmium.

(4) For an activated carbon injection system designed to control emissions of mercury, you are not required to establish an operating limit and monitor sorbent injection rate and carrier gas flow rate (or carrier gas pressure drop) if you use the continuous monitoring system specified in §§ 60.4865(b) and 60.4885(b) to demonstrate compliance with the emission limit for mercury.

(5) For an activated carbon injection system designed to control emissions of dioxins/furans, you are not required to establish an operating limit and monitor sorbent injection rate and carrier gas flow rate (or carrier gas pressure drop) if you use the continuous monitoring system specified in §§ 60.4865(b) and 60.4885(b) to demonstrate compliance with the emission limit for dioxins/furans (total mass basis or toxic equivalency basis).

(b) Minimum pressure drop across each wet scrubber used to meet the particulate matter, lead, and cadmium emission limits in Table 2 or 3 to this subpart, equal to the lowest 4-hour average pressure drop across each such wet scrubber measured during the most recent performance test demonstrating compliance with the particulate matter, lead, and cadmium emission limits.

(c) Minimum scrubber liquid flow rate (measured at the inlet to each wet scrubber), equal to the lowest 4-hour average liquid flow rate measured during the most recent performance test demonstrating compliance with all applicable emission limits. (d) Minimum scrubber liquid pH for each wet scrubber used to meet the sulfur dioxide or hydrogen chloride emission limits in Table 2 or 3 to this subpart, equal to the lowest 1-hour average scrubber liquid pH measured during the most recent performance test demonstrating compliance with the sulfur dioxide and hydrogen chloride emission limits.

(e) Minimum combustion chamber operating temperature (or minimum afterburner temperature), equal to the lowest 4-hour average combustion chamber operating temperature (or afterburner temperature) measured during the most recent performance test demonstrating compliance with all applicable emission limits.

(f) Minimum power input to the electrostatic precipitator collection plates, equal to the lowest 4-hour average secondary electric power

measured during the most recent performance test demonstrating compliance with the particulate matter, lead, and cadmium emission limits. Power input must be calculated as the product of the secondary voltage and secondary amperage to the electrostatic precipitator collection plates. Both the secondary voltage and secondary amperage must be recorded during the performance test. (g) Minimum effluent water flow rate at the outlet of the electrostatic precipitator, equal to the lowest 4-hour average effluent water flow rate at the outlet of the electrostatic precipitator measured during the most recent performance test demonstrating compliance with the particulate matter, lead, and cadmium emission limits. (h) For activated carbon injection, establish the site-specific operating limits specified in paragraphs (h)(1) through (h)(3) of this section.

(1) Minimum mercury sorbent injection rate, equal to the lowest 4-hour average mercury sorbent injection rate measured during the most recent performance test demonstrating compliance with the mercury emission limit.

(2) Minimum dioxin/furan sorbent injection rate, equal to the lowest 4-hour average dioxin/furan sorbent injection rate measured during the most recent performance test demonstrating compliance with the dioxin/furan (total mass basis or toxic equivalency basis) emission limit.

(3) Minimum carrier gas flow rate or minimum carrier gas pressure drop, as follows:

(i) Minimum carrier gas flow rate, equal to the lowest 4-hour average carrier gas flow rate measured during the most recent performance test demonstrating compliance with the applicable emission limit.

(ii) Minimum carrier gas pressure drop, equal to the lowest 4-hour average carrier gas flow rate measured during the most recent performance test demonstrating compliance with the applicable emission limit.

**§ 60.5195 By what date must I conduct the initial air pollution control device inspection and make any necessary repairs?**

(a) You must conduct an air pollution control device inspection according to § 60.5220(c) by the final compliance date under the approved state plan, Federal plan, or delegation, as applicable. For air pollution control devices installed after the final compliance date, you must conduct the air pollution control device inspection within 60 days after installation of the control device.

(b) Within 10 operating days following the air pollution control device inspection under paragraph (a) of this section, all necessary repairs must be completed unless you obtain written approval from the Administrator establishing a date whereby all necessary repairs of the SSI unit must be completed.

**§ 60.5200 How do I develop a site-specific monitoring plan for my continuous monitoring, bag leak detection, and ash handling systems, and by what date must I conduct an initial performance evaluation?**

You must develop and submit to the Administrator for approval a site-specific monitoring plan for each continuous monitoring system required under this subpart, according to the requirements in paragraphs (a) through (c) of this section. This requirement also applies to you if you petition the Administrator for alternative monitoring parameters under § 60.13(i) and paragraph (e) of this section. If you use a continuous automated sampling system to comply with the mercury or dioxin/furan (total mass basis or toxic equivalency basis) emission limits, you must develop your monitoring plan as specified in § 60.58b(q), and you are not required to meet the requirements in paragraphs (a) and (b) of this section. You must also submit a site-specific monitoring plan for your ash handling system, as specified in paragraph (d) of this section. You must submit and update your monitoring plans as specified in paragraphs (f) through (h) of this section.

(a) For each continuous monitoring system, your monitoring plan must address the elements and requirements specified in paragraphs (a)(1) through (a)(8) of this section. You must operate and maintain the continuous monitoring system in continuous operation according to the site-specific monitoring plan.

(1) Installation of the continuous monitoring system sampling probe or other interface at a measurement location relative to each affected process unit such that the measurement is representative of control of the exhaust emissions (*e.g.*, on or downstream of the last control device).

(2) Performance and equipment specifications for the sample interface, the pollutant concentration or parametric signal analyzer and the data collection and reduction systems.

(3) Performance evaluation procedures and acceptance criteria (*e.g.*, calibrations).

(i) For continuous emissions monitoring systems, your performance evaluation and acceptance criteria must

include, but is not limited to, the following:

(A) The applicable requirements for continuous emissions monitoring systems specified in § 60.13.

(B) The applicable performance specifications (*e.g.*, relative accuracy tests) in appendix B of this part.

(C) The applicable procedures (*e.g.*, quarterly accuracy determinations and daily calibration drift tests) in appendix F of this part.

(D) A discussion of how the occurrence and duration of out-of-control periods will affect the suitability of CEMS data, where out-of-control has the meaning given in section (a)(7)(i) of this section.

(ii) For continuous parameter monitoring systems, your performance evaluation and acceptance criteria must include, but is not limited to, the following:

(A) If you have an operating limit that requires the use of a flow monitoring system, you must meet the requirements in paragraphs (a)(3)(ii)(A)(1) through (4) of this section.

(1) Install the flow sensor and other necessary equipment in a position that provides a representative flow.

(2) Use a flow sensor with a measurement sensitivity of no greater than 2 percent of the expected process flow rate.

(3) Minimize the effects of swirling flow or abnormal velocity distributions due to upstream and downstream disturbances.

(4) Conduct a flow monitoring system performance evaluation in accordance with your monitoring plan at the time of each performance test but no less frequently than annually.

(B) If you have an operating limit that requires the use of a pressure monitoring system, you must meet the requirements in paragraphs (a)(3)(ii)(B)(1) through (6) of this section.

(1) Install the pressure sensor(s) in a position that provides a representative measurement of the pressure (*e.g.*, particulate matter scrubber pressure drop).

(2) Minimize or eliminate pulsating pressure, vibration, and internal and external corrosion.

(3) Use a pressure sensor with a minimum tolerance of 1.27 centimeters of water or a minimum tolerance of 1 percent of the pressure monitoring system operating range, whichever is less.

(4) Perform checks at least once each process operating day to ensure pressure measurements are not obstructed (*e.g.*, check for pressure tap pluggage daily).

(5) Conduct a performance evaluation of the pressure monitoring system in

accordance with your monitoring plan at the time of each performance test but no less frequently than annually.

(6) If at any time the measured pressure exceeds the manufacturer's specified maximum operating pressure range, conduct a performance evaluation of the pressure monitoring system in accordance with your monitoring plan and confirm that the pressure monitoring system continues to meet the performance requirements in your monitoring plan. Alternatively, install and verify the operation of a new pressure sensor.

(C) If you have an operating limit that requires a pH monitoring system, you must meet the requirements in paragraphs (a)(3)(ii)(C)(1) through (4) of this section.

(1) Install the pH sensor in a position that provides a representative measurement of scrubber effluent pH.

(2) Ensure the sample is properly mixed and representative of the fluid to be measured.

(3) Conduct a performance evaluation of the pH monitoring system in accordance with your monitoring plan at least once each process operating day.

(4) Conduct a performance evaluation (including a two-point calibration with one of the two buffer solutions having a pH within 1 of the operating limit pH level) of the pH monitoring system in accordance with your monitoring plan at the time of each performance test but no less frequently than quarterly.

(D) If you have an operating limit that requires the use of a temperature measurement device, you must meet the requirements in paragraphs (a)(3)(ii)(D)(1) through (4) of this section.

(1) Install the temperature sensor and other necessary equipment in a position that provides a representative temperature.

(2) Use a temperature sensor with a minimum tolerance of 2.8 degrees Celsius (5 degrees Fahrenheit), or 1.0 percent of the temperature value, whichever is larger, for a noncryogenic temperature range.

(3) Use a temperature sensor with a minimum tolerance of 2.8 degrees Celsius (5 degrees Fahrenheit), or 2.5 percent of the temperature value, whichever is larger, for a cryogenic temperature range.

(4) Conduct a temperature measurement device performance evaluation at the time of each performance test but no less frequently than annually.

(E) If you have an operating limit that requires a secondary electric power monitoring system for an electrostatic precipitator, you must meet the

requirements in paragraphs

(a)(3)(ii)(E)(1) and (2) of this section.

(1) Install sensors to measure (secondary) voltage and current to the electrostatic precipitator collection plates.

(2) Conduct a performance evaluation of the electric power monitoring system in accordance with your monitoring plan at the time of each performance test but no less frequently than annually.

(F) If you have an operating limit that requires the use of a monitoring system to measure sorbent injection rate (*e.g.*, weigh belt, weigh hopper, or hopper flow measurement device), you must meet the requirements in paragraphs (a)(3)(ii)(F)(1) and (2) of this section.

(1) Install the system in a position(s) that provides a representative measurement of the total sorbent injection rate.

(2) Conduct a performance evaluation of the sorbent injection rate monitoring system in accordance with your monitoring plan at the time of each performance test but no less frequently than annually.

(4) Ongoing operation and maintenance procedures in accordance with the general requirements of § 60.11(d).

(5) Ongoing data quality assurance procedures in accordance with the general requirements of § 60.13.

(6) Ongoing recordkeeping and reporting procedures in accordance with the general requirements of § 60.7(b), (c), (c)(1), (c)(4), (d), (e), (f) and (g).

(7) Provisions for periods when the continuous monitoring system is out of control, as follows:

(i) A continuous monitoring system is out of control if the conditions of paragraph (a)(7)(i)(A) or (a)(7)(i)(B) of this section are met.

(A) The zero (low-level), mid-level (if applicable), or high-level calibration drift exceeds two times the applicable calibration drift specification in the applicable performance specification or in the relevant standard.

(B) The continuous monitoring system fails a performance test audit (*e.g.*, cylinder gas audit), relative accuracy audit, relative accuracy test audit, or linearity test audit.

(ii) When the continuous monitoring system is out of control as specified in paragraph (a)(7)(i) of this section, you must take the necessary corrective action and must repeat all necessary tests that indicate that the system is out of control. You must take corrective action and conduct retesting until the performance requirements are below the applicable limits. The beginning of the out-of-control period is the hour you

conduct a performance check (*e.g.*, calibration drift) that indicates an exceedance of the performance requirements established under this part. The end of the out-of-control period is the hour following the completion of corrective action and successful demonstration that the system is within the allowable limits.

(8) Schedule for conducting initial and periodic performance evaluations of your continuous monitoring systems.

(b) If a bag leak detection system is used, your monitoring plan must include a description of the following items:

(1) Installation of the bag leak detection system in accordance with paragraphs (b)(1)(i) and (ii) of this section.

(i) Install the bag leak detection sensor(s) in a position(s) that will be representative of the relative or absolute particulate matter loadings for each exhaust stack, roof vent, or compartment (*e.g.*, for a positive pressure fabric filter) of the fabric filter.

(ii) Use a bag leak detection system certified by the manufacturer to be capable of detecting particulate matter emissions at concentrations of 10 milligrams per actual cubic meter or less.

(2) Initial and periodic adjustment of the bag leak detection system, including how the alarm set-point will be established. Use a bag leak detection system equipped with a system that will sound an alarm when the system detects an increase in relative particulate matter emissions over a preset level. The alarm must be located where it is observed readily and any alert is detected and recognized easily by plant operating personnel.

(3) Evaluations of the performance of the bag leak detection system, performed in accordance with your monitoring plan and consistent with the guidance provided in Fabric Filter Bag Leak Detection Guidance, EPA-454/R-98-015, September 1997 (incorporated by reference, see § 60.17).

(4) Operation of the bag leak detection system, including quality assurance procedures.

(5) Maintenance of the bag leak detection system, including a routine maintenance schedule and spare parts inventory list.

(6) Recordkeeping (including record retention) of the bag leak detection system data. Use a bag leak detection system equipped with a device to continuously record the output signal from the sensor. (c) You must conduct an initial performance evaluation of each continuous monitoring system and bag leak detection system, as applicable,

in accordance with your monitoring plan and to § 60.13(c). For the purpose of this subpart, the provisions of § 60.13(c) also apply to the bag leak detection system. You must conduct the initial performance evaluation of each continuous monitoring system within 60 days of installation of the monitoring system

(d) You must submit a monitoring plan specifying the ash handling system operating procedures that you will follow to ensure that you meet the fugitive emissions limit specified in Table 2 or 3 to this subpart.

(e) You may submit an application to the Administrator for approval of alternate monitoring requirements to demonstrate compliance with the standards of this subpart, subject to the provisions of paragraphs (e)(1) through (e)(6) of this section.

(1) The Administrator will not approve averaging periods other than those specified in this section, unless you document, using data or information, that the longer averaging period will ensure that emissions do not exceed levels achieved over the duration of three performance test runs.

(2) If the application to use an alternate monitoring requirement is approved, you must continue to use the original monitoring requirement until approval is received to use another monitoring requirement.

(3) You must submit the application for approval of alternate monitoring requirements no later than the notification of performance test. The application must contain the information specified in paragraphs (e)(3)(i) through (e)(3)(iii) of this section:

(i) Data or information justifying the request, such as the technical or economic infeasibility, or the impracticality of using the required approach.

(ii) A description of the proposed alternative monitoring requirement, including the operating parameter to be monitored, the monitoring approach and technique, the averaging period for the limit, and how the limit is to be calculated.

(iii) Data or information documenting that the alternative monitoring requirement would provide equivalent or better assurance of compliance with the relevant emission standard.

(4) The Administrator will notify you of the approval or denial of the application within 90 calendar days after receipt of the original request, or within 60 calendar days of the receipt of any supplementary information, whichever is later. The Administrator will not approve an alternate monitoring application unless it would provide

equivalent or better assurance of compliance with the relevant emission standard. Before disapproving any alternate monitoring application, the Administrator will provide the following:

(i) Notice of the information and findings upon which the intended disapproval is based.

(ii) Notice of opportunity for you to present additional supporting information before final action is taken on the application. This notice will specify how much additional time is allowed for you to provide additional supporting information.

(5) You are responsible for submitting any supporting information in a timely manner to enable the Administrator to consider the application prior to the performance test. Neither submittal of an application, nor the Administrator's failure to approve or disapprove the application relieves you of the responsibility to comply with any provision of this subpart.

(6) The Administrator may decide at any time, on a case-by-case basis, that additional or alternative operating limits, or alternative approaches to establishing operating limits, are necessary to demonstrate compliance with the emission standards of this subpart.

(f) You must submit your monitoring plans required in paragraphs (a) and (b) of this section at least 60 days before your initial performance evaluation of your continuous monitoring system(s).

(g) You must submit your monitoring plan for your ash handling system, as required in paragraph (d) of this section, at least 60 days before your initial compliance test date.

(h) You must update and resubmit your monitoring plan if there are any changes or potential changes in your monitoring procedures or if there is a process change, as defined in § 60.5250.

#### **Model Rule—Continuous Compliance Requirements**

##### **§ 60.5205 How and when do I demonstrate continuous compliance with the emission limits and standards?**

To demonstrate continuous compliance with the emission limits and standards specified in Table 2 or 3 to this subpart, use the procedures specified in paragraph (a) of this section. In lieu of using the procedures specified in paragraph (a) of this section, you have the option to demonstrate initial compliance using the procedures specified in paragraph (b) of this section for particulate matter, hydrogen chloride, carbon monoxide, dioxins/furans (total mass basis or toxic equivalency basis), mercury, nitrogen

oxides, sulfur dioxide, cadmium, lead, and fugitive emissions from ash handling. You must meet the requirements of paragraphs (a) and (b) of this section, as applicable, and paragraphs (c) through (e) of this section, according to the performance testing, monitoring, and calibration requirements in § 60.5220(a) and (b). You may also petition the Administrator for alternative monitoring parameters as specified in paragraph (f) of this section.

(a) Demonstrate continuous compliance using a performance test. Except as provided in paragraphs (a)(3) and (e) of this section, following the date that the initial performance test for each pollutant in Table 2 or 3 to this subpart is completed, you must conduct a performance test for each such pollutant on an annual basis (between 11 and 13 calendar months following the previous performance test). The performance test must be conducted using the test methods, averaging methods, and minimum sampling volumes or durations specified in Table 2 or 3 to this subpart and according to the testing, monitoring, and calibration requirements specified in § 60.5220(a).

(1) You may conduct a repeat performance test at any time to establish new values for the operating limits to apply from that point forward. The Administrator may request a repeat performance test at any time.

(2) You must repeat the performance test within 60 days of a process change, as defined in § 60.5250.

(3) Except as specified in paragraphs (a)(1) and (2) of this section, you can conduct performance tests less often for a given pollutant, as specified in paragraphs (a)(3)(i) through (iii) of this section.

(i) You can conduct performance tests less often if your performance tests for the pollutant for at least 2 consecutive years show that your emissions are at or below 75 percent of the emission limit specified in Table 2 or 3 to this subpart, and there are no changes in the operation of the affected source or air pollution control equipment that could increase emissions. In this case, you do not have to conduct a performance test for that pollutant for the next 2 years. You must conduct a performance test during the third year and no more than 37 months after the previous performance test. (ii) If your SSI unit continues to meet the emission limit for the pollutant, you may choose to conduct performance tests for the pollutant every third year if your emissions are at or below 75 percent of the emission limit, and if there are no changes in the operation of the affected source or air pollution control

equipment that could increase emissions, but each such performance test must be conducted no more than 37 months after the previous performance test.

(iii) If a performance test shows emissions exceeded 75 percent of the emission limit for a pollutant, you must conduct annual performance tests for that pollutant until all performance tests over 2 consecutive years show compliance.

(b) Demonstrate continuous compliance using a continuous emissions monitoring system or continuous automated sampling system. The option to use a continuous emissions monitoring system for hydrogen chloride, dioxins/furans, cadmium, or lead takes effect on the date a final performance specification applicable to hydrogen chloride, dioxins/furans, cadmium, or lead is published in the **Federal Register**. The option to use a continuous automated sampling system for dioxins/furans takes effect on the date a final performance specification for such a continuous automated sampling system is published in the **Federal Register**. Collect data as specified in § 60.5220(b)(6) and use the following procedures:

(1) To demonstrate continuous compliance with the emission limits for particulate matter, hydrogen chloride, carbon monoxide, dioxins/furans (total mass basis or toxic equivalency basis), mercury, nitrogen oxides, sulfur dioxide, cadmium, and lead, you may substitute the use of a continuous monitoring system in lieu of conducting the annual performance test required in paragraph (a) of this section, as follows:

(i) You may substitute the use of a continuous emissions monitoring system for any pollutant specified in paragraph (b)(1) of this section in lieu of conducting the annual performance test for that pollutant in paragraph (a) of this section. For determining compliance with the carbon monoxide concentration limit using carbon monoxide CEMS, the correction to 7 percent oxygen does not apply during periods of startup or shutdown. Use the measured carbon monoxide concentration without correcting for oxygen concentration in averaging with other carbon monoxide concentrations (corrected to 7 percent oxygen) to determine the 24-hour average value.

(ii) You may substitute the use of a continuous automated sampling system for mercury or dioxins/furans in lieu of conducting the annual mercury or dioxin/furan performance test in paragraph (a) of this section.

(2) If you use a continuous emissions monitoring system to demonstrate compliance with an applicable emission limit in paragraph (b)(1) of this section, you must use the continuous emissions monitoring system and follow the requirements specified in § 60.5220(b). You must measure emissions according to § 60.13 to calculate 1-hour arithmetic averages, corrected to 7 percent oxygen (or carbon dioxide). You must demonstrate initial compliance using a 24-hour block average of these 1-hour arithmetic average emission concentrations, calculated using Equation 19–19 in section 12.4.1 of Method 19 of 40 CFR part 60, appendix A–7.

(3) If you use a continuous automated sampling system to demonstrate compliance with an applicable emission limit in paragraph (b)(1) of this section, you must:

(i) Use the continuous automated sampling system specified in § 60.58b(p) and (q), and measure and calculate average emissions corrected to 7 percent oxygen (or carbon dioxide) according to § 60.58b(p) and your monitoring plan.

(A) Use the procedures specified in § 60.58b(p) to calculate 24-hour averages to determine compliance with the mercury emission limit in Table 2 to this subpart.

(B) Use the procedures specified in § 60.58b(p) to calculate 2-week averages to determine compliance with the dioxin/furan (total mass basis or toxic equivalency basis) emission limits in Table 2 to this subpart.

(ii) Update your monitoring plan as specified in § 60.4880(e). For mercury continuous automated sampling systems, you must use Performance Specification 12B of appendix B of part 75 and Procedure 5 of appendix F of this part.

(4) Except as provided in paragraph (e) of this section, you must complete your periodic performance evaluations required in your monitoring plan for any continuous emissions monitoring systems and continuous automated sampling systems, according to the schedule specified in your monitoring plan. If you were previously determining compliance by conducting an annual performance test (or according to the less frequent testing for a pollutant as provided in paragraph (a)(3) of this section), you must complete the initial performance evaluation required under your monitoring plan in § 60.5200 for the continuous monitoring system prior to using the continuous emissions monitoring system to demonstrate compliance or continuous automated sampling system. Your performance

evaluation must be conducted using the procedures and acceptance criteria specified in § 60.5200(a)(3).

(c) To demonstrate compliance with the dioxins/furans toxic equivalency emission limit in paragraph (a) or (b) of this section, you must determine dioxins/furans toxic equivalency as follows:

(1) Measure the concentration of each dioxin/furan tetra- through octachlorinated-isomer emitted using Method 23 at 40 CFR part 60, appendix A–7.

(2) For each dioxin/furan (tetra-through octachlorinated) isomer measured in accordance with paragraph (c)(1) of this section, multiply the isomer concentration by its corresponding toxic equivalency factor specified in Table 5 to this subpart.

(3) Sum the products calculated in accordance with paragraph (c)(2) of this section to obtain the total concentration of dioxins/furans emitted in terms of toxic equivalency.

(d) You must submit an annual compliance report as specified in § 60.5235(c). You must submit a deviation report as specified in § 60.5235(d) for each instance that you did not meet each emission limit in Table 2 to this subpart.

(e) If you demonstrate continuous compliance using a performance test, as specified in paragraph (a) of this section, then the provisions of this paragraph (e) apply. If a force majeure is about to occur, occurs, or has occurred for which you intend to assert a claim of force majeure, you must notify the Administrator in writing as specified in § 60.5235(g). You must conduct the performance test as soon as practicable after the force majeure occurs. The Administrator will determine whether or not to grant the extension to the performance test deadline, and will notify you in writing of approval or disapproval of the request for an extension as soon as practicable. Until an extension of the performance test deadline has been approved by the Administrator, you remain strictly subject to the requirements of this subpart.

(f) After any initial requests in § 60.5200 for alternative monitoring requirements for initial compliance, you may subsequently petition the Administrator for alternative monitoring parameters as specified in §§ 60.13(i) and 60.5200(e).

**§ 60.5210 How do I demonstrate continuous compliance with my operating limits?**

You must continuously monitor your operating parameters as specified in

paragraph (a) of this section and meet the requirements of paragraphs (b) and (c) of this section, according to the monitoring and calibration requirements in § 60.5225. You must confirm and re-establish your operating limits as specified in paragraph (d) of this section.

(a) You must continuously monitor the operating parameters specified in paragraphs (a)(1) and (a)(2) of this section using the continuous monitoring equipment and according to the procedures specified in § 60.5225 or established in § 60.5175. To determine compliance, you must use the data averaging period specified in Table 4 to this subpart (except for alarm time of the baghouse leak detection system) unless a different averaging period is established under § 60.5175.

(1) You must demonstrate that the SSI unit meets the operating limits established according to §§ 60.5175 and 60.5190 and paragraph (d) of this section for each applicable operating parameter.

(2) You must demonstrate that the SSI unit meets the operating limit for bag leak detection systems as follows:

(i) For a bag leak detection system, you must calculate the alarm time as follows:

(A) If inspection of the fabric filter demonstrates that no corrective action is required, no alarm time is counted.

(B) If corrective action is required, each alarm time shall be counted as a minimum of 1 hour.

(C) If you take longer than 1 hour to initiate corrective action, each alarm time (*i.e.*, time that the alarm sounds) is counted as the actual amount of time taken by you to initiate corrective action.

(ii) Your maximum alarm time is equal to 5 percent of the operating time during a 6-month period, as specified in § 60.5170(c).

(b) Operation above the established maximum, below the established minimum, or outside the allowable range of the operating limits specified in paragraph (a) of this section constitutes a deviation from your operating limits established under this subpart, except during performance tests conducted to determine compliance with the emission and operating limits or to establish new operating limits. You must submit the deviation report specified in § 60.5235(d) for each instance that you did not meet one of your operating limits established under this subpart.

(c) You must submit the annual compliance report specified in § 60.5235(c) to demonstrate continuous compliance.

(d) You must confirm your operating limits according to paragraph (d)(1) of this section or re-establish operating limits according to paragraph (d)(2) of this section. Your operating limits must be established so as to assure ongoing compliance with the emission limits. These requirements also apply to your operating requirements in your fugitive emissions monitoring plan specified in § 60.5170(d).

(1) Your operating limits must be based on operating data recorded during any performance test required in § 60.5205(a) or any performance evaluation required in § 60.5205(b)(4).

(2) You may conduct a repeat performance test at any time to establish new values for the operating limits to apply from that point forward.

**§ 60.5215 By what date must I conduct annual air pollution control device inspections and make any necessary repairs?**

(a) You must conduct an annual inspection of each air pollution control device used to comply with the emission limits, according to § 60.5220(c), no later than 12 months following the previous annual air pollution control device inspection.

(b) Within 10 operating days following an air pollution control device inspection, all necessary repairs must be completed unless you obtain written

approval from the Administrator establishing a date whereby all necessary repairs of the affected SSI unit must be completed.

**Model Rule—Performance Testing, Monitoring, and Calibration Requirements**

**§ 60.5220 What are the performance testing, monitoring, and calibration requirements for compliance with the emission limits and standards?**

You must meet, as applicable, the performance testing requirements specified in paragraph (a) of this section, the monitoring requirements specified in paragraph (b) of this section, the air pollution control device inspections requirements specified in paragraph (c) of this section, and the bypass stack provisions specified in paragraph (d) of this section.

(a) *Performance testing requirements.*

(1) All performance tests must consist of a minimum of three test runs conducted under conditions representative of normal operations, as specified in § 60.8(c). Emissions in excess of the emission limits or standards during periods of startup, shutdown, and malfunction are considered deviations from the applicable emission limits or standards.

(2) You must document that the dry sludge burned during the performance

test is representative of the sludge burned under normal operating conditions by:

(i) Maintaining a log of the quantity of sewage sludge burned during the performance test by continuously monitoring and recording the average hourly rate that sewage sludge is fed to the incinerator.

(ii) Maintaining a log of the moisture content of the sewage sludge burned during the performance test by taking grab samples of the sewage sludge fed to the incinerator for each 8 hour period that testing is conducted.

(3) All performance tests must be conducted using the test methods, minimum sampling volume, observation period, and averaging method specified in Table 2 or 3 to this subpart.

(4) Method 1 at 40 CFR part 60, appendix A must be used to select the sampling location and number of traverse points.

(5) Method 3A or 3B at 40 CFR part 60, appendix A-2 must be used for gas composition analysis, including measurement of oxygen concentration. Method 3A or 3B at 40 CFR part 60, appendix A-2 must be used simultaneously with each method.

(6) All pollutant concentrations must be adjusted to 7 percent oxygen using Equation 1 of this section:

$$C_{adj} = C_{meas} (20.9 - 7) / (20.9 - \%O_2) \quad (\text{Eq. 1})$$

Where:

$C_{adj}$  = Pollutant concentration adjusted to 7 percent oxygen.

$C_{meas}$  = Pollutant concentration measured on a dry basis.

$(20.9 - 7)$  = 20.9 percent oxygen - 7 percent oxygen (defined oxygen correction basis).

20.9 = Oxygen concentration in air, percent.

$\%O_2$  = Oxygen concentration measured on a dry basis, percent.

(7) Performance tests must be conducted and data reduced in accordance with the test methods and procedures contained in this subpart unless the Administrator does one of the following.

(i) Specifies or approves, in specific cases, the use of a method with minor changes in methodology.

(ii) Approves the use of an equivalent method.

(iii) Approves the use of an alternative method the results of which he has determined to be adequate for indicating whether a specific source is in compliance.

(iv) Waives the requirement for performance tests because you have

demonstrated by other means to the Administrator's satisfaction that the affected SSI unit is in compliance with the standard.

(v) Approves shorter sampling times and smaller sample volumes when necessitated by process variables or other factors. Nothing in this paragraph is construed to abrogate the Administrator's authority to require testing under section 114 of the Clean Air Act.

(8) You must provide the Administrator at least 30 days prior notice of any performance test, except as specified under other subparts, to afford the Administrator the opportunity to have an observer present. If after 30 days notice for an initially scheduled performance test, there is a delay (due to operational problems, *etc.*) in conducting the scheduled performance test, you must notify the Administrator as soon as possible of any delay in the original test date, either by providing at least 7 days prior notice of the rescheduled date of the performance test, or by arranging a rescheduled date

with the Administrator by mutual agreement.

(9) You must provide, or cause to be provided, performance testing facilities as follows:

(i) Sampling ports adequate for the test methods applicable to the SSI unit, as follows:

(A) Constructing the air pollution control system such that volumetric flow rates and pollutant emission rates can be accurately determined by applicable test methods and procedures.

(B) Providing a stack or duct free of cyclonic flow during performance tests, as demonstrated by applicable test methods and procedures.

(ii) Safe sampling platform(s).

(iii) Safe access to sampling platform(s).

(iv) Utilities for sampling and testing equipment.

(10) Unless otherwise specified in this subpart, each performance test must consist of three separate runs using the applicable test method. Each run must be conducted for the time and under the conditions specified in the applicable standard. Compliance with each

emission limit must be determined by calculating the arithmetic mean of the three runs. In the event that a sample is accidentally lost or conditions occur in which one of the three runs must be discontinued because of forced shutdown, failure of an irreplaceable portion of the sample train, extreme meteorological conditions, or other circumstances, beyond your control, compliance may, upon the Administrator's approval, be determined using the arithmetic mean of the results of the two other runs.

(11) During each test run specified in paragraph (a)(1) of this section, you must operate your sewage sludge incinerator at a minimum of 85 percent of your maximum permitted capacity.

(b) *Continuous monitor requirements.* You must meet the following requirements, as applicable, when using a continuous monitoring system to demonstrate compliance with the emission limits in Table 2 or 3 to this subpart. The option to use a continuous emissions monitoring system for hydrogen chloride, dioxins/furans, cadmium, or lead takes effect on the date a final performance specification applicable to hydrogen chloride, dioxins/furans, cadmium, or lead is published in the **Federal Register**. If you elect to use a continuous emissions monitoring system instead of conducting annual performance testing, you must meet the requirements of paragraphs (b)(1) through (b)(6) of this section. If you elect to use a continuous automated sampling system instead of conducting annual performance testing, you must meet the requirements of paragraph (b)(7) of this section. The option to use a continuous automated sampling system for dioxins/furans takes effect on the date a final performance specification for such a continuous automated sampling system is published in the **Federal Register**.

(1) You must notify the Administrator 1 month before starting use of the continuous emissions monitoring system.

(2) You must notify the Administrator 1 month before stopping use of the continuous emissions monitoring system, in which case you must also conduct a performance test within prior to ceasing operation of the system.

(3) You must install, operate, calibrate, and maintain an instrument for continuously measuring and recording the emissions to the atmosphere in accordance with the following:

(i) Section 60.13 of subpart A of this part.

(ii) The following performance specifications of appendix B of this part, as applicable:

(A) For particulate matter, Performance Specification 11 of appendix B of this part.

(B) For hydrogen chloride, Performance Specification 15 of appendix B of this part.

(C) For carbon monoxide, Performance Specification 4B of appendix B of this part with spans appropriate to the applicable emission limit.

(D) [Reserved]

(E) For mercury, Performance Specification 12A of appendix B of this part.

(F) For nitrogen oxides, Performance Specification 2 of appendix B of this part.

(G) For sulfur dioxide, Performance Specification 2 of appendix B of this part.

(iii) For continuous emissions monitoring systems, the quality assurance procedures (e.g., quarterly accuracy determinations and daily calibration drift tests) of appendix F of this part specified in paragraphs (b)(3)(iii)(A) through (b)(3)(iii)(G) of this section. For each pollutant, the span value of the continuous emissions monitoring system is two times the applicable emission limit, expressed as a concentration.

(A) For particulate matter, Procedure 2 in appendix F of this part.

(B) For hydrogen chloride, Procedure 1 in appendix F of this part except that the Relative Accuracy Test Audit requirements of Procedure 1 shall be replaced with the validation requirements and criteria of sections 11.1.1 and 12.0 of Performance Specification 15 of appendix B of this part.

(C) For carbon monoxide, Procedure 1 in appendix F of this part.

(D) [Reserved]

(E) For mercury, Procedures 5 in appendix F of this part.

(F) For nitrogen oxides, Procedure 1 in appendix F of this part.

(G) For sulfur dioxide, Procedure 1 in appendix F of this part.

(iv) If your monitoring system has a malfunction or out-of-control period, you must complete repairs and resume operation of your monitoring system as expeditiously as possible.

(4) During each relative accuracy test run of the continuous emissions monitoring system using the performance specifications in paragraph (b)(3)(ii) of this section, emission data for each regulated pollutant and oxygen (or carbon dioxide as established in (b)(5) of this section) must be collected

concurrently (or within a 30- to 60-minute period) by both the continuous emissions monitoring systems and the test methods specified in paragraph (b)(4)(i) through (b)(4)(viii) of this section. Relative accuracy testing must be at representative operating conditions while the SSI unit is charging sewage sludge.

(i) For particulate matter, Method 5 at 40 CFR part 60, appendix A-3 or Method 26A or 29 at 40 CFR part 60, appendix A-8 shall be used.

(ii) For hydrogen chloride, Method 26 or 26A at 40 CFR part 60, appendix A-8, shall be used, as specified in Tables 1 and 2 to this subpart.

(iii) For carbon monoxide, Method 10, 10A, or 10B at 40 CFR part 60, appendix A-4, shall be used.

(iv) For dioxins/furans, Method 23 at 40 CFR part 60, appendix A-7, shall be used.

(v) For mercury, cadmium, and lead, Method 29 at 40 CFR part 60, appendix A-8, shall be used. Alternatively for mercury, either Method 30B at 40 CFR part 60, appendix A-8 or ASTM D6784-02 (Reapproved 2008) (incorporated by reference, see § 60.17), may be used.

(vi) For nitrogen oxides, Method 7 or 7E at 40 CFR part 60, appendix A-4, shall be used.

(vii) For sulfur dioxide, Method 6 or 6C at 40 CFR part 60, appendix A-4, or as an alternative ANSI/ASME PTC 19.10-1981 (incorporated by reference, see § 60.17) must be used. For sources that have actual inlet emissions less than 100 parts per million dry volume, the relative accuracy criterion for the inlet of the sulfur dioxide continuous emissions monitoring system should be no greater than 20 percent of the mean value of the method test data in terms of the units of the emission standard, or 5 parts per million dry volume absolute value of the mean difference between the method and the continuous emissions monitoring system, whichever is greater.

(viii) For oxygen (or carbon dioxide as established in (b)(5) of this section), Method 3A or 3B at 40 CFR part 60, appendix A-2, or as an alternative ANSI/ASME PTC 19.10-1981 (incorporated by reference, see § 60.17), as applicable, must be used.

(5) You may request that compliance with the emission limits be determined using carbon dioxide measurements corrected to an equivalent of 7 percent oxygen. If carbon dioxide is selected for use in diluent corrections, the relationship between oxygen and carbon dioxide levels must be established during the initial performance test according to the procedures and methods specified in paragraphs (b)(5)(i)

through (b)(5)(iv) of this section. This relationship may be re-established during subsequent performance tests.

(i) The fuel factor equation in Method 3B at 40 CFR part 60, appendix A-2 must be used to determine the relationship between oxygen and carbon dioxide at a sampling location. Method 3A or 3B at 50 CFR part 60, appendix A-2, or as an alternative ANSI/ASME PTC 19.10-1981 (incorporated by reference, *see* § 60.17), as applicable, must be used to determine the oxygen concentration at the same location as the carbon dioxide monitor.

(ii) Samples must be taken for at least 30 minutes in each hour.

(iii) Each sample must represent a 1-hour average.

(iv) A minimum of three runs must be performed.

(6) You must operate the continuous monitoring system and collect data with the continuous monitoring system as follows:

(i) You must collect data using the continuous monitoring system at all times the affected SSI unit is operating and at the intervals specified in paragraph (b)(6)(ii) of this section, except for periods of monitoring system malfunctions that occur during periods specified in § 60.5200(a)(7)(i), repairs associated with monitoring system malfunctions, and required monitoring system quality assurance or quality control activities (including, as applicable, calibration checks and required zero and span adjustments). Any such periods that you do not collect data using the continuous monitoring system constitute a deviation from the monitoring requirements and must be reported in a deviation report.

(ii) You must collect continuous emissions monitoring system data in accordance with § 60.13(e)(2).

(iii) Any data collected during monitoring system malfunctions, repairs associated with monitoring system malfunctions, or required monitoring system quality assurance or control activities must not be included in calculations used to report emissions or operating levels. Any such periods must be reported in a deviation report.

(iv) Any data collected during periods when the monitoring system is out of control as specified in § 60.4880(a)(7)(i), repairs associated with periods when the monitoring system is out of control, or required monitoring system quality assurance or control activities conducted during out-of-control periods must not be included in calculations used to report emissions or operating levels. Any such periods that do not coincide with a monitoring system

malfunction as defined in § 60.5250, constitute a deviation from the monitoring requirements and must be reported in a deviation report.

(v) You must use all the data collected during all periods except those periods specified in paragraphs (b)(6)(iii) and (b)(6)(iv) of this section in assessing the operation of the control device and associated control system.

(7) If you elect to use a continuous automated sampling system instead of conducting annual performance testing, you must:

(i) Install, calibrate, maintain, and operate a continuous automated sampling system according to the site-specific monitoring plan developed in § 60.58b(p)(1) through (p)(6), (p)(9), (p)(10), and (q).

(ii) Collect data according to § 60.58b(p)(5) and paragraph (b)(6) of this section.

(c) *Air pollution control device inspections.* You must conduct air pollution control device inspections that include, at a minimum, the following:

(1) Inspect air pollution control device(s) for proper operation.

(2) Generally observe that the equipment is maintained in good operating condition.

(3) Develop a site-specific monitoring plan according to the requirements in § 60.5200. This requirement also applies to you if you petition the EPA Administrator for alternative monitoring parameters under § 60.13(i). (d) *Bypass stack.* Use of the bypass stack at any time that sewage sludge is being charged to the SSI unit is an emissions standards deviation for all pollutants listed in Table 2 or 3 to this subpart. The use of the bypass stack during a performance test invalidates the performance test.

**§ 60.5225 What are the monitoring and calibration requirements for compliance with my operating limits?**

(a) You must install, operate, calibrate, and maintain the continuous parameter monitoring systems according to the requirements in paragraphs (a)(1) and (2) of this section.

(1) Meet the following general requirements for flow, pressure, pH, and operating temperature measurement devices:

(i) You must collect data using the continuous monitoring system at all times the affected SSI unit is operating and at the intervals specified in paragraph (a)(1)(ii) of this section, except for periods of monitoring system malfunctions that occur during periods specified defined in § 60.5200(a)(7)(i), repairs associated with monitoring system malfunctions, and required

monitoring system quality assurance or quality control activities (including, as applicable, calibration checks and required zero and span adjustments).

Any such periods that you do not collect data using the continuous monitoring system constitute a deviation from the monitoring requirements and must be reported in a deviation report.

(ii) You must collect continuous parameter monitoring system data in accordance with § 60.13(e)(2).

(iii) Any data collected during monitoring system malfunctions, repairs associated with monitoring system malfunctions, or required monitoring system quality assurance or control activities must not be included in calculations used to report emissions or operating levels. Any such periods must be reported in your annual deviation report.

(iv) Any data collected during periods when the monitoring system is out of control as specified in § 60.5200(a)(7)(i) must not be included in calculations used to report emissions or operating levels. Any such periods that do not coincide with a monitoring system malfunction, as defined in § 60.5250, constitute a deviation from the monitoring requirements and must be reported in a deviation report.

(v) You must use all the data collected during all periods except those periods specified in paragraphs (a)(1)(iii) and (a)(1)(iv) of this section in assessing the operation of the control device and associated control system.

(vi) Record the results of each inspection, calibration, and validation check.

(2) Operate and maintain your continuous monitoring system according to your monitoring plan required under § 60.4880. Additionally:

(i) For carrier gas flow rate monitors (for activated carbon injection), during the performance test conducted pursuant to § 60.4885, you must demonstrate that the system is maintained within  $\pm 5$  percent accuracy, according to the procedures in appendix A to part 75 of this chapter.

(ii) For carrier gas pressure drop monitors (for activated carbon injection), during the performance test conducted pursuant to § 60.4885, you must demonstrate that the system is maintained within  $\pm 5$  percent accuracy.

(b) You must operate and maintain your bag leak detection system in continuous operation according to your monitoring plan required under § 60.4880. Additionally:

(1) For positive pressure fabric filter systems that do not duct all

compartments of cells to a common stack, a bag leak detection system must be installed in each baghouse compartment or cell.

(2) Where multiple bag leak detectors are required, the system's instrumentation and alarm may be shared among detectors.

(3) You must initiate procedures to determine the cause of every alarm within 8 hours of the alarm, and you must alleviate the cause of the alarm within 24 hours of the alarm by taking whatever corrective action(s) are necessary. Corrective actions may include, but are not limited to the following:

(i) Inspecting the fabric filter for air leaks, torn or broken bags or filter media, or any other condition that may cause an increase in particulate matter emissions.

(ii) Sealing off defective bags or filter media.

(iii) Replacing defective bags or filter media or otherwise repairing the control device.

(iv) Sealing off a defective fabric filter compartment.

(v) Cleaning the bag leak detection system probe or otherwise repairing the bag leak detection system.

(vi) Shutting down the process producing the particulate matter emissions.

(c) You must operate and maintain the continuous parameter monitoring systems specified in paragraphs (a) and (b) of this section in continuous operation according to your monitoring plan required under § 60.4880.

(d) If your SSI unit has a bypass stack, you must install, calibrate (to manufacturers' specifications), maintain, and operate a device or method for measuring the use of the bypass stack including date, time, and duration.

### Model Rule—Recordkeeping and Reporting

#### § 60.5230 What records must I keep?

You must maintain the items (as applicable) specified in paragraphs (a) through (n) of this section for a period of at least 5 years. All records must be available on site in either paper copy or computer-readable format that can be printed upon request, unless an alternative format is approved by the Administrator.

(a) *Date*. Calendar date of each record.

(b) *Increments of progress*. Copies of the final control plan and any additional notifications, reported under § 60.5235.

(c) *Operator Training*. Documentation of the operator training procedures and records specified in paragraphs (c)(1)

through (c)(4) of this section. You must make available and readily accessible at the facility at all times for all SSI unit operators the documentation specified in paragraph (c)(1) of this section.

(1) Documentation of the following operator training procedures and information:

(i) Summary of the applicable standards under this subpart.

(ii) Procedures for receiving, handling, and feeding sewage sludge.

(iii) Incinerator startup, shutdown, and malfunction preventative and corrective procedures.

(iv) Procedures for maintaining proper combustion air supply levels.

(v) Procedures for operating the incinerator and associated air pollution control systems within the standards established under this subpart.

(vi) Monitoring procedures for demonstrating compliance with the incinerator operating limits.

(vii) Reporting and recordkeeping procedures.

(viii) Procedures for handling ash.

(ix) A list of the materials burned during the performance test, if in addition to sewage sludge.

(x) For each qualified operator and other plant personnel who may operate the unit according to the provisions of § 60.5155(a), the phone and/or pager number at which they can be reached during operating hours.

(2) Records showing the names of SSI unit operators and other plant personnel who may operate the unit according to the provisions of § 60.5155(a), as follows:

(i) Records showing the names of SSI unit operators and other plant personnel who have completed review of the information in paragraph (c)(1) of this section as required by § 60.5160(b), including the date of the initial review and all subsequent annual reviews.

(ii) Records showing the names of the SSI operators who have completed the operator training requirements under § 60.5130, met the criteria for qualification under § 60.5140, and maintained or renewed their qualification under § 60.5145 or § 60.5150. Records must include documentation of training, including the dates of their initial qualification and all subsequent renewals of such qualifications.

(3) Records showing the periods when no qualified operators were accessible for more than 8 hours, but less than 2 weeks, as required in § 60.5155(a).

(4) Records showing the periods when no qualified operators were accessible for 2 weeks or more along with copies of reports submitted as required in § 60.5155(b).

(d) *Air pollution control device inspections*. Records of the results of initial and annual air pollution control device inspections conducted as specified in §§ 60.5195 and 60.5220(c), including any required maintenance and any repairs not completed within 10 days of an inspection or the timeframe established by the Administrator.

(e) *Performance test reports*.

(1) The results of the initial, annual, and any subsequent performance tests conducted to determine compliance with the emission limits and standards and/or to establish operating limits, as applicable.

(2) Retain a copy of the complete performance test report, including calculations.

(3) Keep a record of the hourly dry sludge feed rate measured during performance test runs as specified in § 60.5220(a)(2)(i).

(4) Keep any necessary records to demonstrate that the performance test was conducted under conditions representative of normal operations, including a record of the moisture content measured as required in § 60.5220(a)(2)(ii) for each grab sample taken of the sewage sludge burned during the performance test.

(f) *Continuous monitoring data*. Records of the following data, as applicable:

(1) For continuous emissions monitoring systems, all 1-hour average concentrations of particulate matter, hydrogen chloride, carbon monoxide, dioxins/furans total mass basis, mercury, nitrogen oxides, sulfur dioxide, cadmium, and lead emissions.

(2) For continuous automated sampling systems, all average concentrations measured for mercury and dioxins/furans total mass basis at the frequencies specified in your monitoring plan.

(3) For continuous parameter monitoring systems:

(i) All 1-hour average values recorded for the following operating parameters, as applicable:

(A) Combustion chamber operating temperature (or afterburner temperature).

(B) If a wet scrubber is used to comply with the rule, pressure drop across each wet scrubber system and liquid flow rate to each wet scrubber used to comply with the emission limit in Table 2 or 3 to this subpart for particulate matter, cadmium, or lead, and scrubber liquid flow rate and scrubber liquid pH for each wet scrubber used to comply with an emission limit in Table 2 or 3 to this subpart for sulfur dioxide or hydrogen chloride.

(C) If an electrostatic precipitator is used to comply with the rule, secondary voltage of the electrostatic precipitator collection plates and secondary amperage of the electrostatic precipitator collection plates, and effluent water flow rate at the outlet of the wet electrostatic precipitator.

(D) If activated carbon injection is used to comply with the rule, sorbent flow rate and carrier gas flow rate or pressure drop, as applicable.

(ii) All daily average values recorded for the feed rate and moisture content of the sewage sludge fed to the sewage sludge incinerator, monitored and calculated as specified in § 60.5170(f).

(iii) If a fabric filter is used to comply with the rule, the date, time, and duration of each alarm and the time corrective action was initiated and completed, and a brief description of the cause of the alarm and the corrective action taken. You must also record the percent of operating time during each 6-month period that the alarm sounds, calculated as specified in § 60.5210.

(iv) For other control devices for which you must establish operating limits under § 60.5175, you must maintain data collected for all operating parameters used to determine compliance with the operating limits, at the frequencies specified in your monitoring plan.

(g) *Other records for continuous monitoring systems.* You must keep the following records, as applicable:

(1) Keep records of any notifications to the Administrator in § 60.4915(h)(1) of starting or stopping use of a continuous monitoring system for determining compliance with any emissions limit.

(2) Keep records of any requests under § 60.5220(b)(5) that compliance with the emission limits be determined using carbon dioxide measurements corrected to an equivalent of 7 percent oxygen.

(3) If activated carbon injection is used to comply with the rule, the type of sorbent used and any changes in the type of sorbent used.

(h) *Deviation Reports.* Records of any deviation reports submitted under § 60.5235(e) and (f).

(i) *Equipment specifications and operation and maintenance requirements.* Equipment specifications and related operation and maintenance requirements received from vendors for the incinerator, emission controls, and monitoring equipment.

(j) *Inspections, calibrations, and validation checks of monitoring devices.* Records of inspections, calibration, and validation checks of any monitoring devices as required under §§ 60.5220 and 60.5225.

(k) *Monitoring plan and performance evaluations for continuous monitoring systems.* Records of the monitoring plans required under § 60.5200, and records of performance evaluations required under § 60.5205(b)(5). (l) *Less frequent testing.* If, consistent with 60.5205(a)(3), you elect to conduct performance tests less frequently than annually, you must keep annual records that document that your emissions in the two previous consecutive years were at or below 75 percent of the applicable emission limit in Table 1 or 2 to this subpart, and document that there were no changes in source operations or air pollution control equipment that would cause emissions of the relevant pollutant to increase within the past 2 years.

(m) *Use of bypass stack.* Records indicating use of the bypass stack, including dates, times, and durations as required under § 60.5225(d).

(n) If a malfunction occurs, you must keep a record of the information submitted in your annual report in § 60.5235(c)(16).

#### **§ 60.5235 What reports must I submit?**

You must submit the reports specified in paragraphs (a) through (i) of this section. See Table 6 to this subpart for a summary of these reports.

(a) *Increments of progress report.* If you plan to achieve compliance more than 1 year following the effective date of state plan approval, you must submit the following reports, as applicable:

(1) A final control plan as specified in §§ 60.5085(a) and 60.5110.

(2) You must submit your notification of achievement of increments of progress no later than 10 business days after the compliance date for the increment as specified in §§ 60.5095 and 60.5100.

(3) If you fail to meet an increment of progress, you must submit a notification to the Administrator postmarked within 10 business days after the date for that increment, as specified in § 60.5105.

(4) If you plan to close your SSI unit rather than comply with the state plan, submit a closure notification as specified in § 60.5125.

(b) *Initial compliance report.* You must submit the following information no later than 60 days following the initial performance test.

(1) Company name, physical address, and mailing address.

(2) Statement by a responsible official, with that official's name, title, and signature, certifying the accuracy of the content of the report.

(3) Date of report.

(4) The complete test report for the initial performance test results obtained

by using the test methods specified in Table 2 or 3 to this subpart.

(5) If an initial performance evaluation of a continuous monitoring system was conducted, the results of that initial performance evaluation.

(6) The values for the site-specific operating limits established pursuant to §§ 60.5170 and 60.5175 and the calculations and methods, as applicable, used to establish each operating limit.

(7) If you are using a fabric filter to comply with the emission limits, documentation that a bag leak detection system has been installed and is being operated, calibrated, and maintained as required by § 60.5170(b).

(8) The results of the initial air pollution control device inspection required in § 60.5195, including a description of repairs.

(9) The site-specific monitoring plan required under § 60.5200, at least 60 days before your initial performance evaluation of your continuous monitoring system.

(10) The site-specific monitoring plan for your ash handling system required under § 60.5200, at least 60 days before your initial performance test to demonstrate compliance with your fugitive ash emission limit.

(c) *Annual compliance report.* You must submit an annual compliance report that includes the items listed in paragraphs (c)(1) through (c)(16) of this section for the reporting period specified in paragraph (c)(3) of this section. You must submit your first annual compliance report no later than 12 months following the submission of the initial compliance report in paragraph (b) of this section. You must submit subsequent annual compliance reports no more than 12 months following the previous annual compliance report. (You may be required to submit these reports (or additional compliance information) more frequently by the title V operating permit required in § 60.5240.)

(1) Company name, physical address, and mailing address.

(2) Statement by a responsible official, with that official's name, title, and signature, certifying the accuracy of the content of the report.

(3) Date of report and beginning and ending dates of the reporting period.

(4) If a performance test was conducted during the reporting period, the results of that performance test.

(i) If operating limits were established during the performance test, include the value for each operating limit and, as applicable, the method used to establish each operating limit, including calculations.

(ii) If activated carbon is used during the performance test, include the type of activated carbon used.

(5) For each pollutant and operating parameter recorded using a continuous monitoring system, the highest average value and lowest average value recorded during the reporting period, as follows:

(i) For continuous emission monitoring systems and continuous automated sampling systems, report the highest and lowest 24-hour average emission value.

(ii) For continuous parameter monitoring systems, report the following values:

(A) For all operating parameters except scrubber liquid pH, the highest and lowest 12-hour average values.

(B) For scrubber liquid pH, the highest and lowest 3-hour average values.

(6) If there are no deviations during the reporting period from any emission limit, emission standard, or operating limit that applies to you, a statement that there were no deviations from the emission limits, emission standard, or operating limits.

(7) Information for bag leak detection systems recorded under § 60.5230(f)(3)(iii).

(8) If a performance evaluation of a continuous monitoring system was conducted, the results of that performance evaluation. If new operating limits were established during the performance evaluation, include your calculations for establishing those operating limits.

(9) If you elect to conduct performance tests less frequently as allowed in § 60.5205(a)(3) and did not conduct a performance test during the reporting period, you must include the dates of the last two performance tests, a comparison of the emission level you achieved in the last two performance tests to the 75 percent emission limit threshold specified in § 60.5205(a)(3), and a statement as to whether there have been any process changes and whether the process change resulted in an increase in emissions.

(10) Documentation of periods when all qualified sewage sludge incineration unit operators were unavailable for more than 8 hours, but less than 2 weeks.

(11) Results of annual air pollution control device inspections recorded under § 60.5230(d) for the reporting period, including a description of repairs.

(12) If there were no periods during the reporting period when your continuous monitoring systems had a malfunction, a statement that there were no periods during which your

continuous monitoring systems had a malfunction.

(13) If there were no periods during the reporting period when a continuous monitoring system was out of control, a statement that there were no periods during which your continuous monitoring systems were out of control.

(14) If there were no operator training deviations, a statement that there were no such deviations during the reporting period.

(15) If you did not make revisions to your site-specific monitoring plan during the reporting period, a statement that you did not make any revisions to your site-specific monitoring plan during the reporting period. If you made revisions to your site-specific monitoring plan during the reporting period, a copy of the revised plan.

(16) If you had a malfunction during the reporting period, the compliance report must include the number, duration, and a brief description for each type of malfunction that occurred during the reporting period and that caused or may have caused any applicable emission limitation to be exceeded. The report must also include a description of actions taken by an owner or operator during a malfunction of an affected source to minimize emissions in accordance with § 60.11(d), including actions taken to correct a malfunction.

(d) *Deviation reports.*

(1) You must submit a deviation report if:

(i) Any recorded operating parameter level, based on the averaging time specified in Table 4 to this subpart, is above the maximum operating limit or below the minimum operating limit established under this subpart.

(ii) The bag leak detection system alarm sounds for more than 5 percent of the operating time for the 6-month reporting period.

(iii) Any recorded 24-hour block average emissions level is above the emission limit, if a continuous monitoring system is used to comply with an emission limit.

(iv) There are visible emissions of combustion ash from an ash conveying system for more than 5 percent of the hourly observation period.

(v) A performance test was conducted that deviated from any emission limit in Table 2 or 3 to this subpart.

(vi) A continuous monitoring system was out of control.

(vii) You had a malfunction (e.g., continuous monitoring system malfunction) that caused or may have caused any applicable emission limit to be exceeded.

(2) The deviation report must be submitted by August 1 of that year for data collected during the first half of the calendar year (January 1 to June 30), and by February 1 of the following year for data you collected during the second half of the calendar year (July 1 to December 31).

(3) For each deviation where you are using a continuous monitoring system to comply with an associated emission limit or operating limit, report the items described in paragraphs (d)(3)(i) through (d)(3)(viii) of this section.

(i) Company name, physical address, and mailing address.

(ii) Statement by a responsible official, with that official's name, title, and signature, certifying the accuracy of the content of the report.

(iii) The calendar dates and times your unit deviated from the emission limits, emission standards, or operating limits requirements.

(iv) The averaged and recorded data for those dates.

(v) Duration and cause of each deviation from the following:

(A) Emission limits, emission standards, operating limits, and your corrective actions.

(B) Bypass events and your corrective actions.

(vi) Dates, times, and causes for monitor downtime incidents.

(vii) A copy of the operating parameter monitoring data during each deviation and any test report that documents the emission levels.

(viii) If there were periods during which the continuous monitoring system malfunctioned or was out of control, you must include the following information for each deviation from an emission limit or operating limit:

(A) The date and time that each malfunction started and stopped.

(B) The date, time, and duration that each continuous monitoring system was inoperative, except for zero (low-level) and high-level checks.

(C) The date, time, and duration that each continuous monitoring system was out of control, including start and end dates and hours and descriptions of corrective actions taken.

(D) The date and time that each deviation started and stopped, and whether each deviation occurred during a period of malfunction, during a period when the system as out of control, or during another period.

(E) A summary of the total duration of the deviation during the reporting period, and the total duration as a percent of the total source operating time during that reporting period.

(F) A breakdown of the total duration of the deviations during the reporting

period into those that are due to control equipment problems, process problems, other known causes, and other unknown causes.

(G) A summary of the total duration of continuous monitoring system downtime during the reporting period, and the total duration of continuous monitoring system downtime as a percent of the total operating time of the SSI unit at which the continuous monitoring system downtime occurred during that reporting period.

(H) An identification of each parameter and pollutant that was monitored at the SSI unit.

(I) A brief description of the SSI unit.

(J) A brief description of the continuous monitoring system.

(K) The date of the latest continuous monitoring system certification or audit.

(L) A description of any changes in continuous monitoring system, processes, or controls since the last reporting period.

(4) For each deviation where you are not using a continuous monitoring system to comply with the associated emission limit or operating limit, report the following items:

(i) Company name, physical address, and mailing address.

(ii) Statement by a responsible official, with that official's name, title, and signature, certifying the accuracy of the content of the report.

(iii) The total operating time of each affected source during the reporting period.

(iv) The calendar dates and times your unit deviated from the emission limits, emission standards, or operating limits requirements.

(v) The averaged and recorded data for those dates.

(vi) Duration and cause of each deviation from the following:

(A) Emission limits, emission standards, operating limits, and your corrective actions.

(B) Bypass events and your corrective actions.

(vii) A copy of any performance test report that showed a deviation from the emission limits or standards.

(viii) A brief description of any malfunction reported in paragraph (d)(1)(vii) of this section, including a description of actions taken during the malfunction to minimize emissions in accordance with § 60.11(d) and to correct the malfunction.

(e) *Qualified operator deviation.*

(1) If all qualified operators are not accessible for 2 weeks or more, you must take the two actions in paragraphs (e)(1)(i) and (e)(1)(ii) of this section.

(i) Submit a notification of the deviation within 10 days that includes

the three items in paragraphs (e)(1)(i)(A) through (e)(1)(i)(C) of this section.

(A) A statement of what caused the deviation.

(B) A description of actions taken to ensure that a qualified operator is accessible.

(C) The date when you anticipate that a qualified operator will be available.

(ii) Submit a status report to the Administrator every 4 weeks that includes the three items in paragraphs (e)(1)(ii)(A) through (e)(1)(ii)(C) of this section.

(A) A description of actions taken to ensure that a qualified operator is accessible.

(B) The date when you anticipate that a qualified operator will be accessible.

(C) Request for approval from the Administrator to continue operation of the SSI unit.

(2) If your unit was shut down by the Administrator, under the provisions of § 60.5155(b)(2)(i), due to a failure to provide an accessible qualified operator, you must notify the Administrator within five days of meeting § 60.5155(b)(2)(ii) that you are resuming operation.

(f) *Notification of a force majeure.* If a force majeure is about to occur, occurs, or has occurred for which you intend to assert a claim of force majeure:

(1) You must notify the Administrator, in writing as soon as practicable following the date you first knew, or through due diligence, should have known that the event may cause or caused a delay in conducting a performance test beyond the regulatory deadline, but the notification must occur before the performance test deadline unless the initial force majeure or a subsequent force majeure event delays the notice, and in such cases, the notification must occur as soon as practicable.

(2) You must provide to the Administrator a written description of the force majeure event and a rationale for attributing the delay in conducting the performance test beyond the regulatory deadline to the force majeure; describe the measures taken or to be taken to minimize the delay; and identify a date by which you propose to conduct the performance test.

(g) *Other notifications and reports required.* You must submit other notifications as provided by § 60.7 and as follows:

(1) You must notify the Administrator 1 month before starting or stopping use of a continuous monitoring system for determining compliance with any emission limit.

(2) You must notify the Administrator at least 30 days prior to any

performance test conducted to comply with the provisions of this subpart, to afford the Administrator the opportunity to have an observer present.

(3) As specified in § 60.5220(a)(8), you must notify the Administrator at least 7 days prior to the date of a rescheduled performance test for which notification was previously made in paragraph (g)(2) of this section.

(h) *Report submission form.*

(1) Submit initial, annual, and deviation reports electronically or in paper format, postmarked on or before the submittal due dates.

(2) As of January 1, 2012 and within 60 days after the date of completing each performance test, as defined in § 63.2, conducted to demonstrate compliance with this subpart, you must submit relative accuracy test audit (*i.e.*, reference method) data and performance test (*i.e.*, compliance test) data, except opacity data, electronically to EPA's Central Data Exchange (CDX) by using the Electronic Reporting Tool (ERT) (*see* [http://www.epa.gov/ttn/chief/ert/ert\\_tool.html/](http://www.epa.gov/ttn/chief/ert/ert_tool.html/)) or other compatible electronic spreadsheet. Only data collected using test methods compatible with ERT are subject to this requirement to be submitted electronically into EPA's WebFIRE database.

(i) *Changing report dates.* If the Administrator agrees, you may change the semiannual or annual reporting dates. See § 60.19(c) for procedures to seek approval to change your reporting date.

#### Model Rule—Title V Operating Permits

##### § 60.5240 Am I required to apply for and obtain a Title V operating permit for my existing SSI unit?

Yes, if you are subject to an applicable EPA-approved and effective CAA section 111(d)/129 state or tribal plan or an applicable and effective Federal plan, you are required to apply for and obtain a Title V operating permit for your existing SSI unit unless you meet the relevant requirements for an exemption specified in § 60.5065.

##### § 60.5245 When must I submit a title V permit application for my existing SSI unit?

(a) If your existing SSI unit is not subject to an earlier permit application deadline, a complete title V permit application must be submitted on or before the earlier of the dates specified in paragraphs (a)(1) through (a)(3) of this section. (See sections 129 (e), 503(c), 503(d), and 502(a) of the Clean Air Act and 40 CFR 70.5(a)(1)(i) and 40 CFR 71.5(a)(1)(i)).

(1) 12 months after the effective date of any applicable EPA-approved Clean

Air Act section 111(d)/129 state or tribal plan.

(2) 12 months after the effective date of any applicable Federal plan.

(3) March 21, 2014.

(b) For any existing unit not subject to an earlier permit application deadline, the application deadline of 36 months after the promulgation of this subpart applies regardless of whether or when any applicable Federal plan is effective, or whether or when any applicable Clean Air Act section 111(d)/129 state or tribal plan is approved by EPA and becomes effective.

(c) If your existing unit is subject to title V as a result of some triggering requirement(s) other than those specified in paragraphs (a) and (b) of this section (for example, a unit may be a major source or part of a major source), then your unit may be required to apply for a title V permit prior to the deadlines specified in paragraphs (a) and (b). If more than one requirement triggers a source's obligation to apply for a title V permit, the 12-month timeframe for filing a title V permit application is triggered by the requirement which first causes the source to be subject to title V. (See section 503(c) of the Clean Air Act and 40 CFR 70.3(a) and (b), 40 CFR 70.5(a)(1)(i), 40 CFR 71.3(a) and (b), and 40 CFR 71.5(a)(1)(i).)

(d) A "complete" title V permit application is one that has been determined or deemed complete by the relevant permitting authority under section 503(d) of the Clean Air Act and 40 CFR 70.5(a)(2) or 40 CFR 71.5(a)(2). You must submit a complete permit application by the relevant application deadline in order to operate after this date in compliance with Federal law. (See sections 503(d) and 502(a) of the Clean Air Act and 40 CFR 70.7(b) and 40 CFR 71.7(b).)

#### Model Rule-Definitions

##### § 60.5250 What definitions must I know?

Terms used but not defined in this subpart are defined in the Clean Air Act and § 60.2.

*Administrator* means:

(1) For units covered by the Federal plan, the Administrator of the EPA or his/her authorized representative.

(2) For units covered by an approved state plan, the director of the state air pollution control agency or his/her authorized representative.

*Affected source* means a sewage sludge incineration unit as defined in § 60.5250.

*Affirmative defense* means, in the context of an enforcement proceeding, a response or defense put forward by a defendant, regarding which the

defendant has the burden of proof, and the merits of which are independently and objectively evaluated in a judicial or administrative proceeding.

*Auxiliary fuel* means natural gas, liquefied petroleum gas, fuel oil, or diesel fuel.

*Bag leak detection system* means an instrument that is capable of monitoring particulate matter loadings in the exhaust of a fabric filter (*i.e.*, baghouse) in order to detect bag failures. A bag leak detection system includes, but is not limited to, an instrument that operates on triboelectric, light scattering, light transmittance, or other principle to monitor relative particulate matter loadings.

*Bypass stack* means a device used for discharging combustion gases to avoid severe damage to the air pollution control device or other equipment.

*Calendar year* means 365 consecutive days starting on January 1 and ending on December 31.

*Continuous automated sampling system* means the total equipment and procedures for automated sample collection and sample recovery/analysis to determine a pollutant concentration or emission rate by collecting a single integrated sample(s) or multiple integrated sample(s) of the pollutant (or diluent gas) for subsequent on- or off-site analysis; integrated sample(s) collected are representative of the emissions for the sample time as specified by the applicable requirement.

*Continuous emissions monitoring system* means a monitoring system for continuously measuring and recording the emissions of a pollutant from an affected facility.

*Continuous monitoring system (CMS)* means a continuous emissions monitoring system, continuous automated sampling system, continuous parameter monitoring system or other manual or automatic monitoring that is used for demonstrating compliance with an applicable regulation on a continuous basis as defined by this subpart. The term refers to the total equipment used to sample and condition (if applicable), to analyze, and to provide a permanent record of emissions or process parameters.

*Continuous parameter monitoring system* means a monitoring system for continuously measuring and recording operating conditions associated with air pollution control device systems (*e.g.*, operating temperature, pressure, and power).

*Deviation* means any instance in which an affected source subject to this subpart, or an owner or operator of such a source:

(1) Fails to meet any requirement or obligation established by this subpart, including but not limited to any emission limit, operating limit, or operator qualification and accessibility requirements.

(2) Fails to meet any term or condition that is adopted to implement an applicable requirement in this subpart and that is included in the operating permit for any affected source required to obtain such a permit.

*Dioxins/furans* means tetra- through octa-chlorinated dibenzo-p-dioxins and dibenzofurans.

*Electrostatic precipitator or wet electrostatic precipitator* means an air pollution control device that uses both electrical forces and, if applicable, water to remove pollutants in the exit gas from a sewage sludge incinerator stack.

*Existing sewage sludge incineration unit* means a sewage sludge incineration unit the construction of which is commenced on or before October 14, 2010.

*Fabric filter* means an add-on air pollution control device used to capture particulate matter by filtering gas streams through filter media, also known as a baghouse.

*Fluidized bed incinerator* means an enclosed device in which organic matter and inorganic matter in sewage sludge are combusted in a bed of particles suspended in the combustion chamber gas.

*Malfunction* means any sudden, infrequent, and not reasonably preventable failure of air pollution control and monitoring equipment, process equipment, or a process to operate in a normal or usual manner. Failures that are caused, in part, by poor maintenance or careless operation are not malfunctions.

*Modification* means a change to an existing SSI unit later than September 21, 2011 and that meets one of two criteria:

(1) The cumulative cost of the changes over the life of the unit exceeds 50 percent of the original cost of building and installing the SSI unit (not including the cost of land) updated to current costs (current dollars). To determine what systems are within the boundary of the SSI unit used to calculate these costs, see the definition of SSI unit.

(2) Any physical change in the SSI unit or change in the method of operating it that increases the amount of any air pollutant emitted for which section 129 or section 111 of the Clean Air Act has established standards.

*Modified sewage sludge incineration unit* means an existing SSI unit that

undergoes a modification, as defined in this section.

*Multiple hearth incinerator* means a circular steel furnace that contains a number of solid refractory hearths and a central rotating shaft; rabble arms that are designed to slowly rake the sludge on the hearth are attached to the rotating shaft. Dewatered sludge enters at the top and proceeds downward through the furnace from hearth to hearth, pushed along by the rabble arms.

*Operating day* means a 24-hour period between 12:00 midnight and the following midnight during which any amount of sewage sludge is combusted at any time in the SSI unit.

*Particulate matter* means filterable particulate matter emitted from SSI units as measured by Method 5 at 40 CFR part 60, appendix A-3 or Methods 26A or 29 at 40 CFR part 60, appendix A-8.

*Power input to the electrostatic precipitator* means the product of the test-run average secondary voltage and the test-run average secondary amperage to the electrostatic precipitator collection plates.

*Process change* means a significant permit revision, but only with respect to those pollutant-specific emission units for which the proposed permit revision is applicable, including but not limited to:

(1) A change in the process employed at the wastewater treatment facility associated with the affected SSI unit (e.g., the addition of tertiary treatment at the facility, which changes the method used for disposing of process solids and processing of the sludge prior to incineration).

(2) A change in the air pollution control devices used to comply with the emission limits for the affected SSI unit (e.g., change in the sorbent used for activated carbon injection).

*Sewage sludge* means solid, semi-solid, or liquid residue generated during the treatment of domestic sewage in a treatment works. Sewage sludge includes, but is not limited to, domestic septage; scum or solids removed in

primary, secondary, or advanced wastewater treatment processes; and a material derived from sewage sludge. Sewage sludge does not include ash generated during the firing of sewage sludge in a sewage sludge incineration unit or grit and screenings generated during preliminary treatment of domestic sewage in a treatment works.

*Sewage sludge feed rate* means the rate at which sewage sludge is fed into the incinerator unit.

*Sewage sludge incineration (SSI) unit* means an incineration unit combusting sewage sludge for the purpose of reducing the volume of the sewage sludge by removing combustible matter. Sewage sludge incineration unit designs include fluidized bed and multiple hearth. A SSI unit also includes, but is not limited to, the sewage sludge feed system, auxiliary fuel feed system, grate system, flue gas system, waste heat recovery equipment, if any, and bottom ash system. The SSI unit includes all ash handling systems connected to the bottom ash handling system. The combustion unit bottom ash system ends at the truck loading station or similar equipment that transfers the ash to final disposal. The SSI unit does not include air pollution control equipment or the stack.

*Shutdown* means the period of time after all sewage sludge has been combusted in the primary chamber.

*Solid waste* means any garbage, refuse, sewage sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, agricultural operations, and from community activities, but does not include solid or dissolved material in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial discharges which are point sources subject to permits under section 402 of the Federal Water Pollution Control Act, as amended (33 U.S.C. 1342), or source, special nuclear, or

byproduct material as defined by the Atomic Energy Act of 1954, as amended (42 U.S.C. 2014).

*Standard conditions*, when referring to units of measure, means a temperature of 68 °F (20 °C) and a pressure of 1 atmosphere (101.3 kilopascals).

*Startup* means the period of time between the activation, including the firing of fuels (e.g., natural gas or distillate oil), of the system and the first feed to the unit.

*Toxic equivalency* means the product of the concentration of an individual dioxin isomer in an environmental mixture and the corresponding estimate of the compound-specific toxicity relative to tetrachlorinated dibenzo-p-dioxin, referred to as the toxic equivalency factor for that compound. Table 5 to this subpart lists the toxic equivalency factors.

*Wet scrubber* means an add-on air pollution control device that utilizes an aqueous or alkaline scrubbing liquid to collect particulate matter (including nonvolatile metals and condensed organics) and/or to absorb and neutralize acid gases.

*You* means the owner or operator of an affected SSI unit.

TABLE 1 TO SUBPART MMMM OF PART 60—MODEL RULE—INCREMENTS OF PROGRESS AND COMPLIANCE SCHEDULES FOR EXISTING SEWAGE SLUDGE INCINERATION UNITS

Comply with these increments of progress	By these dates <sup>a</sup>
Increment 1—Submit final control plan.	(Dates to be specified in state plan)
Increment 2—Final compliance.	(Dates to be specified in state plan) <sup>b</sup>

<sup>a</sup>Site-specific schedules can be used at the discretion of the state.

<sup>b</sup>The date can be no later than 3 years after the effective date of state plan approval or March 21, 2016 for SSI units that commenced construction on or before October 14, 2010.

TABLE 2 TO SUBPART MMMM OF PART 60—MODEL RULE—EMISSION LIMITS AND STANDARDS FOR EXISTING FLUIDIZED BED SEWAGE SLUDGE INCINERATION UNITS

For the air pollutant	You must meet this emission limit <sup>a</sup>	Using these averaging methods and minimum sampling volumes or durations	And determining compliance using this method
Particulate matter .....	18 milligrams per dry standard cubic meter.	3-run average (collect a minimum volume of 1 dry standard cubic meters sample per run).	Performance test (Method 5 at 40 CFR part 60, appendix A-3; Method 26A or Method 29 at 40 CFR part 60, appendix A-8).
Hydrogen chloride .....	0.51 parts per million by dry volume	3-run average (Collect a minimum volume of 1 dry standard cubic meters per run).	Performance test (Method 26A at 40 CFR part 60, appendix A-8).

TABLE 2 TO SUBPART MMMM OF PART 60—MODEL RULE—EMISSION LIMITS AND STANDARDS FOR EXISTING FLUIDIZED BED SEWAGE SLUDGE INCINERATION UNITS—Continued

For the air pollutant	You must meet this emission limit <sup>a</sup>	Using these averaging methods and minimum sampling volumes or durations	And determining compliance using this method
Carbon monoxide .....	64 parts per million by dry volume ....	3-run average (collect sample for a minimum duration of one hour per run).	Performance test (Method 10, 10A, or 10B at 40 CFR part 60, appendix A-4).
Dioxins/furans (total mass basis); or Dioxins/furans (toxic equivalency basis) <sup>b</sup>	1.2 nanograms per dry standard cubic meter (total mass basis); or 0.10 nanograms per dry standard cubic meter (toxic equivalency basis).	3-run average (collect a minimum volume of 1 dry standard cubic meters per run).	Performance test (Method 23 at 40 CFR part 60, appendix A-7).
Mercury .....	0.037 milligrams per dry standard cubic meter.	3-run average (For Method 29 and ASTM D6784-02 (Reapproved 2008) <sup>c</sup> , collect a minimum volume of 1 dry standard cubic meters per run. For Method 30B, collect a minimum sample as specified in Method 30B at 40 CFR part 60, appendix A-8).	Performance test (Method 29 at 40 CFR part 60, appendix A-8; Method 30B at 40 CFR part 60, appendix A-8; or ASTM D6784-02 (Reapproved 2008). <sup>c</sup>
Oxides of nitrogen .....	150 parts per million by dry volume ..	3-run average (Collect sample for a minimum duration of one hour per run).	Performance test (Method 7 or 7E at 40 CFR part 60, appendix A-4).
Sulfur dioxide .....	15 parts per million by dry volume ....	3-run average (For Method 6, collect a minimum volume of 60 liters per run. For Method 6C, collect sample for a minimum duration of one hour per run).	Performance test (Method 6 or 6C at 40 CFR part 40, appendix A-4; or ANSI/ASME PTC-19.10-1981. <sup>c</sup>
Cadmium .....	0.0016 milligrams per dry standard cubic meter.	3-run average (collect a minimum volume of 1 dry standard cubic meters per run).	Performance test (Method 29 at 40 CFR part 60, appendix A-8). Use GFAAS or ICP/MS for the analytical finish.
Lead .....	0.0074 milligrams per dry standard cubic meter.	3-run average (collect a minimum volume of 1 dry standard cubic meters sample per run).	Performance test (Method 29 at 40 CFR part 60, appendix A-8. Use GFAAS or ICP/MS for the analytical finish.
Fugitive emissions from ash handling.	Visible emissions of combustion ash from an ash conveying system (including conveyor transfer points) for no more than 5 percent of the hourly observation period.	Three 1-hour observation periods .....	Visible emission test (Method 22 of appendix A-7 of this part).

<sup>a</sup> All emission limits are measured at 7 percent oxygen, dry basis at standard conditions.

<sup>b</sup> You have the option to comply with either the dioxin/furan emission limit on a total mass basis or the dioxin/furan emission limit on a toxic equivalency basis.

<sup>c</sup> Incorporated by reference, see § 60.17.

TABLE 3 TO SUBPART MMMM OF PART 60—MODEL RULE—EMISSION LIMITS AND STANDARDS FOR EXISTING MULTIPLE HEARTH SEWAGE SLUDGE INCINERATION UNITS

For the air pollutant	You must meet this emission limit <sup>a</sup>	Using these averaging methods and minimum sampling volumes or durations	And determining compliance using this method
Particulate matter .....	80 milligrams per dry standard cubic meter.	3-run average (collect a minimum volume of 0.75 dry standard cubic meters per run).	Performance test (Method 5 at 40 CFR part 60, appendix A-3; Method 26A or Method 29 at 40 CFR part 60, appendix A-8).
Hydrogen chloride .....	1.2 parts per million by dry volume ...	3-run average (For Method 26, collect a minimum volume of 200 liters per run. For Method 26A, collect a minimum volume of 1 dry standard cubic meters per run).	Performance test (Method 26 or 26A at 40 CFR part 60, appendix A-8).
Carbon monoxide .....	3,800 parts per million by dry volume	3-run average (collect sample for a minimum duration of one hour per run).	Performance test (Method 10, 10A, or 10B at 40 CFR part 60, appendix A-4).
Dioxins/furans (total mass basis).	5.0 nanograms per dry standard cubic meter; or	3-run average (collect a minimum volume of 1 dry standard cubic meters per run).	Performance test (Method 23 at 40 CFR part 60, appendix A-7).
Dioxins/furans (toxic equivalency basis) <sup>b</sup> .	0.32 nanograms per dry standard cubic meter.		

TABLE 3 TO SUBPART MMMM OF PART 60—MODEL RULE—EMISSION LIMITS AND STANDARDS FOR EXISTING MULTIPLE HEARTH SEWAGE SLUDGE INCINERATION UNITS—Continued

For the air pollutant	You must meet this emission limit <sup>a</sup>	Using these averaging methods and minimum sampling volumes or durations	And determining compliance using this method
Mercury .....	0.28 milligrams per dry standard cubic meter.	3-run average (For Method 29 and ASTM D6784–02 (Reapproved 2008), <sup>c</sup> collect a minimum volume of 1 dry standard cubic meters per run. For Method 30B, collect a minimum sample as specified in Method 30B at 40 CFR part 60, appendix A–8).	Performance test (Method 29 at 40 CFR part 60, appendix A–8; Method 30B at 40 CFR part 60, appendix A–8; or ASTM D6784–02 (Reapproved 2008)). <sup>c</sup>
Oxides of nitrogen .....	220 parts per million by dry volume ..	3-run average (Collect sample for a minimum duration of one hour per run).	Performance test (Method 7 or 7E at 40 CFR part 60, appendix A–4).
Sulfur dioxide .....	26 parts per million by dry volume ....	3-run average (For Method 6, collect a minimum volume of 200 liters per run. For Method 6C, collect sample for a minimum duration of one hour per run).	Performance test (Method 6 or 6C at 40 CFR part 40, appendix A–4; or ANSI/ASME PTC 19.10–1981). <sup>c</sup>
Cadmium .....	0.095 milligrams per dry standard cubic meter.	3-run average (collect a minimum volume of 1 dry standard cubic meters per run).	Performance test (Method 29 at 40 CFR part 60, appendix A–8).
Lead .....	0.30 milligrams per dry standard cubic meter.	3-run average (collect a minimum volume of 1 dry standard cubic meters per run).	Performance test (Method 29 at 40 CFR part 60, appendix A–8).
Fugitive emissions from ash handling.	Visible emissions of combustion ash from an ash conveying system (including conveyor transfer points) for no more than 5 percent of the hourly observation period.	Three 1-hour observation periods .....	Visible emission test (Method 22 of appendix A–7 of this part).

<sup>a</sup>All emission limits are measured at 7 percent oxygen, dry basis at standard conditions.

<sup>b</sup>You have the option to comply with either the dioxin/furan emission limit on a total mass basis or the dioxin/furan emission limit on a toxic equivalency basis.

<sup>c</sup>Incorporated by reference, see § 60.17.

TABLE 4 TO SUBPART MMMM OF PART 60—MODEL RULE—OPERATING PARAMETERS FOR EXISTING SEWAGE SLUDGE INCINERATION UNITS<sup>a</sup>

For these operating parameters	You must establish these operating limits	And monitor using these minimum frequencies		
		Data measurement	Data recording <sup>b</sup>	Data averaging period for compliance
<b>All sewage sludge incineration units</b>				
Combustion chamber operating temperature (not required if afterburner temperature is monitored).	Minimum combustion chamber operating temperature or afterburner temperature.	Continuous .....	Every 15 minutes ...	12-hour block.
Fugitive emissions from ash handling	Site-specific operating requirements	Not applicable .....	No applicable .....	Not applicable.
<b>Scrubber</b>				
Pressure drop across each wet scrubber.	Minimum pressure drop .....	Continuous .....	Every 15 minutes ...	12-hour block.
Scrubber liquid flow rate .....	Minimum flow rate .....	Continuous .....	Every 15 minutes ...	12-hour block.
Scrubber liquid pH .....	Minimum pH .....	Continuous .....	Every 15 minutes ...	3-hour block.
<b>Fabric Filter</b>				
Alarm time of the bag leak detection system alarm.	Maximum alarm time of the bag leak detection system alarm (this operating limit is provided in § 60.4850 and is not established on a site-specific basis)			
<b>Electrostatic precipitator</b>				
Secondary voltage of the electrostatic precipitator collection plates.	Minimum power input to the electrostatic precipitator collection plates.	Continuous .....	Hourly .....	12-hour block.
Secondary amperage of the electrostatic precipitator collection plates.				

TABLE 4 TO SUBPART MMMM OF PART 60—MODEL RULE—OPERATING PARAMETERS FOR EXISTING SEWAGE SLUDGE INCINERATION UNITS <sup>a</sup>—Continued

For these operating parameters	You must establish these operating limits	And monitor using these minimum frequencies		
		Data measurement	Data recording <sup>b</sup>	Data averaging period for compliance
Effluent water flow rate at the outlet of the electrostatic precipitator.	Minimum effluent water flow rate at the outlet of the electrostatic precipitator.	Hourly .....	Hourly .....	12-hour block.
<b>Activated carbon injection</b>				
Mercury sorbent injection rate .....	Minimum mercury sorbent injection rate.	Hourly .....	Hourly .....	12-hour block.
Dioxin/furan sorbent injection rate .....	Minimum dioxin/furan sorbent injection rate.			
Carrier gas flow rate or carrier gas pressure drop.	Minimum carrier gas flow rate or minimum carrier gas pressure drop.	Continuous .....	Every 15 minutes ...	12-hour block.
<b>Afterburner</b>				
Temperature of the afterburner combustion chamber.	Minimum temperature of the afterburner combustion chamber.	Continuous .....	Every 15 minutes ...	12-hour block.

<sup>a</sup> As specified in § 60.5190, you may use a continuous emissions monitoring system or continuous automated sampling system in lieu of establishing certain operating limits.  
<sup>b</sup> This recording time refers to the minimum frequency that the continuous monitor or other measuring device initially records data. For all data recorded every 15 minutes, you must calculate hourly arithmetic averages. For all parameters, you use hourly averages to calculate the 12-hour or 3-hour block average specified in this table for demonstrating compliance. You maintain records of 1-hour averages.

TABLE 5 TO SUBPART MMMM OF PART 60—MODEL RULE—TOXIC EQUIVALENCY FACTORS

Dioxin/furan isomer	Toxic equivalency factor
2,3,7,8-tetrachlorinated dibenzo-p-dioxin .....	1
1,2,3,7,8-pentachlorinated dibenzo-p-dioxin .....	1
1,2,3,4,7,8-hexachlorinated dibenzo-p-dioxin .....	0.1
1,2,3,7,8,9-hexachlorinated dibenzo-p-dioxin .....	0.1
1,2,3,6,7,8-hexachlorinated dibenzo-p-dioxin .....	0.1
1,2,3,4,6,7,8-heptachlorinated dibenzo-p-dioxin .....	0.01
octachlorinated dibenzo-p-dioxin .....	0.0003
2,3,7,8-tetrachlorinated dibenzofuran .....	0.1
2,3,4,7,8-pentachlorinated dibenzofuran .....	0.3
1,2,3,7,8-pentachlorinated dibenzofuran .....	0.03
1,2,3,4,7,8-hexachlorinated dibenzofuran .....	0.1
1,2,3,6,7,8-hexachlorinated dibenzofuran .....	0.1
1,2,3,7,8,9-hexachlorinated dibenzofuran .....	0.1
2,3,4,6,7,8-hexachlorinated dibenzofuran .....	0.1
1,2,3,4,6,7,8-heptachlorinated dibenzofuran .....	0.01
1,2,3,4,7,8,9-heptachlorinated dibenzofuran .....	0.01
octachlorinated dibenzofuran .....	0.0003

TABLE 6 TO SUBPART MMMM OF PART 60—MODEL RULE—SUMMARY OF REPORTING REQUIREMENTS FOR EXISTING SEWAGE SLUDGE INCINERATION UNITS <sup>a</sup>

Report	Due date	Contents	Reference
Increments of progress report	No later than 10 business days after the compliance date for the increment.	1. Final control plan including air pollution control device descriptions, process changes, type of waste to be burned, and the maximum design sewage sludge burning capacity. 2. Notification of any failure to meet an increment of progress. 3. Notification of any closure.	§ 60.5235(a).
Initial compliance report .....	No later than 60 days following the initial performance test.	1. Company name and address .....	§ 60.5235(b).
		2. Statement by a responsible official, with that official's name, title, and signature, certifying the accuracy of the content of the report. 3. Date of report. 4. Complete test report for the initial performance test. 5. Results of CMS <sup>b</sup> performance evaluation.	

TABLE 6 TO SUBPART MMMM OF PART 60—MODEL RULE—SUMMARY OF REPORTING REQUIREMENTS FOR EXISTING SEWAGE SLUDGE INCINERATION UNITS<sup>a</sup>—Continued

Report	Due date	Contents	Reference
Annual compliance report .....	No later than 12 months following the submission of the initial compliance report; subsequent reports are to be submitted no more than 12 months following the previous report.	6. The values for the site-specific operating limits and the calculations and methods used to establish each operating limit. 7. Documentation of installation of bag leak detection system for fabric filter. 8. Results of initial air pollution control device inspection, including a description of repairs. 9. The site-specific monitoring plan required under § 60.5200. 10. The site-specific monitoring plan for your ash handling system required under § 60.5200. 1. Company name and address ..... 2. Statement and signature by responsible official. 3. Date and beginning and ending dates of report. 4. If a performance test was conducted during the reporting period, the results of the test, including any new operating limits and associated calculations and the type of activated carbon used, if applicable. 5. For each pollutant and operating parameter recorded using a CMS, the highest recorded 3-hour average and the lowest recorded 3-hour average, as applicable. 6. If no deviations from emission limits, emission standards, or operating limits occurred, a statement that no deviations occurred. 7. If a fabric filter is used, the date, time, and duration of alarms. 8. If a performance evaluation of a CMS was conducted, the results, including any new operating limits and their associated calculations. 9. If you met the requirements of § 60.5205(a)(3) and did not conduct a performance test, include the dates of the last three performance tests, a comparison to the 50 percent emission limit threshold of the emission level achieved in the last three performance tests, and a statement as to whether there have been any process changes. 10. Documentation of periods when all qualified SSI unit operators were unavailable for more than 8 hours but less than 2 weeks. 11. Results of annual pollutions control device inspections, including description of repairs. 12. If there were no periods during which your CMSs had malfunctions, a statement that there were no periods during which your CMSs had malfunctions. 13. If there were no periods during which your CMSs were out of control, a statement that there were no periods during which your CMSs were out of control. 14. If there were no operator training deviations, a statement that there were no such deviations. 15. Information on monitoring plan revisions, including a copy of any revised monitoring plan.	§ 60.5235(c).
Deviation report (deviations from emission limits, emission standards, or operating limits, as specified in § 60.5235(e)(1)).	By August 1 of a calendar year for data collected during the first half of the calendar year; by February 1 of a calendar year for data collected during the second half of the calendar year.	If using a CMS: ..... 1. Company name and address. 2. Statement by a responsible official. 3. The calendar dates and times your unit deviated from the emission limits or operating limits. 4. The averaged and recorded data for those dates. 5. Duration and cause of each deviation. 6. Dates, times, and causes for monitor downtime incidents. 7. A copy of the operating parameter monitoring data during each deviation and any test report that documents the emission levels. 8. For periods of CMS malfunction or when a CMS was out of control, you must include the information specified in § 60.5235(d)(3)(viii). If not using a CMS: ..... 1. Company name and address. 2. Statement by a responsible official. 3. The total operating time of each affected SSI. 4. The calendar dates and times your unit deviated from the emission limits, emission standard, or operating limits. 5. The averaged and recorded data for those dates.	§ 60.5235(d).

TABLE 6 TO SUBPART MMMM OF PART 60—MODEL RULE—SUMMARY OF REPORTING REQUIREMENTS FOR EXISTING SEWAGE SLUDGE INCINERATION UNITS<sup>a</sup>—Continued

Report	Due date	Contents	Reference
Notification of qualified operator deviation (if all qualified operators are not accessible for 2 weeks or more).	Within 10 days of deviation .....	6. Duration and cause of each deviation. 7. A copy of any performance test report that showed a deviation from the emission limits or standards. 8. A brief description of any malfunction, a description of actions taken during the malfunction to minimize emissions, and corrective action taken.	
Notification of status of qualified operator deviation.	Every 4 weeks following notification of deviation.	1. Statement of cause of deviation ..... 2. Description of actions taken to ensure that a qualified operator will be available. 3. The date when a qualified operator will be accessible.	§ 60.5235(e).
Notification of resumed operation following shutdown (due to qualified operator deviation and as specified in § 60.5155(b)(2)(i)).	Within five days of obtaining a qualified operator and resuming operation.	1. Description of actions taken to ensure that a qualified operator is accessible. 2. The date when you anticipate that a qualified operator will be accessible. 3. Request for approval to continue operation.	§ 60.5235(e).
Notification of a force majeure	As soon as practicable following the date you first knew, or through due diligence should have known that the event may cause or caused a delay in conducting a performance test beyond the regulatory deadline; the notification must occur before the performance test deadline unless the initial force majeure or a subsequent force majeure event delays the notice, and in such cases, the notification must occur as soon as practicable.	1. Notification that you have obtained a qualified operator and are resuming operation.  1. Description of the force majeure event ..... 2. Rationale for attributing the delay in conducting the performance test beyond the regulatory deadline to the force majeure. 3. Description of the measures taken or to be taken to minimize the delay. 4. Identification of the date by which you propose to conduct the performance test.	§ 60.5235(f).
Notification of intent to start or stop use of a CMS.	1 month before starting or stopping use of a CMS.	1. Intent to start or stop use of a CMS .....	§ 60.5235(g).
Notification of intent to conduct a performance test.	At least 30 days prior to the performance test.	1. Intent to conduct a performance test to comply with this subpart.	
Notification of intent to conduct a rescheduled performance test.	At least 7 days prior to the date of a rescheduled performance test.	1. Intent to conduct a rescheduled performance test to comply with this subpart.	

<sup>a</sup> This table is only a summary, see the referenced sections of the rule for the complete requirements.

<sup>b</sup> CMS means continuous monitoring system.

# Appendix B



CHAPTER I -- ENVIRONMENTAL PROTECTION AGENCY  
SUBCHAPTER C -- AIR PROGRAMS

PART 60 -- STANDARDS OF PERFORMANCE FOR NEW STATIONARY SOURCES

§ 60. Appendix A to Part 60 – Test Methods [Continued]

**40 CFR 60. Appendix A** to Part 60

METHOD 15A -- DETERMINATION OF TOTAL REDUCED SULFUR EMISSIONS FROM SULFUR RECOVERY PLANTS IN PETROLEUM REFINERIES

*1. Applicability, Principle, Interferences, Precision, and Bias*

1.1 Applicability. This method is applicable to the determination of total reduced sulfur (TRS) emissions from sulfur recovery plants where the emissions are in a reducing atmosphere, such as in Stretford units. The lower detectable limit is 0.1 ppm of sulfur dioxide (SO<sub>2</sub>) when sampling at 2 liters/min for 3 hours or 0.3 ppm when sampling at 2 liters/min for 1 hour. The upper concentration limit of the method exceeds TRS levels generally encountered in sulfur recovery plants.

1.2 Principle. An integrated gas sample is extracted from the stack, and combustion air is added to the oxygen (O<sub>2</sub>)-deficient gas at a known rate. The TRS compounds (hydrogen sulfide, carbonyl sulfide, and carbon disulfide) are thermally oxidized to sulfur dioxide, collected in hydrogen peroxide as sulfate ion, and then analyzed according to the Method 6 barium-thorin titration procedure.

1.3 Interferences. Reduced sulfur compounds, other than TRS, that are present in the emissions will also be oxidized to SO<sub>2</sub>. For example, thiophene has been identified in emissions from a Stretford unit and produced a positive bias of 30 percent in the Method 15A result. However, these biases may not affect the outcome of the test at units where emissions are low relative to the standard.

Calcium and aluminum have been shown to interfere in the Method 6 titration procedure. Since these metals have been identified in particulate matter emissions from Stretford units, a Teflon filter is required to remove this interference.

NOTE: Mention of trade name or commercial products in this publication does not constitute the endorsement or recommendation for use by the Environmental Protection Agency.

When used to sample emissions containing 7 percent moisture or less, the midget impingers have sufficient volume to contain the condensate collected during sampling. Dilution of the H<sub>2</sub>O does not affect the collection of SO<sub>2</sub>. At higher moisture contents, the potassium citrate-citric acid buffer system used with Method 16A should be used to collect the condensate.

1.4 Precision and bias. Relative standard deviations of 2.8 and 6.9 percent at 41 ppm TRS have been obtained when sampling for 1 and 3 hours, respectively. Results obtained with this method are likely to contain a positive bias due to the presence of nonregulated sulfur compounds (that are present in petroleum) in the emissions.

*2. Apparatus*

2.1 Sampling. The sampling train is shown in Figure 15A-1, and component parts are discussed below.

Modifications to this sampling train are acceptable provided that the system performance check is met.

Figure 15A-1. Method 15A sampling train.

[SEE FIGURE IN ORIGINAL]

2.1.1 Probe. 0.6-cm (1/4-in.) OD Teflon tubing sequentially wrapped with heat-resistant fiber strips, a rubberized heating tape (with a plug at one end), and heat-resistant adhesive tape. A flexible thermocouple or some other suitable temperature-measuring device shall be placed between the Teflon tubing and the fiber strips so that the temperature can be monitored. The probe should be sheathed in stainless steel to provide in-stack rigidity. A series of bored-out stainless steel fittings placed at the front of the sheath will prevent flue gas from entering between the probe and sheath. The sampling probe is depicted in Figure 15A-2.

Figure 15A-2. Method 15A sampling probe.

[SEE FIGURE IN ORIGINAL]

2.1.2 Particulate filter. A 50-mm Teflon filter holder and a 1- to 2-  $\mu$ m porosity Teflon filter (available through Savillex Corporation, 5325 Highway 101, Minnetonka, Minnesota 55345). The filter holder must be maintained in a hot box at a high enough temperature to prevent condensation.

2.1.3 Combustion air delivery system. As shown in the schematic diagram in Figure 15A-3. The rotameter should be selected to measure an air flow rate of 0.5 liter/min.

Figure 15A-3. Combustion air delivery system.

[SEE FIGURE IN ORIGINAL]

2.1.4 Combustion tube. Quartz glass tubing with an expanded combustion chamber 2.54 cm (1 in.) in diameter and at least 30.5 cm (12 in.) long. The tube ends should have an outside diameter of 0.6 cm (1/4 in.) and be at least 15.3 cm (6 in.) long. This length is necessary to maintain the quartz-glass connector at ambient temperature and thereby avoid leaks. Alternatively, the outlet may be constructed with a 90-degree glass elbow and socket that would fit directly onto the inlet of the first peroxide impinger.

2.1.5 Furnace. Of sufficient size to enclose the combustion tube. The furnace shall have a temperature regulator capable of maintaining the temperature at 1100  $\pm$  50 deg. C. The furnace operating temperature shall be checked with a thermocouple to ensure accuracy. Lindberg furnaces have been found to be satisfactory.

2.1.6 Peroxide impingers, stopcock grease, thermometer, drying tube, valve, pump, barometer, and vacuum gauge. Same as in Method 6, Sections 2.1.2, 2.1.4, 2.1.5, 2.1.6, 2.1.7, 2.1.8, 2.1.11, and 2.1.12, respectively.

2.1.7 Rate meters. Rotameters (or equivalent) capable of measuring flow rate to within 5 percent of the selected flow rate and calibrated as in Section 5.2.

2.1.8 Volume meter. Dry gas meter capable of measuring the sample volume under the particular sampling conditions with an accuracy of  $\pm$  2 percent.

2.1.9 U-tube manometer. To measure the pressure at the exit of the combustion gas dry gas meter.

2.2 Sample recovery and analysis. Same as in Method 6, Sections 2.2 and 2.3, except a 10-ml buret with 0.05-ml graduations is required for titrant volumes of less than 10.0 ml, and the spectrophotometer is not needed.

### 3. Reagents

Unless otherwise indicated, all reagents must conform to the specifications established by the Committee on Analytical Reagents of the American Chemical Society. When such specifications are not available, the best available grade shall be used.

3.1 Sampling. The following reagents are needed:

3.1.1 Water. Same as in Method 6, Section 3.1.1.

3.1.2 Hydrogen peroxide, 3 percent. Same as in Method 6, Section 3.1.5 (40 ml is needed per sample).

3.1.3 Recovery check gas. Carbonyl sulfide (COS) in nitrogen (100 ppm or greater, if necessary) in an aluminum cylinder. Verify the concentration by gas chromatography where the instrument is calibrated with a COS permeation tube.

3.1.4 Combustion gas. Air, contained in a gas cylinder equipped with a two-stage regulator. The gas should contain less than 50 ppb of reduced sulfur compounds and less than 10 ppm total hydrocarbons.

3.2 Sample recovery and analysis. Same as in Method 6, Sections 3.2 and 3.3.

### 4. Procedure

4.1 Sampling. Before any source sampling is done, conduct two 30-minute system performance checks in the field, as detailed in Section 4.3, to validate the sampling train components and procedures (optional).

4.1.1 Preparation of sampling train. For the Method 6 part of the train, measure 20 ml of 3 percent hydrogen peroxide into the first and second midjet impingers. Leave the third midjet impinger empty and add silica gel to the fourth impinger. Alternatively, a silica gel drying tube may be used in place of the fourth impinger. Place crushed ice and water around all impingers. Maintain the oxidation furnace at 1100 +/- 50 deg. C to ensure 100 percent oxidation of COS. Maintain the probe and filter temperatures at a high enough level (no visible condensation) to prevent moisture condensation and monitor the temperatures with a thermocouple.

4.1.2 Leak-check procedure. Assemble the sampling train and leak-check as described in Method 6, Section 4.1.2. Include the combustion air delivery system from the needle valve forward in the leak-check.

4.1.3 Sample collection. Adjust the pressure on the second stage of the regulator on the combustion air cylinder to 10 psig. Adjust the combustion air flow rate to 0.50 liter/min (+/- 10 percent) before injecting combustion air into the sampling train. Then inject combustion air into the sampling train, start the sample pump, and open the stack sample gas valve. Carry out these three operations within 15 to 30 seconds to avoid pressurizing the sampling train. Adjust the total sample flow rate to 2.0 liters/min (+/- 10 percent). The combustion air flow rate of 0.50 liter/min and the total sample flow rate of 2.0 liters/min produce an O<sub>2</sub> concentration of 5.0 percent in the stack gas. This O<sub>2</sub> concentration must be maintained constantly to allow oxidation of TRS to SO<sub>2</sub>. Adjust these flow rates during sampling as necessary. Monitor and record the combustion air manometer reading at regular intervals during the sampling period. Sample for 1 or 3 hours. At the end of sampling, turn off the sample pump and combustion air simultaneously (within 15 to 30 seconds of each other). All other procedures are the same as in Method 6, Section 4.1.3, except that the sampling train should not be purged. After collecting the sample, remove the probe from the stack and conduct a leak-check (mandatory).

After each 3-hour test run (or after three 1-hour samples), conduct one system performance check (see Section 4.3). After this system performance check and before the next test run, it is recommended that the probe be rinsed and brushed and the filter replaced.

In Method 15, a test run is composed of 16 individual analyses (injects) performed over a period of not less than 3 hours or more than 6 hours. For Method 15A to be consistent with Method 15, the following may be used to obtain a test run: (1) Collect three 60-minute samples or (2) collect one 3-hour sample. (Three test runs constitute a test.)

4.2 Sample recovery. Recover the hydrogen peroxide-containing impingers as detailed in Method 6, Section 4.2.

4.3 System performance check. A system performance check is done (1) to validate the sampling train components and procedure (before testing, optional) and (2) to validate a test run (after a run). Perform a check in the field before testing consisting of at least two samples (optional), and perform an additional check after each 3-hour run or after three 1-hour samples (mandatory).

The checks involve sampling a known concentration of COS and comparing the analyzed concentration with the known concentration. Mix the recovery gas with N<sub>2</sub> as shown in Figure 15A-4 if dilution is required. Adjust the flow rates to generate a COS concentration in the range of the stack gas or within 20 percent of the applicable standard at a total flow rate of at least 2.5 liters/min. Use Equation 15A-4 to calculate the concentration of recovery gas generated. Calibrate the flow rate from both sources with a soap bubble flow tube so that the diluted concentration of COS can be accurately calculated. Collect 30-minute samples, and analyze in the normal manner. Collect the samples through the probe of the sampling train using a manifold or some other suitable device that will ensure extraction of a representative sample.

[SEE FIGURE IN ORIGINAL]

Figure 15A-4. COS recovery gas generator system.

The recovery check must be performed in the field before replacing the particulate filter and before cleaning the probe. A sample recovery of 100 +/- 20 percent must be obtained for the data to be valid and should be reported with the emission data, but should not be used to correct the data. However, if the performance check results do not affect the compliance or noncompliance status of the affected facility, the Administrator may decide to accept the results of the compliance test. Use Equation 15A-5 to calculate the recovery efficiency.

4.4 Sample analysis. Same as in Method 6, Section 4.3. For compliance tests only, an EPA SO<sub>2</sub> field audit sample shall be analyzed with each set of samples. Such audit samples are available from the Quality Assurance Division, Environmental Monitoring Systems Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.

## 5. Calibration.

5.1 Metering system, thermometers, barometer, and barium perchlorate solution. Calibration procedures are presented in Method 6, Sections 5.1, 5.2, 5.4, and 5.5.

5.2 Rotameters. Calibrate with a bubble flow tube.

## 6. Calculations.

In the calculations, retain at least one extra decimal figure beyond that of the acquired data. Round off figures after final calculations.

### 6.1 Nomenclature.

C[TRS] = Concentration of TRS as SO<sub>2</sub>, dry basis, corrected to standard conditions, ppm.

N = Normality of barium perchlorate titrant, milliequivalents/ml.

P[bar] = Barometric pressure at exit orifice of the dry gas meter, mm Hg.

P[std] = Standard absolute pressure, 760 mm Hg.

T[m] = Average dry gas meter absolute temperature, deg.

T[std] = Standard absolute temperature, 293 deg.

V[a] = Volume of sample aliquot titrated, ml.

V[ms] = Dry gas volume as measured by the sample train dry gas meter, liters.

V[mc] = Dry gas volume as measured by the combustion air dry gas meter, liters.

V[ms(std)] = Dry gas volume measured by the sample train dry gas meter, corrected to standard conditions, liters.

V[mc(std)] = Dry gas volume measured by the combustion air dry gas meter, corrected to standard conditions, liters.

V[soln] = Total volume of solution in which the sulfur dioxide sample is contained, 100 ml.

V[t] = Volume of barium perchlorate titrant used for the sample (average of replicate titrations), ml.

V[tb] = Volume of barium perchlorate titrant used for the blank, ml.

Y = Calibration factor for sampling train dry gas meter.

Y[c] = Calibration factor for combustion air dry gas meter.

C[RG] = Concentration of generated recovery gas, ppm.

C[CO<sub>S</sub>] = Concentration of CO<sub>S</sub> recovery gas, ppm.

Q[CO<sub>S</sub>] = Flow rate of CO<sub>S</sub> recovery gas, liters/min.

Q[N<sub>2</sub>] = Flow rate of diluent N<sub>2</sub>, liters/min.

R = Recovery efficiency for the system performance check, percent.

32.03 = Equivalent weight of sulfur dioxide, mg/meq.

$12025 \mu\text{l} / \text{meq} = ((32.03 \text{ mg}) / (\text{meq})) \times ((24.05 \text{ liters}) / (\text{mole})) \times ((\text{mole}) \times (1 \text{ g}) \times (10^3 \text{ ml}) \times (10^3 \mu\text{l})) / (64.06 \text{ g}) \times (10^3 \text{ g}) \times (\text{liter}) \times (\text{ml})$

6.2 Dry Sample Gas Volume, Corrected to Standard Conditions.

$V[\text{ms}(\text{std})] = ((V[\text{ms}] \times Y \times (T[\text{std}]) \times (P[\text{bar}]))) / (T[\text{m}] \times (P[\text{std}]))) = (K[1] \times Y \times (V[\text{m}] \times (P[\text{bar}])) / T[\text{m}]$

Eq. 15A-1

where:  $K[1] = 0.3858 \text{ deg. K/mm Hg}$  for metric units.

6.3 Combustion Air Gas Volume, Corrected to Standard Conditions.

$$V[\text{mc}(\text{std})] = (k[1] \times Y[\text{c}] \times (V[\text{mc}]) \times (P[\text{bar}])) / T[\text{m}]$$

Eq. 15A-2

NOTE: Correct  $P[\text{bar}]$  for the average pressure of the manometer during the sampling period.

6.4 Concentration of TRS as ppm  $\text{SO}_2$ .

$$C[\text{TRS}] = (K[2] \times (V[\text{t}] - V[\text{tb}]) \times N \times (V[\text{soln}] / V[\text{a}])) / (V[\text{ms}(\text{std})] - V[\text{mc}(\text{std})])$$

Eq. 15A-3

where:  $K[2] = 12025 \text{ } \mu\text{l/meq}$  for metric units.

6.5 Concentration of Generated Recovery Gas.

$$C[\text{RG}] = ((C[\text{COS}]) (Q[\text{COS}])) / (Q[\text{COS}] + Q[\text{N}_2])$$

Eq. 15A-4

6.6 Recovery Efficiency.

$$R = (C[\text{TRS}] / C[\text{RG}]) \times 100$$

Eq. 15A-5

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## METHOD 16 -- SEMICONTINUOUS DETERMINATION OF SULFUR EMISSIONS FROM STATIONARY SOURCES

### *Introduction*

The method described below uses the principle of gas chromatographic separation and flame photometric detection (FPD). Since there are many systems or sets of operating conditions that represent useable methods of determining sulfur emissions, all systems which employ this principle, but differ only in details of equipment and operation, may be used as alternative methods, provided that the calibration precision and sample line loss criteria are met.

### 1. *Principle and Applicability*

1.1 Principle. A gas sample is extracted from the emission source and an aliquot is analyzed for hydrogen sulfide (H<sub>2</sub>S), methyl mercaptan (MeSH), dimethyl sulfide (DMS), and dimethyl disulfide (DMDS) by gas chromatographic (GC) separation and flame photometric detection (FPD). These four compounds are known collectively as total reduced sulfur (TRS).

1.2 Applicability. This method is applicable for determination of TRS compounds from recovery furnaces, lime kilns, and smelt dissolving tanks at kraft pulp mills.

### 2. *Range and Sensitivity*

2.1 Range. The analytical range will vary with the sample loop size. Typically, the analytical range may extend from 0.1 to 100 ppm using 10 to 0.1-ml sample loop sizes. This eliminates the need for sample dilution in most cases.

2.2 Sensitivity. Using the 10-ml sample size, the minimum detectable concentration is approximately 50 ppb.

### 3. *Interferences*

3.1 Moisture Condensation. Moisture condensation in the sample delivery system, the analytical column, or the FPD burner block can cause losses or interferences. This is prevented by maintaining the probe, filter box, and connections at a temperature of at least 120 deg. C (248 deg. F). Moisture is removed in the SO<sub>2</sub> scrubber and heating the sample beyond this point is not necessary provided the ambient temperature is above 0 deg. C. Alternatively, moisture may be eliminated by heating the sample line, and by conditioning the sample with dry dilution air to lower its dew point below the operating temperature of the GC/FPD analytical system prior to analysis.

3.2 Carbon Monoxide and Carbon Dioxide. CO and CO<sub>2</sub> have a substantial desensitizing effect on the flame photometric detector even after dilution. Acceptable systems must demonstrate that they have eliminated this

interference by some procedure such as eluting these compounds before any of the compounds to be measured. Compliance with this requirement can be demonstrated by submitting chromatograms of calibration gases with and without CO<sub>2</sub> in the diluent gas. The CO<sub>2</sub> level should be approximately 10 percent for the case with CO<sub>2</sub> present. The two chromatograms should show agreement within the precision limits of Section 4.1.

3.3 Particulate Matter. Particulate matter in gas samples can cause interference by eventual clogging of the analytical system. This interference is eliminated by using the Teflon filter after the probe.

3.4 Sulfur Dioxide (SO<sub>2</sub>). Sulfur dioxide is not a specific interferent but may be present in such large amounts that it cannot be effectively separated from the other compounds of interest. The SO<sub>2</sub> scrubber described in Section 5.1.3 will effectively remove SO<sub>2</sub> from the sample.

#### 4. *Precision and Accuracy*

4.1 GC/FPD Calibration Precision. A series of three consecutive injections of the same calibration gas, at any dilution, shall produce results which do not vary by more than +/- 5 percent from the mean of the three injections.

4.2 Calibration Drift. The calibration drift determined from the mean of three injections made at the beginning and end of any run or series of runs within a 24-hour period shall not exceed +/- 5 percent.

4.3 System Calibration Accuracy. Losses through the sample transport system must be measured and a correction factor developed to adjust the calibration accuracy to 100 percent.

#### 5. *Apparatus*

##### 5.1. Sampling.

##### 5.1.1 Probe.

Figure 16-1. Probe used for sample gas containing high particulate loadings.

[SEE FIGURE IN ORIGINAL]

5.1.1.1 Teflon or Teflon-lined stainless steel. The probe must be heated to prevent moisture condensation. It shall be designed to allow calibration gas to enter the probe at or near the sample point entry. Any portion of the probe that contacts the stack gas must be heated to prevent moisture condensation.

5.1.1.2 Figure 16-1 illustrates the probe used in lime kilns and other sources where significant amounts of particulate matter are present. The probe is designed with the deflector shield placed between the sample and the gas inlet holes to reduce clogging of the filter and possible adsorption of sample gas. As an alternative, the probe described in Section 2.1.1 of Methods 16A having a nozzle directed away from the gas stream may be used at sources having significant amounts of particulate matter.

5.1.1.3 NOTE: Mention of trade names or specific products does not constitute an endorsement by the Environmental Protection Agency.

5.1.2 Particulate Filter. 50-mm Teflon filter holder and a 1- to 2-micron porosity Teflon filter (available through Savillex Corporation, 5325 Highway 101, Minnetonka, Minnesota 55343). The filter holder must be maintained in a hot box at a temperature of at least 120 deg. C (248 deg. F).

##### 5.1.3 SO<sub>2</sub> Scrubber.

5.1.3.1 Three 300-ml Teflon segmented impingers connected in series with flexible, thick-walled, Teflon tubing. (Impinger parts and tubing available through Savillex.) The first two impingers contain 100 ml of citrate buffer and the third impinger is initially dry. The tip of the tube inserted into the solution should be constricted to less than 3-mm (1/8-in.) ID and should be immersed to a depth of at least 5 cm (2 in.). Immerse the impingers in an ice water bath and maintain near 0 deg. C. The scrubber solution will normally last for a 3-hour run before needing replacement. This will depend upon the effects of moisture and particulate matter on the solution strength and pH.

5.1.3.2 Connections between the probe, particulate filter, and SO<sub>2</sub> scrubber shall be made of Teflon and as short in length as possible. All portions of the probe, particulate filter, and connections prior to the SO<sub>2</sub> scrubber (or alternative point of moisture removal) shall be maintained at a temperature of at least 120 deg. C (248 deg. F).

5.1.4 Sample Line. Teflon, no greater than 1.3-cm (1/2-in.) ID. Alternative materials, such as virgin Nylon, may be used provided the line loss test is acceptable.

5.1.5 Sample Pump. The sample pump shall be leakless Teflon-coated diaphragm type or equivalent.

5.2 Dilution System. Needed only for high sample concentrations. The dilution system must be constructed such that all sample contacts are made of Teflon, glass, or stainless steel.

5.3 Gas Chromatograph. The gas chromatograph must have at least the following components:

5.3.1 Oven. Capable of maintaining the separation column at the proper operating temperature +/- 1 deg. C.

5.3.2 Temperature Gauge. To monitor column oven, detector, and exhaust temperature +/- 1 deg. C.

5.3.3 Flow System. Gas metering system to measure sample, fuel, combustion gas, and carrier gas flows.

5.3.4 Flame Photometric Detector.

5.3.4.1 Electrometer. Capable of full scale amplification of linear ranges of  $10^{-9}$  to  $10^{-4}$  amperes full scale.

5.3.4.2 Power Supply. Capable of delivering up to 750 volts.

5.3.4.3 Recorder. Compatible with the output voltage range of the electrometer.

5.3.4.4 Rotary Gas Valves. Multiport Teflon-lined valves equipped with sample loop. Sample loop volumes shall be chosen to provide the needed analytical range. Teflon tubing and fittings shall be used throughout to present an inert surface for sample gas. The gas chromatograph shall be calibrated with the sample loop used for sample analysis.

5.4 Gas Chromatogram Columns. The column system must be demonstrated to be capable of resolving the four major reduced sulfur compounds: H<sub>2</sub>S, MeSH, DMS, and DMDS. It must also demonstrate freedom from known interferences.

To demonstrate that adequate resolution has been achieved, the tester must submit a chromatogram of a calibration gas containing all four of the TRS compounds in the concentration range of the applicable standard. Adequate resolution will be defined as base line separation of adjacent peaks when the amplifier attenuation is set so that the smaller peak is at least 50 percent of full scale. Baseline separation is defined as a return to zero

+/- 5 percent in the interval between peaks. Systems not meeting this criteria may be considered alternate methods subject to the approval of the Administrator.

5.5 Calibration System. The calibration system must contain the following components. (Figure 16-2)

5.5.1 Tube Chamber. Chamber of glass or Teflon of sufficient dimensions to house permeation tubes.

5.5.2 Flow System. To measure air flow over permeation tubes at +/- 2 percent. Each flowmeter shall be calibrated after a complete test series with a wet test meter. If the flow measuring device differs from the wet test meter by 5 percent, the completed test shall be discarded. Alternatively, the tester may elect to use the flow data that would yield the lower flow measurement. Calibration with a wet test meter before a test is optional. Flow over the permeation device may also be determined using a soap bubble flowmeter.

5.5.3 Constant Temperature Bath. Device capable of maintaining the permeation tubes at the calibration temperature within +/- 0.1 deg. C.

5.5.4 Temperature Gauge. Thermometer or equivalent to monitor bath temperature within +/- 1 deg. C.

## 6. Reagents

6.1 Fuel. Hydrogen (H<sub>2</sub>), prepurified grade or better.

6.2 Combustion Gas. Oxygen (O<sub>2</sub>) or air, research purity or better.

6.3 Carrier Gas. Prepurified grade or better.

6.4 Diluent (If required). Air containing less than 50 ppb total sulfur compounds and less than 10 ppm each of moisture and total hydrocarbons.

6.5 Calibration Gases. Permeation tubes, one each of H<sub>2</sub>S, MeSH, DMS, and DMDS, gravimetrically calibrated and certified at some convenient operating temperature. These tubes consist of hermetically sealed FEP Teflon tubing in which a liquified gaseous substance is enclosed. The enclosed gas permeates through the tubing wall at a constant rate. When the temperature is constant, calibration gases covering a wide range of known concentrations can be generated by varying and accurately measuring the flow rate of diluent gas passing over the tubes. These calibration gases are used to calibrate the GC/FPD system and the dilution system.

6.6 Citrate Buffer. Dissolve 300 grams of potassium citrate and 41 grams of anhydrous citric acid in 1 liter of deionized water. 284 grams of sodium citrate may be substituted for the potassium citrate. Adjust the pH to between 5.4 and 5.6 with potassium citrate or citric acid, as required.

6.7 Sample Line Loss Gas (Optional). As an alternative to permeation gas, H<sub>2</sub>S cylinder gas may be used for the sample line loss test. The gas shall be calibrated against permeation devices having known permeation rates or by the procedure in Section 7 of Method 16A.

## 7. Pretest Procedures

The following procedures are optional but would be helpful in preventing any problem which might occur later and invalidate the entire test.

7.1 After the complete measurement system has been set up at the site and deemed to be operational, the following procedures should be completed before sampling is initiated.

7.1.1 Leak Test. Appropriate leak test procedures should be employed to verify the integrity of all components, sample lines, and connections. The following leak test procedure is suggested: For components upstream of the sample pump, attach the probe end of the sample line to a manometer or vacuum gauge, start the pump and pull greater than 50 mm (2 in.) Hg vacuum, close off the pump outlet, and then stop the pump and ascertain that there is no leak for 1 minute. For components after the pump, apply a slight positive pressure and check for leaks by applying a liquid (detergent in water, for example) at each joint. Bubbling indicates the presence of a leak. As an alternative to the initial leak-test, the sample line loss test described in Section 10.1 may be performed to verify the integrity of components.

7.1.2 System Performance. Since the complete system is calibrated following each test, the precise calibration of each component is not critical. However, these components should be verified to be operating properly. This verification can be performed by observing the response of flowmeters or of the GC output to changes in flow rates or calibration gas concentrations and ascertaining the response to be within predicted limits. In any component, or if the complete system fails to respond in a normal and predictable manner, the source of the discrepancy should be identified and corrected before proceeding.

## 8. Calibration

Prior to any sampling run, calibrate the system using the following procedures. (If more than one run is performed during any 24-hour period, a calibration need not be performed prior to the second and any subsequent runs. The calibration must, however, be verified as prescribed in Section 10, after the last run made within the 24-hour period.)

8.1 General Considerations. This section outlines steps to be followed for use of the GC/FPD and the dilution system (if applicable). The procedure does not include detailed instructions because the operation of these systems is complex, and it requires an understanding of the individual system being used. Each system should include a written operating manual describing in detail the operating procedures associated with each component in the measurement system. In addition, the operator should be familiar with the operating principles of the components, particularly the GC/FPD. The citations in the Bibliography at the end of this method are recommended for review for this purpose.

8.2 Calibration Procedure. Insert the permeation tubes into the tube chamber. Check the bath temperature to assure agreement with the calibration temperature of the tubes within +/- 0.1 deg. C. Allow 24 hours for the tubes to equilibrate. Alternatively equilibration may be verified by injecting samples of calibration gas at 1-hour intervals. The permeation tubes can be assumed to have reached equilibrium when consecutive hourly samples agree within the precision limits of Section 4.1.

Vary the amount of air flowing over the tubes to produce the desired concentrations for calibrating the analytical and dilution systems. The air flow across the tubes must at all times exceed the flow requirement of the analytical systems. The concentration in parts per million generated by a tube containing a specific permeant can be calculated as follows:

$$C = K P[r] / ML$$

Eq. 16-1

Where:

C = Concentration of permeant produced in ppm.

P[r] = Permeation rate of the tube in  $\mu\text{g}/\text{min}$ .

M = Molecular weight of the permeant (g/g-mole).

L = Flow rate, l/min, of air over permeant at 20 deg. C, 760 mm Hg.

K = Gas constant at 20 deg. C and 760 mm Hg = 24.04 l/g mole.

8.3 Calibration of Analysis System. Generate a series of three or more known concentrations spanning the linear range of the FPD (approximately 0.5 to 10 ppm for a 1-ml sample) for each of the four major sulfur compounds. Inject these standards into the GC/FPD analyzer and monitor the responses. Three injects for each concentration must not vary by more than 5 percent from the mean of the three injections. Failure to attain this precision is an indication of a problem in the calibration or analytical system. Any such problem must be identified and corrected before proceeding.

8.4 Calibration Curves. Plot the GC/FPD response in current (amperes) versus their causative concentrations in ppm on log-log coordinate graph paper for each sulfur compound. Alternatively, a least squares equation may be generated from the calibration data. Alternatively, a least squares equation may be generated from the calibration data using concentrations versus the appropriate instrument response units.

## 9. *Sampling and Analysis Procedure*

9.1 Sampling. Insert the sampling probe into the test port making certain that no dilution air enters the stack through the port. Begin sampling. Condition the entire system with sample for a minimum of 15 minutes prior to commencing analysis.

9.2 Analysis. Aliquots of sample are injected into the GC/FPD analyzer for analysis.

9.2.1 Sample Run. A sample run is composed of 16 individual analyses (injects) performed over a period of not less than 3 hours or more than 6 hours.

9.2.2 Observation for Clogging of Probe or Filter. If reductions in sample concentrations are observed during a sample run that cannot be explained by process conditions, the sampling must be interrupted to determine if the probe or filter is clogged with particulate matter. If either is found to be clogged, the test must be stopped and the results up to that point discarded. Testing may resume after cleaning or replacing the probe and filter. After each run, the probe and filter shall be inspected and, if necessary, replaced.

## 10. *Post-Test Procedures*

10.1 Sample line loss. A known concentration of hydrogen sulfide at the level of the applicable standard, +/- 20 percent, must be introduced into the sampling system at the opening of the probe in sufficient quantities to ensure that there is an excess of sample which must be vented to the atmosphere. The sample must be transported through the entire sampling system to the measurement system in the normal manner. (See figure 16-1). The resulting measured concentration should be compared to the known value to determine the sampling system loss.

For sampling losses greater than 20 percent in a sample run, the sample run is not to be used when determining the arithmetic mean of the performance test. For sampling losses of 0-20 percent, the sample concentration must be corrected by dividing the sample concentration by the fraction of recovery. The fraction of recovery is equal to one minus the ratio of the measured concentration to the known concentration of hydrogen sulfide in the sample line loss procedure. The known gas sample may be generated using permeation tubes. Alternatively, cylinders of hydrogen sulfide mixed in nitrogen and certified according to section 6.7 may be used. The optional pretest procedures provide a good guideline for determining if there are leaks in the sampling system.

Figure 16-2. Determination of sample line loss.

[SEE FIGURE IN ORIGINAL]

10.2 Recalibration. After each run, or after a series of runs made within a 24-hour period, perform a partial recalibration using the procedures in Section 8. Only H<sub>2</sub>S (or other calibration gas) need be used to recalibrate the GC/FPD analysis system (Section 8.3).

10.3 Determination of Calibration Drift. Compare the calibration curves obtained prior to the runs, to the calibration curves obtained under Section 10.2. The calibration drift should not exceed the limits set forth in Section 4.2. If the drift exceeds this limit, the intervening run or runs should be considered not valid. The tester, however, may instead have the option of choosing the calibration data set which would give the highest sample values.

### 11. Calculations

11.1 Determine the concentrations of each reduced sulfur compound detected directly from the calibration curves. Alternatively, the concentrations may be calculated using the equation for the least squares line.

11.2 Calculation of TRS. Total reduced sulfur will be determined for each analysis made by summing the concentrations of each reduced sulfur compound resolved during a given analysis.

$$\text{TRS} = \text{SIGMA} (\text{H}_2\text{S}, \text{MeSH}, \text{DMS}, 2\text{DMDS})d$$

Eq. 16-2

Where:

TRS = Total reduced sulfur in ppm, dry basis.

H<sub>2</sub>S = Hydrogen sulfide, ppm.

MeSH = Methyl mercaptan, ppm.

DMS = Dimethyl sulfide, ppm.

DMDS = Dimethyl disulfide, ppm.

d = Dilution factor, dimensionless.

11.3 Average TRS. The average TRS will be determined as follows:

$$\text{Average TRS} = \langle n \rangle \text{SIGMA} [i = 1] \text{TRS}[1] / N(1 - B[\text{wo}])$$

Where:

Average TRS = Average total reduced sulfur in ppm, dry basis.

TRS[1] = Total reduced sulfur in ppm as determined by Equation 16-2.

N = Number of samples.

B[wo] = Fraction of volume of water vapor in the gas stream as determined by reference Method 4 -- Determination of Moisture in Stack Gases.

#### 11.4 Average Concentration of Individual Reduced Sulfur Compounds.

$$C = \langle n \rangle \text{SIGMA } [i = 1] S[i] / N$$

Eq. 16-4

Where:

S[i] = Concentration of any reduced sulfur compound from the ith sample injection, ppm.

C = Average concentration of any one of the reduced sulfur compounds for the entire run, ppm.

N = Number of injections in any run period.

### 12. Bibliography

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### METHOD 16A -- DETERMINATION OF TOTAL REDUCED SULFUR EMISSIONS FROM STATIONARY SOURCES (IMPINGER TECHNIQUE)

#### 1. *Applicability, Principle, Interferences, Precision, and Bias*

1.1 *Applicability*. This method is applicable to the determination of total reduced sulfur (TRS) emissions from recovery boilers, lime kilns, and smelt dissolving tanks at kraft pulp mills, and from other sources when specified in an applicable subpart of the regulations. The TRS compounds include hydrogen sulfide, methyl mercaptan, dimethyl sulfide, and dimethyl disulfide.

The flue gas must contain at least 1 percent oxygen for complete oxidation of all TRS to sulfur dioxide (SO<sub>2</sub>).

The lower detectable limit is 0.1 ppm SO<sub>2</sub> when sampling at 2 liters/min for 3 hours or 0.3 ppm when sampling at 2 liters/min for 1 hour. The upper concentration limit of the method exceeds TRS levels generally encountered at kraft pulp mills.

1.2 Principle. An integrated gas sample is extracted from the stack. SO<sub>2</sub> is removed selectively from the sample using a citrate buffer solution. TRS compounds are then thermally oxidized to SO<sub>2</sub>, collected in hydrogen peroxide as sulfate, and analyzed by the Method 6 barium-thorin titration procedure.

1.3 Interferences. TRS compounds other than those regulated by the emission standards, if present, may be measured by this method. Therefore, carbonyl sulfide, which is partially oxidized to SO<sub>2</sub> and may be present in a lime kiln exit stack, would be a positive interferent.

Particulate matter from the lime kiln stack gas (primarily calcium carbonate) can cause a negative bias if it is allowed to enter the citrate scrubber; the particulate matter will cause the pH to rise and H<sub>2</sub>S to be absorbed prior to oxidation. Furthermore, if the calcium carbonate enters the hydrogen peroxide impingers, the calcium will precipitate sulfate ion. Proper use of the particulate filter described in Section 2.1.3 will eliminate this interference.

1.4 Precision and Bias. Relative standard deviations of 2.0 and 2.6 percent were obtained when sampling a recovery boiler for 1 and 3 hours, respectively.

In a separate study at a recovery boiler, Method 16A was found to be unbiased relative to Method 16. Comparison of Method 16A with Method 16 at a lime kiln indicated that there was no bias in Method 16A. However, instability of the source emissions adversely affected the comparison. The precision of Method 16A at the lime kiln was similar to that obtained at the recovery boiler.

Relative standard deviations of 2.7 and 7.7 percent have been obtained for system performance checks.

## 2. Apparatus

2.1 Sampling. The sampling train is shown in Figure 16A-1 and component parts are discussed below. Modifications to this sampling train are acceptable provided the system performance check (Section 4.3) is met.

### Figure 16A-1. Sampling Train

[SEE FIGURE IN ORIGINAL]

2.1.1 Probe. Teflon (mention of trade names or specific products does not constitute endorsement by the U.S. Environmental Protection Agency) tubing, 0.6-cm (1/4-in.) diameter, sequentially wrapped with heat-resistant fiber strips, a rubberized heat tape (plug at one end), and heat-resistant adhesive tape. A flexible thermocouple or other suitable temperature measuring device should be placed between the Teflon tubing and the fiber strips so that the temperature can be monitored to prevent softening of the probe. The probe should be sheathed in stainless steel to provide in-stack rigidity. A series of bored-out stainless steel fittings placed at the front of the sheath will prevent moisture and particulate from entering between the probe and sheath. A 0.6-cm (1/4-in.) Teflon elbow (bored out) should be attached to the inlet of the probe, and a 2.54-cm (1-in.) piece of Teflon tubing should be attached at the open end of the elbow to permit the opening of the probe to be turned away from the particulate stream; this will reduce the amount of particulate drawn into the sampling train. The sampling probe is depicted in Figure 16A-2.

### Figure 16A-2. Angled sampling probe

[SEE FIGURE IN ORIGINAL]

2.1.2 Probe Brush. Nylon bristle brush with handle inserted into a 3.2-mm (1/8-in.) Teflon tubing. The Teflon tubing should be long enough to pass the brush through the length of the probe.

2.1.3 Particulate Filter. 50-mm Teflon filter holder and a 1- to 2-  $\mu$  porosity, Teflon filter (available through Savillex Corporation, 5325 Highway 101, Minnetonka, Minnesota 55343). The filter holder must be maintained in a hot box at a temperature sufficient to prevent moisture condensation. A temperature of 121 deg. C (250 deg. F) was found to be sufficient when testing a lime kiln under sub-freezing ambient conditions.

2.1.4 SO<sub>2</sub> Scrubber. Three 300-ml Teflon segmented impingers connected in series with flexible, thick-walled, Teflon tubing. (Impinger parts and tubing available through Savillex.) The first two impingers contain 100 ml of citrate buffer and the third impinger is initially dry. The tip of the tube inserted into the solution should be constricted to less than 3 mm (1/8 in.) ID and should be immersed to a depth of at least 5 cm (2 in.).

2.1.5 Combustion Tube. Quartz glass tubing with an expanded combustion chamber 2.54 cm (1 in.) in diameter and at least 30.5 cm (12 in.) long. The tube ends should have an outside diameter of 0.6 cm (1/4 in.) and be at least 15.3 cm (6 in.) long. This length is necessary to maintain the quartz-glass connector at ambient temperature and thereby avoid leaks. Alternatively, the outlet may be constructed with a 90-degree glass elbow and socket that would fit directly onto the inlet of the first peroxide impinger.

2.1.6 Furnace. A furnace of sufficient size to enclose the combustion chamber of the combustion tube with a temperature regulator capable of maintaining the temperature at 800  $\pm$  100 deg. C. The furnace operating temperature should be checked with a thermocouple to ensure accuracy.

2.1.7 Peroxide Impingers, Stopcock Grease, Thermometer, Drying Tube, Valve, Pump, Barometer, and Vacuum Gauge. Same as in Method 6, Sections 2.1.2, 2.1.4, 2.1.6, 2.1.7, 2.1.8, 2.1.11, and 2.1.12, respectively.

2.1.8 Rate Meter. Rotameter, or equivalent, accurate to within 5 percent at the selected flow rate of 2 liters/min.

2.1.9 Volume Meter. Dry gas meter capable of measuring the sample volume under the sampling conditions of 2 liters/min with an accuracy of  $\pm$  2 percent.

2.1.10 Polyethylene Bottles. 250-ml bottles for hydrogen peroxide solution recovery.

2.2 Sample Preparation and Analysis. Same as in Method 6, Section 2.3, except a 10-ml buret with 0.05-ml graduations is required and the spectrophotometer is not needed.

### 3. Reagents

Unless otherwise indicated, all reagents must conform to the specifications established by the Committee on Analytical Reagents of the American Chemical Society. When such specifications are not available, the best available grade shall be used.

3.1 Sampling. The following reagents are needed:

3.1.1 Water. Same as in Method 6, Section 3.1.1.

3.1.2 Citrate Buffer. 300 g of potassium citrate (or 284 g of sodium citrate) and 41 g of anhydrous citric acid dissolved in 1 liter of water (200 ml is needed per test). Adjust the pH to between 5.4 and 5.6 with potassium citrate or citric acid, as required.

3.1.3 Hydrogen Peroxide, 3 percent. Same as in Method 6, Section 3.1.3 (40 ml is needed per sample).

3.1.4 Recovery Check Gas. Hydrogen sulfide (100 ppm or less) in nitrogen, stored in aluminum cylinders. Verify the concentration by Method 11 or by gas chromatography where the instrument is calibrated with an H<sub>2</sub>S permeation tube as described below. For Method 11, the standard deviation should not exceed 5 percent on at least three 20-minute runs.

Alternatively, hydrogen sulfide recovery gas generated from a permeation device gravimetrically calibrated and certified at some convenient operating temperature may be used. The permeation rate of the device must be such that at a dilution gas flow rate of 3 liters/min, an H<sub>2</sub>S concentration in the range of the stack gas or within 20 percent of the standard can be generated.

3.1.5 Combustion Gas. Gas containing less than 50 ppb reduced sulfur compounds and less than 10 ppm total hydrocarbons. The gas may be generated from a clean-air system that purifies ambient air and consists of the following components: Diaphragm pump, silica gel drying tube, activated charcoal tube, and flow rate measuring device. Flow from a compressed air cylinder is also acceptable.

3.2 Sample Recovery and Analysis. Same as in Method 6, Sections 3.2.1 and 3.3.

#### 4. Procedure

4.1 Sampling. Before any source sampling is done, conduct two 30-minute system performance checks in the field as detailed in Section 4.3 to validate the sampling train components and procedure (optional).

4.1.1 Preparation of Collection Train. For the SO<sub>2</sub> scrubber, measure 100 ml of citrate buffer into the first and second impingers; leave the third impinger empty. Immerse the impingers in an ice bath, and locate them as close as possible to the filter heat box. The connecting tubing should be free of loops. Maintain the probe and filter temperatures sufficiently high to prevent moisture condensation, and monitor with a suitable temperature indicator.

For the Method 6 part of the train, measure 20 ml of 3 percent hydrogen peroxide into the first and second midjet impingers. Leave the third midjet impinger empty, and place silica gel in the fourth midjet impinger. Alternatively, a silica gel drying tube may be used in place of the fourth impinger. Maintain the oxidation furnace at 800 +/- 100 deg. C. Place crushed ice and water around all impingers.

4.1.2 Citrate Scrubber Conditioning Procedure. Condition the citrate buffer scrubbing solution by pulling stack gas through the Teflon impingers and bypassing all other sampling train components. A purge rate of 2 liters/min for 10 minutes has been found to be sufficient to obtain equilibrium. After the citrate scrubber has been conditioned, assemble the sampling train, and conduct (optional) a leak-check as described in Method 6, Section 4.1.2.

4.1.3 Sample Collection. Same as in Method 6, Section 4.1.3, except the sampling rate is 2 liters/min (+/- 10 percent) for 1 or 3 hours. After the sample is collected, remove the probe from the stack, and conduct (mandatory) a post-test leak check as described in Method 6, Section 4.1.2. The 15-minute purge of the train following collection should not be performed. After each 3-hour test run (or after three 1-hour samples), conduct one system performance check (see Section 4.3) to determine the reduced sulfur recovery efficiency through the sampling train. After this system performance check and before the next test run, rinse and brush the probe with water, replace the filter, and change the citrate scrubber (recommended but optional).

In Method 16, a test run is composed of 16 individual analyses (injects) performed over a period of not less than 3 hours or more than 6 hours. For Method 16A to be consistent with Method 16, the following may be used to obtain a test run: (1) collect three 60-minute samples or (2) collect one 3-hour sample. (Three test runs constitute a test.)

4.2 Sample Recovery. Disconnect the impingers. Quantitatively transfer the contents of the midjet impingers of the Method 6 part of the train into a leak-free polyethylene bottle for shipment. Rinse the three midjet impingers and the connecting tubes with water and add the washings to the same storage container. Mark the fluid level. Seal and identify the sample container.

4.3 System Performance Check. A system performance check is done (1) to validate the sampling train components and procedure (prior to testing; optional) and (2) to validate a test run (after a run). Perform a check in the field prior to testing consisting of a least two samples (optional), and perform an additional check after each 3-hour run or after three 1-hour samples (mandatory).

The checks involve sampling a known concentration of H<sub>2</sub>S and comparing the analyzed concentration with the known concentration. Mix the H<sub>2</sub>S recovery gas (Section 3.1.4) and combustion gas in a dilution system such as is shown in Figure 16A-3. Adjust the flow rates to generate an H<sub>2</sub>S concentration in the range of the stack gas or within 20 percent of the applicable standard and an oxygen concentration greater than 1 percent at a total flow rate of at least 2.5 liters/min. Use Equation 16A-3 to calculate the concentration of recovery gas generated. Calibrate the flow rate from both sources with a soap bubble flow tube so that the diluted concentration of H<sub>2</sub>S can be accurately calculated. Collect 30-minute samples, and analyze in the normal manner (as discussed in Section 4.1.3). Collect the sample through the probe of the sampling train using a manifold or some other suitable device that will ensure extraction of a representative sample.

[SEE FIGURE IN ORIGINAL]

Figure 16A-3. Recovery gas dilution system.

The recovery check must be performed in the field prior to replacing the SO<sub>2</sub> scrubber and particulate filter and before the probe is cleaned. A sample recovery of 100 +/- 20 percent must be obtained for the data to be valid and should be reported with the emission data, but should not be used to correct the data. However, if the performance check results do not affect the compliance or noncompliance status of the affected facility, the Administrator may decide to accept the results of the compliance test. Use Equation 16A-4 to calculate the recovery efficiency.

4.4 Sample Analysis. Same as in Method 6, Section 4.3, except for 1-hour sampling, take a 40-ml aliquot, add 160 ml of 100 percent isopropanol, and four drops of thorin. Analyze an EPA SO<sub>2</sub> field audit sample with each set of samples. Such audit samples are available from the Source Branch, Quality Assurance Division, Environmental Monitoring Systems Laboratory, U. S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711.

## 5. Calibration

5.1 Metering System, Thermometers, Rotameters, Barometers, and Barium Perchlorate Solution. Calibration procedures are presented in Method 6, Sections 5.1 through 5.5.

## 6. Calculations

In the calculations, at least one extra decimal figure should be retained beyond that of the acquired data. Figures should be rounded off after final calculations.

### 6.1 Nomenclature.

C[TRS] = Concentration of TRS as SO<sub>2</sub>, dry basis corrected to standard conditions, ppm.

C[RG] = Concentration of recovery gas generated, ppm.

C[H<sub>2</sub>S] = Verified concentration of H<sub>2</sub>S recovery gas.

N = Normality of barium perchlorate titrant, milliequivalents/ml.

P[bar] = Barometric pressure at exit orifice of the dry gas meter, mm Hg (in. Hg).

P[std] = Standard absolute pressure, 760 mm Hg (29.92 in. Hg).

Q[H<sub>2</sub>S] = Calibrated flow rate of H<sub>2</sub>S recovery gas, liters/min.

Q[CG] = Calibrated flow rate of combustion gas, liters/min.

R = Recovery efficiency for the system performance check, percent.

T[m] = Average dry gas meter absolute temperature, deg. K (deg. R).

T[std] = Standard absolute temperature, 293 deg. K, (528 deg. R).

V[a] = Volume of sample aliquot titrated, ml.

V[m] = Dry gas volume as measured by the dry gas meter, liters (dcf).

V[m(std)] = Dry gas volume measured by the dry gas meter, corrected to standard conditions, liters (dscf).

V[soln] = Total volume of solution in which the sulfur dioxide sample is contained, 100 ml.

V[t] = Volume of barium perchlorate titrant used for the sample, ml (average of replicate titrations).

V[tb] = Volume of barium perchlorate titrant used for the blank, ml.

Y = Dry gas meter calibration factor.

32.03 = Equivalent weight of sulfur dioxide, mg/meq.

6.2 Dry Sample Gas Volume, Corrected to Standard Conditions.

$$V[m(std)] = V[m] Y T[std] / T[m] \times P[bar] / P[std] = K[1] Y \times V[m] - P[bar] / T[m]$$

Where: K[1] = 0.3858 deg. K/mm Hg for metric units.

6.3 Concentration of TRS as ppm SO<sub>2</sub>.

$$C[TRS(ppm)] = K[2] (V[t] - V[tb]) N (V[soln] / V[a] / V[m(std)])$$

Eq. 16A-2

Where: K[2] = 32.03 X mg / meq X 24.05 liters / mole X 1 g / 1000 mg X 1000 ml/ liter X 1000 mu l / 1 ml = 12025 X mu l / meq

6.4 Concentration of Recovery Gas Generated in the System Performance Check.

$$C[RG] = (Q[H_2S]) (C[H_2S]) / Q [H_2S] + Q[CG]$$

Eq. 16A-3

6.5 Recovery Efficiency for the System Performance Check.

$$R = C[TRS] / C[RG] \times 100 \text{ Eq.}$$

16A-4

## 7. Alternative Procedures

**7.1 Determination of H<sub>2</sub>S Content in Cylinder Gases.** As an alternative to the procedures specified in section 3.1.4, the following procedure may be used to verify the concentration of the recovery check gas. The H<sub>2</sub>S is collected from the calibration gas cylinder and is absorbed in zinc acetate solution to form zinc sulfide. The latter compound is then measured iodometrically. The method has been examined in the range of 5 to 1500 ppm. There are no known interferences to this method when used to analyze cylinder gases containing H<sub>2</sub>S in nitrogen. Laboratory tests have shown a relative standard deviation of less than 3 percent. The method showed no bias when compared to a gas chromatographic method that used gravimetrically certified permeation tubes for calibration.

**7.1.1 Sampling Apparatus.** The sampling train is shown in Figure 16A-4 and consists of the following components:

[SEE FIGURE IN ORIGINAL]

Figure 16A-4. Recovery check gas sampling train.

**7.1.1.1 Sampling Line.** Teflon tubing (1/4-in.) to connect the cylinder regulator to the sampling valve.

**7.1.1.2 Needle Valve.** Stainless Steel or Teflon needle valve to control the flow rate of gases to the impingers.

**7.1.1.3 Impingers.** Three impingers of approximately 100-ml capacity, constructed to permit the addition of reagents through the gas inlet stem. The impingers shall be connected in series with leak-free glass or Teflon connectors. The impingers bottoms have a standard 24/25 ground-glass fitting. The stems are from standard 1/4-in. (0.64-cm) ball joint midget impingers, custom lengthened by about 1 in. When fitted together, the stem end should be approximately 1/2 in. (1.27-cm) from the bottom (Southern Scientific, Inc., Micanopy, Florida: Set Number S6962-048). The third in-line impinger acts as a drop-out bottle.

**7.1.1.4 Drying Tube, Flowmeter, and Barometer.** Same as in Method 11, Sections 5.1.5, 5.1.8, and 5.1.10.

**7.1.1.5 Cylinder Gas Regulator.** Stainless steel, to reduce the pressure of the gas stream entering the Teflon sampling line to a safe level.

**7.1.1.6 Soap Bubble Meter.** Calibrated for 100 and 500 ml, or two separate bubble meters.

**7.1.1.7 Critical Orifice.** For volume and rate measurements. The critical orifice may be fabricated according to Section 7.1.4.3 and must be calibrated as specified in Section 7.1.8.4.

**7.1.1.8 Graduated Cylinder.** 50-ml size.

7.1.1.9 *Volumetric Flask*. 1-liter size.

7.1.1.10 *Volumetric Pipette*. 15-ml size.

7.1.1.11 *Vacuum Gauge*. Minimum 20-in. Hg capacity.

7.1.1.12 *Stopwatch*.

7.1.2 *Sample Recovery and Analysis Apparatus*.

7.1.2.1 *Erlenmeyer Flasks*. 125- and 250-ml sizes.

7.1.2.2 *Pipettes*. 2-, 10-, 20-, and 100-ml volumetric.

7.1.2.3 *Burette*. 50-ml size.

7.1.2.4 *Volumetric Flask*. 1-liter size.

7.1.2.5 *Graduated Cylinder*. 50-ml size.

7.1.2.6 *Wash Bottle*.

7.1.2.7 *Stirring Plate and Bars*.

7.1.3 *Reagents*. Unless otherwise indicated, all reagents shall conform to the specifications established by the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Otherwise, use the best available grade.

7.1.3.1 *Water*. Same as in Method 11, Section 6.1.3.

7.1.3.2 *Zinc Acetate Absorbing Solution*. Dissolve 20 g zinc acetate in water and dilute to 1 liter.

7.1.3.3 *Potassium Bi-iodate [KH(IO<sub>3</sub>)<sub>2</sub>] Solution, Standard 0.100 N*. Dissolve 3.249 g anhydrous KH(IO<sub>3</sub>)<sub>2</sub> in water, and dilute to 1 liter.

7.1.3.4 *Sodium Thiosulfate (Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub>) Solution, Standard 0.1 N*. Same as in Method 11, Section 6.3.1. Standardize according to Section 7.1.8.2.

7.1.3.5 *Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub>) Solution, Standard 0.01 N*. Pipette 100.0 ml of 0.1 N Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub>) solution into a 1-liter volumetric flask, and dilute to the mark with water.

7.1.3.6 *Iodine Solution, 0.1 N*. Same as in Method 11, Section 6.2.2.

7.1.3.7 *Standard Iodine Solution, 0.01 N*. Same as in Method 11, Section 6.2.3. Standardize according to Section 7.1.8.3.

7.1.3.8 *Hydrochloric Acid (HCl) Solution, 10 Percent by Weight*. Add 230 ml concentrated HCl (specific gravity 1.19) to 770 ml water.

7.1.3.9 *Starch Indicator Solution*. To 5 g starch (potato, arrowroot, or soluble), add a little cold water, and grind in a mortar to a thin paste. Pour into 1 liter of boiling water, stir, and let settle overnight. Use the clear supernatant. Preserve with 1.25 g salicylic acid, 4 g zinc chloride, or a combination of 4 g sodium propionate

and 2 g sodium azide per liter of starch solution. Some commercial starch substitutes are satisfactory.

#### 7.1.4 Sampling Procedure.

7.1.4.1 *Selection of Gas Sample Volumes.* This procedure has been validated for estimating the volume of cylinder gas sample needed when the H<sub>2</sub>S concentration is in the range of 5 to 1500 ppm. The sample volume ranges were selected in order to ensure a 35 to 60 percent consumption of the 20 ml of 0.01 N iodine (thus ensuring a 0.01 N (Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub>) titer of approximately 7 to 12 ml). The sample volumes for various H<sub>2</sub>S concentrations can be estimated by dividing the approximate ppm-liters desired for a given concentration range by the H<sub>2</sub>S concentration stated by the manufacturer.

Approximate cylinder gas H <sub>2</sub> S concentration (ppm)	Approximate ppm-liters desired
5 to < 30	650
30 to < 500	800
500 to < 1500	1000

For example, for analyzing a cylinder gas containing approximately 10 ppm H<sub>2</sub>S, the optimum sample volume is 65 liters (650 ppm-liters/10 ppm). For analyzing a cylinder gas containing approximately 1000 ppm H<sub>2</sub>S, the optimum sample volume is 1 liter (1000 ppm-liters/1000 ppm).

7.1.4.2 *Critical Orifice Flow Rate Selection.* The following table shows the ranges of sample flow rates that are desirable in order to ensure capture of H<sub>2</sub>S in the impinger solution. Slight deviations from these ranges will not have an impact on measured concentrations.

Cylinder gas H <sub>2</sub> S concentration (ppm)	Critical orifice flow rate (ml/min)
5 to < 50 ppm	1500 +/- 500
50 to < 250 ppm	500 +/- 250
250 to < 1000 ppm	200 +/- 50
> 1000 ppm	75 +/- 25

7.1.4.3 *Critical Orifice Fabrication.* Critical orifice of desired flow rates may be fabricated by selecting an orifice tube of desired length and connecting 1/16-in. X 1/4-in. (0.16-cm X 0.64-cm) reducing fittings to both ends. The inside diameters and lengths of orifice tubes needed to obtain specific flow rates are shown below.

Tube (in. OD)	Tube Length	Flow rate Altech
---------------	-------------	------------------

	(in. ID)	(in.)	(ml/ min)	catalog No.	n1
1/16	0.007	1.2	85	301430	
1/16	0.01	3.2	215	300530	
1/16	0.01	1.2	350	300530	
1/16	0.02	1.2	1400	300230	

n1 Altech Associates, 2051 Waukegon Road., Deerfield, Illinois 60015.

**7.1.4.4 Determination of Critical Orifice Approximate Flow Rate.** Connect the critical orifice to the sampling system as shown in Figure 16A-4 but without the H<sub>2</sub>S cylinder. Connect a rotameter in the line to the first impinger. Turn on the pump, and adjust the valve to give a reading of about half atmospheric pressure. Observe the rotameter reading. Slowly increase the vacuum until a stable flow rate is reached, and record this as the critical vacuum. The measured flow rate indicates the expected critical flow rate of the orifice. If this flow rate is in the range shown in Section 7.1.4.2, proceed with the critical orifice calibration according to Section 7.1.8.4.

**7.1.4.5 Determination of Approximate Sampling Time.** Determine the approximate sampling time for a cylinder of known concentration. Use the optimum sample volume obtained in Section 7.1.4.1.

Approximate sampling time (min) = Optimum volume X 1000 / Critical orifice flow rate (ml/min)

**7.1.4.6 Sample Collection.** Connect the Teflon tubing, Teflon tee, and rotameter to the flow control needle valve as shown in Figure 16A-4. Vent the rotameter to an exhaust hood. Plug the open end of the tee. Five to 10 minutes prior to sampling, open the cylinder valve while keeping the flow control needle valve closed. Adjust the delivery pressure to 20 psi. Open the needle valve slowly until the rotameter shows a flow rate approximately 50 to 100 ml above the flow rate of the critical orifice being used in the system.

Place 50 ml of zinc acetate solution in two of the impingers, connect them and the empty third impinger (dropout bottle) and the rest of the equipment as shown in Figure 16A-4. Make sure the ground-glass fittings are tight. The impingers can be easily stabilized by using a small cardboard box in which three holes have been cut, to act as a holder. Connect the Teflon sample line to the first impinger. Cover the impingers with a dark cloth or piece of plastic to protect the absorbing solution from light during sampling.

Record the temperature and barometric pressure. Note the gas flow rate through the rotameter. Open the closed end of the tee. Connect the sampling tube to the tee, ensuring a tight connection. Start the sampling pump and stopwatch simultaneously. Note the decrease in flow rate through the excess flow rotameter. This decrease should equal the known flow rate of the critical orifice being used. Continue sampling for the period determined in Section 7.1.4.5.

When sampling is complete, turn off the pump and stopwatch. Disconnect the sampling line from the tee and plug it. Close the needle valve followed by the cylinder valve. Record the sampling time.

**7.1.5 Blank Analysis.** While the sample is being collected, run a blank as follows: To a 250-ml Erlenmeyer flask, add 100 ml of zinc acetate solution, 20.0 ml. 0.01 N iodine solution, and 2 ml HCl solution. Titrate, while stirring, with 0.01 N Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> until the solution is light yellow. Add starch, and continue titrating until the blue color disappears. Analyze a blank with each sample, as the blank titer has been observed to change over the course of a day.

NOTE: Iodine titration of zinc acetate solutions is difficult to perform because the solution turns slightly white in color near the end point, and the disappearance of the blue color is hard to recognize. In addition, a blue color may reappear in the solution about 30 to 45 seconds after the titration endpoint is reached. This should not be taken to mean the original endpoint was in error. It is recommended that persons conducting this test perform several titrations to be able to correctly identify the endpoint. The importance of this should be recognized because the results of this analytical procedure are extremely sensitive to errors in titration.

7.1.6 *Sample Analysis.* Sample treatment is similar to the blank treatment. Before detaching the stems from the bottoms of the impingers, add 20.0 ml of 0.01 N iodine solution *through the stems* of the impingers holding the zinc acetate solution, dividing it between the two (add about 15 ml to the first impinger and the rest to the second). Add 2 ml HCl solution through the stems, dividing it as with the iodine. Disconnect the sampling line, and store the impingers for 30 minutes. At the end of 30 minutes, rinse the impinger stems into the impinger bottoms. Titrate the impinger contents with 0.01 N Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub>. Do not transfer the contents of the impinger to a flask because this may result in a loss of iodine and cause a positive bias.

7.1.7 *Post-test Orifice Calibration.* Conduct a post-test critical orifice calibration run using the calibration procedures outlined in Section 7.1.8.4. If the Q[std] obtained before and after the test differs by more than 5 percent, void the sample; if not, proceed to perform the calculations.

7.1.8 *Calibrations and Standardizations.*

7.1.8.1 *Rotameter and Barometer.* Same as in Method 11, Sections 8.2.3 and 8.2.4.

7.1.8.2 *Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> Solution, 0.1 N.* Standardize the 0.1 N Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> solution as follows: To 80 ml water, stirring constantly, add 1 ml concentrated H<sub>2</sub>SO<sub>4</sub>, 10.0 ml 0.100 N KH(IO<sub>3</sub>)<sub>2</sub> and 1 g potassium iodide. Titrate immediately with 0.1 N Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> until the solution is light yellow. Add 3 ml starch solution, and titrate until the blue color just disappears. Repeat the titration until replicate analyses agree within 0.05 ml. Take the average volume of Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> consumed to calculate the normality to three decimal figures using Equation 16A-5.

7.1.8.3 *Iodine Solution, 0.01 N.* Standardize the 0.01 N iodine solution as follows: Pipet 20.0 ml of 0.01 N iodine solution into a 125-ml Erlenmeyer flask. Titrate with standard 0.01 N Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> solution until the solution is light yellow. Add 3 ml starch solution, and continue titrating until the blue color just disappears.

If the normality of the iodine tested is not 0.010, add a few ml of 0.1 N iodine solution if it is low, or a few ml of water if it is high, and standardize again. Repeat the titration until replicate values agree within 0.05 ml. Take the average volume to calculate the normality to three decimal figures using Equation 16A-6.

7.1.8.4 *Critical Orifice.* Calibrate the critical orifice using the sampling train shown in Figure 16A-4 but without the H<sub>2</sub>S cylinder and vent rotameter. Connect the soap bubble meter to the Teflon line that is connected to the first impinger. Turn on the pump, and adjust the needle valve until the vacuum is higher than the critical vacuum determined in Section 7.1.4.4. Record the time required for gas flow to equal the soap bubble meter volume (use the 100-ml soap bubble meter for gas flow rates below 100 ml/min, otherwise use the 500-ml soap bubble meter). Make three runs, and record the data listed in Table 1. Use these data to calculate the volumetric flow rate of the orifice.

7.1.9 *Calculations.*

7.1.9.1 *Nomenclature.*

B[wa] = Fraction of water vapor in ambient air during orifice calibration.

$C[H_2S]$  =  $H_2S$  concentration in cylinder gas, ppm.

$K$  = Conversion factor = 12025 ml/eq

= 17.03 g / g-eq X 24.05 liters  $H_2S$  / mole  $H_2S$  X 1 mole  $H_2S$  / 34.06 g  $H_2S$  X 10<sup>3</sup> ml / liter

$M[a]$  = Molecular weight of ambient air saturated at impinger temperature, g/g-mole.

$M[s]$  = Molecular weight of sample gas (nitrogen) saturated at impinger temperature, g/g-mole. (For tests carried out in a laboratory where the impinger temperature is 25 deg. C,  $M[a]$  = 28.5 g/g-mole and  $M[s]$  = 27.7 g/g-mole.)

$N[I]$  = Normality of standard iodine solution (0.01 N), g-eq/liter.

$N[T]$  = Normality of standard  $Na_2S_2O_3$  solution (0.01 N), g-eq/liter.

$P[bar]$  = Barometric pressure, mm Hg.

$P[std]$  = Standard absolute pressure, 760 mm Hg.

$Q[std]$  = Volumetric flow rate through critical orifice, liters/min.

Date

Critical orifice ID

Soap bubble meter volume,  $V[sb]$  liters

Time, circle minus[ab]

Run no. 1 min sec

Run no. 2 min sec

Run no. 3 min sec

Average min sec

Convert the seconds to fraction of minute:

Time

= min + Sec/60

= min

Barometric pressure,  $P[bar]$  = mm Hg

Ambient temperature,  $t[amb]$  = 273 + deg. C = deg. K

Pump vacuum, = mm Hg. (This should be approximately 0.4 times barometric pressure.)

$$V[\text{sb}(\text{std})] = (V[\text{sb}])(T[\text{std}])(P[\text{bar}])(10^{-3}) / (T[\text{amb}]) (P[\text{std}])$$

= --liters

$$Q[\text{std}] = V[\text{sb}(\text{std})] / \text{theta}[\text{sb}]$$

= --liters/min

#### TABLE 1 -- CRITICAL ORIFICE CALIBRATION DATA.

$Q[\text{std, average}]$  = Average standard flow rate through critical orifice, liters/min.

$Q[\text{std, before}]$  = Average standard flow rate through critical orifice determined before H<sub>2</sub>S sampling (Section 7.1.4.4), liters/min.

$Q[\text{std, after}]$  = Average standard flow rate through critical orifice determined after H<sub>2</sub>S sampling (Section 7.1.7), liters/min.

$T[\text{amb}]$  = Absolute ambient temperature, deg. K.

$T[\text{std}]$  = Standard absolute temperature, 293 deg. K.

$\text{Theta minus}[s]$  = Sampling time, min.

$\text{Theta minus}[sb]$  = Time for soap bubble meter flow rate measurement, min.

$V[m(\text{std})]$  = Sample gas volume measured by the critical orifice, corrected to standard conditions, liters.

$V[\text{sb}]$  = Volume of gas as measured by the soap bubble meter, ml.

$V[\text{sb}(\text{std})]$  = Volume of gas as measured by the soap bubble meter, corrected to standard conditions, liters.

$V[\text{I}]$  = Volume of standard iodine solution (0.01 N) used, ml.

$V[\text{T}]$  = Volume of standard Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> solution (0.01 N) used, ml.

$V[\text{TB}]$  = Volume of standard Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> solution (0.01 N) used for the blank, ml.

7.1.9.2 Normality of Standard Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> Solution (0.1. N).

$N[\text{T}] = 1 / \text{ml Na}_2\text{S}_2\text{O}_3 \text{ Consumed}$

Eq. 16A-5

7.1.9.3 Normality of Standard Iodine Solution (0.01 N)

$N[\text{I}] = N[\text{T}] V[\text{T}] / V[\text{I}]$

Eq. 16A-6

7.1.9.4 Sample Gas Volume.

$$V[m(\text{std})] = (Q[\text{std}] (\Theta[s]) (1 - B[\text{wa}]) X M[\text{a}] / M[\text{b}]$$

Eq. 16A-7

7.1.9.5 Concentration of H<sub>2</sub>S in the Gas Cylinder.

$$C[\text{H}_2\text{S}] = K N[\text{T}] (V[\text{TB}] - V[\text{T}]) / V[m(\text{std})]$$

Eq. 16A-8

## 8. Bibliography

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METHOD 16B -- DETERMINATION OF TOTAL REDUCED SULFUR EMISSIONS FROM

## STATIONARY SOURCES

### 1. *Applicability, Principle, Range and Sensitivity, Interferences, and Precision and Accuracy*

1.1 *Applicability.* This method is applicable to the determination of total reduced sulfur (TRS) emissions from recovery furnaces, lime kilns, and smelt dissolving tanks at kraft pulp mills, and from other sources when specified in an applicable subpart of the regulations. The TRS compounds include hydrogen sulfide (H<sub>2</sub>S), methyl mercaptan, dimethyl sulfide, and dimethyl disulfide.

The flue gas must contain at least 1 percent oxygen for complete oxidation of all TRS to sulfur dioxide (SO<sub>2</sub>).

1.2 *Principle.* An integrated gas sample is extracted from the stack. The SO<sub>2</sub> is removed selectively from the sample using a citrate buffer solution. The TRS compounds are then thermally oxidized to SO<sub>2</sub> and analyzed as SO<sub>2</sub> by gas chromatography (GC) using flame photometric detection (FPD).

1.3 *Range and Sensitivity.* Coupled with a GC utilizing a 1-ml sample size, the maximum limit of the FPD for SO<sub>2</sub> is approximately 10 ppm. This limit is expanded by dilution of the sample gas before analysis or by reducing the sample aliquot size. For sources with emission levels between 10 and 100 ppm, the measuring range can be best extended by reducing the sample size.

1.4 *Interferences.* The TRS compounds other than those regulated by the emission standards, if present, may be measured by this method. Therefore, carbonyl sulfide, which is partially oxidized to SO<sub>2</sub> and may be present in a lime kiln exit stack, would be a positive interferent.

Particulate matter from the lime kiln stack gas (primarily calcium carbonate) can cause a negative bias if it is allowed to enter the citrate scrubber; the particulate matter will cause the pH to rise and H<sub>2</sub>S to be absorbed before oxidation. Proper use of the particulate filter, described in Section 2.1.3 of Method 16A, will eliminate this interference.

Carbon monoxide (CO) and carbon dioxide (CO<sub>2</sub>) have substantial desensitizing effects on the FPD even after dilution. Acceptable systems must demonstrate that they have eliminated this interference by some procedure such as eluting these compounds before the SO<sub>2</sub>. Compliance with this requirement can be demonstrated by submitting chromatograms of calibration gases with and without CO<sub>2</sub> in diluent gas. The CO<sub>2</sub> level should be approximately 10 percent for the case with CO<sub>2</sub> present. The two chromatograms should show agreement within the precision limits of Section 1.5.

1.5 *Precision and Accuracy.* The GC/FPD and dilution calibration precision and drift, and the system calibration accuracy are the same as in Method 16, Sections 4.1 to 4.3.

Field tests between this method and Method 16A showed an average difference of less than 4.0 percent. This difference was not determined to be significant.

### 2. *Apparatus*

2.1 *Sampling.* A sampling train is shown in Figure 16B-1. Modifications to the apparatus are accepted provided the system performance check is met.

Figure 16B-1. Sampling train.

[SEE FIGURE IN ORIGINAL]

2.1.1 *Probe, Probe Brush, Particulate Filter, SO<sub>2</sub> Scrubber, Combustion Tube, and Furnace.* Same as in

Method 16A, Sections 2.1.1 to 2.1.6.

2.1.2 *Sampling Pump*. Leakless Teflon-coated diaphragm type or equivalent.

2.2 *Analysis*.

2.2.1 *Dilution System (optional), Gas Chromatograph, Oven, Temperature Gauges, Flow System, Flame Photometric Detector, Electrometer, Power Supply, Recorder, Calibration System, Tube Chamber, Flow System, and Constant Temperature Bath*. Same as in Method 16, Sections 5.2, 5.4, and 5.5.

2.2.2 *Gas Chromatograph Columns*. Same as in Method 16, Section 12.1.4.1.1. Other columns with demonstrated ability to resolve SO<sub>2</sub> and be free from known interferences are acceptable alternatives.

3. *Reagents*

Same as in Method 16, Section 6, except the following:

3.1 *Calibration Gas*. SO<sub>2</sub> permeation tube gravimetrically calibrated and certified at some convenient operating temperature.

These tubes consist of hermetically sealed FEP Teflon tubing in which a liquefied gaseous substance is enclosed. The enclosed gas permeates through the tubing wall at a constant rate. When the temperature is constant, calibration gases covering a wide range of known concentrations can be generated by varying and accurately measuring the flow rate of diluent gas passing over the tubes. In place of SO<sub>2</sub> permeation tubes, National Bureau of Standards traceable cylinder gases containing SO<sub>2</sub> in nitrogen may be used for calibration. The calibration gas is used to calibrate the GC/FPD system and the dilution system.

3.2 *Recovery Check Gas*. Hydrogen sulfide (100 ppm or less) in nitrogen, stored in aluminum cylinders. Verify the concentration by Method 11, the procedure discussed in Section 7.1 of Method 16A, or gas chromatography where the instrument is calibrated with an H<sub>2</sub>S permeation tube as described below. For the wet-chemical methods, the standard deviation should not exceed 5 percent on at least three 20-minute runs.

Hydrogen sulfide recovery gas generated from a permeation device gravimetrically calibrated and certified at some convenient operation temperature may be used. The permeation rate of the device must be such that at a dilution gas flow rate of 3 liters/min, an H<sub>2</sub>S concentration in the range of the stack gas or within 20 percent of the standard can be generated.

3.3 *Combustion Gas*. Gas containing less than 50 ppb reduced sulfur compounds and less than 10 ppm total hydrocarbons. The gas may be generated from a clean-air system that purifies ambient air and consists of the following components: diaphragm pump, silica gel drying tube, activated charcoal tube, and flow rate measuring device. Gas from a compressed air cylinder is also acceptable.

4. *Pretest Procedures*

Same as in Method 16, Section 7.

5. *Calibration*

Same as in Method 16, Section 8, except SO<sub>2</sub> is used instead of H<sub>2</sub>S.

6. *Sampling and Analysis Procedure*

6.1 *Sampling*. Before any source sampling is done, conduct a system performance check as detailed in Section 7.1 to validate the sampling train components and procedures. Although this test is optional, it would significantly reduce the possibility of rejecting tests as a result of failing the post-test performance check. At the completion of the pretest system performance check, insert the sampling probe into the test port making certain that no dilution air enters the stack through the port. Condition the entire system with sample for a minimum of 15 minutes before beginning analysis. If the sample is diluted, determine the precise dilution factor as in Section 8.5 of Method 16.

6.2 *Analysis*. Pass aliquots of diluted sample through the SO<sub>2</sub> scrubber and oxidation furnace, and then inject into the GC/FPD analyzer for analysis. The rest of the analysis is the same as in Method 16, Sections 9.2.1 and 9.2.2.

## 7. Post-Test Procedures

7.1 *System Performance Check*. Same as in Method 16A, Section 4.3. Sufficient numbers of sample injections should be made so that the precision requirements of Section 4.1 of Method 16 are satisfied.

7.2 *Recalibration*. Same as in Method 16, Section 10.2.

7.3 *Determination of Calibration Drift*. Same as in Method 16, Section 10.3.

## 8. Calculations

### 8.1 *Nomenclature*.

C[SO<sub>2</sub>] = Sulfur dioxide concentration, ppm.

C[TRS] = Total reduced sulfur concentration as determined by Equation 16B-1, ppm.

d = Dilution factor, dimensionless.

N = Number of samples.

8.2 *SO<sub>2</sub> Concentration*. Determine the concentration of SO<sub>2</sub> (C[SO<sub>2</sub>]) directly from the calibration curves. Alternatively, the concentration may be calculated using the equation for the least-squares line.

### 8.3 *TRS Concentration*.

$C[TRS] = (C[SO_2]) (d)$

Eq. 16B-1

### 8.4 *Average TRS Concentration*.

Avg. C[TRS] =  $\langle n \rangle \text{SIGMA } [i = 1] C[TRS] / N$

Eq. 16B-2

## 9. Example System

Same as in Method 16, Section 12. Single column systems using the column in Section 12.1.4.1.1 of Method 16 or a 7-ft Carbosorb B HT 100 column have been found satisfactory in resolving SO<sub>2</sub> from CO<sub>2</sub>.

## 10. Bibliography

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## METHOD 17 -- DETERMINATION OF PARTICULATE EMISSIONS FROM STATIONARY SOURCES (IN-STACK FILTRATION METHOD)

### *Introduction*

Particulate matter is not an absolute quantity; rather, it is a function of temperature and pressure. Therefore, to prevent variability in particulate matter emission regulations and/or associated test methods, the temperature and pressure at which particulate matter is to be measured must be carefully defined. Of the two variables (i.e., temperature and pressure), temperature has the greater effect upon the amount of particulate matter in an effluent gas stream; in most stationary source categories, the effect of pressure appears to be negligible.

In Method 5, 250 deg. F is established as a nominal reference temperature. Thus, where Method 5 is specified in an applicable subpart of the standards, particulate matter is defined with respect to temperature. In order to maintain a collection temperature of 250 deg. F, Method 5 employs a heated glass sample probe and a heated filter holder. This equipment is somewhat cumbersome and requires care in its operation. Therefore, where particulate matter concentrations (over the normal range of temperature associated with a specified source category) are known to be independent of temperature, it is desirable to eliminate the glass probe and heating systems, and sample at stack temperature.

This method describes an in-stack sampling system and sampling procedures for use in such cases. It is intended to be used only when specified by an applicable subpart of the standards, and only within the applicable temperature limits (if specified), or when otherwise approved by the Administrator.

### *1. Principle and Applicability*

1.1 Principle. Particulate matter is withdrawn isokinetically from the source and collected on a glass fiber filter maintained at stack temperature. The particulate mass is determined gravimetrically after removal of uncombined water.

1.2 Applicability. This method applies to the determination of particulate emissions from stationary sources for determining compliance with new source performance standards, only when specifically provided for in an applicable subpart of the standards. This method is not applicable to stacks that contain liquid droplets or are saturated with water vapor. In addition, this method shall not be used as written if the projected cross-sectional area of the probe extension-filter holder assembly covers more than 5 percent of the stack cross-sectional area (see Section 4.1.2).

### *2. Apparatus*

2.1 Sampling Train. A schematic of the sampling train used in this method is shown in Figure 17-1. Construction details for many, but not all, of the train components are given in APTD-0581 (Citation 2 in

Bibliography); for changes from the APTD-0581 document and for allowable modifications to Figure 17-1, consult with the Administrator.

Figure 17-1. Particulate-Sampling Train, Equipped with In-Stack Filter.

[SEE FIGURE IN ORIGINAL]

The operating and maintenance procedures for many of the sampling train components are described in APTD-0576 (Citation 3 in Bibliography). Since correct usage is important in obtaining valid results, all users should read the APTD-0576 document and adopt the operating and maintenance procedures outlined in it, unless otherwise specified herein. The sampling train consists of the following components:

2.1.1 Probe Nozzle. Stainless steel (316) or glass, with sharp, tapered leading edge. The angle of taper shall be 30 deg. and the taper shall be on the outside to preserve a constant internal diameter. The probe nozzle shall be of the button-hook or elbow design, unless otherwise specified by the Administrator. If made of stainless steel, the nozzle shall be constructed from seamless tubing. Other materials of construction may be used subject to the approval of the Administrator.

A range of sizes suitable for isokinetic sampling should be available, e.g., 0.32 to 1.27 cm (1/8 to 1/2 in.) -- or larger if higher volume sampling trains are used -- inside diameter (ID) nozzles in increments of 0.16 cm (1/16 in.). Each nozzle shall be calibrated according to the procedures outlined in Section 5.1.

2.1.2 Filter Holder. The in-stack filter holder shall be constructed of borosilicate or quartz glass, or stainless steel; if a gasket is used, it shall be made of silicone rubber, Teflon, or stainless steel. Other holder and gasket materials may be used subject to the approval of the Administrator. The filter holder shall be designed to provide a positive seal against leakage from the outside or around the filter.

2.1.3 Probe Extension. Any suitable rigid probe extension may be used after the filter holder.

2.1.4 Pitot Tube. Type S, as described in Section 2.1 of Method 2, or other device approved by the Administrator; the pitot tube shall be attached to the probe extension to allow constant monitoring of the stack gas velocity (see Figure 17-1). The impact (high pressure) opening plane of the pitot tube shall be even with or above the nozzle entry plane during sampling (see Method 2, Figure 2-6b). It is recommended: (1) that the pitot tube have a known baseline coefficient, determined as outlined in Section 4 of Method 2; and (2) that this known coefficient be preserved by placing the pitot tube in an interference-free arrangement with respect to the sampling nozzle, filter holder, and temperature sensor (see Figure 17-1). Note that the 1.9 cm (0.75 in.) free-space between the nozzle and pitot tube shown in Figure 17-1, is based on a 1.3 cm (0.5 in.) ID nozzle. If the sampling train is designed for sampling at higher flow rates than that described in APTD-0581, thus necessitating the use of larger sized nozzles, the free-space shall be 1.9 cm (0.75 in.) with the largest sized nozzle in place.

Source-sampling assemblies that do not meet the minimum spacing requirements of Figure 17-1 (or the equivalent of these requirements, e.g., Figure 2-7 of Method 2) may be used; however, the pitot tube coefficients of such assemblies shall be determined by calibration, using methods subject to the approval of the Administrator.

2.1.5 Differential Pressure Gauge. Inclined manometer or equivalent device (two), as described in Section 2.2 of Method 2. One manometer shall be used for velocity head (DELTA p) readings, and the other, for orifice differential pressure readings.

2.1.6 Condenser. It is recommended that the impinger system described in Method 5 be used to determine the moisture content of the stack gas. Alternatively, any system that allows measurement of both the water

condensed and the moisture leaving the condenser, each to within 1 ml or 1 g, may be used. The moisture leaving the condenser can be measured either by: (1) monitoring the temperature and pressure at the exit of the condenser and using Dalton's law of partial pressures; or (2) passing the sample gas stream through a silica gel trap with exit gases kept below 20 deg. C (68 deg. F) and determining the weight gain.

Flexible tubing may be used between the probe extension and condenser. If means other than silica gel are used to determine the amount of moisture leaving the condenser, it is recommended that silica gel still be used between the condenser system and pump to prevent moisture condensation in the pump and metering devices and to avoid the need to make corrections for moisture in the metered volume.

2.1.7 Metering System. Vacuum gauge, leak-free pump, thermometers capable of measuring temperature to within 3 deg. C (5.4 deg. F), dry gas meter capable of measuring volume to within 2 percent, and related equipment, as shown in Figure 17-1. Other metering systems capable of maintaining sampling rates within 10 percent of isokinetic and of determining sample volumes to within 2 percent may be used, subject to the approval of the Administrator. When the metering system is used in conjunction with a pitot tube, the system shall enable checks of isokinetic rates.

Sampling trains utilizing metering systems designed for higher flow rates than that described in APTD-0581 or APTD-0576 may be used provided that the specifications of this method are met.

2.1.8 Barometer. Mercury, aneroid, or other barometer capable of measuring atmospheric pressure to within 2.5 mm Hg (0.1 in. Hg). In many cases, the barometric reading may be obtained from a nearby National Weather Service station, in which case the station value (which is the absolute barometric pressure) shall be requested and an adjustment for elevation differences between the weather station and sampling point shall be applied at a rate of minus 2.5 mm Hg (0.1 in. Hg) per 30 m (100 ft) elevation increase or vice versa for elevation decrease.

2.1.9 Gas Density Determination Equipment. Temperature sensor and pressure gauge, as described in Sections 2.3 and 2.4 of Method 2, and gas analyzer, if necessary, as described in Method 3.

The temperature sensor shall be attached to either the pitot tube or to the probe extension, in a fixed configuration. If the temperature sensor is attached in the field, the sensor shall be placed in an interference-free arrangement with respect to the Type S pitot tube openings (as shown in Figure 17-1 or in Figure 2-7 of Method 2). Alternatively, the temperature sensor need not be attached to either the probe extension or pitot tube during sampling, provided that a difference of not more than 1 percent in the average velocity measurement is introduced. This alternative is subject to the approval of the Administrator.

## 2.2 Sample Recovery.

2.2.1 Probe Nozzle Brush. Nylon bristle brush with stainless steel wire handle. The brush shall be properly sized and shaped to brush out the probe nozzle.

2.2.2 Wash Bottles -- Two. Glass wash bottles are recommended; polyethylene wash bottles may be used at the option of the tester. It is recommended that acetone not be stored in polyethylene bottles for longer than a month.

2.2.3 Glass Sample Storage Containers. Chemically resistant, borosilicate glass bottles, for acetone washes, 500 ml or 1000 ml. Screw cap liners shall either be rubber-backed Teflon or shall be constructed so as to be leak-free and resistant to chemical attack by acetone. (Narrow mouth glass bottles have been found to be less prone to leakage.) Alternatively, polyethylene bottles may be used.

2.2.4 Petri Dishes. For filter samples; glass or polyethylene, unless otherwise specified by the Administrator.

2.2.5 Graduated Cylinder and/or Balance. To measure condensed water to within 1 ml or 1 g. Graduated cylinders shall have subdivisions no greater than 2 ml. Most laboratory balances are capable of weighing to the nearest 0.5 g or less. Any of these balances is suitable for use here and in Section 2.3.4.

2.2.6 Plastic Storage Containers. Air tight containers to store silica gel.

2.2.7 Funnel and Rubber Policeman. To aid in transfer of silica gel to container; not necessary if silica gel is weighed in the field.

2.2.8 Funnel. Glass or polyethylene, to aid in sample recovery.

2.3 Analysis.

2.3.1 Glass Weighing Dishes.

2.3.2 Desiccator.

2.3.3 Analytical Balance. To measure to within 0.1 mg.

2.3.4 Balance. To measure to within 0.5 mg.

2.3.5 Beakers. 250 ml.

2.3.6 Hygrometer. To measure the relative humidity of the laboratory environment.

2.3.7 Temperature Gauge. To measure the temperature of the laboratory environment.

### 3. *Reagents*

#### 3.1 Sampling.

3.1.1 Filters. The in-stack filters shall be glass mats or thimble fiber filters, without organic binders, and shall exhibit at least 99.95 percent efficiency (0.05 percent penetration) on 0.3 micron dioctyl phthalate smoke particles. The filter efficiency tests shall be conducted in accordance with ASTM Standard Method D2986-71 (Reapproved 1978) (incorporated by reference -- see § 60.17). Test data from the supplier's quality control program are sufficient for this purpose.

3.1.2 Silica Gel. Indicating type, 6- to 16-mesh. If previously used, dry at 175 deg. C (350 deg. F) for 2 hours. New silica gel may be used as received. Alternatively, other types of desiccants (equivalent or better) may be used, subject to the approval of the Administrator.

3.1.3 Crushed Ice.

3.1.4 Stopcock Grease. Acetone-insoluble, heat-stable silicone grease. This is not necessary if screw-on connectors with Teflon sleeves, or similar, are used. Alternatively, other types of stopcock grease may be used, subject to the approval of the Administrator.

3.1.5 Water. Same as in Method 5, section 3.1.3.

3.2 Sample Recovery. Acetone, reagent grade, 0.001 percent residue, in glass bottles. Acetone from metal containers generally has a high residue blank and should not be used. Sometimes, suppliers transfer acetone to glass bottles from metal containers. Thus, acetone blanks shall be run prior to field use and only acetone with

low blank values (0.001 percent) shall be used. In no case shall a blank value of greater than 0.001 percent of the weight of acetone used be subtracted from the sample weight.

### 3.3 Analysis.

#### 3.3.1 Acetone. Same as 3.2.

3.3.2 Desiccant. Anhydrous calcium sulfate, indicating type. Alternatively, other types of desiccants may be used, subject to the approval of the Administrator.

## 4. Procedure

4.1 Sampling. The complexity of this method is such that, in order to obtain reliable results, testers should be trained and experienced with the test procedures.

4.1.1 Pretest Preparation. All components shall be maintained and calibrated according to the procedure described in APTD-0576, unless otherwise specified herein.

Weigh several 200 to 300 g portions of silica gel in air-tight containers to the nearest 0.5 g. Record the total weight of the silica gel plus container, on each container. As an alternative, the silica gel need not be preweighed, but may be weighed directly in its impinger or sampling holder just prior to train assembly.

Check filters visually against light for irregularities and flaws or pinhole leaks. Label filters of the proper size on the back side near the edge using numbering machine ink. As an alternative, label the shipping containers (glass or plastic petri dishes) and keep the filters in these containers at all times except during sampling and weighing.

Desiccate the filters at 20 +/- 5.6 deg. C (68 +/- 10 deg. F) and ambient pressure for at least 24 hours and weigh at intervals of at least 6 hours to a constant weight, i.e., 0.5 mg change from previous weighing; record results to the nearest 0.1 mg. During each weighing the filter must not be exposed to the laboratory atmosphere for a period greater than 2 minutes and a relative humidity above 50 percent. Alternatively (unless otherwise specified by the Administrator), the filters may be oven dried at 105 deg. C (220 deg. F) for 2 to 3 hours, desiccated for 2 hours, and weighed. Procedures other than those described, which account for relative humidity effects, may be used, subject to the approval of the Administrator.

4.1.2 Preliminary Determinations. Select the sampling site and the minimum number of sampling points according to Method 1 or as specified by the Administrator. Make a projected-area model of the probe extension-filter holder assembly, with the pitot tube face openings positioned along the centerline of the stack, as shown in Figure 17-2. Calculate the estimated cross-section blockage, as shown in Figure 17-2. If the blockage exceeds 5 percent of the duct cross sectional area, the tester has the following options: (1) a suitable out-of-stack filtration method may be used instead of in-stack filtration; or (2) a special in-stack arrangement, in which the sampling and velocity measurement sites are separate, may be used; for details concerning this approach, consult with the Administrator (see also Citation 10 in Bibliography). Determine the stack pressure, temperature, and the range of velocity heads using Method 2; it is recommended that a leak-check of the pitot lines (see Method 2, Section 3.1) be performed. Determine the moisture content using Approximation Method 4 or its alternatives for the purpose of making isokinetic sampling rate settings. Determine the stack gas dry molecular weight, as described in Method 2, Section 3.6; if integrated Method 3 sampling is used for molecular weight determination, the integrated bag sample shall be taken simultaneously with, and for the same total length of time as, the particulate sample run.

Figure 17-2. Projected-area model of cross-section blockage (approximate average for a sample traverse) caused by an in-stack filter holder-probe extension assembly.

[SEE FIGURE IN ORIGINAL]

Select a nozzle size based on the range of velocity heads, such that it is not necessary to change the nozzle size in order to maintain isokinetic sampling rates. During the run, do not change the nozzle size. Ensure that the proper differential pressure gauge is chosen for the range of velocity heads encountered (see Section 2.2 of Method 2).

Select a probe extension length such that all traverse points can be sampled. For large stacks, consider sampling from opposite sides of the stack to reduce the length of probes.

Select a total sampling time greater than or equal to the minimum total sampling time specified in the test procedures for the specific industry such that (1) the sampling time per point is not less than 2 minutes (or some greater time interval if specified by the Administrator), and (2) the sample volume taken (corrected to standard conditions) will exceed the required minimum total gas sample volume. The latter is based on an approximate average sampling rate.

It is recommended that the number of minutes sampled at each point be an integer or an integer plus one-half minute, in order to avoid timekeeping errors.

In some circumstances, e.g., batch cycles, it may be necessary to sample for shorter times at the traverse points and to obtain smaller gas sample volumes. In these cases, the Administrator's approval must first be obtained.

4.1.3 Preparation of Collection Train. During preparation and assembly of the sampling train, keep all openings where contamination can occur covered until just prior to assembly or until sampling is about to begin.

If impingers are used to condense stack gas moisture, prepare them as follows: place 100 ml of water in each of the first two impingers, leave the third impinger empty, and transfer approximately 200 to 300 g of preweighed silica gel from its container to the fourth impinger. More silica gel may be used, but care should be taken to ensure that it is not entrained and carried out from the impinger during sampling. Place the container in a clean place for later use in the sample recovery. Alternatively, the weight of the silica gel plus impinger may be determined to the nearest 0.5 g and recorded.

If some means other than impingers is used to condense moisture, prepare the condenser (and, if appropriate, silica gel for condenser outlet) for use.

Using a tweezer or clean disposable surgical gloves, place a labeled (identified) and weighed filter in the filter holder. Be sure that the filter is properly centered and the gasket properly placed so as not to allow the sample gas stream to circumvent the filter. Check filter for tears after assembly is completed. Mark the probe extension with heat resistant tape or by some other method to denote the proper distance into the stack or duct for each sampling point.

Assemble the train as in Figure 17-1, using a very light coat of silicone grease on all ground glass joints and greasing only the outer portion (see APTD-0576) to avoid possibility of contamination by the silicone grease. Place crushed ice around the impingers.

4.1.4 Leak Check Procedures.

4.1.4.1 Pretest Leak-Check. A pretest leak-check is recommended, but not required. If the tester opts to conduct the pretest leak-check, the following procedure shall be used.

After the sampling train has been assembled, plug the inlet to the probe nozzle with a material that will be able

to withstand the stack temperature. Insert the filter holder into the stack and wait approximately 5 minutes (or longer, if necessary) to allow the system to come to equilibrium with the temperature of the stack gas stream. Turn on the pump and draw a vacuum of at least 380 mm Hg (15 in. Hg); note that a lower vacuum may be used, provided that it is not exceeded during the test. Determine the leakage rate. A leakage rate in excess of 4 percent of the average sampling rate or 0.00057 m<sup>3</sup>/min. (0.02 cfm), whichever is less, is unacceptable.

The following leak-check instructions for the sampling train described in APTD-0576 and APTD-0581 may be helpful. Start the pump with by-pass valve fully open and coarse adjust valve completely closed. Partially open the coarse adjust valve and slowly close the by-pass valve until the desired vacuum is reached. Do not reverse direction of by-pass valve. If the desired vacuum is exceeded, either leak-check at this higher vacuum or end the leak-check as shown below and start over.

When the leak-check is completed, first slowly remove the plug from the inlet to the probe nozzle and immediately turn off the vacuum pump. This prevents water from being forced backward and keeps silica gel from being entrained backward.

4.1.4.2 Leak-Checks During Sample Run. If, during the sampling run, a component (e.g., filter assembly or impinger) change becomes necessary, a leak-check shall be conducted immediately before the change is made. The leak-check shall be done according to the procedure outlined in Section 4.1.4.1 above, except that it shall be done at a vacuum equal to or greater than the maximum value recorded up to that point in the test. If the leakage rate is found to be no greater than 0.00057 m<sup>3</sup>/min (0.02 cfm) or 4 percent of the average sampling rate (whichever is less), the results are acceptable, and no correction will need to be applied to the total volume of dry gas metered; if, however, a higher leakage rate is obtained, the tester shall either record the leakage rate and plan to correct the sample volume as shown in Section 6.3 of this method, or shall void the sampling run.

Immediately after component changes, leak-checks are optional; if such leak-checks are done, the procedure outlined in Section 4.1.4.1 above shall be used.

4.1.4.3 Post-Test Leak-Check. A leak-check is mandatory at the conclusion of each sampling run. The leak-check shall be done in accordance with the procedures outlined in Section 4.1.4.1, except that it shall be conducted at a vacuum equal to or greater than the maximum value reached during the sampling run. If the leakage rate is found to be no greater than 0.00057 m<sup>3</sup>/min (0.02 cfm) or 4 percent of the average sampling rate (whichever is less), the results are acceptable, and no correction need be applied to the total volume of dry gas metered. If, however, a higher leakage rate is obtained, the tester shall either record the leakage rate and correct the sample volume as shown in Section 6.3 of this method, or shall void the sampling run.

4.1.5 Particulate Train Operation. During the sampling run, maintain a sampling rate such that sampling is within 10 percent of true isokinetic, unless otherwise specified by the Administrator.

For each run, record the data required on the example data sheet shown in Figure 17-3. Be sure to record the initial dry gas meter reading. Record the dry gas meter readings at the beginning and end of each sampling time increment, when changes in flow rates are made, before and after each leak check, and when sampling is halted. Take other readings required by Figure 17-3 at least once at each sample point during each time increment and additional readings when significant changes (20 percent variation in velocity head readings) necessitate additional adjustments in flow rate. Level and zero the manometer. Because the manometer level and zero may drift due to vibrations and temperature changes, make periodic checks during the traverse.

#### FIGURE 17-3 -- PARTICULATE FIELD DATA

[SEE FIGURE IN ORIGINAL]

Clean the portholes prior to the test run to minimize the chance of sampling the deposited material. To begin

sampling, remove the nozzle cap and verify that the pitot tube and probe extension are properly positioned. Position the nozzle at the first traverse point with the tip pointing directly into the gas stream. Immediately start the pump and adjust the flow to isokinetic conditions. Nomographs are available, which aid in the rapid adjustment to the isokinetic sampling rate without excessive computations. These nomographs are designed for use when the Type S pitot tube coefficient is  $0.85 \pm 0.02$ , and the stack gas equivalent density (dry molecular weight) is equal to  $29 \pm 4$ . APTD-0576 details the procedure for using the nomographs. If  $C[p]$  and  $M[d]$  are outside the above stated ranges, do not use the nomographs unless appropriate steps (see Citation 7 in Bibliography) are taken to compensate for the deviations.

When the stack is under significant negative pressure (height of impinger stem), take care to close the coarse adjust valve before inserting the probe extension assembly into the stack to prevent water from being forced backward. If necessary, the pump may be turned on with the coarse adjust valve closed.

When the probe is in position, block off the openings around the probe and porthole to prevent unrepresentative dilution of the gas stream.

Traverse the stack cross section, as required by Method 1 or as specified by the Administrator, being careful not to bump the probe nozzle into the stack walls when sampling near the walls or when removing or inserting the probe extension through the portholes, to minimize chance of extracting deposited material.

During the test run, take appropriate steps (e.g., adding crushed ice to the impinger ice bath) to maintain a temperature of less than 20 deg. C (68 deg. F) at the condenser outlet; this will prevent excessive moisture losses. Also, periodically check the level and zero of the manometer.

If the pressure drop across the filter becomes too high, making isokinetic sampling difficult to maintain, the filter may be replaced in the midst of a sample run. It is recommended that another complete filter holder assembly be used rather than attempting to change the filter itself. Before a new filter holder is installed, conduct a leak check, as outlined in Section 4.1.4.2. The total particulate weight shall include the summation of all filter assembly catches.

A single train shall be used for the entire sample run, except in cases where simultaneous sampling is required in two or more separate ducts or at two or more different locations within the same duct, or, in cases where equipment failure necessitates a change of trains. In all other situations, the use of two or more trains will be subject to the approval of the Administrator. Note that when two or more trains are used, a separate analysis of the collected particulate from each train shall be performed, unless identical nozzle sizes were used on all trains, in which case the particulate catches from the individual trains may be combined and a single analysis performed.

At the end of the sample run, turn off the pump, remove the probe extension assembly from the stack, and record the final dry gas meter reading. Perform a leak-check, as outlined in Section 4.1.4.3. Also, leak-check the pitot lines as described in Section 3.1 of Method 2; the lines must pass this leak-check, in order to validate the velocity head data.

4.1.6 Calculation of Percent Isokinetic. Calculate percent isokinetic (see Section 6.11) to determine whether another test run should be made. If there is difficulty in maintaining isokinetic rates due to source conditions, consult with the Administrator for possible variance on the isokinetic rates.

4.2 Sample Recovery. Proper cleanup procedure begins as soon as the probe extension assembly is removed from the stack at the end of the sampling period. Allow the assembly to cool.

When the assembly can be safely handled, wipe off all external particulate matter near the tip of the probe nozzle and place a cap over it to prevent losing or gaining particulate matter. Do not cap off the probe tip tightly

while the sampling train is cooling down as this would create a vacuum in the filter holder, forcing condenser water backward.

Before moving the sample train to the cleanup site, disconnect the filter holder-probe nozzle assembly from the probe extension; cap the open inlet of the probe extension. Be careful not to lose any condensate, if present. Remove the umbilical cord from the condenser outlet and cap the outlet. If a flexible line is used between the first impinger (or condenser) and the probe extension, disconnect the line at the probe extension and let any condensed water or liquid drain into the impingers or condenser. Disconnect the probe extension from the condenser; cap the probe extension outlet. After wiping off the silicone grease, cap off the condenser inlet. Ground glass stoppers, plastic caps, or serum caps (whichever are appropriate) may be used to close these openings.

Transfer both the filter holder-probe nozzle assembly and the condenser to the cleanup area. This area should be clean and protected from the wind so that the chances of contaminating or losing the sample will be minimized.

Save a portion of the acetone used for cleanup as a blank. Take 200 ml of this acetone directly from the wash bottle being used and place it in a glass sample container labeled "acetone blank."

Inspect the train prior to and during disassembly and note any abnormal conditions. Treat the samples as follows:

*Container No. 1.* Carefully remove the filter from the filter holder and place it in its identified petri dish container. Use a pair of tweezers and/or clean disposable surgical gloves to handle the filter. If it is necessary to fold the filter, do so such that the particulate cake is inside the fold. Carefully transfer to the petri dish any particulate matter and/or filter fibers which adhere to the filter holder gasket, by using a dry Nylon bristle brush and/or a sharp-edged blade. Seal the container.

*Container No. 2.* Taking care to see that dust on the outside of the probe nozzle or other exterior surfaces does not get into the sample, quantitatively recover particulate matter or any condensate from the probe nozzle, fitting, and front half of the filter holder by washing these components with acetone and placing the wash in a glass container. Distilled water may be used instead of acetone when approved by the Administrator and shall be used when specified by the Administrator; in these cases, save a water blank and follow Administrator's directions on analysis. Perform the acetone rinses as follows:

Carefully remove the probe nozzle and clean the inside surface by rinsing with acetone from a wash bottle and brushing with a Nylon bristle brush. Brush until acetone rinse shows no visible particles, after which make a final rinse of the inside surface with acetone.

Brush and rinse with acetone the inside parts of the fitting in a similar way until no visible particles remain. A funnel (glass or polyethylene) may be used to aid in transferring liquid washes to the container. Rinse the brush with acetone and quantitatively collect these washings in the sample container. Between sampling runs, keep brushes clean and protected from contamination.

After ensuring that all joints are wiped clean of silicone grease (if applicable), clean the inside of the front half of the filter holder by rubbing the surfaces with a Nylon bristle brush and rinsing with acetone. Rinse each surface three times or more if needed to remove visible particulate. Make final rinse of the brush and filter holder. After all acetone washings and particulate matter are collected in the sample container, tighten the lid on the sample container so that acetone will not leak out when it is shipped to the laboratory. Mark the height of the fluid level to determine whether or not leakage occurred during transport. Label the container to clearly identify its contents.

*Container No. 3.* If silica gel is used in the condenser system for moisture content determination, note the color

of the gel to determine if it has been completely spent; make a notation of its condition. Transfer the silica gel back to its original container and seal. A funnel may make it easier to pour the silica gel without spilling, and a rubber policeman may be used as an aid in removing the silica gel. It is not necessary to remove the small amount of dust particles that may adhere to the walls and are difficult to remove. Since the gain in weight is to be used for moisture calculations, do not use any water or other liquids to transfer the silica gel. If a balance is available in the field, follow the procedure for Container No. 3 under "Analysis."

*Condenser Water.* Treat the condenser or impinger water as follows: make a notation of any color or film in the liquid catch. Measure the liquid volume to within +/- 1 ml by using a graduated cylinder or, if a balance is available, determine the liquid weight to within +/- 0.5 g. Record the total volume or weight of liquid present. This information is required to calculate the moisture content of the effluent gas. Discard the liquid after measuring and recording the volume or weight.

4.3 Analysis. Record the data required on the example sheet shown in Figure 17-4. Handle each sample container as follows:

*Container No. 1.* Leave the contents in the shipping container or transfer the filter and any loose particulate from the sample container to a tared glass weighing dish. Desiccate for 24 hours in a desiccator containing anhydrous calcium sulfate. Weigh to a constant weight and report the results to the nearest 0.1 mg. For purposes of this Section, 4.3, the term "constant weight" means a difference of no more than 0.5 mg or 1 percent of total weight less tare weight, whichever is greater, between two consecutive weighings, with no less than 6 hours of desiccation time between weighings.

Alternatively, the sample may be oven dried at the average stack temperature or 105 deg. C (220 deg. F), whichever is less, for 2 to 3 hours, cooled in the desiccator, and weighed to a constant weight, unless otherwise specified by the Administrator. The tester may also opt to oven dry the sample at the average stack temperature or 105 deg. C (220 deg. F), whichever is less, for 2 to 3 hours, weigh the sample, and use this weight as a final weight.

FIGURE 17-4 -- ANALYTICAL DATA

Plant

Date

Run No.

Filter No.

Amount liquid lost during transport

Acetone blank volume, ml

Acetone wash volume, ml

Acetone blank concentration, mg/mg (Equation 17-4)

Acetone wash blank, mg (Equation 17-5)

Container number	Weight of particulate collected, mg		Weight gain
	Final weight	Tare weight	



5.1 Probe Nozzle. Probe nozzles shall be calibrated before their initial use in the field. Using a micrometer, measure the inside diameter of the nozzle to the nearest 0.025 mm (0.001 in.). Make three separate measurements using different diameters each time, and obtain the average of the measurements. The difference between the high and low numbers shall not exceed 0.1 mm (0.004 in.). When nozzles become nicked, dented, or corroded, they shall be reshaped, sharpened, and recalibrated before use. Each nozzle shall be permanently and uniquely identified.

5.2 Pitot Tube. If the pitot tube is placed in an interference-free arrangement with respect to the other probe assembly components, its baseline (isolated tube) coefficient shall be determined as outlined in Section 4 of Method 2. If the probe assembly is not interference-free, the pitot tube assembly coefficient shall be determined by calibration, using methods subject to the approval of the Administrator.

5.3 Metering System. Before its initial use in the field, the metering system shall be calibrated according to the procedure outlined in APTD-0576. Instead of physically adjusting the dry gas meter dial readings to correspond to the wet test meter readings, calibration factors may be used to mathematically correct the gas meter dial readings to the proper values.

Before calibrating the metering system, it is suggested that a leak-check be conducted. For metering systems having diaphragm pumps, the normal leak-check procedure will not detect leakages within the pump. For these cases the following leak-check procedure is suggested: make a 10-minute calibration run at 0.00057 m<sup>3</sup> / min (0.02 cfm); at the end of the run, take the difference of the measured wet test meter and dry gas meter volumes; divide the difference by 10, to get the leak rate. The leak rate should not exceed 0.00057 m<sup>3</sup> / min (0.02 cfm).

After each field use, the calibration of the metering system shall be checked by performing three calibration runs at a single, intermediate orifice setting (based on the previous field test), with the vacuum set at the maximum value reached during the test series. To adjust the vacuum, insert a valve between the wet test meter and the inlet of the metering system. Calculate the average value of the calibration factor. If the calibration has changed by more than 5 percent, recalibrate the meter over the full range of orifice settings, as outlined in APTD-0576.

Alternative procedures, e.g., using the orifice meter coefficients, may be used, subject to the approval of the Administrator.

NOTE: If the dry gas meter coefficient values obtained before and after a test series differ by more than 5 percent, the test series shall either be voided, or calculations for the test series shall be performed using whichever meter coefficient value (i.e., before or after) gives the lower value of total sample volume.

5.4 Temperature Gauges. Use the procedure in Section 4.3 of Method 2 to calibrate in-stack temperature gauges. Dial thermometers, such as are used for the dry gas meter and condenser outlet, shall be calibrated against mercury-in-glass thermometers.

5.5 Leak Check of Metering System Shown in Figure 17-1. That portion of the sampling train from the pump to the orifice meter should be leak checked prior to initial use and after each shipment. Leakage after the pump will result in less volume being recorded than is actually sampled. The following procedure is suggested (see Figure 17-5). Close the main valve on the meter box. Insert a one-hole rubber stopper with rubber tubing attached into the orifice exhaust pipe. Disconnect and vent the low side of the orifice manometer. Close off the low side orifice tap. Pressurize the system to 13 to 18 cm (5 to 7 in.) water column by blowing into the rubber tubing. Pinch off the tubing and observe the manometer for one minute. A loss of pressure on the manometer indicates a leak in the meter box; leaks, if present, must be corrected.

Figure 17-5. Leak Check of meter box.

[See Figure in Original]

5.6 Barometer. Calibrate against a mercury barometer.

## 6. Calculations

Carry out calculations, retaining at least one extra decimal figure beyond that of the acquired data. Round off figures after the final calculation. Other forms of the equations may be used as long as they give equivalent results.

### 6.1 Nomenclature.

A[n] = Cross-sectional area of nozzle,  $m^2$  ( $ft^2$ ).

B[ws] = Water vapor in the gas stream, proportion by volume.

C[a] = Acetone blank residue concentration, mg/mg.

c[s] = Concentration of particulate matter in stack gas, dry basis, corrected to standard conditions, g/dscm (g/dscf).

I = Percent of isokinetic sampling.

L[a] = Maximum acceptable leakage rate for either a pretest leak check or for a leak check following a component change; equal to  $0.00057 m^3/min$  (0.02 cfm) or 4 percent of the average sampling rate, whichever is less.

L[i] = Individual leakage rate observed during the leak check conducted prior to the "i<sup>th</sup>" component change (i = 1, 2, 3 . . . n),  $m^3/min$  (cfm).

L[p] = Leakage rate observed during the post-test leak check,  $m^3/min$  (cfm).

m[a] = Mass of residue of acetone after evaporation, mg.

m[n] = Total amount of particulate matter collected, mg.

M[W] = Molecular weight of water, 18.0 g/g-mole (18.0 lb/lb-mole).

P[bar] = Barometric pressure at the sampling site, mm Hg (in. Hg).

P[s] = Absolute stack gas pressure, mm Hg (in. Hg).

P[std] = Standard absolute pressure, 760 mm Hg (29.92 in Hg).

R = Ideal gas constant,  $0.062326 mm\ Hg \cdot m^3 / degrees\ K \cdot g \cdot mole$  ( $21.85 in. Hg \cdot ft^3 / degrees\ R \cdot lb \cdot mole$ ).

T[m] = Absolute average dry gas meter temperature (see Figure 17-3), deg. K ( deg. R).

T[s] = Absolute average stack gas temperature (see Figure 17-3), degrees K (degrees R).

T[std] = Standard absolute temperature, 293 deg. K (528 deg. R).

V[a] = Volume of acetone blank, ml.

V[aw] = Volume of acetone used in wash, ml.

V[lc] = Total volume of liquid collected in impingers and silica gel (see Figure 17-4),ml.

V[m] = Volume of gas sample as measured by dry gas meter, dcm (dcf).

V[m(std)] = Volume of gas sample measured by the dry gas meter, corrected to standard conditions, dscm (dscf).

V[w(std)] = Volume of water vapor in the gas sample, corrected to standard conditions, scm (scf).

V[s] = Stack gas velocity, calculated by Method 2, Equation 2-9, using data obtained from Method 17, m/sec (ft/sec).

W[a] = Weight of residue in acetone wash, mg.

Y = Dry gas meter calibration coefficient.

DELTA H = Average pressure differential across the orifice meter (see Figure 17-3), mm H<sub>2</sub>O (in. H<sub>2</sub>O).

rho[a] = Density of acetone, mg/ml (see label on bottle).

rho[W] = Density of water, 0.9982 g/ml (0.002201 lb/ml).

theta = Total sampling time, min.

theta[1] = Sampling time interval, between two successive component changes, beginning with the interval between the first and second changes, min.

theta[p] = Sampling time interval, from the final (n<th>) component change until the end of the sampling run, min.

13.6 = Specific gravity of mercury.

60 = Sec/min.

100 = Conversion to percent.

6.2 Average Dry Gas Meter Temperature and Average Orifice Pressure Drop. See data sheet (Figure 17-3).

6.3 Dry Gas Volume. Correct the sample volume measured by the dry gas meter to standard conditions (20 deg. C, 760 mm Hg or 68 deg. F, 29.92 in. Hg) by using Equation 17-1.

$$V[m(std)] = V[m]Y \times (T[std] / T[m]) \times P[bar] + DELTA H / [13.6] / P[std] = K[1]V[m]Y \times P[bar] + (DELTA H / 13.6) / T[m]$$

Eq. 71-1

Where:

$K[1] = 0.3858 \text{ deg. K/mm Hg}$  for metric units;  $17.64 \text{ deg. R/in. Hg}$  for English units.

NOTE: Equation 17-1 can be used as written unless the leakage rate observed during any of the mandatory leak checks (i.e., the post-test leak check or leak checks conducted prior to component changes) exceeds  $L[a]$ . If  $L[p]$  or  $L[i]$  exceeds  $L[a]$ , Equation 17-1 must be modified as follows:

(a) Case I. No component changes made during sampling run. In this case, replace  $V[m]$  in Equation 17-1 with the expression:

$$[V[m] - (L[p] - L[a]) \theta]$$

(b) Case II. One or more component changes made during the sampling run. In this case, replace  $V[m]$  in Equation 17-1 by the expression:

$$[V[m] - (L[1] - L[a]) \theta_1 - \dots - \text{SIGMA } [i = 2] X (L[i] - L[a]) X \theta_i - (L[p] - L[a]) X \theta_p]$$

and substitute only for those leakage rates ( $L[i]$  or  $L[p]$ ) which exceed  $L[a]$ .

6.4 volume of Water Vapor.

$$V[w(\text{std})] = V[lc] X (p[w] / M[w]) X (RT[\text{std}] / P [\text{std}]) = K[2] V[lc]$$

Eq. 17-2

Where:

$K[2] = 0.001333 \text{ m}^3/\text{ml}$  for metric units;  $0.04707 \text{ ft}^3/\text{ml}$  for English units.

6.5 Moisture Content.

$$B[ws] = V[w(\text{std})] / V[m(\text{std}) + V[w(\text{std})]$$

Eq. 17-3

6.6 Acetone Blank Concentration.

$$C[a] = m[a] / V[a] \rho[a]$$

Eq. 17-4

6.7 Acetone Wash Blank.

$$W[a] = C[a]V[aw] \rho[a]$$

Eq. 17-5

6.8 Total Particulate Weight. Determine the total particulate catch from the sum of the weights obtained from Containers 1 and 2 less the acetone blank (see Figure 17-4).

NOTE: Refer to Section 4.1.5 to assist in calculation of results involving two or more filter assemblies or two or more sampling trains.

## 6.9 Particulate Concentration

$$c[s] = (0.001 \text{ g/mg}) (m[n] / V[m(\text{std})])$$

Eq. 17-6

## 6.10 Conversion Factors:

From	To	Multiply by
scf	m <sup>3</sup>	0.02832
g/ft <sup>3</sup>	gr/ft <sup>3</sup>	15.43
g/ft <sup>3</sup>	lb/ft <sup>3</sup>	2.205X10 <sup>-3</sup>
g/ft <sup>3</sup>	g/m <sup>3</sup>	35.31

## 6.11 Isokinetic Variation.

### 6.11.1 Calculation from Raw Data.

$$I = 100 T[S] (K[3] V[lc] + (V[m] Y / t[m]) X (P[\text{bar}] + \text{DELTAH} / 13.6)) / 60 \theta V[s] P[s] A[n]$$

Eq. 17-7

Where:

K[3] = 0.003454 mm Hg-m<sup>3</sup>/ml-deg. K for metric units; 0.002669 in. Hg-ft<sup>3</sup>/ml-deg. R for English units.

### 6.11.2 Calculation from Intermediate Values.

$$I = T[s] V[m(\text{std})] P[\text{std}] 100 / T[\text{std}] v[s] \theta A[n] P[s] (I-B[\text{ws}])$$
$$= K[4] T[s] V[m(\text{std})] / P[s] v[s] A[n] \theta (I-B[\text{ws}])$$

Eq. 17-8

Where:

K[4] = 4.320 for metric units; 0.09450 for English units.

6.12 Acceptable Results. If 90 percent <I < 110 percent, the results are acceptable. If the results are low in comparison to the standard and I is beyond the acceptable range, or, if I is less than 90 percent, the Administrator may opt to accept the results. Use Citation 4 in Bibliography to make judgments. Otherwise, reject the results and repeat the test.

## 7. Bibliography

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## METHOD 18 -- MEASUREMENT OF GASEOUS ORGANIC COMPOUND EMISSIONS BY GAS CHROMATOGRAPHY

### *Introduction*

This method should not be attempted by persons unfamiliar with the performance characteristics of gas chromatography, nor by those persons who are unfamiliar with source sampling. Particular care should be exercised in the area of safety concerning choice of equipment and operation in potentially explosive atmospheres.

### *1. Applicability and Principle*

1.1 Applicability. This method applies to the analysis of approximately 90 percent of the total gaseous organics emitted from an industrial source. It does not include techniques to identify and measure trace amounts of organic compounds, such as those found in building air and fugitive emission sources.

This method will not determine compounds that (1) are polymeric (high molecular weight), (2) can polymerize before analysis, or (3) have very low vapor pressures at stack or instrument conditions.

### *1.2 Principle.*

The major organic components of a gas mixture are separated by gas chromatography (GC) and individually quantified by flame ionization, photoionization, electron capture, or other appropriate detection principles.

The retention times of each separated component are compared with those of known compounds under identical

conditions. Therefore, the analyst confirms the identity and approximate concentrations of the organic emission components before-hand. With this information, the analyst then prepares or purchases commercially available standard mixtures to calibrate the GC under conditions identical to those of the samples. The analyst also determines the need for sample dilution to avoid detection saturation, gas stream filtration to eliminate particulate matter, and prevention of moisture condensation.

## *2. Range and Sensitivity*

2.1 Range. The range of this method is from about 1 part per million (ppm) to the upper limit governed by GC detector saturation or column overloading. The upper limit can be extended by diluting the stack gases with an inert gas or by using smaller gas sampling loops.

2.2 Sensitivity. The sensitivity limit for a compound is defined as the minimum detectable concentration of that compound, or the concentration that produces a signal-to-noise ratio of three to one. The minimum detectable concentration is determined during the presurvey calibration for each compound.

## *3. Precision and Accuracy*

Gas chromatographic techniques typically provide a precision of 5 to 10 percent relative standard deviation (RSD), but an experienced GC operator with a reliable instrument can readily achieve 5 percent RSD. For this method, the following combined GC/operator values are required.

(a) Precision. Duplicate analyses are within 5 percent of their mean value.

(b) Accuracy. Analysis results of prepared audit samples are within 10 percent of preparation values.

## *4. Interferences*

Resolution interferences that may occur can be eliminated by appropriate GC column and detector choice or by shifting the retention times through changes in the column flow rate and the use of temperature programming.

The analytical system is demonstrated to be essentially free from contaminants by periodically analyzing blanks that consist of hydrocarbon-free air or nitrogen.

Sample cross-contamination that occurs when high-level and low-level samples or standards are analyzed alternately, is best dealt with by thorough purging of the GC sample loop between samples.

To Assure consistent detector response, calibration gases are contained in dry air. To adjust gaseous organic concentrations when water vapor is present in the sample, water vapor concentrations are determined for those samples, and a correction factor is applied.

## *5. Presurvey and Presurvey Sampling.*

Perform a presurvey for each source to be tested. Refer to Figure 18-1. Some of the information can be collected from literature surveys and source personnel. Collect gas samples that can be analyzed to confirm the identities and approximate concentrations of the organic emissions.

5.1 Apparatus. This apparatus list also applies to Sections 6 and 7.

5.1.1 Teflon Tubing. (Mention of trade names or specific products does not constitute endorsement by the U.S. Environmental Protection Agency.) Diameter and length determined by connection requirements of cylinder regulators and the GC. Additional tubing is necessary to connect the GC sample loop to the sample.

5.1.2 Gas Chromatograph. GC with suitable detector, columns, temperature-controlled sample loop and valve assembly, and temperature programmable oven, if necessary. The GC shall achieve sensitivity requirements for the compounds under study.

5.1.3 Pump. Capable of pumping 100 ml/min. For flushing sample loop.

5.1.4 Flowmeters. To measure flow rates.

5.1.5 Regulators. Used on gas cylinders for GC and for cylinder standards.

5.1.6 Recorder. Recorder with linear strip chart is minimum acceptable. Integrator (optional) is recommended.

5.1.7 Syringes. 0.5-ml, 1.0- and 10-microliter sizes, calibrated, maximum accuracy (gas tight), for preparing calibration standards. Other appropriate sizes can be used.

5.1.8 Tubing Fittings. To plumb GC and gas cylinders.

5.1.9 Septums. For syringe injections.

5.1.10 Glass Jars. If necessary, clean-colored glass jars with Teflon-lined lids for condensate sample collection. Size depends on volume of condensate.

5.1.11 Soap Film Flow Meter. To determine flow rates.

5.1.12 Tedlar Bags. 10- and 50-liter capacity, for preparation of standards.

5.1.13 Dry Gas Meter with Temperature and Pressure Gauges. Accurate to +/- 2 percent, for preparation of gas standards.

5.1.14 Midget Impinger/Hot Plate Assembly. For preparation of gas standards.

5.1.15 Sample Flasks. For presurvey samples, must have gas-tight seals.

5.1.16 Adsorption Tubes. If necessary, blank tubes filled with necessary adsorbent (charcoal, Tenax, XAD-2, etc.) for presurvey samples.

5.1.17 Personnel Sampling Pump. Calibrated, for collecting adsorbent tube presurvey samples.

5.1.18 Dilution System. Calibrated, the dilution system is to be constructed following the specifications of an acceptable method.

5.1.19 Sample Probes. Pyrex or stainless steel, of sufficient length to reach centroid of stack, or a point no closer to the walls than 1 m.

5.1.20 Barometer. To measure barometric pressure.

5.2 Reagents.

5.2.1 Deionized Distilled Water.

5.2.2 Methylene Dichloride.

5.2.3 Calibration Gases. A series of standards prepared for every compound of interest.

5.2.4 Organic Compound Solutions. Pure (99.9 percent), or as pure as can reasonably be obtained, liquid samples of all the organic compounds needed to prepare calibration standards.

5.2.5 Extraction Solvents. For extraction of adsorbent tube samples in preparation for analysis.

5.2.6 Fuel. As recommended by the manufacturer for operation of the GC.

5.2.7 Carrier Gas. Hydrocarbon free, as recommended by the manufacturer for operation of the detector and compatibility with the column.

5.2.8 Zero Gas. Hydrocarbon free air or nitrogen, to be used for dilutions, blank preparation, and standard preparation.

### 5.3 Sampling.

5.3.1 Collection of Samples with Glass Sampling Flasks. Presurvey samples can be collected in precleaned 250-ml double-ended glass sampling flasks. Teflon stopcocks, without grease, are preferred. Flasks should be cleaned as follows: Remove the stopcocks from both ends of the flasks, and wipe the parts to remove any grease. Clean the stopcocks, barrels, and receivers with methylene dichloride. Clean all glass ports with a soap solution, then rinse with tap and deionized distilled water. Place the flask in a cool glass annealing furnace and apply heat up to 500 deg. C. Maintain at this temperature for 1 hour. After this time period, shut off and open the furnace to allow the flask to cool. Grease the stopcocks with stopcock grease and return them to the flask receivers. Purge the assembly with high-purity nitrogen for 2 to 5 minutes. Close off the stopcocks after purging to maintain a slight positive nitrogen pressure. Secure the stopcocks with tape.

Presurvey samples can be obtained either by drawing the gases into the previously evacuated flask or by drawing the gases into and purging the flask with a rubber suction bulb.

5.3.1.1 Evacuated Flask Procedure. Use a high-vacuum pump to evacuate the flask to the capacity of the pump; then close off the stopcock leading to the pump. Attach a 6-mm outside diameter (OD) glass tee to the flask inlet with a short piece of Teflon tubing. Select a 6-mm OD borosilicate sampling probe, enlarged at one end to a 12-mm OD and of sufficient length to reach the centroid of the duct to be sampled. Insert a glass wool plug in the enlarged end of the probe to remove particulate matter. Attach the other end of the probe to the tee with a short piece of Teflon tubing. Connect a rubber suction bulb to the third leg of the tee. Place the filter end of the probe at the centroid of the duct, or at a point no closer to the walls than 1 m, and purge the probe with the rubber suction bulb. After the probe is completely purged and filled with duct gases, open the stopcock to the grab flask until the pressure in the flask reaches duct pressure. Close off the stopcock, and remove the probe from the duct. Remove the tee from the flask and tape the stopcocks to prevent leaks during shipment. Measure and record the duct temperature and pressure.

5.3.1.2 Purged Flask Procedure. Attach one end of the sampling flask to a rubber suction bulb. Attach the other end to a 6-mm OD glass probe as described in Section 5.3.1.1. Place the filter end of the probe at the centroid of the duct, or at a point no closer to the walls than 1 m, and apply suction with the bulb to completely purge the probe and flask. After the flask has been purged, close off the stopcock near the suction bulb, and then close the stopcock near the probe. Remove the probe from the duct, and disconnect both the probe and suction bulb. Tape the stopcocks to prevent leakage during shipment. Measure and record the duct temperature and pressure.

5.3.2 Flexible Bag Procedure. Tedlar or aluminized Mylar bags can also be used to obtain the presurvey sample. Use new bags, and leak check them before field use. In addition, check the bag before use for contamination by

filling it with nitrogen or air, and analyzing the gas by GC at high sensitivity. Experience indicates that it is desirable to allow the inert gas to remain in the bag about 24 hours or longer to check for desorption of organics from the bag. Follow the leak check and sample collection procedures given in Section 7.1.

5.3.3 Determination of Moisture Content. For combustion or water-controlled processes, obtain the moisture content from plant personnel or by measurement during the presurvey. If the source is below 59 deg. C, measure the wet bulb and dry bulb temperatures, and calculate the moisture content using a psychrometric chart. At higher temperatures, use Method 4 to determine the moisture content.

5.4 Determination of Static Pressure. Obtain the static pressure from the plant personnel or measurement. If a type S pitot tube and an inclined manometer are used, take care to align the pitot tube 90 deg. from the direction of the flow. Disconnect one of the tubes to the manometer, and read the static pressure; note whether the reading is positive or negative.

5.5 Collection of Presurvey Samples with Adsorption Tube. Follow Section 7.4 for presurvey sampling.

## 6. *Analysis Development*

### 6.1 Selection of GC Parameters.

6.1.1 Column Choice. Based on the initial contact with plant personnel concerning the plant process and the anticipated emissions, choose a column that provides good resolution and rapid analysis time. The choice of an appropriate column can be aided by a literature search, contact with manufacturers of GC columns, and discussion with personnel at the emission source.

Most column manufacturers keep excellent records of their products. Their technical service departments may be able to recommend appropriate columns and detector type for separating the anticipated compounds, and they may be able to provide information on interferences, optimum operating conditions, and column limitations.

Plants with analytical laboratories may also be able to provide information on appropriate analytical procedures.

6.1.2 Preliminary GC Adjustment. Using the standards and column obtained in Section 6.1.1, perform initial tests to determine appropriate GC conditions that provide good resolution and minimum analysis time for the compounds of interest.

6.1.3 Preparation of Presurvey Samples. If the samples were collected on an adsorbent, extract the sample as recommended by the manufacturer for removal of the compounds with a solvent suitable to the type of GC analysis. Prepare other samples in an appropriate manner.

6.1.4 Presurvey Sample Analysis. Before analysis, heat the presurvey sample to the duct temperature to vaporize any condensed material. Analyze the samples by the GC procedure, and compare the retention times against those of the calibration samples that contain the components expected to be in the stream. If any compounds cannot be identified with certainty by this procedure, identify them by other means such as GC/mass spectroscopy (GC/MS) or GC/infrared techniques. A GC/MS system is recommended.

Use the GC conditions determined by the procedures of Section 6.1.2 for the first injection. Vary the GC parameters during subsequent injections to determine the optimum settings. Once the optimum settings have been determined, perform repeat injections of the sample to determine the retention time of each compound. To inject a sample, draw sample through the loop at a constant rate (100 ml/min for 30 seconds). Be careful not to pressurize the gas in the loop. Turn off the pump and allow the gas in the sample loop to come to ambient pressure. Activate the sample valve, and record injection time, loop temperature, column temperature, carrier

flow rate, chart speed, and attenuator setting. Calculate the retention time of each peak using the distance from injection to the peak maximum divided by the chart speed. Retention times should be repeatable within 0.5 seconds.

If the concentrations are too high for appropriate detector response, a smaller sample loop or dilutions may be used for gas samples, and, for liquid samples, dilution with solvent is appropriate. Use the standard curves (Section 6.3) to obtain an estimate of the concentrations.

Identify all peaks by comparing the known retention times of compounds expected to be in the retention times of peaks in the sample. Identify any remaining unidentified peaks which have areas larger than 5 percent of the total using a GC/MS, or estimation of possible compounds by their retention times compared to known compounds, with confirmation by further GC analysis.

6.2 Calibration Standards. Prepare or obtain enough calibration standards so that there are three different concentrations of each organic compound expected to be measured in the source sample. For each organic compound, select those concentrations that bracket the concentrations expected in the source samples. A calibration standard may contain more than one organic compound. If available, commercial cylinder gases may be used if their concentrations have been certified by direct analysis.

If samples are collected in adsorbent tubes (charcoal, XAD-2, Tenax, etc.), prepare or obtain standards in the same solvent used for the sample extraction procedure. Refer to Section 7.4.3.

Verify the stability of all standards for the time periods they are used. If gas standards are prepared in the laboratory, use one or more of the following procedures.

6.2.1 Preparation of Standards from High Concentration Cylinder Standards. Obtain enough high concentration cylinder standards to represent all the organic compounds expected in the source samples.

Use these high concentration standards to prepare lower concentration standards by dilution, as shown by Figures 18-5 and 18-6.

To prepare the diluted calibration samples, calibrated rotameters are normally used to meter both the high concentration calibration gas and the diluent gas. Other types of flowmeters and commercially available dilution systems can also be used.

Calibrate each flowmeter before use by placing it between the diluent gas supply and suitably sized bubble meter, spirometer, or wet test meter. Record all data shown on Figure 18-4. While it is desirable to calibrate the cylinder gas flowmeter with cylinder gas, the available quantity and cost may preclude it. The error introduced by using the diluent gas for calibration is insignificant for gas mixtures of up to 1,000 to 2,000 ppm of each organic component.

Once the flowmeters are calibrated, connect the flowmeters to the calibration and diluent gas supplies using 6-mm Teflon tubing. Connect the outlet side of the flowmeters through a connector to a leak-free Tedlar bag as shown in Figure 18-5. (See Section 7.1 for bag leak-check procedures.) Adjust the gas flow to provide the desired dilution, and fill the bag with sufficient gas for GC calibration. Be careful not to overfill and cause the bag to apply additional pressure on the dilution system. Record the flow rates of both flowmeters, and the laboratory temperature and atmospheric pressure. Calculate the concentration C[s] in ppm of each organic in the diluted gas as follows:

$$C[s] = 10^6 (X q[c]) / q[c] + q[d]$$

EQ. 18-1

where:

$10^{[6]}$  = Conversion to ppm.

X = Mole or volume fraction of the organic in the calibration gas to be diluted.

q[c] = Flow rate of the calibration gas to be diluted.

q[d] = Diluent gas flow rate.

Single-stage dilutions should be used to prepare calibration mixtures up to about 1:20 dilution factor.

For greater dilutions, a double dilution system is recommended, as shown in Figure 18-6. Fill the Tedlar bag with the dilute gas from the second stage. Record the laboratory temperature, barometric pressure, and static pressure readings. Correct the flow reading for temperature and pressure. Calculate the concentration C[s] in ppm of the organic in the final gas mixture as follows:

$$C[s] = 10^{[6]} X (q[c1] / (q[c1] + q[d1])) X (q[c2] / (q[c2] + q[d2]))$$

Eq. 18-2

Where:

$10^{[6]}$  = Conversion to ppm.

X = Mole or volume fraction of the organic in the calibration gas to be diluted.

q[c1] = Flow rate of the calibration gas to be diluted in stage 1.

q[c2] = Flow rate of the calibration gas to be diluted in stage 2.

q[d1] = Flow rate of diluent gas in stage 1.

q[d2] = Flow rate of diluent gas in stage 2.

Further details of the calibration methods for flowmeters and the dilution system can be found in Citation 21 in the Bibliography.

6.2.2 Preparation of Standards from Volatile Materials. Record all data shown on Figure 18-3.

6.2.2.1 Gas Injection Technique. This procedure is applicable to organic compounds that exist entirely as a gas at ambient conditions. Evacuate a 10-liter Tedlar bag that has passed a leak-check (see Section 7.1), and meter in 5.0 liters of air or nitrogen through a dry gas meter that has been calibrated in a manner consistent with the procedure described in Section 5.1.1 of Method 5. While the bag is filling use a 0.5-ml syringe to inject a known quantity of "pure" gas of the organic compound through the wall of the bag, or through a septum-capped tee at the bag inlet. Withdraw the syringe needle, and immediately cover the resulting hole with a piece of masking tape. In a like manner, prepare dilutions having other concentrations. Prepare a minimum of three concentrations. Place each bag on a smooth surface, and alternately depress opposite sides of the bag 50 times to mix the gases. Record the average meter temperature and pressure, the gas volume and the barometric pressure. Record the syringe temperature and pressure before injection.

Calculate each organic standard concentration C, in ppm as follows:

$$C[s] = G[v] \times 10^6 \times 293 / T[s] \times P[s] / 760 / V[m] \times Y \times 293 / T[m] \times P[m] / 760 \times 1000$$
$$= G[v] \times 10^3 \times P[s] / T[s] \times T[m] / P[m] / Y[m] \times Y$$

where:

G[v] = Gas volume or organic compound injected, ml.

10<sup>6</sup> = Conversion to ppm.

P[s] = Absolute pressure of syringe before injection, mm Hg.

T[s] = Absolute temperature of syringe before injection, deg. K.

V[m] = Gas volume indicated by dry gas meter, liters.

Y = Dry gas meter calibration factor, dimensionless.

P[m] = Absolute pressure of dry gas meter, mm Hg.

T[m] = Absolute temperature of dry gas meter, deg. K.

1000 = Conversion factor, ml/liter.

**6.2.2.2 Liquid Injection Technique.** Use the equipment shown in Figure 18-8. Calibrate the dry gas meter as described in Section 6.2.2.1 with a wet test meter or a spirometer. Use a water manometer for the pressure gauge and glass, Teflon, brass, or stainless steel for all connections. Connect a valve to the inlet of the 50-liter Tedlar bag.

To prepare the standards, assemble the equipment as shown in Figure 18-8, and leak-check the system. Completely evacuate the bag. Fill the bag with hydrocarbon-free air, and evacuate the bag again. Close the inlet valve.

Turn on the hot plate, and allow the water to reach boiling. Connect the bag to the impinger outlet. Record the initial meter reading, open the bag inlet valve, and open the cylinder. Adjust the rate so that the bag will be completely filled in approximately 15 minutes. Record meter pressure and temperature, and local barometric pressure.

Allow the liquid organic to equilibrate to room temperature. Fill the 1.0- or 10-microliter syringe to the desired liquid volume with the organic. Place the syringe needle into the impinger inlet using the septum provided, and inject the liquid into the flowing air stream. Use a needle of sufficient length to permit injection of the liquid below the air inlet branch of the tee. Remove the syringe.

When the bag is filled, stop the pump, and close the bag inlet valve. Record the final meter reading, temperature, and pressure.

Disconnect the bag from the impinger outlet, and either set it aside for at least 1 hour, or massage the bag to insure complete mixing.

Measure the solvent liquid density at room temperature by accurately weighing a known volume of the material

on an analytical balance to the nearest 1.0 milligram. A ground-glass stoppered 25-mil volumetric flask or a glass-stoppered specific gravity bottle is suitable for weighing. Calculate the result in terms of g/ml. As an alternative, literature values of the density of the liquid at 20 deg. C may be used.

Calculate each organic standard concentration C[s] in ppm as follows:

$$C[s] = \frac{L[v] \times \rho \times (24.055 \times 10^6)}{V[m] \times Y \times 293 / T[m] \times P[m] / 760 \times 1000} = 6.24 \times 10^4 \times \frac{L[v] \times \rho \times T[m] / M \times V[m] \times Y \times P[m]}$$

Eq. 18-4

where:

L[v] = Liquid volume of organic injected, ml.

$\rho$  = Liquid organic density as determined, g/ml.

M = Molecular weight of organic, g/g-mole.

24.055 = Ideal gas molar volume at 293 deg. K and 760 mm Hg, liters/g-mole.

$10^6$  = Conversion to ppm.

1000 = Conversion factor, ml/l.

**6.3 Preparation of Calibration Curves.** Establish proper GC conditions, then flush the sampling loop for 30 seconds at a rate of 100 ml/min. Allow the sample loop pressure to equilibrate to atmospheric pressure, and activate the injection valve. Record the standard concentration, attenuator factor, injection time, chart speed, retention time, peak area, sample loop temperature, column temperature, and carrier gas flow rate. Repeat the standard injection until two consecutive injections give area counts within 5 percent of their average. The average value multiplied by the attenuator factor is then the calibration area value for the concentration.

Repeat this procedure for each standard. Prepare a graphical plot of concentration (C[s]) versus the calibration area values. Perform a regression analysis, and draw the least squares line.

**6.4 Relative Response Factors.** The calibration curve generated from the standards for a single organic can usually be related to each of the individual GC response curves that are developed in the laboratory for all the compounds in the source. In the field, standards for that single organic can then be used to "calibrate" the GC for all the organics present. This procedure should first be confirmed in the laboratory by preparing and analyzing calibration standards containing multiple organic compounds.

**6.5 Quality Assurance for Laboratory Procedures.** Immediately after the preparation of the calibration curves and prior to the presurvey sample analysis, the analysis audit described in 40 CFR Part 61, Appendix C, Procedure 2: "Procedure for Field Auditing GC Analysis," should be performed. The information required to document the analysis of the audit samples has been included on the example data sheets shown in Figures 18-3 and 18-7. The audit analyses should agree with the audit concentrations within 10 percent. When available, the tester may obtain audit cylinders by contacting: U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Quality Assurance Division (MD-77), Research Triangle Park, North Carolina, 27711. Audit cylinders obtained from a commercial gas manufacturer may be used provided that (a) the gas manufacturer certifies the audit cylinder in a manner similar to the procedure described in 40 CFR Part 61, Appendix B, Method 106, Section 5.2.3.1, and (b) the gas manufacturer obtains an independent analysis of the audit cylinders to verify this analysis. Independent analysis is defined as an analysis performed by an individual

other than the individual who performs the gas manufacturer's analysis, while using calibration standards and analysis equipment different from those used for the gas manufacturer's analysis. Verification is complete and acceptable when the independent analysis concentration is within 5 percent of the gas manufacturer's concentration.

## *7. Final Sampling and Analysis Procedure*

Considering safety (flame hazards) and the source conditions, select an appropriate sampling and analysis procedure (Section 7.1, 7.2, 7.3, or 7.4). In situations where a hydrogen flame is a hazard and no intrinsically safe GC is suitable, use the flexible bag collection technique or an adsorption technique. If the source temperature is below 100 deg. C, and the organic concentrations are suitable for the detector to be used, use the direct interface method. If the source gases require dilution, use a dilution interface and either the bag sample or adsorption tubes. The choice between these two techniques will depend on the physical layout of the site, the source temperature, and the storage stability of the compounds if collected in the bag. Sample polar compounds by direct interfacing or dilution interfacing to prevent sample loss by adsorption on the bag.

### 7.1 Integrated Bag Sampling and Analysis.

**7.1.1 Evacuated Container Sampling Procedure.** In this procedure, the bags are filled by evacuating the rigid airtight containers that hold the bags. Use a field sample data sheet as shown in Figure 18-10. Collect triplicate sample from each sample location.

#### 7.1.1.1 Apparatus.

**7.1.1.1.1 Probe.** Stainless steel, Pyrex glass, or Teflon tubing probe, according to the duct temperature, with 6.4-mm OD Teflon tubing of sufficient length to connect to the sample bag. Use stainless steel or Teflon unions to connect probe and sample line.

**7.1.1.1.2 Quick Connects.** Male (2) and female (2) of stainless steel construction.

**7.1.1.1.3 Needle Valve.** To control gas flow.

**7.1.1.1.4 Pump.** Leakless Teflon-coated diaphragm-type pump or equivalent. To deliver at least 1 liter/min.

**7.1.1.1.5 Charcoal Adsorption Tube.** Tube filled with activated charcoal, with glass wool plugs at each end, to adsorb organic vapors.

**7.1.1.1.6 Flowmeter.** 0 to 500-ml flow range; with manufacturer's calibration curve.

**7.1.1.2 Sampling Procedure.** To obtain a sample, assemble the sample train as shown in Figure 18-9. Leak check both the bag and the container. Connect the vacuum line from the needle valve to the Teflon sample line from the probe. Place the end of the probe at the centroid of the stack, or at a point no closer to the walls than 1 m, and start the pump with the needle valve adjusted to yield a flow of 0.5 liter/minute. After allowing sufficient time to purge the line several times, connect the vacuum line to the bag, and evacuate until the rotameter indicates no flow. Then position the sample and vacuum lines for sampling, and begin the actual sampling, keeping the rate proportional to the stack velocity. As a precaution, direct the gas exiting the rotameter away from sampling personnel. At the end of the sample period, shut off the pump, disconnect the sample line from the bag, and disconnect the vacuum line from the bag container. Record the source temperature, barometric pressure, ambient temperature, sampling flow rate, and initial and final sampling time on the data sheet shown in Figure 18-10. Protect the Tedlar bag and its container from sunlight. When possible, perform the analysis within 2 hours of sample collection.

7.1.2 Direct Pump Sampling Procedure. Follow 7.1.1, except place the pump and needle valve between the probe and the bag. Use a pump and needle valve constructed of stainless steel or some other material not affected by the stack gas. Leak check the system, and then purge with stack gas before the connecting to the previously evacuated bag.

7.1.3 Explosion Risk Area Bag Sampling Procedure. Follow 7.1.1 except replace the pump with another evacuated can (see Figure 18-9a). Use this method whenever there is a possibility of an explosion due to pumps, heated probes, or other flame producing equipment.

7.1.4 Other Modified Bag Sampling Procedures. In the event that condensation is observed in the bag while collecting the sample and a direct interface system cannot be used, heat the bag during collection, and maintain it at a suitably elevated temperature during all subsequent operations. (Note: Take care to leak check the system prior to the dilutions so as not to create a potentially explosive atmosphere.) As an alternative, collect the sample gas, and simultaneously dilute it in the Tedlar bag.

In the first procedure, heat the box containing the sample bag to the source temperature, provided the components of the bag and the surrounding box can withstand this temperature. Then transport the bag as rapidly as possible to the analytical area while maintaining the heating, or cover the box with an insulating blanket. In the analytical area, keep the box heated to source temperature until analysis. Be sure that the method of heating the box and the control for the heating circuit are compatible with the safety restrictions required in each area.

To use the second procedure, prefill the Tedlar bag with a known quantity of inert gas. Meter the inert gas into the bag according to the procedure for the preparation of gas concentration standards of volatile liquid materials (Section 6.2.2.2), but eliminate the midjet impinger section. Take the partly filled bag to the source, and meter the source gas into the bag through heated sampling lines and a heated flowmeter, or Teflon positive displacement pump. Verify the dilution factors periodically through dilution and analysis of gases of known concentration.

#### 7.1.5 Analysis of Bag Samples.

7.1.5.1 Apparatus. Same as Section 5. A minimum of three gas standards are required.

7.1.5.2 Procedure. Establish proper GC operating conditions as described in Section 6.3, and record all data listed in Figure 18-7. Prepare the GC so that gas can be drawn through the sample valve. Flush the sample loop with gas from one of the three calibration mixtures, and activate the valve. Obtain at least two chromatograms for the mixture. The results are acceptable when the peak areas from two consecutive injections agree to within 5 percent of their average. If they do not, run additional analyses or correct the analytical techniques until this requirement is met. Then analyze the other two calibration mixtures in the same manner. Prepare a calibration curve as described in the same manner. Prepare a calibration curve as described in Section 6.3.

Analyze the source gas samples by connecting each bag to the sampling valve with a piece of Teflon tubing identified for that bag. Follow the specifications on replicate analyses specified for the calibration gases. Record the data listed in Figure 18-11. If certain items do not apply, use the notation "N.A." After all samples have been analyzed, repeat the analyses of the calibration gas mixtures, and generate a second calibration curve. Use an average of the two curves to determine the sample gas concentrations. If the two calibration curves differ by more than 5 percent from their mean value, then report the final results by comparison to both calibration curves.

7.1.6 Determination of Bag Water Vapor Content. Measure and record the ambient temperature and barometric pressure near the bag. From a water saturation vapor pressure table, determine and record the water vapor content as a decimal figure. (Assume the relative humidity to be 100 percent unless a lesser value is known.) If

the bag has been maintained at an elevated temperature as described in Section 7.1.4, determine the stack gas water content by Method 4.

7.1.7 Quality Assurance. Immediately prior to the analysis of the stack gas samples, perform audit analyses as described in Section 6.5. The audit analyses must agree with the audit concentrations within 10 percent. If the results are acceptable, proceed with the analyses of the source samples. If they do not agree within 10 percent, then determine the reason for the discrepancy, and take corrective action before proceeding.

7.1.8 Emission Calculations. From the average calibration curve described in Section 7.1.5., select the value of C[s] that corresponds to the peak area. Calculate the concentration C[c] in ppm, dry basis, of each organic in the sample as follows:

$$C[c] = C[s] P[r] T[i] F[r] / P[i] T[r] (1-B[ws])$$

Eq. 18-5

where:

C[s] = Concentration of the organic from the calibration curve, ppm.

P[r] = Reference pressure, the barometric pressure or absolute sample loop pressure recorded during calibration, mm Hg.

T[i] = Sample loop temperature at the time of sample analysis, deg. K.

F[r] = Relative response factor (if applicable, see Section 6.4).

P[i] = Barometric or absolute sample loop pressure at time of sample analysis, mm Hg.

T[r] = Reference temperature, the temperature of the sample loop recorded during calibration, deg. K.

B[ws] = Water vapor content of the bag sample or stack gas, proportion by volume.

7.2 Direct Interface Sampling and Analysis Procedure. The direct interface procedure can be used provided that the moisture content of the gas does not interfere with the analysis procedure, the physical requirements of the equipment can be met at the site, and the source gas concentration is low enough that detector saturation is not a problem. Adhere to all safety requirements with this method.

7.2.1 Apparatus.

7.2.1.1 Probe. Constructed of stainless steel, Pyrex glass, or Teflon tubing as required by duct temperature, 6.4-mm OD, enlarged at duct end to contain glass wool plug. If necessary, heat the probe with heating tape or a special heating unit capable of maintaining duct temperature.

7.2.1.2 Sample Lines. 6.4-mm OD Teflon lines, heat-traced to prevent condensation of material.

7.2.1.3 Quick Connects. To connect sample line to gas sampling valve on GC instrument and to pump unit used to withdraw source gas. Use a quick connect or equivalent on the cylinder or bag containing calibration gas to allow connection of the calibration gas to the gas sampling valve.

7.2.1.4 Thermocouple Readout Device. Potentiometer or digital thermometer, to measure source temperature and probe temperature.

7.2.1.5 Heated Gas Sampling Valve. Of two-position, six-port design, to allow sample loop to be purged with source gas or to direct source gas into the GC instrument.

7.2.1.6 Needle Valve. To control gas sampling rate from the source.

7.2.1.7 Pump. Leakless Teflon-coated diaphragm-type pump or equivalent, capable of at least 1 liter/minute sampling rate.

7.2.1.8 Flowmeter. Of suitable range to measure sampling rate.

7.2.1.9 Charcoal Adsorber. To adsorb organic vapor collected from the source to prevent exposure of personnel to source gas.

7.2.1.10 Gas Cylinders. Carrier gas (helium or nitrogen), and oxygen and hydrogen for a flame ionization detector (FID) if one is used.

7.2.1.11 Gas Chromatograph. Capable of being moved into the field, with detector, heated gas sampling valve, column required to complete separation of desired components, and option for temperature programming.

7.2.1.12 Recorder/Integrator. To record results.

7.2.2 Procedure. To obtain a sample, assemble the sampling system as shown in Figure 18-12. Make sure all connections are tight. Turn on the probe and sample line heaters. As the temperature of the probe and heated line approaches the source temperature as indicated on the thermocouple readout device, control the heating to maintain a temperature of 0 to 3 deg. C above the source temperature. While the probe and heated line are being heated, disconnect the sample line from the gas sampling valve, and attach the line from the calibration gas mixture. Flush the sample loop with calibration gas and analyze a portion of that gas. Record the results. After the calibration gas sample has been flushed into the GC instrument, turn the gas sampling valve to flush position, then reconnect the probe sample line to the valve. Place the inlet of the probe at the centroid of the duct, or at a point no closer to the walls than 1 m, and draw source gas into the probe, heated line, and sample loop. After thorough flushing, analyze the sample using the same conditions as for the calibration gas mixture. Repeat the analysis on an additional sample. Measure the peak areas for the two samples, and if they do not agree to within 5 percent of their mean value, analyze additional samples until two consecutive analyses meet this criteria. Record the data. After consistent results are obtained, remove the probe from the source and analyze a second calibration gas mixture. Record this calibration data and the other required data on the data sheet shown in Figure 18-11, deleting the dilution gas information.

(NOTE: Take care to draw all samples, calibration mixtures, and audits through the sample loop at the sample loop at the same pressure.)

7.2.3 Determination of Stack Gas Moisture Content. Use Method 4 to measure the stack gas moisture content.

7.2.4 Quality Assurance. Same as Section 7.1.7. Introduce the audit gases in the sample line immediately following the probe.

7.2.5 Emission Calculations. Same as Section 7.1.8.

7.3 Dilution Interface Sampling and Analysis Procedure. Source samples that contain a high concentration of organic materials may require dilution prior to analysis to prevent saturating the GC detector. The apparatus required for this direct interface procedure is basically the same as that described in the Section 7.2, except a dilution system is added between the heated sample line and the gas sampling valve. The apparatus is arranged

so that either a 10:1 or 100:1 dilution of the source gas can be directed to the chromatograph. A pump of larger capacity is also required, and this pump must be heated and placed in the system between the sample line and the dilution apparatus.

7.3.1 Apparatus. The equipment required in addition to that specified for the direct interface system is as follows:

7.3.1.1 Sample Pump. Leakless Teflon-coated diaphragm-type that can withstand being heated to 120 deg. C and deliver 1.5 liters/minute.

7.3.1.2 Dilution Pumps. Two Model A-150 Komhyr Teflon positive displacement type delivering 150 cc/minute, or equivalent. As an option, calibrated flowmeters can be used in conjunction with Teflon-coated diaphragm pumps.

7.3.1.3 Valves. Two Teflon three-way valves, suitable for connecting to 6.4-mm OD Teflon tubing.

7.3.1.4 Flowmeters. Two, for measurement of diluent gas, expected delivery flow rate to be 1,350 cc/min.

7.3.1.5 Diluent Gas with Cylinders and Regulators. Gas can be nitrogen or clean dry air, depending on the nature of the source gases.

7.3.1.6 Heated Box. Suitable for being heated to 120 degrees C, to contain the three pumps, three-way valves, and associated connections. The box should be equipped with quick connect fittings to facilitate connection of: (1) The heated sample line from the probe, (2) the gas sampling valve, (3) the calibration gas mixtures, and (4) diluent gas lines. A schematic diagram of the components and connections is shown in Figure 18-13.

NOTE: Care must be taken to leak check the system prior to the dilutions so as not to create a potentially explosive atmosphere.)

The heated box shown in Figure 18-13 is designed to receive a heated line from the probe. An optional design is to build a probe unit that attaches directly to the heated box. In this way, the heated box contains the controls for the probe heaters, or, if the box is placed against the duct being sampled, it may be possible to eliminate the probe heaters. In either case, a heated Teflon line is used to connect the heated box to the gas sampling valve on the chromatograph.

7.3.2 Procedure. Assemble the apparatus by connecting the heated box, shown in Figure 18-13, between the heated sample line from the probe and the gas sampling valve on the chromatograph. Vent the source gas from the gas sampling valve directly to the charcoal filter, eliminating the pump and rotameter. Heat the sample probe, sample line, and heated box. Insert the probe and source thermocouple to the centroid of the duct, or to a point no closer to the walls than 1 m. Measure the source temperature, and adjust all heating units to a temperature 0 to 3 deg. C above this temperature. If this temperature is above the safe operating temperature of the Teflon components, adjust the heating to maintain a temperature high enough to prevent condensation of water and organic compounds. Verify the operation of the dilution system by analyzing a high concentration gas of known composition through either the 10:1 or 100:1 dilution stages, as appropriate. (If necessary, vary the flow of the diluent gas to obtain other dilution ratios.) Determine the concentration of the diluted calibration gas using the dilution factor and the calibration curves prepared in the laboratory. Record the pertinent data on the data sheet shown in Figure 18-11. If the data on the diluted calibration gas are not within 10 percent of the expected values, determine whether the chromatograph or the dilution system is in error, and correct it. Verify the GC operation using a low concentration standard by diverting the gas into the sample loop, bypassing the dilution system. If these analyses are not within acceptable limits, correct the dilution system to provide the desired dilution factors. Make this correction by diluting a high-concentration standard gas mixture to adjust the dilution ratio as required.

Once the dilution system and GC operations are satisfactory, proceed with the analysis of source gas, maintaining the same dilution settings as used for the standards. Repeat the analyses until two consecutive valves do not vary by more than 5 percent from their mean value are obtained.

Repeat the analysis of the calibration gas mixtures to verify equipment operation. Analyze the two field audit samples using either the dilution system, or directly connect to the gas sampling valve as required. Record all data and report the results to the audit supervisor.

7.3.3 Determination of Stack Gas Moisture Content. Same as Section 7.2.3.

7.3.4 Quality Assurance. Same as Section 7.2.4.

7.3.5 Emission Calculations. Same as Section 7.2.5, with the dilution factor applied.

7.4 Adsorption Tube Procedure (Alternative Procedure). It is suggested that the tester refer to the National Institute of Occupational Safety and Health (NIOSH) method for the particular organics to be sampled. The principal interferent will be water vapor. If water vapor is present at concentrations above 3 percent, silica gel should be used in front of the charcoal. Where more than one compound is present in the emissions, then develop relative adsorptive capacity information.

7.4.1 Additional Apparatus. In addition to the equipment listed in the NIOSH method for the particular organic(s) to be sampled, the following items (or equivalent) are suggested.

7.4.1.1 Probe (Optional). Borosilicate glass or stainless steel, approximately 6-mm ID, with a heating system if water condensation is a problem, and a filter (either in-stack or out-stack heated to stack temperature) to remove particulate matter. In most instances, a plug of glass wool is a satisfactory filter.

7.4.1.2 Flexible Tubing. To connect probe to absorption tubes. Use a material that exhibits minimal sample adsorption.

7.4.1.3 Leakless Sample Pump. Flow controlled, constant rate pump, with a set of limiting (sonic) orifices to provide pumping rates from approximately 10 to 100 cc/min.

7.4.1.4 Bubble-Tube Flowmeter. Volume accuracy within +/- 1 percent, to calibrate pump.

7.4.1.5 Stopwatch. To time sampling and pump rate calibration.

7.4.1.6 Adsorption Tubes. Similar to ones specified by NIOSH, except the amounts of adsorbent per primary/backup sections are 800/200 mg for charcoal tubes and 1040/260 mg for silica gel tubes. As an alternative, the tubes may contain a porous polymer adsorbent such as Tenax GC or XAD-2.

7.4.1.7 Barometer. Accurate to 5 mm Hg, to measure atmospheric pressure during sampling and pump calibration.

7.4.1.8 Rotameter. 0 to 100 cc/min, to detect changes in flow rate during sampling.

7.4.2 Sampling and Analysis. It is suggested that the tester follow the sampling and analysis portion of the respective NIOSH method section entitled "Procedure." Calibrate the pump and limiting orifice flow rate through adsorption tubes with the bubble tube flowmeter before sampling. The sample system can be operated as a "recirculating loop" for this operation. Record the ambient temperature and barometric pressure. Then, during sampling, use the rotameter to verify that the pump and orifice sampling rate remains constant.

Use a sample probe, if required, to obtain the sample at the centroid of the duct, or at a point no closer to the walls than 1 m. Minimize the length of flexible tubing between the probe and absorption tubes. Several absorption tubes can be connected in series, if the extra absorptive capacity is needed. Provide the gas sample to the sample system at a pressure sufficient for the limiting orifice to function as a sonic orifice. Record the total time and sample flow rate (or the number of pump strokes), the barometric pressure, and ambient temperature. Obtain a total sample volume commensurate with the expected concentration(s) of the volatile organic(s) present, and recommended sample loading factors (weight sample per weight absorption media). Laboratory tests prior to actual sampling may be necessary to predetermine this volume. When more than one organic is present in the emissions, then develop relative absorptive capacity information. If water vapor is present in the sample at concentrations above 2 to 3 percent, the absorptive capacity may be severely reduced. Operate the gas chromatograph according to the manufacturer's instructions. After establishing optimum conditions, verify and document these conditions during all operations. Analyze the audit samples (see Section 7.4.4.3), then the emission samples. Repeat the analysis of each sample until the relative deviation of two consecutive injections does not exceed 5 percent.

**7.4.3 Standards and Calibration.** The standards can be prepared according to the respective NIOSH method. Use a minimum of three different standards; select the concentrations to bracket the expected average sample concentration. Perform the calibration before and after each day's sample analyses. Prepare the calibration curve by using the least squares method.

**7.4.4 Quality Assurance.**

**7.4.4.1 Determination of Desorption Efficiency.** During the testing program, determine the desorption efficiency in the expected sample concentration range for each batch of adsorption media to be used. Use an internal standard. A minimum desorption efficiency of 50 percent shall be obtained. Repeat the desorption determination until the relative deviation of two consecutive determinations does not exceed 5 percent. Use the average desorption efficiency of these two consecutive determinations for the correction specified in Section 7.4.4.5. If the desorption efficiency of the compound(s) of interest is questionable under actual sampling conditions, use of the Method of Standard Additions may be helpful to determine this value.

**7.4.4.2 Determination of Sample Collection Efficiency.** For the source samples, analyze the primary and backup portions of the adsorption tubes separately. If the backup portion exceeds 10 percent of the total amount (primary and backup), repeat the sampling with a larger sampling portion.

**7.4.4.3 Analysis Audit.** Immediately before the sample analyses, analyze the two audits in accordance with Section 7.4.2. The analysis audit shall agree with the audit concentration within 10 percent.

**7.4.4.4 Pump Leak Checks and Volume Flow Rate Checks.** Perform both of these checks immediately after sampling with all sampling train components in place. Perform all leak checks according to the manufacturer's instructions, and record the results. Use the bubble-tube flowmeter to measure the pump volume flow rate with the orifice used in the test sampling, and the result. If it has changed by more than 5 but less than 20 percent, calculate an average flow rate for the test. If the flow rate has changed by more than 20 percent, recalibrate the pump and repeat the sampling.

**7.4.4.5 Calculations.** All calculations can be performed according to the respective NIOSH method. Correct all sample volumes to standard conditions. If a sample dilution system has been used, multiply the results by the appropriate dilution ratio. Correct all results by dividing by the desorption efficiency (decimal value). Report results as ppm by volume, dry basis.

**7.5 Reporting of Results.** At the completion of the field analysis portion of the study, ensure that the data sheets shown in Figure 18-11 have been completed. Summarize this data on the data sheets shown in Figure 18-15.

SOURCE: [36 FR 24877, Dec. 23, 1971]

AUTHORITY: 42 U.S.C. 7401, 7411, 7414, 7416, and 7601.

Title 40 -- Protection of Environment; Revised as of July 1, 1991

CHAPTER I -- ENVIRONMENTAL PROTECTION AGENCY  
SUBCHAPTER C -- AIR PROGRAMS

PART 60 -- STANDARDS OF PERFORMANCE FOR NEW STATIONARY SOURCES

§ 60. Appendix A to Part 60 -- Test Methods [PART VI OF VII]

**40 CFR 60. Appendix A** to Part 60

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Figure 18-1. Preliminary survey data sheet.

[SEE FIGURE IN ORIGINAL]

Figure 18-1 (continued). Preliminary survey data sheet.

[SEE FIGURE IN ORIGINAL]

Figure 18-2. Chromatographic conditions data sheet.

[SEE FIGURE IN ORIGINAL]

### Preparation of Standards in Tedlar Bags and Calibration Curve

Standards Preparation Data:	Standard s		
	Mixture # 1	Mixture # 2	Mixture # 3

Organic:

Bag number or identification

Dry gas meter calibration factor

Final meter reading (liters)

Initial meter reading (liters)

Metered volume (liters)

Average meter temperature (deg. K)

Average meter pressure, gauge (mm Hg)

Average atmospheric pressure (mm Hg)

Average meter pressure, absolute (mm Hg)

Syringe temperature (deg. K)  
(Section 6.2.2.1)

Syringe pressure, absolute (mm Hg)  
(Section 6.2.2.1)

Volume of gas in syringe (ml)  
(Section 6.2.2.1)

Density of liquid organic (g/ml)  
(Section 6.2.2.2)

Volume of liquid in syringe (l)  
(Section 6.2.2.2)

GC Operating Conditions:

Sample loop volume (ml)

Sample loop temperature (deg. C)

Carrier gas flow rate (ml/min)

Column temperature

Initial (deg. C)

Rate change (deg. C/min)

Final (deg. C)

Organic Peak Identification and  
Calculated Concentrations:

Injection time (24-hr clock)

Distance to peak (cm)

Chart speed (cm/min)

Organic retention time (min)

Attenuation factor

Peak height (mm)

Peak area (mm<sup>2</sup>)  
 Peak area X attenuation factor (mm<sup>2</sup>)  
 Calculated concentration (ppm)  
 (Equation 18-3 or 18-4)

Plot peak area X attenuation factor against calculated concentration to obtain calibration curve.

Figure 18-3. Standards prepared in Tedlar bags and calibration curve.

**Flowmeter Calibration**

Flowmeter number or identification

Flowmeter type

Calibration device (X): Bubble meter Spirometer Wet test meter

Readings at laboratory conditions:

Laboratory temperature (T[lab]) deg. K

Laboratory barometric pressure (P[lab]) mm Hg

Flow data:

	<b>Flowmeter</b>	
<b>reading</b>	<b>temp.</b>	<b>pressure</b>
(as marked)	(deg. K)	(absolute)

	<b>Calibration device</b>	
<b>Time</b>	<b>gas</b>	<b>flow</b>
(min)	volume<a>	rate<b>

a = Volume of gas measured by calibration device, corrected to standard conditions (liters).

b = Calibration device gas volume/time.

Plot flowmeter reading against flow rate (standard conditions), and draw a smooth curve. If the flowmeter being calibrated is a rotameter or other flow device that is viscosity dependent, it may be necessary to generate a "family" of calibration curves that cover the operating pressure and temperature ranges of the flowmeter.

While the following technique should be verified before application, it may be possible to calculate flow rate readings for rotameters at standard conditions Q[std] as follows:

$$Q[\text{std}] = Q[\text{lab}] \times (760 \times T[1\text{ab}] / P[1\text{ab}] \times 293)^{1/2}$$

**Flow rate**                      **Flow rate**

(laboratory  
conditions)

(standard  
conditions)

Figure 18-4. Flowmeter calibration.

Figure 18-5. Single-stage calibration gas dilution system.

[SEE FIGURE IN ORIGINAL]

Figure 18-6. Two-stage dilution apparatus.

[SEE FIGURE IN ORIGINAL]

Preparation of Standards by Dilution of Cylinder Standard

Cylinder standard: Organic Certified concentration ppm

Standards Preparation Data:	3 Date		
Stage 1	Mixture 1	Mixture 2	Mixture 3
Standard gas flowmeter reading			
Diluent gas flowmeter reading			
Laboratory temperature (deg. K)			
Barometric pressure (mm Hg)			
Flowmeter gage pressure (mm Hg)			
Flow rate cylinder gas at standard conditions (ml/min)			
Flow rate diluent gas at standard conditions (ml/min)			
Calculated concentration (ppm)			
Stage 2 (if used)			
Standard gas flowmeter reading			
Diluent gas flowmeter reading			
Flow rate stage 1 gas at standard conditions (ml/min)			
Flow rate diluent gas at standard conditions (ml/min)			
Calculated concentration (ppm)			
GC Operating Conditions:			

Sample loop volume (ml)  
Sample loop temperature  
(deg. C)  
Carrier gas flow rate  
(ml/min)  
Column temperature:  
    Initial (deg. C)  
    Program rate (deg.  
C/min)  
    Final (deg. C)  
Organic Peak Identification  
and  
Calculated Concentrations:  
    Injection time (24-hr clock)  
    Distance to peak (cm)  
    Chart speed (cm/min)  
    Retention time (min)  
    Attenuation factor  
    Peak area (mm<sup>2</sup>)  
    Peak area X attenuation  
factor

Plot peak area X attenuation factor against calculated concentration to obtain calibration curve.

Figure 18-7. Standards prepared by dilution of cylinder standard.

Figure 18-8. Apparatus for preparation of liquid materials.

[SEE FIGURE IN ORIGINAL]

Figure 18-9. Integrated bag sampling train.

[SEE FIGURE IN ORIGINAL]

Figure 18-9a. Explosion risk gas sampling method.

[SEE FIGURE IN ORIGINAL]

Figure 18-10. Field sample data sheet - Tedlar bag collection method.

[SEE FIGURE IN ORIGINAL] Plant Date Location

### 1. General Information

C) Source temperature (deg.  
C) Probe temperature (deg.  
C) Ambient temperature (deg.  
C) Atmospheric pressure (mm)  
Source pressure ("Hg)

Absolute source pressure  
 (mm)  
 Sampling rate (liter/min)  
 Sample loop volume (ml)  
 Sample loop temperature  
 (deg. C)  
 Columnar temperature:  
     Initial (deg. C)/time  
 (min)  
     Program rate (deg.  
 C/min)  
     Final (deg. C/time  
 (min)  
     Carrier gas flow rate  
 (ml/min)  
     Detector temperature  
 (deg. C)  
     Injection time (24-hour  
 basis)  
     Chart speed (mm/min)  
     Dilution gas flow rate  
 (ml/min)  
     Dilution Gas used  
 (symbol)  
     Dilution ratio

Figure 18-11. Field analysis data sheets.

## 2. Field Analysis Data - Calibration Gas

Run No.	Time	A X A	Conc. (ppm)
Components	Area Attenuation	Factor	

Figure 18-11 (continued). Field analysis data sheets.

Figure 18-12. Direct interface sampling system.

[SEE FIGURE IN ORIGINAL]

Figure 18-13. Schematic diagram of the heated box required for dilution of sample gas.

[SEE FIGURE IN ORIGINAL]

## GASEOUS ORGANIC SAMPLING AND ANALYSIS CHECK LIST

(Respond with initials or number as appropriate)

Date

1. Presurvey data:
  - A. Grab sample collected square
  - B. Grab sample analyzed  
for composition square
    - Method GC square square
    - GC/MS square square
    - Other square square
  - C. GC-FID analysis per-  
formed square
2. Laboratory calibration data:
  - A. Calibration curves pre-  
pared square
    - Number of compo-  
nents square square
    - Number of concen-  
trations/  
component (3 re-  
quired) square square
  - B. Audit samples (option-  
al):
    - Analysis complet-  
ed square
    - Verified for con-  
centration square
    - OK obtained for  
field work square
3. Sampling procedures:
  - A. Method:
    - Bag sample square square
    - Direct interface square square
    - Dilution interface square square
  - B. Number of samples col-  
lected 1square
4. Field analysis:
  - A. Total hydrocarbon  
analysis performed square
  - B. Calibration curve pre-  
pared square
    - Number of compo-  
nents square square
    - Number of concen-  
trations per com-  
ponent (3 re-  
quired) square square

Figure 18-14. Sampling and analysis check.

Plant

Date

Location

Source sample	Source sample	Source sample
1	2	3

1. General

information:

Source

temperature

(deg. C)

Probe

temperature

(deg. C)

Ambient

temperature

(deg. C)

Atmospheric

pressure

(mm Hg)

Source

pressure

(mm Hg)

Sampling rate

(ml/min)

Sample loop

volume (ml)

Sample loop

temperature

(deg. C)

Sample

collection

time (24-hr

basis)

Column

tempera-

ture:

Initial

(deg. C)

Program

rate (deg. C/

min)

Final (deg. C)

Carrier gas

flow rate

(ml/min)  
Detector  
temperature  
(deg. C)  
Chart speed  
(cm/min)  
Dilution gas  
flow rate  
(ml/min)  
Diluent gas  
used  
(symbol)  
Dilution ratio

Performed by (signature):

Date:

Figure 18-14. Sampling and analysis sheet.

## METHOD 19--DETERMINATION OF SULFUR DIOXIDE REMOVAL EFFICIENCY AND PARTICULATE MATTER, SULFUR DIOXIDE, AND NITROGEN OXIDES EMISSION RATES

### *1. Applicability and Principle*

1.1 Applicability. This method is applicable for (a) determining particulate matter (PM), sulfur dioxide (SO<sub>2</sub>), and nitrogen oxides (NO<sub>x</sub>) emission rates; (b) determining sulfur removal efficiencies of fuel pretreatment and SO<sub>2</sub> control devices; (c) determining overall reduction of potential SO<sub>2</sub> emissions from steam generating units or other sources as specified in applicable regulations; and (d) determining SO<sub>2</sub> rates based on fuel sampling and analysis procedures.

#### 1.2 Principle.

1.2.1 Pollutant emission rates are determined from concentrations of PM, SO<sub>2</sub>, or NO<sub>x</sub>, and oxygen (O<sub>2</sub>) or carbon dioxide (CO<sub>2</sub>) along with F factors (ratios of combustion gas volumes to heat inputs).

1.2.2 An overall SO<sub>2</sub> emission reduction efficiency is computed from the efficiency of fuel pretreatment systems (optional) and the efficiency of SO<sub>2</sub> control devices.

1.2.3 The sulfur removal efficiency of a fuel pretreatment system is determined by fuel sampling and analysis of the sulfur and heat contents of the fuel before and after the pretreatment system.

1.2.4 The SO<sub>2</sub> removal efficiency of a control device is determined by measuring the SO<sub>2</sub> rates before and after the control device.

1.2.5 The inlet rates to SO<sub>2</sub> control systems and when SO<sub>2</sub> control systems are not used, SO<sub>2</sub> emission rates to the atmosphere may be determined by fuel sampling and analysis (optional).

### *2. Emission Rates of Particulate Matter, Sulfur Dioxide, and Nitrogen Oxides*

Select from the following sections the applicable procedure to compute the PM, SO<sub>2</sub>, or NO<sub>x</sub> emission rate

(E) in ng/J (lb/million Btu). The pollutant concentration must be in ng/scm (lb/scf) and the F factor must be in scm/J (scf/million Btu). If the pollutant concentration (C) is not in the appropriate units, use the following table to make the proper conversion:

## CONVERSION FACTORS FOR CONCENTRATION

From	To	Multiply by
g/scm	ng/scm	$10^{-9}$
mg/scm	ng/scm	$10^{-6}$
lb/scf	ng/scm	$1.602 \times 10^{13}$
ppm SO <sub>2</sub>	ng/scm	$2.66 \times 10^6$
ppm NO <sub>x</sub>	ng/scm	$1.912 \times 10^6$
ppm SO <sub>2</sub>	lb/scf	$1.660 \times 10^{-7}$
ppm NO <sub>x</sub>	lb/scf	$1.194 \times 10^{-7}$

An F factor is the ratio of the gas volume of the products of combustion to the heat content of the fuel. The dry F factor (F<sub>d</sub>) includes all components of combustion less water, the wet F factor (F<sub>w</sub>) includes all components of combustion, and the carbon F factor (F<sub>c</sub>) includes only carbon dioxide.

NOTE: Since F<sub>w</sub> factors include water resulting only from the combustion of hydrogen in the fuel, the procedures using F<sub>w</sub> factors are not applicable for computing E from steam generating units with wet scrubbers or with other processes that add water (e.g., steam injection)

2.1 Oxygen-Based F Factor, Dry Basis. When measurements are on a dry basis for both O<sub>2</sub> (%O<sub>2d</sub>) and pollutant (C<sub>d</sub>) concentrations, use the following equation:

$$E = C[d] \times F[d] \left[ \frac{20.9}{(20.9 - \%O[2d])} \right]$$

Eq. 19-1

2.2 Oxygen-Based F Factor, Wet Basis. When measurements are on a wet basis for both O<sub>2</sub> (%O<sub>2w</sub>) and pollutant (C<sub>w</sub>) concentrations, use either of the following:

2.2.1 If the moisture fraction of ambient air (B<sub>wa</sub>) is measured:

$$E = [C[w] \times F[w] \times 20.9] / [20.9 \times (1 - B[wa]) - \%O[2w]]$$

Eq. 19-2

Instead of actual measurement, B<sub>wa</sub> may be estimated according to the procedure below. (NOTE: The estimates are selected to ensure that negative errors will not be larger than -1.5 percent. However, positive errors, or over-estimation of emissions, of as much as 5 percent may be introduced depending upon the geographic location of the facility and the associated range of ambient moisture):

2.2.1.1 B<sub>wa</sub> = 0.027. This value may be used at any location at all times.

2.2.1.2 B<sub>wa</sub> = Highest monthly average of B<sub>wa</sub> that occurred within the previous calendar year at the nearest Weather Service Station. This value shall be determined annually and may be used as an estimate for the entire current calendar year.

2.2.1.3 B[wa] = Highest daily average of B[wa] that occurred within a calendar month at the nearest Weather Service Station, calculated from the data from the past 3 years. This value shall be computed for each month and may be used as an estimate for the current respective calendar month.

2.2.2 If the moisture fraction (B[wa]) of the effluent gas is measured:

$$E = C[w] \times F[d] \left[ \frac{20.9}{20.9 \times (1 - B[wa]) - \%O[2w]} \right]$$

Eq. 19-3

2.3 Oxygen-Based F Factor, Dry/Wet Basis.

2.3.1 When the pollutant concentration is measured on a wet basis (C[w]) and O<sub>2</sub> concentration is measured on a dry basis (%O<sub>2d</sub>), use the following equation:

$$E = \left[ \frac{C[w] \times F[d]}{1 - B[wa]} \right] \left[ \frac{20.9}{20.9 - \%O[2d]} \right]$$

Eq. 19-4

2.3.2 When the pollutant concentration is measured on a dry basis (C[d]) and the O<sub>2</sub> concentration is measured on a wet basis (%O<sub>2w</sub>), use the following equation:

$$E = \frac{C[d] \times F[d] \times 20.9}{20.9 - \%O[2w] \times (1 - B[wa])}$$

Eq. 19-5

2.4 Carbon Dioxide-Based F Factor, Dry Basis. When measurements are on a dry basis for both CO<sub>2</sub> (%CO<sub>2d</sub>) and pollutant (C[d]) concentrations, use the following equation:

$$E = C[d] \times F[c] \times \left( \frac{100}{\%CO[2d]} \right)$$

Eq. 19-6

2.5 Carbon Dioxide-Based F Factor, Wet Basis. When measurements are on a wet basis for both CO<sub>2</sub> (%CO<sub>2w</sub>) and pollutant (C[w]) concentrations, use the following equation:

$$E = C[w] \times F[c] \times \left( \frac{100}{\%CO[2w]} \right)$$

Eq. 19-7

2.6 Carbon Dioxide-Based F Factor, Dry/Wet Basis.

2.6.1 When the pollutant concentration is measured on a wet basis (C[w]) and CO<sub>2</sub> concentration is measured on a dry basis (%CO<sub>2d</sub>), use the following equation:

$$E = \left[ \frac{C[w] \times F[c]}{1 - B[wa]} \right] \times \left( \frac{100}{\%CO[2d]} \right)$$

Eq. 19-8

2.6.2 When the pollutant concentration is measured on a dry basis (C[d]) and CO<sub>2</sub> concentration is measured on a wet basis (%CO<sub>2w</sub>), use the following equation:

$$E = C[d] \times (1 - B[wa]) \times F[c] \times (100 / \%CO[2w])$$

Eq. 19-9

2.7 Direct-Fired Reheat Fuel Burning. The effect of direct-fired reheat fuel burning (for the purpose of raising the temperature of the exhaust effluent from wet scrubbers to above the moisture dew-point) on emission rates will be less than +/- 1.0 percent and, therefore, may be ignored.

2.8 Combined Cycle-Gas Turbine Systems. For gas turbine-steam generator combined cycle systems, determine the emissions from the steam generating unit or the percent reduction in potential SO<sub>2</sub> emissions as follows:

2.8.1 Compute the emission rate from the steam generating unit using the following equation:

$$E[bo] = E[co] + (H[g] / H[b]) \times (E[co] - E[g])$$

Eq. 19-10

where:

E[bo] = pollutant emission rate from the steam generating unit, ng/J (lb/million Btu).

E[co] = pollutant emission rate in combined effluent, ng/J (lb/million Btu).

E[g] = pollutant rate from gas turbine, ng/J (lb/million Btu).

H[b] = heat input rate to the steam generating unit from fuels fired in the steam generating unit, J/hr (million Btu/hr).

H[g] = heat input rate to gas turbine from all fuels fired in the gas turbine, J/hr (million Btu/hr).

2.8.1.1 Use the test methods and procedures section of Subpart GG to obtain E[co] and E[g]. Do not use F[w] factors for determining E[g] or E[co]. If an SO<sub>2</sub> control device is used, measure E[co] after the control device.

2.8.1.2 Suitable methods shall be used to determine the heat input rates to the steam generating units (H[b]) and the gas turbine (H[g]).

2.8.2 If a control device is used, compute the percent of potential SO<sub>2</sub> emissions (%P[s]) using the following equations:

$$E[bi] = E[ci] - (H[g] / H[b]) \times (E[ci] - E[g])$$

Eq. 19-11

$$\%P[s] = 100 \times (1 - E[bo] / E[bi])$$

Eq. 19-12

where:

E[bi] = pollutant rate from the steam generating unit, ng/J (lb/million Btu)

E[ci] = pollutant rate in combined effluent, ng/J (lb/million Btu).

Use the test methods and procedures section of Subpart GG to obtain E[ci] and E[g]. Do not use F[w] factors for determining E[g] or E[ci].

### 3. F Factors

Use an average F factor according to Section 3.1 or determine an applicable F factor according to Section 3.2. If combined fuels are fired, prorate the applicable F factors using the procedure in Section 3.3.

3.1 Average F Factors. Average F factors (F[d], F[w], or F[c]) from Table 19-1 may be used.

TABLE 19-1--F FACTORS FOR VARIOUS FUELS n1

Fuel type	F[d]		F[w]	
	dscf/10<6>		wscf/10<6>	
	dscm/J	Btu	wscm/J	Btu
Coal:				
Anthracite n2	2.71 X 10<-7>	10,100	2.83 X 10<-7>	10,540
Bituminous n2	2.63 X 10<-7>	9,780	2.86 X 10<-7>	10,640
Lignite	2.65 X 10<-7>	9,860	3.21 X 10<-7>	11,950
Oil n3	2.47 X 10<-7>	9,190	2.77 X 10<-7>	10,320
Gas:				
Natural	2.43 X 10<-7>	8,710	2.85 X 10<-7>	10,610
Propane	2.34 X 10<-7>	8,710	2.74 X 10<-7>	10,200
Butane	2.34 X 10<-7>	8,710	2.79 X 10<-7>	10,390
Wood	2.48 X 10<-7>	9,240		
Wood Bark	2.58 X 10<-7>	9,600		
Municipal Solid Waste	2.57 X 10<-7>	9,570		

Fuel type	scm/J	F[c]	
		scf/10<6>	Btu
Coal:			
Anthracite n2	0.530 X 10<-7>		1,970
Bituminous n2	0.484 X 10<-7>		1,800
Lignite	0.513 X		1,910

	10<-7>	
	0.383 X	
Oil n3	10<-7>	1,420
Gas		
	0.287 X	
Natural	10<-7>	1,040
	0.321 X	
Propane	10<-7>	1,190
	0.337 X	
Butane	10<-7>	1,250
	0.492 X	
Wood	10<-7>	1,830
	0.516 X	
Wood Bark	10<-7>	1,920
	0.488 X	
Municipal	10<-7>	1,820
Solid Waste		

n1 Determined at standard conditions: 20 deg. C (68 deg. F) and 760 mm Hg (29.92 in. Hg).

n2 As classified according to ASTM D388-77.

n3 Crude, residual, or distillate.

3.2 Determined F Factors. If the fuel burned is not listed in Table 19-1 or if the owner or operator chooses to determine an F factor rather than use the values in Table 19-1, use the procedure below:

3.2.1 Equations. Use the equations below, as appropriate, to compute the F factors:

$$F[d] = K \times [(K[hd]\%H) + (K[c]\%C) + (K[s]\%S) + (K[n]\%N) - (K[o]\%O)] / GCV$$

Eq. 19-13

$$F[w] = K \times [(K[hw]\%H) + (K[c]\%C) + (K[s]\%S) + (K[n]\%N) - (K[o]\%O) + (K[w]\%H[2]O)] / GCV[w]$$

Eq. 19-14

$$F[c] = K \times (K[cc]\%C) / GCV$$

Eq. 19-15

(NOTE.--Omit the %H[2]O term in the equations for F[w] if %H and %O include the unavailable hydrogen and oxygen in the form of H[2]O.)

where:

F[d],F[w],F[c] = volumes of combustion components per unit of heat content, scm/J (scf/million Btu).

%H, %C, %S, %N, %O, and %H[2]O = concentrations of hydrogen, carbon, sulfur, nitrogen, oxygen, and water from an ultimate analysis of fuel, weight percent.

GCV = gross calorific value of the fuel consistent with the ultimate analysis, kJ/kg (Btu/lb).

K = conversion factor, 10<sup>-5</sup> (kJ/J)/(%) [10<sup>6</sup> Btu/million Btu].

$K_{hd} = 22.7 \text{ (scm/kg)} [(3.64 \text{ (scf/lb)})/(\%)]$ .

$K_c = 9.57 \text{ (scm/kg)} [(1.53 \text{ (scf/lb)})/(\%)]$ .

$K_s = 3.54 \text{ (scm/kg)} [(0.57 \text{ (scf/lb)})/(\%)]$ .

$K_n = 0.86 \text{ (scm/kg)} [0.14 \text{ (scf/lb)}/(\%)]$ .

$K_o = 2.85 \text{ (scm/kg)} [0.46 \text{ (scf/lb)}/(\%)]$ .

$K_{hw} = 34.74 \text{ (scm/kg)} [5.57 \text{ (scf/lb)}/(\%)]$ .

$K_w = 1.30 \text{ (scm/kg)} [(0.21 \text{ (scf/lb)})/(\%)]$ .

$K_{cc} = 2.0 \text{ (scm/kg)} [(0.321 \text{ (scf/lb)})/(\%)]$ .

3.2.2 Use applicable sampling procedures in Section 5.2.1 or 5.2.2 to obtain samples for analyses.

3.2.3 Use ASTM D3176-74 (incorporated by reference--see § 60.17) for ultimate analysis of the fuel.

3.2.4 Use applicable methods in Section 5.2.1 or 5.2.2 to determine the heat content of solid or liquid fuels. For gaseous fuels, use ASTM D1826-77 (IBR--see § 60.17) to determine the heat content.

3.3 F Factors for Combination of Fuels. If combinations of fuels are burned, use the following equations, as applicable unless otherwise specified in applicable subpart:

$$F_d = \sum_{k=1}^n X_k F_{dk}$$

Eq. 19-16

$$F_w = \sum_{k=1}^n X_k F_{wk}$$

Eq. 19-17

$$F_c = \sum_{k=1}^n X_k F_{ck}$$

Eq. 19-18

where:

$X_k$  = fraction of total heat input from each type of fuel k.

n = number of fuels being burned in combination.

#### 4. Determination of Average Pollutant Rates

4.1 Average Pollutant Rates from Hourly Values. When hourly average pollutant rates ( $E[h]$ ), inlet or outlet, are obtained (e.g., CEMS values), compute the average pollutant rate ( $E[a]$ ) for the performance test period (e.g., 30

days) specified in the applicable regulation using the following equation:

$$E[a] = (1 / H) \times \sum_{j=1}^n E[h_j]$$

Eq. 19-19

where:

E [a] = average pollutant rate for the specified performance test period, ng/J (lb/million Btu).

E[h] = hourly average pollutant, ng/J (lb/million Btu).

H = total number of operating hours for which pollutant rates are determined in the performance test period.

4.2 Average Pollutant Rates from Other than Hourly Averages. When pollutant rates are determined from measured values representing longer than 1-hour periods (e.g., daily fuel sampling and analyses or Method 6B values), or when pollutant rates are determined from combinations of 1-hour and longer than 1-hour periods (e.g., CEMS and Method 6B values), compute the average pollutant rate (E[a]) for the performance test period (e.g., 30 days) specified in the applicable regulation using the following equation:

$$E[a] = \left[ \sum_{j=1}^D (n[d] \times E[d]) \right] / \sum_{j=1}^D n[d]$$

Eq. 19-20

where:

E[d] = average pollutant rate for each sampling period (e.g., 24-hr Method 6B sample or 24-hr fuel sample) or for each fuel lot (e.g., amount of fuel bunkered), ng/J (lb/million Btu).

n[d] = number of operating hours of the affected facility within the performance test period for each E[d] determined.

D = number of sampling periods during the performance test period.

4.3 Daily Geometric Average Pollutant Rates from Hourly Values. The geometric average pollutant rate (E[ga]) is computed using the following equation:

$$E[ga] = \text{EXP} \left[ \left( \frac{1}{n} \right) \times \sum_{j=1}^n \ln(E[h_j]) \right]$$

Eq. 19-20a

where:

E[ga] = daily geometric average pollutant rate, ng/J (lbs/million Btu) or ppm corrected to 7 percent O<sub>2</sub>.

E[h<sub>j</sub>] = hourly arithmetic average pollutant rate for hour "j," ng/J (lb/million Btu) or ppm corrected to 7 percent O<sub>2</sub>.

n = total number of hourly averages for which pollutant rates are available within the 24 hr midnight to midnight daily period.

ln = natural log of indicated value.

EXP = the natural logarithmic base (2.718) raised to the value enclosed by brackets.

## 5. Determination of Overall Reduction in Potential Sulfur Dioxide Emission

5.1 Overall Percent Reduction. Compute the overall percent SO<sub>2</sub> reduction (%R<sub>[o]</sub>) using the following equation:

$$\%R[o] = 100 \times [1.0 - (1.0 - \%R[f] / 100) \times (1.0 - R[g] / 100)]$$

Eq. 19-21

where:

%R<sub>[f]</sub> = SO<sub>2</sub> removal efficiency from fuel pretreatment, percent.

%R<sub>[g]</sub> = SO<sub>2</sub> removal efficiency of the control device, percent.

5.2 Pretreatment Removal Efficiency (Optional). Compute the SO<sub>2</sub> removal efficiency from fuel pretreatment (%R<sub>[f]</sub>) for the averaging period (e.g., 90 days) as specified in the applicable regulation using the following equation:

$$\%R[f] = 100 \times (1.0 - [\text{<n> SIGMA } [j = 1] \times (\%S[p_j] / \text{GCV}[p_j]) \times L[p_j] / [\text{<n> SIGMA } [j = 1] \times (\%S[r_j] / \text{GCV}[r_j]) \times L[r_j]])$$

Eq. 19-22

where:

%S<sub>[p]</sub>, %S<sub>[r]</sub> = sulfur content of the product and raw fuel lots, respectively, dry basis weight percent.

GCV<sub>[p]</sub>, GCV<sub>[r]</sub> = gross calorific value for the product and raw fuel lots, respectively, dry basis, kg/kg (Btu/lb).

L<sub>[p]</sub>, L<sub>[r]</sub> = weight of the product and raw fuel lots, respectively, metric ton (ton).

n = number of fuel lots during the averaging period.

NOTE: In calculating %R<sub>[f]</sub>, include %S and GCV values for all fuel lots that are not pretreated and are used during the averaging period.

### 5.2.1 Solid Fossil (Including Waste) Fuel -- Sampling and Analysis.

NOTE: For the purposes of this method, raw fuel (coal or oil) is the fuel delivered to the desulfurization (pretreatment) facility. For oil, the input oil to the oil desulfurization process (e.g., hydrotreatment) is considered to be the raw fuel.

5.2.1.1 Sample Increment Collection. Use ASTM D2234-76 (IBR - see § 60.17), Type I, Conditions A, B, or C, and systematic spacing. As used in this method, systematic spacing is intended to include evenly spaced increments in time or increments based on equal weights of coal passing the collection area.

As a minimum, determine the number and weight of increments required per gross sample representing each

coal lot according to Table 2 or Paragraph 7.1.5.2 of ASTM D2234-76. Collect one gross sample for each lot of raw coal and one gross sample for each lot of product coal.

5.2.1.2 ASTM Lot Size. For the purpose of Section 5.2 (fuel pretreatment), the lot size of product coal is the weight of product coal from one type of raw coal. The lot size of raw coal is the weight of raw coal used to produce one lot of product coal. Typically, the lot size is the weight of coal processed in a 1-day (24-hour) period. If more than one type of coal is treated and produced in 1 day, then gross samples must be collected and analyzed for each type of coal. A coal lot size equaling the 90-day quarterly fuel quantity for a steam generating unit may be used if representative sampling can be conducted for each raw coal and product coal.

NOTE: Alternative definitions of lot sizes may be used, subject to prior approval of the Administrator.

5.2.1.3 Gross Sample Analysis. Use ASTM D2013-72 to prepare the sample, ASTM D3177-75 or ASTM D4239-85 to determine sulfur content (%S), ASTM D3173-73 to determine moisture content, and ASTM D2015-77 or ASTM D3286-85 to determine gross calorific value (GCV) (all methods cited IBR -- see § 60.17) on a dry basis for each gross sample.

5.2.2 Liquid Fossil Fuel -- Sampling and Analysis. See NOTE under Section 5.2.1.

5.2.2.1 Sample Collection. Follow the procedures for continuous sampling in ASTM D270-65 (Reapproved 1975) (IBR -- see § 60.17) for each gross sample from each fuel lot.

5.2.2.2 Lot Size. For the purpose of Section 5.2 (fuel pretreatment), the lot size of a product oil is the weight of product oil from one pretreatment facility and intended as one shipment (ship load, barge load, etc.). The lot size of raw oil is the weight of each crude liquid fuel type used to produce a lot of product oil.

NOTE: Alternative definitions of lot sizes may be used, subject to prior approval of the Administrator.

5.2.2.3 Sample Analysis. Use ASTM D129-64 (Reapproved 1978), ASTM D1552-83, or ASTM D4057-81 to determine the sulfur content (%S) and ASTM D240-76 (all methods cited IBR -- see § 60.17) to determine the GCV of each gross sample. These values may be assumed to be on a dry basis. The owner or operator of an affected facility may elect to determine the GCV by sampling the oil combusted on the first steam generating unit operating day of each calendar month and then using the lowest GCV value of the three GCV values per quarter for the GCV of all oil combusted in that calendar quarter.

5.2.3 Use appropriate procedures, subject to the approval of the Administrator, to determine the fraction of total mass input derived from each type of fuel.

5.3 Control Device Removal Efficiency. Compute the percent removal efficiency (%R[g]) of the control device using the following equation:

$$\%R[g] = 100 [1.0 - E[ao] / E[ai]]$$

Eq. 19-23

where:

E[ao], E[ai] = average pollutant rate of the control device, outlet and inlet, respectively, for the performance test period, ng/J (lb/million Btu).

5.3.1 Use continuous emission monitoring systems or test methods, as appropriate, to determine the outlet SO<sub>2</sub> rates and, if appropriate, the inlet SO<sub>2</sub> rates. The rates may be determined as hourly (E[h]) or other

sampling period averages (E[d]). Then, compute the average pollutant rates for the performance test period (E[ao] and E[ai]) using the procedures in Section 4.

5.3.2 As an alternative, as-fired fuel sampling and analysis may be used to determine inlet SO<sub>2</sub> rates as follows:

5.3.2.1 Compute the average inlet SO<sub>2</sub> rate (E[di]) for each sampling period using the following equation:

$$E[di] = K (\%S / GCV)$$

Eq. 19-24

where:

E[di] = average inlet SO<sub>2</sub> rate for each sampling period d, ng / J (lb/million Btu)

% S = sulfur content of as-fired fuel lot, dry basis, weight percent.

GCV = gross calorific value of the fuel lot consistent with the sulfur analysis, kJ / kg (Btu/lb).

$$K = 2 \times 10^7 \times [(kg)(ng) / (\%)(J)] \times [2 \times 10^4 (lb)(Btu / (\%)) (\text{million Btu})]$$

After calculating E[di] use the procedures in Section 4.2 to determine the average inlet SO<sub>2</sub> rate for the performance test period (E [ai]).

5.3.2.2 Collect the fuel samples from a location in the fuel handling system that provides a sample representative of the fuel bunkered or consumed during a steam generating unit operating day.

For the purpose of as-fired fuel sampling under Section 5.3.2 or Section 6, the lot size for coal is the weight of coal bunkered or consumed during each steam generating unit operating day. The lot size for oil is the weight of oil supplied to the "day" tank or consumed during each steam generating unit operating day.

For reporting and calculation purposes, the gross sample shall be identified with the calendar day on which sampling began. For steam generating unit operating days when a coal-fired steam generating unit is operated without coal being added to the bunkers, the coal analysis from the previous "as bunkered" coal sample shall be used until coal is bunkered again. For steam generating unit operating days when an oil-fired steam generating unit is operated without oil being added to the oil "day" tank, the oil analysis from the previous day shall be used until the "day" tank is filled again.

Alternative definitions of fuel lot size may be used, subject to prior approval of the Administrator.

5.3.2.3 Use ASTM procedures specified in Section 5.2.1 or 5.2.2 to determine the sulfur contents (%S) and gross calorific values (GCV).

5.4 Daily Geometric Average Percent Reduction from Hourly Values. The geometric average percent reduction (%R[ga]) is computed using the following equation:

$$\%R[ga] = 100 [1 - \text{EXP}[(1 / n) \times \sum_{j=1}^n \ln(E[jo] / E[ji])]]$$

Eq. 19-24a

where:

%R[ga] = daily geometric average percent reduction.

E[jo], E[ji] = matched pair hourly arithmetic average pollutant rate, outlet and inlet, respectively, ng/J (lb/million Btu) or ppm corrected to 7 percent O<sub>2</sub>.

n = total number of hourly averages for which paired inlet and outlet pollutant rates are available within the 24-hr midnight to midnight daily period.

ln = natural log of indicated value.

EXP = the natural logarithmic base (2.718) raised to the value enclosed by brackets.

NOTE: The calculation includes only paired data sets (hourly average) for the inlet and outlet pollutant measurements.

### 6. Sulfur Retention Credit for Compliance Fuel

If fuel sampling and analysis procedures in Section 5.2.1 are being used to determine average SO<sub>2</sub> emission rates (E[as]) to the atmosphere from a coal-fired steam generating unit when there is no SO<sub>2</sub> control device, the following equation may be used to adjust the emission rate for sulfur retention credits (no credits are allowed for oil-fired systems) (E[di]) for each sampling period using the following equation:

$$E[di] = 0.97 K (\%S / GCV)$$

Eq. 19-25

E[di] = average inlet SO<sub>2</sub> rate for each sampling period d, ng/J (lb/million Btu)

%S = sulfur content of as-fired fuel lot, dry basis, weight percent.

GCV = gross calorific value of the fuel lot consistent with the sulfur analysis, kg/kg (Btu/lb).

$$K = 2 \times 10^7 \times [(\text{kg})(\text{ng}) / (\%)(\text{J})] \times [2 \times 10^4 (\text{lb})(\text{Btu} / (\%))(\text{million Btu})]$$

After calculating E [di] use the procedures in Section 4-2 to determine the average SO<sub>2</sub> emission rate to the atmosphere for the performance test period (E[ao]).

### 7. Determination of Compliance When Minimum Data Requirement Is Not Met

7.1 Adjusted Emission Rates and Control Device Removal Efficiency. When the minimum data requirement is not met, the Administrator may use the following adjusted emission rates or control device removal efficiencies to determine compliance with the applicable standards.

7.1.1 Emission Rate. Compliance with the emission rate standard may be determined by using the lower confidence limit of the emission rate (E[ao]\*) as follows:

$$E[ao] * = E[ao] - t[0.95] S[o]$$

Eq. 19-26

where:

S[o] = standard deviation of the hourly average emission rates for each performance test period, ng/J (lb/million Btu).

t[0.95] = values shown in Table 19-2 for the indicated number of data points n.

7.1.2 Control Device Removal Efficiency. Compliance with the overall emission reduction (%R[o]) may be determined by using the lower confidence limit of the emission rate (E[ao]\*) and the upper confidence limit of the inlet pollutant rate (E[ai]\*) in calculating the control device removal efficiency (%R[g]) as follows:

$$\%R[g] = 100 \times [1.0 - E[ao] * / E[ai] *]$$

Eq. 19-27

$$E[ai] * = E[ai] + t[0.95] S[i]$$

Eq. 19-28

where:

S[1] = standard deviation of the hourly average inlet pollutant rates for each performance test period, ng/J (lb/million Btu).

TABLE 19-2 -- VALUES FOR T[0.95]

n	n1	t[0.95]	n	n1	t[0.95]	n	n1	t[0.95]
2		6.31	8		1.89	22-26		1.71
3		2.42	9		1.86	27-31		1.70
4		2.35	10		1.83	32-51		1.68
5		2.13	11		1.81	59-91		1.67
6		2.02	12-16		1.77	92-151		1.66
7		1.94	17-21		1.73	152 or more		1.65

n1 The values of this table are corrected for n-1 degrees of freedom. Use n equal to the number (H) of hourly average data points.

7.2 Standard Deviation of Hourly Average Pollutant Rates. Compute the standard deviation (S[e]) of the hourly average pollutant rates using the following equation:

$$S[e] = \sqrt{\frac{1}{H} - \frac{1}{H[r]} \times \left[ \sqrt{\sum_{j=1}^H (E[h_j] - E[a])^2} \right] / (H - 1)}$$

Eq. 19-29

where:

S = standard deviation of the hourly average pollutant rates for each performance test period, ng/J (lb/million Btu).

$H[r]$  = total numbers of hours in the performance test period (e.g., 720 hours for 30-day performance test period).

Equation 19-29 may be used to compute the standard deviation for both the outlet ( $S[o]$ ) and, if applicable, inlet ( $S[i]$ ) pollutant rates.

## METHOD 20 -- DETERMINATION OF NITROGEN OXIDES, SULFUR DIOXIDE, AND DILUENT EMISSIONS FROM STATIONARY GAS TURBINES

### 1. *Principle and Applicability*

1.1 Applicability. This method is applicable for the determination of nitrogen oxides ( $NO[x]$ ), sulfur dioxide ( $SO[2]$ ), and a diluent gas, either oxygen ( $O[2]$ ) or carbon dioxide ( $CO[2]$ ), emissions from stationary gas turbines. For the  $NO[x]$  and diluent concentration determinations, this method includes: (1) Measurement system design criteria; (2) Analyzer performance specifications and performance test procedures; and (3) Procedures for emission testing.

1.2 Principle. A gas sample is continuously extracted from the exhaust stream of a stationary gas turbine; a portion of the sample stream is conveyed to instrumental analyzers for determination of  $NO[x]$  and diluent content. During each  $NO[x]$  and diluent determination, a separate measurement of  $SO[2]$  emissions is made, using Method 6, or its equivalent. The diluent determination is used to adjust the  $NO[x]$  and  $SO[2]$  concentrations to a reference condition.

### 2. *Definitions*

2.1 Measurement System. The total equipment required for the determination of a gas concentration or a gas emission rate. The system consists of the following major subsystems:

2.1.1 Sample Interface. That portion of a system that is used for one or more of the following: sample acquisition, sample transportation, sample conditioning, or protection of the analyzers from the effects of the stack effluent.

2.1.2  $NO[x]$  Analyzer. That portion of the system that senses  $NO[x]$  and generates an output proportional to the gas concentration.

2.1.3  $O[2]$  Analyzer. That portion of the system that senses  $O[2]$  and generates an output proportional to the gas concentration.

2.1.4  $CO[2]$  Analyzer. That portion of the system that senses  $CO[2]$  and generates an output proportional to the gas concentration.

2.1.5 Data Recorder. That portion of the measurement system that provides a permanent record of the analyzer(s) output. The data recorder may include automatic data reduction capabilities.

2.2 Span Value. The upper limit of a gas concentration measurement range that is specified for affected source categories in the applicable part of the regulations.

2.3 Calibration Gas. A known concentration of a gas in an appropriate diluent gas.

2.4 Calibration Error. The difference between the gas concentration indicated by the measurement system and the known concentration of the calibration gas.

2.5 Zero Drift. The difference in the measurement system output readings from zero after a stated period of operation during which no unscheduled maintenance, repair, or adjustment took place and the input concentration at the time of the measurements was zero.

2.6 Calibration Drift. The difference in the measurement system output readings from the known concentration of the calibration gas after a stated period of operation during which no unscheduled maintenance, repair, or adjustment took place and the input at the time of the measurements was a high-level value.

2.7 Response Time. The amount of time required for the measurement system to display on the data output 95 percent of a step change in pollutant concentration.

2.8 Interference Response. The output response of the measurement system to a component in the sample gas, other than the gas component being measured.

### 3. *Measurement System Performance Specifications*

3.1 NO<sub>2</sub> to NO Converter. Greater than 90 percent conversion efficiency of NO<sub>2</sub> to NO.

3.2 Interference Response. Less than +/- 2 percent of the span value.

3.3 Response Time. No greater than 30 seconds.

3.4 Zero Drift. Less than +/- 2 percent of the span value over the period of each test run.

3.5 Calibration Drift. Less than +/- 2 percent of the span value over the period of each test run.

### 4. *Apparatus and Reagents*

4.1 Measurement System. Use any measurement system for NO<sub>x</sub> and diluent that is expected to meet the specifications in this method. A schematic of an acceptable measurement system is shown in Figure 20-1. The essential components of the measurement system are described below:

Figure 20.1 Measurement system design.

[SEE FIGURE IN ORIGINAL]

4.1.1 Sample Probe. Heated stainless steel, or equivalent, open-ended, straight tube of sufficient length to traverse the sample points.

4.1.2 Sample Line. Heated (> 95 deg. C) stainless steel or Teflon tubing to transport the sample gas to the sample conditioners and analyzers.

4.1.3 Calibration Valve Assembly. A three-way valve assembly to direct the zero and calibration gases to the sample conditioners and to the analyzers. The calibration valve assembly shall be capable of blocking the sample gas flow and of introducing calibration gases to the measurement system when in the calibration mode.

4.1.4 NO<sub>2</sub> to NO Converter. That portion of the system that converts the nitrogen dioxide (NO<sub>2</sub>) in the sample gas to nitrogen oxide (NO). Some analyzers are designed to measure NO<sub>x</sub> as NO<sub>2</sub> on a wet basis and can be used without an NO<sub>2</sub> to NO converter or a moisture removal trap provided the sample line to the analyzer is heated (> 95 deg. C) to the inlet of the analyzer. In addition, an NO<sub>2</sub> to NO converter is not necessary if the NO<sub>2</sub> portion of the exhaust gas is less than 5 percent of the total NO<sub>x</sub> concentration. As a guideline, an NO<sub>2</sub> to NO converter is not necessary if the gas turbine is operated at 90 percent or more of peak

load capacity. A converter is necessary under lower load conditions.

4.1.5 Moisture Removal Trap. A refrigerator-type condenser or other type device designed to continuously remove condensate from the sample gas while maintaining minimal contact between any condensate and the sample gas. The moisture removal trap is not necessary for analyzers that can measure NO[x] concentrations on a wet basis; for these analyzers, (a) heat the sample line up to the inlet of the analyzers, (b) determine the moisture content using methods subject to the approval of the Administrator, and (c) correct the NO[x] and diluent concentrations to a dry basis.

4.1.6 Particulate Filter. An in-stack or an out-of-stack glass fiber filter, of the type specified in EPA Method 5; however, an out-of-stack filter is recommended when the stack gas temperature exceeds 250 to 300 deg. C.

4.1.7 Sample Pump. A nonreactive leakfree sample pump to pull the sample gas through the system at a flow rate sufficient to minimize transport delay. The pump shall be made from stainless steel or coated with Teflon or equivalent.

4.1.8 Sample Gas Manifold. A sample gas manifold to divert portions of the sample gas stream to the analyzers. The manifold may be constructed of glass, Teflon, stainless steel, or equivalent.

4.1.9 Diluent Gas Analyzer. An analyzer to determine the percent O<sub>2</sub> or CO<sub>2</sub> concentration of the sample gas.

4.1.10 Nitrogen Oxides Analyzer. An analyzer to determine the ppm NO[x] concentration in the sample gas stream.

4.1.11 Data Recorder. A strip-chart recorder, analog computer, or digital recorder for recording measurement data.

4.2 Sulfur Dioxide Analysis. EPA Method 6 apparatus and reagents.

4.3 NO[x] Calibration Gases. The calibration gases for the NO[x] analyzer shall be NO in N<sub>2</sub>. Use four calibration gas mixtures as specified below:

4.3.1 High-level Gas. A gas concentration that is equivalent to 80 to 90 percent of the span value.

4.3.2 Mid-level Gas. A gas concentration that is equivalent to 45 to 55 percent of the span value.

4.3.3 Low-level Gas. A gas concentration that is equivalent to 20 to 30 percent of the span value.

4.3.4 Zero Gas. A gas concentration of less than 0.25 percent of the span value. Ambient air may be used for the NO[x] zero gas.

4.4 Diluent Calibration Gases.

4.4.1 For O<sub>2</sub> calibration gases, use purified air at 20.9 percent O<sub>2</sub> as the high-level O<sub>2</sub> gas. Use a gas concentration between 11 and 15 percent O<sub>2</sub> in nitrogen for the mid-level gas, and use purified nitrogen for the zero gas.

4.4.2 For CO<sub>2</sub> calibration gases, use a gas concentration between 8 and 12 percent CO<sub>2</sub> in air for the high-level calibration gas. Use a gas concentration between 2 and 5 percent CO<sub>2</sub> in air for the mid-level calibration gas, and use purified air (< 100 ppm CO<sub>2</sub>) as the zero level calibration gas.

## 5. Measurement System Performance Test Procedures

Perform the following procedures prior to measurement of emissions (Section 6) and only once for each test program, i.e., the series of all test runs for a given gas turbine engine.

5.1 Calibration Gas Checks. There are two alternatives for checking the concentrations of the calibration gases. (a) The first is to use calibration gases that are documented traceable to National Bureau of Standards Reference Materials. Use *Traceability Protocol for Establishing True Concentrations of Gases Used for Calibrations and Audits of Continuous Source Emission Monitors* (Protocol Number 1) that is available from the Environmental Monitoring Systems Laboratory, Quality Assurance Branch, Mail Drop 77, Environmental Protection Agency, Research Triangle Park, NC 27711. Obtain a certification from the gas manufacturer that the protocol was followed. These calibration gases are not to be analyzed with the Reference Methods. (b) The second alternative is to use calibration gases not prepared according to the protocol. If this alternative is chosen, within 1 month prior to the emission test, analyze each of the calibration gas mixtures in triplicate using Method 7 or the procedure outlined in Citation 1 for NO[x] and use Method 3 for O[2] or CO[2]. Record the results on a data sheet (example is shown in Figure 20-2). For the low-level, mid-level, or high-level gas mixtures, each of the individual NO[x] analytical results must be within 10 percent (or 10 ppm, whichever is greater) of the triplicate set average (O[2] or CO[2] test results must be within 0.5 percent O[2] or CO[2]); otherwise, discard the entire set and repeat the triplicate analyses. If the average of the triplicate reference method test results is within 5 percent for NO[x] gas or 0.5 percent O[2] or CO[2] for the O[2] or CO[2] gas of the calibration gas manufacturer's tag value, use the tag value; otherwise, conduct at least three additional reference method test analyses until the results of six individual NO[x] runs (the three original plus three additional) agree within 10 percent (or 10 ppm, whichever is greater) of the average (O[2] or CO[2] test results must be within 0.5 percent O[2] or CO[2]). Then use this average for the cylinder value.

5.2 Measurement System Preparation. Prior to the emission test, assemble the measurement system following the manufacturer's written instructions in preparing and operating the NO[2] to NO converter, the NO[x] analyzer, the diluent analyzer, and other components.

FIGURE 20-2 -- ANALYSIS OF CALIBRATION GASES

Date (Must be within 1 month prior to the test period)

Reference method used

Sample run	Gas concentration, ppm		
	Low level a	Mid level b	High level c
1			
2			
3			
Average			
Maximum % deviation d			

a Average must be 20 to 30% of span value.

b Average must be 45 to 55% of span value.

c Average must be 80 to 90% of span value.

d Must be  $\leq \pm 10\%$  of applicable average or 10 ppm, whichever is greater.

FIGURE 20-3 -- ZERO AND CALIBRATION DATA

Turbine type	Identification number
Date	Test number
Analyzer type	Identification number

	Cylinder value, ppm or %	Initial analyzer response, ppm or %	Final analyzer responses, ppm or %
Zero gas			
Low-level gas			
Mid-level gas			
High-level gas			

	Difference: initial- final, ppm or %
Zero gas	
Low-level gas	
Mid-level gas	
High-level gas	

5.3 Calibration Check. Conduct the calibration checks for both the NO[x] and the diluent analyzers as follows:

5.3.1 After the measurement system has been prepared for use (Section 5.2), introduce zero gases and the mid-level calibration gases; set the analyzer output responses to the appropriate levels. Then introduce each of the remainder of the calibration gases described in Sections 4.3 or 4.4, one at a time, to the measurement system. Record the responses on a form similar to Figure 20-3.

5.3.2 If the linear curve determined from the zero and mid-level calibration gas responses does not predict the actual response of the low-level (not applicable for the diluent analyzer) and high-level gases within 2 percent of the span value, the calibration shall be considered invalid. Take corrective measures on the measurement system before proceeding with the test.

5.4 Interference Response. Introduce the gaseous components listed in Table 20-1 into the measurement system

separately, or as gas mixtures. Determine the total interference output response of the system to these components in concentration units; record the values on a form similar to Figure 20-4. If the sum of the interference responses of the test gases for either the NO[x] or diluent analyzers is greater than 2 percent of the applicable span value, take corrective measure on the measurement system.

$$\text{Percent drift} = \text{Absolute difference} / \text{Span value} \times 100$$

TABLE 20-1 -- INTERFERENCE TEST GAS CONCENTRATION

CO	500 +/- 50 ppm	CO[2]	10 +/- 1 percent.
SO[2]	200 +/- 20 ppm	O[2]	20.9 +/- 1 percent.

FIGURE 20-4 -- INTERFERENCE RESPONSE

Date of test

Analyzer type

Serial No.

Test gas type	Concentration, ppm	Analyzer output response	% of span
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$$\% \text{ of span} = \text{Analyzer output response} / \text{Instrument span} \times 100$$

Conduct an interference response test of each analyzer prior to its initial use in the field. Thereafter, recheck the measurement system if changes are made in the instrumentation that could alter the interference response, e.g., changes in the type of gas detector.

In lieu of conducting the interference response test, instrument vendor data, which demonstrate that for the test gases of Table 20-1 the interference performance specification is not exceeded, are acceptable.

5.5 Response Time. To determine response time, first introduce zero gas into the system at the calibration valve until all readings are stable; then, switch to monitor the stack effluent until a stable reading can be obtained. Record the upscale response time. Next, introduce high-level calibration gas into the system. Once the system has stabilized at the high-level concentration, switch to monitor the stack effluent and wait until a stable value is reached. Record the downscale response time. Repeat the procedure three times. A stable value is equivalent to a change of less than 1 percent of span value for 30 seconds or less than 5 percent of the measured average concentration for 2 minutes. Record the response time data on a form similar to Figure 20-5, the readings of the upscale or downscale response time, and report the greater time as the "response time" for the analyzer. Conduct a response time test prior to the initial field use of the measurement system, and repeat if changes are made in the measurement system.

FIGURE 20-5 -- RESPONSE TIME

Date of test

Analyzer type

S/N

Span gas concentration: ppm.

Analyzer span setting: ppm.

Upscale:

1 seconds.

2 seconds.

3 seconds.

Average upscale response seconds.

Downscale:

1 seconds.

2 seconds.

3 seconds.

Average downscale response seconds.

System response time=

slower average time=

seconds.

## 5.6 NO<sub>2</sub> to NO Conversion Efficiency.

5.6.1 Add gas from the mid-level NO in N<sub>2</sub> calibration gas cylinder to a clean, evacuated, leak-tight Tedlar bag. Dilute this gas approximately 1:1 with 20.9 percent O<sub>2</sub> purified air. Immediately attach the bag outlet to the calibration valve assembly and begin operation of the sampling system. Operate the sampling system, recording the NO<sub>x</sub> response, for at least 30 minutes. If the NO<sub>2</sub> to NO conversion is 100 percent, the instrument response will be stable at the highest peak value observed. If the response at the end of 30 minutes decreases more than 2.0 percent of the highest peak value, the system is not acceptable and corrections must be made before repeating the check.

5.6.2 Alternatively, the NO<sub>2</sub> to NO converter check described in Title 40, Part 86: Certification and Test Procedures for Heavy-duty Engines for 1979 and Later Model Years may be used. Other alternative procedures may be used with approval of the Administrator.

## 6. Emission Measurement Test Procedure

## 6.1 Preliminaries.

6.1.1 Selection of a Sampling Site. Select a sampling site as close as practical to the exhaust of the turbine. Turbine geometry, stack configuration, internal baffling, and point of introduction of dilution air will vary for different turbine designs. Thus, each of these factors must be given special consideration in order to obtain a representative sample. Whenever possible, the sampling site shall be located upstream of the point of introduction of dilution air into the duct. Sample ports may be located before or after the upturn elbow, in order to accommodate the configuration of the turning vanes and baffles and to permit a complete, unobstructed traverse of the stack. The sample ports shall not be located within 5 feet or 2 diameters (whichever is less) of the gas discharge to atmosphere. For supplementary-fired, combined-cycle plants, the sampling site shall be located between the gas turbine and the boiler. The diameter of the sample ports shall be sufficient to allow entry of the sample probe.

6.1.2 A preliminary O<sub>2</sub> or CO<sub>2</sub> traverse is made for the purpose of selecting sampling points of low O<sub>2</sub> or high CO<sub>2</sub> concentrations, as appropriate for the measurement system. Conduct this test at the turbine operating condition that is the lowest percentage of peak load operation included in the test program. Follow the procedure below, or use an alternative procedure subject to the approval of the Administrator.

6.1.2.1 Minimum Number of Points. Select a minimum number of points as follows: (1) Eight, for stacks having cross-sectional areas less than 1.5 m<sup>2</sup> (16.1 ft<sup>2</sup>); (2) eight plus one additional sample point for each 0.2 m<sup>2</sup> (2.2 ft<sup>2</sup>) of areas, for stacks of 1.5 m<sup>2</sup> to 10.0 m<sup>2</sup> (16.1-107.6 ft<sup>2</sup>) in cross-sectional area; and (3) 49 sample points (48 for circular stacks) for stacks greater than 10.0 m<sup>2</sup> (107.6 ft<sup>2</sup>) in cross-sectional area. Note that for circular ducts, the number of sample points must be a multiple of 4, and for rectangular ducts, the number of points must be one of those listed in Table 20-2; therefore, round off the number of points (upward), when appropriate.

6.1.2.2 Cross-sectional Layout and Location of Traverse Points. After the number of traverse points for the preliminary diluent sampling has been determined, use Method 1 to located the traverse points.

6.1.2.3 Preliminary Diluent Measurement. While the gas turbine is operating at the lowest percent of peak load, conduct a preliminary diluent measurement as follows: Position the probe at the first traverse point and begin sampling. The minimum sampling time at each point shall be 1 minute plus the average system response time. Determine the average steady-state concentration of diluent at each point and record the data on Figure 20-6.

6.1.2.4 Selection of Emission Test Sampling Points. Select the eight sampling points at which the lowest O<sub>2</sub> concentrations or highest CO<sub>2</sub> concentrations were obtained. Sample at each of these selected points during each run at the different turbine load conditions. More than eight points may be used, if desired, providing that the points selected as described above are included.

TABLE 20-2 -- CROSS-SECTIONAL LAYOUT FOR RECTANGULAR STACKS

	<b>Matrix layout</b>
No. of traverse points:	
9	3 x 3
12	4 x 3
16	4 x 4
20	5 x 4
25	5 x 5

30	6 x 5
36	6 x 6
42	7 x 6
49	7 x 7

FIGURE 20-6 -- PRELIMINARY DILUENT TRAVERSE

Date

Location:

Plant

City, State

Turbine identification:

Manufacturer

Model, serial number

Sample point	Diluent concentration, ppm
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6.2 NO[x] and Diluent Measurement. This test is to be conducted at each of the specified load conditions. Three test runs at each load condition constitute a complete test.

6.2.1 At the beginning of each NO[x] test run and, as applicable, during the run, record turbine data as indicated in Figure 20-7. Also, record the location and number of the traverse points on a diagram.

6.2.2 Position the probe at the first point determined in the preceding section and begin sampling. The minimum sampling time at each point shall be at least 1 minute plus the average system response time. Determine the average steady-state concentration of diluent and NO[x] at each point and record the data on Figure 20-8.

FIGURE 20-7 -- STATIONARY GAS TURBINE DATA

TURBINE OPERATION RECORD

Test operator Date

Turbine identification:

Type

Serial No.

Location:

Plant

City

Ambient temperature

Ambient humidity

Test time start

Test time finish

Fuel flow rate na

Water or steam flow rate na

Ambient pressure

Ultimate fuel analysis:

C

H

O

N

S

Ash

H<sub>2</sub>O

Trace metals:

Na

Va

K

etc nb

Operating load

a Describe measurement method, i.e., continuous flow meter, start finish volumes, etc.

b i.e., additional elements added for smoke suppression.

FIGURE 20-8 -- STATIONARY GAS TURBINE SAMPLE POINT RECORD

Turbine identification:

Manufacturer

Model, serial No.

Location:

Plant

City, State

Ambient temperature

Ambient pressure

Date

Test time: start

Test time: finish

Test operator name

Diluent instrument type

Serial No

NO[x] instrument type

Serial No.

Sample point	Time, min	Diluent a%	NO[x] a, ppm
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a Average steady-state value from recorder or instrument readout.

6.2.3 After sampling the last point, conclude the test run by recording the final turbine operating parameters and by determining the zero and calibration drift, as follows:

Immediately following the test run at each load condition, or if adjustments are necessary for the measurement system during the tests, reintroduce the zero and mid-level calibration gases as described in Sections 4.3 and 4.4, one at a time, to the measurement system at the calibration valve assembly. (Make no adjustments to the measurement system until after the drift checks are made). Record the analyzers' responses on a form similar to Figure 20-3. If the drift values exceed the specified limits, the test run preceding the check is considered invalid and will be repeated following corrections to the measurement system. Alternatively, recalibrate the measurement system and recalculate the measurement data. Report the test results based on both the initial calibration and the recalibration data.

6.3 SO<sub>2</sub> Measurement. This test is conducted only at the 100 percent peak load condition. Determine SO<sub>2</sub> using Method 6, or equivalent, during the test. Select a minimum of six total points from those required for the

NO<sub>x</sub> measurements; use two points for each sample run. The sample time at each point shall be at least 10 minutes. Average the diluent readings taken during the NO<sub>x</sub> test runs at sample points corresponding to the SO<sub>2</sub> traverse points (see Section 6.2.2) and use this average diluent concentration to correct the integrated SO<sub>2</sub> concentration obtained by Method 6 to 15 percent diluent (see Equation 20-1).

If the applicable regulation allows fuel sampling and analysis for fuel sulfur content to demonstrate compliance with sulfur emission unit, emission sampling with Method 6 is not required, provided the fuel sulfur content meets the limits of the regulation.

## 7. Emission Calculations

7.1 Moisture Correction. Measurement data used in most of these calculations must be on a dry basis. If measurements must be corrected to dry conditions, use the following equation:

$$C [d] = C[w] / 1 - B[ws]$$

Eq. 20-1

where:

C[d] = Pollutant or diluent concentration adjusted to dry conditions, ppm or percent.

C[w] = Pollutant or diluent concentration measured under moist sample conditions, ppm or percent.

B[ws] = Moisture content of sample gas as measured with Method 4, reference method, or other approved method, percent/100.

7.2 CO<sub>2</sub> Correction Factor. If pollutant concentrations are to be corrected to 15 percent O<sub>2</sub> and CO<sub>2</sub> concentration is measured in lieu of O<sub>2</sub> concentration measurement, a CO<sub>2</sub> correction factor is needed. Calculate the CO<sub>2</sub> correction factor as follows:

7.2.1 Calculate the fuel-specific F<sub>o</sub> value for the fuel burned during the test using values obtained from Method 19, Section 5.2, and the following equation.

$$F[o] = 0.209 F[d] / F[c]$$

Eq. 20-2

where:

F<sub>o</sub> = Fuel factor based on the ratio of oxygen volume to the ultimate CO<sub>2</sub> volume produced by the fuel at zero percent excess air, dimensionless.

0.209 = Fraction of air that is oxygen, percent/100.

F<sub>d</sub> = Ratio of the volume of dry effluent gas to the gross calorific value of the fuel from Method 19, dscf/10<sup>6</sup> Btu).

F<sub>c</sub> = Ratio of the volume of carbon dioxide produced to the gross calorific value of the fuel from Method 19, dscf/10<sup>6</sup> Btu).

7.2.2 Calculate the CO<sub>2</sub> correction factor for correcting measurement data to 15 percent oxygen, as follows:

$$X[\text{CO}_2] = 5.9 / F[\text{O}_2]$$

Eq. 20-3

where:

$X[\text{CO}_2]$  =  $\text{CO}_2$  Correction factor, percent.

5.9 = 20.9 percent  $\text{O}_2$  - 15 percent  $\text{O}_2$ , the defined  $\text{O}_2$  correction value, percent.

7.3 Correction of Pollutant Concentrations to 15 percent  $\text{O}_2$ . Calculate the  $\text{NO}_x$  and  $\text{SO}_2$  gas concentrations adjusted to 15 percent  $\text{O}_2$  using Equation 20-4 or 20-5, as appropriate. The correction to 15 percent  $\text{O}_2$  is very sensitive to the accuracy of the  $\text{O}_2$  or  $\text{CO}_2$  concentration measurement. At the level of the analyzer drift specified in Section 3, the  $\text{O}_2$  or  $\text{CO}_2$  correction can exceed 5 percent at the concentration levels expected in gas turbine exhaust gases. Therefore,  $\text{O}_2$  or  $\text{CO}_2$  analyzer stability and careful calibration are necessary.

7.3.1 Correction of Pollutant Concentration Using  $\text{O}_2$  Concentration. Calculate the  $\text{O}_2$  corrected pollutant concentration, as follows:

$$C[\text{adj}] = C[\text{d}] \frac{5.9}{20.9 - \% \text{O}_2}$$

Eq. 20-4

where:

$C[\text{adj}]$  = Pollutant concentration corrected to 15 percent  $\text{O}_2$  ppm.

$C[\text{d}]$  = Pollutant concentration measured, dry basis, ppm.

$\% \text{O}_2$  = Measured  $\text{O}_2$  concentration dry basis, percent.

7.3.2 Correction of Pollutant Concentration Using  $\text{CO}_2$  Concentration. Calculate the  $\text{CO}_2$  corrected pollutant concentration, as follows:

$$C[\text{adj}] = C[\text{d}] \frac{X[\text{CO}_2]}{\% \text{CO}_2}$$

Eq. 20-5

where:

$\% \text{CO}_2$  = Measured  $\text{CO}_2$  concentration measured, dry basis, percent.

7.4 Average Adjusted  $\text{NO}_x$  Concentration. Calculate the average adjusted  $\text{NO}_x$  concentration by summing the adjusted values for each sample point and dividing by the number of points for each run.

7.5  $\text{NO}_x$  and  $\text{SO}_2$  Emission Rate Calculations. The emission rates for  $\text{NO}_x$  and  $\text{SO}_2$  in units of pollutant mass per quantity of heat input can be calculated using the pollutant and diluent concentrations and fuel-specific F-factors based on the fuel combustion characteristics. The measured concentrations of pollutant in units of parts per million by volume (ppm) must be converted to mass per unit volume concentration units for these calculations. Use the following table for such conversions:

## CONVERSION FACTORS FOR CONCENTRATION

From	To	Multiply by
g/sm <sup>3</sup>	ng/sm <sup>3</sup>	10 <sup>9</sup>
mg/sm <sup>3</sup>	ng/sm <sup>3</sup>	10 <sup>6</sup>
lb/scf	ng/sm <sup>3</sup>	1.602 x 10 <sup>13</sup>
ppm (SO <sub>2</sub> )	ng/sm <sup>3</sup>	2.660 x 10 <sup>6</sup>
ppm (NO <sub>x</sub> )	ng/sm <sup>3</sup>	1.912 x 10 <sup>6</sup>
ppm (SO <sub>2</sub> )	lb/scf	1.660 x 10 <sup>-7</sup>
ppm (NO <sub>x</sub> )	lb/scf	1.194 x 10 <sup>-7</sup>

7.5.1 Calculation of Emission Rate Using Oxygen Correction. Both the O<sub>2</sub> concentration and the pollutant concentration must be on a dry basis. Calculate the pollutant emission rate, as follows:

$$E = C[d]F[d] \frac{20.9}{20.9 - \%O_2}$$

Eq. 20-6

where:

E = Mass emission rate of pollutant, ng/J (lb/10<sup>6</sup> Btu).

7.5.2 Calculation of Emission Rate Using Carbon Dioxide Correction. The CO<sub>2</sub> concentration and the pollutant concentration may be on either a dry basis or a wet basis, but both concentrations must be on the same basis for the calculations. Calculate the pollutant emission rate using Equation 20-7 or 20-8:

$$E = C[d]F[c] \frac{100}{\%CO_2}$$

Eq. 20-7

$$E = C[w]F[c] \frac{100}{\%CO_{2w}}$$

Eq. 20-8

where:

C[w] = Pollutant concentration measured on a moist sample basis, ng/sm<sup>3</sup> (lb/scf).

%CO<sub>2w</sub> = Measured CO<sub>2</sub> concentration measured on a moist sample basis, percent.

## 8. Bibliography

1. Curtis, F. A Method for Analyzing NO<sub>x</sub> Cylinder Gases-Specific Ion Electrode Procedure, Monograph available from Emission Measurement Laboratory, ESED, Research Triangle Park, NC 27711, October 1978.

2. Sigsby, John E., F. M. Black, T. A. Bellar, and D. L. Klosterman. Chemiluminescent Method for Analysis of Nitrogen Compounds in Mobile Source Emissions (NO, NO<sub>2</sub>, and NH<sub>3</sub>). "Environmental Science and Technology," 7:51-54. January 1973.

3. Shigehara, R. T., R. M. Neulicht, and W. S. Smith. Validating Orsat Analysis Data from Fossil Fuel-Fired Units. Emission Measurement Branch, Emission Standards and Engineering Division, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. June 1975.

## METHOD 21 -- DETERMINATION OF VOLATILE ORGANIC COMPOUNDS LEAKS

### 1. *Applicability and Principle*

1.1 **Applicability.** This method applies to the determination of volatile organic compound (VOC) leaks from process equipment. These sources include, but are not limited to, valves, flanges and other connections, pumps and compressors, pressure relief devices, process drains, open-ended valves, pump and compressor seal system degassing vents, accumulator vessel vents, agitator seals, and access door seals.

1.2 **Principle.** A portable instrument is used to detect VOC leaks from individual sources. The instrument detector type is not specified, but it must meet the specifications and performance criteria contained in Section 3. A leak definition concentration based on a reference compound is specified in each applicable regulation. This procedure is intended to locate and classify leaks only, and is not to be used as a direct measure of mass emission rates from individual sources.

### 2. *Definitions*

2.1 **Leak Definition Concentration.** The local VOC concentration at the surface of a leak source that indicates that a VOC emission (leak) is present. The leak definition is an instrument meter reading based on a reference compound.

2.2 **Reference Compound.** The VOC species selected as an instrument calibration basis for specification of the leak definition concentration. (For example: If a leak definition concentration is 10,000 ppmv as methane, then any source emission that results in a local concentration that yields a meter reading of 10,000 on an instrument calibrated with methane would be classified as a leak. In this example, the leak definition is 10,000 ppmv, and the reference compound is methane.)

2.3 **Calibration Gas.** The VOC compound used to adjust the instrument meter reading to a known value. The calibration gas is usually the reference compound at a concentration approximately equal to the leak definition concentration.

2.4 **No Detectable Emission.** Any VOC concentration at a potential leak source (adjusted for local VOC ambient concentration) that is less than a value corresponding to the instrument readability specification of section 3.1.1(c) indicates that a leak is not present.

2.5 **Response Factor.** The ratio of the known concentration of a VOC compound to the observed meter reading when measured using an instrument calibrated with the reference compound specified in the application regulation.

2.6 **Calibration Precision.** The degree of agreement between measurements of the same known value, expressed as the relative percentage of the average difference between the meter readings and the known concentration to the known concentration.

2.7 Response Time. The time interval from a step change in VOC concentration at the input of the sampling system to the time at which 90 percent of the corresponding final value is reached as displayed on the instrument readout meter.

### 3. Apparatus

#### 3.1 Monitoring Instrument.

##### 3.1.1 Specifications.

a. The VOC instrument detector shall respond to the compounds being processed. Detector types which may meet this requirement include, but are not limited to, catalytic oxidation, flame ionization, infrared absorption, and photoionization.

b. Both the linear response range and the measurable range of the instrument for each of the VOC to be measured, and for the VOC calibration gas that is used for calibration, shall encompass the leak definition concentration specified in the regulation. A dilution probe assembly may be used to bring the VOC concentration within both ranges; however, the specifications for instrument response time and sample probe diameter shall still be met.

c. The scale of the instrument meter shall be readable to  $\pm 2.5$  percent of the specified leak definition concentration when performing a no detectable emission survey.

d. The instrument shall be equipped with an electrically driven pump to insure that a sample is provided to the detector at a constant flow rate. The nominal sample flow rate, as measured at the sample probe tip, shall be 0.10 to 3.0 liters per minute when the probe is fitted with a glass wool plug or filter that may be used to prevent plugging of the instrument.

e. The instrument shall be intrinsically safe as defined by the applicable U.S.A. standards (e.g., National Electric Code by the National Fire Prevention Association) for operation in any explosive atmospheres that may be encountered in its use. The instrument shall, at a minimum, be intrinsically safe for Class 1, Division 1 conditions, and Class 2, Division 1 conditions, as defined by the example Code. The instrument shall not be operated with any safety device, such as an exhaust flame arrestor, removed.

f. The instrument shall be equipped with a probe or probe extension for sampling not to exceed 1/4 in. in outside diameter, with a single end opening for admission of sample.

##### 3.1.2 Performance Criteria.

(a) The instrument response factors for each of the VOC to be measured shall be less than 10. When no instrument is available that meets this specification when calibrated with the reference VOC specified in the applicable regulation, the available instrument may be calibrated with one of the VOC to be measured, or any other VOC, so long as the instrument then has a response factor of less than 10 for each of the VOC to be measured.

(b) The instrument response time shall be equal to or less than 30 seconds. The instrument pump, dilution probe (if any), sample probe, and probe filter, that will be used during testing, shall all be in place during the response time determination.

c. The calibration precision must be equal to or less than 10 percent of the calibration gas value.

d. The evaluation procedure for each parameter is given in Section 4.4.

### 3.1.3 Performance Evaluation Requirements.

- a. A response factor must be determined for each compound that is to be measured, either by testing or from reference sources. The response factor tests are required before placing the analyzer into service, but do not have to be repeated at subsequent intervals.
- b. The calibration precision test must be completed prior to placing the analyzer into service, and at subsequent 3-month intervals or at the next use whichever is later.
- c. The response time test is required prior to placing the instrument into service. If a modification to the sample pumping system or flow configuration is made that would change the response time, a new test is required prior to further use.

3.2 Calibration Gases. The monitoring instrument is calibrated in terms of parts per million by volume (ppmv) of the reference compound specified in the applicable regulation. The calibration gases required for monitoring and instrument performance evaluation are a zero gas (air, less than 10 ppmv VOC) and a calibration gas in air mixture approximately equal to the leak definition specified in the regulation. If cylinder calibration gas mixtures are used, they must be analyzed and certified by the manufacturer to be within  $\pm 2$  percent accuracy, and a shelf life must be specified. Cylinder standards must be either reanalyzed or replaced at the end of the specified shelf life. Alternately, calibration gases may be prepared by the user according to any accepted gaseous standards preparation procedure that will yield a mixture accurate to within  $\pm 2$  percent. Prepared standards must be replaced each day of use unless it can be demonstrated that degradation does not occur during storage.

Calibrations may be performed using a compound other than the reference compound if a conversion factor is determined for that alternative compound so that the resulting meter readings during source surveys can be converted to reference compound results.

## 4. Procedures

4.1 Pretest Preparations. Perform the instrument evaluation procedures given in Section 4.4 if the evaluation requirements of Section 3.1.3 have not been met.

4.2 Calibration Procedures. Assemble and start up the VOC analyzer according to the manufacturer's instructions. After the appropriate warmup period and zero internal calibration procedure, introduce the calibration gas into the instrument sample probe. Adjust the instrument meter readout to correspond to the calibration gas value.

NOTE: If the meter readout cannot be adjusted to the proper value, a malfunction of the analyzer is indicated and corrective actions are necessary before use.

### 4.3 Individual Source Surveys.

4.3.1 Type I -- Leak Definition Based on Concentration. Place the probe inlet at the surface of the component interface where leakage could occur. Move the probe along the interface periphery while observing the instrument readout. If an increased meter reading is observed, slowly sample the interface where leakage is indicated until the maximum meter reading is obtained. Leave the probe inlet at this maximum reading location for approximately two times the instrument response time. If the maximum observed meter reading is greater than the leak definition in the applicable regulation, record and report the results as specified in the regulation reporting requirements. Examples of the application of this general technique to specific equipment types are:

- a. Valves -- The most common source of leaks from valves is at the seal between the stem and housing. Place the probe at the interface where the stem exits the packing gland and sample the stem circumference. Also, place the probe at the interface of the packing gland take-up flange seat and sample the periphery. In addition, survey valve housings of multipart assembly at the surface of all interfaces where a leak could occur.
- b. Flanges and Other Connections -- For welded flanges, place the probe at the outer edge of the flange-gasket interface and sample the circumference of the flange. Sample other types of nonpermanent joints (such as threaded connections) with a similar traverse.
- c. Pumps and Compressors -- Conduct a circumferential traverse at the outer surface of the pump or compressor shaft and seal interface. If the source is a rotating shaft, position the probe inlet within 1 cm of the shaft-seal interface for the survey. If the housing configuration prevents a complete traverse of the shaft periphery, sample all accessible portions. Sample all other joints on the pump or compressor housing where leakage could occur.
- d. Pressure Relief Devices -- The configuration of most pressure relief devices prevents sampling at the sealing seat interface. For those devices equipped with an enclosed extension, or horn, place the probe inlet at approximately the center of the exhaust area to the atmosphere.
- e. Process Drains -- For open drains, place the probe inlet at approximately the center of the area open to the atmosphere. For covered drains, place the probe at the surface of the cover interface and conduct a peripheral traverse.
- f. Open-Ended Lines or Valves -- Place the probe inlet at approximately the center of the opening to the atmosphere.
- g. Seal System Degassing Vents and Accumulator Vents -- Place the probe inlet at approximately the center of the opening to the atmosphere.
- h. Access Door Seals -- Place the probe inlet at the surface of the door seal interface and conduct a peripheral traverse.

#### 4.3.2 Type II -- "No Detectable Emission".

Determine the local ambient concentration around the source by moving the probe inlet randomly upwind and downwind at a distance of one to two meters from the source. If an interference exists with this determination due to a nearby emission or leak, the local ambient concentration may be determined at distances closer to the source, but in no case shall the distance be less than 25 centimeters. Then move the probe inlet to the surface of the source and determine the concentration described in 4.3.1. The difference between these concentrations determines whether there are no detectable emissions. Record and report the results as specified by the regulation.

For those cases where the regulation requires a specific device installation, or that specified vents be ducted or piped to a control device, the existence of these conditions shall be visually confirmed. When the regulation also requires that no detectable emissions exist, visual observations and sampling surveys are required. Examples of this technique are:

- (a) Pump or Compressor Seals -- If applicable, determine the type of shaft seal. Perform a survey of the local area ambient VOC concentration and determine if detectable emissions exist as described above.
- (b) Seal System Degassing Vents, Accumulator Vessel Vents, Pressure Relief Devices -- If applicable, observe whether or not the applicable ducting or piping exists. Also, determine if any sources exist in the ducting or piping where emissions could occur prior to the control device. If the required ducting or piping exists and there

are no sources where the emissions could be vented to the atmosphere prior to the control device, then it is presumed that no detectable emissions are present. If there are sources in the ducting or piping where emissions could be vented or sources where leaks could occur, the sampling surveys described in this paragraph shall be used to determine if detectable emissions exist.

4.3.3 Alternative Screening Procedure. A screening procedure based on the formation of bubbles in a soap solution that is sprayed on a potential leak source may be used for those sources that do not have continuously moving parts, that do not have surface temperatures greater than the boiling point or less than the freezing point of the soap solution, that do not have open areas to the atmosphere that the soap solution cannot bridge, or that do not exhibit evidence of liquid leakage. Sources that have these conditions present must be surveyed using the instrument techniques of 4.3.1 or 4.3.2.

Spray a soap solution over all potential leak sources. The soap solution may be a commercially available leak detection solution or may be prepared using concentrated detergent and water. A pressure sprayer or a squeeze bottle may be used to dispense the solution. Observe the potential leak sites to determine if any bubbles are formed. If no bubbles are observed, the source is presumed to have no detectable emissions or leaks as applicable. If any bubbles are observed, the instrument techniques of 4.3.1 or 4.3.2 shall be used to determine if a leak exists, or if the source has detectable emissions, as applicable.

4.4 Instrument Evaluation Procedures. At the beginning of the instrument performance evaluation test, assemble and start up the instrument according to the manufacturer's instructions for recommended warmup period and preliminary adjustments.

4.4.1 Response Factor. Calibrate the instrument with the reference compound as specified in the applicable regulation. For each organic species that is to be measured during individual source surveys, obtain or prepare a known standard in air at a concentration of approximately 80 percent of the applicable leak definition unless limited by volatility or explosivity. In these cases, prepare a standard at 90 percent of the saturation concentration, or 70 percent of the lower explosive limit, respectively. Introduce this mixture to the analyzer and record the observed meter reading. Introduce zero air until a stable reading is obtained. Make a total of three measurements by alternating between the known mixture and zero air. Calculate the response factor for each repetition and the average response factor.

Alternatively, if response factors have been published for the compounds of interest for the instrument or detector type, the response factor determination is not required, and existing results may be referenced. Examples of published response factors for flame ionization and catalytic oxidation detectors are included in Bibliography.

4.4.2 Calibration Precision. Make a total of three measurements by alternately using zero gas and the specified calibration gas. Record the meter readings. Calculate the average algebraic difference between the meter readings and the known value. Divide this average difference by the known calibration value and multiply by 100 to express the resulting calibration precision as a percentage.

4.4.3 Response Time. Introduce zero gas into the instrument sample probe. When the meter reading has stabilized, switch quickly to the specified calibration gas. Measure the time from switching to when 90 percent of the final stable reading is attained. Perform this test sequence three times and record the results. Calculate the average response time.

## 5. Bibliography

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## METHOD 22 -- VISUAL DETERMINATION OF FUGITIVE EMISSIONS FROM MATERIAL SOURCES AND SMOKE EMISSIONS FROM FLARES

### 1. *Introduction*

This method involves the visual determination of fugitive emissions, i.e., emissions not emitted directly from a process stack or duct. Fugitive emissions include emissions that (1) escape capture by process equipment exhaust hoods; (2) are emitted during material transfer; (3) are emitted from buildings housing material processing or handling equipment; and (4) are emitted directly from process equipment. This method is used also to determine visible smoke emissions from flares used for combustion of waste process materials.

This method determines the amount of time that any visible emissions occur during the observation period, i.e., the accumulated emission time. This method does not require that the opacity of emissions be determined. Since this procedure requires only the determination of whether a visible emission occurs and does not require the determination of opacity levels, observer certification according to the procedures of Method 9 are not required. However, it is necessary that the observer is educated on the general procedures for determining the presence of visible emissions. As a minimum, the observer must be trained and knowledgeable regarding the effects on the visibility of emissions caused by background contrast, ambient lighting, observer position relative to lighting, wind, and the presence of uncombined water (condensing water vapor). This training is to be obtained from written materials found in Citations 1 and 2 of Bibliography or from the lecture portion of the Method 9 certification course.

### 2. *Applicability and Principle*

2.1 *Applicability.* This method applies to the determination of the frequency of fugitive emissions from stationary sources (located indoors or outdoors) when specified as the test method for determining compliance with new source performance standards.

This method also is applicable for the determination of the frequency of visible smoke emissions from flares.

2.2 *Principle.* Fugitive emissions produced during material processing, handling, and transfer operations or smoke emissions from flares are visually determined by an observer without the aid of instruments.

### 3. *Definitions*

3.1 *Emission Frequency.* Percentage of time that emissions are visible during the observation period.

3.2 *Emission Time.* Accumulated amount of time that emissions are visible during the observation period.

3.3 *Fugitive Emissions.* Pollutant generated by an affected facility which is not collected by a capture system and is released to the atmosphere.

3.4 *Smoke Emissions.* Pollutant generated by combustion in a flare and occurring immediately downstream of the flame. Smoke occurring within the flame, but not downstream of the flame, is not considered a smoke

emission.

3.5 Observation Period. Accumulated time period during which observations are conducted, not to be less than the period specified in the applicable regulation.

#### 4. *Equipment*

4.1 Stopwatches. Accumulative type with unit divisions of at least 0.5 seconds; two required.

4.2 Light Meter. Light meter capable of measuring illuminance in the 50- to 200-lux range; required for indoor observations only.

#### 5. *Procedure*

5.1 Position. Survey the affected facility or building or structure housing the process to be observed and determine the locations of potential emissions. If the affected facility is located inside a building, determine an observation location that is consistent with the requirements of the applicable regulation (i.e., outside observation of emissions escaping the building/structure or inside observation of emissions directly emitted from the affected facility process unit). Then select a position that enables a clear view of the potential emission point(s) of the affected facility or of the building or structure housing the affected facility, as appropriate for the applicable subpart. A position at least 15 feet, but not more than 0.25 miles, from the emission source is recommended. For outdoor locations, select a position where the sun is not directly in the observer's eyes.

#### 5.2 Field Records.

5.2.1 Outdoor Location. Record the following information on the field data sheet (Figure 22-1): company name, industry, process unit, observer's name, observer's affiliation, and date. Record also the estimated wind speed, wind direction, and sky condition. Sketch the process unit being observed and note the observer location relative to the source and the sun. Indicate the potential and actual emission points on the sketch.

5.2.2 Indoor Location. Record the following information on the field data sheet (Figure 22-2): company name, industry, process unit, observer's name, observer's affiliation, and date. Record as appropriate the type, location, and intensity of lighting on the data sheet. Sketch the process unit being observed and note observer location relative to the source. Indicate the potential and actual fugitive emission points on the sketch.

5.3 Indoor Lighting Requirements. For indoor locations, use a light meter to measure the level of illumination at a location as close to the emission source(s) as is feasible. An illumination of greater than 100 lux (10 foot candles) is considered necessary for proper application of this method.

5.4 Observations. Record the clock time when observations begin. Use one stopwatch to monitor the duration of the observation period; start this stopwatch when the observation period begins. If the observation period is divided into two or more segments by process shutdowns or observer rest breaks, stop the stopwatch when a break begins and restart it without resetting when the break ends. Stop the stopwatch at the end of the observation period. The accumulated time indicated by this stopwatch is the duration of the observation period. When the observation period is completed, record the clock time.

During the observation period, continuously watch the emission source. Upon observing an emission (condensed water vapor is not considered an emission), start the second accumulative stopwatch; stop the watch when the emission stops. Continue this procedure for the entire observation period. The accumulated elapsed time on this stopwatch is the total time emissions were visible during the observation period, i.e., the emission time.

5.4.1 Observation Period. Choose an observation period of sufficient length to meet the requirements for determining compliance with the emission regulation in the applicable subpart. When the length of the observation period is specifically stated in the applicable subpart, it may not be necessary to observe the source for this entire period if the emission time required to indicate noncompliance (based on the specified observation period) is observed in a shorter time period. In other words, if the regulation prohibits emissions for more than 6 minutes in any hour, then observations may (optional) be stopped after an emission time of 6 minutes is exceeded. Similarly, when the regulation is expressed as an emission frequency and the regulation prohibits emissions for greater than 10 percent of the time in any hour, then observations may (optional) be terminated after 6 minutes of emissions are observed since 6 minutes is 10 percent of an hour. In any case, the observation period shall not be less than 6 minutes in duration. In some cases, the process operation may be intermittent or cyclic. In such cases, it may be convenient for the observation period to coincide with the length of the process cycle.

5.4.2 Observer Rest Breaks. Do not observe emissions continuously for a period of more than 15 to 20 minutes without taking a rest break. For sources requiring observation periods of greater than 20 minutes, the observer shall take a break of not less than 5 minutes and not more than 10 minutes after every 15 to 20 minutes of observation. If continuous observations are desired for extended time periods, two observers can alternate between making observations and taking breaks.

5.4.3 Visual Interference. Occasionally, fugitive emissions from sources other than the affected facility (e.g., road dust) may prevent a clear view of the affected facility. This may particularly be a problem during periods of high wind. If the view of the potential emission points is obscured to such a degree that the observer questions the validity of continuing observations, then the observations are terminated, and the observer clearly notes this fact on the data form.

5.5 Recording Observations. Record the accumulated time of the observation period on the data sheet as the observation period duration. Record the accumulated time emissions were observed on the data sheet as the emission time. Record the clock time the observation period began and ended, as well as the clock time any observer breaks began and ended.

## 6. *Calculations*

If the applicable subpart requires that the emission rate be expressed as an emission frequency (in percent), determine this value as follows: Divide the accumulated emission time (in seconds) by the duration of the observation period (in seconds) or by any minimum observation period required in the applicable subpart, if the actual observation period is less than the required period and multiply this quotient by 100.

## 7. *Bibliography*

1. Missan, Robert and Arnold Stein. Guidelines for Evaluation of Visible Emissions Certification, Field Procedures, Legal Aspects, and Background Material. EPA Publication No. EPA-340/1-75-007. April 1975
2. Wohlschlegel, P. and D. E. Wagoner. Guidelines for Development of a Quality Assurance Program: Volume IX -- Visual Determination of Opacity Emissions From Stationary Sources. EPA Publication No. EPA-650/4-74-005-i. November 1975.

Figure 22-1

[SEE FIGURE IN ORIGINAL]

Figure 22-2

[SEE FIGURE IN ORIGINAL]

## METHOD 23--DETERMINATION OF POLYCHLORINATED DIBENZO-P-DIOXINS AND POLYCHLORINATED DIBENZOFURANS FROM STATIONARY SOURCES

### *1. Applicability and Principle*

1.1 Applicability. This method is applicable to the determination of polychlorinated dibenzo-p-dioxins (PCDD's) and polychlorinated dibenzofurans (PCDF's) from stationary sources.

1.2 Principle. A sample is withdrawn from the gas stream isokinetically and collected in the sample probe, on a glass fiber filter, and on a packed column of adsorbent material. The sample cannot be separated into a particle vapor fraction. The PCDD's and PCDF's are extracted from the sample, separated by high resolution gas chromatography, and measured by high resolution mass spectrometry.

### *2. Apparatus*

2.1 Sampling. A schematic of the sampling train used in this method is shown in Figure 23-1. Sealing greases may not be used in assembling the train. The train is identical to that described in section 2.1 of Method 5 of this appendix with the following additions:

Figure 23.1 Sampling train

[SEE FIGURE IN ORIGINAL]

2.1.1 Nozzle. The nozzle shall be made of nickel, nickel-plated stainless steel, quartz, or borosilicate glass.

2.1.2 Sample Transfer Lines. The sample transfer lines, if needed, shall be heat traced, heavy walled TFE (1/2 in. OD with 1/8 in. wall) with connecting fittings that are capable of forming leak-free, vacuum-tight connections without using sealing greases. The line shall be as short as possible and must be maintained at 120 deg. C.

2.1.1 Filter Support. Teflon or Teflon-coated wire.

2.1.2 Condenser. Glass, coil type with compatible fittings. A schematic diagram is shown in Figure 23-2.

2.1.3 Water Bath. Thermostatically controlled to maintain the gas temperature exiting the condenser at <20 deg. C (68 deg. F).

2.1.4 Adsorbent Module. Glass container to hold the solid adsorbent. A schematic diagram is shown in Figure 23-2. Other physical configurations of the resin trap/condenser assembly are acceptable. The connecting fittings shall form leak-free, vacuum tight seals. No sealant greases shall be used in the sampling train. A coarse glass frit is included to retain the adsorbent.

### *2.2 Sample Recovery.*

2.2.1 Fitting Caps. Ground glass, Teflon tape, or aluminum foil (Section 2.2.6) to cap off the sample exposed sections of the train.

2.2.2 Wash Bottles. Teflon, 500-ml.

2.2.3 Probe-Liner Probe-Nozzle, and Filter-Holder Brushes. Inert bristle brushes with precleaned stainless steel

or Teflon handles. The probe brush shall have extensions of stainless steel or Teflon, at least as long as the probe. The brushes shall be properly sized and shaped to brush out the nozzle, probe liner, and transfer line, if used.

Figure 23.2. Condenser and adsorbent trap

[SEE FIGURE IN ORIGINAL]

2.2.4 Filter Storage Container. Sealed filter holder, wide-mouth amber glass jar with Teflon-lined cap, or glass petri dish.

2.2.5 Balance. Triple beam.

2.2.6 Aluminum Foil. Heavy duty, hexane-rinsed.

2.2.7 Metal Storage Container. Air tight container to store silica gel.

2.2.8 Graduated Cylinder. Glass, 250-ml with 2-ml graduation.

2.2.9 Glass Sample Storage Container. Amber glass bottle for sample glassware washes, 500- or 1000-ml, with leak free Teflon-lined caps.

2.3 Analysis.

2.3.1 Sample Container. 125- and 250-ml flint glass bottles with Teflon-lined caps.

2.3.2 Test Tube. Glass.

2.3.3 Soxhlet Extraction Apparatus. Capable of holding 43 x 123 mm extraction thimbles.

2.3.4 Extraction Thimble. Glass, precleaned cellulosic, or glass fiber.

2.3.5 Pasteur Pipettes. For preparing liquid chromatographic columns.

2.3.6 Reacti-vials. Amber glass, 2-ml, silanized prior to use.

2.3.7 Rotary Evaporator. Buchi/Brinkman RF-121 or equivalent.

2.3.8 Nitrogen Evaporative Concentrator. N-Evap Analytical Evaporator Model III or equivalent.

2.3.9 Separatory Funnels. Glass, 2-liter.

2.3.10 Gas Chromatograph. Consisting of the following components:

2.3.10.1 Oven. Capable of maintaining the separation column at the proper operating temperature +/- deg. C and performing programmed increases in temperature at rates of at least 40 deg. C/min.

2.3.10.2 Temperature Gauge. To monitor column oven, detector, and exhaust temperatures +/- 1 deg. C.

2.3.10.3 Flow System. Gas metering system to measure sample, fuel, combustion gas, and carrier gas flows.

2.3.10.4 Capillary Columns. A fused silica column, 60 X 0.25 mm inside diameter (ID), coated with DB-5 and a

fused silica column, 30 m X 0.25 mm ID coated with DB-225. Other column systems may be used provided that the user is able to demonstrate using calibration and performance checks that the column system is able to meet the specifications of section 6.1.2.2.

2.3.11 Mass Spectrometer. Capable of routine operation at a resolution of 1:10000 with a stability of +/- 5 ppm.

2.3.12 Data System. Compatible with the mass spectrometer and capable of monitoring at least five groups of 25 ions.

2.3.13 Analytical Balance. To measure within 0.1 mg.

### 3. Reagents

#### 3.1 Sampling.

3.1.1 Filters. Glass fiber filters, without organic binder, exhibiting at least 99.95 percent efficiency (<0.05 percent penetration) on 0.3-micron dioctyl phthalate smoke particles. The filter efficiency test shall be conducted in accordance with ASTM Standard Method D 2986-71 (Reapproved 1978) (incorporated by reference--see § 60.17).

3.1.1.1 Precleaning. All filters shall be cleaned before their initial use. Place a glass extraction thimble and 1 g of silica gel and a plug of glass wool into a Soxhlet apparatus, charge the apparatus with toluene, and reflux for a minimum of 3 hours. Remove the toluene and discard it, but retain the silica gel. Place no more than 50 filters in the thimble onto the silica gel bed and top with the cleaned glass wool. Charge the Soxhlet with toluene and reflux for 16 hours. After extraction, allow the Soxhlet to cool, remove the filters, and dry them under a clean N<sub>2</sub> stream. Store the filters in a glass petri dish sealed with Teflon tape.

3.1.2 Adsorbent Resin. Amberlite XAD-2 resin. Thoroughly cleaned before initial use.

3.1.2.1 Cleaning Procedure. This procedure may be carried out in a giant Soxhlet extractor. An all-glass filter thimble containing an extra-course frit is used for extraction of XAD-2. The frit is recessed 10-15 mm above a crenelated ring at the bottom of the thimble to facilitate drainage. The resin must be carefully retained in the extractor cup with a glass wool plug and a stainless steel ring because it floats on methylene chloride. This process involves sequential extraction in the following order.

Solvent	Procedure
Water	Initial rinse: Place resin in a beaker, rinse once with water, and discard. Fill with water a second time, let stand overnight, and discard.
Water	Extract with water for 8 hours.
Methanol	Extract for 22 hours.
Methylene Chloride	Extract for 22 hours.

Toluene

Extract for 22 hours.

### 3.1.2.2 Drying.

3.1.2.2.1 Drying Column. Pyrex pipe, 10.2 cm ID by 0.6 m long, with suitable retainers.

3.1.2.2.2 Procedure. The adsorbent must be dried with clean inert gas. Liquid nitrogen from a standard commercial liquid nitrogen cylinder has proven to be a reliable source of large volumes of gas free from organic contaminants. Connect the liquid nitrogen cylinder to the column by a length of cleaned copper tubing, 0.95 cm ID, coiled to pass through a heat source. A convenient heat source is a water-bath heated from a steam line. The final nitrogen temperature should only be warm to the touch and not over 40 deg. C. Continue flowing nitrogen through the adsorbent until all the residual solvent is removed. The flow rate should be sufficient to gently agitate the particles but not so excessive as to cause the particles to fracture.

3.1.2.3 Quality Control Check. The adsorbent must be checked for residual toluene.

3.1.2.3.1 Extraction. Weigh 1.0 g sample of dried resin into a small vial, add 3 ml of toluene, cap the vial, and shake it well.

3.1.2.3.2 Analysis. Inject a 2  $\mu$ l sample of the extract into a gas chromatograph operated under the following conditions:

Column: 6 ft X 1/8 in stainless steel containing 10 percent OV-101 on 100/120 Supelcoport.

Carrier Gas: Helium at a rate of 30 ml/min.

Detector: Flame ionization detector operated at a sensitivity of  $4 \times 10^{-11}$  A/mV.

Injection Port Temperature: 250 deg. C.

Detector Temperature: 305 deg. C.

Oven Temperature: 30 deg. C for 4 min; programmed to rise at 40 deg. C/min until it reaches 250 deg. C; return to 30 deg. C after 17 minutes.

Compare the results of the analysis to the results from the reference solution. Prepare the reference solution by injection 2.5  $\mu$ l of methylene chloride into 100 ml of toluene. This corresponds to 100  $\mu$ g of methylene chloride per g of adsorbent. The maximum acceptable concentration is 1000  $\mu$ g/g of adsorbent. If the adsorbent exceeds this level, drying must be continued until the excess methylene chloride is removed.

3.1.2.4 Storage. The adsorbent must be used within 4 weeks of cleaning. After cleaning, it may be stored in a wide mouth amber glass container with a Teflon-lined cap or placed in one of the glass adsorbent modules tightly sealed with glass stoppers. If precleaned adsorbent is purchased in sealed containers, it must be used within 4 weeks after the seal is broken.

3.1.3 Glass Wool. Cleaned by sequential immersion in three aliquots of methylene chloride, dried in a 110 deg. C oven, and stored in a methylene chloride-washed glass jar with a Teflon-lined screw cap.

3.1.4 Water. Deionized distilled and stored in a methylene chloride-rinsed glass container with a Teflon-lined screw cap.

3.1.5 Silica Gel. Indicating type, 6 to 16 mesh. If previously used, dry at 175 deg. C (350 deg. F) for two hours. New silica gel may be used as received. Alternately other types of desiccants (equivalent or better) may be used, subject to the approval of the Administrator.

3.1.6 Chromic Acid Cleaning Solution. Dissolve 20 g of sodium dichromate in 15 ml of water, and then carefully add 400 ml of concentrated sulfuric acid.

3.2 Sample Recovery.

3.2.2 Acetone. Pesticide quality.

3.2.2 Methylene Chloride. Pesticide quality.

3.2.3 Toluene. Pesticide quality.

3.3 Analysis.

3.3.1 Potassium Hydroxide. ACS grade, 2-percent (weight/volume) in water.

3.3.2 Sodium Sulfate. Granulated, reagent grade. Purify prior to use by rinsing with methylene chloride and oven drying. Store the cleaned material in a glass container with a Teflon-lined screw cap.

3.3.3 Sulfuric Acid. Reagent grade.

3.3.4 Sodium Hydroxide. 1.0 N. Weigh 40 g of sodium hydroxide into a 1-liter volumetric flask. Dilute to 1 liter with water.

3.3.5 Hexane. Pesticide grade.

3.3.6 Methylene Chloride. Pesticide grade.

3.3.7 Benzene. Pesticide Grade.

3.3.8 Ethyl Acetate.

3.3.9 Methanol. Pesticide Grade.

3.3.10 Toluene. Pesticide Grade.

3.3.11 Nonane. Pesticide Grade.

3.3.12 Cyclohexane. Pesticide Grade.

3.3.13 Basic Alumina. Activity grade 1, 100-200 mesh. Prior to use, activate the alumina by heating for 16 hours at 130 deg. C before use. Store in a desiccator. Pre-activated alumina may be purchased from a supplier and may be used as received.

3.3.14 Silica Gel. Bio-Sil A, 100-200 mesh. Prior to use, activate the silica gel by heating for at least 30 minutes at 180 deg. C. After cooling, rinse the silica gel sequentially with methanol and methylene chloride. Heat the rinsed silica gel at 50 deg. C for 10 minutes, then increase the temperature gradually to 180 deg. C over 25 minutes and maintain it at this temperature for 90 minutes. Cool at room temperature and store in a glass container with a Teflon-lined screw cap.

3.3.15 Silica Gel Impregnated with Sulfuric Acid. Combine 100 g of silica gel with 44 g of concentrated sulfuric acid in a screw capped glass bottle and agitate thoroughly. Disperse the solids with a stirring rod until a uniform mixture is obtained. Store the mixture in a glass container with a Teflon-lined screw cap.

3.3.16 Silica Gel Impregnated with Sodium Hydroxide. Combine 39 g of 1 N sodium hydroxide with 100 g of silica gel in a screw capped glass bottle and agitate thoroughly. Disperse solids with a stirring rod until a uniform mixture is obtained. Store the mixture in glass container with a Teflon-lined screw cap.

3.3.17 Carbon/Celite. Combine 10.7 g of AX-21 carbon with 124 g of Celite 545 in a 250-ml glass bottle with a Teflon-lined screw cap. Agitate the mixture thoroughly until a uniform mixture is obtained. Store in the glass container.

3.3.18 Nitrogen. Ultra high purity.

3.3.19 Hydrogen. Ultra high purity.

3.3.20 Internal Standard Solution. Prepare a stock standard solution containing the isotopically labelled PCDD's and PCDF's at the concentrations shown in Table 1 under the heading "Internal Standards" in 10 ml of nonane.

3.3.21 Surrogate Standard Solution. Prepare a stock standard solution containing the isotopically labelled PCDD's and PCDF's at the concentrations shown in Table 1 under the heading "Surrogate Standards" in 10 ml of nonane.

3.3.22 Recovery Standard Solution. Prepare a stock standard solution containing the isotopically labelled PCDD's and PCDF's at the concentrations shown in Table 1 under the heading "Recovery Standards" in 10 ml of nonane.

#### *4. Procedure*

4.1 Sampling. The complexity of this method is such that, in order to obtain reliable results, testers should be trained and experienced with the test procedures.

##### 4.1.1 Pretest Preparation.

4.1.1.1 Cleaning Glassware. All glass components of the train upstream of and including the adsorbent module, shall be cleaned as described in section 3A of the "Manual of Analytical Methods for the Analysis of Pesticides in Human and Environmental Samples." Special care shall be devoted to the removal of residual silicone grease sealants on ground glass connections of used glassware. Any residue shall be removed by soaking the glassware for several hours in a chromic acid cleaning solution prior to cleaning as described above.

4.1.1.2 Adsorbent Trap. The traps must be loaded in a clean area to avoid contamination. They may not be loaded in the field. Fill a trap with 20 to 40 g of XAD-2. Follow the XAD-2 with glass wool and tightly cap both ends of the trap. Add 100  $\mu$ l of the surrogate standard solution (section 3.3.21) to each trap.

4.1.1.3 Sample Train. It is suggested that all components be maintained according to the procedure described in APTD-0576.

4.1.1.4 Silica Gel. Weigh several 200 to 300 g portions of silica gel in an air tight container to the nearest 0.5 g. Record the total weight of the silica gel plus container, on each container. As an alternative, the silica gel may be weighed directly in its impinger or sampling holder just prior to sampling.

4.1.1.5 Filter. Check each filter against light for irregularities and flaws or pinhole leaks. Pack the filters flat in a clean glass container.

4.1.2 Preliminary Determinations. Same as section 4.1.2 of Method 5.

4.1.3 Preparation of Collection Train.

4.1.3.1 During preparation and assembly of the sampling train, keep all train openings where contamination can enter, sealed until just prior to assembly or until sampling is about to begin.

NOTE: Do not use sealant grease in assembling the train.

4.1.3.2 Place approximately 100 ml of water in the second and third impingers, leave the first and fourth impingers empty, and transfer approximately 200 to 300 g of preweighed silica gel from its container to the fifth impinger.

4.1.3.3 Place the silica gel container in a clean place for later use in the sample recovery. Alternatively, the weight of the silica gel plus impinger may be determined to the nearest 0.5 g and recorded.

4.1.3.4 Assemble the train as shown in Figure 23-1.

4.1.3.5 Turn on the adsorbent module and condenser coil recirculating pump and begin monitoring the adsorbent module gas entry temperature. Ensure proper sorbent temperature gas entry temperature before proceeding and before sampling is initiated. It is extremely important that the XAD-2 adsorbent resin temperature never exceed 50 deg. C because thermal decomposition will occur. During testing, the XAD-2 temperature must not exceed 20 deg. C for efficient capture of the PCDD's and PCDF's.

4.1.4 Leak-Check Procedure. Same as Method 5, section 4.1.4.

4.1.5 Sample Train Operation. Same as Method 5, section 4.1.5.

4.2 Sample Recovery. Proper cleanup procedure begins as soon as the probe is removed from the stack at the end of the sampling period. Seal the nozzle end of the sampling probe with Teflon tape or aluminum foil.

When the probe can be safely handled, wipe off all external particulate matter near the tip of the probe. Remove the probe from the train and close off both ends with aluminum foil. Seal off the inlet to the train with Teflon tape, a ground glass cap, or aluminum foil.

Transfer the probe and impinger assembly to the cleanup area. This area shall be clean and enclosed so that the chances of losing or contaminating the sample are minimized. Smoking, which could contaminate the sample, shall not be allowed in the cleanup area.

Inspect the train prior to and during disassembly and note any abnormal conditions, e.g., broken filters, colored impinger liquid, etc. Treat the samples as follows: 4.2.1 Container No. 1. Either seal the filter holder or carefully remove the filter from the filter holder and place it in its identified container. Use a pair of cleaned tweezers to handle the filter. If it is necessary to fold the filter, do so such that the particulate cake is inside the fold. Carefully transfer to the container any particulate matter and filter fibers which adhere to the filter holder gasket, by using a dry inert bristle brush and a sharp-edged blade. Seal the container.

4.2.2 Adsorbent Module. Remove the module from the train, tightly cap both ends, label it, cover with aluminum foil, and store it on ice for transport to the laboratory.

4.2.3 Container No. 2. Quantitatively recover material deposited in the nozzle, probe transfer lines, the front half of the filter holder, and the cyclone, if used, first, by brushing while rinsing three times each with acetone and then, by rinsing the probe three times with methylene chloride. Collect all the rinses in Container No. 2.

Rinse the back half of the filter holder three times with acetone. Rinse the connecting line between the filter and the condenser three times with acetone. Soak the connecting line with three separate portions of methylene chloride for 5 minutes each. If using a separate condenser and adsorbent trap, rinse the condenser in the same manner as the connecting line. Collect all the rinses in Container No. 2 and mark the level of the liquid on the container.

4.2.4 Container No. 3. Repeat the methylene chloride-rinsing described in Section 4.2.3 using toluene as the rinse solvent. Collect the rinses in Container No. 3 and mark the level of the liquid on the container.

4.2.5 Impinger Water. Measure the liquid in the first three impingers to within  $\pm 1$  ml by using a graduated cylinder or by weighing it to within  $\pm 0.5$  g by using a balance. Record the volume or weight of liquid present. This information is required to calculate the moisture content of the effluent gas.

Discard the liquid after measuring and recording the volume or weight.

4.2.7 Silica Gel. Note the color of the indicating silica gel to determine if it has been completely spent and make a mention of its condition. Transfer the silica gel from the fifth impinger to its original container and seal.

## 5. Analysis

All glassware shall be cleaned as described in section 3A of the "Manual of Analytical Methods for the Analysis of Pesticides in Human and Environmental Samples." All samples must be extracted within 30 days of collection and analyzed within 45 days of extraction.

### 5.1 Sample Extraction.

5.1.1 Extraction System. Place an extraction thimble (section 2.3.4), 1 g of silica gel, and a plug of glass wool into the Soxhlet apparatus, charge the apparatus with toluene, and reflux for a minimum of 3 hours. Remove the toluene and discard it, but retain the silica gel. Remove the extraction thimble from the extraction system and place it in a glass beaker to catch the solvent rinses.

5.1.2 Container No. 1 (Filter). Transfer the contents directly to the glass thimble of the extraction system and extract them simultaneously with the XAD-2 resin.

5.1.3 Adsorbent Cartridge. Suspend the adsorbent module directly over the extraction thimble in the beaker (See section 5.1.1). The glass frit of the module should be in the up position. Using a Teflon squeeze bottle containing toluene, flush the XAD-2 into the thimble onto the bed of cleaned silica gel. Thoroughly rinse the glass module catching the rinsings in the beaker containing the thimble. If the resin is wet, effective extraction can be accomplished by loosely packing the resin in the thimble. Add the XAD-2 glass wool plug into the thimble.

5.1.4 Container No. 2 (Acetone and Methylene Chloride). Concentrate the sample to a volume of about 1-5 ml using the rotary evaporator apparatus, at a temperature of less than 37 deg. C. Rinse the sample container three times with small portions of methylene chloride and add these to the concentrated solution and concentrate further to near dryness. This residue contains particulate matter removed in the rinse of the train probe and nozzle. Add the concentrate to the filter and the XAD-2 resin in the Soxhlet apparatus described in section 5.1.1.

5.1.5 Extraction. Add 100  $\mu$ l of the internal standard solution (Section 3.3.20) to the extraction thimble containing the contents of the adsorbent cartridge, the contents of Container No. 1, and the concentrate from section 5.1.4. Cover the contents of the extraction thimble with the cleaned glass wool plug to prevent the XAD-2 resin from floating into the solvent reservoir of the extractor. Place the thimble in the extractor, and add the toluene contained in the beaker to the solvent reservoir. Pour additional toluene to fill the reservoir approximately 2/3 full. Add Teflon boiling chips and assemble the apparatus. Adjust the heat source to cause the extractor to cycle three times per hour. Extract the sample for 16 hours. After extraction, allow the Soxhlet to cool. Transfer the toluene extract and three 10-ml rinses to the rotary evaporator. Concentrate the extract to approximately 10 ml. At this point the analyst may choose to split the sample in half. If so, split the sample, store one half for future use, and analyze the other according to the procedures in sections 5.2 and 5.3. In either case, use a nitrogen evaporative concentrator to reduce the volume of the sample being analyzed to near dryness. Dissolve the residue in 5 ml of hexane.

5.1.6 Container No. 3 (Toluene Rinse). Add 100  $\mu$ l of the Internal Standard solution (section 3.3.2) to the contents of the container. Concentrate the sample to a volume of about 1-5 ml using the rotary evaporator apparatus at a temperature of less than 37 deg. C. Rinse the sample container apparatus at a temperature of less than 37 deg. C. Rinse the sample container three times with small portions of toluene and add these to the concentrated solution and concentrate further to near dryness. Analyze the extract separately according to the procedures in sections 5.2 and 5.3, but concentrate the solution in a rotary evaporator apparatus rather than a nitrogen evaporative concentrator.

## 5.2 Sample Cleanup and Fractionation.

5.2.1 Silica Gel Column. Pack one end of a glass column, 20 mm x 230 mm, with glass wool. Add in sequence, 1 g silica gel, 2 g of sodium hydroxide impregnated silica gel, 1 g silica gel, 4 g of acid-modified silica gel, and 1 g of silica gel. Wash the column with 30 ml of hexane and discard it. Add the sample extract, dissolved in 5 ml of hexane to the column with two additional 5-ml rinses. Elute the column with an additional 90 ml of hexane and retain the entire eluate. Concentrate this solution to a volume of about 1 ml using the nitrogen evaporative concentrator (section 2.3.7).

5.2.2 Basic Alumina Column. Shorten a 25-ml disposable Pasteur pipette to about 16 ml. Pack the lower section with glass wool and 12 g of basic alumina. Transfer the concentrated extract from the silica gel column to the top of the basic alumina column and elute the column sequentially with 120 ml of 0.5 percent methylene chloride in hexane followed by 120 ml of 35 percent methylene chloride in hexane. Discard the first 120 ml of eluate. Collect the second 120 ml of eluate and concentrate it to about 0.5 ml using the nitrogen evaporative concentrator.

5.2.3 AX-21 Carbon/Celite 545 Column. Remove the bottom 0.5 in. from the tip of a 9-ml disposable Pasteur pipette. Insert a glass fiber filter disk in the top of the pipette 2.5 cm from the constriction. Add sufficient carbon/celite mixture to form a 2 cm column. Top with a glass wool plug. In some cases AX-21 carbon fines may wash through the glass wool plug and enter the sample. This may be prevented by adding a celite plug to the exit end of the column. Rinse the column in sequence with 2 ml of 50 percent benzene in ethyl acetate, 1 ml of 50 percent methylene chloride in cyclohexane, and 2 ml of hexane. Discard these rinses. Transfer the concentrate in 1 ml of hexane from the basic alumina column to the carbon/celite column along with 1 ml of hexane rinse. Elute the column sequentially with 2 ml of 50 percent methylene chloride in hexane and 2 ml of 50 percent benzene in ethyl acetate and discard these eluates. Invert the column and elute in the reverse direction with 13 ml of toluene. Collect this eluate. Concentrate the eluate in a rotary evaporator at 50 deg. C to about 1 ml. Transfer the concentrate to a Reacti-vial using a toluene rinse and concentrate to a volume of 200  $\mu$ l using a stream of N<sub>2</sub>. Store extracts at room temperature, shielded from light, until the analysis is performed.

5.3 Analysis. Analyze the sample with a gas chromatograph coupled to a mass spectrometer (GC/MS) using the

instrumental parameters in sections 5.3.1 and 5.3.2. Immediately prior to analysis, add a 20  $\mu$ l aliquot of the Recovery Standard solution from Table 1 to each sample. A 2  $\mu$ l aliquot of the extract is injected into the GC. Sample extracts are first analyzed using the DB-5 capillary column to determine the concentration of each isomer of PCDD's and PCDF's (tetra-through octa-). If tetra-chlorinated dibenzofurans are detected in this analysis, then analyze another aliquot of the sample in a separate run, using the DB-225 column to measure the 2,3,7,8 tetra-chloro dibenzofuran isomer. Other column systems may be used, provided that the user is able to demonstrate using calibration and performance checks that the column system is able to meet the specifications of section 6.1.2.2.

### 5.3.1 Gas Chromatograph Operating Conditions.

5.3.1.1 Injector. Configured for capillary column, splitless, 250 deg. C.

5.3.1.2 Carrier Gas. Helium, 1-2 ml/min.

5.3.1.3 Oven. Initially at 150 deg. C. Raise by at least 40 deg. C/min to 190 deg. C and then at 3 deg. C/min up to 300 deg. C.

### 5.3.2 High Resolution Mass Spectrometer.

5.3.2.1 Resolution. 10000 m/e.

5.3.2.2 Ionization Mode. Electron impact.

5.3.2.3 Source Temperature 250 deg. C.

5.3.2.4 Monitoring Mode. Selected ion monitoring. A list of the various ions to be monitored is summarized in Table 3.

5.3.2.5 Identification Criteria. The following identification criteria shall be used for the characterization of polychlorinated dibenzodioxins and dibenzofurans.

1. The integrated ion-abundance ratio ( $M/M + 2$  or  $M + 2 / M + 4$ ) shall be within 15 percent of the theoretical value. The acceptable ion-abundance ratio ranges for the identification of chlorine-containing compounds are given in Table 4.

2. The retention time for the analytes must be within 3 seconds of the corresponding  $<13>$  C-labeled internal standard, surrogate or alternate standard.

3. The monitored ions, shown in Table 3 for a given analyte, shall reach their maximum within 2 seconds of each other.

4. The identification of specific isomers that do not have corresponding  $<13>$  C-labeled standards is done by comparison of the relative retention time (RRT) of the analyte to the nearest internal standard retention time with reference (i.e., within 0.005 RRT units) to the comparable RRT's found in the continuing calibration.

5. The signal to noise ratio for all monitored ions must be greater than 2.5.

6. The confirmation of 2, 3, 7, 8-TCDD and 2, 3, 7, 8-TCDF shall satisfy all of the above identification criteria.

7. For the identification of PCDF's, no signal may be found in the corresponding PCDF channels.

5.3.2.6 Quantification. The peak areas for the two ions monitored for each analyte are summed to yield the total response for each analyte. Each internal standard is used to quantify the indigenous PCDD's or PCDF's in its homologous series. For example, the <13> C[12]-2,3,7,8-tetra chlorinated dibenzodioxin is used to calculate the concentrations of all other tetra chlorinated isomers. Recoveries of the tetra- and penta- internal standards are calculated using the <13> C [12] -1,2,3,4-TCDD. Recoveries of the hexa- through octa- internal standards are calculated using <13> C [12] -1,2,3,7,8,9-HxCDD. Recoveries of the surrogate standards are calculated using the corresponding homolog from the internal standard.

## 6. Calibration

Same as Method 5 with the following additions.

### 6.1. GC/MS System.

6.1.1 Initial Calibration. Calibrate the GC/MS system using the set of five standards shown in Table 2. The relative standard deviation for the mean response factor from each of the unlabeled analytes (Table 2) and of the internal, surrogate, and alternate standards shall be less than or equal to the values in Table 5. The signal to noise ratio for the GC signal present in every selected ion current profile shall be greater than or equal to 2.5. The ion abundance ratios shall be within the control limits in Table 4.

### 6.1.2 Daily Performance Check.

6.1.2.1 Calibration Check. Inject on  $\mu$ l of solution Number 3 from Table 2. Calculate the relative response factor (RRF) for each compound and compare each RRF to the corresponding mean RRF obtained during the initial calibration. The analyzer performance is acceptable if the measured RRF's for the labeled and unlabeled compounds for the daily run are within the limits of the mean values shown in Table 5. In addition, the ion-abundance ratios shall be within the allowable control limits shown in Table 4.

6.1.2.2 Column Separation Check. Inject a solution of a mixture of PCDD's and PCDF's that documents resolution between 2,3,7,8-TCDD and other TCDD isomers. Resolution is defined as a valley between peaks that is less than 25 percent of the lower of the two peaks. Identify and record the retention time windows for each homologous series.

Perform a similar resolution check on the confirmation column to document the resolution between 2,3,7,8 TCDF and other TCDF isomers.

6.2 Lock Channels. Set mass spectrometer lock channels as specified in Table 3. Monitor the quality control check channels specified in Table 3 to verify instrument stability during the analysis.

## 7. Quality Control

7.1 Sampling Train Collection Efficiency Check. Add 100  $\mu$ l of the surrogate standards in Table 1 to the absorbent cartridge of each train before collecting the field samples.

7.2 Internal Standard Percent Recoveries. A group of nine carbon labeled PCDD's and PCDF's representing, the tetra-through octachlorinated homologues, is added to every sample prior to extraction. The role of the internal standards is to quantify the native PCDD's and PCDF's present in the sample as well as to determine the overall method efficiency. Recoveries of the internal standards must be between 40 to 130 percent for the tetra-through hexachlorinated compounds while the range is 25 to 130 percent for the higher hepta- and octachlorinated homologues.

7.3 Surrogate Recoveries. The five surrogate compounds in Table 2 are added to the resin in the adsorbent

sampling cartridge before the sample is collected. The surrogate recoveries are measured relative to the internal standards and are a measure of collection efficiency. They are not used to measure native PCDD's and PCDF's. All recoveries shall be between 70 and 130 percent. Poor recoveries for all the surrogates may be an indication of breakthrough in the sampling train. If the recovery of all standards is below 70 percent, the sampling runs must be repeated. As an alternative, the sampling runs do not have to be repeated if the final results are divided by the fraction of surrogate recovery. Poor recoveries of isolated surrogate compounds should not be grounds for rejecting an entire set of the samples.

7.4 Toluene QA Rinse. Report the results of the toluene QA rinse separately from the total sample catch. Do not add it to the total sample.

## 8. *Quality Assurance*

8.1 Applicability. When the method is used to analyze samples to demonstrate compliance with a source emission regulation, an audit sample must be analyzed, subject to availability.

8.2 Audit Procedure. Analyze an audit sample with each set of compliance samples. The audit sample contains tetra through octa isomers of PCDD and PCDF. Concurrently, analyze the audit sample and a set of compliance samples in the same manner to evaluate the technique of the analyst and the standards preparation. The same analyst, analytical reagents, and analytical system shall be used both for the compliance samples and the EPA audit sample.

8.3 Audit Sample Availability. Audit samples will be supplied only to enforcement agencies for compliance tests. The availability of audit samples may be obtained by writing: Source Test Audit Coordinator (MD-77B), Quality Assurance Division, Atmospheric Research and Exposure Assessment Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711, or by calling the Source Test Audit Coordinator (STAC) at (919) 541-7834. The request for the audit sample must be made at least 30 days prior to the scheduled compliance sample analysis.

8.4 Audit Results. Calculate the audit sample concentration according to the calculation procedure described in the audit instructions included with the audit sample. Fill in the audit sample concentration and the analyst's name on the audit response form included with the audit instructions. Send one copy to the EPA Regional Office or the appropriate enforcement agency and a second copy to the STAC. The EPA Regional office or the appropriate enforcement agency will report the results of the audit to the laboratory being audited. Include this response with the results of the compliance samples in relevant reports to the EPA Regional Office or the appropriate enforcement agency.

## 9. *Calculations*

Same as Method 5, section 6 with the following additions.

### 9.1 Nomenclature.

A [ai] = Integrated ion current of the noise at the retention time of the analyte.

A \* [ci] = Integrated ion current of the two ions characteristic of the internal standard i in the calibration standard.

A [cij] = Integrated ion current of the two ions characteristic of compound i in the jth calibration standard.

A \* [cij] = Integrated ion current of the two ions characteristic of the internal standard i in the jth calibration standard.

A [csi] = Integrated ion current of the two ions characteristic of surrogate compound i in the calibration standard.

A [i] = Integrated ion current of the two ions characteristic of compound i in the sample.

A \* [i] = Integrated ion current of the two ions characteristic of internal standard i in the sample.

A [rs] = Integrated ion current of the two ions characteristic of the recovery standard.

A [si] = Integrated ion current of the two ions characteristic of surrogate compound i in the sample.

C [i] = Concentration of PCDD or PCDF i in the sample, pg/M <3>.

C [T] = Total concentration of PCDD's or PCDF's in the sample, pg/M <3>.

m [ci] = Mass of compound i in the calibration standard injected into the analyzer, pg.

m [rs] = Mass of recovery standard in the calibration standard injected into the analyzer, pg.

m [si] = Mass of surrogate compound i in the calibration standard, pg.

RRF [i] = Relative response factor.

RRF [rs] = Recovery standard response factor.

RRF [s] = Surrogate compound response factor.

9.2 Average Relative Response Factor.

$$RRF[1] = 1 / n \sum_{j=1}^n A[cij]m*[ci] / A*[cij]m[ci]$$

Eq. 23-1 . . .

9.3 Concentration of the PCDD's and PCDF's.

$$C[i] = m[i]*A[i] / A[i]*RRF[i]V[mstd]$$

Eq. 23-2

9.4 Recovery Standard Response Factor.

$$RRF[rs] = A[ci]*m[rs] / A[rs]m[ci]*$$

Eq. 23-3

9.5 Recovery of Internal Standards (R\*).

$$R* = A[i]*m[rs] / A[rs]RF[rs]m[i]* \times 100\%$$

Eq. 23-4

## 9.6 Surrogate Compound Response Factor.

$$\text{RRF}[s] = A[\text{ci}]^*m[s] / A[\text{cis}]m[\text{ci}]^*$$

Eq. 23-5

## 9.7 Recovery of Surrogate Compounds (R [s]).

$$R[s] = A[s]m[i]^* / A[i]^*RRF[s]m[s] \times 100\%$$

Eq. 23-6

## 9.8 Minimum Detectable Limit (MDL).

$$\text{MDL} = 2.5 A[\text{si}]m[i]^* / A[\text{ci}]^*RRF[i]$$

Eq. 23-7

## 9.9 Total Concentration of PCDD's and PCDF's in the Sample.

$$n C[\text{Tr}] = \text{Sigma } C[i] \text{ } i = 1$$

Eq. 23-8

Any PCDD's or PCDF's that are reported as nondetected (below the MDL) shall be counted as zero for the purpose of calculating the total concentration of PCDD's and PCDF's in the sample.

## 10. Bibliography

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3. Thompson, J. R. (ed.). Analysis of Pesticide Residues in Human and Environmental Samples. U.S. Environmental Protection Agency. Research Triangle Park, NC. 1974.
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5. U.S. Environmental Protection Agency. Method 8290 -- The Analysis of Polychlorinated Dibenzo-p-dioxin and Polychlorinated Dibenzofurans by High-Resolution Gas Chromatography/High-Resolution Mass Spectrometry. In: Test Methods for Evaluating Solid Waste. Washington, DC. SW-846.

TABLE 1 -- COMPOSITION OF THE SAMPLE FORTIFICATION AND RECOVERY STANDARDS SOLUTIONS

Analyte	Concentration (pg/ mu l)
Internal Standards:	
<13> C [12] -2,3,7,8-TCDD	100
<13> C [12] -1,2,3,7,8-PeCDD	100
<13> C [12] -1,2,3,6,7,8-HxCDD	100
<13> C [12] -1,2,3,4,6,7,8-HpCDD	100
<13> C [12] -OCDD	100
<13> C [12] -2,3,7,8-TCDF	100
<13> C [12] -1,2,3,7,8-PeCDF	100
<13> C [12] -1,2,3,6,7,8-HxCDF	100
<13> C [12] -1,2,3,4,6,7,8-HpCDF	100
Surrogate Standards:	
<37> Cl [4] -2,3,7,8-TCDD	100
<13> C [12] -1,2,3,4,7,8-HxCDD	100
<13> C [12] -2,3,4,7,8-PeCDF	100
<13> C [12] -1,2,3,4,7,8-HxCDF	100
<13> C [12] -1,2,3,4,7,8,9-HpCDF	100
Recovery Standards:	
<13> C [12] -1,2,3,4-TCDD	500
<13> C [12] -1,2,3,7,8,9-HxCDD	500

TABLE 2 -- COMPOSITION OF THE INITIAL CALIBRATION SOLUTIONS

Compound	Concentrations (pg/mu l)				
	Solution No.				
	1	2	3	4	5
Alternate Standard:					
<13> C [12] -1,2,3,7,8,9-HxCDF	2.5	5	25	250	500
Recovery Standards:					
<13> C [12] -1,2,3,4-TCDD	100	100	100	100	100
<13> C [12] -1,2,3,7,8,9-HxCDD	100	100	100	100	100

TABLE 3 -- ELEMENTAL COMPOSITIONS AND EXACT MASSES OF THE IONS MONITORED BY HIGH RESOLUTION MASS SPECTROMETRY FOR PCDD'S AND PCDF'S

Descriptor No.	Accurate mass	Ion type	Elemental composition	Analyte
2	292.9825	LOCK	C [7] F [11]	PFK
	303.9016	M	C [12] H [4] <35> Cl [4] O	TCDF
	305.8987	M + 2	C [12] H [4] <35> Cl <37> O	TCDF
	315.9419	M	<13> C [12] H [4] <35> Cl [4] O	TCDF (S)
	317.9389	M + 2	<13>C[12]H[4]<35>Cl[3]<37>ClO	TCDF (S)
	319.8965	M	C[12]H[4]<35>ClO[2]	TCDD
	321.8936	M + 2	C[12]H[4]<35>Cl[3]<37>ClO[2]	TCDD
	327.8847	M	C[12]H[4]<37>Cl[4]O[2]	TCDD (S)
	330.9792	QC	C[7]F[13]	PFK
	331.9368	M	<13>C[12]H[4]<35>Cl[4]O[2]	TCDD (S)
	333.9339	M + 2	<13>C[12]H[4]<35>Cl<37>ClO[2]	TCDD (S)
	339.8597	M + 2	C[12]H[3]<35>Cl[4]<37>ClO	PeCDF
	341.8567	M + 4	C[12]H[3]<35>Cl[3]<37>Cl[2]O	PeCDF
	351.9000	M + 2	<13>C[12]H[3]<35>Cl[4]<37>ClO	PeCDF (S)
	353.8970	M + 4	<13>C[12]H[3]<35>Cl<3537>Cl[2]O	PeCDF (S)
	355.8546	M + 2	C[12]H[3]<35>Cl[3]37ClO[2]	PeCDD
	357.8516	M + 4	C[12]H[3]<35>Cl[3]<37>Cl[2]O[2]	PeCDD
	367.8949	M + 2	<13>C[12]H[3]<35>Cl[4]<37>ClO[2]	PeCDD (S)
	369.8919	M + 4	<13>C[12]H[3]<35>Cl[3]<37>Cl[2]O[2] (S)	PeCDD (S)
	375.8364	M + 2	C[12]H[4]<35>Cl[5]<37>ClO	HxCDFE
	409.7974	M + 2	C[12]H[3]<35>Cl[6]<37>ClO	HpCPDE
3	373.8208	M + 2	C[12]H[2]35Cl[5]<37>ClO	HxCDF
	375.8178	M + 4	C[12]H[2]<35>Cl[4]<37>Cl[2]O	HxCDF
	383.8639	M	<13>C[12]H[2]<35>Cl[6]O	HxCDF (S)
	385.8610	M + 2	<13>C[12]H[2]<35>Cl[5]<37>ClO	HxCDF (S)
	389.8157	M + 2	C[12]H[2]<35>Cl[5]<37>ClO[2]	HxCDD
	391.8127	M + 4	C[12]H[2]<35>Cl[4]<37>Cl[2]O[2]	HxCDD
	392.9760	LOCK	C[9]F[15]	PFK
	401.8559	M + 2	<13>C[12]H[2]<35>Cl[5]<37>ClO[2]	HxCDD (S)
	403.8529	M + 4	<13>C[12]H[2]<35>Cl[4]<37>Cl[2]O	HxCDD (S)
	455.7555	M + 4	C[12]H[2]<35>Cl[6]<37>Cl[2]O	OCDPE

430.9729 QC	C[9]F[17]	PFK
4 407.7818 M + 2	C[12]H<35>CI[6]<37>CIO	HpCDF
409.7789 M + 4	C[12]H<35>CI[5]<37>CI[2]O	HpCDF
417.8253 M	<13>C[12]H<35>CI[7]O	HpCDF (S)
419.8220 M + 2	<13>C[12]H<35>CI[6]<37>CIO	HpCDF (S)
423.7766 M + 2	C[12]H<35>CI[6]<37>CIO[2]	HpCDD
425.7737 M + 4	C[12]H<35>CI[5]<37>CI[2]O[2]	HpCDD
435.8169 M + 2	<13>C[12]H<35>CI[6]<37>CIO[2]	HpCDD (S)
437.8140 M + 4	<13>C[12]H<35>CI[5]<37>CI[2]O[2]	HpCDD (S)
479.7165 M + 4	C[12]H<35>CI[7]<<37>CI[2]O	NCPDE
430.9729 LOCK	C[9]F[17]	PFK
441.7428 M + 2	C[12]<35>CI[7]<37>CIO	OCDF
443.7399 M + 4	C[12]<35>CI[6]<37>CI[2]O	OCDF
457.7377 M + 2	C[12]<35>CI[7]<37>CIO[2]	OCDD
459.7348 M + 4	C[12]<35>CI[6]<37>CI[2]O[2]	OCDD
469.7779 M + 2	<13>C[12]<35>CI[7]<37>CIO[2]	OCDD (S)
471.7750 M + 4	<13>C[12]<35>CI[6]<37>CI[2]O[2]	OCDD (S)
513.6775 M + 4	C[12]<35>CI[8]<37>CI[2]O[2]	DCDPE
442.9728 QC	C[10]F[17]	PFK

(a) The following nuclidic masses were used:

H = 1.007825

C = 12.000000

<13>C = 13.003355

F = 18.9984

O = 15.994915

<35>CI = 34.968853

<37>CI = 36.965903

S = Labeled Standard

QC = Ion selected for monitoring instrument stability during the GC/MS analysis.

TABLE 4 -- ACCEPTABLE RANGES FOR ION ABUNDANCE RATIOS OF PCDD'S AND PCDF'S

No. of chlorine atoms	of Ion type	Theo- retical ratio	Control limits	
			Lower	Upper
4	M/M + 2	0.77	0.65	0.89
5	M + 2 / M + 4	1.55	1.32	1.78

TABLE 4 -- ACCEPTABLE RANGES FOR ION-ABUNDANCE RATIOS OF PCDD'S AND PCDF'S --  
Continued

No. of chlorine atoms	Ion type	Theo- retical ratio	Control limits	
			Lower	Upper
6 4	M + 2 / M +	1.24	1.05	1.43

TABLE 4 -- ACCEPTABLE RANGES FOR ION-ABUNDANCE RATIOS OF PCDD'S AND PCDF'S --  
Continued

No. of chlorine atoms	Ion type	Theo- retical ratio	Control limits	
			Lower	Upper
a 6	M/M + 2	0.51	0.43	0.59
b 7	M/M + 2	0.44	0.37	0.51
7 4	M + 2 / M +	1.04	0.88	1.20
8 4	M + 2 / M +	0.89	0.76	1.02

a Used only for <13>C-HxCDF.

b Used only for <13>C-HpCDF.

TABLE 5 -- MINIMUM REQUIREMENTS FOR INITIAL AND DAILY CALIBRATION RESPONSE FACTORS

Compound	Relative response factors	
	Initial	Daily
	calibration RSD	calibration % difference
Unlabeled		
Analytes:		
2,3,7,8-TCDD	25	25
2,3,7,8-TCDF	25	25
1,2,3,7,8-PeCDD	25	25
1,2,3,7,8-PeCDF	25	25
2,3,4,7,8-PeCDF	25	25
1,2,4,5,7,8-HxCDD	25	25
1,2,3,6,7,8-HxCDD	25	25
1,2,3,7,8,9-HxCDD	25	25
1,2,3,4,7,8-HxCDF	25	25
1,2,3,6,7,8-HxCDF	25	25

1,2,3,7,8,9-HxCDF	25	25
2,3,4,6,7,8-HxCDF	25	25
1,2,3,4,6,7,8-HpCDD	25	25
1,2,3,4,6,7,8-HpCDF	25	25
OCDD	25	25
OCDF	30	30
Internal		
Standards:		
<13>C[12]-2,3,7,8-TCDD	25	25
<13>C[12]-1,2,3,7,8-PeCDD	30	30
<13>C[12]-1,2,3,6,7,8-HxCDD	25	25
<13>C[12]-1,2,3,4,6,7,8-HpCDD	30	30
<13>C[12]-OCDD	30	30
<13>C[12]-2,3,7,8-TCDF	30	30
<13>C[12]-1,2,3,7,8-PeCDF	30	30
<13>C[12]-1,2,3,6,7,8-HxCDF	30	30
<13>C[12]-1,2,3,4,6,7,8-HpCDF	30	30
Surrogate		
Standards:		
<37>CI[4]-2,3,7,8-TCDD	25	25
<13>C[12]-2,3,4,7,8-PeCDF	25	25
<13>C[12]-1,2,3,4,7,8-HxCDD	25	25
<13>C[12]-1,2,3,4,7,8-HxCDF	25	25
<13>C[12]-1,2,3,4,7,8,9-HpCDF	25	25
Alternate		
Standard:		
<13>C[12]-1,2,3,7,8,9-HxCDF	25	25

## METHOD 24 -- DETERMINATION OF VOLATILE MATTER CONTENT, WATER CONTENT, DENSITY, VOLUME SOLIDS, AND WEIGHT SOLIDS OF SURFACE COATINGS

### 1. *Applicability and Principle*

1.1 **Applicability.** This method applies to the determination of volatile matter content, water content, density, volume solids, and weight solids of paint, varnish, lacquer, or related surface coatings.

1.2 **Principle.** Standard methods are used to determine the volatile matter content, water content, density, volume solids, and weight solids of the paint, varnish, lacquer, or related surface coatings.

### 2. *Applicable Standard Methods*

Use the apparatus, reagents, and procedures specified in the standard methods below:

2.1 ASTM D1475-60 (Reapproved 1980), Standard Test Method for Density of Paint, Varnish, Lacquer, and Related Products (incorporated by reference -- see § 60.17).

2.2 ASTM D2369-81, Standard Test Method for Volatile Content of Coatings (incorporated by reference -- see § 60.17).

2.3 ASTM D3792-79, Standard Test Method for Water Content of Water-Reducible Paints by Direct Injection into a Gas Chromatograph (incorporated by reference -- see § 60.17).

2.4 ASTM D4017-81, Standard Test Method for Water in Paints and Paint Materials by the Karl Fischer Titration Method (incorporated by reference -- see § 60.17).

### 3. Procedure

3.1 Volatile Matter Content. Use the procedure in ASTM D2369-81 (incorporated by reference -- see § 60.17) to determine the volatile matter content (may include water) of the coating. Record the following information:

W[1] = Weight of dish and sample before heating, g.

W[2] = Weight of dish and sample after heating, g.

W[3] = Sample weight, g.

Run analyses in pairs (duplicate sets) for each coating until the criterion in Section 4.3 is met. Calculate the weight fraction of the volatile matter (W[v]) for each analysis as follows:

$$W[v] = W[1] - W[2] / W[3]$$

Eq. 24-1

Record the arithmetic average (W[v]).

3.2 Water Content. For waterborne (water reducible) coatings only, determine the weight fraction of water (W[w]) using either "Standard Content Method Test for Water of Water-Reducible Paints by Direct Injection into a Gas Chromatograph" or "Standard Test Method for Water in Paint and Paint Materials by Karl Fischer Method." (These two methods are incorporated by reference -- see § 60.17.) A waterborne coating is any coating which contains more than 5 percent water by weight in its volatile fraction. Run duplicate sets of determinations until the criterion in Section 4.3 is met. Record the arithmetic average (W[w]).

3.3 Coating Density. Determine the density (D[c], kg/liter) of the surface coating using the procedure in ASTM D1475-60 (Reapproved 1980) (incorporated by reference -- see § 60.17).

Run duplicate sets of determinations for each coating until the criterion in Section 4.3 is met. Record the arithmetic average (D[c]).

3.4 Solids Content. Determine the volume fraction (V[s]) solids of the coating by calculation using the manufacturer's formulation.

### 4. Data Validation Procedure

4.1 Summary. The variety of coatings that may be subject to analysis makes it necessary to verify the ability of the analyst and the analytical procedures to obtain reproducible results for the coatings tested. This is done by

running duplicate analyses on each sample tested and comparing results with the within-laboratory precision statements for each parameter. Because of the inherent increased imprecision in the determination of the VOC content of waterborne coatings as the weight percent water increases, measured parameters for waterborne coatings are modified by the appropriate confidence limits based on between-laboratory precision statements.

4.2 Analytical Precision Statements. The within-laboratory and between-laboratory precision statements are given below:

	<b>Within- laboratory</b>	<b>Between- laboratory</b>
Volatile matter content, W[v]	1.5 pct W[v]	4.7 pct W[v]
Water content, W[w]	2.9 pct W[w]	7.5 pct W[w.]
Density, D[c]	0.001 kg/liter	0.002 kg/liter.

4.3 Sample Analysis Criteria. For W[v] and W[w], run duplicate analyses until the difference between the two values in a set is less than or equal to the within-laboratory precision statement for that parameter. For D[c] run duplicate analyses until each value in a set deviates from the mean of the set by no more than the within-laboratory precision statement. If after several attempts it is concluded that the ASTM procedures cannot be used for the specific coating with the established within-laboratory precision, the Administrator will assume responsibility for providing the necessary procedures for revising the method or precision statements upon written request to: Director, Emission Standards and Engineering Division, (MD-13) Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.

4.4 Confidence Limit Calculations for Waterborne Coatings. Based on the between-laboratory precision statements, calculate the confidence limits for waterborne coatings as follows:

To calculate the lower confidence limit, subtract the appropriate between-laboratory precision value from the measured mean value for that parameter. To calculate the upper confidence limit, add the appropriate between-laboratory precision value to the measured mean value for that parameter. For W[v] and D[c], use the lower confidence limits, and for W[w], use the upper confidence limit. Because V[s] is calculated, there is no adjustment for the parameter.

## 5. Calculations

### 5.1 Nonaqueous Volatile Matter.

#### 5.1.1 Solvent-borne Coatings.

$$W[o] = W[v]$$

Eq. 24-2

Where:

W[o] = Weight fraction nonaqueous volatile matter, g/g.

#### 5.1.2 Waterborne Coatings.

$$W[o] = W[v] - W[w]$$

Eq. 24-3

## 5.2 Weight Fraction Solids.

$$W[s] = 1 - W[v]$$

Eq. 24-4

Where:  $W[s]$  = Weight solids, g/g.

## METHOD 24A -- DETERMINATION OF VOLATILE MATTER CONTENT AND DENSITY OF PRINTING INKS AND RELATED COATINGS

### 1. *Applicability and Principle*

1.1 Applicability. This method applies to the determination of the volatile organic compound (VOC) content and density of solvent-borne (solvent reducible) printing inks or related coatings.

1.2 Principle. Separate procedures are used to determine the VOC weight fraction and density of the coating and the density of the solvent in the coating. The VOC weight fraction is determined by measuring the weight loss of a known sample quantity which has been heated for a specified length of time at a specified temperature. The density of both the coating and solvent are measured by a standard procedure. From this information, the VOC volume fraction is calculated.

### 2. *Procedure*

#### 2.1 Weight Fraction VOC.

##### 2.1.1 Apparatus.

2.1.1.1 Weighing Dishes. Aluminum foil, 58 mm in diameter by 18 mm high, with a flat bottom. There must be at least three weighing dishes per sample.

2.1.1.2 Disposable Syringe. 5 ml.

2.1.1.3 Analytical Balance. To measure to within 0.1 mg.

2.1.1.4 Oven. Vacuum oven capable of maintaining a temperature of 120 +/- 2 deg. C and an absolute pressure of 510 +/- 51 mm Hg for 4 hours. Alternatively, a forced draft oven capable of maintaining a temperature of 120 +/- 2 deg. C for 24 hours.

2.1.2 Analysis. Shake or mix the sample thoroughly to assure that all the solids are completely suspended. Label and weigh to the nearest 0.1 mg a weighing dish and record this weight ( $M[x1]$ ).

Using a 5-ml syringe without a needle remove a sample of the coating. Weigh the syringe and sample to the nearest 0.1 mg and record this weight ( $M[cY1]$ ). Transfer 1 to 3 g of the sample to the tared weighing dish. Reweigh the syringe and sample to the nearest 0.1 mg and record this weight ( $M[cY2]$ ). Heat the weighing dish and sample in a vacuum oven at an absolute pressure of 510 +/- 51 mm Hg and a temperature of 120 +/- 2 deg. C for 4 hours. Alternatively, heat the weighing dish and sample in a forced draft oven at a temperature of 120 +/- 2 deg. C for 24 hours. After the weighing dish has cooled, reweigh it to the nearest 0.1 mg and record the

weight (M[x2]). Repeat this procedure for a total of three determinations for each sample.

2.2 Coating Density. Determine the density of the ink or related coating according to the procedure outlined in ASTM D 1475-60 (Reapproved 1980), (incorporated by reference -- see § 60.17).

2.3 Solvent Density. Determine the density of the solvent according to the procedure outlined in ASTM D 1475-60 (reapproved 1980). Make a total of three determinations for each coating. Report the density D[o] as the arithmetic average of the three determinations.

### 3. Calculations

3.1 Weight Fraction VOC. Calculate the weight fraction volatile organic content W[o] using the following equation:

$$W[o] = \frac{M[x1] + M[cY1] - M[cY2] - M[x2]}{M[cY1] - M[cY2]}$$

Eq. 24A-1

Report the weight fraction VOC W[o] as the arithmetic average of the three determinations.

3.2 Volume Fraction VOC. Calculate the volume fraction volatile organic content V[o] using the following equation:

$$V[o] = \frac{W[o] D[c]}{D[o]}$$

Eq. 24A-2

### 4. Bibliography

1. Standard Test Method for Density of Paint, Varnish, Lacquer, and Related Products. ASTM Designation D 1475-60 (Reapproved 1980).
2. Teleconversation. Wright, Chuck, Inmont Corporation with Reich, R. A., Radian Corporation. September 25, 1979. Gravure Ink Analysis.
3. Teleconversation. Oppenheimer, Robert, Gravure Research Institute with Burt, Rick, Radian Corporation, November 5, 1979. Gravure Ink Analysis.

## METHOD 25 -- DETERMINATION OF TOTAL GASEOUS NONMETHANE ORGANIC EMISSIONS AS CARBON

### 1. Applicability and Principle

1.1 Applicability. This method applies to the measurement of volatile organic compounds (VOC) as total gaseous nonmethane organics (TGNMO) as carbon in source emissions. Organic particulate matter will interfere with the analysis and, therefore, a particulate filter is required. The minimum detectable for the method is 50 ppm as carbon.

When carbon dioxide (CO[2]) and water vapor are present together in the stack, they can produce a positive bias in the sample. The magnitude of the bias depends on the concentrations of CO[2] and water vapor. As a guideline, multiply the CO[2] concentration, expressed as volume percent, times the water vapor concentration. If this product does not exceed 100, the bias can be considered insignificant. For example, the bias is not

significant for a source having 10 percent CO<sub>2</sub> and 10 percent water vapor, but it would be significant for a source near the detection limit having 10 percent CO<sub>2</sub> and 20 percent water vapor.

This method is not the only method that applies to the measurement of TGNMO. Costs, logistics, and other practicalities of source testing may make other test methods more desirable for measuring VOC contents of certain effluent streams. Proper judgment is required in determining the most applicable VOC test method. For example, depending upon the molecular weight of the organics in the effluent stream, a totally automated semicontinuous nonmethane organics (NMO) analyzer interfaced directly to the source may yield accurate results. This approach has the advantage of providing emission data semicontinuously over an extended time period.

Direct measurement of an effluent with a flame ionization detector (FID) analyzer may be appropriate with prior characterization of the gas stream and knowledge that the detector responds predictably to the organic compounds in the stream. If present, methane (CH<sub>4</sub>) will, of course, also be measured. The FID can be applied to the determination of the mass concentration of the total molecular structure of the organic emissions under any of the following limited conditions: (1) Where only one compound is known to exist; (2) when the organic compounds consist of only hydrogen and carbon; (3) where the relative percentages of the compounds are known or can be determined, and the FID responses to the compounds are known; (4) where a consistent mixture of the compounds exists before and after emission control and *only* the relative concentrations are to be assessed; or (5) where the FID can be calibrated against mass standards of the compounds emitted (solvent emissions, for example).

Another example of the use of a direct FID is as a screening method. If there is enough information available to provide a rough estimate of the analyzer accuracy, the FID analyzer can be used to determine the VOC content of an uncharacterized gas stream. With a sufficient buffer to account for possible inaccuracies, the direct FID can be a useful tool to obtain the desired results without costly exact determination.

In situations where a qualitative/quantitative analysis of an effluent stream is desired or required, a gas chromatographic FID system may apply. However, for sources emitting numerous organics, the time and expense of this approach will be formidable.

1.2 Principle. An emission sample is withdrawn from the stack at a constant rate through a heated filter and a chilled condensate trap by means of an evacuated sample tank. After sampling is completed, the TGNMO are determined by independently analyzing the condensate trap and sample tank fractions and combining the analytical results. The organic content of the condensate trap fraction is determined by oxidizing the NMO to CO<sub>2</sub> and quantitatively collecting the effluent in an evacuated vessel; then a portion of the CO<sub>2</sub> is reduced to CH<sub>4</sub> and measured by an FID. The organic content of the sample tank fraction is measured by injecting a portion of the sample into a gas chromatographic column to separate the NMO from carbon monoxide (CO), CO<sub>2</sub> and CH<sub>4</sub>; the NMO are oxidized to CO<sub>2</sub>, reduced to CH<sub>4</sub>, and measured by an FID. In this manner, the variable response of the FID associated with different types of organics is eliminated.

## 2. Apparatus

2.1 Sampling. The sampling system consists of a heated probe, heated filter, condensate trap, flow control system, and sample tank (Figure 25-1). The TGNMO sampling equipment can be constructed from commercially available components and components fabricated in a machine shop. The following equipment is required:

2.1.1 Heated Probe. 6.4-mm (1/4-in.) OD stainless steel tubing with a heating system capable of maintaining a gas temperature at the exit end of at least 129 deg. C (265 deg. F). The probe shall be equipped with a thermocouple at the exit end to monitor the gas temperature.

A suitable probe is shown in Figure 25-1. The nozzle is an elbow fitting attached to the front end of the probe while the thermocouple is inserted in the side arm of a tee fitting attached to the rear of the probe. The probe is wrapped with a suitable length of high temperature heating tape, and then covered with two layers of glass cloth insulation and one layer of aluminum foil.

2.1.2 Filter Holder. 25-mm (15/16-in.) ID Gelman filter holder with stainless steel body and stainless steel support screen with the Viton O-ring replaced by a Teflon O-ring.

2.1.3 Filter Heating System. A metal box consisting of an inner and an outer shell separated by insulating material with a heating element in the inner shell capable of maintaining a gas temperature at the filter of 121 +/- 3 deg. C (250 +/- 5 deg. F).

A suitable heating box is shown in Figure 25-2. The outer shell is a metal box that measures 102 mm X 280 mm X 292 mm (4 in. X 11 in. X 11 1/2 in.), while the inner shell is a metal box measuring 76 mm X 229 mm X 241 mm (3 in. X 9 in. X 9 1/2 in.). The inner box is supported by 13-mm (1/2-in.) phenolic rods. The void space between the boxes is filled with fiberfrax insulation which is sealed in place by means of a silicon rubber bead around the upper sides of the box. A removable lid made in a similar manner, with a 25-mm (1-in.) gap between the parts, is used to cover the heating chamber.

The inner box is heated with a 250-watt cartridge heater, shielded by a stainless steel shroud. The heater is regulated by a thermostatic temperature controller which is set to maintain a temperature of 121 deg. C as measured by a thermocouple in the gas line just before the filter. An additional thermocouple is used to monitor the temperature of the gas behind the filter.

2.1.4 Condensate Trap. 9.5-mm (3/8-in.) OD 316 stainless steel tubing bent into a U-shape. Exact dimensions are shown in Figure 25-3. The tubing shall be packed with coarse quartz wool, to a density of approximately 0.11 g/cc before bending. While the condensate trap is packed with dry ice in the Dewar, an ice bridge may form between the arms of the condensate trap making it difficult to remove the condensate trap. This problem can be prevented by attaching a steel plate between the arms of the condensate trap in the same plane as the arms to completely fill the intervening space.

2.1.5 Valve. Stainless steel shut-off valve for starting and stopping sample flow.

2.1.6 Metering Valve. Stainless steel control valve for regulating the sample flow rate through the sample train.

2.1.7 Rotameter. Glass tube with stainless steel fittings, capable of measuring sample flow in the range of 60 to 100 cc/min.

2.1.8 Sample Tank. Stainless steel or aluminum tank with a minimum volume of 4 liters.

2.1.9 Mercury Manometer or Absolute Pressure Gauge. Capable of measuring pressure to within 1 mm Hg in the range of 0 to 900 mm.

2.1.10 Vacuum Pump. Capable of evacuating to an absolute pressure of 10 mm Hg.

2.2. Condensate Recovery Apparatus. The system for the recovery of the organics captured in the condensate trap consists of a heat source, oxidation catalyst, nondispersive infrared (NDIR) analyzer and an intermediate collection vessel (ICV). Figure 25-4 is a schematic of a typical system. The system shall be capable of proper oxidation and recovery, as specified in Section 5.1. The following major components are required:

2.2.1. Heat Source. Sufficient to heat the condensate trap (including connecting tubing) to a temperature of 200 deg. C. A system using both a heat gun and an electric tube furnace is recommended.

2.2.2. Heat Tape. Sufficient to heat the connecting tubing between the water trap and the oxidation catalyst to 100 deg. C.

2.2.3. Oxidation Catalyst. A suitable length of 9.5-mm (3/8-in.) OD Inconel 600 tubing packed with 15 cm (6 in.) of 3.2-mm (1/8-in.) diameter 19 percent chromia on alumina pellets. The catalyst material is packed in the center of the catalyst tube with quartz wool packed on either end to hold it in place. The catalyst tube shall be mounted vertically in a 650 deg. C tube furnace.

2.2.4 Water Trap. Leak proof, capable of removing moisture from the gas stream.

2.2.5 Syringe Port. A 6.4-mm (1/4-in.) OD stainless steel tee fitting with a rubber septum placed in the side arm.

2.2.6 NDIR Detector. Capable of indicating CO<sub>2</sub> concentration in the range of zero to 5 percent, to monitor the progress of combustion of the organic compounds from the condensate trap.

2.2.7 Flow-Control Valve. Stainless steel, to maintain the trap conditioning system near atmospheric pressure.

2.2.8 Intermediate Collection Vessel. Stainless steel or aluminum, equipped with a female quick connect. Tanks with nominal volumes of at least 6 liters are recommended.

2.2.9 Mercury Manometer or Absolute Pressure Gauge. Capable of measuring pressure to within 1 mm Hg in the range of 0 to 900 mm.

2.2.10 Syringe. 10-ml gas-tight, glass syringe equipped with an appropriate needle.

2.3 NMO Analyzer. The NMO analyzer is a gas chromatograph (GC) with backflush capability for NMO analysis and is equipped with an oxidation catalyst, reduction catalyst, and FID. Figures 25-5 and 25-6 are schematics of a typical NMO analyzer. This semicontinuous GC/FID analyzer shall be capable of: (1) Separating CO, CO<sub>2</sub>, and CH<sub>4</sub> from NMO, (2) reducing the CO<sub>2</sub> to CH<sub>4</sub> and quantifying as CH<sub>4</sub>, and (3) oxidizing the NMO to CO<sub>2</sub>, reducing the CO<sub>2</sub> to CH<sub>4</sub> and quantifying as CH<sub>4</sub>, according to Section 5.2. The analyzer consists of the following major components:

2.3.1 Oxidation Catalyst. A suitable length of 9.5-mm (3/8-in.) OD Inconel 600 tubing packed with 5.1 cm (2 in.) of 19 percent chromia on 3.2-mm (1/8-in.) alumina pellets. The catalyst material is packed in the center of the tube supported on either side by quartz wool. The catalyst tube must be mounted vertically in a 650 deg. C furnace.

2.3.2 Reduction Catalyst. A 7.6-cm (3-in.) length of 6.4-mm (1/4-in.) OD Inconel tubing fully packed with 100-mesh pure nickel powder. The catalyst tube must be mounted vertically in a 400 deg. C furnace.

2.3.3 Separation Column(s). A 30-cm (1-ft) length of 3.2-mm (1/8-in.) OD stainless steel tubing packed with 60/80 mesh Unibeads 1S followed by a 61-cm (2-ft) length of 3.2-mm (1/8-in.) OD stainless steel tubing packed with 60/80 mesh Carbosieve G. The Carbosieve and Unibeads columns must be baked separately at 200 deg. C with carrier gas flowing through them for 24 hours before initial use.

2.3.4 Sample Injection System. A 10-port GC sample injection valve fitted with a sample loop properly sized to interface with the NMO analyzer (1-cc loop recommended).

2.3.5 FID. An FID meeting the following specifications is required:

2.3.5.1 Linearity. A linear response (+/- 5 percent) over the operating range as demonstrated by the procedures

established in Section 5.2.3.

2.3.5.2 Range. A full scale range of 10 to 50,000 ppm CH<sub>4</sub>. Signal attenuators shall be available to produce a minimum signal response of 10 percent of full scale.

2.3.6 Data Recording System. Analog strip chart recorder or digital integration system compatible with the FID for permanently recording the analytical results.

2.4 Other Analysis Apparatus.

2.4.1 Barometer. Mercury, aneroid, or other barometer capable of measuring atmospheric pressure to within 1 mm Hg.

2.4.2 Thermometer. Capable of measuring the laboratory temperature to within 1 deg. C.

2.4.3 Vacuum Pump. Capable of evacuating to an absolute pressure of 10 mm Hg.

2.4.4 Syringes. 10-  $\mu$ l and 50-  $\mu$ l liquid injection syringes.

2.4.5 Liquid Sample Injection Unit. 316 SS U-tube fitted with an injection septum, see Figure 25-7.

### 3. Reagents

3.1 Sampling. The following are required for sampling:

3.1.1 Crushed Dry Ice.

3.1.2 Coarse Quartz Wool. 8 to 15  $\mu$ m.

3.1.3 Filters. Glass fiber filters, without organic binder.

3.2 NMO Analysis. The following gases are needed:

3.2.1 Carrier Gases. Zero grade helium (He) and oxygen (O<sub>2</sub>) containing less than 1 ppm CO<sub>2</sub> and less than 0.1 ppm C as hydrocarbon.

3.2.2 Fuel Gas. Zero grade hydrogen (H<sub>2</sub>), 99.999 percent pure.

3.2.3 Combustion Gas. Zero grade air or O<sub>2</sub> as required by the detector.

3.3 Condensate Analysis. The following gases are needed:

3.3.1 Carrier Gas. Zero grade air, containing less than 1 ppm C.

3.3.2 Auxiliary O<sub>2</sub>. Zero grade O<sub>2</sub>, containing less than 1 ppm C.

3.3.3 Hexane. ACS grade, for liquid injection.

3.3.4 Decane. ACS grade, for liquid injection.

3.4 Calibration. For all calibration gases, the manufacturer must recommend a maximum shelf life for each cylinder (i.e., the length of time the gas concentration is not expected to change more than +/- 5 percent from its

certified value). The date of gas cylinder preparation, certified organic concentration, and recommended maximum shelf life must be affixed to each cylinder before shipment from the gas manufacturer to the buyer. The following calibration gases are required:

3.4.1 Oxidation Catalyst Efficiency Check Calibration Gas. Gas mixture standard with nominal concentration of 1 percent methane in air.

3.4.2 FID Linearity and NMO Calibration Gases. Three gas mixture standards with nominal propane concentrations of 20 ppm, 200 ppm, and 3000 ppm, in air.

3.4.3 CO<sub>2</sub> Calibration Gases. Three gas mixture standards with nominal CO<sub>2</sub> concentrations of 50 ppm, 500 ppm, and 1 percent, in air.

3.4.4 NMO Analyzer System Check Calibration Gases. Four calibration gases are needed as follows:

3.4.4.1 Propane Mixture. Gas mixture standard containing (nominal) 50 ppm CO, 50 ppm CH<sub>4</sub>, 2 percent CO<sub>2</sub>, and 20 ppm C<sub>3</sub>H<sub>8</sub>, prepared in air.

3.4.4.2 Hexane. Gas mixture standard containing (nominal) 50 ppm hexane in air.

3.4.4.3 Toluene. Gas mixture standard containing (nominal) 20 ppm toluene in air.

3.4.4.4 Methanol. Gas mixture standard containing (nominal) 100 ppm methanol in air.

## 4. Procedure

### 4.1 Sampling.

4.1.1 Cleaning Sampling Equipment. Before its initial use and after each subsequent use, a condensate trap should be thoroughly cleaned and checked to ensure that it is not contaminated. Both cleaning and checking can be accomplished by installing the trap in the condensate recovery system and treating it as if it were a sample. The trap should be heated as described in the final paragraph of Section 4.3.3. A trap may be considered clean when the CO<sub>2</sub> concentration in its effluent gas drops below 10 ppm. This check is optional for traps that have been used to collect samples which were then recovered according to the procedure in Section 4.3.3.

4.1.2 Sample Tank Evacuation and Leak Check. Evacuate the sample tank to 10 mm Hg absolute pressure or less. Then close the sample tank valve, and allow the tank to sit for 60 minutes. The tank is acceptable if no change in tank vacuum is noted. The evacuation and leak check may be conducted either in the laboratory or the field. The results of the leak check should be included in the test report.

4.1.3 Sample Train Assembly. Just before assembly, measure the tank vacuum using a mercury U-tube manometer or absolute pressure gauge. Record this vacuum, the ambient temperature, and the barometric pressure at this time. Close the sample tank valve and assemble the sampling system as shown in Figure 25-1. Immerse the condensate trap body in dry ice. The point where the inlet tube joins the trap body should be 2.5 to 5 cm above the top of the dry ice.

4.1.4 Pretest Leak Check. A pretest leak check is required. Calculate or measure the approximate volume of the sampling train from the probe tip to the sample tank valve. After assembling the sampling train, plug the probe tip, and make certain that the sample tank valve is closed. Turn on the vacuum pump, and evacuate the sampling system from the probe tip to the sample tank valve to an absolute pressure of 10 mm Hg or less. Close the purge valve, turn off the pump, wait a minimum period of 5 minutes, and recheck the indicated vacuum. Calculate the maximum allowable pressure change based on a leak rate of 1 percent of the sampling rate using Equation 25-1, Section 6.2. If the measured pressure change exceeds the calculated limit, correct the problem before beginning sampling. The results of the leak check should be included in the test report.

4.1.5 Sample Train Operation. Unplug the probe tip, and place the probe into the stack such that the probe is perpendicular to the duct or stack axis; locate the probe tip at a single preselected point of average velocity facing away from the direction of gas flow. For stacks having a negative static pressure, seal the sample port sufficiently to prevent air in-leakage around the probe. Set the probe temperature controller to 129 deg. C (265 deg. F) and the filter temperature controller to 121 deg. C (250 deg. F). Allow the probe and filter to heat for about 30 minutes before purging the sample train.

Close the sample valve, open the purge valve, and start the vacuum pump. Set the flow rate between 60 and 100 cc/min, and purge the train with stack gas for at least 10 minutes. When the temperatures at the exit ends of the probe and filter are within their specified range, sampling may begin.

Check the dry ice level around the condensate trap, and add dry ice if necessary. Record the clock time. To begin sampling, close the purge valve and stop the pump. Open the sample valve and the sample tank valve. Using the flow control valve, set the flow through the sample train to the proper rate. Adjust the flow rate as necessary to maintain a constant rate (+/- 10 percent) throughout the duration of the sampling period. Record the sample tank vacuum and flowmeter setting at 5-minute intervals. (See Figure 25-8.) Select a total sample time greater than or equal to the minimum sampling time specified in the applicable subpart of the regulation; end the sampling when this time period is reached or when a constant flow rate can no longer be maintained because of reduced sample tank vacuum.

4.2 Sample Recovery. After sampling is completed, close the flow control valve, and record the final tank

vacuum; then record the tank temperature and barometric pressure. Close the sample tank valve, and disconnect the sample tank from the sample system. Disconnect the condensate trap at the flowmetering system, and tightly seal both ends of the condensate trap. Do not include the probe from the stack to the filter as part of the condensate sample. Keep the trap packed in dry ice until the samples are returned to the laboratory for analysis. Ensure that the test run number is properly identified on the condensate trap and the sample tank(s).

4.3 Condensate Recovery. See Figure 25-9. Set the carrier gas flow rate, and heat the catalyst to its operating temperature to condition the apparatus.

4.3.1 Daily Performance Checks. Each day before analyzing any samples, perform the following tests:

4.3.1.1 Leak Check. With the carrier gas inlets and the flow control valve closed, install a clean condensate trap in the system, and evacuate the system to 10 mm Hg absolute pressure or less. Close the vacuum pump valve and turn off the vacuum pump. Monitor the system pressure for 10 minutes. The system is acceptable if the pressure change is less than 2 mm Hg.

4.3.1.2 System Background Test. Adjust the carrier gas and auxiliary oxygen flow rate to their normal values of 100 cc/min and 150 cc/min, respectively, with the sample recovery valve in vent position. Using a 10-ml syringe withdraw a sample from the system effluent through the syringe port. Inject this sample into the NMO analyzer, and measure the CO<sub>2</sub> content. The system background is acceptable if the CO<sub>2</sub> concentration is less than 10 ppm.

4.3.1.3 Oxidation Catalyst Efficiency Check. Conduct a catalyst efficiency test as specified in Section 5.1.2 of this method. If the criterion of this test cannot be met, make the necessary repairs to the system before proceeding.

4.3.2 Condensate Trap CO<sub>2</sub> Purge and Sample Tank Pressurization. After sampling is completed, the condensate trap will contain condensed water and organics and a small volume of sampled gas. This gas from the stack may contain a significant amount of CO<sub>2</sub> which must be removed from the condensate trap before the sample is recovered. This is accomplished by purging the condensate trap with zero air and collecting the purged gas in the original sample tank.

Begin with the sample tank and condensate trap from the test run to be analyzed. Set the four-port valve of the condensate recovery system in the CO<sub>2</sub> purge position as shown in Figure 25-9. With the sample tank valve closed, attach the sample tank to the sample recovery system. With the sample recovery valve in the vent position and the flow control valve fully open, evacuate the manometer or pressure gauge to the vacuum of the sample tank. Next, close the vacuum pump valve, open the sample tank valve, and record the tank pressure.

Attach the dry-ice-cooled condensate trap to the recovery system, and initiate the purge by switching the sample recovery valve from vent to collect position. Adjust the flow control valve to maintain atmospheric pressure in the recovery system. Continue the purge until the CO<sub>2</sub> concentration of the trap effluent is less than 5 ppm. CO<sub>2</sub> concentration in the trap effluent should be measured by extracting syringe samples from the recovery system and analyzing the samples with the NMO analyzer. This procedure should be used only after the NDIR response has reached a minimum level. Using a 10-ml syringe, extract a sample from the syringe port prior to the NDIR, and inject this sample into the NMO analyzer.

After the completion of the CO<sub>2</sub> purge, use the carrier gas bypass valve to pressurize the sample tank to approximately 1060 mm Hg absolute pressure with zero air.

4.3.3 Recovery of the Condensate Trap Sample. See Figure 25-10. Attach the ICV to the sample recovery system. With the sample recovery valve in a closed position, between vent and collect, and the flow control and ICV valves fully open, evacuate the manometer or gauge, the connecting tubing, and the ICV to 10 mm Hg

absolute pressure. Close the flow-control and vacuum pump valves.

Begin auxiliary oxygen flow to the oxidation catalyst at a rate of 150 cc/min, then switch the four-way valve to the trap recovery position and the sample recovery valve to collect position. The system should now be set up to operate as indicated in Figure 25-10. After the manometer or pressure gauge begins to register a slight positive pressure, open the flow control valve. Adjust the flow-control valve to maintain atmospheric pressure in the system within 10 percent.

Now, remove the condensate trap from the dry ice, and allow it to warm to ambient temperature while monitoring the NDIR response. If after 5 minutes, the CO<sub>2</sub> concentration of the catalyst effluent is below 10,000 ppm, discontinue the auxiliary oxygen flow to the oxidation catalyst. Begin heating the trap by placing it in a furnace preheated to 200 deg. C. Once heating has begun, carefully monitor the NDIR response to ensure that the catalyst effluent concentration does not exceed 50,000 ppm. Whenever the CO<sub>2</sub> concentration exceeds 50,000 ppm, supply auxiliary oxygen to the catalyst at the rate of 150 cc/min. Begin heating the tubing that connected the heated sample box to the condensate trap only after the CO<sub>2</sub> concentration falls below 10,000 ppm. This tubing may be heated in the same oven as the condensate trap or with an auxiliary heat source such as a heat gun. Heating temperature must not exceed 200 deg. C. If a heat gun is used, heat the tubing slowly along its entire length from the upstream end to the downstream end, and repeat the pattern for a total of three times. Continue the recovery until the CO<sub>2</sub> concentration drops to less than 10 ppm as determined by syringe injection as described under the condensate trap CO<sub>2</sub> purge Procedure, Section 4.3.2.

After the sample recovery is completed, use the carrier gas bypass valve to pressurize the ICV to approximately 1060 mm Hg absolute pressure with zero air.

**4.4 Analysis.** Before putting the NMO analyzer into routine operation, conduct an initial performance test. Start the analyzer, and perform all the necessary functions in order to put the analyzer into proper working order; then conduct the performance test according to the procedures established in Section 5.2. Once the performance test has been successfully completed and the CO<sub>2</sub> and NMO calibration response factors have been determined, proceed with sample analysis as follows:

**4.4.1 Daily Operations and Calibration Checks.** Before and immediately after the analysis of each set of samples or on a daily basis (whichever occurs first), conduct a calibration test according to the procedures established in Section 5.3. If the criteria of the daily calibration test cannot be met, repeat the NMO analyzer performance test (Section 5.2) before proceeding.

**4.4.2 Operating Conditions.** The carrier gas flow rate is 29.5 cc/min He and 2.2 cc/min O<sub>2</sub>. The column oven is heated to 85 deg. C. The order of elution for the sample from the column is CO, CH<sub>4</sub>, CO<sub>2</sub>, and NMO.

**4.4.3 Analysis of Recovered Condensate Sample.** Purge the sample loop with sample, and then inject the sample. Under the specified operating conditions, the CO<sub>2</sub> in the sample will elute in approximately 100 seconds. As soon as the detector response returns to baseline following the CO<sub>2</sub> peak, switch the carrier gas flow to backflush, and raise the column oven temperature to 195 deg. C as rapidly as possible. A rate of 30 deg. C/min has been shown to be adequate. Record the value obtained for the condensible organic material (C<sub>cm</sub>) measured as CO<sub>2</sub> and any measured NMO. Return the column oven temperature to 85 deg. C in preparation for the next analysis. Analyze each sample in triplicate, and report the average C<sub>cm</sub>.

**4.4.4 Analysis of Sample Tank.** Perform the analysis as described in Section 4.4.3, but record only the value measured for NMO (C<sub>tm</sub>).

**4.5 Audit Samples.** Analyze a set of two audit samples concurrently with any compliance samples and in exactly the same manner to evaluate the analyst's technique and the instrument calibration. The same analysts, analytical reagents, and analytical system shall be used for the compliance samples and the EPA audit samples;

if this condition is met, auditing of subsequent compliance analyses for the same enforcement agency within 30 days is not required. An audit sample set may not be used to validate different sets of compliance samples under the jurisdiction of different enforcement agencies, unless prior arrangements are made with both enforcement agencies.

Calculate the concentrations of the audit samples in ppm using the specified sample volume in the audit instructions. (NOTE. -- Indication of acceptable results may be obtained immediately by reporting the audit results in ppm and compliance results in ppm by telephone to the responsible enforcement agency.) Include the results of both audit samples, their identification numbers, and the analyst's name with the results of the compliance determination samples in appropriate reports to the EPA regional office or the appropriate enforcement agency during the 30-day period.

The concentration of the audit samples obtained by the analyst shall agree within 20 percent of the actual concentrations. Failure to meet the 20-percent specification may require retests until the audit problems are resolved. However, if the audit results do not affect the compliance or noncompliance status of the affected facility, the Administrator may waive the reanalysis requirement, further audits, or retests and accept the results of the compliance test. While steps are being taken to resolve audit analysis problems, the Administrator may also choose to use the data to determine the compliance or noncompliance of the affected facility.

### *5. Calibration and Operational Checks*

Maintain a record of performance of each item.

5.1 Initial Performance Check of Condensate Recovery Apparatus. Perform these tests before the system is first placed in operation, after any shutdown of 6 months or more, and after any major modification of the system, or at the specified frequency.

5.1.1 Carrier Gas and Auxiliary O<sub>2</sub> Blank Check. Analyze each new tank of carrier gas or auxiliary O<sub>2</sub> with the NMO analyzer to check for contamination. Treat the gas cylinders as noncondensable gas samples, and analyze according to the procedure in Section 4.4.3. Add together any measured CH<sub>4</sub>, CO, CO<sub>2</sub>, or NMO. The total concentration must be less than 5 ppm.

5.1.2 Catalyst Efficiency Check. With a clean condensate trap installed in the recovery system, replace the carrier gas cylinder with the high level methane standard gas cylinder (Section 3.4.1). Set the four-port valve to the recovery position, and attach an ICV to the recovery system. With the sample recovery valve in vent position and the flow-control and ICV valves fully open, evacuate the manometer or gauge, the connecting tubing, and the ICV to 10 mm Hg absolute pressure. Close the flow-control and vacuum pump valves.

After the NDIR response has stabilized switch the sample recovery valve from vent to collect. When the manometer or pressure gauge begins to register a slight positive pressure, open the flow-control valve. Keep the flow adjusted so that atmospheric pressure is maintained in the system within 10 percent. Continue collecting the sample in a normal manner until the ICV is filled to a nominal gauge pressure of 300 mm Hg. Close the ICV valve, and remove the ICV from the system. Place the sample recovery valve in the vent position, and return the recovery system to its normal carrier gas and normal operating conditions. Analyze the ICV for CO<sub>2</sub> using the NMO analyzer; the catalyst efficiency is acceptable if the CO<sub>2</sub> concentration is within 2 percent of the methane standard concentration.

5.1.3 System Performance Check. Construct a liquid sample injection unit similar in design to the unit shown in Figure 25-7. Insert this unit into the condensate recovery and conditioning system in place of a condensate trap, and set the carrier gas and auxiliary O<sub>2</sub> flow rates to normal operating levels. Attach an evacuated ICV to the system, and switch from system vent to collect. With the carrier gas routed through the injection unit and the oxidation catalyst, inject a liquid sample (See Sections 5.1.3.1 to 5.1.3.4) into the injection port. Operate the

trap recovery system as described in Section 4.3.3. Measure the final ICV pressure, and then analyze the vessel to determine the CO<sub>2</sub> concentration. For each injection, calculate the percent recovery using the equation in Section 6.6.

The performance test is acceptable if the average percent recovery is 100 +/- 10 percent with a relative standard deviation (Section 6.9) of less than 5 percent for each set of triplicate injections as follows:

5.1.3.1 50 µl Hexane.

5.1.3.2 10 µl Hexane.

5.1.3.3 50 µl Decane.

5.1.3.4 10 µl Decane.

5.2 Initial NMO Analyzer Performance Test. Perform these tests before the system is first placed in operation, after any shutdown longer than 6 months, and after any major modification of the system.

5.2.1 Oxidation Catalyst Efficiency Check. Turn off or bypass the NMO analyzer reduction catalyst. Make triplicate injections of the high level methane standard (Section 3.4.1). The oxidation catalyst operation is acceptable if the FID response is less than 1 percent of the injected methane concentration.

5.2.2 Reduction Catalyst Efficiency Check. With the oxidation catalyst unheated or bypassed and the heated reduction catalyst bypassed, make triplicate injections of the high level methane standard (Section 3.4.1). Repeat this procedure with both catalysts operative. The reduction catalyst operation is acceptable if the response under both conditions agree within 5 percent.

5.2.3 Analyzer Linearity Check and NMO Calibration. While operating both the oxidation and reduction catalysts, conduct a linearity check of the analyzer using the propane standards specified in Section 3.4.2. Make triplicate injections of each calibration gas, and then calculate the average response factor (area/ppm C) for each gas, as well as the overall mean of the response factor values. The instrument linearity is acceptable if the average response factor of each calibration gas is within 2.5 percent of the overall mean value and if the relative standard deviation (Section 6.9) for each set of triplicate injections is less than 2 percent. Record the overall mean of the propane response factor values as the NMO calibration response factor (RF[NMO]).

Repeat the linearity check using the CO<sub>2</sub> standards specified in Section 3.4.3. Make triplicate injections of each gas, and then calculate the average response factor (area/ppm C) for each gas, as well as the overall mean of the response factor values. Record the overall mean of the response factor values as the CO<sub>2</sub> calibration response factor (RF[CO<sub>2</sub>]). Linearity is acceptable if the average response factor of each calibration gas is within 2.5 percent of the overall mean value and if the relative standard deviation for each set of triplicate injections is less than 2 percent. The RF[CO<sub>2</sub>] must be within 10 percent of the RF[NMO].

5.2.4 System Performance Check. Check the column separation and overall performance of the analyzer by making triplicate injections of the calibration gases listed in Section 3.4.4. The analyzer performance is acceptable if the measured NMO value for each gas (average of triplicate injections) is within 5 percent of the expected value.

5.3 NMO Analyzer Daily Calibration.

5.3.1 CO<sub>2</sub> Response Factor. Inject triplicate samples of the high level CO<sub>2</sub> calibration gas (Section 3.4.3), and calculate the average response factor. The system operation is adequate if the calculated response factor is within 5 percent of the RF[CO<sub>2</sub>] calculated during the initial performance test (Section 5.2.3). Use the daily

response factor (DRF[CO<sub>2</sub>]) for analyzer calibration and the calculation of measured CO<sub>2</sub> concentrations in the ICV samples.

5.3.2 NMO Response Factors. Inject triplicate samples of the mixed propane calibration cylinder (Section 3.4.4.1), and calculate the average NMO response factor. The system operation is adequate if the calculated response factor is within 5 percent of the RF[NMO] calculated during the initial performance test (Section 5.2.4). Use the daily response factor (DRF[NMO]) for analyzer calibration and calculation of NMO concentrations in the sample tanks.

5.4 Sample Tank and ICV Volume. The volume of the gas sampling tanks used must be determined. Determine the tank and ICV volumes by weighing them empty and then filled with deionized distilled water; weigh to the nearest 5 g, and record the results. Alternatively, measure the volume of water used to fill them to the nearest 5 ml.

## 6. Calculations

All equations are written using absolute pressure; absolute pressures are determined by adding the measured barometric pressure to the measured gauge or manometer pressure.

### 6.1 Nomenclature.

C = TGNMO concentration of the effluent, ppm C equivalent.

C[c] = Calculated condensable organic (condensate trap) concentration of the effluent, ppm C equivalent.

C[cm] = Measured concentration (NMO analyzer) for the condensate trap ICV, ppm CO<sub>2</sub>.

C[t] = Calculated noncondensable organic concentration (sample tank) of the effluent, ppm C equivalent.

C[tm] = Measured concentration (NMO analyzer) for the sample tank, ppm NMO.

F = Sampling flow rate, cc/min.

L = Volume of liquid injected, ml.

M = Molecular weight of the liquid injected, g/g-mole.

m[c] = TGNMO mass concentration of the effluent, mg C/dsm<sup>3</sup>.

N = Carbon number of the liquid compound injected (N = 12 for decane, N = 6 for hexane).

P[f] = Final pressure of the intermediate collection vessel, mm Hg absolute.

P[b] = Barometric pressure, cm Hg.

P[ti] = Gas sample tank pressure before sampling, mm Hg absolute.

P[t] = Gas sample tank pressure after sampling, but before pressurizing, mm Hg absolute.

P[tf] = Final gas sample tank pressure after pressurizing, mm Hg absolute.

T[f] = Final temperature of intermediate collection vessel, deg. K.

$T[ti]$  = Sample tank temperature before sampling, deg. K.

$T[t]$  = Sample tank temperature at completion of sampling, deg. K.

$T[tf]$  = Sample tank temperature after pressurizing, deg. K.

$V$  = Sample tank volume, m<sup>3</sup>.

$V[t]$  = Sample train volume, cc.

$V[v]$  = Intermediate collection vessel volume, m<sup>3</sup>.

$V[s]$  = Gas volume sampled, dsm<sup>3</sup>.

$n$  = Number of data points.

$q$  = Total number of analyzer injections of intermediate collection vessel during analysis (where  $k$  = injection number, 1 . . .  $q$ ).

$r$  = Total number of analyzer injections of sample tank during analysis (where  $j$  = injection number, 1 . . .  $r$ ).

$x[i]$  = Individual measurements.

$\bar{x}$  = Mean value.

$\rho$  = Density of liquid injected, g/cc.

THETA = Leak check period, min.

DELTA P = Allowable pressure change, cm Hg.

6.2 Allowable Pressure Change. For the pretest leak check, calculate the allowable pressure change:

$$\text{DELTA P} = 0.01 \text{ FP}[b] \text{ THETA} / V[t]$$

Eq. 25-1

6.3 Sample Volume. For each test run, calculate the gas volume sampled:

$$V[S] = 0.3857 V [P[t] / T[t] - P[ti] / T[ti]]$$

Eq. 25-2

6.4 Noncondensable Organics. For each sample tank, determine the concentration of nonmethane organics (ppm C):

$$C[t] = [P[tf] / T[tf] / P[t] / T[ti] - / T[t] T[ti] X 1/r \langle r \rangle \text{SIGMA } [j = 1] C[tm][j]$$

Eq. 25-3

6.5 Condensable Organics. For each condensate trap determine the concentration of organics (ppm C):

$$C[c] = 0.3857 V[v] P[f] / V[s] T[f] X [1 / q <q> SIGMA [k = 1] C[cm][k]$$

Eq. 25-4

6.6 TGNMO. To determine the TGNMO concentration for each test run, use the following equation:

$$C = C[t] + C[c]$$

Eq. 25-5

6.7 TGNMO Mass Concentration. To determine the TGNMO mass concentration as carbon for each test run, use the following equation:

$$m[c] = 0.4993 C$$

Eq. 25-6

6.8 Percent Recovery. To calculate the percent recovery for the liquid injections to the condensate recovery and conditioning system use the following equation.

$$\text{Percent recovery} = 1.604 M / L X V[v] / P X P[t] / T[f] X C[cm] / N$$

Eq. 25-7

6.9 Relative Standard Deviation.

$$RSD = 100 / - x \text{ root} / SIGMA (x[1] - x) <2> / n - 1$$

Eq. 25-8

## 7. Bibliography

1. Salo, Albert E., Samuel Witz, and Robert D. MacPhee. Determination of Solvent Vapor Concentrations by Total Combustion Analysis: A Comparison of Infrared with Flame Ionization Detectors. Paper No. 75-33.2. (Presented at the 68th Annual Meeting of the Air Pollution Control Association. Boston, Massachusetts. June 15-20, 1975.) 14 p.

2. Salo, Albert E., William L. Oaks, and Robert D. MacPhee. Measuring the Organic Carbon Content of Source Emissions for Air Pollution Control. Paper No. 74-190. (Presented at the 67th Annual Meeting of the Air Pollution Control Association. Denver, Colorado. June 9-13, 1974.) 25 p.

Figure 25-1. Sampling train.

[SEE FIGURE IN ORIGINAL]

Figure 25-2. Out-of-stack filter box.

[SEE FIGURE IN ORIGINAL]

Figure 25-3. Condensate trap.

[SEE FIGURE IN ORIGINAL]

Figure 25-4. Condensate recovery system.

[SEE FIGURE IN ORIGINAL]

Figure 25-5. Simplified schematic of nonmethane organic (NMO) analyzer.

[SEE FIGURE IN ORIGINAL]

Figure 25-6. Nonmethane organic analyzer (NMO).

[SEE FIGURE IN ORIGINAL]

Figure 25-7. Liquid sample injection unit.

[SEE FIGURE IN ORIGINAL]

Figure 25-8. Example field data form.

[SEE FIGURE IN ORIGINAL]

Figure 25-9. Condensate recovery system, CO<sub>2</sub> purge.

[SEE FIGURE IN ORIGINAL]

Figure 25-10. Condensate recovery system, collection of trap organics.

[SEE FIGURE IN ORIGINAL]

## METHOD 25A -- DETERMINATION OF TOTAL GASEOUS ORGANIC CONCENTRATION USING A FLAME IONIZATION ANALYZER

### *1. Applicability and Principle*

1.1 Applicability. This method applies to the measurement of total gaseous organic concentration of vapors consisting primarily of alkanes, alkenes, and/or arenes (aromatic hydrocarbons). The concentration is expressed in terms of propane (or other appropriate organic calibration gas) or in terms of carbon.

1.2 Principle. A gas sample is extracted from the source through a heated sample line, if necessary, and glass fiber filter to a flame ionization analyzer (FIA). Results are reported as volume concentration equivalents of the calibration gas or as carbon equivalents.

### *2. Definitions*

2.1 Measurement System. The total equipment required for the determination of the gas concentration. The system consists of the following major subsystems:

2.1.1 Sample Interface. That portion of the system that is used for one or more of the following: sample acquisition, sample transportation, sample conditioning, or protection of the analyzer from the effects of the stack effluent.

2.1.2 Organic Analyzer. That portion of the system that senses organic concentration and generates an output proportional to the gas concentration.

2.2 Span Value. The upper limit of a gas concentration measurement range that is specified for affected source categories in the applicable part of the regulations. The span value is established in the applicable regulation and is usually 1.5 to 2.5 times the applicable emission limit. If no span value is provided, use a span value equivalent to 1.5 to 2.5 times the expected concentration. For convenience, the span value should correspond to 100 percent of the recorder scale.

2.3 Calibration Gas. A known concentration of a gas in an appropriate diluent gas.

2.4 Zero Drift. The difference in the measurement system response to a zero level calibration gas before and after a stated period of operation during which no unscheduled maintenance, repair, or adjustment took place.

2.5 Calibration Drift. The difference in the measurement system response to a mid-level calibration gas before and after a stated period of operation during which no unscheduled maintenance, repair or adjustment took place.

2.6 Response Time. The time interval from a step change in pollutant concentration at the inlet to the emission measurement system to the time at which 95 percent of the corresponding final value is reached as displayed on the recorder.

2.7 Calibration Error. The difference between the gas concentration indicated by the measurement system and the known concentration of the calibration gas.

### 3. Apparatus

A schematic of an acceptable measurement system is shown in Figure 25A-1. The essential components of the measurement system are described below:

Figure 26A 1. Organic Concentration Measurement System.

[SEE FIGURE IN ORIGINAL]

3.1 Organic Concentration Analyzer. A flame ionization analyzer (FIA) capable of meeting or exceeding the specifications in this method.

3.2 Sample Probe. Stainless steel, or equivalent, three-hole rake type. Sample holes shall be 4 mm in diameter or smaller and located at 16.7, 50, and 83.3 percent of the equivalent stack diameter. Alternatively, a single opening probe may be used so that a gas sample is collected from the centrally located 10 percent area of the stack cross-section.

3.3 Sample Line. Stainless steel or Teflon n\* tubing to transport the sample gas to the analyzer. The sample line should be heated, if necessary, to prevent condensation in the line.

\* Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency.

3.4 Calibration Valve Assembly. A three-way valve assembly to direct the zero and calibration gases to the analyzers is recommended. Other methods, such as quick-connect lines, to route calibration gas to the analyzers are applicable.

3.5 Particulate Filter. An in-stack or an out-of-stack glass fiber filter is recommended if exhaust gas particulate loading is significant. An out-of-stack filter should be heated to prevent any condensation.

3.6 Recorder. A strip-chart recorder, analog computer, or digital recorder for recording measurement data. The minimum data recording requirement is one measurement value per minute. Note: This method is often applied in highly explosive areas. Caution and care should be exercised in choice of equipment and installation.

#### 4. *Calibration and Other Gases*

Gases used for calibrations, fuel, and combustion air (if required) are contained in compressed gas cylinders. Preparation of calibration gases shall be done according to the procedure in Protocol No. 1, listed in Citation 2 of Bibliography. Additionally, the manufacturer of the cylinder should provide a recommended shelf life for each calibration gas cylinder over which the concentration does not change more than  $\pm 2$  percent from the certified value. For calibration gas values not generally available (i.e., organics between 1 and 10 percent by volume), alternative methods for preparing calibration gas mixtures, such as dilution systems, may be used with prior approval of the Administrator.

Calibration gases usually consist of propane in air or nitrogen and are determined in terms of the span value. Organic compounds other than propane can be used following the above guidelines and making the appropriate corrections for response factor.

4.1 Fuel. A 40 percent H<sub>2</sub>/60 percent He or 40 percent H<sub>2</sub>/60 percent N<sub>2</sub> gas mixture is recommended to avoid an oxygen synergism effect that reportedly occurs when oxygen concentration varies significantly from a mean value.

4.2 Zero Gas. High purity air with less than 0.1 parts per million by volume (ppmv) of organic material (propane or carbon equivalent) or less than 0.1 percent of the span value, whichever is greater.

4.3 Low-level Calibration Gas. An organic calibration gas with a concentration equivalent to 25 to 35 percent of the applicable span value.

4.4 Mid-level Calibration Gas. An organic calibration gas with a concentration equivalent to 45 to 55 percent of the applicable span value.

4.5 High-level Calibration Gas. An organic calibration gas with a concentration equivalent to 80 to 90 percent of the applicable span value.

#### 5. *Measurement System Performance Specifications*

5.1 Zero Drift. Less than  $\pm 3$  percent of the span value.

5.2 Calibration Drift. Less than  $\pm 3$  percent of span value.

5.3 Calibration Error. Less than  $\pm 5$  percent of the calibration gas value.

#### 6. *Pretest Preparations*

6.1 Selection of Sampling Site. The location of the sampling site is generally specified by the applicable regulation or purpose of the test; i.e., exhaust stack, inlet line, etc. The sample port shall be located at least 1.5 meters or 2 equivalent diameters upstream of the gas discharge to the atmosphere.

6.2 Location of Sample Probe. Install the sample probe so that the probe is centrally located in the stack, pipe,

or duct and is sealed tightly at the stack port connection.

6.3 Measurement System Preparation. Prior to the emission test, assemble the measurement system following the manufacturer's written instructions in preparing the sample interface and the organic analyzer. Make the system operable.

FIA equipment can be calibrated for almost any range of total organics concentrations. For high concentrations of organics (> 1.0 percent by volume as propane) modifications to most commonly available analyzers are necessary. One accepted method of equipment modification is to decrease the size of the sample to the analyzer through the use of a smaller diameter sample capillary. Direct and continuous measurement of organic concentration is a necessary consideration when determining any modification design.

6.4 Calibration Error Test. Immediately prior to the test series, (within 2 hours of the start of the test) introduce zero gas and high-level calibration gas at the calibration valve assembly. Adjust the analyzer output to the appropriate levels, if necessary. Calculate the predicted response for the low-level and mid-level gases based on a linear response line between the zero and high-level responses. Then introduce low-level and mid-level calibration gases successively to the measurement system. Record the analyzer responses for low-level and mid-level calibration gases and determine the differences between the measurement system responses and the predicted responses. These differences must be less than 5 percent of the respective calibration gas value. If not, the measurement system is not acceptable and must be replaced or repaired prior to testing. No adjustments to the measurement system shall be conducted after the calibration and before the drift check (Section 7.3). If adjustments are necessary before the completion of the test series, perform the drift checks prior to the required adjustments and repeat the calibration following the adjustments. If multiple electronic ranges are to be used, each additional range must be checked with a mid-level calibration gas to verify the multiplication factor.

6.5 Response Time Test. Introduce zero gas into the measurement system at the calibration valve assembly. When the system output has stabilized, switch quickly to the high-level calibration gas. Record the time from the concentration change to the measurement system response equivalent to 95 percent of the step change. Repeat the test three times and average the results.

## 7. Emission Measurement Test Procedure

7.1 Organic Measurement. Begin sampling at the start of the test period, recording time and any required process information as appropriate. In particular, note on the recording chart periods of process interruption or cyclic operation.

7.2 Drift Determination. Immediately following the completion of the test period and hourly during the test period, reintroduce the zero and mid-level calibration gases, one at a time, to the measurement system at the calibration valve assembly. (Make no adjustments to the measurement system until after both the zero and calibration drift checks are made.) Record the analyzer response. If the drift values exceed the specified limits, invalidate the test results preceding the check and repeat the test following corrections to the measurement system. Alternatively, recalibrate the test measurement system as in Section 6.4 and report the results using both sets of calibration data (i.e., data determined prior to the test period and data determined following the test period).

## 8. Organic Concentration Calculations

Determine the average organic concentration in terms of ppmv as propane or other calibration gas. The average shall be determined by the integration of the output recording over the period specified in the applicable regulation.

If results are required in terms of ppmv as carbon, adjust measured concentrations using Equation 25A-1.

$$C[c] = K C[\text{meas}]$$

Eq. 25A-1

Where:

C[c] = Organic concentration as carbon, ppmv.

C[meas] = Organic concentration as measured, ppmv.

K = Carbon equivalent correction factor,

K = 2 for ethane.

K = 3 for propane.

K = 4 for butane.

K = Appropriate response factor for other organic calibration gases.

## 9. *Bibliography*

1. Measurement of Volatile Organic Compounds -- Guideline Series. U.S. Environmental Protection Agency. Research Triangle Park, NC. Publication No. EPA-450/2-78-041. June 1978. p. 46-54.
2. Traceability Protocol for Establishing True Concentrations of Gases Used for Calibration and Audits of Continuous Source Emission Monitors (Protocol No. 1). U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory. Research Triangle Park, NC. June 1978.
3. Gasoline Vapor Emission Laboratory Evaluation -- Part 2. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, NC. EMB Report No. 75-GAS-6. August 1975.

## METHOD 25B -- DETERMINATION OF TOTAL GASEOUS ORGANIC CONCENTRATION USING A NONDISPERSIVE INFRARED ANALYZER

### 1. *Applicability and Principle*

1.1 Applicability. This method applies to the measurement of total gaseous organic concentration of vapors consisting primarily of alkanes. (Other organic materials may be measured using the general procedure in this method, the appropriate calibration gas, and an analyzer set to the appropriate absorption band.) The concentration is expressed in terms of propane (or other appropriate organic calibration gas) or in terms of carbon.

1.2 Principle. A gas sample is extracted from the source through a heated sample line, if necessary, and glass fiber filter to a nondispersive infrared analyzer (NDIR). Results are reported as volume concentration equivalents of the calibration gas or as carbon equivalents.

### 2. *Definitions*

The terms and definitions are the same as for Method 25A.

### 3. *Apparatus*

The apparatus is the same as for Method 25A with the exception of the following:

3.1 Organic Concentration Analyzer. A nondispersive infrared analyzer designed to measure alkane organics and capable of meeting or exceeding the specifications in this method.

### 4. *Calibration Gases*

The calibration gases are the same as required for Method 25A, Section 4. No fuel gas is required for an NDIR.

### 5. *Measurement System Performance Specifications*

5.1 Zero Drift. Less than +/- 3 percent of the span value.

5.2 Calibration Drift. Less than +/- 3 percent of the span value.

5.3 Calibration Error. Less than +/- 5 percent of the calibration gas value.

### 6. *Pretest Preparations*

6.1 Selection of Sampling Site. Same as in Method 25A, Section 6.1.

6.2 Location of Sample Probe. Same as in Method 25A, Section 6.2.

6.3 Measurement System Preparation. Prior to the emission test, assemble the measurement system following the manufacturer's written instructions in preparing the sample interface and the organic analyzer. Make the system operable.

6.4 Calibration Error Test. Same as in Method 25A, Section 6.4.

6.5 Response Time Test Procedure. Same as in Method 25A, Section 6.5.

### 7. *Emission Measurement Test Procedure*

Proceed with the emission measurement immediately upon satisfactory completion of the calibration.

7.1 Organic Measurement. Same as in Method 25A, Section 7.1.

7.2 Drift Determination. Same as in Method 25A, Section 7.2.

### 8. *Organic Concentration Calculations*

The calculations are the same as in Method 25A, Section 8.

### 9. *Bibliography*

The bibliography is the same as in Method 25A.

METHOD 26--DETERMINATION OF HYDROGEN CHLORIDE EMISSIONS FROM STATIONARY SOURCES

## 1. Applicability, Principle, Interferences, Precision, Bias, and Stability

1.1 Applicability. This method is applicable for determining hydrogen chloride (HCl) emissions from stationary sources.

1.2 Principle. An integrated sample is extracted from the stack and passed through dilute sulfuric acid. In the dilute acid, the HCl gas is dissolved and forms chloride ( $\text{Cl}^-$ ) ions. The  $\text{Cl}^-$  is analyzed by ion chromatography (IC).

1.3 Interferences. Volatile materials which produce chloride ions upon dissolution during sampling are obvious interferences. Another likely interferent is diatomic chlorine ( $\text{Cl}_2$ ) gas which reacts to form HCl and hypochlorous acid (HOCl) upon dissolving in water. However,  $\text{Cl}_2$  gas exhibits a low solubility in water and the use of acidic, rather than neutral or basic collection solutions, greatly reduces the chance of dissolving any chlorine present. This method does not experience a significant bias when sampling a 400 ppm HCl gas stream containing 50 ppm  $\text{Cl}_2$ . Sampling a 220 ppm HCl gas stream containing 180 ppm  $\text{Cl}_2$  results in a positive bias of 3.4 percent in the HCl measurement.

1.4 Precision and Bias. The within-laboratory relative standard deviations are 6.2 and 3.2 percent at HCl concentrations of 3.9 and 15.3 ppm, respectively. The method does not exhibit a bias to  $\text{Cl}_2$  when sampling at concentrations less than 50 ppm.

1.5 Stability. The collected samples can be stored for up to 4 weeks before analysis.

1.6 Detection Limit. The analytical detection limit of the method is 0.1  $\mu\text{g}/\text{ml}$ .

## 2. Apparatus

2.1 Sampling. The sampling train is shown in Figure 26-1, and component parts are discussed below.

2.1.1 Probe. Borosilicate glass, approximately 3/8-in. (9-mm) I.D. with a heating system to prevent moisture condensation. A 3/8-in I.D. Teflon elbow should be attached to the inlet of the probe and a 1-in. (25-mm) length of 3/8-in. I.D. Teflon tubing should be attached to the open end of the elbow to permit the opening of the probe to be turned away from the gas stream. This reduces the amount of particulate entering the train. This probe configuration should be used when the concentration of particulate matter in the emissions is high. When high concentrations are not present, the Teflon elbow is not necessary, and the probe inlet may be perpendicular to the gas stream. A glass wool plug should *not* be used to remove particulate matter since a negative bias in the data could result. Instead, a Teflon filter (see Section 2.1.5) should be installed at the inlet (for stack temperatures < 300 deg. F) or outlet (for stack temperatures > 300 deg. F) of the probe.

2.1.2 Three-way Stopcock. A borosilicate, three-way glass stopcock with a heating system to prevent moisture condensation. The heated stopcock should connect directly to the outlet of the probe and the inlet of the first impinger. The heating system should be capable of preventing condensation up to the inlet of the first impinger. Silicone grease may be used, if necessary, to prevent leakage.

Figure 26-1. Sampling train.

[SEE FIGURE IN ORIGINAL]

2.1.3 Impingers. Four 30-ml midget impingers with leak-free glass connectors. Silicone grease may be used, if necessary, to prevent leakage. For sampling at high moisture sources or for sampling times greater than 1 hour, a midget impinger with a shortened stem (such that the gas sample does not bubble through the collected condensate) should be used in front of the first impinger.

2.1.4 Drying Tube or Impinger. Tube or impinger, of Mae West design, filled with 6- to 16-mesh indicating type silica gel, or equivalent, to dry the gas sample and to protect the dry gas meter and pump. If the silica gel has been used previously, dry at 175 deg. C (350 deg. F) for 2 hours. New silica gel may be used as received. Alternatively, other types of desiccants (equivalent or better) may be used.

2.1.5 Filter. A 25-mm Teflon mat, Pallflex TX40H175 or equivalent. Locate between the probe liner and Teflon elbow in a glass or quartz filter holder in a filter box heated to 250 deg. F.

2.1.6 Sample Line. Leak-free, with compatible fittings to connect the last impinger to the needle valve.

2.1.7 Rate Meter. Rotameter, or equivalent, capable of measuring flow rate to within 2 percent of the selected flow rate of 2 liters/min.

2.1.8 Purge Pump, Purge Line, Drying Tube, Needle Valve, and Rate Meter. Pump capable of purging the sampling probe at 2 liters/min, with drying tube, filled with silica gel or equivalent, to protect pump, and a rate meter capable of measuring 0 to 5 liters/min.

2.1.9 Stopcock Grease, Valve, Pump, Volume Meter, Barometer, and Vacuum Gauge. Same as in Method 6, Sections 2.1.4, 2.1.7, 2.1.8, 2.1.10, 2.1.11, and 2.1.12.

2.2 Sample Recovery.

2.2.1 Wash Bottles. Polyethylene or glass, 500-ml or larger, two.

2.2.2 Storage Bottles. 100-ml glass, with Teflon-lined lids, to store impinger samples (two per sampling run). During clean-up, the two front impinger contents (0.1 N H<sub>2</sub>SO<sub>4</sub>) should be combined. The contents of the two rear impinger (0.1 N NaOH) may be discarded, as these solutions are included only to absorb Cl<sub>2</sub>, and thus protect the pump.

2.3 Sample Preparation and Analysis. The materials required for volumetric dilution and chromatographic analysis of samples are described below.

2.3.1 Volumetric Flasks. Class A, 100-ml size.

2.3.2 Volumetric Pipets. Class A, assortment. To dilute samples into the calibration range of the instrument.

2.3.3 Ion Chromatograph. Suppressed or nonsuppressed, with a conductivity detector and electronic integrator operating in the peak area mode. Other detectors, strip chart recorders, and peak height measurements may be used provided the 5 percent repeatability criteria for sample analysis and the linearity criteria for the calibration curve can be met.

### 3. Reagents

Unless otherwise indicated, all reagents must conform to the specifications established by the Committee on Analytical Reagents of the American Chemical Society (ACS reagent grade). When such specifications are not available, the best available grade shall be used.

3.1. Sampling.

3.1.1 Water. Deionized, distilled water that conforms to ASTM Specification D 1193-77, Type 3.

3.1.2 Absorbing solution, 0.1 N Sulfuric Acid (H<sub>2</sub>SO<sub>4</sub>). To prepare 100 ml of the absorbing solution for the front impinger pair, slowly add 0.28 ml of concentrated H<sub>2</sub>SO<sub>4</sub> to about 90 ml of water while stirring, and adjust the final volume to 100 ml using additional water. Shake well to mix the solution.

3.1.3 Chlorine Scrubber Solution, 0.1 N Sodium Hydroxide (NaOH). To prepare 100 ml of the scrubber solution for the back pair of impingers, dissolve 0.40 g of solid NaOH in about 90 ml of water, and adjust the final solution volume to 100 ml using additional water. Shake well to mix the solution.

### 3.2 Sample Preparation and Analysis.

3.2.1 Water. Same as in Section 3.1.1.

3.2.2 Blank Solution. A separate blank solution of the absorbing reagent should be prepared for analysis with the field samples. Dilute 30 ml of absorbing solution to 100 ml with water in a separate volumetric flask.

3.2.3 Sodium Chloride (NaCl) Stock Standard Solution. Solutions containing a nominal certified concentration of 1000 mg/l are commercially available as convenient stock solutions from which working standards can be made by appropriate volumetric dilution. Alternately, concentrated stock solutions may be produced from reagent grade NaCl. The NaCl should be dried at 100 deg. C for 2 or more hours and cooled to room temperature in a desiccator immediately before weighing. Accurately weigh 1.6 to 1.7 g of the dried NaCl to within 0.1 mg, dissolve in water, and dilute to 1 liter. The exact Cl concentration can be calculated using Eq. 26-1.

$$\mu\text{g Cl}^-/\text{ml} = \text{g of NaCl} \times 10^3 \times 35.453 / 58.44$$

Eq. 26-1

Refrigerate the stock standard solution and store no longer than 1 month.

3.2.4 Chromatographic Eluent. Effective eluents for nonsuppressed IC using a resin- or silica-based weak ion exchange column are a 4 mM potassium hydrogen phthalate solution, adjusted to pH 4.0 using a saturated sodium borate solution, and a 4 mM 4-hydroxy benzoate solution, adjusted to pH 8.6 using 1 N NaOH. An effective eluent for suppressed ion chromatography is a solution containing 3 mM sodium bicarbonate and 2.4 mM sodium carbonate. Other dilute solutions buffered to a similar pH and containing no interfering ions may be used. When using suppressed ion chromatography, if the "water dip" resulting from sample injection interferes with the chloride peak, use a 2 mM NaOH/2.4 mM sodium bicarbonate eluent.

## 4. Procedure

### 4.1 Sampling.

4.1.1 Preparation of Collection Train. Prepare the sampling train as follows: Pour 15 ml of the absorbing solution into each of the first two impingers, and add 15 ml of scrubber solution to the third and fourth impingers. Connect the impingers in series with the knockout impinger first, followed by the two impingers containing absorbing solution and the two containing the scrubber solution. Place a fresh charge of silica gel, or equivalent, in the drying tube or Mae West impinger.

4.1.2 Leak-Check Procedures. Leak-check the probe and three-way stopcock before inserting the probe into the stack. Connect the stopcock to the outlet of the probe, and connect the sample line to the needle valve. Plug the probe inlet, turn on the sample pump, and pull a vacuum of at least 250 mm Hg (10 in. Hg). Turn off the needle valve, and note the vacuum gauge reading. The vacuum should remain stable for at least 30 seconds. Place the probe in the stack at the sampling location, and adjust the probe and stopcock heating system to a temperature

sufficient to prevent water condensation. Connect the first impinger to the stopcock, and connect the sample line to the last impinger and the needle valve. Upon completion of a sampling run, remove the probe from the stack and leak-check as described above. If a leak has occurred, the sampling run must be voided. Alternately, the portion of the train behind the probe may be leak-checked between multiple runs at the same site as follows: Close the stopcock to the first impinger (see Figure 1A of Figure 26-1), and turn on the sampling pump. Pull a vacuum of at least 250 mm Hg, turn off the needle valve, and note the vacuum gauge reading. The vacuum should remain stable for at least 30 seconds. Release the vacuum on the impinger train by turning the stopcock to the vent position to permit ambient air to enter (see Figure 1B of Figure 26-2). If this procedure is used, the full train leak-check described above must be conducted following the final run, and all preceding sampling runs must be voided if a leak has occurred.

4.1.3 Purge Procedure. Immediately before sampling, connect the purge line to the stopcock, and turn the stopcock to permit the purge pump to purge the probe (see Figure 1A of Figure 26-1). Turn on the purge pump, and adjust the purge rate to 2 liters/min. Purge for at least 5 minutes before sampling.

4.1.4 Sample Collection. Turn on the sampling pump, pull a slight vacuum of approximately 25 mm Hg (1 in. Hg) on the impinger train, and turn the stopcock to permit stack gas to be pulled through the impinger train (see Figure 1C of Figure 26-3). Adjust the sampling rate to 2 liters/min, as indicated by the rate meter, and maintain this rate to within 10 percent during the entire sampling run. Take readings of the dry gas meter volume and temperature, rate meter, and vacuum gauge at least once every 5 minutes during the run. A sampling time of 1 hour is recommended. Shorter sampling times may introduce a significant negative bias in the HCl concentration. At the conclusion of the sampling run, remove the train from the stack, cool, and perform a leak-check as described in section 4.1.2.

4.2 Sample Recovery. Disconnect the impingers after sampling. Quantitatively transfer the contents of the first three impingers (the knockout impinger and the two absorbing solution impingers) to a leak-free storage bottle. Add the water rinses of each of these impingers and connecting glassware to the storage bottle. The contents of the scrubber impingers and connecting glassware rinses may be discarded. The sample bottle should be sealed, shaken to mix, and labeled. The fluid level should be marked so that if any sample is lost during transport, a correction proportional to the lost volume can be applied.

4.3 Sample Preparation for Analysis. Check the liquid level in each sample, and determine if any sample was lost during shipment. If a noticeable amount of leakage has occurred, the volume lost can be determined from the difference between the initial and final solution levels, and this value can be used to correct the analytical results. Quantitatively transfer the sample solution to a 100-ml volumetric flask, and dilute the solution to 100 ml with water.

4.4 Sample Analysis.

4.4.1 The IC conditions will depend upon analytical column type and whether suppressed or nonsuppressed IC is used. An example chromatogram from a nonsuppressed system using a 150-mm Hamilton PRP-X100 anion column, a \* \* \*. 2 l/min flow rate of a 4 mM 4-hydroxy benzoate solution adjusted to a pH of 8.6 using 1 N NaOH, a 50  $\mu$ l sample loop, and a conductivity detector set on 1.0  $\mu$ S full scale is shown in Figure 26-2.

4.4.2 Before sample analysis, establish a stable baseline. Next, inject a sample of water, and determine if any Cl $\leftrightarrow$  appears in the chromatogram. If Cl $\leftrightarrow$  is present, repeat the load/injection procedure until no Cl $\leftrightarrow$  is present. At this point, the instrument is ready for use.

4.4.3 First, inject the calibration standards covering an appropriate concentration range, starting with the lowest concentration standard. Next, inject in duplicate, a QC sample followed by a water blank and the field samples. Finally, repeat the injection of calibration standards to allow compensation for any drift in the instrument during analysis of the field samples. Measure the Cl $\leftrightarrow$  peak areas or heights of the samples. Use the average response

from the duplicate injections to determine the field sample concentrations using a linear calibration curve generated from the standards.

4.5 Audit Analysis. An audit sample must be analyzed, subject to availability.

Figure 26-2. Example Chromatogram

[SEE FIGURE IN ORIGINAL]

## 5. Calibration

5.1 Dry Gas Metering System, Thermometers, Rate Meter, and Barometer. Same as in Method 6, sections 5.1, 5.2, 5.3, and 5.4.

5.2 Calibration Curve for Ion Chromatograph. To prepare calibration standards, dilute given volumes (1.0 ml or greater) of the stock standard solution, with 0.1 N H<sub>2</sub>SO<sub>4</sub> (section 3.1.2) to convenient volumes. Prepare at least four standards that are within the linear range of the instrument and which cover the expected concentration range of the field samples. Analyze the standards as instructed in section 4.4.3, beginning with the lowest concentration standard. Determine the peak measurements, and plot individual values versus Cl<sup>-</sup> concentration in  $\mu\text{g/ml}$ . Draw a smooth curve through the points. Use linear regression to calculate a formula describing the resulting linear curve.

## 6. Quality Assurance

6.1 Applicability. When the method is used to analyze samples to demonstrate compliance with a source emission regulation, a set of two audit samples must be analyzed.

6.2 Audit Procedure. The audit sample are chloride solutions. Concurrently analyze the two audit samples and a set of compliance samples in the same manner to evaluate the technique of the analyst and the standards preparation. The same analyst, analytical reagents, and analytical system shall be used both for compliance samples and the EPA audit samples. If this condition is met, auditing the subsequent compliance analyses for the same enforcement agency within 30 days is not required. An audit sample set may not be used to validate different sets of compliance samples under the jurisdiction of different enforcement agencies, unless prior arrangements are made with both enforcement agencies.

6.3 Audit Sample Availability. The audit samples may be obtained by writing or calling the EPA Regional Office or the appropriate enforcement agency. The request for the audit samples must be made at least 30 days prior to the scheduled compliance sample analyses.

6.4 Audit Results. Calculate the concentrations in mg/dscm using the specified sample volume in the audit instructions.

NOTE: Indication of acceptable results may be obtained immediately by reporting the audit results in mg/dscm and compliance results in total  $\mu\text{g HCl/sample}$  to the responsible enforcement agency. Include the results of both audit samples, their identification numbers, and the analyst's name with the results of the compliance determination samples in appropriate reports to the EPA Regional Office or the appropriate enforcement agency. Include this information with subsequent analyses for the same enforcement agency during the 30-day period.

The concentrations of the audit samples obtained by the analyst shall agree within 10 percent of the actual concentrations. If the 10 percent specification is not met, reanalyze the compliance samples and audit samples, and include initial and reanalysis values in the test report.

Failure to meet the 10 percent specification may require retests until the audit problems are resolved. However, if the audit results do not affect the compliance or noncompliance status of the affected facility, the Administrator may waive the reanalysis requirement, further audits, or retests and accept the results of the compliance test. While steps are being taken to resolve audit analysis problems, the Administrator may also choose to use the data to determine the compliance or noncompliance status of the affected facility.

## 7. Calculations

Retain at least one extra decimal figure beyond those contained in the available data in intermediate calculations, and round off only the final answer appropriately.

7.1 Sample Volume, Dry Basis, Corrected to Standard Conditions. Calculate the sample volume using Eq. 6-1 of Method 6.

7.2 Total  $\mu\text{g HCl}$  Per Sample.

$$m = (S - B) \times (100) \times (36.46) / (35.453) = (102.84) \times (S - B)$$

Eq. 26-2

where:

$m$  = Mass of HCl in sample,  $\mu\text{g}$ .

$S$  = Concentration of sample,  $\mu\text{g Cl}^-/\text{ml}$ .

$B$  = Concentration of blank,  $\mu\text{g Cl}^-/\text{ml}$ .

100 = Volume of filtered and diluted sample, ml.

36.46 = Molecular weight of HCl,  $\mu\text{g} / \mu\text{g-mole}$ .

35.453 = Atomic weight of Cl,  $\mu\text{g} / \mu\text{g-mole}$ .

7.3 Concentration of HCl in the Flue Gas.

$$C = K[m] / V[m(\text{std})]$$

Eq. 26-3

where:

$C$  = Concentration of HCl, dry basis,  $\text{mg/dscm}$ .

$K = 10^{-3} \text{ mg}/\mu\text{g}$ .

$m$  = Mass of HCl in sample,  $\mu\text{g}$ .

$V[m(\text{std})]$  = Dry gas volume measured by the dry gas meter, corrected to standard conditions,  $\text{dscm}$ .

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2. State of California, Air Resources Board. Method 421. "Determination of Hydrochloric Acid Emissions from Stationary Sources." March 18, 1987.

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## METHOD 27--DETERMINATION OF VAPOR TIGHTNESS OF GASOLINE DELIVERY TANK USING PRESSURE-VACUUM TEST

### 1. *Applicability and Principle*

1.1 Applicability. This method is applicable for the determination of vapor tightness of a gasoline delivery tank which is equipped with vapor collection equipment.

1.2 Principle. Pressure and vacuum are applied alternately to the compartments of a gasoline delivery tank and the change in pressure or vacuum is recorded after a specified period of time.

### 2. *Definitions and Nomenclature*

2.1 Gasoline. Any petroleum distillate or petroleum distillate/alcohol blend having a Reid vapor pressure of 27.6 kilopascals or greater which is used as a fuel for internal combustion engines.

2.2 Delivery Tank. Any container, including associated pipes and fittings, that is attached to or forms a part of any truck, trailer, or railcar used for the transport of gasoline.

2.3 Compartment. A liquid-tight division of a delivery tank.

2.4 Delivery Tank Vapor Collection Equipment. Any piping, hoses, and devices on the delivery tank used to collect and route gasoline vapors either from the tank to a bulk terminal vapor control system or from a bulk plant or service station into the tank.

2.5 Time Period of the Pressure or Vacuum Test (t). The time period of the test, as specified in the appropriate regulation, during which the change in pressure or vacuum is monitored, in minutes.

2.6 Initial Pressure (P[i]). The pressure applied to the delivery tank at the beginning of the static pressure test, as specified in the appropriate regulation, in mm H<sub>2</sub>O.

2.7 Initial Vacuum (V[i]). The vacuum applied to the delivery tank at the beginning of the static vacuum test, as specified in the appropriate regulation, in mm H<sub>2</sub>O.

2.8 Allowable Pressure Change (DELTA p). The allowable amount of decrease in pressure during the static pressure test, within the time period t, as specified in the appropriate regulation, in mm H<sub>2</sub>O.

2.9 Allowable Vacuum Change (DELTA v). The allowable amount of decrease in vacuum during the static vacuum test, within the time period t, as specified in the appropriate regulation, in mm H<sub>2</sub>O.

### 3. Apparatus

3.1 Pressure Source. Pump or compressed gas cylinder of air or inert gas sufficient to pressurize the delivery tank to 500 mm H<sub>2</sub>O above atmospheric pressure.

3.2 Regulator. Low pressure regulator for controlling pressurization of the delivery tank.

3.3 Vacuum Source. Vacuum pump capable of evacuating the delivery tank to 250 mm H<sub>2</sub>O below atmospheric pressure.

3.4 Pressure-Vacuum Supply Hose.

3.5 Manometer. Liquid manometer, or equivalent instrument, capable of measuring up to 500 mm H<sub>2</sub>O gauge pressure with +/- 2.5 mm H<sub>2</sub>O precision.

3.6 Pressure-Vacuum Relief Valves. The test apparatus shall be equipped with an in-line pressure-vacuum relief valve set to activate at 675 mm H<sub>2</sub>O above atmospheric pressure or 250 mm H<sub>2</sub>O below atmospheric pressure, with a capacity equal to the pressurizing or evacuating pumps.

3.7 Test Cap for Vapor Recovery Hose. This cap shall have a tap for manometer connection and a fitting with shut-off valve for connection to the pressure-vacuum supply hose.

3.8 Caps for Liquid Delivery Hoses.

### 4. Pretest Preparations

4.1 Summary. Testing problems may occur due to the presence of volatile vapors and/or temperature fluctuations inside the delivery tank. Under these conditions, it is often difficult to obtain a stable initial pressure at the beginning of a test, and erroneous test results may occur. To help prevent this, it is recommended that, prior to testing, volatile vapors be removed from the tank and the temperature inside the tank be allowed to stabilize. Because it is not always possible to attain completely these pretest conditions a provision to ensure reproducible results is included. The difference in results for two consecutive runs must meet the criterion in Sections 5.2.5 and 5.3.5.

4.2 Emptying of Tank. The delivery tank shall be emptied of all liquid.

4.3 Purging of Vapor. As much as possible, the delivery tank shall be purged of all volatile vapors by any safe, acceptable method. One method is to carry a load of non-volatile liquid fuel, such as diesel or heating oil, immediately prior to the test, thus flushing out all the volatile gasoline vapors. A second method is to remove the volatile vapors by blowing ambient air into each tank compartment for at least 20 minutes. This second method is usually not as effective and often causes stabilization problems, requiring a much longer time for stabilization problems, requiring a much longer time for stabilization during the testing.

4.4 Temperature Stabilization. As much as possible, the test shall be conducted under isothermal conditions. The temperature of the delivery tank should be allowed to equilibrate in the test environment. During the test, the tank should be protected from extreme environmental and temperature variability, such as direct sunlight.

### 5. Test Procedure

5.1 Preparations.

5.1.1 Open and close each dome cover.

5.1.2 Connect static electrical ground connections to tank. Attach the liquid delivery and vapor return hoses, remove the liquid delivery elbows, and plug the liquid delivery fittings.

5.1.3 Attach the test cap to the end of the vapor recovery hose.

5.1.4 Connect the pressure-vacuum supply hose and the pressure-vacuum relief valve to the shut-off valve. Attach a manometer to the pressure tap.

5.1.5 Connect compartments of the tank internally to each other if possible. If not possible, each compartment must be tested separately, as if it were an individual delivery tank.

## 5.2 Pressure Test.

5.2.1 Connect the pressure source to the pressure-vacuum supply hose.

5.2.2 Open the shut-off valve in the vapor recovery hose cap. Applying air pressure slowly, pressurize the tank to  $P[i]$ , the initial pressure specified in the regulation.

5.2.3 Close the shut-off valve and allow the pressure in the tank to stabilize, adjusting the pressure if necessary to maintain pressure of  $P[i]$ . When the pressure stabilizes, record the time and initial pressure.

5.2.4 At the end of  $t$  minutes, record the time and final pressure.

5.2.5 Repeat steps 5.2.2 through 5.2.4 until the change in pressure for two consecutive runs agrees within  $\pm 12.5$  mm H<sub>2</sub>O.

Calculate the arithmetic average of the two results.

5.2.6 Compare the average measured change in pressure to the allowable pressure change, DELTA  $p$ , as specified in the regulation. If the delivery tank does not satisfy the vapor tightness criterion specified in the regulation, repair the sources of leakage, and repeat the pressure test until the criterion is met.

5.2.7 Disconnect the pressure source from the pressure-vacuum supply hose, and slowly open the shut-off valve to bring the tank to atmospheric pressure.

## 5.3 Vacuum Test.

5.3.1 Connect the vacuum source to the pressure-vacuum supply hose.

5.3.2 Open the shut-off valve in the vapor recovery hose cap. Slowly evacuate the tank to  $V[i]$ , the initial vacuum specified in the regulation.

5.3.3 Close the shut-off valve and allow the pressure in the tank to stabilize, adjusting the pressure if necessary to maintain a vacuum of  $V[i]$ . When the pressure stabilizes, record the time and initial vacuum.

5.3.4 At the end of  $t$  minutes, record the time and final vacuum.

5.3.5 Repeat steps 5.3.2 through 5.3.4 until the change in vacuum for two consecutive runs agrees within  $\pm 12.5$  mm H<sub>2</sub>O. Calculate the arithmetic average of the two results.

5.3.6 Compare the average measured change in vacuum to the allowable vacuum change, DELTA  $v$ , as

specified in the regulation. If the delivery tank does not satisfy the vapor tightness criterion specified in the regulation, repair the sources of leakage, and repeat the vacuum test until the criterion is met.

5.3.7 Disconnect the vacuum source from the pressure-vacuum supply hose, and slowly open the shut-off valve to bring the tank to atmospheric pressure.

5.4 Post-Test Clean-Up. Disconnect all test equipment and return the delivery tank to its pretest condition.

## 6. *Alternative Procedures*

6.1 The pumping of water into the bottom of a delivery tank is an acceptable alternative to the pressure source described above. Likewise, the draining of water out of the bottom of a delivery tank may be substituted for the vacuum source. Note that some of the specific step-by-step procedures in the method must be altered slightly to accommodate these different pressure and vacuum sources.

6.2 Techniques other than specified above may be used for purging and pressurizing a delivery tank, if prior approval is obtained from the Administrator. Such approval will be based upon demonstrated equivalency with the above method.

## METHOD 28 -- CERTIFICATION AND AUDITING OF WOOD HEATERS

### 1. *Applicability and Principle*

1.1 *Applicability.* This method is applicable for the certification and auditing of wood heaters. This method describes the test facility, test fuel charge, and wood heater operation as well as procedures for determining burn rates and particulate emission rates and for reducing data.

1.2 *Principle.* Particulate matter emissions are measured from a wood heater burning a prepared test fuel crib in a test facility maintained at a set of prescribed conditions.

### 2. *Definitions*

2.1 *Burn Rate.* The rate at which test fuel is consumed in a wood heater. Measured in kilograms of wood (dry basis) per hour (kg/hr).

2.2 *Certification or Audit Test.* A series of at least four test runs conducted for certification or audit purposes that meets the burn rate specifications in Section 5.

2.3 *Firebox.* The chamber in the wood heater in which the test fuel charge is placed and combusted.

2.4 *Secondary Air Supply.* An air supply that introduces air to the wood heater such that the burn rate is not altered by more than 25 percent when the secondary air supply is adjusted during the test run. The wood heater manufacturer can document this through design drawings that show the secondary air is introduced only into a mixing chamber or secondary chamber outside the firebox.

2.5 *Test Facility.* The area in which the wood heater is installed, operated, and sampled for emissions.

2.6 *Test Fuel Charge.* The collection of test fuel pieces placed in the wood heater at the start of the emission test run.

2.7 *Test Fuel Crib.* The arrangement of the test fuel charge with the proper spacing requirements between adjacent fuel pieces.

2.8 Test Fuel Loading Density. The weight of the as-fired test fuel charge per unit volume of usable firebox.

2.9 Test Fuel Piece. The 2 X 4 or 4 X 4 wood piece cut to the length required for the test fuel charge and used to construct the test fuel crib.

2.10 Test Run. An individual emission test which encompasses the time required to consume the mass of the test fuel charge.

2.11 Usable Firebox Volume. The volume of the firebox determined using the following definitions:

2.11.1 Height. The vertical distance extending above the loading door, if fuel could reasonably occupy that space, but not more than 2 inches above the top (peak height) of the loading door, to the floor of the firebox (i.e., below a permanent grate) if the grate allows a 1-inch diameter piece of wood to pass through the grate, or, if not, to the top of the grate. Firebox height is not necessarily uniform but must account for variations caused by internal baffles, air channels, or other permanent obstructions.

2.11.2 Length. The longest horizontal fire chamber dimension that is parallel to a wall of the chamber.

2.11.3 Width. The shortest horizontal fire chamber dimension that is parallel to a wall of the chamber.

2.12 Wood Heater. An enclosed, woodburning appliance capable of and intended for space heating or domestic water heating, as defined in the applicable regulation.

2.13 Pellet Burning Wood Heater. A wood heater which meets the following criteria: (1) The manufacturer makes no reference to burning cord wood in advertising or other literature, (2) the unit is safety listed for pellet fuel only, (3) the unit operating and instruction manual must state that the use of cordwood is prohibited by law, and (4) the unit must be manufactured and sold including the hopper and auger combination as integral parts.

### *3. Apparatus*

3.1 Insulated Solid Pack Chimney. For installation of wood heaters. Solid pack insulated chimneys shall have a minimum of 2.5 cm (1 in.) solid pack insulating material surrounding the entire flue and possess a label demonstrating conformance to U.L. Standard 103 (incorporated by reference. See § 60.17).

3.2 Platform Scale and Monitor. For monitoring of fuel load weight change. The scale shall be capable of measuring weight to within 0.05 kg (0.1 lb) or 1 percent of the initial test fuel charge weight, whichever is greater.

3.3 Wood Heater Temperature Monitors. Seven, each capable of measuring temperature to within 1.5 percent of expected absolute temperatures.

3.4 Test Facility Temperature Monitor. A thermocouple located centrally in a vertically oriented 150 mm (6 in.) long, 50 mm (2 in.) diameter pipe shield that is open at both ends, capable of measuring temperature to within 1.5 percent of expected temperatures.

3.5 Balance (optional). Balance capable of weighing the test fuel charge to within 0.05 kg (0.1 lb).

3.6 Moisture Meter. Calibrated electrical resistance meter for measuring test fuel moisture to within 1 percent moisture content.

3.7 Anemometer. Device capable of detecting air velocities less than 0.10 m/sec (20 ft/min), for measuring air

velocities near the test appliance.

3.8 Barometer. Mercury, aneroid or other barometer capable of measuring atmospheric pressure to within 2.5 mm Hg (0.1 in. Hg).

3.9 Draft Gauge. Electromanometer or other device for the determination of flue draft or static pressure readable to within 0.50 Pa (0.002 in. H<sub>2</sub>O).

3.10 Humidity Gauge. Psychrometer or hygrometer for measuring room humidity.

3.11 Sampling Methods. Use particulate emission measurement Method 5G or Method 5H to determine particulate concentrations, gas flow rates, and particulate emission rates.

#### *4. Test Facility, Test Fuel Properties, and Test Fuel Charge Specifications*

##### 4.1 Test Facility.

4.1.1 Wood Heater Flue. Steel flue pipe extending to 2.6 +/- 0.15 m (8.5 +/- 0.5 ft) above the top of the platform scale, and above this level, insulated solid pack type chimney extending to 4.6 + 0.3 m (15 +/- 1 ft) above the platform scale, and of the size specified by the wood heater manufacturer. This applies to both freestanding and insert type wood heaters.

Other chimney types (e.g., solid pack insulated pipe) may be used in place of the steel flue pipe if the wood heater manufacturer's written appliance specifications require such chimney for home installation (e.g., zero clearance wood heater inserts). Such alternative chimney or flue pipe must remain and be sealed with the wood heater following the certification test.

4.1.2 Test Facility Conditions. The test facility temperature shall be maintained between 18 and 32 degrees C (65 and 90 degrees F) during each test run.

Air velocities within 0.6 m (2 ft) of the test appliance and exhaust system shall be less than 0.25 m/sec (50 ft/min) without fire in the unit.

The flue shall discharge into the same space or into a space freely communicating with the test facility. Any hood or similar device used to vent combustion products shall not induce a draft greater than 1.25 Pa (0.005 in. H<sub>2</sub>O) on the wood heater measured when the wood heater is not operating.

For test facilities with artificially induced barometric pressures (e.g., pressurized chambers), the barometric pressure in the test facility shall not exceed 1,033 mb (30.5 in. Hg) during any test run.

4.2 Test Fuel Properties. The test fuel shall conform to the following requirements:

4.2.1 Fuel Species. Untreated, air-dried, Douglas fir lumber. Kiln-dried lumber is not permitted. The lumber shall be certified C grade (standard) or better Douglas fir by a lumber grader at the mill of origin as specified in the West Coast Lumber Inspection Bureau standard No. 16 (incorporated by reference. See § 60.17).

4.2.2 Fuel Moisture. The test fuel shall have a moisture content range between 16 to 20 percent on a wet basis (19 to 25 percent dry basis).

Addition of moisture to previously dried wood is not allowed. It is recommended that the test fuel be stored in a temperature and humidity-controlled room.

4.2.3 Fuel Temperature. The test fuel shall be at the test facility temperature 18 to 32 degrees C (65 to 90 degrees F).

#### 4.3 Test Fuel Charge Specifications.

4.3.1 Fuel Dimensions. The dimensions of each test fuel piece shall conform to the nominal measurements of 2 X 4 and 4 X 4 lumber. Each piece of test fuel (not including spacers) shall be of equal length, except as necessary to meet requirements in Section 6.2.5, and shall closely approximate 5/6 the dimensions of the length of the usable firebox. The fuel piece dimensions shall be determined in relation to the appliance's firebox volume according to guidelines listed below:

4.3.1.1 If the usable firebox volume is less than or equal to 0.043 m<sup>3</sup> (1.5 ft<sup>3</sup>), use 2 X 4 lumber.

4.3.1.2 If the usable firebox volume is greater than 0.043 m<sup>3</sup> (1.5 ft<sup>3</sup>) and less than or equal to 0.085 m<sup>3</sup> (3.0 ft<sup>3</sup>), use 2 X 4 and 4 X 4 lumber. About half the weight of the test fuel charge shall be 2 X 4 lumber, and the remainder shall be 4 X 4 lumber.

4.3.1.3 If the usable firebox volume is greater than 0.085 m<sup>3</sup> (3.0 ft<sup>3</sup>), use 4 X 4 lumber.

4.3.2 Test Fuel Spacers. Air-dried, Douglas fir lumber meeting the fuel properties in Section 4.2. The spacers shall be 130 X 40 X 20 mm (5 X 1.5 X 0.75 in.).

4.3.3 Test Fuel Charge Density. The test fuel charge density shall be 112 +/- 11.2 kg / m<sup>3</sup> (7 +/- 0.7 lb/ft<sup>3</sup>) of usable firebox volume on a wet basis.

4.4 Wood Heater Thermal Equilibrium. The average of the wood heater surface temperatures at the end of the test run shall agree with the average surface temperature at the start of the test run to within 70 degrees C (125 degrees F).

### 5. Burn Rate Criteria

5.1 Burn Rate Categories. One emission test run is required in each of the following burn rate categories:

#### BURN RATE CATEGORIES

(Average kg/hr, dry basis)

Category 1	Category 2	Category 3	Category 4
< 0.80	0.80 to 1.25	1.25 to 1.90	Maximum burn rate.

5.1.1 Maximum Burn Rate. For Category 4, the wood heater shall be operated with the primary air supply inlet controls fully open (or, if thermostatically controlled, the thermostat shall be set at maximum heat output) during the entire test run, or the maximum burn rate setting specified by the manufacturer's written instructions.

5.1.2 Other Burn Rate Categories. For burn rates in Categories 1 through 3, the wood heater shall be operated with the primary air supply inlet control, or other mechanical control device, set at a predetermined position

necessary to obtain the average burn rate required for the category.

5.2 Alternative Burn Rates for Burn Rate Categories 1 and 2. If a wood heater cannot be operated at a burn rate below 0.80 kg/hr, two test runs shall be conducted with burn rates within Category 2. If a wood heater cannot be operated at a burn rate below 1.25 kg/hr, the flue shall be dampered or the air supply otherwise controlled in order to achieve two test runs within Category 2.

Evidence that a wood heater cannot be operated at a burn rate less than 0.80 kg/hr shall include documentation of two or more attempts to operate the wood heater in burn rate Category 1 and fuel combustion has stopped, or results of two or more test runs demonstrating that the burn rates were greater than 0.80 kg/hr when the air supply controls were adjusted to the lowest possible position or settings. Stopped fuel combustion is evidenced when an elapsed time of 30 minutes or more has occurred without a measurable ( $< 0.05$  kg (0.1 lb) or 1.0 percent, whichever is greater) weight change in the test fuel charge. See also Section 6.4.3. Report the evidence and the reasoning used to determine that a test in burn rate Category 1 cannot be achieved; for example, two attempts to operate at a burn rate of 0.4 kg/hr are not sufficient evidence that burn rate Category 1 cannot be achieved.

## 6. Procedures

6.1 Catalytic Combustor and Wood Heater Aging. The catalyst-equipped wood heater or a wood heater of any type shall be aged before the certification test begins. The aging procedure shall be conducted and documented by a testing laboratory accredited according to procedures in § 60.535 of 40 CFR Part 60.

6.1.1 Catalyst-equipped Wood Heater. Operate the catalyst-equipped wood heater using fuel described in Section 4.2 or cordwood with a moisture content between 15 and 25 percent on a wet basis. Operate the wood heater at a medium burn rate (Category 2 or 3) with a new catalytic combustor in place and in operation for at least 50 hours. Record and report hourly catalyst exit temperature data (Section 6.2.2) and the hours of operation.

6.1.2 Non-Catalyst Wood Heater. Operate the wood heater using the fuel described in Section 6.1.1 at a medium burn rate for at least 10 hours. Record and report the hours of operation.

6.2 Pretest Preparation. Record the test fuel charge dimensions and weights, and wood heater and catalyst descriptions as shown in the example in Figure 28-3.

6.2.1 Wood Heater Installation. Assemble the wood heater appliance and parts in conformance with the manufacturer's written installation instructions. Place the wood heater centrally on the platform scale and connect the wood heater to the flue described in Section 4.1.1. Clean the flue with an appropriately sized, wire chimney brush before each certification test.

6.2.2 Wood Heater Temperature Monitors. For catalyst-equipped wood heaters, locate a temperature monitor (optional) about 25 mm (1 in.) upstream of the catalyst at the centroid of the catalyst face area, and locate a temperature monitor (mandatory) that will indicate the catalyst exhaust temperature. This temperature monitor is centrally located within 25 mm (1 in.) downstream at the centroid of catalyst face area. Record these locations.

Locate wood heater surface temperature monitors at five locations on the wood heater firebox exterior surface. Position the temperature monitors centrally on the top surface, on two sidewall surfaces, and on the bottom and back surfaces. Position the monitor sensing tip on the firebox exterior surface inside of any heat shield, air circulation walls, or other wall or shield separated from the firebox exterior surface. Surface temperature locations for unusual design shapes (e.g., spherical, etc.) shall be positioned so that there are four surface temperature monitors in both the vertical and horizontal planes passing at right angles through the centroid of

the firebox, not including the fuel loading door (total of five temperature monitors).

6.2.3 Test Facility Conditions. Locate the test facility temperature monitor on the horizontal plane that includes the primary air intake opening for the wood heater. Locate the temperature monitor 1 to 2 m (3 to 6 ft) from the front of the wood heater in the 90 degrees sector in front of the wood heater.

Use an anemometer to measure the air velocity. Measure and record the room air velocity before the pretest ignition period (Section 6.3) and once immediately following the test run completion.

Measure and record the test facility's ambient relative humidity, barometric pressure, and temperature before and after each test run.

Measure and record the flue draft or static pressure in the flue at a location no greater than 0.3 m (1 ft) above the flue connector at the wood heater exhaust during the test run at the recording intervals (Section 6.4.2).

6.2.4 Wood Heater Firebox Volume. Determine the firebox volume using the definitions for height, width, and length in Section 2. Volume adjustments due to presence of firebrick and other permanent fixtures may be necessary. Adjust width and length dimensions to extend to the metal wall of the wood heater above the firebrick or permanent obstruction if the firebrick or obstruction extending the length of the side(s) or back wall extends less than one-third of the usable firebox height. Use the width or length dimensions inside the firebrick if the firebrick extends more than one-third of the usable firebox height. If a log retainer or grate is a permanent fixture and the manufacturer recommends that no fuel be placed outside the retainer, the area outside of the retainer is excluded from the firebox volume calculations.

In general, exclude the area above the ash lip if that area is less than 10 percent of the usable firebox volume. Otherwise, take into account consumer loading practices. For instance, if fuel is to be loaded front-to-back, an ash lip may be considered usable firebox volume.

Include areas adjacent to and above a baffle (up to two inches above the fuel loading opening) if four inches or more horizontal space exist between the edge of the baffle and a vertical obstruction (e.g., sidewalls or air channels).

6.2.5 Test Fuel Charge. Prepare the test fuel pieces in accordance with the specifications in Section 4.3. Determine the test fuel moisture content with a calibrated electrical resistance meter or other equivalent performance meter. (To convert moisture meter readings from the dry basis to the wet basis:  $(100)(\text{percent dry reading}) / (100 + \text{percent dry reading}) = \text{percent moisture wet basis}$ .) Determine fuel moisture for each fuel piece (not including spacers) by averaging at least three moisture meter readings, one from each of three sides, measured parallel to the wood grain. Average all the readings for all the fuel pieces in the test fuel charge. If an electrical resistance type meter is used, penetration of insulated electrodes shall be one-fourth the thickness of the test fuel piece or 19 mm (0.75 in.), whichever is greater. Measure the moisture content within a 4-hour period prior to the test run. Determine the fuel temperature by measuring the temperature of the room where the wood has been stored for at least 24 hours prior to the moisture determination.

Attach the spacers to the test fuel pieces with uncoated, ungalvanized nails or staples as illustrated in Figure 28-1. Attachment of spacers to the top of the test fuel piece(s) on top of the test fuel charge is optional.

To avoid stacking difficulties, or when a whole number of test fuel pieces does not result, all piece lengths shall be adjusted uniformly to remain within the specified loading density. The shape of the test fuel crib shall be geometrically similar to the shape of the firebox volume without resorting to special angular or round cuts on the individual fuel pieces.

6.2.6 Sampling Method. Prepare the sampling equipment as defined by the selected method. Collect one

particulate emission sample for each test run.

6.2.7 Secondary Air Adjustment Validation. If design drawings do not show the introductions of secondary air into a chamber outside the firebox (Section 2.4), conduct a separate test of the wood heater's secondary air supply. Operate the wood heater at a burn rate in Category 1 (Sections 5.1 or 5.2) with the secondary air supply operated following the manufacturer's written instructions. Start the secondary air validation test run as described in Section 6.4.1, except no emission sampling is necessary and burn rate data shall be recorded at 5-minute intervals.

After the start of the test run, operate the wood heater with the secondary air supply set as per the manufacturer's instructions, but with no adjustments to this setting. After 25 percent of the test fuel has been consumed, adjust the secondary air supply controls to another setting, as per the manufacturer's instructions. Record the burn rate data (5-minute intervals) for 20 minutes following the air supply adjustment.

Adjust the air supply control(s) to the original position(s), operate at this condition for at least 20 minutes, and repeat the air supply adjustment procedure above. Repeat the procedure three times at equal intervals over the entire burn period as defined in Section 6.4. If the secondary air adjustment results in a burn rate change of more than an average of 25 percent between the 20-minute periods before and after the secondary adjustments, the secondary air supply shall be considered a primary air supply, and no adjustment to this air supply is allowed during the test run.

6.3 Pretest Ignition. Build a fire in the wood heater in accordance with the manufacturer's written instructions.

6.3.1 Pretest Fuel Charge. Crumpled newspaper loaded with kindling may be used to help ignite the pretest fuel. The pretest fuel, used to sustain the fire, shall meet the same fuel requirements prescribed in Section 4.2. The pretest fuel charge shall consist of whole 2 x 4's that are no less than 1/3 the length of the test fuel pieces. Pieces of 4 x 4 lumber in approximately the same weight ratio as for the test fuel charge may be added to the pretest fuel charge.

6.3.2 Wood Heater Operation and Adjustments. Set the air inlet supply controls at any position that will maintain combustion of the pretest fuel load. At least one hour before the start of the test run, set the air supply controls at the approximate positions necessary to achieve the burn rate desired for the test run. Adjustment of the air supply controls, fuel addition or subtractions, and coalbed raking shall be kept to a minimum but are allowed up to 15 minutes prior to the start of the test run. For the purposes of this method, coalbed raking is the use of a metal tool (poker) to stir coals, break burning fuel into smaller pieces, dislodge fuel pieces from positions of poor combustion, and check for the condition of uniform charcoalization. Record all adjustments made to the air supply controls, adjustments to and additions or subtractions of fuel, and any other changes to wood heater operations that occur during pretest ignition period. Record fuel weight data and wood heater temperature measurements at 10-minute intervals during the hour of the pretest ignition period preceding the start of the test run. During the 15-minute period prior to the start of the test run, the wood heater loading door shall not be open more than a total of 1 minute. Coalbed raking is the only adjustment allowed during this period.

The weight of pretest fuel remaining at the start of the test run is determined as the difference between the weight of the wood heater with the remaining pretest fuel and the tare weight of the cleaned, dry wood heater with or without dry ash or sand added consistent with the manufacturer's instructions and the owner's manual. The tare weight of the wood heater must be determined with the wood heater (and ash, if added) in a dry condition.

6.4 Test Run. Complete a test run in each burn rate category, as follows:

6.4.1 Test Run Start. When the kindling and pretest fuel have been consumed to leave a fuel weight between 20

and 25 percent of the weight of the test fuel charge, record the weight of the fuel remaining and start the test run. Record and report any other criteria, in addition to those specified in this section, used to determine the moment of the test run start (e.g., firebox or catalyst temperature), whether such criteria are specified by the wood heater manufacturer or the testing laboratory. Record all wood heater individual surface temperatures, catalyst temperatures, any initial sampling method measurement values, and begin the particulate emission sampling. Within 1 minute following the start of the test run, open the wood heater door, load the test fuel charge, and record the test fuel charge weight. Recording of average, rather than individual, surface temperatures is acceptable for tests conducted in accordance with § 60.533(o)(3)(i) of 40 CFR Part 60.

Position the fuel charge so that the spacers are parallel to the floor of the firebox, with the spacer edges abutting each other. If loading difficulties result, some fuel pieces may be placed on edge. If the usable firebox volume is between 0.043 and 0.085 m<sup>3</sup> (1.5 and 3.0 ft<sup>3</sup>), alternate the piece sizes in vertical stacking layers to the extent possible. For example, place 2 x 4's on the bottom layer in direct contact with the coal bed and 4 x 4's on the next layer, etc. (See Figure 28-2). Position the fuel pieces parallel to each other and parallel to the longest wall of the firebox to the extent possible within the specifications in Section 6.2.5.

Load the test fuel in appliances having unusual or unconventional firebox design maintaining air space intervals between the test fuel pieces and in conformance with the manufacturer's written instructions. For any appliance that will not accommodate the loading arrangement specified in the paragraph above, the test facility personnel shall contact the Administrator for an alternative loading arrangement.

The wood heater door may remain open and the air supply controls adjusted up to five minutes after the start of the test run in order to make adjustments to the test fuel charge and to ensure ignition of the test fuel charge has occurred. Within the five minutes after the start of the test run, close the wood heater door and adjust the air supply controls to the position determined to produce the desired burn rate. No other adjustments to the air supply controls or the test fuel charge are allowed (except as specified in Sections 6.4.3 and 6.4.4) after the first five minutes of the test run. Record the length of time the wood heater door remains open, the adjustments to the air supply controls, and any other operational adjustments.

6.4.2 Data Recording. Record fuel weight data, wood heater individual surface and catalyst temperature measurements, other wood heater operational data (e.g., draft), test facility temperature and sampling method data at 10-minute intervals (or more frequently at the option of the tester) as shown on example data sheet, Figure 28-4.

6.4.3 Test Fuel Charge Adjustment. The test fuel charge may be adjusted (i.e., re-positioned) once during a test run if more than 60 percent of the initial test fuel charge weight has been consumed and more than 10 minutes have elapsed without a measurable (<0.05 kg (0.11lb) or 1.0 percent, whichever is greater) weight change. The time used to make this adjustment shall be less than 15 seconds.

6.4.4 Air Supply Adjustment. Secondary air supply controls may be adjusted once during the test run following the manufacturer's written instructions (see Section 6.2.7). No other air supply adjustments are allowed during the test run.

Recording of wood heater flue draft during the test run is optional for tests conducted in accordance with § 60.533(o)(3)(i) of 40 CFR Part 60.

6.4.5 Auxiliary Wood Heater Equipment Operation. Heat exchange blowers sold with the wood heater shall be operated during the test run following the manufacturer's written instructions. If no manufacturer's written instructions are available, operate the heat exchange blower in the "high" position. (Automatically operated blowers shall be operated as designed.) Shaker grates, by-pass controls, or other auxiliary equipment may be adjusted only one time during the test run following the manufacturer's written instructions.

Record all adjustments on a wood heater operational written record.

NOTE: If the wood heater is sold with a heat exchange blower as an option, test the wood heater with the heat exchange blower operating as described in Sections 5 and 6 and report the results. As an alternative to repeating all test runs without the heat exchange blower operating, the tester may conduct one test run without the blower operating as described in Section 6.4.5 at a burn rate in Category 2 (Section 5.1). If the emission rate resulting from this test run without the blower operating is equal to or less than the emission rate plus 1.0 g/hr for the test run in burn rate Category 2 with the blower operating, the wood heater may be considered to have the same average emission rate with or without the blower operating. Additional test runs without the blower operating are unnecessary.

6.5 Consecutive Test Runs. Test runs on a wood heater may be conducted consecutively provided that a minimum one-hour interval occurs between test runs.

6.6 Additional Test Runs. The testing laboratory may conduct more than one test run in each of the burn rate categories specified in Section 5.1. If more than one test run is conducted at a specified burn rate, the results from at least two-thirds of the test runs in that burn rate category shall be used in calculating the weighted average emission rate (see Section 8.1). The measurement data and results of all test runs shall be reported regardless of which values are used in calculating the weighted average emission rate (see NOTE: in Section 5.2).

6.7 Pellet Burning Heaters. Certification testing procedures for pellet burning wood heaters are based on the procedures in this method. The differences in the procedures from the sections in Method 28 are as follows:

6.7.1 Test Fuel Properties. The test fuel shall be all wood pellets with a moisture content no greater than 20 percent on a wet basis (25 percent on a dry basis). Determine the wood moisture content with either ASTM-D2016-74(82)(Method A) or ASTM D4442-84. (incorporated by reference. See Section 60.17).

6.7.2 Test Fuel Charge Specifications. The test fuel charge size shall be as per the manufacturer's written instructions for maintaining the desired burn rate.

6.7.3 Wood Heater Firebox Volume. The firebox volume need not be measured or determined for establishing the test fuel charge size. The firebox dimensions and other heater specifications needed to identify the heater for certification purposes shall be reported.

6.7.4 Heater Installation. Arrange the heater with the fuel supply hopper on the platform scale as described in Section 6.2.1.

6.7.5 Pretest Ignition. Start a fire in the heater as directed by the manufacturer's written instructions, and adjust the heater controls to achieve the desired burn rate. Operate the heater at the desired burn rate for at least 1 hour before the start of the test run.

6.7.6 Sampling Method. Method 5G or 5H shall be used for the certification testing of pellet burners. Prepare the sampling equipment as described in Method 5G or 5H. Collect one particulate emission sample for each test run.

6.7.7 Test Run. Complete a test run in each burn rate category as follows:

6.7.7.1 Test Run Start. When the wood heater has operated for at least 1 hour at the desired burn rate, add fuel to the supply hopper as necessary to complete the test run, record the weight of the fuel in the supply hopper (the wood heater weight), and start the test run. Add no additional fuel to the hopper during the test run.

Record all the wood heater surface temperatures, the initial sampling method measurement values, the time at the start of the test, and begin the emission sampling. Make no adjustments to the wood heater air supply or wood supply rate during the test run.

6.7.7.2 Data Recording. Record the fuel (wood heater) weight data, wood heater temperature and operational data, and emission sampling data as described in Section 6.4.2.

6.7.7.3 Test Run Completion. Continue emission sampling and wood heater operation for 2 hours. At the end of the test run, stop the particulate sampling, and record the final fuel weight, the run time, and all final measurement values.

6.7.8 Calculations. Determine the burn rate using the difference between the initial and final fuel (wood heater) weights and the procedures described in Section 8.3. Complete the other calculations as described in Section 8.

## 7. Calibrations

7.1 Platform Scale. Perform a multipoint calibration (at least five points spanning the operational range) of the platform scale before its initial use. The scale manufacturer's calibration results are sufficient for this purpose. Before each certification test, audit the scale with the wood heater in place by weighing at least one calibration weight (Class F) that corresponds to 20 percent to 80 percent of the expected test fuel charge weight. If the scale cannot reproduce the value of the calibration weight within 0.05 kg (0.1 lbs) or 1 percent of the expected test fuel charge weight, whichever is greater, recalibrate the scale before use with at least five calibration weights spanning the operational range of the scale.

7.2 Balance (optional). Calibrate as described in Section 7.1.

7.3 Temperature Monitor. Calibrate as in Method 2, Section 4.3, before the first certification test and semiannually thereafter.

7.4 Moisture Meter. Calibrate as per the manufacturer's instructions before each certification test.

7.5 Anemometer. Calibrate the anemometer as specified by the manufacturer's instructions before the first certification test and semiannually thereafter.

7.6 Barometer. Calibrate against a mercury barometer before the first certification test and semiannually thereafter.

7.7 Draft Gauge. Calibrate as per the manufacturer's instructions; a liquid manometer does not require calibration.

7.8 Humidity Gauge. Calibrate as per the manufacturer's instructions before the first certification test and semiannually thereafter.

## 8. Calculations and Reporting

Carry out calculations retaining at least one extra decimal figure beyond that of the acquired data. Round off figures after the final calculation.

8.1 Weighted Average Emission Rate.

$$E[w] = \frac{\sum_{i=1}^n K[i] E[i]}{\sum_{i=1}^n K[i]}$$

Eq. 28-1

where:

$E[w]$  = Weighted average emission rate, g/hr;

$E[i]$  = Emission rate for test run,  $i$ , from Method 5G or 5H, g/hr;

$k[i]$  = Test run weighting factor =  $P[i+1] - P[i-1]$ ;

$n$  = Total number of test runs;

$P[1]$  = Probability for burn rate during test run,  $i$ , obtained from Table 28-1. Use linear interpolation to determine probability values for burn rates between those listed on the table.

Note:  $P[0]$  always equals 0,  $P[(n+1)]$  always equals 1,  $P[1]$  corresponds to the probability of the lowest recorded burn rate,  $P[2]$  corresponds to the probability of the next lowest burn rate, etc. An example calculation is shown on Figure 28-5.

8.2 Average Wood Heater Surface Temperatures. Calculate the average of the wood heater surface temperatures for the start of the test run (Section 6.3.1) and for the test run completion (Section 6.3.6). If the two average temperatures do not agree within 70 degrees C (125 degrees F), report the test run results, but do not include the test run results in the test average. Replace such test run results with results from another test run in the same burn rate category.

8.3 Burn Rate.

$BR = 60 W[wd] / \theta 100$  -- percent Mw / 100

Eq. 28-2

Where:

$BR$  = Dry wood burn rate, kg/hr (lb/hr)

$W[wd]$  = Total mass of wood burned during the test run, kg(lb)

$\theta$  -- Total time of test run, min.

$\%M[w]$  = Average moisture in test fuel charge, wet basis, percent.

8.4 Reporting Criteria. Submit both raw and reduced test data for wood heater tests. Specific reporting requirements are as follows:

8.4.1 Wood Heater Identification. Report wood heater identification information. An example data form is shown on Figure 28-4.

8.4.2 Test Facility Information. Report test facility temperature, air velocity, and humidity information. An example data form is shown on Figure 28-4.

8.4.3 Test Equipment Calibration and Audit Information. Report calibration and audit results for the platform scale, test fuel balance, test fuel moisture meter, and sampling equipment including volume metering systems

and gaseous analyzers.

8.4.4 Pretest Procedure Description. Report all pretest procedures including pretest fuel weight, burn rates, wood heater temperatures, and air supply settings. An example data form is shown on Figure 28-4.

8.4.5 Particulate Emission Data. Report a summary of test results for all test runs and the weighted average emission rate. Submit copies of all data sheets and other records collected during the testing. Submit examples of all calculations.

8.4.6 Suggested Test Report Format.

*a. Introduction*

1. Purpose of test -- certification, audit, efficiency, research and development.
2. Wood heater identification -- manufacturer, model number, catalytic/ noncatalytic options.
3. Laboratory -- name, location (altitude), participants.
4. Test information -- date wood heater received, date of tests, sampling methods used, number of test runs.

*b. Summary and Discussion of Results*

1. Table of results (in order of increasing burn rate) -- test run number, burn rate, particulate emission rate, efficiency (if determined), averages (indicate which test runs are used).
2. Summary of other data -- test facility conditions, surface temperature averages, catalyst temperature averages, pretest fuel weights, test fuel charge weights, run times.
3. Discussion -- Burn rate categories achieved, test run result selection, specific test run problems and solutions.

*c. Process Description*

1. Wood heater dimensions -- volume, height, width, lengths (or other linear dimensions), weight, volume adjustments.
2. Firebox configuration--air supply locations and operation, air supply introduction location, refractory location and dimensions, catalyst location, baffle and by-pass location and operation (include line drawings or photographs).
3. Process operation during test -- air supply settings and adjustments, fuel bed adjustments, draft.
4. Test fuel -- test fuel properties (moisture and temperature), test fuel crib description (include line drawing or photograph), test fuel charge density.

*d. Sampling Locations*

Describe sampling location relative to wood heater. Include drawing or photograph.

*e. Sampling and Analytical Procedures*

1. Sampling methods -- brief reference to operational and sampling procedures and optional and alternative

procedures used.

2. Analytical methods -- brief description of sample recovery and analysis procedures.

*f. Quality Control and Assurance Procedures and Results*

1. Calibration procedures and results -- certification procedures, sampling and analysis procedures.

2. Test method quality control procedures -- leak-checks, volume meter checks, stratification (velocity) checks, proportionality results.

APPENDICES

1. Results and Example Calculations. Complete summary tables and accompanying examples of all calculations.

2. Raw Data. Copies of all uncorrected data sheets for sampling measurements, temperature records and sample recovery data. Copies of all pretest burn rate and wood heater temperature data.

3. Sampling and Analytical Procedures. Detailed description of procedures followed by laboratory personnel in conducting the certification test, emphasizing particularly parts of the procedures differing from the methods (e.g., approved alternatives).

4. Calibration Results. Summary of all calibrations, checks, and audits pertinent to certification test results with dates.

5. Participants. Test personnel, manufacturer representatives, and regulatory observers.

6. Sampling And Operation Records. Copies of uncorrected records of activities not included on raw data sheets (e.g., wood heater door open times and durations).

7. Additional Information. Wood heater manufacturer's written instructions for operation during the certification test.

*9. Bibliography*

1. Oregon Department of Environmental Quality Standard Method for Measuring the Emissions and Efficiencies of Woodstoves, June 8, 1984. Pursuant to Oregon Administrative Rules Chapter 340, Division 21.

2. American Society for Testing Materials. Proposed Test Methods for Heating Performance and Emissions of Residential Wood-Fired Closed Combustion-Chamber Heating Appliances. E-6 Proposal P 180. August, 1986.

3. Radian Corporation, OMNI Environmental Services, Inc., Cumulative Probability for a Given Burn Rate Based on Data Generated in the CONEG and BPA Studies. Package of materials submitted to the Fifth Session of the Regulatory Negotiation Committee, July 16-17, 1986.

Figure 28-1. Test fuel spacer dimensions.

[SEE FIGURE IN ORIGINAL]

Figure 28-2. Test fuel crib arrangements

[SEE FIGURE IN ORIGINAL]

Figure 28-3. Wood Heater and Test Fuel Information.

[SEE FIGURE IN ORIGINAL]

Figure 28-4. Test run wood heater operation data sheet

[SEE FIGURE IN ORIGINAL]

FIGURE 28-5 -- EXAMPLE CALCULATION OF WEIGHTED AVERAGE EMISSION RATE

Burn rate category	Burn		
	Test number	rate Dry-kg/hr)	Emis-sions (g/hr)
1	1	0.65	5.0
2 n1	2	0.85	6.7
2	3	0.90	4.7
2	4	1.00	5.3
3	5	1.45	3.8
4	6	2.00	5.1

n1 As permitted in Section 6.6, this test run may be omitted from the calculation of the weighted average emission rate because three runs were conducted for this burn rate category.

Test number	Burn rate	P[1] P1	E[1] E1	K[1] K1
1	0.65	0.121	5.0	0.300
2	0.90	0.300	4.7	0.259
3	1.00	0.380	5.3	0.422
4	1.45	0.722	3.8	0.532
5	2.00	0.912	5.1	0.278

$$K[1] = P[2] - P[0] = \text{RHO}[0] = 0.300 - 0 = 0.300$$

$$K[2] = P[3] - P[1] = 0.380 - 0.121 = 0.259$$

$$K[3] = P[4] - P[2] = 0.722 - 0.300 = 0.422$$

$$K[4] = P[5] - P[3] = 0.912 - 0.380 = 0.532$$

$$K[5] = P[6] - P[4] = 1 - 0.722 = 0.278$$

$$n \langle n \rangle \text{SIGMA } [i = 1] \times K[i] = 0.300 + 0.259 + 0.422 + 0.532 + 0.278$$

$$\langle n \rangle \text{SIGMA } [i = 1] = 1.791 \quad E[w] = \langle n \rangle \text{SIGMA } [i = 1] \times (K[i]E[i]) / \langle n \rangle \text{SIGMA } [i = 1] \times K[i]$$

$$E[w] (0.3)(5.0)+(0.259)(4.7)+(0.422)(5.3)+(0.532)(3.8)+(0.278)(5.1) \text{ divided by } 1.791$$

$$\text{EPSILON } [w] = 4.69 \text{ g/hr.}$$

TABLE 28-1 -- BURN RATE WEIGHTED PROBABILITIES FOR CALCULATING WEIGHTED AVERAGE EMISSION RATES

Burn rate (kg/hr-dry)	Cumulative Probability (P)
0.00	0.000
0.05	0.002
0.10	0.007
0.15	0.012
0.20	0.016
0.25	0.021
0.30	0.028
0.35	0.033
0.40	0.041
0.45	0.054
0.50	0.065
0.55	0.086
0.60	0.100
0.65	0.121
0.70	0.150
0.75	0.185
0.80	0.220
0.85	0.254
0.90	0.300
0.95	0.328
1.00	0.380
1.05	0.407
1.10	0.460
1.15	0.490
1.20	0.550
1.25	0.572
1.30	0.620
1.35	0.654
1.40	0.695
1.45	0.722
1.50	0.750
1.55	0.779
1.60	0.800
1.65	0.825

1.70	0.840
1.75	0.857
1.80	0.875
1.85	0.882
1.90	0.895
1.95	0.906
2.00	0.912
2.05	0.920
2.10	0.925
2.15	0.932
2.20	0.936
2.25	0.940
2.30	0.945
2.35	0.951
2.40	0.956
2.45	0.959
2.50	0.964
2.55	0.968
2.60	0.972
2.65	0.975
2.70	0.977
2.75	0.979
2.80	0.980
2.85	0.981
2.90	0.982
2.95	0.984
3.00	0.984
3.05	0.985
3.10	0.986
3.15	0.987
3.20	0.987
3.25	0.988
3.30	0.988
3.35	0.989
3.40	0.989
3.45	0.989
3.50	0.990
3.55	0.991
3.60	0.991
3.65	0.992
3.70	0.992
3.75	0.992
3.80	0.993
3.85	0.994
3.90	0.994
3.95	0.994
4.00	0.994
4.05	0.995
4.10	0.995
4.15	0.995

4.20	0.995
4.25	0.995
4.30	0.996
4.35	0.996
4.40	0.996
4.45	0.996
4.50	0.996
4.55	0.996
4.60	0.996
4.65	0.996
4.70	0.996
4.75	0.997
4.80	0.997
4.85	0.997
4.90	0.997
4.95	0.997
.>/=5.00	1.000

## METHOD 28A MEASUREMENT OF AIR TO FUEL RATIO AND MINIMUM ACHIEVABLE BURN RATES FOR WOOD-FIRED APPLIANCES

### *1. Applicability and Principle*

1.1 Applicability. This method is applicable for the measurement of air to fuel ratios and minimum achievable burn rates, for determining whether a wood-fired appliance is an affected facility, as specified in 40 CFR 60.530.

1.2 Principle. A gas sample is extracted from a location in the stack of a wood-fired appliance while the appliance is operating at a prescribed set of conditions. The gas sample is analyzed for percent carbon dioxide (CO[2]), percent oxygen (O[2]), and percent carbon monoxide (CO). These stack gas components are measured for determining dry molecular weight of exhaust gas. Total moles of exhaust gas are determined stoichiometrically. Air to fuel ratio is determined by relating the mass of dry combustion air to the mass of dry fuel consumed.

### *2. Definitions*

2.1 Burn Rate, Firebox, Secondary Air Supply, Test Facility, Test Fuel Charge, Test Fuel Crib, Test Fuel Loading Density, Test Fuel Piece, Test Run, Usable Firebox Volume, and Wood Heater. Same as Method 28, Sections 2.1 and 2.3 to 2.12.

2.2 Air to Fuel Ratio. Ratio of the mass of dry combustion air introduced into the firebox, to the mass of dry fuel consumed (grams of dry air per gram of dry wood burned).

### *3. Apparatus*

3.1 Test Facility. Insulated Solid Pack Chimney, Platform Scale and Monitor, Room Temperature Monitor, Balance, Moisture Meter, Anemometer, Barometer, Draft Gauge, and Humidity Gauge. Same as Method 28, Sections 3.1, 3.2, and 3.4 to 3.10, respectively.

3.2 Sampling System. Probe, Condenser, Valve, Pump, Rate Meter, Flexible Bag, Pressure Gauge, and Vacuum Gauge. Same as Method 3, Sections 2.2.1 to 2.2.8, respectively. The sampling systems described in Method 5H,

Sections 2.2.1, 2.2.2, and 2.2.3, may be used.

3.3 Analysis. Orsat analyzer, same as Method 3, Section 2.3; or instrumental analyzers, same as Method 5H, Sections 2.2.4 and 2.2.5, for CO<sub>2</sub> and CO analyzers, except use a CO analyzer with a range of 0 to 5 percent and use a CO<sub>2</sub> analyzer with a range of 0 to 5 percent. Use an O<sub>2</sub> analyzer capable of providing a measure of O<sub>2</sub> in the range of 0 to 25 percent by volume at least once every 10 minutes. Prepare cylinder gases for the three analyzers as described in Method 5H, Section 3.3.

#### *4. Test Preparation*

4.1 Test Facility, Wood Heater Appliance Installation, and Test Facility Conditions. Same as Method 28, Sections 4.1.1 and 4.1.2, respectively, with the exception that barometric dampers or other devices designed to introduce dilution air downstream of the firebox shall be sealed.

4.2 Wood Heater Air Supply Adjustments. This section describes how dampers are to be set or adjusted and air inlet ports closed or sealed during Method 28A tests. The specifications in this section are intended to ensure that affected facility determinations are made on the facility configurations that could reasonably be expected to be employed by the user. They are also intended to prevent circumvention of the standard through the addition of an air port that would often be blocked off in actual use. These specifications are based on the assumption that consumers will remove such items as dampers or other closure mechanism stops if this can be done readily with household tools; that consumers will block air inlet passages not visible during normal operation of the appliance using aluminum tape or parts generally available at retail stores; and that consumers will cap off any threaded or flanged air inlets. They also assume that air leakage around glass doors, sheet metal joints or through inlet grilles visible during normal operation of the appliance would not be further blocked or taped off by a consumer.

It is not the intention of this section to cause an appliance that is clearly designed, intended, and, in most normal installations, used as a fireplace to be converted into a wood heater for purposes of applicability testing. Such a fireplace would be identifiable by such features as large or multiple glass doors or panels that are not gasketed, relatively unrestricted air inlets intended, in large part, to limit smoking and fogging of glass surfaces, and other aesthetic features not normally included in wood heaters.

4.2.1 Adjustable Air Supply Mechanisms. Any commercially available flue damper, other adjustment mechanism or other air inlet port that is designed, intended or otherwise reasonably expected to be adjusted or closed by consumers, installers, or dealers and which could restrict air into the firebox shall be set so as to achieve minimum air into the firebox, i.e., closed off or set in the most closed position.

Flue dampers, mechanisms and air inlet ports which could reasonably be expected to be adjusted or closed would include:

- (a) All internal or externally adjustable mechanisms (including adjustments that affect the tightness of door fittings) that are accessible either before and/or after installation.
- (b) All mechanisms, other inlet ports, or inlet port stops that are identified in the owner's manual or in any dealer literature as being adjustable or alterable. For example, an inlet port that could be used to provide access to an outside air duct but which is identified as being closable through use of additional materials whether or not they are supplied with the facility.
- (c) Any combustion air inlet port or commercially available flue damper or mechanism stop, which would readily lend itself to closure by consumers who are handy with household tools by the removal of parts or the addition of parts generally available at retail stores (e.g., addition of a pipe cap or plug, addition of a small metal plate to an inlet hole on a nondecorative sheet metal surface, or removal of riveted or screwed damper stops).

(d) Any flue damper, other adjustment mechanisms or other air inlet ports that are found and documented in several (e.g., a number sufficient to reasonably conclude that the practice is not unique or uncommon) actual installations as having been adjusted to a more closed position, or closed by consumers, installers, or dealers.

4.2.2 Air Supply Adjustments During Test. The test shall be performed with all air inlets identified under this section in the closed or most closed position or in the configuration which otherwise achieves the lowest air inlet (e.g., greatest blockage).

For the purposes of this section, air flow shall not be minimized beyond the point necessary to maintain combustion or beyond the point that forces smoke into the room.

Notwithstanding Section 4.2.1, any flue damper, adjustment mechanism or air inlet port (whether or not equipped with flue dampers or adjusting mechanisms) that is visible during normal operation of the appliance and which could not reasonably be closed further or blocked except through means that would significantly degrade the aesthetics of the facility (e.g., through use of duct tape) will not be closed further or blocked.

4.3 Test Fuel Properties and Test Fuel Charge Specifications. Same as Method 28, Sections 4.2 to 4.3, respectively.

4.4 Sampling System.

4.4.1 Sampling Location. Same as Method 5H, Section 5.1.2.

4.4.2 Sampling System Set Up. Set up the sampling equipment as described in Method 3, Section 3.2, or as in Method 3A, Section 7.

## 5. Procedures

5.1 Pretest Preparation. Same as Method 28, Sections 6.2.1 and 6.2.3 to 6.2.5.

5.2 Pretest Ignition. Same as Method 28, Section 6.3. Set the wood heater air supply settings to achieve a burn rate in Category 1 or the lowest achievable burn rate (see Section 4.2).

5.3 Test Run. Same as Method 28, Section 6.4. Begin sample collection at the start of the test run as defined in Method 28, Section 6.4.1. If Method 3 is used, collect a minimum of two bag samples simultaneously at a constant sampling rate for the duration of the test run. A minimum sample volume of 30 l per bag is recommended. If instrumental gas concentration measurement procedures are used, conduct the gas measurement system performance specifications checks as described in Method 5H, Sections 6.7, 6.8, and 6.9. The zero drift and calibration drift limits for all three analyzers shall be 0.2 percent O<sub>2</sub>, CO<sub>2</sub>, or CO, as applicable, or less. Other measurement system performance specifications are as defined in Method 5H, Section 4. Sample at a constant rate for the duration of the test run.

5.3.1 Data Recording. Record wood heater operational data, test facility temperature, sample train flow rate, and fuel weight data at 10-minute intervals.

5.3.2 Test Run Completion. Same as Method 28, Section 6.4.6.

5.4 Analysis Procedure.

5.4.1 Method 3 Integrated Bag Samples. Within 4 hours after the sample collection, analyze each bag sample for percent CO<sub>2</sub>, O<sub>2</sub>, and CO using an Orsat analyzer as described in Method 3, Sections 4.2.5 through

4.2.7.

5.4.2 Instrumental Analyzers. Average the percent CO<sub>2</sub>, CO, and O<sub>2</sub> values for the test run.

5.5 Quality Control Procedures.

5.5.1 Data Validation. The following quality control procedure is suggested to provide a check on the quality of the data.

5.5.1.1 Calculate a fuel factor, F<sub>0</sub>, using the following equation:

$$F_0 = (20.9 - \% O_2) / \% CO_2$$

Eq. 28a-4

where:

%O<sub>2</sub> Percent O<sub>2</sub> by volume (dry basis).

%CO<sub>2</sub> Percent CO<sub>2</sub> by volume (dry basis).

20.9 Percent O<sub>2</sub> by volume in ambient air.

If CO is present in quantities measurable by this method, adjust the O<sub>2</sub> and CO<sub>2</sub> values before performing the calculation for F<sub>0</sub> as follows:

$$CO_2 \text{ (adj)} = \% CO_2 + \% CO$$

$$\% O_2 \text{ (adj)} = \% O_2 - 0.5 \% CO$$

where:

%CO = Percent CO by volume (dry basis).

5.5.1.2 Compare the calculated F<sub>0</sub> factor with the expected F<sub>0</sub> range for wood (1.000 - 1.120). Calculated F<sub>0</sub> values beyond this acceptable range should be investigated before accepting the test results. For example, the strength of the solutions in the gas analyzer and the analyzing technique should be checked by sampling and analyzing a known concentration, such as air. If no detectable or correctable measurement error can be identified, the test should be repeated. Alternatively, determine a range of air to fuel ratio results that could include the correct value by using an F<sub>0</sub> value of 1.05 and calculating a potential range of CO<sub>2</sub> and O<sub>2</sub> values. Acceptance of such results will be based on whether the calculated range includes the exemption limit and the judgment of the administrator.

5.5.1.3 Method 3 Analyses. Compare the results of the analyses of the two bag samples. If all the gas components (O<sub>2</sub>, CO, and CO<sub>2</sub>) values for the two analyses agree within 0.5 percent (e.g., 6.0 percent O<sub>2</sub> for bag 1 and 6.5 percent O<sub>2</sub> for bag 2, agree within 0.5 percent), the results of the bag analyses may be averaged for the calculations in Section 6. If the analysis results do not agree within 0.5 percent for each component, calculate the air-to-fuel ratio using both sets of analyses and report the results.

## 6. Calculations

Carry out calculations, retaining at least one extra decimal figure beyond that of the acquired data. Round off

figure after the final calculation. Other forms of the equations may be used as long as they give equivalent results.

## 6.1 Nomenclature.

$M[d]$  = Dry molecular weight, g/g-mole(lb/lb-mole).

$\%CO_2$  = Percent  $CO_2$  by volume (dry basis).

$\%O_2$  = Percent  $O_2$  by volume (dry basis).

$\%CO$  = Percent CO by volume (dry basis).

$\%N_2$  = Percent  $N_2$  by volume (dry basis).

$N[T]$  = Total gram-moles of dry exhaust gas per kg of wood burned (lb-moles/lb).

$Y[CO_2]$  = Measured mole fraction of  $CO_2$  (e.g., 10 percent  $CO_2$  = .10 mole fraction), g/g-mole (lb/lb-mole).

$Y[CO]$  = Measured mole fraction of CO (e.g., 1 percent CO = .01 mole fraction), g/g-mole (lb/lb-mole).

$Y[HC]$  = Assumed mole fraction of HC (dry as  $CH_4$ )

= 0.0088 for catalytic wood heaters;

= 0.0132 for noncatalytic wood heaters.

= 0.0080 for pellet-fired wood heaters.

0.280 = Molecular weight of  $N_2$  or CO, divided by 100.

0.320 = Molecular weight of  $O_2$  divided by 100.

0.440 = Molecular weight of  $CO_2$  divided by 100.

42.5 = Gram-moles of carbon in 1 kg of dry wood assuming 51 percent carbon by weight dry basis (.0425 lb/lb).

510 = Grams of carbon in exhaust gas per kg of wood burned.

1,000 = Grams in 1 kg.

6.2 Dry Molecular Weight. Use Equation 28a-1 to calculate the dry molecular weight of the stack gas.

$$M[d] = 0.440(\%CO_2) + 0.320(\%O_2) + 0.280(\%N_2 + \%CO)$$

Eq. 28a-1

NOTE: The above equation does not consider argon in air (about 0.9 percent, molecular weight of 37.7). A negative error of about 0.4 percent is introduced. The tester may opt to include argon in the analysis using procedures subject to approval of the Administrator.

6.3 Dry Moles of Exhaust Gas. Use Equation 28a-2 to calculate the total moles of dry exhaust gas produced per kilogram of dry wood burned.

$$N[T] = (42.5 / (Y[CO_2] + Y[CO] + Y[HC]))$$

Eq. 28a-2

6.4 Air to Fuel Ratio. Use Equation 28a-3 to calculate the air to fuel ratio on a dry mass basis.

$$A/F = ((N[T] \times M[d] - (510) / (1000))$$

Eq. 28a-3

6.5 Burn Rate. Calculate the fuel burn rate as in Method 28, Section 8.3.

### *7. Bibliography*

Same as Method 3, Section 7, and Method 5H, Section 7.

SOURCE: [36 FR 24877, Dec. 23, 1971]

AUTHORITY: 42 U.S.C. 7401, 7411, 7414, 7416, and 7601.

