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EMISSION FACTOR DOCUMENTATION FOR

AP-42 SECTION 2.1,

REFUSE COMBUSTION

**Office of Air Quality Planning and Standards
Office of Air and Radiation
U.S. Environmental Protection Agency
Research Triangle Park, North Carolina 27711**

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1.0 INTRODUCTION

The document "Compilation of Air Pollutant Emission Factors" (AP-42) has been published by the U.S. Environmental Protection Agency (EPA) since 1972. New additions of emission source categories and updates to existing emission factors to supplement the AP-42 have been routinely published. These supplements are in response to the emission factor needs of the EPA, State, and local air pollution control programs, and industry.

An emission factor relates the quantity (weight) of pollutants emitted from a unit source. The emission factors presented in AP-42 can be used to determine the following:

- (1) Estimates of area-wide emissions;
- (2) Emission estimates for a specific facility; and
- (3) Evaluation of emissions relative to ambient air quality.¹

The purpose of this report is to provide background information on refuse combustion and the reports reviewed and used to calculate emission factors.

Including the introduction (Chapter 1.0), this report contains five chapters. Chapter 2.0 gives a description of municipal waste combustors (MWCs). It includes a characterization of the industry, an overview of the different process types, a discussion of emission sources, and a description of the technology used to control emissions resulting from MWCs. Chapter 3.0 is a review of emissions data collection and analysis procedures. The AP-42 methodology is presented in Chapter 3.0, including the discussion of the literature search, emissions data screening procedure, the data quality rating system, and the data used. Chapter 4.0 describes the pollutant emission factor development. The data utilized are reviewed, the protocol methodology is discussed, and the results of the analysis are presented. Chapter 5.0 presents AP-42 Section 2.1, Refuse Combustion.

REFERENCES FOR CHAPTER 1.0

1. U.S. Environmental Protection Agency, Emission Inventory Branch, Technical Support Division. Technical Procedures for Developing AP-42 Emission Factors and Preparing AP-42 Sections. (Draft), March 6, 1992.

2.0 INDUSTRY DESCRIPTION

2.1 CHARACTERIZATION OF THE INDUSTRY

As of January 1992, there were over 160 MWC facilities in operation or under construction in the United States with capacities greater than 36 megagrams per day (Mg/day) [40 tons per day (tpd)]. It has been projected that in the 5-year period between 1992 and 1997, construction will commence on an additional 60 plants.¹ Although this illustrates an increase in the use of combustion as a waste management technique, the projected capacity is not sufficient to meet the increasing level of MSW generation in the United States.

In addition to these existing and projected MWCs, there are numerous smaller facilities. This population of very small MWC facilities comprises a small percentage of the total MWC capacity in the United States. Many of these very small MWC facilities are found in small, remote communities where conditions are unsuitable for landfills.

There are three main types of technologies used to combust MSW: mass burn, modular, and refuse-derived fuel (RDF). A fourth type, fluidized-bed combustors (FBCs), is less common and can be considered a subset of the RDF technology. More detailed descriptions of these different combustor technologies are presented in Section 2.2. Of the 160 larger facilities, 53 percent are mass burn, 31 percent are modular, and 15 percent are RDF. Of the total MWC capacity in the United States, about 70 percent is in mass burn facilities, 25 percent is in RDF facilities, and 5 percent is in modular facilities. Of the total design capacity of MWC plants projected to be constructed between 1992 and 1997, mass burn facilities will account for the majority of the new MWC capacity.

New York, Florida, Minnesota, and Massachusetts have the greatest number of existing facilities, with between 10 and 15 each. In terms of total capacity, Florida is the leader with a capacity of about 15,700 Mg/day (17,300 tpd) of MSW. New York, Massachusetts, Pennsylvania, Virginia, and Connecticut have the

next largest capacities, ranging from 6,100 to 11,300 Mg/day (6,700 to 12,500 tpd) of MSW. Table 2-1 summarizes the geographic distribution of facilities and their capacities.

2.2 PROCESS DESCRIPTION

There are three major types of MWCs:

- (1) Mass burn,
- (2) Modular, and
- (3) RDF-fired (including co-firing).

Within these major combustor categories, there are a number of different designs. The more common design subclasses are described in this chapter.

Most MWC plants consist of one to four combustor units. Unit capacities range from about 4.5 to 905 Mg/day (5 to 1,000 tpd), and total facility capacities range from 4.5 to 2,700 Mg/day (5 to 3,000 tpd). Modular MWCs are at the low end of this size range, while mass burn and RDF units tend to be larger.

2.2.1 Mass Burn Combustors

Mass burn combustors use gravity or mechanical ram systems to feed MSW onto a moving grate where the waste is combusted. Historically, mass burn combustors have been used to combust MSW that generally has not been preprocessed, except to remove bulky items too large to go through the feed system. Waste that has been processed to remove recyclable materials, but has not been further processed (e.g., shredded, pelletized) to produce RDF, can also be combusted in these units. Mass burn combustors are usually field-erected and range in size from 46 to 900 Mg/day (50 to 1,000 tpd) of MSW per unit. Many mass burn facilities have two or more combustors and have site capacities up to 2,700 Mg/day (3,000 tpd).

Mass burn combustors can be divided into mass burn/waterwall (MB/WW), mass burn/rotary waterwall (MB/RC), and mass burn/refractory-wall (MB/REF) designs. Descriptions of these combustor technologies are provided below.

TABLE 2-1. SUMMARY OF GEOGRAPHICAL DISTRIBUTION OF MWC FACILITIES^a

State	Number of MWC Facilities	State MWC Capacity (tpd)	Percentage of Total MWC Capacity in the United States
AK	2	170	<1
AL	2	990	1
AR	5	380	<1
CA	3	2560	2
CT	9	6663	6
DC	1	1000	1
DE	1	600	<1
FL	14	17346	16
GA	1	500	<1
HI	1	2760	2
IA	1	200	<1
ID	1	50	<1
IN	1	2362	2
IL	1	1600	1
MA	10	10340	9
MD	3	3810	3
ME	4	1870	2
MI	5	4825	4
MN	13	5332	5
MO	1	78	<1
MS	1	150	<1
MT	1	72	<1
NC	4	775	1
NH	4	856	1
NJ	6	5822	5
NY	15	12509	11
OH	4	4800	4
OK	2	1230	1
OR	3	813	1
PA	6	7202	6
PR	1	1040	1
SC	2	840	1
TN	4	1480	1
TX	4	244	<1
UT	1	400	<1
VA	9	6841	6
WA	5	1498	1
WI	9	1362	1

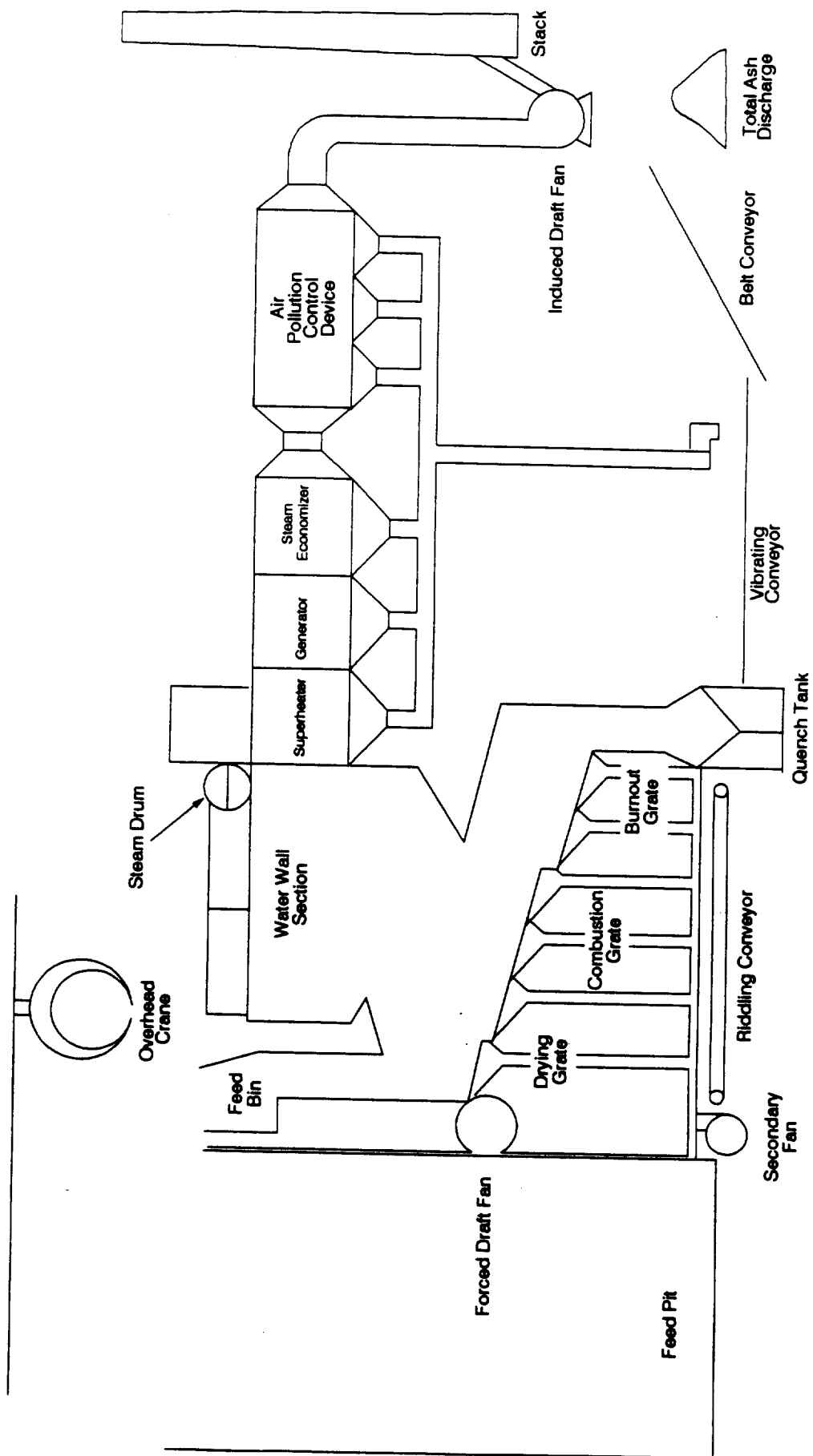
^aAs of January 1992.

2.2.1.1 Mass Burn Waterwall Combustors

The MB/WW design represents the predominant technology in the existing population of MWCs. It is expected that over 50 percent of new units will be MB/WW designs. In MB/WW units, the combustor walls are constructed of metal tubes that contain circulating pressurized water used to recover heat from the combustion chamber. In the lower actively burning region of the chamber, where high temperatures and variable gas conditions may lead to corrosive conditions, the walls are generally lined with castable refractory. Waterwall tubes may be embedded in the refractory. Heat is also recovered in the convective sections (i.e., superheater, economizer) of the combustor.

A typical MB/WW combustor is shown in Figure 2-1. Waste (with large, bulky materials removed) is delivered by an overhead crane to a feed hopper, which feeds the waste into the combustion chamber. Earlier MB/WW designs utilized gravity feeders, but it is now more typical for the waste to be fed into the combustor using single or dual hydraulic rams.

Most modern MB/WW facilities have reciprocating or roller grates that move the waste through the combustion chamber. The primary purpose of all types of grates is to agitate the waste bed to ensure good mixing of the waste with undergrate air and to move the waste uniformly through the combustor. The grates typically include three sections where distinct stages in the combustion process take place. On the initial grate section, referred to as the drying grate, the moisture content of the waste is reduced prior to ignition. The second grate section, referred to as the burning grate, is where the majority of active burning takes place. The third grate section, referred to as the burnout or finishing grate, is where remaining combustibles in the waste are burned. Smaller units may have two rather than three individual grate sections. Bottom ash is discharged from the finishing grate into a water-filled ash quench pit or ram discharger. From there, the wet ash is discharged to a conveyor system and transported to an ash load-out or storage area prior



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Figure 2-1. Typical mass burn waterwall combustor.

to disposal. Dry air systems were used in some older designs, but are not common now.

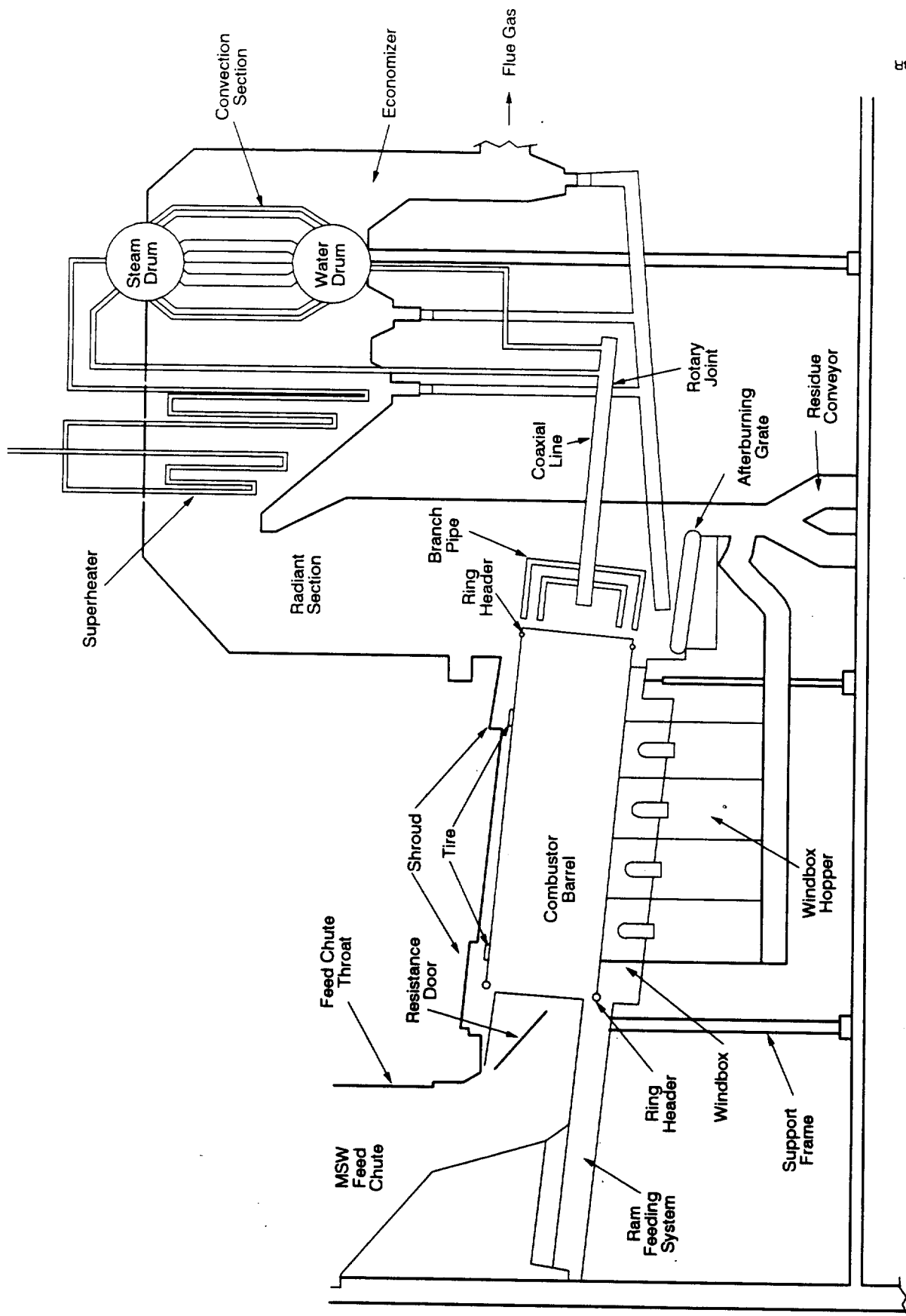
Combustion air is added to the waste from beneath each grate section through underfire air plenums. The ability to control burning and heat release from the waste bed is enhanced by the provision of separately controllable air flows to each grate section. The refractory-lined walls in the lower furnace help to prevent excessive heat removal in the lower furnace by waterwall tubes. As the waste bed burns, additional air is required to oxidize fuel-rich gases and complete the combustion process. Overfire air is injected through rows of high pressure nozzles located in the side walls of the combustor. Properly designed and operated overfire air systems are essential for good mixing and burnout of organics in the flue gas.

Typically, MB/WW MWCs are operated with 80 to 100 percent excess air. Normally 25 to 40 percent of total air is supplied as overfire air and 60 to 75 percent as underfire air. These are nominal ranges and may vary for specific designs.

The flue gas exits the combustor and passes through additional heat recovery sections (superheater, economizer) to one or more air pollution control devices (APCDs). The types of APCDs that may be used are discussed in Section 2.4.

2.2.1.2 Mass Burn/Rotary Waterwall Combustors

Mass burn/rotary waterwall combustors range in size from 180 to 2,400 Mg/day (200 to 2,700 tpd), with typically two or three units per plant. A typical MB/RC is shown in Figure 2-2. Waste is conveyed to a feed chute and ram fed to the rotary combustion chamber. The rotary combustion chamber sits at a slight angle, and rotates at about 10 revolutions per hour, causing the waste to advance and tumble as it burns. The combustion cylinder consists of alternating watertubes and perforated steel plates. Preheated combustion air enters the combustor through the plates. Underfire air is injected through the waste bed, and overfire air is provided above the waste bed. Bottom ash is discharged from the rotary combustor to an after-burning grate and then into a wet quench pit or ram extractor.



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Figure 2-2. Simplified process flow diagram, gas cycle for a rotary Waterwall Combustor

From there, the moist ash is conveyed to an ash load-out or storage area prior to disposal.

Approximately 80 percent of the total combustion air is provided along the rotary combustion chamber length, with most of the air provided in the first half of the chamber length. The rest of the combustion air is supplied to the afterburning grate and through the overfire air jets located above the rotary combustor outlet in the boiler. The MB/RC operates at about 50 percent excess air, compared with 80 to 100 percent excess air for typical MB/WW firing systems. Heat recovery occurs both in the rotary chamber watertubes and in the boiler waterwall, superheater, and economizer. From the economizer, the flue gas is typically routed to APCDs.

2.2.1.3 Mass Burn Refractory-Wall Combustors

Prior to 1970 there were numerous MB/REF MWCs operating. The goal of these plants was to achieve waste reduction; energy recovery was generally not incorporated into their design. By today's standards, these facilities were frequently poorly designed and operated and, as a result, had significant emissions of particulate matter (PM) and other pollutants. Because of environmental restrictions imposed on large combustion devices by EPA in the early 1970's, most of these facilities closed. Most of the roughly 25 MB/REF plants that still operate or that have been built in the 1970's and 1980's have installed electrostatic precipitators (ESPs) to reduce PM emissions, and several have installed heat recovery boilers. Most MB/REF plants have combustor unit sizes of 90 to 270 Mg/day (100 to 300 tpd). It is not expected that additional plants of this design will be built in the United States.

The MB/REF combustors have several designs. One design involves a batch-fed upright combustor, which may be cylindrical or rectangular in shape. This type of combustor was prevalent in the 1950's, but only three units are reported as still in operation. A second, more common design consists of rectangular combustion chambers with traveling, rocking, or reciprocating grates. The traveling grate moves on a set of sprockets and

provides little mixing of the waste bed as it advances through the combustor. As a result, waste burnout is inhibited by fuel bed thickness, and there is considerable potential for unburned waste to be discharged into the bottom ash pit unless fuel feeding, grate speeds, and combustion air flows and distributions are well controlled. It is unlikely that these operational requirements are routinely accomplished by these units. Rocking or reciprocating grates stir and aerate the waste bed as it advances through the combustor chamber, thereby improving contact between the waste and combustion air and increasing the burnout of combustibles. A rotary kiln may be added to the end of the grate system to complete combustion.

There are a number of design features and operating practices in place at existing MB/REF MWCs that inherently cause elevated emission levels of air pollutants. Some of the primary concerns include fuel feeding, combustion air distribution and control, excess air levels, and startup/shutdown procedures. Typically, these plants use a gravity feed system and control fuel feeding by adjusting the grate speeds. Problems with waste burnout can result from changes in waste properties (e.g., moisture) or poor distribution of waste on the grate. Reciprocating and rocking grates can minimize these problems, but traveling grates cannot respond to changes in fuel properties. Combustion air systems on many existing MB/REF MWCs are inadequate to provide good combustion and minimize levels of trace organic emissions. Some overfire air systems simply inject air for dilution and cooling rather than providing penetration and coverage of the combustor cross section.

The MB/REF combustors typically operate at higher excess air rates (150 to 300 percent) than MB/WW combustors (80 to 100 percent). This is because MB/REF combustors do not recover heat from the combustion chamber, thus higher excess air levels are required to prevent excessive temperatures, which can result in refractory damage, slagging, fouling, and corrosion problems.

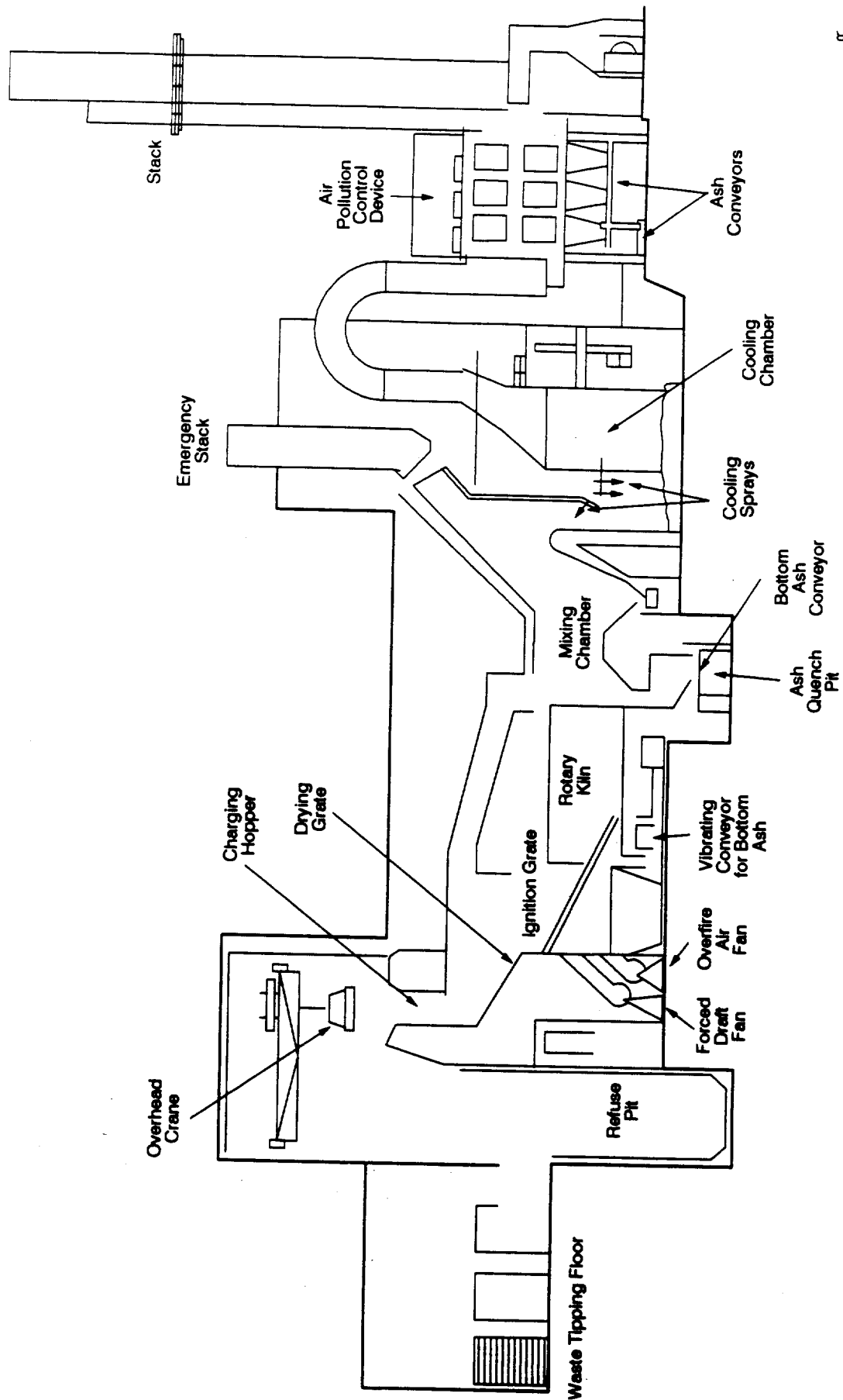
One adverse effect of high excess air levels is the potential for increased carryover of PM from the combustion

chamber and, ultimately, increased stack emission rates. It is hypothesized that high PM carryover may also contribute to increased chlorinated dibenzo p-dioxin/chlorinated dibenzofuran (CDD/CDF) emissions by providing increased surface area for downstream catalytic formation to take place. A second problem is the potential for high excess air levels to quench (cool) the combustion reactions, preventing destruction of organic species.

An alternate, newer MB/REF combustor is the Volund design shown in Figure 2-3. This design minimizes some of the problems of other MB/REF systems. In this design, a refractory arch is installed above the combustion zone to reduce radiant heat losses and improve solids burnout. The refractory arch also routes part of the rising gases from the drying and combustion grates through a gas by-pass duct to the mixing chamber. There the gas is mixed with gas from the burnout grate or kiln. Bottom ash is conveyed to an ash quench pit. Volund MB/REF combustors operate with 80 to 120 percent excess air, which is more in line with excess air levels in the MB/WW designs. As a result, lower CO levels and better organics destruction, as compared to other MB/REF combustors are achievable.

2.2.2 Modular Combustors

Modular combustors are similar to mass burn combustors in that they burn waste that has not been pre-processed except for removal of very bulky items. However, modular combustors are shop-fabricated and generally range in unit size from about 4 to 130 Mg/day (5 to 140 tpd) of MSW throughput. Because multiple combustors may be located at a plant, plant capacities can range up to about 450 Mg/day (500 tpd), but are generally smaller. The most common type of modular combustor is the starved-air or controlled-air type. Another type of modular combustor, which is functionally similar from a combustion standpoint to the larger MB/WW systems is referred to as an excess-air combustor.



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Figure 2-3. Volund mass burn refractory - wall combustor with grate/rotary kiln

2.2.2.1 Modular Starved-Air Combustors

In terms of number of units, modular starved-air (MOD/SA) combustors represent a large segment of the existing MWC population, however because of their small size, they account for only a small percent of the total capacity.

A typical MOD/SA MWC is shown in Figure 2-4. The basic design includes two separate combustion chambers, referred to as the "primary" and "secondary" chambers. Waste is batch-fed to the primary chamber by a hydraulically activated ram. Waste feeding occurs automatically, with generally 6 to 10 minutes between charges. Waste is moved through the primary combustion chamber by either hydraulic transfer rams or reciprocating grates, and waste retention times in the primary chamber are long, lasting up to 12 hours. Bottom ash from this chamber is usually discharged to a wet quench pit.

Combustion air is introduced in the primary chamber at sub-stoichiometric levels, resulting in a flue gas rich in unburned hydrocarbons. The combustion air flow rate to the primary chamber is controlled to maintain an exhaust gas temperature set point [generally 650 to 760°C (1,200 to 1,400°F)], which normally corresponds to about 40 percent theoretical air. Other system designs operate with a primary chamber temperature between 870 and 980°C (1,600 and 1,800°F), which requires 50 to 60 percent theoretical air.

As the hot, fuel-rich gases flow to the secondary chamber, they are mixed with excess air to complete the burning process. The temperature of the exhaust gases from the primary chamber is above the auto ignition point. Thus, completing combustion is simply a matter of introducing air to the fuel-rich gases. The amount of air added to the secondary chamber is controlled to maintain a desired flue gas exit temperature, typically 980 to 1,200°C (1,800 to 2,200°F). Approximately 80 percent of the total combustion air is introduced as secondary air. Typical excess air levels vary from 80 to 150 percent.

The walls of the primary and secondary combustion chambers are refractory lined. Early MOD/SA combustors did not include

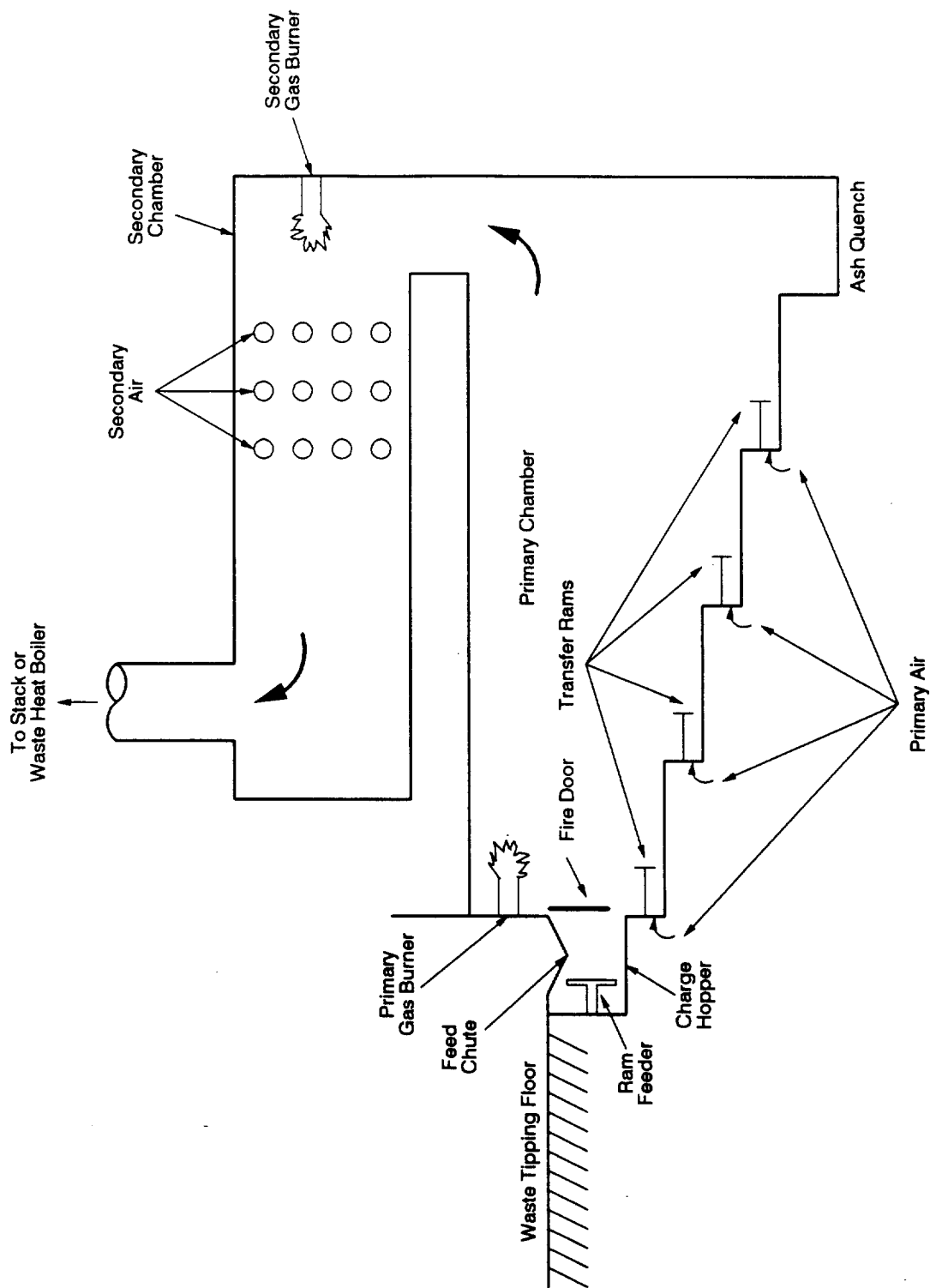


Figure 2-4. Typical modular starved-air combustor with transfer rams

heat recovery, but a waste heat boiler is common in newer facilities, with two or more combustion modules sometimes manifolded to a common boiler. Combustors with heat recovery capabilities also maintain dump stacks for use in an emergency, or when the boiler is not in operation.

Most MOD/SA MWCs are equipped with auxiliary fuel burners located in both the primary and secondary combustion chambers. Auxiliary fuel can be used during startup (many modular units do not operate continuously, or when problems are experienced maintaining desired combustion temperatures. In general, the combustion process is self-sustaining through control of air flows and feed rate, so continuous co-firing of auxiliary fuel is normally not necessary.

The high combustion temperatures and sufficient mixing of flue gas with air in the secondary combustion chamber provide good combustion, resulting in relatively low CO and trace organic emissions. Because of the limited amount of combustion air introduced through the primary chamber, gas velocities in the primary chamber and the amount of entrained particulate are low. As a result, uncontrolled particulate emissions from MOD/SA MWCs are relatively low. Many existing modular systems do not have air pollution controls. This is especially true of the smaller facilities.

2 .2.2 Modular Excess-Air Combustors

There are fewer modular excess-air (MOD/EA) MWCs than MOD/SA designs. Individual capacities of existing combustors range from 7 to 130 Mg/day (8 to 140 tpd), but the newer units tend to be larger [90 to 145 Mg/day (100 to 160 tpd per combustor)]. The basic design is similar to that of the MOD/SA units, including primary and secondary combustion chambers. Waste is batch-fed to the refractory-lined primary chamber and moved through the primary chamber by hydraulic transfer rams, oscillating grates, or a revolving hearth. Bottom ash is discharged to a wet quench pit. Additional flue gas residence time is provided in the secondary chamber, which is also refractory-lined. Heat is typically recovered in a waste heat boiler. Facilities with

multiple combustors may have a tertiary chamber where flue gases from each combustor are mixed prior to entering the heat recovery boiler.

Unlike the MOD/SA combustors, and similar to MB/REF units, the MOD/EA combustor typically operates at about 100 percent excess air in the primary chamber, but may vary between 50 and 250 percent excess air. The MOD/EA combustors also use recirculated flue gas for combustion air to maintain desired temperatures in the primary, secondary, and tertiary chambers. Due to higher air velocities, PM emissions from MOD/EA combustors are higher than those from MOD/SA combustors, and are more similar to PM emissions from mass burn units. However, nitrogen oxides (NO_x) emissions from MOD/EA combustors appear to be lower than those from either MOD/SA or mass burn units.

2.2.3 Refuse-derived Fuel Combustors

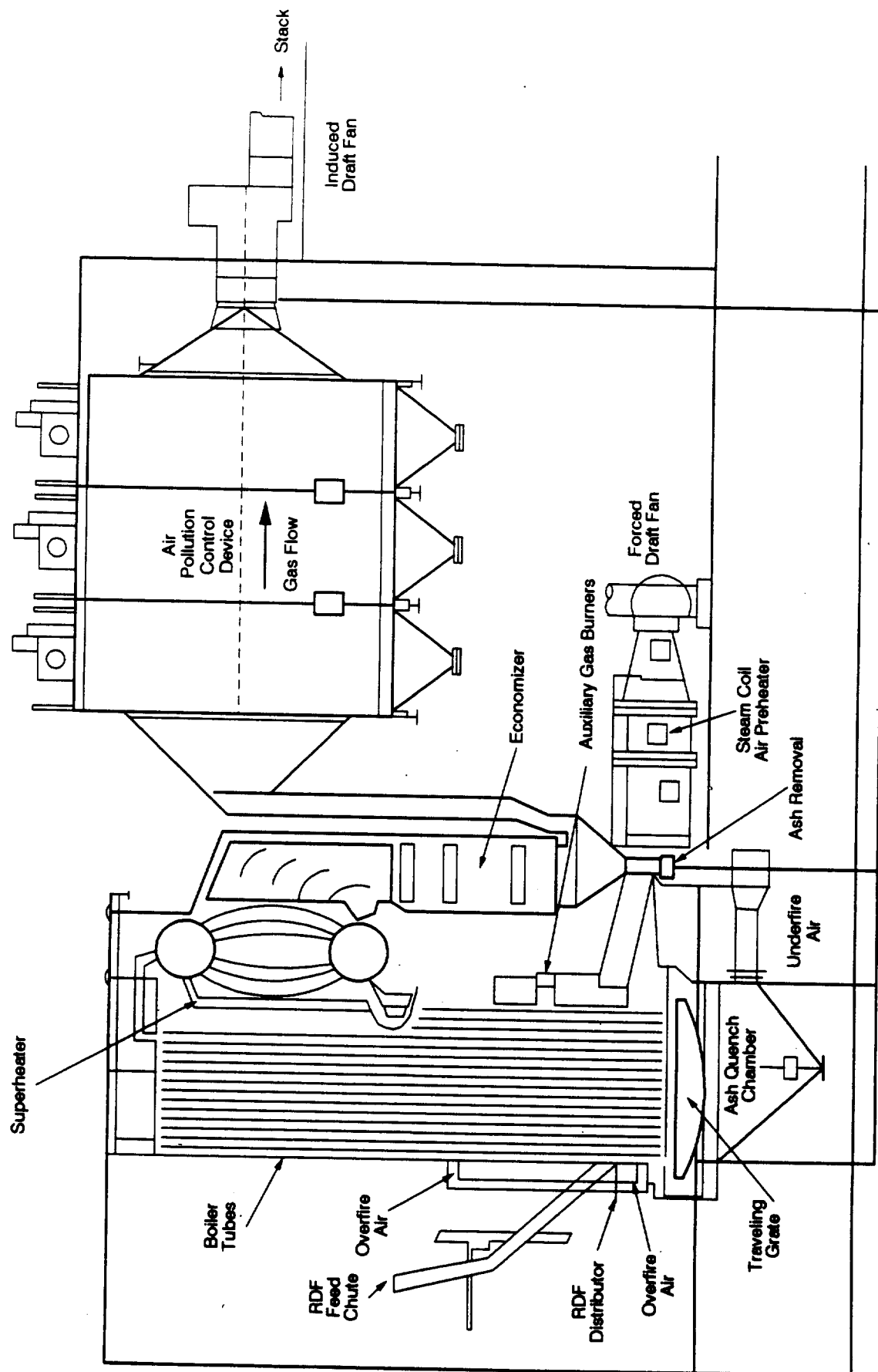
Refuse-derived fuel combustors burn MSW that has been processed to varying degrees, from simple removal of bulky and noncombustible items accompanied by shredding, to extensive processing to produce a finely divided fuel suitable for co-firing in pulverized coal-fired boilers. Processing MSW to RDF generally raises the heating value of the waste because many of the noncombustible items are removed. These facilities use waterwall and convective heat transfer to recover heat for production of steam for electrical generation or industrial processes. There are fewer RDF plants than mass burn or modular plants, but since plant capacities tend to be large, they represent about 30 percent of existing and planned capacity. Individual combustor sizes range from 290 to 1,270 Mg/day (320 to 1,400 tpd). Generally, RDF facilities have two or more combustors, and site capacities range to over 2,720 Mg/day (3,000 tpd). Most RDF is fired in spreader stoker boilers, either by itself or as a mixture of RDF and other materials such as wood waste. In addition to these dedicated RDF combustors, several pulverized coal utility boilers co-fire RDF as a supplemental fuel. This section discusses RDF spreader-stoker boilers and coal/RDF co-fired combustors. Fluidized bed

combustors, a distinct design that also fires RDF, are discussed in Section 2.2.4.

2.2.3.1 Spreader-Stoker Boilers

A schematic of a typical RDF spreader-stoker boiler is shown in Figure 2-5. With few exceptions, boilers that are designed to burn RDF as a primary fuel utilize spreader-stokers and fire fluff RDF in a semi-suspension mode. In this mode, RDF is fed into the combustor through a feed chute using an air-swept distributor, which allows a portion of the feed to burn in suspension and the remainder to be burned out after falling on a horizontal traveling grate. The number of RDF distributors in a single unit varies directly with unit capacity. The distributors are normally adjustable so that the trajectory of the waste feed can be varied. Because the traveling grate moves from the rear to the front of the furnace, distributor settings are adjusted so that most of the waste lands on the rear two-thirds of the grate. This allows more time for combustion to be completed on the grate. Bottom ash drops into a water-filled quench chamber. Some traveling grates operate at a single speed, but most can be manually adjusted to accommodate variations in burning conditions. Underfire air is normally preheated and introduced beneath the grate by a single plenum. Overfire air is injected through rows of high pressure nozzles, providing a zone for mixing and completion of the combustion process. These combustors typically operate with 80 to 100 percent excess air.

Due to the basic design of RDF feeding systems, PM levels at the APCD inlet are typically double those of mass burn systems and more than an order of magnitude higher than MOD/SA combustors. The higher particulate loadings may contribute to the catalytic formation of CDD/CDF; however, mercury (Hg) emissions from these plants may be considerably lower than from mass burn plants as a result of the higher levels of carbon present in the PM carryover (as explained in Section 2.4, Hg adsorbs onto the carbon and can be subsequently captured by the PM control device).



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Figure 2-5. Typical RDF-fired spreader stoker boiler.

2.2.3.2 Co-Fired Combustors

Refuse-derived fuel can be co-fired in various types of coal-fired boilers including pulverized coal-fired and cyclone-fired boilers. During the 1980's and early 1990's, RDF was co-fired at six utility boilers located at four facilities. Five of the units use pulverized coal boilers and one unit uses a cyclone boiler. Due to local conditions, however, several of these units have discontinued RDF co-firing.

In the pulverized coal-fired systems, the RDF is introduced into the combustor by air transport injectors that are located above or even with the coal nozzles. Due to its high moisture content and large particle size, RDF requires a longer burnout time than coal. A portion of the larger particles become disengaged from the gas flow and fall onto stationary drop grates at the bottom of the furnace where combustion is completed. Ash that accumulates on the grate is periodically dumped into the ash hopper below the grate.

Most RDF/pulverized coal-firing units operate with 50 percent excess air. Furnace exit temperatures are generally in excess of 1,095°C (2,000°F).

In an RDF/coal-fired cyclone combustor, the RDF is injected into the combustion chamber along with secondary air through ports in the top of the cylinder. The cyclone operates at temperatures exceeding 1,370°C (2,500°F), which melts the combustion ash into a liquid slag. Most of the incoming coal and RDF get caught in the slag layer and burn rapidly. The rest becomes entrained in the gas flow and is carried to the convection section and subsequently is captured by the APCD. Slag is drained through a slag tap hole and quenched to form bottom ash.

Refuse-derived fuel can also be compressed to form a pellet that can be used in a mechanical stoker-fired boiler designed for coal. Several small commercial and institutional facilities have used pelletized RDF, but such uses are less common than other RDF firing methods.

Co-firing RDF with coal affects various combustor operating and performance parameters including boiler efficiency, flue gas flow rates, stack emissions, bottom ash production, and slagging and fouling. Co-firing with RDF can affect the emissions of PM and acid gases. Compared to coal, RDF typically has a lower sulfur content and a higher chlorine and ash content. Therefore, co-firing generally increases hydrogen chloride (HCl) and PM emissions while it decreases sulfur dioxide (SO₂) emissions. In addition, fly ash resistivity may increase with RDF co-firing, and the increased resistivity along with increased flue gas volume may decrease APCD efficiency.

2.2.4 Fluidized Bed Combustors

Fluidized bed combustors have typically been used for combustion of fossil fuels and nonmunicipal waste fuels (i.e., agricultural waste), but they are beginning to be used with RDF. In an FBC, waste is combusted in a turbulent bed of noncombustible material such as limestone, sand, or silica. In its simplest form, an FBC consists of a combustion vessel equipped with a gas distribution plate and underfire air windbox at the bottom. The combustion bed overlies the gas distribution plate. The RDF may be injected into or above the bed through ports in the combustor wall. Other wastes and supplemental fuel may be blended with the RDF outside the combustor or added into the combustor through separate openings. The combustion bed is suspended or "fluidized" through the introduction of underfire air at a high flow rate. Overfire air is used to complete the combustion process.

There are two basic types of FBC systems: bubbling bed combustors and circulating bed combustors. With a bubbling bed combustor, most of the fluidized solids are maintained near the bottom of the combustor by using relatively low fluidization velocities. This helps reduce the entrainment of solids from the bed into the flue gas. In contrast, circulating bed combustors operate at relatively high fluidization velocities to promote carryover of solids into the upper section of the combustor. Combustion occurs in both the bed and upper section of the

combustor. By design, a fraction of the bed material from the circulating bed combustor is entrained in the combustion gas and enters a cyclone separator that recycles unburned waste and inert particles to the lower bed. Some of the ash is removed from the cyclone and with the solids from the bed.

Good mixing is inherent in the FBC design. The FBCs have very uniform temperatures and mass compositions in both the bed and in the upper region of the combustor. This allows the FBCs to operate at lower excess air and temperatures than conventional combustion systems. Waste-fired FBCs typically operate at excess air levels between 30 and 100 percent and at bed temperatures around 815°C (1,500°F). Low temperatures are necessary for waste-firing FBCs because higher temperatures lead to softening of ash in the waste fuel that results in bed agglomeration.

2.3 EMISSIONS

Depending on the characteristics of the MSW and combustion conditions in the MWC, combustion can result in emissions of the following pollutants:

- NO_x;
- Carbon monoxide (CO);
- Acid gases (HCl, SO₂);
- PM;
- Metals [cadmium (Cd), lead (Pb), Hg, arsenic (As), nickel (Ni), chromium (Cr), etc.]; and
- Toxic organics [CDD/CDF, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), etc.].

A brief discussion of the formation mechanisms for each of these pollutants is provided below.

2.3.1 Nitrogen Oxides

The oxides of nitrogen are products of all combustion processes. Nitric oxide (NO) is the dominant component in NO_x; however, nitrogen dioxide (NO₂) and nitrous oxide (N₂O) are also formed in smaller amounts. The combination of these compounds is referred to as NO_x.

Levels of uncontrolled NO_x are tied to combustor types, excess air level, and air distribution.⁴ Nitrogen oxides data from MB/RC and MOD/EA combustors are consistently lower than from other mass burn units, due to the design of these MWCs. In addition, MOD/EA units typically incorporate flue gas recirculation (FGR), a NO_x control combustion modification where cooled flue gas is mixed with combustion air to reduce the O_2 content of the combustion air supply.

The NO_x emission concentrations for MB/WW, MB/REF, RDF, and MOD/SA units are similar. Because the MB/REF plants are generally older and operate with greater fluctuations in combustor flue gas temperature profiles than other types of MWCs, significant variations in NO_x levels may occur.

2.3.2 Carbon Monoxide

Carbon monoxide emissions result when all of the carbon in the waste is not oxidized to carbon dioxide (CO_2). High levels of CO indicate that the flue gases were not held at a high temperature in the presence of sufficient O_2 for a long enough time to oxidize CO to CO_2 . As waste burns in a fuel bed, it releases CO_2 , CO, hydrogen (H_2), and unburned hydrocarbons. Additional air then reacts with the gases escaping from the fuel bed to convert CO and H_2 to CO_2 and H_2O . Adding too much air to the combustion zone will lower the local gas temperature and quench (retard) the oxidation reactions. If too little air is added, the probability of incomplete mixing increases, allowing greater quantities of unburned hydrocarbons to escape the furnace. Part of these hydrocarbons are then converted into CDD/CDF.

Because O_2 concentrations and air distributions vary among combustor types, CO levels also vary. Operation with good combustion practices (GCP) can reduce the upper range of CO levels; however, distinctions between combustor types still exist. For example, semi-suspension-fired RDF units generally have higher CO levels than mass burn units, due to the effects of carryover of incompletely combusted materials into low

temperature portions of the boiler, and, in some cases, due to instabilities that result from fuel feed characteristics.

Carbon monoxide concentration is a good indicator of combustion efficiency, and is an important criterion for indicating instabilities and nonuniformities in the combustion process. It is during unstable combustion conditions that more carbonaceous material is available and higher CDD/CDF levels are expected. The relationship between emissions of CDD/CDF and CO indicates that high levels of CO (several hundred parts per million by volume [ppmv]), corresponding to poor combustion conditions, frequently correlate with high CDD/CDF emissions. When CO levels are low, however, correlations between CO and CDD/CDF are not well defined (due to the fact that many mechanisms may contribute to CDD/CDF formation), but CDD/CDF emissions are generally lower.

2.3.3 Acid Gases

The chief acid gases of concern from the combustion of MSW are HCl and SO₂. Hydrogen fluoride (HF), hydrogen bromide (HBr), and sulfur trioxide (SO₃) are also generally present, but at much lower concentrations. Concentrations of HCl and SO₂ in MWC flue gases directly relate to the chlorine and sulfur content in the waste. The chlorine and sulfur contents vary considerably based on seasonal and local waste variations. Emissions of SO₂ and HCl from MWCs depend on the chemical form of sulfur and chlorine in the waste, the availability of alkali materials in combustion-generated fly ash that act as sorbents, and the type of emission control system used. Acid gas concentrations are considered to be independent of combustion conditions. One of the major sources of chlorine in MSW are paper and plastics. Sulfur is contained in many constituents of MSW, such as asphalt shingles, gypsum wallboard, and tires. Because RDF processing does not generally impact the distribution of combustible materials in the waste fuel, HCl and SO₂ concentrations for mass burn and RDF units are similar.

2.3.4 Particulate Matter

As used in this discussion, PM refers to total PM, as measured by EPA Reference Method 5. The amount of PM exiting the furnace of an MWC depends on the waste characteristics, the combustor's design, and the combustor's operation. Under normal combustion conditions, solid fly ash particles formed from inorganic, noncombustible constituents in MSW are released into the flue gas. The majority of these particles are captured by the particulate collector and are not emitted to the atmosphere.

Particulate matter can vary greatly in size with diameters ranging from less than one micrometer (μm) to hundreds of micrometers. Particles with diameters less than $10\ \mu\text{m}$ (known as PM-10) are of concern because there is a greater potential for inhalation and passage into the pulmonary region. Further, acid gases, metals, and toxic organics may preferentially adsorb onto smaller particles.⁷

Particulate matter concentrations at the inlet of the APCD will vary according to boiler design and load, air distribution, and waste characteristics. For example, facilities that operate with high underfire/overfire air ratios or relatively high excess air levels may entrain greater quantities of PM and have high PM levels at the APCD inlet. For boilers with multiple passes that change the direction of the flue gas flow, greater quantities of PM may be removed prior to the APCD. Lastly, the physical properties of the waste being fed and the method of feeding influences PM levels in the flue gas. Typically, RDF units have higher PM carryover from the furnace due to the suspension-feeding of the RDF. However, controlled PM emissions from RDF units do not vary substantially from other MWCs (i.e., MB/WW), because the PM is efficiently collected in the APCD.

2.3.5 Metals

Metals are present in a variety of MSW streams, including paper, newsprint, yard wastes, wood, batteries, and metal cans. Metals present in MSW are emitted from MWCs in association with PM (e.g., As, Cd, Cr, and Pb) and as volatile gases (e.g., Hg). Metal concentrations are highly variable, due to the variability

in MSW composition, and are essentially independent of combustor type. If the condensation temperature of a vaporized metal is such that condensation onto particulates in the flue gas is possible, the metal can be effectively removed by the PM control device. With the exception of Hg, most metals have condensation points well above 300°C (570°F) which is greater than the normal operating temperatures of most control devices. Therefore, removal by the PM control device for these metals is high. Capture by the PM control device for mercury, however, is highly variable. In addition to temperature, the level of carbon in the fly ash can affect Hg control. A high level of carbon in the fly ash can enhance Hg adsorption onto particles removed by the PM control device.

2.3.6 Toxic Organics

A variety of organic compounds, including CDD/CDFs, chlorobenzene (CB), PCBs, chlorophenols (CPs), and PAHs are present in MSW or can be formed during the combustion and post-combustion processes. Organics in the flue gas can exist in the vapor phase or can be condensed or absorbed onto fine particulates. Control of organic emissions is accomplished through proper design and operation of both the combustor and the APCDs.

Based on potential health effects, CDD/CDF have been a focus of many research and regulatory activities. Due to toxicity levels, attention is most often placed on levels of the CDD/CDF in the tetra through octa total homolog groups and on the specific isomers within those groups that have chlorine substituted in the 2, 3, 7, and 8 positions. Uncontrolled emissions of CDD/CDF are dependent on combustor type, with generally higher emissions from RDF units. As a result of formation mechanisms that are related to flue gas temperature, operation of an APCD may either increase or decrease CDD/CDF emissions.⁶

2.4 AIR POLLUTION CONTROL TECHNIQUES

Emissions from MWCs can be controlled through combustion/process modifications and application of add-on APCDs.

This section discusses the effects of GCP, various APCDs, and control techniques used to treat MWC flue gas to reduce emissions.

2.4.1 Good Combustion Practice

Good combustion practice is defined as MWC system design, operation, and maintenance techniques which, when applied with appropriate flue gas cleaning techniques, can increase combustion efficiency and minimize trace organic emissions. The GCP control strategy includes collectively applying a number of combustion conditions to achieve three broad goals:

- (1) Maximize in-furnace destruction of organics;
- (2) Minimize PM carryover out of the furnace; and
- (3) Minimize low temperature reactions that promote formation of CDD/CDF.

There are three specific measurable parameters that compose a set of combustor operating conditions that can be related directly or indirectly to the GCP components. These three combustion parameters are:

- CO levels in the flue gas;
- Operating load; and
- PM control device inlet flue gas temperature.

Good combustion is associated with low emissions of CDD/CDF and other trace organics. As noted earlier, available emissions data indicate that CO is a good indicator of CDD/CDF emissions. The ability to maintain low CO and CDD/CDF concentrations in MWC flue gases is dependent on combustor design features and operation practices. A review of emissions data from MWCs indicates that design limitations may make it challenging for some combustor types to achieve CO emission levels that are routinely attained by other units. For example and as noted previously, semi-suspension-fired RDF systems may have more difficulty maintaining low CO levels than mass burn units due to the effects of carryover of incompletely combusted materials into low temperature portions of the boiler, and, in some cases, due to combustion control instabilities that result from fuel feeding characteristics.

2.4.2 Particulate Matter/Metals Control

The control of PM, along with metals that have adsorbed onto the PM, is most frequently accomplished through the use of control devices such as ESPs and fabric filters (FFs). Although other PM control technologies (e.g., cyclones, electrified gravel beds, venturi scrubbers) are available, they are seldom used on existing systems, and it is anticipated they will not be frequently used in future MWC systems. This section, therefore, focuses on ESP and FF design and performance.

2.4.2.1 Electrostatic Precipitators¹¹

Electrostatic precipitators consist of a series of high-voltage (up to 100 kV) discharge electrodes and grounded metal plates through which PM-laden flue gas flows. Negatively charged ions formed by this high-voltage field (known as a "corona") attach to PM in the flue gas, causing the charged particles to migrate toward and be collected on the grounded plates. The most common ESP types used by MWCs are: (1) plate-wire units in which the discharge electrode is a bottom-weighted or rigid wire, and (2) flat plate units, which use flat plates rather than wires as the discharge electrode. As a general rule, the greater the amount of collection plate area, the greater the ESP's PM collection efficiency.

In general, fly ashes with resistivities between 1×10^8 and 5×10^{10} ohm-cm and with a minimum of very fine particles ($<1 \mu\text{m}$) can be efficiently collected in ESPs. If the resistivity of the collected PM exceeds roughly 2×10^{10} ohm-cm, the collected PM layer may have sufficient electrical charge to create a "back corona" phenomenon that interferes with the migration of charged fly ash particles to the collecting electrode and significantly reduces collection efficiency. At resistivities below 10^8 ohm-cm, the electrical charge on individual particles may be so low that reentrainment of collected dust during electrode cleaning or simply as a result of contact with moving flue gas can become severe.

Particle size also plays a role in ESP performance. Small particles generally migrate toward the collection plates more

slowly than large particles, and are therefore more difficult to collect. This factor is especially important to MWCs because of the amount of total fly ash less than 1 μm . For MWCs, 20 to 70 percent of the fly ash at the ESP inlet is less than 1 μm . In comparison, for pulverized coal-fired boilers, only 1 to 3 percent of the fly ash is generally less than 1 μm . Effective collection of a MWC's PM will require greater collection areas and lower flue gas velocities than PM from many other fuel types.

Several parameters affect PM collection and resulting PM and metals emissions. These include the number of fields, specific collection area (SCA), gas temperature, particle resistivity, and inlet PM concentration.

The design and PM control performance of ESPs at existing MWCs varies significantly. Depending on the uncontrolled PM levels and the permitted emission limits in effect at the time the ESP was built, some units were built with SCAs of less than 200 and only 1 or 2 fields. Newer ESPs can have as many as 4 or 5 fields, with SCAs of 400 to 600.

There is a strong correlation between PM control and the collection of most metals. As a result, for metals other than Hg, good control of PM will also achieve significant reductions in metals emissions. If PM removal efficiency is 98 percent or greater, the removal efficiency of As, Be, Cd, Cr, Pb, and Ni will generally be at least 95 percent. Mercury is rarely removed by an ESP alone (i.e., without acid gas controls) since Hg exists in a vaporous state at normal ESP operating temperatures.

The ESP operating temperature is a key parameter affecting CDD/CDF emissions. The formation of CDD/CDF across the ESP increases with increasing ESP inlet temperatures, and is at a maximum at about 300°C (570°F). Because fly ash resistivity is greatly affected by temperature, most ESPs on MWCs have traditionally operated at 225 to 290°C (440 to 550°F) to avoid potential problems with PM collection. However, individual ESPs with temperatures as low as 195°C (380°F) and as high as 315°C (600°F) have been reported.

2.4.2.2 Fabric Filters¹¹

Fabric filters are also used for PM and metals control, particularly in combination with acid gas control and flue gas cooling. Fabric filters (also known as "baghouses") remove PM by passing flue gas through a porous fabric that has been sewn into a cylindrical bag. Multiple individual filter bags are mounted and arranged in a compartment. A complete FF may contain several individual compartments that can be independently operated.

Fabric filters are very effective in removing both coarse and fine particulate. Removal efficiencies are typically greater than 99 percent. Similar to MWCs with ESPs, metals removal for a MWC equipped with an FF is related to PM collection efficiency.

As with ESPs, formation of CDD/CDF decreases with decreasing FF inlet temperatures. Generally, a FF in combination with acid gas scrubbing can achieve somewhat lower levels of CDD/CDF emissions than an ESP with the same acid gas control device.

2.4.3 Acid Gas Controls

The control of acid gas emissions (i.e., SO₂ and HCl) is accomplished through the application acid gas control technologies such as spray drying and dry sorbent injection, and wet scrubbing.

2.4.3.1 Spray Drying¹¹

Spray drying is the most frequently used acid gas control technology for MWCs in the United States. Spray drying can be used in combination with either an ESP or FF for PM control. Spray dryer/fabric filter (SD/FF) systems are more common than SD/ESP systems and are used most on new, large MWCs. In the spray drying process, lime is slurried and then injected into the SD through either a rotary atomizer or dual-fluid nozzles. The moisture in the lime slurry evaporates to cool the flue gas, and the lime reacts with the acid gases to form calcium salts.

The key design and operating parameters that significantly affect SD performance are the SD's outlet approach to saturation temperature and lime-to-acid gas stoichiometric ratio. The SD outlet approach to saturation temperature is controlled by the amount of water in the lime slurry. More effective acid gas

removal occurs at lower temperatures, but the gas temperature must be kept high enough to ensure the slurry and reaction products are adequately dried prior to collection in the PM control device.

2.4.3.2 Dry Sorbent Injection¹¹

There are two different dry sorbent injection technologies used to control acid gas emissions. The first, referred to as duct sorbent injection (DSI), is the more widely used approach, and involves injecting dry alkali sorbents into flue gas downstream of the combustor outlet and upstream of the PM control device. The second approach, referred to as furnace sorbent injection (FSI), injects sorbent directly into the combustor.

With DSI, powdered sorbent is pneumatically injected into either a separate reaction vessel or a section of flue gas duct located downstream of the combustor economizer. Alkali in the sorbent (generally hydrated lime or sodium bicarbonate) reacts with HCl and SO₂ to form alkali salts (e.g., calcium chloride [CaCl₂] and calcium sulfite [CaSO₃]). Reaction products, fly ash, and unreacted sorbent are collected with either an ESP or FF.¹²

Furnace sorbent injection has been applied to conventional and fluidized bed MWCs. This acid gas control technique involves the injection of powdered calcium sorbents (lime, hydrated lime, or limestone) into the furnace section of a combustor. This can be accomplished by addition of sorbent to the overfire air, injection through separate ports, or mixing with the waste prior to feeding to the combustor. As with DSI, reaction products, fly ash, and unreacted sorbent are collected primarily using an ESP or FF.

2.4.3.3 Wet Scrubbing¹²

Many types of wet scrubbers have been used for controlling acid gas emissions from MWCs. These include spray towers, centrifugal scrubbers, and venturi scrubbers. Wet scrubbing technology has primarily been used in Japan and Europe.

Wet scrubbing normally involves passing the flue gas through an ESP to reduce PM, followed by one or two absorbers. When two

absorbers are used, the first absorber is typically a low pH water absorber followed by a high pH alkaline absorber. The primary objective of the first absorber is to lower the flue gas temperature and remove HCl. The second absorber is used to remove SO₂ and residual HCl. When a single absorber is used, an alkaline absorber is used to remove both HCl and SO₂. The resulting salts are then removed from the absorber liquids and disposed of as a wastewater or solid waste.

2.4.4 Mercury Control Techniques

Add-on Hg control techniques include the injection of activated carbon or sodium sulfide (Na₂S) into the flue gas in conjunction with the DSI- or SD-based acid gas control systems, and the use of activated carbon filters. These technologies have not been used commercially on MWCs in the United States, but have been applied to MWCs in Europe, Canada, and Japan. However, recent test programs using activated carbon and Na₂S injection have been conducted in the United States.

With activated carbon injection, Hg is adsorbed onto the carbon particle, which is subsequently collected in the PM control device. The collected carbon, fly ash, and sorbent mixture are then disposed of as a solid waste. Mercury removal efficiencies reported generally range from 80 percent to over 95 percent.^{13,14,15}

In sodium sulfide injection, a Na₂S solution is sprayed into cooled flue gas (about 200°C [390°F]) prior to the acid gas control device. The reaction of Na₂S and Hg precipitates solid mercuric sulfide (HgS) that can be collected in the PM control device. Results from tests on Canadian and European MWCs using Na₂S injection indicate Hg reduction efficiencies of 50 to over 90 percent. However, questions have been raised regarding these performance levels, based on Hg levels measured during a Na₂S test program on an MWC in the United States. As part of this test program, the laboratory filter used to filter residual solids in the sampling train was digested and analyzed. This step is not usually part of the analytical method (EPA Method 101A). The additional filter analyses found significant

amounts of Hg in the outlet sampling train (after Na₂S addition), thus suggesting that some of the Hg collected by Method 101A may not be detected during analysis and that the reported removal efficiencies from MWCs in Canada and Europe may be overstated.¹⁶

Fixed bed activated carbon filters are another Hg control technology being used in Europe. With this technology, flue gas passes through a fixed bed of granular activated carbon where Hg is adsorbed. Segments of the bed are periodically replaced as system pressure drop increases.¹³

2.4.5 Nitrogen Oxide Control Techniques

The control of NO_x emissions can be accomplished through either combustion controls or add-on controls. Combustion controls include staged combustion, low excess air (LEA), and flue gas recirculation (FGR). Add-on controls that have been tested on MWCs include selective noncatalytic reduction (SNCR), selective catalytic reduction (SCR), and natural gas reburning.

Combustion controls involving the control of temperature or O₂ to reduce NO_x formation have been applied to a variety of combustion sources. Because of the lower combustion temperatures present in MWCs, [$<1,000^{\circ}\text{C}$ ($1,800^{\circ}\text{F}$)] compared to fossil fuel-fired utility and industrial boilers [$>1,200^{\circ}\text{C}$ ($2,200^{\circ}\text{F}$)], relatively little thermal NO_x is formed. As a result, most of the NO_x emitted by MWCs is produced from oxidation of nitrogen present in the fuel. As a result, combustion modifications at MWCs have generally shown small to moderate reductions in NO_x emissions compared to fossil fuel-fired boilers. Discussion on LEA, staged combustion, and FGR are presented below.

Low excess air and staged combustion can be used separately or together. With LEA, less air is supplied to the combustor than normal, lowering the supply of O₂ available in the flame zone to react with N₂ in the combustion air. With staged combustion, the amount of underfire (primary) air is reduced, generating a starved-air region. By creating a starved-air zone, part of the fuel-bound nitrogen is converted to NH₃. Secondary air to complete combustion is added as overfire (secondary) air. If the addition of overfire air is properly controlled, NH₃, NO_x,

and O_2 react to form N_2 and water. However, because of the variability of MSW fuel characteristics and the difficulty of carefully controlling the combustion process in most MWCs, achieving these reactions is difficult. An exception is the MB/RC in which more precise control of combustion air may make staged combustion processes effective in reducing NO_x .⁴

In FGR, cooled flue gas is mixed with combustion air, thereby reducing the O_2 content of the combustion air supply. The flame temperature is lowered by the recirculated flue gas and less O_2 is present in the flame zone, thereby potentially reducing thermal NO_x generation. At a mass burn combustor where FGR is used to supply 10 percent of the underfire air, reductions in NO_x emissions have been observed, although quantitative results are not available.

Selective noncatalytic reduction refers to add-on NO_x control techniques that reduce NO to N_2 without the use of catalysts. These techniques include Thermal De NO_x TM (licensed by Exxon), which uses ammonia (NH_3) injection; NO_x OUTTM (Electric Power Research Institute/Nalco Fuel Tech), which uses urea (NH_2CONH_2) injection along with chemical additives; and two-stage urea/methanol injection (Emcotek).

Based on analyses of data from MWCs in the United States, SNCR can reduce NO_x by 45 percent or more. Key factors affecting the performance of SNCR are the stability of temperature profiles within the combustor and the reagent injection rate. A temperature range of roughly 870 to 1,100°C (1,600 to 2,000°F) is needed for the Thermal De NO_x TM process to be effective. The NO_x OUTTM process operates in a temperature range of 870 to 1,200°C (1,600 to 2,200°F), and chemical enhancers can extend the lower end of this range down to 700 to 815°C (1,300 to 1,500°F).¹⁷ If the flue gas temperature at the injection point is too high, the reducing agent will convert to NO and NO_2 , thereby increasing NO_x emissions. When the NH_3 is injected at too low a temperature or at a high rate, NH_3 can be emitted from the stack. If the HCl levels in the stack exceed roughly 5 ppmv,

NH₃ and HCl can react to form ammonia chloride (NH₃Cl₂), which results in a visible plume.⁴

Selective catalytic reduction involves injecting NH₃ into the gas flue gas downstream of the boiler where it is mixed with the NO_x contained in the flue gas and passed through a catalyst bed. In the catalyst bed, NO_x is reduced to N₂ by reaction with NH₃. Reductions in NO_x of over 80 percent may be possible based on data from an MWC in Germany.¹⁸ Selective catalytic reduction has not been applied to any MWCs in the United States.

Natural gas reburning is a NO_x control technique that overlaps combustion control technique. Combustion air is limited at the combustor grate to produce an LEA zone. Recirculated flue gas and natural gas are then added to this LEA zone to generate a fuel-rich zone. The resulting reducing conditions inhibit NO_x formation and promote reduction of NO_x that is formed by reaction with unoxidized ions. Natural gas reburning (also termed METHANE de-NO_xTM) at MWCs has been evaluated at both pilot-scale and full-scale levels. During these tests, NO_x emissions were reduced by up to 70 percent, with an average reduction of 50 percent in a pilot-scale study.¹⁹

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18. Carlsson, K.B., and T. Ekman. Reduction of Nitrogen Oxides with SCR Technology in Solid Waste Incinerators. Presented at the International Conference on Municipal Waste Combustion. Hollywood, Florida. April 1989.
19. Bijetina, R., H.A. Abbasi, M.E. Cousino, and R. Dunnette. Field Evaluation of Methane de-NO_x at Olmstead Waste-to-Energy Facility. Presented at the 7th Annual Waste-to-Energy Symposium. Minneapolis, Minnesota, January 28-30, 1992.

3.0 GENERAL DATA REVIEW AND ANALYSIS PROCEDURES

In the preparation stage for the refuse combustion AP-42 section, a data gathering task was undertaken. This task included an extensive literature search, contacts to identify ongoing projects within the EPA and industry, and electronic database searches. Included in the data gathering was the collection of MWC source test reports. After the data gathering was completed, a review and analysis of the information obtained was undertaken to reduce and synthesize the information. The following sections present the general data gathering and review/analysis procedures performed in the preparation of the Refuse Combustion AP-42 section.

3.1 DATA GATHERING

3.1.1 Literature Search

The literature search conducted for the preparation of this AP-42 section included an on-line library system search of the National Technical Information Service (NTIS). Information gathered under previous work assignments concerning the New Source Performance Standards (NSPS) was also accessed. Once information was obtained and retrieved from the formal searches, references cited in reports and documents were reviewed for additional sources of information.

3.1.2 Contacts

Contact was made with EPA and EPA consultants with expertise in MWCs and testing to request input, support, and potential sources of information not previously obtained. Telephone contacts were also conducted to identify ongoing projects within the EPA and industry which may generate useful emissions information.

3.1.3 Electronic Database Searches

The Crosswalk/Air Toxics Emission Factors (XATEF), VOC/PM Chemical Speciation (SPECIATE), and the Aerometric Information Retrieval System (AIRS)/Facility Subsystem Emission Factors (AFSEF) electronic databases were searched.

3.2 LITERATURE AND DATA REVIEW/ANALYSIS

Reduction of the literature and data to a smaller, more pertinent subset for development of the Refuse Combustion AP-42 section was governed by the following:

- Only primary references of emissions data were used.
- Test study source processes were clearly identified.
- Test studies specified whether emissions were controlled or uncontrolled.
- Studies referenced for controlled emissions specify the control devices.
- Sufficient support of data was supplied.
- Test study units were convertible to selected reporting units.
- Test studies that were positively biased to a particular situation were excluded.

3.3 EMISSION DATA QUALITY RATING SYSTEM

As delineated by the Emission Inventory Branch (EIB), the reduced subset of emission data was ranked for quality. The ranking/rating of the data was used to identify questionable data. Each data set was ranked as follows:

- A - Tests performed by a sound methodology and reported in enough detail for adequate validation. These tests are not necessarily EPA reference method tests, although such reference methods were preferred.
- B - Tests performed by a generally sound methodology, but lacking enough detail for adequate validation.
- C - Tests based on an untested or new methodology or are lacking a significant amount of background data.
- D - Tests based on a generally unacceptable method but the method may provide an order-of-magnitude value for the source.¹

The selected rankings were based on the following criteria:

- Source operation. The manner in which the source was operated is well documented in the report. The source was operating within typical parameters during the test.

- Sampling procedures. If actual procedures deviated from standard methods, the deviations are well documented. Procedural alterations are often made in testing an uncommon type of source. When this occurs an evaluation is made of how such alternative procedures could influence the test results.
- Sampling and process data. Many variations can occur without warning during testing, sometimes without being noticed. Such variations can induce wide deviation in sampling results. If a large spread between test results cannot be explained by information contained in the test report, the data are suspect and are given a lower rating.
- Analysis and calculations. The test reports contain original raw data sheets. The nomenclature and equations used are compared with those specified by the EPA, to establish equivalency. The depth of review of the calculations is dictated by the reviewers' confidence in the ability and conscientiousness of the tester, which in turn is based on factors such as consistency of results and completeness of other areas of the test report.

3.4 EMISSION FACTOR DETERMINATION AND RANKING

Once the data are ranked, the selection of data for use in the development of emission factors for uncontrolled and controlled emissions is made. Similar to the ranking of the data, the emission factors developed and presented in the emission factor tables are ranked. The quality ranking ranges from A (best) to E (worst). As delineated by the EIB, the emission factor ratings are applied as follows:

- Excellent. Developed only from A-rated source test data taken from many randomly chosen facilities in the industry population. The source category is specific enough to minimize variability within the source population.
- Above average. Developed only from A-rated test data from a reasonable number of facilities. Although no specific bias is evident, it is not clear if the facilities tested represent a random sample of the industries. As with the A rating, the source is specific enough to minimize variability within the source population.
- Average. Developed only from A- and B-rated test data from a reasonable number of facilities. Although no

specific bias is evident, it is not clear if the facilities tested represent a random sample of the industry. As with the A rating, the source category is specific enough to minimize variability within the source population.

- D. Below average. The emission factor was developed only from A- and B-rated test data from a small number of facilities, and there may be reason to suspect that these facilities do not represent a random sample of the industry. There also may be evidence of variability within the source population. Any limitations on the use of the emission factor are footnoted in the emission factor table.
- E. Poor. The emission factor was developed from C- and or D-rated test data, and there may be reason to suspect that the facilities tested do not represent a random sample of the industry. There also may be evidence of variability within the source category population. Any limitations on the use of these factors are always clearly noted.

Emission data quality and emission factor development and ranking according to the discussed methodology in this chapter are presented in more detail in Chapter 4.0.

REFERENCES FOR CHAPTER 3.0

1. Technical Procedures for Developing AP-42 Emission Factors and Preparing AP-42 Sections. Draft, Emission Inventory Branch. Office of Air and Radiation. Office of Air Quality Planning and Standards. U.S. Environmental Protection Agency, Research Triangle Park, NC, March 6, 1992.

4.0 POLLUTANT EMISSION FACTOR DEVELOPMENT

This chapter describes the test data and methodology used to develop pollutant emission factors for MWCs.

4.1 REVIEW OF THE DATA SET

The test data quality evaluation of most of the MWC data presented in Section 2.1 of the AP-42 was performed by persons working on New Source Performance Standards (NSPS) for MWCs. Discussions with key persons involved in the data review indicate that the same screening procedures described in Chapter 3.0 were used to evaluate the data. In general, data of questionable quality were not used in the NSPS team's evaluation of emissions from MWCs.

In the development of AP-42 emission factors, seven key reports which summarize test report information were identified:

U.S. Environmental Protection Agency (1989) Municipal Waste Combustors-Background Information for Proposed Standards: Post-Combustion Technology Performance¹

Radian Corporation (1991) Summary of Cadmium and Lead Emissions Data From Municipal Waste Combustors²

Nebel and White (1991) A Summary of Mercury Emissions and Applicable Control Technologies for Municipal Waste Combustors³

U.S. Environmental Protection Agency (1990) Municipal Waste Combustion: Background Information for Promulgated Standards and Guidelines-Summary of Public Comments and Responses, Appendix C⁴

Schindler and Nelson (1989) Municipal Waste Combustion Assessment: Technical Basis for Good Combustion Practice⁵

U.S. Environmental Protection Agency (1989) Municipal Waste Combustors-Background Information for Proposed Standards: Control of NO_x Emissions⁶

U.S. Environmental Protection Agency (1987) Municipal Waste Combustion Study: Emission Database for Municipal Waste Combustors⁷

From these seven reports, data from a total of 104 test reports were obtained. Specific references for each test report and/or data package are listed at the end of this chapter.

Although these test reports were gathered in the development of the NSPS for MWCs, there is little reason to suspect any bias in the data due to the selection of facilities. The reason that this bias is unlikely to exist is due to the extraordinary amount of test data available for this source category. Of the total number of MWCs in the United States, approximately 50 percent of the population has been tested at one time.

Within the NSPS data set, test data were excluded for facilities from other countries (Kure, Japan³⁶, and Munich⁵⁹ and Wurzburg¹⁰³, Germany) due to the possibility that there could be significant differences in the composition or heat content of the waste streams combusted. While it is acknowledged that there may be significant regional (and seasonal) differences in the waste streams generated and combusted across the United States, removing data from these facilities is an attempt to somewhat standardize the U.S. waste stream data. Test data from two Canadian facilities (Vancouver and Quebec City) were left in the database, however, as it is not anticipated that the waste streams in Canada would differ significantly from the waste streams in the United States pilot scale emission test data from the Quebec City facility were not included, however, because the test results may not be representative of performance for commercial operations. Additionally, the pilot scale testing was conducted prior to combustor modifications, therefore, the results would not represent GCP operation.

Other test data were excluded if testing occurred during startup or shutdown, if there were particularly low or high APCD temperatures, or if the data were intentionally obtained during periods of poor combustion.

In addition to the 104 test reports whose data were obtained from the references listed above, additional test data for 6 facilities were recent enough to be included in the database. The full citations for these test reports/data packages are also included at the end of this chapter.

The discussion in Sections 4.1.1 - 4.1.3 identifies the facilities from which the test data for PM, metals (As, Cd, Cr,

Hg, Ni, Pb), acid gases (HCl and SO₂), and CDD/CDF were obtained for each type of MWC. Information used to develop emission factors for NO_x and CO is discussed separately in Section 4.1.4.

All of the test data used in the development of emission factors for MWCs are rated as "A" data because of the high degree of confidence in the measurement methods and conditions of the unit and the APCD at the time of testing. All questionable data have already been excluded from the database. Although emissions from MWCs may vary greatly depending on the composition of the refuse and other factors, the test data used in the development of emission factors are deemed to be representative for this industry.

The emission factor ratings, therefore, are based primarily on the number of data points used to calculate the emission factor. For example, if only one data point is shown for arsenic from MOD/SA MWCs, the emission factor receives an "E" rating. If several data points from a mix a facilities are used, then the emission factor receives an "A" or "B" rating, depending on the number of facilities and the number of facilities in the United States of that combustor type. Another factor considered in the emission factor rating is the range in the emissions data. If there are test data from many facilities, but there is a wide range in the data, a "B" rating is assigned. A "C" or "D" rating is assigned to emission factors which are derived from several data points, but from very few facilities.

4.1.1 Mass Burn Combustor Test Data

The mass burn combustor test data are divided into three groups: MB/WW, MB/RC, and MB/REF. The majority of the data are for MB/WW; data were provided for 34 facilities: Adirondack, NY^{115,116}; Alexandria, VA^{9,10}; Babylon, NY^{11,12}; Baltimore, MD^{13,14}; Bridgeport, CT¹⁰⁸; Bristol, CT¹⁰⁷; Camden County, NJ¹¹⁷; Charleston, SC^{20,118}; Chicago, IL⁵; Claremont, NH^{21,22}; Commerce, CA^{23,25}; Concord, NH¹⁰⁸; Fairfax County, VA¹⁰⁷; Gloucester, NY¹⁰⁸; Hampton, VA³³; Haverhill, MA^{39,40}; Hempstead, NY³⁴; Hillsborough County, FL³⁵; Huntsville, AL³; Indianapolis, IN³⁸; Kent, WA³; Long Beach, CA^{41,42}; Marion County, OR⁴³⁻⁴⁶;

Millbury, MA⁵⁰⁻⁵⁶; North Andover, MA⁶³; Peekskill, NY⁶⁷⁻⁶⁹; Pinellas County, FL⁷⁵; Portland, ME^{78,79}; Quebec City, Canada⁸²⁻⁸⁴; Saugus, MA⁵; Stanislaus County, CA^{95,96}; Tulsa, OK⁹⁷; Vancouver, Canada^{99,100}; and Westchester County, NY⁵.

Data for MB/RCs are presented for 5 facilities: Bay County, FL¹⁶; Delaware County, PA¹¹⁹; Dutchess County, NY^{29,30}; Gallatin, TN³²; and York, PA^{104,105}. Four MB/REF facilities provided test data: Dayton, OH²⁶; Galax, VA³¹; McKay Bay, FL⁴⁷; and Philadelphia, PA⁷³.

4.1.2 Refuse-Derived Fuel Combustor Test Data

Data from the following 11 RDF facilities were used: Albany, NY¹¹⁴; Biddeford, ME^{17,18}; Detroit, MI²⁷; Honolulu, HI³⁷; Lawrence, ME^{109,110}; Mid-Connecticut, CT^{48,49}; NSP Red Wing, MN⁸⁵⁻⁸⁷; Niagara Falls, NY^{61,62}; Penobscot, ME^{71,72}; SEMASS, MA⁸⁸; and West Palm Beach, FL¹⁰¹.

4.1.3 Modular Combustor Test Data

Test data from 4 MOD/EA MWCs were provided: Pigeon Point, DE⁷⁴; Pittsfield, MA⁷⁶; Pope/Douglas, MN^{77,106}; and St. Croix, WI⁹⁰⁻⁹⁴. For MOD/SA MWCs, data were used from 7 facilities: Barron County, WI¹⁵; Cattaraugus County, NY¹⁹; Dyersburg, TN⁷; N. Little Rock, AR¹¹³; Oneida County, NY^{111,112}; Oswego County, NY^{65,66}; and Tuscaloosa, AL⁹⁸.

4.1.4 NO_x and CO Data

Emissions of NO_x from MWCs are not controlled through the use of traditional acid gas/PM control systems. Methods of add-on control, such as SNCR, and combustion controls, such as gas reburning, are available but are not currently in widespread use.⁶ A number of facilities, however, have recently been permitted with SNCR. The majority of information on NO_x emissions has been adapted from Reference 6, which presents NO_x emissions test data for MWCs without add-on controls. Some of the emissions data in Reference 6 represent combustion modifications, such as high or low excess air, and high or low overfire air. These data were not included in the tables, however, because they may not necessarily represent "normal" operating conditions.

As discussed in Chapter 2, emissions of CO are generally controlled through GCP. The data for CO are primarily from Reference 5, which presents an evaluation of GCP and the effects on pollutant emissions, particularly CO.

4.2 RESULTS OF DATA ANALYSIS

Tables 4-1 through 4-6 present test data summaries for each combustor type. Within each table, the data are grouped by control technology and pollutant. The data are presented on a concentration basis, corrected to 7 percent O₂, and represent average test concentrations. For each pollutant/technology grouping (e.g., As for SD/FF), and average is also shown. In cases where emission levels were below detectable levels, the detection limit is shown in the tables and is used when calculating facility and pollutant/technology averages. These values are footnoted. In some instances, detection limits were not provided in the test reports. For those cases, an ND (nondetect) is shown in the tables, and a zero is used in calculating averages.

Note that in these tables a "U" (uncontrolled) is shown as control technology to indicate emissions data collected prior to the pollution control device. An "NA" (not applicable) is shown for the NO_x and CO data, which are grouped irrespective of control device, since control of these pollutants is not tied to traditional acid gas/PM controls.

4.3 PROTOCOL FOR DATABASE

4.3.1 Engineering Methodology

Following the elimination of source test reports deemed unacceptable for use in the AP-42, the test data from the facilities selected for inclusion were entered into a LotusTM spreadsheet. The concentration data were first averaged as the arithmetic mean of different sampling runs prior to inclusion in the database. Test programs at most facilities consisted of three sampling runs conducted during normal operating conditions.

TABLE 4-1. MASS BURN/WATERWALL COMBUSTOR DATA

Facility Name	Combustor Type ^a	Control Technology ^b	Pollutant ^c	Concentration ^{d,e}	Units
Baltimore RESCO (Unit 2)	MB/WW	U	As	2.26E+02	μg/dscm
Camden (Unit 1)	MB/WW	U	As	1.51E+03	μg/dscm
Commerce	MB/WW	U	As	6.90E+01	μg/dscm
Commerce	MB/WW	U	As	2.20E+02	μg/dscm
Commerce (1988)	MB/WW	U	As	7.40E+01	μg/dscm
Commerce average	MB/WW	U	As	1.21E+02	μg/dscm
Vancouver	MB/WW	U	As	7.60E+02	μg/dscm
AVERAGE	MB/WW	U	As	6.54E+02	μg/dscm
Commerce	MB/WW	U	CDD/CDF	4.46E-01	μg/dscm
Commerce	MB/WW	U	CDD/CDF	2.80E-02	μg/dscm
Commerce	MB/WW	U	CDD/CDF	7.83E-01	μg/dscm
Commerce average	MB/WW	U	CDD/CDF	4.19E-01	μg/dscm
Marion County	MB/WW	U	CDD/CDF	4.30E-02	μg/dscm
Millbury	MB/WW	U	CDD/CDF	1.70E-01	μg/dscm
North Andover	MB/WW	U	CDD/CDF	2.45E-01	μg/dscm
Peekskill	MB/WW	U	CDD/CDF	2.28E-01	μg/dscm
Peekskill	MB/WW	U	CDD/CDF	6.17E-01	μg/dscm
Peekskill	MB/WW	U	CDD/CDF	4.78E-01	μg/dscm
Peekskill	MB/WW	U	CDD/CDF	4.38E-01	μg/dscm
Peekskill average	MB/WW	U	CDD/CDF	4.40E-01	μg/dscm
Pinellas County (Unit 3)	MB/WW	U	CDD/CDF	5.40E-02	μg/dscm
Vancouver	MB/WW	U	CDD/CDF	7.80E-02	μg/dscm
AVERAGE	MB/WW	U	CDD/CDF	2.07E-01	μg/dscm
Camden (Unit 1)	MB/WW	U	Cd	1.80E+03	μg/dscm
Commerce	MB/WW	U	Cd	9.60E+02	μg/dscm
Commerce	MB/WW	U	Cd	1.60E+03	μg/dscm
Commerce average	MB/WW	U	Cd	1.28E+03	μg/dscm
Marion County	MB/WW	U	Cd	1.10E+03	μg/dscm
Vancouver	MB/WW	U	Cd	1.16E+03	μg/dscm
AVERAGE	MB/WW	U	Cd	1.33E+03	μg/dscm
Baltimore RESCO (Unit 2)	MB/WW	U	Cr	2.96E+03	μg/dscm
Camden (Unit 1)	MB/WW	U	Cr	1.18E+03	μg/dscm
Commerce	MB/WW	U	Cr	5.56E+02	μg/dscm
Commerce	MB/WW	U	Cr	3.45E+03	μg/dscm
Commerce	MB/WW	U	Cr	7.30E+02	μg/dscm
Commerce average	MB/WW	U	Cr	1.58E+03	μg/dscm
Marion County	MB/WW	U	Cr	4.22E+02	μg/dscm
Marion County	MB/WW	U	Cr	4.22E+02	μg/dscm
Marion County average	MB/WW	U	Cr	4.22E+02	μg/dscm
Vancouver	MB/WW	U	Cr	4.45E+02	μg/dscm
AVERAGE	MB/WW	U	Cr	1.32E+03	μg/dscm
Adirondack (Boiler A)	MB/WW	U	HCl	8.67E+02	ppmv
Adirondack (Boiler B)	MB/WW	U	HCl	7.06E+02	ppmv
Adirondack (Boiler B)	MB/WW	U	HCl	6.24E+02	ppmv
Adirondack average	MB/WW	U	HCl	7.32E+02	ppmv
Babylon	MB/WW	U	HCl	7.62E+02	ppmv
Babylon	MB/WW	U	HCl	7.17E+02	ppmv
Babylon	MB/WW	U	HCl	1.02E+03	ppmv
Babylon average	MB/WW	U	HCl	8.32E+02	ppmv
Camden (Unit 1)	MB/WW	U	HCl	3.28E+02	ppmv
Camden (Unit 2)	MB/WW	U	HCl	1.41E+02	ppmv
Camden (Unit 3)	MB/WW	U	HCl	5.47E+01	ppmv
Camden average	MB/WW	U	HCl	1.75E+02	ppmv
Claremont	MB/WW	U	HCl	4.50E+02	ppmv
Claremont (Unit 1)	MB/WW	U	HCl	4.48E+02	ppmv
Claremont (Unit 1)	MB/WW	U	HCl	7.88E+02	ppmv
Claremont (Unit 2)	MB/WW	U	HCl	6.42E+02	ppmv
Claremont average	MB/WW	U	HCl	5.82E+02	ppmv

TABLE 4-1. (CONTINUED)

Facility Name	Combustor Type ^a	Control Technology ^b	Pollutant ^c	Concentration ^{d,e}	Units
Commerce	MB/WW	U	HCl	5.33E+02	ppmv
Commerce	MB/WW	U	HCl	6.46E+02	ppmv
Commerce	MB/WW	U	HCl	8.95E+02	ppmv
Commerce average	MB/WW	U	HCl	6.91E+02	ppmv
Marion County	MB/WW	U	HCl	5.71E+02	ppmv
Marion County	MB/WW	U	HCl	6.46E+02	ppmv
Marion County (1986)	MB/WW	U	HCl	5.70E+02	ppmv
Marion County (1987)	MB/WW	U	HCl	6.80E+02	ppmv
Marion County average	MB/WW	U	HCl	6.17E+02	ppmv
Millbury	MB/WW	U	HCl	6.97E+02	ppmv
Millbury	MB/WW	U	HCl	7.70E+02	ppmv
Millbury (Unit 1)	MB/WW	U	HCl	7.70E+02	ppmv
Millbury (Unit 2)	MB/WW	U	HCl	7.30E+02	ppmv
Millbury average	MB/WW	U	HCl	7.42E+02	ppmv
Vancouver	MB/WW	U	HCl	2.70E+02	ppmv
Vancouver	MB/WW	U	HCl	2.38E+02	ppmv
Vancouver	MB/WW	U	HCl	1.94E+02	ppmv
Vancouver average	MB/WW	U	HCl	2.34E+02	ppmv
AVERAGE	MB/WW	U	HCl	5.76E+02	ppmv
Adirondack (Boiler A)	MB/WW	U	Hg	3.28E+02	µg/dscm
Adirondack (Boiler B)	MB/WW	U	Hg	6.59E+02	µg/dscm
Adirondack (Boiler B)	MB/WW	U	Hg	4.39E+02	µg/dscm
Adirondack average	MB/WW	U	Hg	4.75E+02	µg/dscm
Camden (Unit 1)	MB/WW	U	Hg	7.10E+02	µg/dscm
Commerce	MB/WW	U	Hg	4.50E+02	µg/dscm
Commerce	MB/WW	U	Hg	4.53E+02	µg/dscm
Commerce	MB/WW	U	Hg	2.61E+02	µg/dscm
Commerce average	MB/WW	U	Hg	3.88E+02	µg/dscm
Vancouver (11/88)	MB/WW	U	Hg	5.27E+02	µg/dscm
Vancouver (3/89)	MB/WW	U	Hg	1.20E+03	µg/dscm
Vancouver (4/89)	MB/WW	U	Hg	1.36E+03	µg/dscm
Vancouver (8/89)	MB/WW	U	Hg	6.61E+02	µg/dscm
Vancouver average	MB/WW	U	Hg	9.37E+02	µg/dscm
AVERAGE	MB/WW	U	Hg	6.28E+02	µg/dscm
Camden (Unit 1)	MB/WW	U	Ni	4.32E+02	µg/dscm
Commerce	MB/WW	U	Ni	6.80E+02	µg/dscm
Commerce	MB/WW	U	Ni	4.05E+03	µg/dscm
Commerce	MB/WW	U	Ni	1.85E+03	µg/dscm
Commerce average	MB/WW	U	Ni	2.19E+03	µg/dscm
Marion County	MB/WW	U	Ni	1.20E+01	µg/dscm
Marion County	MB/WW	U	Ni	1.24E+01	µg/dscm
Marion County average	MB/WW	U	Ni	1.22E+01	µg/dscm
Vancouver	MB/WW	U	Ni	2.14E+03	µg/dscm
AVERAGE	MB/WW	U	Ni	1.19E+03	µg/dscm
Adirondack (Boiler A)	MB/WW	U	PM	5.07E+03	mg/dscm
Adirondack (Boiler B)	MB/WW	U	PM	5.19E+03	mg/dscm
Adirondack (Boiler B)	MB/WW	U	PM	5.61E+03	mg/dscm
Adirondack average	MB/WW	U	PM	5.29E+03	mg/dscm
Baltimore RESCO (Unit 2)	MB/WW	U	PM	4.69E+03	mg/dscm
Commerce	MB/WW	U	PM	4.60E+03	mg/dscm
Commerce	MB/WW	U	PM	4.07E+03	mg/dscm
Commerce	MB/WW	U	PM	2.81E+03	mg/dscm
Commerce average	MB/WW	U	PM	3.83E+03	mg/dscm
Long Beach	MB/WW	U	PM	3.62E+03	mg/dscm
Marion County	MB/WW	U	PM	2.02E+03	mg/dscm
North Andover	MB/WW	U	PM	1.90E+03	mg/dscm

TABLE 4-1. (CONTINUED)

Facility Name	Combustor Type ^a	Control Technology ^b	Pollutant ^c	Concentration ^{d,e}	Units
Peekskill	MB/WW	U	PM	2.22E+03	mg/dscm
Peekskill	MB/WW	U	PM	3.73E+03	mg/dscm
Peekskill	MB/WW	U	PM	4.85E+03	mg/dscm
Peekskill	MB/WW	U	PM	4.81E+03	mg/dscm
Peekskill average	MB/WW	U	PM	3.90E+03	mg/dscm
Pinellas County (Unit 3)	MB/WW	U	PM	2.20E+03	mg/dscm
AVERAGE	MB/WW	U	PM	3.43E+03	mg/dscm
Camden (Unit 1)	MB/WW	U	Pb	3.30E+04	µg/dscm
Commerce	MB/WW	U	Pb	1.55E+04	µg/dscm
Commerce	MB/WW	U	Pb	1.72E+04	µg/dscm
Commerce average	MB/WW	U	Pb	1.64E+04	µg/dscm
Conner County	MB/WW	U	Pb	2.05E+04	µg/dscm
Couder	MB/WW	U	Pb	3.04E+04	µg/dscm
AVERAGE	MB/WW	U	Pb	2.51E+04	µg/dscm
Adirondack (Boiler A)	MB/WW	U	SO ₂	9.45E+01	ppmv
Adirondack (Boiler B)	MB/WW	U	SO ₂	1.81E+02	ppmv
Adirondack (Boiler B)	MB/WW	U	SO ₂	6.37E+01	ppmv
Adirondack average	MB/WW	U	SO ₂	1.13E+02	ppmv
Babylon	MB/WW	U	SO ₂	1.91E+02	ppmv
Babylon	MB/WW	U	SO ₂	1.41E+02	ppmv
Babylon	MB/WW	U	SO ₂	1.78E+02	ppmv
Babylon average	MB/WW	U	SO ₂	1.70E+02	ppmv
Camden (Unit 1)	MB/WW	U	SO ₂	2.10E+02	ppmv
Camden (Unit 2)	MB/WW	U	SO ₂	1.05E+02	ppmv
Camden (Unit 3)	MB/WW	U	SO ₂	1.62E+02	ppmv
Camden average	MB/WW	U	SO ₂	1.59E+02	ppmv
Commerce	MB/WW	U	SO ₂	1.32E+02	ppmv
Commerce	MB/WW	U	SO ₂	2.73E+02	ppmv
Commerce	MB/WW	U	SO ₂	1.11E+02	ppmv
Commerce average	MB/WW	U	SO ₂	1.72E+02	ppmv
Long Beach	MB/WW	U	SO ₂	1.40E+02	ppmv
Long Beach	MB/WW	U	SO ₂	1.38E+02	ppmv
Long Beach average	MB/WW	U	SO ₂	1.39E+02	ppmv
Marion County	MB/WW	U	SO ₂	1.83E+02	ppmv
Marion County	MB/WW	U	SO ₂	3.33E+02	ppmv
Marion County (1986)	MB/WW	U	SO ₂	1.80E+02	ppmv
Marion County (1987)	MB/WW	U	SO ₂	3.30E+02	ppmv
Marion County average	MB/WW	U	SO ₂	2.57E+02	ppmv
Millbury	MB/WW	U	SO ₂	2.96E+02	ppmv
Millbury	MB/WW	U	SO ₂	1.74E+02	ppmv
Millbury	MB/WW	U	SO ₂	2.05E+02	ppmv
Millbury (Unit 1)	MB/WW	U	SO ₂	2.10E+02	ppmv
Millbury (Unit 2)	MB/WW	U	SO ₂	3.00E+02	ppmv
Millbury average	MB/WW	U	SO ₂	2.37E+02	ppmv
Portland	MB/WW	U	SO ₂	3.00E+02	ppmv
Portland	MB/WW	U	SO ₂	2.81E+02	ppmv
Portland	MB/WW	U	SO ₂	3.22E+02	ppmv
Portland average	MB/WW	U	SO ₂	3.01E+02	ppmv
Stanislaus County	MB/WW	U	SO ₂	5.88E+01	ppmv
Stanislaus County	MB/WW	U	SO ₂	6.67E+01	ppmv
Stanislaus County average	MB/WW	U	SO ₂	6.28E+01	ppmv
Vancouver	MB/WW	U	SO ₂	1.61E+02	ppmv
Vancouver	MB/WW	U	SO ₂	1.57E+02	ppmv
Vancouver	MB/WW	U	SO ₂	1.39E+02	ppmv
Vancouver average	MB/WW	U	SO ₂	1.52E+02	ppmv
AVERAGE	MB/WW	U	SO ₂	1.76E+02	ppmv

TABLE 4-1. (CONTINUED)

Facility Name	Combustor Type ^a	Control Technology ^b	Pollutant ^c	Concentration ^{d,e}	Units
Commerce	MB/WW	SD/FF	As	1.90E+00	µg/dscm ^f
Commerce	MB/WW	SD/FF	As	5.00E-02	µg/dscm
Commerce	MB/WW	SD/FF	As	1.50E-01	µg/dscm
Commerce average	MB/WW	SD/FF	As	1.00E-01	µg/dscm ^g
Long Beach	MB/WW	SD/FF	As	3.03E+01	µg/dscm ^{f,h}
Stanislaus County	MB/WW	SD/FF	As	1.59E+00	µg/dscm
Stanislaus County	MB/WW	SD/FF	As	7.50E-01	µg/dscm
Stanislaus County average	MB/WW	SD/FF	As	1.17E+00	µg/dscm
AVERAGE	MB/WW	SD/FF	As	6.35E-01	µg/dscm
Babylon	MB/WW	SD/FF	CDD/CDF	2.19E-02	µg/dscm
Commerce	MB/WW	SD/FF	CDD/CDF	1.01E-03	µg/dscm
Commerce	MB/WW	SD/FF	CDD/CDF	3.47E-03	µg/dscm
Commerce	MB/WW	SD/FF	CDD/CDF	2.78E-03	µg/dscm
Commerce	MB/WW	SD/FF	CDD/CDF	9.59E-03	µg/dscm
Commerce average	MB/WW	SD/FF	CDD/CDF	4.21E-03	µg/dscm
Indianapolis	MB/WW	SD/FF	CDD/CDF	1.13E-02	µg/dscm
Long Beach	MB/WW	SD/FF	CDD/CDF	4.14E-03	µg/dscm
Marion County	MB/WW	SD/FF	CDD/CDF	1.26E-03	µg/dscm
Stanislaus County	MB/WW	SD/FF	CDD/CDF	6.53E-03	µg/dscm
Stanislaus County	MB/WW	SD/FF	CDD/CDF	6.25E-03	µg/dscm
Stanislaus County average	MB/WW	SD/FF	CDD/CDF	6.39E-03	µg/dscm
AVERAGE	MB/WW	SD/FF	CDD/CDF	8.20E-03	µg/dscm
Babylon	MB/WW	SD/FF	Cd	1.00E+00	µg/dscm
Babylon	MB/WW	SD/FF	Cd	5.00E+00	µg/dscm
Babylon	MB/WW	SD/FF	Cd	7.00E-01	µg/dscm ^f
Babylon average	MB/WW	SD/FF	Cd	2.23E+00	µg/dscm
Bridgeport	MB/WW	SD/FF	Cd	ND	µg/dscm
Bridgeport	MB/WW	SD/FF	Cd	4.00E+00	µg/dscm
Bridgeport	MB/WW	SD/FF	Cd	ND	µg/dscm
Bridgeport average	MB/WW	SD/FF	Cd	1.33E+00	µg/dscm
Bristol	MB/WW	SD/FF	Cd	2.00E+00	µg/dscm
Bristol	MB/WW	SD/FF	Cd	1.00E+00	µg/dscm
Bristol	MB/WW	SD/FF	Cd	2.00E+00	µg/dscm
Bristol average	MB/WW	SD/FF	Cd	1.67E+00	µg/dscm
Commerce	MB/WW	SD/FF	Cd	4.00E-01	µg/dscm
Commerce	MB/WW	SD/FF	Cd	3.20E+00	µg/dscm ^f
Commerce	MB/WW	SD/FF	Cd	2.00E+00	µg/dscm
Commerce average	MB/WW	SD/FF	Cd	1.87E+00	µg/dscm
Fairfax	MB/WW	SD/FF	Cd	9.00E+00	µg/dscm
Fairfax	MB/WW	SD/FF	Cd	6.00E+00	µg/dscm
Fairfax	MB/WW	SD/FF	Cd	6.00E+00	µg/dscm
Fairfax	MB/WW	SD/FF	Cd	5.00E+00	µg/dscm
Fairfax average	MB/WW	SD/FF	Cd	6.50E+00	µg/dscm
Gloucester	MB/WW	SD/FF	Cd	ND	µg/dscm
Gloucester	MB/WW	SD/FF	Cd	ND	µg/dscm
Gloucester	MB/WW	SD/FF	Cd	ND	µg/dscm
Gloucester average	MB/WW	SD/FF	Cd	0.00E+00	µg/dscm
Hempstead	MB/WW	SD/FF	Cd	7.25E-01	µg/dscm ^f
Hempstead	MB/WW	SD/FF	Cd	6.55E-01	µg/dscm ^f
Hempstead	MB/WW	SD/FF	Cd	6.99E-01	µg/dscm ^f
Hempstead average	MB/WW	SD/FF	Cd	6.93E-01	µg/dscm
Kent	MB/WW	SD/FF	Cd	4.00E+00	µg/dscm
Kent	MB/WW	SD/FF	Cd	4.00E+00	µg/dscm
Kent average	MB/WW	SD/FF	Cd	4.00E+00	µg/dscm
Long Beach	MB/WW	SD/FF	Cd	1.80E+01	µg/dscm
Marion County	MB/WW	SD/FF	Cd	3.00E+00	µg/dscm

TABLE 4-1. (CONTINUED)

Facility Name	Combustor Type ^a	Control Technology ^b	Pollutant ^c	Concentration ^{d,e}	Units
Stanislaus County	MB/WW	SD/FF	Cd	2.00E+00	µg/dscm
Stanislaus County	MB/WW	SD/FF	Cd	2.00E+00	µg/dscm
Stanislaus County	MB/WW	SD/FF	Cd	2.00E+00	µg/dscm
Stanislaus County average	MB/WW	SD/FF	Cd	2.00E+00	µg/dscm
AVERAGE	MB/WW	SD/FF	Cd	3.75E+00	µg/dscm
Commerce	MB/WW	SD/FF	Cr	3.00E-01	µg/dscm
Commerce	MB/WW	SD/FF	Cr	7.00E-01	µg/dscm ^f
Commerce	MB/WW	SD/FF	Cr	2.20E+00	µg/dscm
Commerce average	MB/WW	SD/FF	Cr	1.07E+00	µg/dscm
Long Beach	MB/WW	SD/FF	Cr	2.63E+00	µg/dscm
Marion County	MB/WW	SD/FF	Cr	1.70E-01	µg/dscm
Stanislaus County	MB/WW	SD/FF	Cr	1.22E+01	µg/dscm
Stanislaus County	MB/WW	SD/FF	Cr	9.80E+00	µg/dscm
Stanislaus County average	MB/WW	SD/FF	Cr	1.10E+01	µg/dscm
AVERAGE	MB/WW	SD/FF	Cr	3.72E+00	µg/dscm
Babylon	MB/WW	SD/FF	HCl	2.00E+01	ppmv
Babylon	MB/WW	SD/FF	HCl	4.90E+01	ppmv
Babylon	MB/WW	SD/FF	HCl	2.40E+01	ppmv
Babylon average	MB/WW	SD/FF	HCl	3.10E+01	ppmv
Commerce	MB/WW	SD/FF	HCl	5.50E+00	ppmv
Commerce	MB/WW	SD/FF	HCl	7.30E+00	ppmv
Commerce	MB/WW	SD/FF	HCl	8.80E+00	ppmv
Commerce average	MB/WW	SD/FF	HCl	7.20E+00	ppmv
Indianapolis	MB/WW	SD/FF	HCl	5.00E-01	ppmv
Indianapolis	MB/WW	SD/FF	HCl	2.00E-01	ppmv
Indianapolis	MB/WW	SD/FF	HCl	1.68E+01	ppmv
Indianapolis average	MB/WW	SD/FF	HCl	5.83E+00	ppmv
Long Beach	MB/WW	SD/FF	HCl	2.42E+01	ppmv
Marion County	MB/WW	SD/FF	HCl	4.80E+01	ppmv
Marion County	MB/WW	SD/FF	HCl	1.77E+01	ppmv
Marion County average	MB/WW	SD/FF	HCl	3.29E+01	ppmv
Stanislaus County	MB/WW	SD/FF	HCl	7.30E-01	ppmv
Stanislaus County	MB/WW	SD/FF	HCl	2.60E+00	ppmv
Stanislaus County average	MB/WW	SD/FF	HCl	1.67E+00	ppmv
AVERAGE	MB/WW	SD/FF	HCl	1.71E+01	ppmv
Babylon	MB/WW	SD/FF	Hg	3.23E+02	µg/dscm
Bristol	MB/WW	SD/FF	Hg	9.90E+01	µg/dscm
Bristol	MB/WW	SD/FF	Hg	1.05E+02	µg/dscm
Bristol	MB/WW	SD/FF	Hg	6.40E+01	µg/dscm
Bristol	MB/WW	SD/FF	Hg	3.99E+02	µg/dscm
Bristol average	MB/WW	SD/FF	Hg	1.67E+02	µg/dscm
Commerce (1987)	MB/WW	SD/FF	Hg	5.70E+02	µg/dscm
Commerce (1988)	MB/WW	SD/FF	Hg	6.80E+01	µg/dscm
Commerce (1988)	MB/WW	SD/FF	Hg	3.90E+01	µg/dscm
Commerce average	MB/WW	SD/FF	Hg	2.26E+02	µg/dscm
Fairfax	MB/WW	SD/FF	Hg	3.31E+02	µg/dscm
Fairfax	MB/WW	SD/FF	Hg	4.06E+02	µg/dscm
Fairfax	MB/WW	SD/FF	Hg	4.66E+02	µg/dscm
Fairfax	MB/WW	SD/FF	Hg	5.14E+02	µg/dscm
Fairfax average	MB/WW	SD/FF	Hg	4.29E+02	µg/dscm
Hempstead, Unit 1 (9/89)	MB/WW	SD/FF	Hg	9.28E+00	µg/dscm
Hempstead, Unit 2 (9/89)	MB/WW	SD/FF	Hg	2.55E+01	µg/dscm
Hempstead, Unit 3 (10/89)	MB/WW	SD/FF	Hg	2.50E+01	µg/dscm
Hempstead average	MB/WW	SD/FF	Hg	1.99E+01	µg/dscm
Huntsville	MB/WW	SD/FF	Hg	4.63E+02	µg/dscm
Huntsville	MB/WW	SD/FF	Hg	1.28E+03	µg/dscm
Huntsville average	MB/WW	SD/FF	Hg	8.69E+02	µg/dscm

TABLE 4-1. (CONTINUED)

Facility Name	Combustor Type ^a	Control Technology ^b	Pollutant ^c	Concentration ^{d,e}	Units
Indianapolis	MB/WW	SD/FF	Hg	2.00E+02	µg/dscm
Indianapolis	MB/WW	SD/FF	Hg	2.77E+02	µg/dscm
Indianapolis (Unit 1)	MB/WW	SD/FF	Hg	2.83E+02	µg/dscm
Indianapolis average	MB/WW	SD/FF	Hg	2.53E+02	µg/dscm
Kent	MB/WW	SD/FF	Hg	1.66E+02	µg/dscm
Kent	MB/WW	SD/FF	Hg	2.48E+02	µg/dscm
Kent average	MB/WW	SD/FF	Hg	2.07E+02	µg/dscm
Long Beach	MB/WW	SD/FF	Hg	1.80E+02	µg/dscm
Marion County	MB/WW	SD/FF	Hg	2.39E+02	µg/dscm
Stanislaus County	MB/WW	SD/FF	Hg	4.27E+02	µg/dscm
Stanislaus County	MB/WW	SD/FF	Hg	5.08E+02	µg/dscm
Stanislaus County	MB/WW	SD/FF	Hg	4.81E+02	µg/dscm
Stanislaus County (Unit 1)	MB/WW	SD/FF	Hg	4.99E+02	µg/dscm
Stanislaus County (Unit 2)	MB/WW	SD/FF	Hg	4.62E+02	µg/dscm
Stanislaus County average	MB/WW	SD/FF	Hg	4.75E+02	µg/dscm
AVERAGE	MB/WW	SD/FF	Hg	3.08E+02	µg/dscm
Commerce	MB/WW	SD/FF	Ni	6.00E+00	µg/dscm
Commerce	MB/WW	SD/FF	Ni	2.00E-01	µg/dscm
Commerce	MB/WW	SD/FF	Ni	3.00E+01	µg/dscm ^f
Commerce average	MB/WW	SD/FF	Ni	3.10E+00	µg/dscm ^g
Long Beach	MB/WW	SD/FF	Ni	2.81E+00	µg/dscm
Marion County	MB/WW	SD/FF	Ni	3.10E+00	µg/dscm
Stanislaus County	MB/WW	SD/FF	Ni	2.58E+01	µg/dscm
Stanislaus County	MB/WW	SD/FF	Ni	1.96E+01	µg/dscm
Stanislaus County average	MB/WW	SD/FF	Ni	2.27E+01	µg/dscm
AVERAGE	MB/WW	SD/FF	Ni	7.93E+00	µg/dscm
Babylon	MB/WW	SD/FF	PM	2.75E+00	mg/dscm
Babylon	MB/WW	SD/FF	PM	2.75E+00	mg/dscm
Babylon	MB/WW	SD/FF	PM	7.55E+00	mg/dscm
Babylon	MB/WW	SD/FF	PM	3.89E+00	mg/dscm
Babylon	MB/WW	SD/FF	PM	6.64E+00	mg/dscm
Babylon average	MB/WW	SD/FF	PM	4.71E+00	mg/dscm
Bridgeport	MB/WW	SD/FF	PM	1.60E+00	mg/dscm
Bridgeport	MB/WW	SD/FF	PM	1.60E+00	mg/dscm
Bridgeport	MB/WW	SD/FF	PM	8.92E+00	mg/dscm
Bridgeport	MB/WW	SD/FF	PM	1.24E+01	mg/dscm
Bridgeport	MB/WW	SD/FF	PM	4.35E+00	mg/dscm
Bridgeport	MB/WW	SD/FF	PM	1.60E+00	mg/dscm
Bridgeport average	MB/WW	SD/FF	PM	5.07E+00	mg/dscm
Bristol	MB/WW	SD/FF	PM	3.20E+00	mg/dscm
Bristol	MB/WW	SD/FF	PM	3.20E+00	mg/dscm
Bristol	MB/WW	SD/FF	PM	7.09E+00	mg/dscm
Bristol	MB/WW	SD/FF	PM	1.51E+01	mg/dscm
Bristol average	MB/WW	SD/FF	PM	7.15E+00	mg/dscm
Commerce	MB/WW	SD/FF	PM	3.20E+00	mg/dscm
Commerce	MB/WW	SD/FF	PM	1.60E+00	mg/dscm
Commerce	MB/WW	SD/FF	PM	6.18E+00	mg/dscm
Commerce average	MB/WW	SD/FF	PM	3.66E+00	mg/dscm
Fairfax	MB/WW	SD/FF	PM	4.81E+00	mg/dscm
Fairfax	MB/WW	SD/FF	PM	2.29E+01	mg/dscm
Fairfax	MB/WW	SD/FF	PM	4.81E+00	mg/dscm
Fairfax	MB/WW	SD/FF	PM	1.01E+01	mg/dscm
Fairfax average	MB/WW	SD/FF	PM	1.06E+01	mg/dscm
Gloucester	MB/WW	SD/FF	PM	3.89E+00	mg/dscm
Gloucester	MB/WW	SD/FF	PM	1.40E+01	mg/dscm
Gloucester	MB/WW	SD/FF	PM	1.14E+00	mg/dscm
Gloucester average	MB/WW	SD/FF	PM	6.33E+00	mg/dscm

TABLE 4-1. (CONTINUED)

Facility Name	Combustor Type ^a	Control Technology ^b	Pollutant ^c	Concentration ^{d,e}	Units
Hempstead	MB/WW	SD/FF	PM	3.43E+00	mg/dscm
Hempstead	MB/WW	SD/FF	PM	6.18E+00	mg/dscm
Hempstead	MB/WW	SD/FF	PM	2.75E+00	mg/dscm
Hempstead average	MB/WW	SD/FF	PM	4.12E+00	mg/dscm
Huntsville	MB/WW	SD/FF	PM	3.89E+00	mg/dscm
Huntsville	MB/WW	SD/FF	PM	1.90E+01	mg/dscm
Huntsville average	MB/WW	SD/FF	PM	1.14E+01	mg/dscm
Indianapolis	MB/WW	SD/FF	PM	5.03E+00	mg/dscm
Indianapolis	MB/WW	SD/FF	PM	8.24E+00	mg/dscm
Indianapolis	MB/WW	SD/FF	PM	9.38E+00	mg/dscm
Indianapolis	MB/WW	SD/FF	PM	5.95E+00	mg/dscm
Indianapolis	MB/WW	SD/FF	PM	9.15E+00	mg/dscm
Indianapolis average	MB/WW	SD/FF	PM	7.55E+00	mg/dscm
Kent	MB/WW	SD/FF	PM	4.58E-01	mg/dscm
Kent	MB/WW	SD/FF	PM	4.58E-01	mg/dscm
Kent average	MB/WW	SD/FF	PM	4.58E-01	mg/dscm
Long Beach	MB/WW	SD/FF	PM	1.37E+01	mg/dscm
Marion County	MB/WW	SD/FF	PM	1.33E+01	mg/dscm
Marion County	MB/WW	SD/FF	PM	3.64E+01	mg/dscm
Marion County	MB/WW	SD/FF	PM	1.21E+01	mg/dscm
Marion County	MB/WW	SD/FF	PM	5.26E+00	mg/dscm
Marion County average	MB/WW	SD/FF	PM	1.68E+01	mg/dscm
Stanislaus County	MB/WW	SD/FF	PM	9.38E+00	mg/dscm
Stanislaus County	MB/WW	SD/FF	PM	1.26E+01	mg/dscm
Stanislaus County	MB/WW	SD/FF	PM	5.03E+00	mg/dscm
Stanislaus County	MB/WW	SD/FF	PM	1.26E+01	mg/dscm
Stanislaus County	MB/WW	SD/FF	PM	5.03E+00	mg/dscm
Stanislaus County average	MB/WW	SD/FF	PM	8.92E+00	mg/dscm
AVERAGE	MB/WW	SD/FF	PM	7.74E+00	mg/dscm
Babylon	MB/WW	SD/FF	Pb	1.00E+00	µg/dscm
Babylon	MB/WW	SD/FF	Pb	1.00E+00	µg/dscm
Babylon	MB/WW	SD/FF	Pb	3.60E+01	µg/dscm
Babylon average	MB/WW	SD/FF	Pb	1.27E+01	µg/dscm
Bridgeport	MB/WW	SD/FF	Pb	ND	µg/dscm
Bridgeport	MB/WW	SD/FF	Pb	ND	µg/dscm
Bridgeport	MB/WW	SD/FF	Pb	4.00E+01	µg/dscm
Bridgeport	MB/WW	SD/FF	Pb	9.00E+00	µg/dscm
Bridgeport	MB/WW	SD/FF	Pb	ND	µg/dscm
Bridgeport	MB/WW	SD/FF	Pb	ND	µg/dscm
Bridgeport average	MB/WW	SD/FF	Pb	8.17E+00	µg/dscm
Bristol	MB/WW	SD/FF	Pb	1.50E+01	µg/dscm
Bristol	MB/WW	SD/FF	Pb	1.80E+01	µg/dscm
Bristol	MB/WW	SD/FF	Pb	3.20E+01	µg/dscm
Bristol	MB/WW	SD/FF	Pb	2.80E+01	µg/dscm
Bristol average	MB/WW	SD/FF	Pb	2.33E+01	µg/dscm
Commerce	MB/WW	SD/FF	Pb	2.00E+00	µg/dscm
Commerce	MB/WW	SD/FF	Pb	3.00E+00	µg/dscm
Commerce average	MB/WW	SD/FF	Pb	2.50E+00	µg/dscm
Fairfax	MB/WW	SD/FF	Pb	2.60E+01	µg/dscm
Fairfax	MB/WW	SD/FF	Pb	2.90E+01	µg/dscm
Fairfax	MB/WW	SD/FF	Pb	2.60E+01	µg/dscm
Fairfax	MB/WW	SD/FF	Pb	3.50E+01	µg/dscm
Fairfax average	MB/WW	SD/FF	Pb	2.90E+01	µg/dscm
Gloucester	MB/WW	SD/FF	Pb	2.00E+00	µg/dscm
Gloucester	MB/WW	SD/FF	Pb	2.00E+01	µg/dscm
Gloucester	MB/WW	SD/FF	Pb	1.00E+01	µg/dscm
Gloucester average	MB/WW	SD/FF	Pb	1.07E+01	µg/dscm

TABLE 4-1. (CONTINUED)

Facility Name	Combustor Type ^a	Control Technology ^b	Pollutant ^c	Concentration ^{d,e}	Units
Hempstead	MB/WW	SD/FF	Pb	2.00E+00	µg/dscm
Hempstead	MB/WW	SD/FF	Pb	4.00E+00	µg/dscm
Hempstead	MB/WW	SD/FF	Pb	6.00E+00	µg/dscm
Hempstead average	MB/WW	SD/FF	Pb	4.00E+00	µg/dscm
Huntsville	MB/WW	SD/FF	Pb	5.30E+02	µg/dscm
Huntsville	MB/WW	SD/FF	Pb	1.10E+01	µg/dscm
Huntsville average	MB/WW	SD/FF	Pb	2.71E+02	µg/dscm
Indianapolis	MB/WW	SD/FF	Pb	4.00E+00	µg/dscm
Indianapolis	MB/WW	SD/FF	Pb	7.20E+01	µg/dscm
Indianapolis	MB/WW	SD/FF	Pb	4.00E+00	µg/dscm
Indianapolis average	MB/WW	SD/FF	Pb	2.67E+01	µg/dscm
Kent	MB/WW	SD/FF	Pb	7.00E+00	µg/dscm
Kent	MB/WW	SD/FF	Pb	7.00E+00	µg/dscm
Kent average	MB/WW	SD/FF	Pb	7.00E+00	µg/dscm
Long Beach	MB/WW	SD/FF	Pb	5.00E+00	µg/dscm
Marion County	MB/WW	SD/FF	Pb	8.00E+01	µg/dscm
Marion County	MB/WW	SD/FF	Pb	1.00E+01	µg/dscm
Marion County	MB/WW	SD/FF	Pb	1.90E+01	µg/dscm
Marion County	MB/WW	SD/FF	Pb	8.00E+00	µg/dscm
Marion County average	MB/WW	SD/FF	Pb	2.93E+01	µg/dscm
Stanislaus County	MB/WW	SD/FF	Pb	2.60E+01	µg/dscm
Stanislaus County	MB/WW	SD/FF	Pb	3.70E+01	µg/dscm
Stanislaus County	MB/WW	SD/FF	Pb	2.30E+01	µg/dscm
Stanislaus County average	MB/WW	SD/FF	Pb	2.87E+01	µg/dscm
AVERAGE	MB/WW	SD/FF	Pb	3.52E+01	µg/dscm
Babylon	MB/WW	SD/FF	SO ₂	3.70E+01	ppmv
Babylon	MB/WW	SD/FF	SO ₂	2.10E+01	ppmv
Babylon	MB/WW	SD/FF	SO ₂	1.60E+01	ppmv
Babylon average	MB/WW	SD/FF	SO ₂	2.47E+01	ppmv
Commerce	MB/WW	SD/FF	SO ₂	3.80E+00	ppmv
Commerce	MB/WW	SD/FF	SO ₂	1.30E+00	ppmv
Commerce	MB/WW	SD/FF	SO ₂	1.90E+00	ppmv
Commerce average	MB/WW	SD/FF	SO ₂	2.33E+00	ppmv
Long Beach	MB/WW	SD/FF	SO ₂	6.80E+00	ppmv
Marion County	MB/WW	SD/FF	SO ₂	1.51E+02	ppmv
Marion County	MB/WW	SD/FF	SO ₂	3.10E+01	ppmv
Marion County average	MB/WW	SD/FF	SO ₂	9.10E+01	ppmv
Stanislaus County	MB/WW	SD/FF	SO ₂	2.90E+00	ppmv
Stanislaus County	MB/WW	SD/FF	SO ₂	5.40E+00	ppmv
Stanislaus County average	MB/WW	SD/FF	SO ₂	4.15E+00	ppmv
AVERAGE	MB/WW	SD/FF	SO ₂	2.58E+01	ppmv
Adirondack (Boiler A)	MB/WW	SD/ESP	As	3.20E-01	µg/dscm ^f
Adirondack (Boiler B)	MB/WW	SD/ESP	As	3.00E-01	µg/dscm ^f
Adirondack (Boiler B)	MB/WW	SD/ESP	As	6.19E-01	µg/dscm ^f
Adirondack average	MB/WW	SD/ESP	As	4.13E-01	µg/dscm
Camden (Unit 1)	MB/WW	SD/ESP	As	1.19E+00	µg/dscm ^f
Charleston (Unit A)	MB/WW	SD/ESP	As	1.39E+00	µg/dscm
Charleston (Unit B)	MB/WW	SD/ESP	As	8.04E-01	µg/dscm
Charleston average	MB/WW	SD/ESP	As	1.10E+00	µg/dscm
Millbury	MB/WW	SD/ESP	As	4.60E+00	µg/dscm
Millbury	MB/WW	SD/ESP	As	3.55E+00	µg/dscm
Millbury average	MB/WW	SD/ESP	As	4.08E+00	µg/dscm
AVERAGE	MB/WW	SD/ESP	As	1.69E+00	µg/dscm
Adirondack (Boiler A)	MB/WW	SD/ESP	CDD/CDF	2.81E-02	µg/dscm
Adirondack (Boiler B)	MB/WW	SD/ESP	CDD/CDF	4.02E-02	µg/dscm
Adirondack average	MB/WW	SD/ESP	CDD/CDF	3.42E-02	µg/dscm
Camden (Unit 1)	MB/WW	SD/ESP	CDD/CDF	7.49E-02	µg/dscm
Charleston (Unit B)	MB/WW	SD/ESP	CDD/CDF	4.42E-02	µg/dscm

TABLE 4-1. (CONTINUED)

Facility Name	Combustor Type ^a	Control Technology ^b	Pollutant ^c	Concentration ^{d,e}	Units
Millbury	MB/WW	SD/ESP	CDD/CDF	5.92E-02	µg/dscm
Portland	MB/WW	SD/ESP	CDD/CDF	1.73E-01	µg/dscm
AVERAGE	MB/WW	SD/ESP	CDD/CDF	7.71E-02	µg/dscm
Adirondack (Boiler A)	MB/WW	SD/ESP	Cd	1.90E+00	µg/dscm
Adirondack (Boiler B)	MB/WW	SD/ESP	Cd	5.21E+00	µg/dscm
Adirondack (Boiler B)	MB/WW	SD/ESP	Cd	1.03E+00	µg/dscm
Adirondack average	MB/WW	SD/ESP	Cd	2.71E+00	µg/dscm
Camden (Unit 1)	MB/WW	SD/ESP	Cd	6.18E+00	µg/dscm ^f
Charleston (Unit A)	MB/WW	SD/ESP	Cd	5.83E+00	µg/dscm
Charleston (Unit B)	MB/WW	SD/ESP	Cd	5.02E+00	µg/dscm
Charleston average	MB/WW	SD/ESP	Cd	5.43E+00	µg/dscm
Haverhill	MB/WW	SD/ESP	Cd	3.80E+01	µg/dscm
Haverhill	MB/WW	SD/ESP	Cd	1.80E+01	µg/dscm
Haverhill	MB/WW	SD/ESP	Cd	1.00E+01	µg/dscm
Haverhill average	MB/WW	SD/ESP	Cd	2.20E+01	µg/dscm
Millbury	MB/WW	SD/ESP	Cd	1.30E+01	µg/dscm
Millbury	MB/WW	SD/ESP	Cd	2.20E+01	µg/dscm
Millbury	MB/WW	SD/ESP	Cd	3.20E+01	µg/dscm
Millbury	MB/WW	SD/ESP	Cd	6.00E+00	µg/dscm
Millbury	MB/WW	SD/ESP	Cd	1.80E+01	µg/dscm
Millbury	MB/WW	SD/ESP	Cd	7.00E+00	µg/dscm
Millbury	MB/WW	SD/ESP	Cd	1.10E+01	µg/dscm
Millbury average	MB/WW	SD/ESP	Cd	1.56E+01	µg/dscm
Portland	MB/WW	SD/ESP	Cd	4.00E+00	µg/dscm
Portland	MB/WW	SD/ESP	Cd	4.00E+00	µg/dscm
Portland average	MB/WW	SD/ESP	Cd	4.00E+00	µg/dscm
AVERAGE	MB/WW	SD/ESP	Cd	9.31E+00	µg/dscm
Adirondack (Boiler A)	MB/WW	SD/ESP	Cr	5.29E+00	µg/dscm
Adirondack (Boiler B)	MB/WW	SD/ESP	Cr	1.02E+01	µg/dscm
Adirondack (Boiler B)	MB/WW	SD/ESP	Cr	2.47E+00	µg/dscm ^f
Adirondack average	MB/WW	SD/ESP	Cr	5.98E+00	µg/dscm
Camden (Unit 1)	MB/WW	SD/ESP	Cr	2.35E+01	µg/dscm ^f
Charleston (Unit A)	MB/WW	SD/ESP	Cr	1.72E+01	µg/dscm
Charleston (Unit B)	MB/WW	SD/ESP	Cr	3.49E+01	µg/dscm
Charleston average	MB/WW	SD/ESP	Cr	2.61E+01	µg/dscm
Millbury	MB/WW	SD/ESP	Cr	4.77E+01	µg/dscm
Millbury	MB/WW	SD/ESP	Cr	9.87E+01	µg/dscm
Millbury average	MB/WW	SD/ESP	Cr	7.32E+01	µg/dscm
AVERAGE	MB/WW	SD/ESP	Cr	3.22E+01	µg/dscm
Adirondack (Boiler A)	MB/WW	SD/ESP	HCl	2.83E+01	ppmv
Adirondack (Boiler B)	MB/WW	SD/ESP	HCl	1.74E+01	ppmv ^f
Adirondack (Boiler B)	MB/WW	SD/ESP	HCl	1.27E+01	ppmv
Adirondack average	MB/WW	SD/ESP	HCl	1.95E+01	ppmv
Camden (Unit 1)	MB/WW	SD/ESP	HCl	7.01E+00	ppmv
Camden (Unit 2)	MB/WW	SD/ESP	HCl	2.82E+00	ppmv
Camden (Unit 3)	MB/WW	SD/ESP	HCl	3.23E+00	ppmv
Camden average	MB/WW	SD/ESP	HCl	4.35E+00	ppmv
Millbury	MB/WW	SD/ESP	HCl	6.08E+00	ppmv
Millbury	MB/WW	SD/ESP	HCl	2.33E+01	ppmv
Millbury average	MB/WW	SD/ESP	HCl	1.47E+01	ppmv
AVERAGE	MB/WW	SD/ESP	HCl	1.28E+01	ppmv
Adirondack (Boiler A)	MB/WW	SD/ESP	Hg	5.74E+01	µg/dscm
Adirondack (Boiler B)	MB/WW	SD/ESP	Hg	7.48E+01	µg/dscm
Adirondack (Boiler B)	MB/WW	SD/ESP	Hg	1.31E+02	µg/dscm
Adirondack average	MB/WW	SD/ESP	Hg	8.77E+01	µg/dscm
Camden (Unit 1)	MB/WW	SD/ESP	Hg	2.17E+02	µg/dscm
Charleston (Units A & B)	MB/WW	SD/ESP	Hg	7.23E+02	µg/dscm
Charleston (Unit A)	MB/WW	SD/ESP	Hg	4.57E+02	µg/dscm

TABLE 4-1. (CONTINUED)

Facility Name	Combustor Type ^a	Control Technology ^b	Pollutant ^c	Concentration ^{d,e}	Units
Charleston (Unit B)	MB/WW	SD/ESP	Hg	4.98E+02	µg/dscm
Charleston average	MB/WW	SD/ESP	Hg	5.59E+02	µg/dscm
Haverill, Unit A (6/89)	MB/WW	SD/ESP	Hg	2.47E+02	µg/dscm
Haverill, Unit B (3/90)	MB/WW	SD/ESP	Hg	5.67E+02	µg/dscm
Haverill, Unit B (6/89)	MB/WW	SD/ESP	Hg	2.08E+02	µg/dscm
Haverill average	MB/WW	SD/ESP	Hg	3.41E+02	µg/dscm
Millbury (Unit 1)	MB/WW	SD/ESP	Hg	5.65E+02	µg/dscm
Millbury (Unit 2)	MB/WW	SD/ESP	Hg	9.54E+02	µg/dscm
Millbury average	MB/WW	SD/ESP	Hg	7.60E+02	µg/dscm
Portland, Unit 1 (12/89)	MB/WW	SD/ESP	Hg	5.50E+02	µg/dscm
Portland, Unit 2 (12/89)	MB/WW	SD/ESP	Hg	3.82E+02	µg/dscm
Portland average	MB/WW	SD/ESP	Hg	4.66E+02	µg/dscm
AVERAGE	MB/WW	SD/ESP	Hg	4.05E+02	µg/dscm
Adirondack (Boiler A)	MB/WW	SD/ESP	Ni	2.35E+01	µg/dscm
Adirondack (Boiler B)	MB/WW	SD/ESP	Ni	1.40E+02	µg/dscm
Adirondack (Boiler B)	MB/WW	SD/ESP	Ni	8.82E+00	µg/dscm
Adirondack average	MB/WW	SD/ESP	Ni	5.74E+01	µg/dscm
Camden (Unit 1)	MB/WW	SD/ESP	Ni	1.66E+01	µg/dscm ^f
Charleston (Unit A)	MB/WW	SD/ESP	Ni	1.59E+01	µg/dscm
Charleston (Unit B)	MB/WW	SD/ESP	Ni	3.42E+01	µg/dscm
Charleston average	MB/WW	SD/ESP	Ni	2.51E+01	µg/dscm
Millbury	MB/WW	SD/ESP	Ni	1.44E+01	µg/dscm
Millbury	MB/WW	SD/ESP	Ni	2.19E+01	µg/dscm
Millbury average	MB/WW	SD/ESP	Ni	1.82E+01	µg/dscm
AVERAGE	MB/WW	SD/ESP	Ni	3.35E+01	µg/dscm
Adirondack (Boiler A)	MB/WW	SD/ESP	PM	7.10E+00	mg/dscm
Adirondack (Boiler B)	MB/WW	SD/ESP	PM	5.95E+00	mg/dscm
Adirondack (Boiler B)	MB/WW	SD/ESP	PM	1.05E+01	mg/dscm
Adirondack average	MB/WW	SD/ESP	PM	7.85E+00	mg/dscm
Camden (Unit 1)	MB/WW	SD/ESP	PM	6.97E+00	mg/dscm
Camden (Unit 2)	MB/WW	SD/ESP	PM	1.02E+01	mg/dscm
Camden (Unit 3)	MB/WW	SD/ESP	PM	1.57E+01	mg/dscm
Camden average	MB/WW	SD/ESP	PM	8.59E+00	mg/dscm
Haverhill	MB/WW	SD/ESP	PM	9.84E+00	mg/dscm
Haverhill	MB/WW	SD/ESP	PM	9.84E+00	mg/dscm
Haverhill	MB/WW	SD/ESP	PM	1.01E+01	mg/dscm
Haverhill average	MB/WW	SD/ESP	PM	9.92E+00	mg/dscm
Millbury	MB/WW	SD/ESP	PM	1.95E+00	mg/dscm
Millbury	MB/WW	SD/ESP	PM	1.01E+01	mg/dscm
Millbury	MB/WW	SD/ESP	PM	4.12E+00	mg/dscm
Millbury	MB/WW	SD/ESP	PM	9.84E+00	mg/dscm
Millbury	MB/WW	SD/ESP	PM	1.85E+01	mg/dscm
Millbury	MB/WW	SD/ESP	PM	1.90E+01	mg/dscm
Millbury	MB/WW	SD/ESP	PM	4.12E+00	mg/dscm
Millbury	MB/WW	SD/ESP	PM	8.24E+00	mg/dscm
Millbury average	MB/WW	SD/ESP	PM	9.48E+00	mg/dscm
Portland	MB/WW	SD/ESP	PM	7.32E+00	mg/dscm
Portland	MB/WW	SD/ESP	PM	8.24E+00	mg/dscm
Portland average	MB/WW	SD/ESP	PM	7.78E+00	mg/dscm
AVERAGE	MB/WW	SD/ESP	PM	8.72E+00	mg/dscm
Adirondack (Boiler A)	MB/WW	SD/ESP	Pb	2.77E+01	µg/dscm
Adirondack (Boiler B)	MB/WW	SD/ESP	Pb	2.91E+01	µg/dscm
Adirondack (Boiler B)	MB/WW	SD/ESP	Pb	1.52E+01	µg/dscm ^f
Adirondack average	MB/WW	SD/ESP	Pb	2.40E+01	µg/dscm
Camden (Unit 1)	MB/WW	SD/ESP	Pb	5.52E+01	µg/dscm ^f
Charleston (Unit A)	MB/WW	SD/ESP	Pb	1.03E+02	µg/dscm
Charleston (Unit B)	MB/WW	SD/ESP	Pb	6.05E+01	µg/dscm
Charleston average	MB/WW	SD/ESP	Pb	8.18E+01	µg/dscm

TABLE 4-1. (CONTINUED)

Facility Name	Combustor Type ^a	Control Technology ^b	Pollutant ^c	Concentration ^{d,e}	Units
Haverhill	MB/WW	SD/ESP	Pb	1.40E+02	µg/dscm
Haverhill	MB/WW	SD/ESP	Pb	1.50E+02	µg/dscm
Haverhill	MB/WW	SD/ESP	Pb	4.90E+02	µg/dscm
Haverhill average	MB/WW	SD/ESP	Pb	2.60E+02	µg/dscm
Millbury	MB/WW	SD/ESP	Pb	3.30E+02	µg/dscm
Millbury	MB/WW	SD/ESP	Pb	2.80E+02	µg/dscm
Millbury	MB/WW	SD/ESP	Pb	8.80E+01	µg/dscm
Millbury	MB/WW	SD/ESP	Pb	1.70E+02	µg/dscm
Millbury	MB/WW	SD/ESP	Pb	1.20E+02	µg/dscm
Millbury	MB/WW	SD/ESP	Pb	2.80E+02	µg/dscm
Millbury	MB/WW	SD/ESP	Pb	1.50E+02	µg/dscm
Millbury average	MB/WW	SD/ESP	Pb	2.03E+02	µg/dscm
Portland	MB/WW	SD/ESP	Pb	5.60E+01	µg/dscm
Portland	MB/WW	SD/ESP	Pb	5.90E+01	µg/dscm
Portland average	MB/WW	SD/ESP	Pb	5.75E+01	µg/dscm
AVERAGE	MB/WW	SD/ESP	Pb	1.14E+02	µg/dscm
Adirondack (Boiler A)	MB/WW	SD/ESP	SO ₂	1.62E+01	ppmv
Adirondack (Boiler B)	MB/WW	SD/ESP	SO ₂	1.89E+01	ppmv
Adirondack (Boiler B)	MB/WW	SD/ESP	SO ₂	8.10E+00	ppmv
Adirondack average	MB/WW	SD/ESP	SO ₂	1.44E+01	ppmv
Camden (Unit 1)	MB/WW	SD/ESP	SO ₂	2.27E+01	ppmv
Camden (Unit 2)	MB/WW	SD/ESP	SO ₂	1.08E+01	ppmv
Camden (Unit 3)	MB/WW	SD/ESP	SO ₂	1.77E+01	ppmv
Camden average	MB/WW	SD/ESP	SO ₂	1.71E+01	ppmv
Millbury	MB/WW	SD/ESP	SO ₂	3.38E+01	ppmv
Millbury	MB/WW	SD/ESP	SO ₂	5.39E+01	ppmv
Millbury	MB/WW	SD/ESP	SO ₂	6.15E+01	ppmv
Millbury average	MB/WW	SD/ESP	SO ₂	4.97E+01	ppmv
Portland	MB/WW	SD/ESP	SO ₂	3.17E+01	ppmv
Portland	MB/WW	SD/ESP	SO ₂	4.89E+01	ppmv
Portland average	MB/WW	SD/ESP	SO ₂	4.03E+01	ppmv
AVERAGE	MB/WW	SD/ESP	SO ₂	3.04E+01	ppmv
Baltimore RESCO (Unit 2)	MB/WW	ESP	As	5.80E+00	µg/dscm
Quebec City	MB/WW	ESP	As	2.70E+00	µg/dscm
Peekskill	MB/WW	ESP	As	2.17E+00	µg/dscm
Pinellas County (Unit 3)	MB/WW	ESP	As	3.50E+00	µg/dscm
AVERAGE	MB/WW	ESP	As	3.54E+00	µg/dscm
North Andover	MB/WW	ESP	CDD/CDF	3.62E-01	µg/dscm
Peekskill	MB/WW	ESP	CDD/CDF	1.79E-01	µg/dscm
Peekskill	MB/WW	ESP	CDD/CDF	1.07E-01	µg/dscm
Peekskill	MB/WW	ESP	CDD/CDF	1.48E-01	µg/dscm
Peekskill	MB/WW	ESP	CDD/CDF	1.26E-01	µg/dscm
Peekskill	MB/WW	ESP	CDD/CDF	2.63E-01	µg/dscm
Peekskill average	MB/WW	ESP	CDD/CDF	1.65E-01	µg/dscm
Pinellas County (Unit 3)	MB/WW	ESP	CDD/CDF	1.00E-01	µg/dscm
Quebec City	MB/WW	ESP	CDD/CDF	6.40E-02	µg/dscm
Tulsa	MB/WW	ESP	CDD/CDF	3.80E-02	µg/dscm
AVERAGE	MB/WW	ESP	CDD/CDF	1.45E-01	µg/dscm
Pinellas County	MB/WW	ESP	Cd	7.73E+00	µg/dscm
Quebec City	MB/WW	ESP	Cd	2.34E+01	µg/dscm
Tulsa	MB/WW	ESP	Cd	3.90E+02	µg/dscm
Tulsa	MB/WW	ESP	Cd	1.40E+02	µg/dscm
Tulsa average	MB/WW	ESP	Cd	2.65E+02	µg/dscm
AVERAGE	MB/WW	ESP	Cd	9.87E+01	µg/dscm
Baltimore RESCO (Unit 2)	MB/WW	ESP	Cr	2.92E+01	µg/dscm
Pinellas County (Unit 3)	MB/WW	ESP	Cr	4.18E+00	µg/dscm
Quebec City	MB/WW	ESP	Cr	7.20E+00	µg/dscm
AVERAGE	MB/WW	ESP	Cr	1.35E+01	µg/dscm

TABLE 4-1. (CONTINUED)

Facility Name	Combustor Type ^a	Control Technology ^b	Pollutant ^c	Concentration ^{d,e}	Units
Hillsborough	MB/WW	ESP	Hg	8.23E+02	µg/dscm
Pinellas County	MB/WW	ESP	Hg	8.47E+02	µg/dscm
Quebec City	MB/WW	ESP	Hg	6.85E+02	µg/dscm
Tulsa	MB/WW	ESP	Hg	7.46E+02	µg/dscm
Tulsa	MB/WW	ESP	Hg	4.66E+02	µg/dscm
Tulsa	MB/WW	ESP	Hg	7.11E+02	µg/dscm
Tulsa	MB/WW	ESP	Hg	6.00E+02	µg/dscm
Tulsa	MB/WW	ESP	Hg	4.18E+02	µg/dscm
Tulsa	MB/WW	ESP	Hg	1.00E+03	µg/dscm
Tulsa	MB/WW	ESP	Hg	9.70E+01	µg/dscm
Tulsa average	MB/WW	ESP	Hg	5.77E+02	µg/dscm
AVERAGE	MB/WW	ESP	Hg	7.33E+02	µg/dscm
Pinellas County (Unit 3)	MB/WW	ESP	Ni	2.38E+00	µg/dscm
Quebec City	MB/WW	ESP	Ni	5.10E+00	µg/dscm
AVERAGE	MB/WW	ESP	Ni	3.74E+00	µg/dscm
Alexandria (Unit 2)	MB/WW	ESP	PM	6.87E+01	mg/dscm
Alexandria (Unit 3)	MB/WW	ESP	PM	5.72E+01	mg/dscm
Alexandria average	MB/WW	ESP	PM	6.29E+01	mg/dscm
Baltimore RESCO (Unit 1)	MB/WW	ESP	PM	4.58E+00	mg/dscm
Baltimore RESCO (Unit 2)	MB/WW	ESP	PM	1.01E+01	mg/dscm
Baltimore RESCO (Unit 2)	MB/WW	ESP	PM	6.18E+00	mg/dscm
Baltimore RESCO (Unit 3)	MB/WW	ESP	PM	2.29E+00	mg/dscm
Baltimore average	MB/WW	ESP	PM	5.78E+00	mg/dscm
Hillsborough	MB/WW	ESP	PM	1.08E+01	mg/dscm
North Andover	MB/WW	ESP	PM	8.24E+00	mg/dscm
Peekskill	MB/WW	ESP	PM	3.43E+01	mg/dscm
Peekskill	MB/WW	ESP	PM	3.66E+01	mg/dscm
Peekskill	MB/WW	ESP	PM	3.43E+01	mg/dscm
Peekskill	MB/WW	ESP	PM	4.58E+01	mg/dscm
Peekskill average	MB/WW	ESP	PM	3.78E+01	mg/dscm
Pinellas County	MB/WW	ESP	PM	5.26E+00	mg/dscm
Pinellas County (Unit 3)	MB/WW	ESP	PM	5.26E+00	mg/dscm
Pinellas County average	MB/WW	ESP	PM	5.26E+00	mg/dscm
Quebec City	MB/WW	ESP	PM	2.29E+01	mg/dscm
Tulsa	MB/WW	ESP	PM	1.95E+01	mg/dscm
Tulsa	MB/WW	ESP	PM	5.26E+00	mg/dscm
Tulsa	MB/WW	ESP	PM	5.58E+01	mg/dscm
Tulsa (Unit 1)	MB/WW	ESP	PM	2.15E+01	mg/dscm
Tulsa (Unit 2)	MB/WW	ESP	PM	1.12E+01	mg/dscm
Tulsa average	MB/WW	ESP	PM	2.27E+01	mg/dscm
AVERAGE	MB/WW	ESP	PM	2.20E+01	mg/dscm
Hillsborough	MB/WW	ESP	Pb	3.20E+02	µg/dscm
Pinellas County	MB/WW	ESP	Pb	1.53E+02	µg/dscm
Quebec City	MB/WW	ESP	Pb	6.55E+02	µg/dscm
Tulsa	MB/WW	ESP	Pb	4.10E+02	µg/dscm
AVERAGE	MB/WW	ESP	Pb	3.85E+02	µg/dscm
Vancouver average	MB/WW	DSI/FF	As	1.60E+00	µg/dscm
Claremont (Unit 1)	MB/WW	DSI/FF	CDD/CDF	3.76E-02	µg/dscm
Claremont (Unit 2)	MB/WW	DSI/FF	CDD/CDF	3.23E-02	µg/dscm
Claremont average	MB/WW	DSI/FF	CDD/CDF	3.50E-02	µg/dscm
Vancouver	MB/WW	DSI/FF	CDD/CDF	4.84E-03	µg/dscm
AVERAGE	MB/WW	DSI/FF	CDD/CDF	1.96E-02	µg/dscm
Vancouver average	MB/WW	DSI/FF	Cd	3.70E+00	µg/dscm
Vancouver average	MB/WW	DSI/FF	Cr	4.10E+01	µg/dscm
Claremont (Unit 1)	MB/WW	DSI/FF	HCl	1.04E+02	ppmv
Claremont (Unit 1)	MB/WW	DSI/FF	HCl	2.37E+01	ppmv
Claremont (Unit 2)	MB/WW	DSI/FF	HCl	3.68E+01	ppmv
Claremont average	MB/WW	DSI/FF	HCl	5.48E+01	ppmv

TABLE 4-1. (CONTINUED)

Facility Name	Combustor Type ^a	Control Technology ^b	Pollutant ^c	Concentration ^{d,e}	Units
Vancouver	MB/WW	DSI/FF	HCl	1.70E+01	ppmv
Vancouver	MB/WW	DSI/FF	HCl	9.00E+00	ppmv
Vancouver	MB/WW	DSI/FF	HCl	1.70E+01	ppmv
Vancouver average	MB/WW	DSI/FF	HCl	1.43E+01	ppmv
AVERAGE	MB/WW	DSI/FF	HCl	3.46E+01	ppmv
Vancouver (12/89)	MB/WW	DSI/FF	Hg	1.56E+02	µg/dscm
Vancouver (12/89)	MB/WW	DSI/FF	Hg	1.17E+02	µg/dscm
Vancouver (12/89)	MB/WW	DSI/FF	Hg	1.27E+02	µg/dscm
Vancouver (3/89)	MB/WW	DSI/FF	Hg	4.56E+02	µg/dscm
Vancouver (4/89)	MB/WW	DSI/FF	Hg	6.32E+02	µg/dscm
Vancouver (8/89)	MB/WW	DSI/FF	Hg	9.50E+01	µg/dscm
Vancouver, Unit 1 (9/89)	MB/WW	DSI/FF	Hg	4.70E+02	µg/dscm
Vancouver, Unit 2 (9/89)	MB/WW	DSI/FF	Hg	3.68E+02	µg/dscm
Vancouver, Unit 3 (11/88)	MB/WW	DSI/FF	Hg	4.85E+02	µg/dscm
Vancouver, Unit 3 (9/89)	MB/WW	DSI/FF	Hg	1.08E+03	µg/dscm
Vancouver, Unit 3 (9/89)	MB/WW	DSI/FF	Hg	1.09E+03	µg/dscm
Vancouver average	MB/WW	DSI/FF	Hg	4.61E+02	µg/dscm
Vancouver average	MB/WW	DSI/FF	Ni	1.18E+01	µg/dscm
Claremont (Unit 1)	MB/WW	DSI/FF	PM	2.52E+01	mg/dscm
Claremont (Unit 2)	MB/WW	DSI/FF	PM	9.84E+00	mg/dscm
Claremont average	MB/WW	DSI/FF	PM	1.75E+01	mg/dscm
Concord	MB/WW	DSI/FF	PM	6.87E-01	mg/dscm
Concord	MB/WW	DSI/FF	PM	1.37E+00	mg/dscm
Concord average	MB/WW	DSI/FF	PM	1.03E+00	mg/dscm
Vancouver	MB/WW	DSI/FF	PM	3.27E+01	mg/dscm
Vancouver	MB/WW	DSI/FF	PM	1.01E+01	mg/dscm
Vancouver	MB/WW	DSI/FF	PM	1.81E+01	mg/dscm
Vancouver average	MB/WW	DSI/FF	PM	2.03E+01	mg/dscm
AVERAGE	MB/WW	DSI/FF	PM	1.29E+01	mg/dscm
Concord	MB/WW	DSI/FF	Pb	5.00E+00	µg/dscm
Concord	MB/WW	DSI/FF	Pb	1.00E+01	µg/dscm
Concord average	MB/WW	DSI/FF	Pb	7.50E+00	µg/dscm
Vancouver	MB/WW	DSI/FF	Pb	7.80E+01	µg/dscm
AVERAGE	MB/WW	DSI/FF	Pb	4.28E+01	µg/dscm
Claremont (Unit 1)	MB/WW	DSI/FF	SO ₂	3.79E+01	ppmv
Claremont (Unit 1)	MB/WW	DSI/FF	SO ₂	2.31E+02	ppmv
Claremont (Unit 2)	MB/WW	DSI/FF	SO ₂	6.01E+01	ppmv
Claremont average	MB/WW	DSI/FF	SO ₂	1.10E+02	ppmv
Vancouver	MB/WW	DSI/FF	SO ₂	1.80E+01	ppmv
Vancouver	MB/WW	DSI/FF	SO ₂	3.10E+01	ppmv
Vancouver	MB/WW	DSI/FF	SO ₂	1.50E+01	ppmv
Vancouver average	MB/WW	DSI/FF	SO ₂	2.13E+01	ppmv
AVERAGE	MB/WW	DSI/FF	SO ₂	6.55E+01	ppmv
Adirondack (Boiler A)	MB/WW	NA	CO	8.39E+01	ppmv
Adirondack (Boiler B)	MB/WW	NA	CO	8.50E+01	ppmv
Adirondack (Boiler B)	MB/WW	NA	CO	4.34E+01	ppmv
Adirondack average	MB/WW	NA	CO	7.06E+01	ppmv
Alexandria	MB/WW	NA	CO	1.80E+01	ppmv
Camden (Unit 1)	MB/WW	NA	CO	1.50E+01	ppmv
Camden (Unit 2)	MB/WW	NA	CO	4.18E+01	ppmv
Camden (Unit 3)	MB/WW	NA	CO	1.68E+01	ppmv
Camden average	MB/WW	NA	CO	2.45E+01	ppmv
Chicago	MB/WW	NA	CO	2.15E+02	ppmv
Claremont	MB/WW	NA	CO	5.50E+01	ppmv
Commerce	MB/WW	NA	CO	5.00E+01	ppmv
Commerce	MB/WW	NA	CO	1.80E+01	ppmv
Commerce	MB/WW	NA	CO	2.20E+01	ppmv
Commerce average	MB/WW	NA	CO	2.93E+01	ppmv

TABLE 4-1. (CONTINUED)

Facility Name	Combustor Type ^a	Control Technology ^b	Pollutant ^c	Concentration ^{d,e}	Units
Hampton	MB/WW	NA	CO	2.40E+01	ppmv
Long Beach	MB/WW	NA	CO	1.18E+02	ppmv
Marion County	MB/WW	NA	CO	1.80E+01	ppmv
Millbury	MB/WW	NA	CO	3.80E+01	ppmv
North Andover	MB/WW	NA	CO	4.30E+01	ppmv
Pinellas County	MB/WW	NA	CO	4.00E+00	ppmv
Portland, ME, North Unit	MB/WW	NA	CO	4.10E+01	ppmv
Portland, ME, South Unit	MB/WW	NA	CO	7.50E+01	ppmv
Portland average	MB/WW	NA	CO	5.80E+01	ppmv
Quebec City	MB/WW	NA	CO	8.20E+01	ppmv
Quebec City	MB/WW	NA	CO	3.50E+01	ppmv
Quebec City	MB/WW	NA	CO	3.10E+01	ppmv
Quebec City	MB/WW	NA	CO	2.90E+01	ppmv
Quebec City	MB/WW	NA	CO	2.80E+01	ppmv
Quebec City	MB/WW	NA	CO	5.00E+01	ppmv
Quebec City	MB/WW	NA	CO	2.10E+01	ppmv
Quebec City	MB/WW	NA	CO	4.60E+01	ppmv
Quebec City	MB/WW	NA	CO	2.00E+01	ppmv
Quebec City average	MB/WW	NA	CO	3.80E+01	ppmv
Saugus	MB/WW	NA	CO	4.00E+01	ppmv
Tulsa	MB/WW	NA	CO	2.20E+01	ppmv
Westchester County	MB/WW	NA	CO	7.00E+00	ppmv
Westchester County	MB/WW	NA	CO	2.10E+01	ppmv
Westchester County	MB/WW	NA	CO	3.60E+01	ppmv
Westchester County	MB/WW	NA	CO	2.40E+01	ppmv
Westchester County average	MB/WW	NA	CO	2.20E+01	ppmv
AVERAGE	MB/WW	NA	CO	4.93E+01	ppmv
Adirondack (Boiler A)	MB/WW	NA	NO _x	1.92E+02	ppmv
Adirondack (Boiler B)	MB/WW	NA	NO _x	1.61E+02	ppmv
Adirondack (Boiler B)	MB/WW	NA	NO _x	1.78E+02	ppmv
Adirondack average	MB/WW	NA	NO _x	1.77E+02	ppmv
Alexandria	MB/WW	NA	NO _x	2.08E+02	ppmv
Baltimore (Unit 1)	MB/WW	NA	NO _x	2.22E+02	ppmv
Baltimore (Unit 2)	MB/WW	NA	NO _x	1.94E+02	ppmv
Baltimore (Unit 3)	MB/WW	NA	NO _x	1.94E+02	ppmv
Baltimore average	MB/WW	NA	NO _x	2.03E+02	ppmv
Camden (Unit 1)	MB/WW	NA	NO _x	2.08E+02	ppmv
Camden (Unit 2)	MB/WW	NA	NO _x	2.08E+02	ppmv
Camden (Unit 3)	MB/WW	NA	NO _x	2.18E+02	ppmv
Camden average	MB/WW	NA	NO _x	2.11E+02	ppmv
Claremont (Unit 1)	MB/WW	NA	NO _x	2.59E+02	ppmv
Claremont (Unit 2)	MB/WW	NA	NO _x	2.10E+02	ppmv
Claremont average	MB/WW	NA	NO _x	2.35E+02	ppmv
Commerce	MB/WW	NA	NO _x	1.54E+02	ppmv
Hampton (Unit 1)	MB/WW	NA	NO _x	2.19E+02	ppmv
Hampton (Unit 2)	MB/WW	NA	NO _x	2.39E+02	ppmv
Hampton average	MB/WW	NA	NO _x	2.29E+02	ppmv
Long Beach	MB/WW	NA	NO _x	6.82E+01	ppmv
Marion County	MB/WW	NA	NO _x	2.86E+02	ppmv
Marion County	MB/WW	NA	NO _x	2.57E+02	ppmv
Marion County (Unit 2)	MB/WW	NA	NO _x	2.85E+02	ppmv
Marion County (Unit 2)	MB/WW	NA	NO _x	2.44E+02	ppmv
Marion County average	MB/WW	NA	NO _x	2.68E+02	ppmv
Millbury (Unit 1)	MB/WW	NA	NO _x	2.34E+02	ppmv
Millbury (Unit 2)	MB/WW	NA	NO _x	2.28E+02	ppmv
Millbury average	MB/WW	NA	NO _x	2.30E+02	ppmv
Nashville Thermal	MB/WW	NA	NO _x	2.21E+02	ppmv

TABLE 4-1. (CONTINUED)

Facility Name	Combustor Type ^a	Control Technology ^b	Pollutant ^c	Concentration ^{d,e}	Units
Peekskill	MB/WW	NA	NO _x	2.36E+02	ppmv
Peekskill	MB/WW	NA	NO _x	2.18E+02	ppmv
Peekskill average	MB/WW	NA	NO _x	2.27E+02	ppmv
Peekskill County	MB/WW	NA	NO _x	2.86E+02	ppmv
Quebec City	MB/WW	NA	NO _x	3.14E+02	ppmv
Stanislaus (Unit 1)	MB/WW	NA	NO _x	2.97E+02	ppmv
Stanislaus (Unit 2)	MB/WW	NA	NO _x	3.04E+02	ppmv
Stanislaus average	MB/WW	NA	NO _x	3.01E+02	ppmv
Tulsa (Unit 1)	MB/WW	NA	NO _x	3.68E+02	ppmv
Tulsa (Unit 2)	MB/WW	NA	NO _x	3.72E+02	ppmv
Tulsa (Unit 2) average	MB/WW	NA	NO _x	3.70E+02	ppmv
AVERAGE	MB/WW	NA	NO _x	2.31E+02	ppmv

^a MB/WW = Mass Burn/Waterwall.

^b U = Uncontrolled (prior to pollution control equipment).

SD/FF = Spray Dryer/Fabric Filter.

SD/ESP = Spray Dryer/Electrostatic Precipitator.

ESP = Electrostatic Precipitator.

DSI/FF = Duct Sorbent Injection/Fabric Filter.

NA = Not Applicable. Control of CO and NO_x is not tied to traditional acid gas/PM control devices; therefore, the pollution control device is not specified.

^c CDD/CDF levels are for the sum of all tetra- through octa- CDD and CDF homologues. PM levels are for total particulate.

^d All concentrations are corrected to 7 percent O₂ on a dry basis.

^e ND = Non-detect. Detection limits were not given. Considered zero when calculating averages.

^f Results were less than the detection limit; therefore, the detection limit is shown and is used in calculating averages, unless otherwise noted.

^g Average does not include detection limit value since other substantially lower data runs were available.

^h Detection limit value not included in total SD/FF average since the detection limit is much higher than other detectable data.

TABLE 4-2. MASS BURN/ROTARY WATERWALL COMBUSTOR DATA

Facility Name	Combustor Type ^a	Control Technology ^b	Pollutant ^c	Concentration ^d	Units
Gallatin	MB/RC	U	As	4.22E+02	μg/dscm
Gallatin	MB/RC	U	Cr	1.04E+03	μg/dscm
Dutchess County (Unit 1)	MB/RC	U	SO ₂	1.21E+02	ppmv
Dutchess County (Unit 2)	MB/RC	U	SO ₂	1.38E+02	ppmv
Dutchess County average	MB/RC	U	SO ₂	1.30E+02	ppmv
Delaware (Unit 1)	MB/RC	SD/FF	As	1.63E-01	μg/dscm ^e
Delaware (Unit 2)	MB/RC	SD/FF	As	2.53E-01	μg/dscm ^e
Delaware (Unit 3)	MB/RC	SD/FF	As	1.93E-01	μg/dscm ^e
Delaware (Unit 4)	MB/RC	SD/FF	As	2.23E-01	μg/dscm ^e
Delaware (Unit 5)	MB/RC	SD/FF	As	3.43E-01	μg/dscm ^e
Delaware (Unit 6)	MB/RC	SD/FF	As	1.73E-01	μg/dscm ^e
Delaware (Unit 1)	MB/RC	SD/FF	As	2.60E-01	μg/dscm ^e
Delaware (Unit 2)	MB/RC	SD/FF	As	2.77E-01	μg/dscm ^e
Delaware (Unit 3)	MB/RC	SD/FF	As	2.50E-01	μg/dscm ^e
Delaware (Unit 4)	MB/RC	SD/FF	As	2.80E-01	μg/dscm ^e
Delaware (Unit 5)	MB/RC	SD/FF	As	2.57E-01	μg/dscm ^e
Delaware (Unit 6)	MB/RC	SD/FF	As	2.37E-01	μg/dscm ^e
Delaware average	MB/RC	SD/FF	As	2.42E-01	μg/dscm
York (Unit 1)	MB/RC	SD/FF	As	4.10E-01	μg/dscm ^e
York (Unit 2)	MB/RC	SD/FF	As	7.03E-01	μg/dscm
York (Unit 3)	MB/RC	SD/FF	As	4.10E-01	μg/dscm ^e
York (Unit 1)	MB/RC	SD/FF	As	6.23E-01	μg/dscm
York (Unit 2)	MB/RC	SD/FF	As	2.00E-01	μg/dscm
York (Unit 3)	MB/RC	SD/FF	As	4.83E-01	μg/dscm
York (Unit 1)	MB/RC	SD/FF	As	3.33E-01	μg/dscm ^e
York (Unit 2)	MB/RC	SD/FF	As	2.07E-01	μg/dscm ^e
York (Unit 3)	MB/RC	SD/FF	As	2.50E-01	μg/dscm
York (Unit 1)	MB/RC	SD/FF	As	1.09E+00	μg/dscm
York (Unit 2)	MB/RC	SD/FF	As	3.67E-01	μg/dscm
York (Unit 3)	MB/RC	SD/FF	As	5.17E-01	μg/dscm
York (Unit 1)	MB/RC	SD/FF	As	9.83E-01	μg/dscm
York (Unit 1)	MB/RC	SD/FF	As	1.70E+00	μg/dscm ^e
York (Unit 2)	MB/RC	SD/FF	As	6.03E-01	μg/dscm ^e
York (Unit 3)	MB/RC	SD/FF	As	5.90E-01	μg/dscm ^e
York (Unit 1)	MB/RC	SD/FF	As	4.67E-01	μg/dscm ^e
York (Unit 2)	MB/RC	SD/FF	As	5.67E-01	μg/dscm ^e
York (Unit 3)	MB/RC	SD/FF	As	6.60E-01	μg/dscm
York average	MB/RC	SD/FF	As	5.67E-01	μg/dscm
AVERAGE	MB/RC	SD/FF	As	4.15E-01	μg/dscm
Delaware (Unit 1)	MB/RC	SD/FF	Cd	4.67E-01	μg/dscm ^e
Delaware (Unit 2)	MB/RC	SD/FF	Cd	4.13E-01	μg/dscm ^e
Delaware (Unit 3)	MB/RC	SD/FF	Cd	3.27E-01	μg/dscm ^e
Delaware (Unit 4)	MB/RC	SD/FF	Cd	3.20E-01	μg/dscm ^e
Delaware (Unit 5)	MB/RC	SD/FF	Cd	8.43E-01	μg/dscm ^e
Delaware (Unit 6)	MB/RC	SD/FF	Cd	6.30E-01	μg/dscm ^e
Delaware (Unit 1)	MB/RC	SD/FF	Cd	6.43E-01	μg/dscm ^e
Delaware (Unit 2)	MB/RC	SD/FF	Cd	7.13E-01	μg/dscm ^e
Delaware (Unit 3)	MB/RC	SD/FF	Cd	6.23E-01	μg/dscm ^e
Delaware (Unit 4)	MB/RC	SD/FF	Cd	7.00E-01	μg/dscm ^e

TABLE 4-2. (CONTINUED)

Facility Name	Combustor Type ^a	Control Technology ^b	Pollutant ^c	Concentration ^d	Units
Delaware (Unit 5)	MB/RC	SD/FF	Cd	6.40E-01	μg/dscm ^e
Delaware (Unit 6)	MB/RC	SD/FF	Cd	6.03E-01	μg/dscm ^e
Delaware average	MB/RC	SD/FF	Cd	5.77E-01	μg/dscm
York (Unit 1)	MB/RC	SD/FF	Cd	4.08E+00	μg/dscm ^e
York (Unit 2)	MB/RC	SD/FF	Cd	4.11E+00	μg/dscm ^e
York (Unit 3)	MB/RC	SD/FF	Cd	3.47E+00	μg/dscm ^e
York (Unit 1)	MB/RC	SD/FF	Cd	2.80E-01	μg/dscm ^e
York (Unit 2)	MB/RC	SD/FF	Cd	1.22E+00	μg/dscm
York (Unit 3)	MB/RC	SD/FF	Cd	2.41E+00	μg/dscm
York (Unit 1)	MB/RC	SD/FF	Cd	5.23E-01	μg/dscm
York (Unit 2)	MB/RC	SD/FF	Cd	7.47E-01	μg/dscm
York (Unit 3)	MB/RC	SD/FF	Cd	1.40E+00	μg/dscm
York (Unit 1)	MB/RC	SD/FF	Cd	2.35E+00	μg/dscm
York (Unit 2)	MB/RC	SD/FF	Cd	1.91E+00	μg/dscm
York (Unit 3)	MB/RC	SD/FF	Cd	2.30E+00	μg/dscm
York (Unit 1)	MB/RC	SD/FF	Cd	1.39E+00	μg/dscm
York (Unit 1)	MB/RC	SD/FF	Cd	1.49E+00	μg/dscm ^e
York (Unit 2)	MB/RC	SD/FF	Cd	8.70E-01	μg/dscm
York (Unit 3)	MB/RC	SD/FF	Cd	1.47E+00	μg/dscm ^e
York (Unit 1)	MB/RC	SD/FF	Cd	1.46E+00	μg/dscm ^e
York (Unit 2)	MB/RC	SD/FF	Cd	1.27E+00	μg/dscm ^e
York (Unit 3)	MB/RC	SD/FF	Cd	2.89E+00	μg/dscm ^e
York average	MB/RC	SD/FF	Cd	1.88E+00	μg/dscm
AVERAGE	MB/RC	SD/FF	Cd	1.23E+00	μg/dscm
Delaware (Unit 1)	MB/RC	SD/FF	CDD/CDF	1.72E-03	μg/dscm
Delaware (Unit 2)	MB/RC	SD/FF	CDD/CDF	3.84E-03	μg/dscm
Delaware (Unit 3)	MB/RC	SD/FF	CDD/CDF	9.89E-03	μg/dscm
Delaware (Unit 4)	MB/RC	SD/FF	CDD/CDF	1.08E-02	μg/dscm
Delaware (Unit 5)	MB/RC	SD/FF	CDD/CDF	3.94E-03	μg/dscm
Delaware (Unit 6)	MB/RC	SD/FF	CDD/CDF	9.80E-03	μg/dscm
Delaware average	MB/RC	SD/FF	CDD/CDF	6.66E-03	μg/dscm
York (Unit 1)	MB/RC	SD/FF	CDD/CDF	4.32E-03	μg/dscm
York (Unit 2)	MB/RC	SD/FF	CDD/CDF	5.61E-03	μg/dscm
York (Unit 3)	MB/RC	SD/FF	CDD/CDF	3.58E-03	μg/dscm
York (Unit 1)	MB/RC	SD/FF	CDD/CDF	1.38E-02	μg/dscm
York (Unit 3)	MB/RC	SD/FF	CDD/CDF	1.24E-02	μg/dscm
York (Unit 1)	MB/RC	SD/FF	CDD/CDF	1.68E-03	μg/dscm
York (Unit 2)	MB/RC	SD/FF	CDD/CDF	5.11E-03	μg/dscm
York (Unit 3)	MB/RC	SD/FF	CDD/CDF	4.33E-03	μg/dscm
York (Unit 1)	MB/RC	SD/FF	CDD/CDF	5.39E-03	μg/dscm
York (Unit 2)	MB/RC	SD/FF	CDD/CDF	7.51E-03	μg/dscm
York (Unit 3)	MB/RC	SD/FF	CDD/CDF	8.01E-03	μg/dscm
York average	MB/RC	SD/FF	CDD/CDF	6.51E-03	μg/dscm
AVERAGE	MB/RC	SD/FF	CDD/CDF	6.59E-03	μg/dscm
Delaware (Unit 1)	MB/RC	SD/FF	Hg	4.06E+01	μg/dscm
Delaware (Unit 2)	MB/RC	SD/FF	Hg	2.28E+01	μg/dscm
Delaware (Unit 3)	MB/RC	SD/FF	Hg	3.05E+01	μg/dscm
Delaware (Unit 4)	MB/RC	SD/FF	Hg	2.73E+01	μg/dscm
Delaware (Unit 5)	MB/RC	SD/FF	Hg	5.43E+01	μg/dscm

TABLE 4-2. (CONTINUED)

Facility Name	Combustor Type ^a	Control Technology ^b	Pollutant ^c	Concentration ^d	Units
Delaware (Unit 6)	MB/RC	SD/FF	Hg	8.41E+01	µg/dscm
Delaware (Unit 1)	MB/RC	SD/FF	Hg	3.01E+01	µg/dscm
Delaware (Unit 2)	MB/RC	SD/FF	Hg	5.02E+01	µg/dscm
Delaware (Unit 3)	MB/RC	SD/FF	Hg	5.76E+01	µg/dscm
Delaware (Unit 4)	MB/RC	SD/FF	Hg	8.70E+01	µg/dscm
Delaware (Unit 5)	MB/RC	SD/FF	Hg	4.10E+01	µg/dscm
Delaware (Unit 6)	MB/RC	SD/FF	Hg	4.28E+01	µg/dscm
Delaware average	MB/RC	SD/FF	Hg	4.74E+01	µg/dscm
York (Unit 1)	MB/RC	SD/FF	Hg	1.58E+02	µg/dscm
York (Unit 2)	MB/RC	SD/FF	Hg	1.50E+02	µg/dscm
York (Unit 3)	MB/RC	SD/FF	Hg	7.93E+01	µg/dscm
York (Unit 1)	MB/RC	SD/FF	Hg	1.51E+02	µg/dscm
York (Unit 2)	MB/RC	SD/FF	Hg	1.67E+02	µg/dscm
York (Unit 3)	MB/RC	SD/FF	Hg	1.36E+02	µg/dscm
York (Unit 1)	MB/RC	SD/FF	Hg	1.55E+02	µg/dscm
York (Unit 2)	MB/RC	SD/FF	Hg	1.67E+02	µg/dscm
York (Unit 3)	MB/RC	SD/FF	Hg	1.36E+02	µg/dscm
York (Unit 1)	MB/RC	SD/FF	Hg	3.61E+01	µg/dscm
York (Unit 2)	MB/RC	SD/FF	Hg	5.30E+01	µg/dscm
York (Unit 3)	MB/RC	SD/FF	Hg	1.20E+02	µg/dscm
York (Unit 1)	MB/RC	SD/FF	Hg	4.84E+01	µg/dscm
York (Unit 1)	MB/RC	SD/FF	Hg	5.40E+01	µg/dscm
York (Unit 2)	MB/RC	SD/FF	Hg	5.54E+01	µg/dscm
York (Unit 3)	MB/RC	SD/FF	Hg	4.01E+01	µg/dscm
York (Unit 1)	MB/RC	SD/FF	Hg	1.53E+02	µg/dscm
York (Unit 2)	MB/RC	SD/FF	Hg	7.92E+01	µg/dscm
York (Unit 3)	MB/RC	SD/FF	Hg	1.50E+02	µg/dscm
York average	MB/RC	SD/FF	Hg	1.10E+02	µg/dscm
AVERAGE	MB/RC	SD/FF	Hg	7.86E+01	µg/dscm
Delaware (Unit 1)	MB/RC	SD/FF	Ni	1.61E+00	µg/dscm
Delaware (Unit 2)	MB/RC	SD/FF	Ni	5.75E+00	µg/dscm
Delaware (Unit 3)	MB/RC	SD/FF	Ni	1.48E+00	µg/dscm
Delaware (Unit 4)	MB/RC	SD/FF	Ni	7.96E+00	µg/dscm
Delaware (Unit 5)	MB/RC	SD/FF	Ni	2.03E+00	µg/dscm
Delaware (Unit 6)	MB/RC	SD/FF	Ni	3.36E+00	µg/dscm
Delaware (Unit 1)	MB/RC	SD/FF	Ni	1.53E+01	µg/dscm
Delaware (Unit 2)	MB/RC	SD/FF	Ni	2.60E+00	µg/dscm
Delaware (Unit 3)	MB/RC	SD/FF	Ni	7.39E+00	µg/dscm
Delaware (Unit 4)	MB/RC	SD/FF	Ni	2.07E+00	µg/dscm
Delaware (Unit 5)	MB/RC	SD/FF	Ni	2.74E+00	µg/dscm
Delaware (Unit 6)	MB/RC	SD/FF	Ni	2.69E+00	µg/dscm
Delaware average	MB/RC	SD/FF	Ni	4.58E+00	µg/dscm
York (Unit 1)	MB/RC	SD/FF	Ni	3.58E+00	µg/dscm
York (Unit 2)	MB/RC	SD/FF	Ni	2.14E+00	µg/dscm
York (Unit 3)	MB/RC	SD/FF	Ni	3.45E+00	µg/dscm
York (Unit 1)	MB/RC	SD/FF	Ni	9.97E-01	µg/dscm
York (Unit 2)	MB/RC	SD/FF	Ni	3.13E+00	µg/dscm
York (Unit 3)	MB/RC	SD/FF	Ni	2.33E+00	µg/dscm
York (Unit 1)	MB/RC	SD/FF	Ni	1.09E+00	µg/dscm

TABLE 4-2. (CONTINUED)

Facility Name	Combustor Type ^a	Control Technology ^b	Pollutant ^c	Concentration ^d	Units
York (Unit 2)	MB/RC	SD/FF	Ni	7.53E-01	µg/dscm
York (Unit 3)	MB/RC	SD/FF	Ni	1.18E+00	µg/dscm
York (Unit 1)	MB/RC	SD/FF	Ni	1.66E+00	µg/dscm
York (Unit 2)	MB/RC	SD/FF	Ni	1.09E+00	µg/dscm
York (Unit 3)	MB/RC	SD/FF	Ni	1.49E+00	µg/dscm
York (Unit 1)	MB/RC	SD/FF	Ni	1.03E+00	µg/dscm
York (Unit 1)	MB/RC	SD/FF	Ni	2.61E+00	µg/dscm
York (Unit 2)	MB/RC	SD/FF	Ni	2.12E+00	µg/dscm
York (Unit 3)	MB/RC	SD/FF	Ni	2.90E-01	µg/dscm
York (Unit 1)	MB/RC	SD/FF	Ni	1.28E+00	µg/dscm
York (Unit 2)	MB/RC	SD/FF	Ni	1.91E+00	µg/dscm
York (Unit 3)	MB/RC	SD/FF	Ni	7.75E+00	µg/dscm
York average	MB/RC	SD/FF	Ni	2.10E+00	µg/dscm
AVERAGE	MB/RC	SD/FF	Ni	3.34E+00	µg/dscm
Delaware (Unit 1)	MB/RC	SD/FF	Pb	7.07E+00	µg/dscm ^e
Delaware (Unit 2)	MB/RC	SD/FF	Pb	5.99E+00	µg/dscm ^e
Delaware (Unit 3)	MB/RC	SD/FF	Pb	8.18E+00	µg/dscm ^e
Delaware (Unit 4)	MB/RC	SD/FF	Pb	5.28E+00	µg/dscm ^e
Delaware (Unit 5)	MB/RC	SD/FF	Pb	1.01E+01	µg/dscm ^e
Delaware (Unit 6)	MB/RC	SD/FF	Pb	5.90E+00	µg/dscm ^e
Delaware (Unit 1)	MB/RC	SD/FF	Pb	3.89E+00	µg/dscm
Delaware (Unit 2)	MB/RC	SD/FF	Pb	1.50E+01	µg/dscm
Delaware (Unit 3)	MB/RC	SD/FF	Pb	2.22E+00	µg/dscm
Delaware (Unit 4)	MB/RC	SD/FF	Pb	1.69E+00	µg/dscm
Delaware (Unit 5)	MB/RC	SD/FF	Pb	1.35E+00	µg/dscm
Delaware (Unit 6)	MB/RC	SD/FF	Pb	4.04E+00	µg/dscm
Delaware average	MB/RC	SD/FF	Pb	5.89E+00	µg/dscm
York (Unit 1)	MB/RC	SD/FF	Pb	2.21E+01	µg/dscm
York (Unit 2)	MB/RC	SD/FF	Pb	9.53E+00	µg/dscm ^e
York (Unit 3)	MB/RC	SD/FF	Pb	8.23E+00	µg/dscm ^e
York (Unit 1)	MB/RC	SD/FF	Pb	3.17E+00	µg/dscm
York (Unit 2)	MB/RC	SD/FF	Pb	3.82E+01	µg/dscm
York (Unit 3)	MB/RC	SD/FF	Pb	7.09E+01	µg/dscm
York (Unit 1)	MB/RC	SD/FF	Pb	1.31E+01	µg/dscm
York (Unit 2)	MB/RC	SD/FF	Pb	1.44E+01	µg/dscm
York (Unit 3)	MB/RC	SD/FF	Pb	2.41E+01	µg/dscm
York (Unit 1)	MB/RC	SD/FF	Pb	4.74E+01	µg/dscm
York (Unit 2)	MB/RC	SD/FF	Pb	4.50E+01	µg/dscm
York (Unit 3)	MB/RC	SD/FF	Pb	5.73E+01	µg/dscm
York (Unit 1)	MB/RC	SD/FF	Pb	1.47E+01	µg/dscm
York (Unit 1)	MB/RC	SD/FF	Pb	6.73E+00	µg/dscm
York (Unit 2)	MB/RC	SD/FF	Pb	4.71E+00	µg/dscm
York (Unit 3)	MB/RC	SD/FF	Pb	5.21E+00	µg/dscm
York (Unit 1)	MB/RC	SD/FF	Pb	2.78E+00	µg/dscm
York (Unit 2)	MB/RC	SD/FF	Pb	5.87E+00	µg/dscm
York (Unit 3)	MB/RC	SD/FF	Pb	2.91E+01	µg/dscm
Average	MB/RC	SD/FF	Pb	2.22E+01	µg/dscm
AVERAGE	MB/RC	SD/FF	Pb	1.41E+01	µg/dscm

TABLE 4-2. (CONTINUED)

Facility Name	Combustor Type ^a	Control Technology ^b	Pollutant ^c	Concentration ^d	Units
Delaware (Unit 1)	MB/RC	SD/FF	PM	1.83E+00	mg/dscm
Delaware (Unit 2)	MB/RC	SD/FF	PM	1.08E+01	mg/dscm
Delaware (Unit 3)	MB/RC	SD/FF	PM	2.06E+00	mg/dscm
Delaware (Unit 4)	MB/RC	SD/FF	PM	4.81E+00	mg/dscm
Delaware (Unit 5)	MB/RC	SD/FF	PM	2.98E+00	mg/dscm
Delaware (Unit 6)	MB/RC	SD/FF	PM	7.56E+00	mg/dscm
Delaware (Unit 1)	MB/RC	SD/FF	PM	5.50E+00	mg/dscm
Delaware (Unit 2)	MB/RC	SD/FF	PM	1.83E+00	mg/dscm
Delaware (Unit 3)	MB/RC	SD/FF	PM	2.52E+00	mg/dscm
Delaware (Unit 4)	MB/RC	SD/FF	PM	2.98E+00	mg/dscm
Delaware (Unit 5)	MB/RC	SD/FF	PM	2.75E+00	mg/dscm
Delaware (Unit 6)	MB/RC	SD/FF	PM	9.20E-01	mg/dscm
Delaware average	MB/RC	SD/FF	PM	3.88E+00	mg/dscm
York (Unit 1)	MB/RC	SD/FF	PM	1.51E+01	mg/dscm
York (Unit 2)	MB/RC	SD/FF	PM	1.37E+01	mg/dscm
York (Unit 3)	MB/RC	SD/FF	PM	9.38E+00	mg/dscm
York (Unit 1)	MB/RC	SD/FF	PM	1.51E+01	mg/dscm
York (Unit 2)	MB/RC	SD/FF	PM	6.64E+00	mg/dscm
York (Unit 3)	MB/RC	SD/FF	PM	1.67E+01	mg/dscm
York (Unit 1)	MB/RC	SD/FF	PM	3.11E+01	mg/dscm
York (Unit 2)	MB/RC	SD/FF	PM	2.34E+01	mg/dscm
York (Unit 3)	MB/RC	SD/FF	PM	2.40E+01	mg/dscm
York (Unit 1)	MB/RC	SD/FF	PM	4.35E+00	mg/dscm
York (Unit 2)	MB/RC	SD/FF	PM	5.50E+00	mg/dscm
York (Unit 3)	MB/RC	SD/FF	PM	1.24E+01	mg/dscm
York (Unit 1)	MB/RC	SD/FF	PM	1.60E+00	mg/dscm
York (Unit 2)	MB/RC	SD/FF	PM	5.73E+00	mg/dscm
York (Unit 3)	MB/RC	SD/FF	PM	9.20E-01	mg/dscm
York (Unit 1)	MB/RC	SD/FF	PM	2.29E+00	mg/dscm
York (Unit 2)	MB/RC	SD/FF	PM	2.29E+00	mg/dscm
York (Unit 3)	MB/RC	SD/FF	PM	8.47E+00	mg/dscm
York average	MB/RC	SD/FF	PM	1.10E+01	mg/dscm
AVERAGE	MB/RC	SD/FF	PM	7.46E+00	mg/dscm
Bay County (Unit 1)	MB/RC	ESP	PM	4.35E+01	mg/dscm
Bay County (Unit 2)	MB/RC	ESP	PM	5.49E+01	mg/dscm
Bay County average	MB/RC	ESP	PM	4.92E+01	mg/dscm
Dutchess County (Unit 1)	MB/RC	DSI/FF	As	1.34E-01	μg/dscm ^e
Dutchess County (Unit 2)	MB/RC	DSI/FF	As	1.34E-01	μg/dscm ^e
Dutchess County average	MB/RC	DSI/FF	As	1.34E-01	μg/dscm
Dutchess County (Unit 1)	MB/RC	DSI/FF	CDD/CDF	4.83E-03	μg/dscm
Dutchess County (Unit 2)	MB/RC	DSI/FF	CDD/CDF	1.79E-02	μg/dscm
Dutchess County average	MB/RC	DSI/FF	CDD/CDF	1.14E-02	μg/dscm
Dutchess County	MB/RC	DSI/FF	Cd	3.00E+00	μg/dscm
Dutchess County	MB/RC	DSI/FF	Cd	3.00E+00	μg/dscm
Dutchess County average	MB/RC	DSI/FF	Cd	3.00E+00	μg/dscm
Dutchess County (Unit 1)	MB/RC	DSI/FF	Cr	8.27E+00	μg/dscm
Dutchess County (Unit 2)	MB/RC	DSI/FF	Cr	6.48E+00	μg/dscm
Dutchess County average	MB/RC	DSI/FF	Cr	7.38E+00	μg/dscm

TABLE 4-2. (CONTINUED)

Facility Name	Combustor Type ^a	Control Technology ^b	Pollutant ^c	Concentration ^d	Units
Dutchess County (Unit 1)	MB/RC	DSI/FF	HCl	3.00E+01	ppmv
Dutchess County (Unit 2)	MB/RC	DSI/FF	HCl	1.83E+02	ppmv
Dutchess County (Unit 2)	MB/RC	DSI/FF	HCl	2.00E+02	ppmv
Dutchess County average	MB/RC	DSI/FF	HCl	1.38E+02	ppmv
Dutchess County	MB/RC	DSI/FF	Hg	8.47E+01	µg/dscm
Dutchess County (Unit 1)	MB/RC	DSI/FF	Ni	1.12E+01	µg/dscm
Dutchess County (Unit 2)	MB/RC	DSI/FF	Ni	7.47E+00	µg/dscm
Dutchess County average	MB/RC	DSI/FF	Ni	9.34E+00	µg/dscm
Dutchess County	MB/RC	DSI/FF	PM	2.20E+01	mg/dscm
Dutchess County	MB/RC	DSI/FF	PM	8.01E+01	mg/dscm
Dutchess County (Unit 1)	MB/RC	DSI/FF	PM	2.22E+01	mg/dscm
Dutchess County (Unit 2)	MB/RC	DSI/FF	PM	1.81E+01	mg/dscm
Dutchess County (Unit 2)	MB/RC	DSI/FF	PM	2.52E+01	mg/dscm
Dutchess County (Unit 2)	MB/RC	DSI/FF	PM	8.01E+01	mg/dscm
Dutchess County average	MB/RC	DSI/FF	PM	4.13E+01	mg/dscm
Dutchess County	MB/RC	DSI/FF	Pb	4.90E+01	µg/dscm
Dutchess County	MB/RC	DSI/FF	Pb	3.90E+01	µg/dscm
Dutchess County average	MB/RC	DSI/FF	Pb	4.40E+01	µg/dscm
Dutchess County (Unit 1)	MB/RC	DSI/FF	SO ₂	1.05E+02	ppmv
Dutchess County (Unit 1)	MB/RC	DSI/FF	SO ₂	1.05E+02	ppmv
Dutchess County (Unit 2)	MB/RC	DSI/FF	SO ₂	1.36E+02	ppmv
Dutchess County (Unit 2)	MB/RC	DSI/FF	SO ₂	1.23E+02	ppmv
Dutchess County average	MB/RC	DSI/FF	SO ₂	1.17E+02	ppmv
Bay County	MB/RC	NA	CO	6.80E+01	ppmv
Dutchess County	MB/RC	NA	CO	8.70E+01	ppmv
Dutchess County	MB/RC	NA	CO	1.03E+02	ppmv
Dutchess County average	MB/RC	NA	CO	9.50E+01	ppmv
AVERAGE	MB/RC	NA	CO	8.15E+01	ppmv
Gallatin	MB/RC	NA	NO _x	1.46E+02	ppmv

^a MB/RC = Mass Burn/Rotary Waterwall Combustor.

^b U = Uncontrolled (prior to pollution control equipment).

SD/FF = Spray Dryer/Fabric Filter.

ESP = Electrostatic Precipitator.

DSI/FF = Duct Sorbent Injection/Fabric Filter.

NA = Not Applicable. Control of NO_x is not tied to traditional acid gas/PM control devices; therefore, the pollution control device is not specified.

^c CDD/CDF levels are for the sum of all tetra- through octa- CDD and CDF homologues. PM levels are for total particulate.

^d All concentrations are corrected to 7 percent O₂ on a dry basis.

^e Results were less than the detection limit; therefore, the detection limit is shown and is used in calculating averages.

TABLE 4-3. MASS BURN/REFRACTORY WALL COMBUSTOR DATA

Facility Name	Combustor Type ^a	Control Technology ^b	Pollutant ^c	Concentration ^d	Units
Dayton	MB/REF	U	As	2.34E+02	µg/dscm
Dayton	MB/REF	U	As	2.10E+02	µg/dscm
Dayton (Unit 3)	MB/REF	U	As	2.22E+02	µg/dscm
Dayton (Unit 3)	MB/REF	U	As	2.12E+02	µg/dscm
Dayton average	MB/REF	U	As	2.20E+02	µg/dscm
Dayton	MB/REF	U	CDD/CDF	5.31E+00	µg/dscm
Dayton (Unit 3)	MB/REF	U	CDD/CDF	2.52E-01	µg/dscm
Dayton (Unit 3)	MB/REF	U	CDD/CDF	3.28E-02	µg/dscm
Dayton average	MB/REF	U	CDD/CDF	1.86E+00	µg/dscm
Dayton	MB/REF	U	Cd	1.20E+03	µg/dscm
Dayton	MB/REF	U	Cd	1.10E+03	µg/dscm
Dayton	MB/REF	U	Cd	1.95E+03	µg/dscm
Dayton	MB/REF	U	Cd	1.30E+03	µg/dscm
Dayton	MB/REF	U	Cd	1.50E+03	µg/dscm
Dayton average	MB/REF	U	Cd	1.41E+03	µg/dscm
Dayton	MB/REF	U	Cr	1.85E+02	µg/dscm
Dayton	MB/REF	U	Cr	1.92E+02	µg/dscm
Dayton (Unit 3)	MB/REF	U	Cr	1.90E+02	µg/dscm
Dayton (Unit 3)	MB/REF	U	Cr	1.23E+02	µg/dscm
Dayton average	MB/REF	U	Cr	1.73E+02	µg/dscm
Dayton	MB/REF	U	HCl	1.11E+02	ppmv
Dayton	MB/REF	U	HCl	1.87E+02	ppmv
Dayton	MB/REF	U	HCl	1.26E+02	ppmv
Dayton	MB/REF	U	HCl	2.00E+02	ppmv
Dayton	MB/REF	U	HCl	9.40E+01	ppmv
Dayton	MB/REF	U	HCl	1.81E+02	ppmv
Dayton average	MB/REF	U	HCl	1.50E+02	ppmv
Dayton	MB/REF	U	Hg	7.16E+02	µg/dscm
Dayton	MB/REF	U	Hg	9.07E+02	µg/dscm
Dayton	MB/REF	U	Hg	9.62E+02	µg/dscm
Dayton	MB/REF	U	Hg	9.73E+02	µg/dscm
Dayton	MB/REF	U	Hg	1.06E+03	µg/dscm
Dayton average	MB/REF	U	Hg	9.23E+02	µg/dscm
Dayton	MB/REF	U	Ni	9.40E+01	µg/dscm
Dayton	MB/REF	U	Ni	1.10E+02	µg/dscm
Dayton (Unit 3)	MB/REF	U	Ni	8.06E+01	µg/dscm
Dayton (Unit 3)	MB/REF	U	Ni	8.72E+01	µg/dscm
Dayton average	MB/REF	U	Ni	9.30E+01	µg/dscm
Dayton	MB/REF	U	PM	1.47E+03	mg/dscm
Dayton	MB/REF	U	PM	2.72E+03	mg/dscm
Dayton	MB/REF	U	PM	1.28E+03	mg/dscm
Dayton	MB/REF	U	PM	1.29E+03	mg/dscm
Dayton	MB/REF	U	PM	2.59E+03	mg/dscm
Dayton average	MB/REF	U	PM	1.87E+03	mg/dscm
Dayton	MB/REF	U	Pb	3.31E+04	µg/dscm
Dayton	MB/REF	U	Pb	3.63E+04	µg/dscm
Dayton	MB/REF	U	Pb	3.61E+04	µg/dscm
Dayton	MB/REF	U	Pb	2.69E+04	µg/dscm
Dayton	MB/REF	U	Pb	2.69E+04	µg/dscm
Dayton average	MB/REF	U	Pb	3.19E+04	µg/dscm

TABLE 4-3. (CONTINUED)

Facility Name	Combustor Type ^a	Control Technology ^b	Pollutant ^c	Concentration ^d	Units
Dayton	MB/REF	U	SO ₂	1.11E+02	ppmv
Dayton	MB/REF	U	SO ₂	1.19E+02	ppmv
Dayton	MB/REF	U	SO ₂	1.14E+02	ppmv
Dayton	MB/REF	U	SO ₂	1.21E+02	ppmv
Dayton	MB/REF	U	SO ₂	7.20E+01	ppmv
Dayton	MB/REF	U	SO ₂	1.29E+02	ppmv
Dayton average	MB/REF	U	SO ₂	1.11E+02	ppmv
Dayton (Unit 3)	MB/REF	ESP	As	2.51E+00	µg/dscm
Dayton (Unit 3)	MB/REF	ESP	As	2.94E+00	µg/dscm
Dayton average	MB/REF	ESP	As	2.73E+00	µg/dscm
Dayton (Unit 3)	MB/REF	ESP	CDD/CDF	8.86E-01	µg/dscm ^e
Dayton (Unit 3)	MB/REF	ESP	CDD/CDF	1.71E+01	µg/dscm ^f
Dayton average	MB/REF	ESP	CDD/CDF	8.99E+00	µg/dscm
Dayton	MB/REF	ESP	Cd	3.00E+01	µg/dscm
Dayton	MB/REF	ESP	Cd	1.90E+01	µg/dscm
Dayton average	MB/REF	ESP	Cd	2.45E+01	µg/dscm
Dayton (Unit 3)	MB/REF	ESP	Cr	4.78E+00	µg/dscm
Dayton (Unit 3)	MB/REF	ESP	Cr	7.11E+00	µg/dscm
Dayton average	MB/REF	ESP	Cr	5.95E+00	µg/dscm
Dayton	MB/REF	ESP	Hg	1.02E+03	µg/dscm
Dayton	MB/REF	ESP	Hg	1.15E+03	µg/dscm
Dayton average	MB/REF	ESP	Hg	1.08E+03	µg/dscm
Dayton (Unit 3)	MB/REF	ESP	Ni	5.63E+00	µg/dscm
Dayton (Unit 3)	MB/REF	ESP	Ni	2.74E+00	µg/dscm
Dayton average	MB/REF	ESP	Ni	4.19E+00	µg/dscm
Dayton	MB/REF	ESP	PM	1.51E+01	mg/dscm
Dayton	MB/REF	ESP	PM	1.44E+01	mg/dscm
Dayton average	MB/REF	ESP	PM	1.48E+01	mg/dscm
McKay Bay (Unit 1)	MB/REF	ESP	PM	2.97E+01	mg/dscm
McKay Bay (Unit 2)	MB/REF	ESP	PM	2.75E+01	mg/dscm
McKay Bay (Unit 3)	MB/REF	ESP	PM	9.61E+00	mg/dscm
McKay Bay (Unit 4)	MB/REF	ESP	PM	1.81E+01	mg/dscm
McKay Bay average	MB/REF	ESP	PM	2.12E+01	mg/dscm
AVERAGE	MB/REF	ESP	PM	1.80E+01	mg/dscm
Dayton	MB/REF	ESP	Pb	5.30E+02	µg/dscm
Dayton	MB/REF	ESP	Pb	5.60E+02	µg/dscm
Dayton average	MB/REF	ESP	Pb	5.45E+02	µg/dscm
Dayton	MB/REF	DSI/ESP	As	2.00E+00	µg/dscm ^g
Dayton	MB/REF	DSI/ESP	CDD/CDF	5.72E-02	µg/dscm
Dayton	MB/REF	DSI/ESP	Cd	1.10E+01	µg/dscm
Dayton	MB/REF	DSI/ESP	Cr	3.83E+00	µg/dscm
Dayton	MB/REF	DSI/ESP	HCl	2.28E+01	ppmv
Dayton	MB/REF	DSI/ESP	HCl	8.90E+00	ppmv
Dayton	MB/REF	DSI/ESP	HCl	4.02E+01	ppmv
Dayton	MB/REF	DSI/ESP	HCl	1.19E+01	ppmv
Dayton	MB/REF	DSI/ESP	HCl	1.74E+01	ppmv
Dayton	MB/REF	DSI/ESP	HCl	3.44E+01	ppmv
Dayton average	MB/REF	DSI/ESP	HCl	2.26E+01	ppmv
Dayton	MB/REF	DSI/ESP	Hg	4.91E+02	µg/dscm
Dayton	MB/REF	DSI/ESP	Ni	4.00E+00	µg/dscm

TABLE 4-3. (CONTINUED)

Facility Name	Combustor Type ^a	Control Technology ^b	Pollutant ^c	Concentration ^d	Units
Dayton	MB/REF	DSI/ESP	PM	7.32E+00	mg/dscm
Dayton	MB/REF	DSI/ESP	Pb	3.60E+02	µg/dscm
Dayton	MB/REF	DSI/ESP	SO ₂	3.89E+01	ppmv
Dayton	MB/REF	DSI/ESP	SO ₂	5.90E+01	ppmv
Dayton	MB/REF	DSI/ESP	SO ₂	5.48E+01	ppmv
Dayton	MB/REF	DSI/ESP	SO ₂	3.57E+01	ppmv
Dayton	MB/REF	DSI/ESP	SO ₂	4.23E+01	ppmv
Dayton	MB/REF	DSI/ESP	SO ₂	3.46E+01	ppmv
Dayton average	MB/REF	DSI/ESP	SO ₂	4.42E+01	ppmv
Dayton	MB/REF	NA	CO	1.46E+02	ppmv
Dayton	MB/REF	NA	CO	3.10E+01	ppmv
Dayton	MB/REF	NA	CO	2.92E+02	ppmv
Dayton	MB/REF	NA	CO	1.34E+02	ppmv
Dayton	MB/REF	NA	CO	2.30E+02	ppmv
Dayton	MB/REF	NA	CO	4.10E+01	ppmv
Dayton average	MB/REF	NA	CO	1.46E+02	ppmv
Dayton (Unit 1)	MB/REF	NA	NO _x	2.39E+02	ppmv
Dayton (Unit 2)	MB/REF	NA	NO _x	7.14E+01	ppmv
Dayton average	MB/REF	NA	NO _x	1.55E+02	ppmv
Galax	MB/REF	NA	NO _x	1.61E+02	ppmv
McKay Bay (Unit 2)	MB/REF	NA	NO _x	5.94E+01	ppmv
McKay Bay (Unit 3)	MB/REF	NA	NO _x	1.52E+02	ppmv
McKay Bay (Unit 4)	MB/REF	NA	NO _x	2.16E+02	ppmv
McKay Bay average	MB/REF	NA	NO _x	1.43E+02	ppmv
Philadelphia NW 1	MB/REF	NA	NO _x	1.71E+02	ppmv
Philadelphia NW 2	MB/REF	NA	NO _x	1.92E+02	ppmv
Philadelphia average	MB/REF	NA	NO _x	1.82E+02	ppmv
AVERAGE	MB/REF	NA	NO _x	1.60E+02	ppmv

^a MB/REF = Mass Burn/Refractory Wall.

^b U = Uncontrolled (prior to pollution control equipment).

ESP = Electrostatic Precipitator.

DSI/ESP = Duct Sorbent Injection/Electrostatic Precipitator.

NA = Not Applicable. Control of CO and NO_x is not tied to traditional acid gas/PM control devices; therefore, the pollution control device is not specified.

^c CDD/CDF levels are for the sum of all tetra- through octa- CDD and CDF homologues. PM levels are for total particulate.

^d All concentrations corrected to 7 percent O₂ on a dry basis.

^e ESP temperature = 575°F.

^f ESP temperature = 400°F.

^g Results were less than the detection limit; therefore, the detection limit is shown and is used in calculating averages.

TABLE 4-4. REFUSE-DERIVED FUEL-FIRED COMBUSTOR DATA

Facility Name	Combustor Type ^a	Control Technology ^b	Pollutant ^c	Concentration ^{d,e}	Units
Biddeford	RDF	U	As	5.83E+02	µg/dscm
Biddeford	RDF	U	As	5.09E+02	µg/dscm
Biddeford average	RDF	U	As	5.46E+02	µg/dscm
Mid-Connecticut	RDF	U	As	1.06E+03	µg/dscm
Mid-Connecticut	RDF	U	As	1.06E+03	µg/dscm
Mid-Connecticut average	RDF	U	As	1.06E+03	µg/dscm
NSP Red Wing	RDF	U	As	2.03E+02	µg/dscm
NSP Red Wing	RDF	U	As	2.03E+02	µg/dscm
NSP Red Wing average	RDF	U	As	2.03E+02	µg/dscm
AVERAGE	RDF	U	As	6.03E+02	µg/dscm
Biddeford	RDF	U	CDD/CDF	9.03E-01	µg/dscm
Mid-Connecticut	RDF	U	CDD/CDF	1.02E+00	µg/dscm
AVERAGE	RDF	U	CDD/CDF	9.61E-01	µg/dscm
Biddeford	RDF	U	Cd	1.10E+03	µg/dscm
Mid-Connecticut	RDF	U	Cd	5.00E+02	µg/dscm
Mid-Connecticut	RDF	U	Cd	5.67E+02	µg/dscm
Mid-Connecticut	RDF	U	Cd	1.10E+03	µg/dscm
Mid-Connecticut	RDF	U	Cd	6.00E+02	µg/dscm
Mid-Connecticut	RDF	U	Cd	6.17E+02	µg/dscm
Mid-Connecticut average	RDF	U	Cd	6.77E+02	µg/dscm
AVERAGE	RDF	U	Cd	8.88E+02	µg/dscm
Biddeford	RDF	U	Cr	3.17E+03	µg/dscm
Biddeford	RDF	U	Cr	2.75E+03	µg/dscm
Biddeford average	RDF	U	Cr	2.96E+03	µg/dscm
Mid-Connecticut	RDF	U	Cr	9.27E+02	µg/dscm
Mid-Connecticut	RDF	U	Cr	9.21E+02	µg/dscm
Mid-Connecticut average	RDF	U	Cr	9.24E+02	µg/dscm
NSP Red Wing	RDF	U	Cr	3.81E+02	µg/dscm
NSP Red Wing	RDF	U	Cr	3.81E+02	µg/dscm
NSP Red Wing average	RDF	U	Cr	3.81E+02	µg/dscm
AVERAGE	RDF	U	Cr	1.42E+03	µg/dscm
Biddeford	RDF	U	HCl	5.80E+02	ppmv
Biddeford	RDF	U	HCl	5.82E+02	ppmv
Biddeford average	RDF	U	HCl	5.81E+02	ppmv
Albany	RDF	U	HCl	3.48E+02	ppmv
AVERAGE	RDF	U	HCl	4.65E+02	ppmv
Biddeford	RDF	U	Hg	3.89E+02	µg/dscm
Mid-Connecticut (2/89)	RDF	U	Hg	6.68E+02	µg/dscm
Mid-Connecticut (7/88)	RDF	U	Hg	1.01E+03	µg/dscm
Mid-Connecticut (7/88)	RDF	U	Hg	8.84E+02	µg/dscm
Mid-Connecticut average	RDF	U	Hg	8.53E+02	µg/dscm
AVERAGE	RDF	U	Hg	6.21E+02	µg/dscm
Mid-Connecticut	RDF	U	Ni	5.41E+02	µg/dscm
Mid-Connecticut	RDF	U	Ni	5.41E+02	µg/dscm
Mid-Connecticut average	RDF	U	Ni	5.41E+02	µg/dscm
NSP Red Wing	RDF	U	Ni	3.44E+02	µg/dscm
NSP Red Wing	RDF	U	Ni	3.44E+02	µg/dscm
NSP Red Wing average	RDF	U	Ni	3.44E+02	µg/dscm
AVERAGE	RDF	U	Ni	4.43E+02	µg/dscm
Biddeford	RDF	U	PM	7.32E+03	mg/dscm
Albany	RDF	U	PM	1.06E+04	mg/dscm
Mid-Connecticut	RDF	U	PM	4.81E+03	mg/dscm
Mid-Connecticut	RDF	U	PM	4.14E+03	mg/dscm

TABLE 4-4. (CONTINUED)

Facility Name	Combustor Type ^a	Control Technology ^b	Pollutant ^c	Concentration ^{d,e}	Units
Mid - Connecticut	RDF	U	PM	3.36E+03	mg/dscm
Mid - Connecticut	RDF	U	PM	5.51E+03	mg/dscm
Mid - Connecticut	RDF	U	PM	3.46E+03	mg/dscm
Mid - Connecticut average	RDF	U	PM	4.26E+03	mg/dscm
NSP Red Wing	RDF	U	PM	4.69E+03	mg/dscm
Niagara Falls	RDF	U	PM	8.03E+03	mg/dscm
Niagara Falls	RDF	U	PM	6.36E+03	mg/dscm
Niagara Falls average	RDF	U	PM	7.20E+03	mg/dscm
Semass	RDF	U	PM	8.83E+03	mg/dscm
Semass	RDF	U	PM	9.79E+03	mg/dscm
Semass average	RDF	U	PM	9.31E+03	mg/dscm
West Palm Beach	RDF	U	PM	6.09E+03	mg/dscm
AVERAGE	RDF	U	PM	7.07E+03	mg/dscm
Biddeford	RDF	U	Pb	2.74E+04	µg/dscm
Mid - Connecticut	RDF	U	Pb	7.70E+03	µg/dscm
Mid - Connecticut	RDF	U	Pb	1.06E+04	µg/dscm
Mid - Connecticut	RDF	U	Pb	1.09E+04	µg/dscm
Mid - Connecticut	RDF	U	Pb	4.20E+01	µg/dscm
Mid - Connecticut	RDF	U	Pb	3.74E+04	µg/dscm
Mid - Connecticut average	RDF	U	Pb	1.33E+04	µg/dscm
AVERAGE	RDF	U	Pb	2.04E+04	µg/dscm
Biddeford	RDF	U	SO ₂	1.00E+02	ppmv
Biddeford	RDF	U	SO ₂	1.01E+02	ppmv
Biddeford average	RDF	U	SO ₂	1.01E+02	ppmv
Semass	RDF	U	SO ₂	1.54E+02	ppmv
Semass	RDF	U	SO ₂	1.62E+02	ppmv
Semass average	RDF	U	SO ₂	1.58E+02	ppmv
Albany	RDF	U	SO ₂	1.88E+02	ppmv
AVERAGE	RDF	U	SO ₂	1.49E+02	ppmv
Biddeford	RDF	SD/FF	As	6.50E+00	µg/dscm
Biddeford	RDF	SD/FF	CDD/CDF	4.38E-03	µg/dscm
Mid - Connecticut	RDF	SD/FF	CDD/CDF	6.60E-04	µg/dscm
Penobscot	RDF	SD/FF	CDD/CDF	2.39E-03	µg/dscm
AVERAGE	RDF	SD/FF	CDD/CDF	2.48E-03	µg/dscm
Biddeford	RDF	SD/FF	Cd	1.25E+01	µg/dscm ^f
Mid - Connecticut	RDF	SD/FF	Cd	ND	µg/dscm
Mid - Connecticut	RDF	SD/FF	Cd	ND	µg/dscm
Mid - Connecticut	RDF	SD/FF	Cd	ND	µg/dscm
Mid - Connecticut	RDF	SD/FF	Cd	ND	µg/dscm
Mid - Connecticut average	RDF	SD/FF	Cd	0.00E+00	µg/dscm
AVERAGE	RDF	SD/FF	Cd	6.25E+00	µg/dscm
Biddeford	RDF	SD/FF	Cr	6.10E+00	µg/dscm ^f
Penobscot	RDF	SD/FF	Cr	2.17E+00	µg/dscm
AVERAGE	RDF	SD/FF	Cr	4.14E+00	µg/dscm
Biddeford	RDF	SD/FF	HCl	5.84E+00	ppmv
Penobscot	RDF	SD/FF	HCl	1.20E+00	ppmv
AVERAGE	RDF	SD/FF	HCl	3.52E+00	ppmv
Mid - Connecticut (2/89)	RDF	SD/FF	Hg	9.20E+00	µg/dscm
Mid - Connecticut (7/88)	RDF	SD/FF	Hg	5.00E+01	µg/dscm
AVERAGE	RDF	SD/FF	Hg	2.96E+01	µg/dscm
Biddeford	RDF	SD/FF	PM	3.25E+01	mg/dscm
Biddeford	RDF	SD/FF	PM	3.20E+01	mg/dscm
Biddeford average	RDF	SD/FF	PM	3.23E+01	mg/dscm

TABLE 4-4. (CONTINUED)

Facility Name	Combustor Type ^a	Control Technology ^b	Pollutant ^c	Concentration ^{d,e}	Units
Mid-Connecticut	RDF	SD/FF	PM	4.58E+00	mg/dscm
Mid-Connecticut	RDF	SD/FF	PM	9.15E+00	mg/dscm
Mid-Connecticut	RDF	SD/FF	PM	5.49E+00	mg/dscm
Mid-Connecticut	RDF	SD/FF	PM	3.43E+00	mg/dscm
Mid-Connecticut	RDF	SD/FF	PM	6.41E+00	mg/dscm
Mid-Connecticut average	RDF	SD/FF	PM	5.81E+00	mg/dscm
Penobscot	RDF	SD/FF	PM	2.52E+00	mg/dscm
ERAGE	RDF	SD/FF	PM	1.35E+01	mg/dscm
Biddeford	RDF	SD/FF	Pb	1.60E+02	µg/dscm
Mid-Connecticut	RDF	SD/FF	Pb	4.50E+01	µg/dscm
Mid-Connecticut	RDF	SD/FF	Pb	6.80E+01	µg/dscm
Mid-Connecticut	RDF	SD/FF	Pb	3.90E+01	µg/dscm
Mid-Connecticut average	RDF	SD/FF	Pb	5.07E+01	µg/dscm
AVERAGE	RDF	SD/FF	Pb	1.05E+02	µg/dscm
Biddeford	RDF	SD/FF	SO ₂	2.26E+01	ppmv
Penobscot	RDF	SD/FF	SO ₂	1.11E+01	ppmv
AVERAGE	RDF	SD/FF	SO ₂	1.69E+01	ppmv
Semass	RDF	SD/ESP	As	1.50E+00	µg/dscm
Semass	RDF	SD/ESP	As	7.00E-01	µg/dscm
Semass average	RDF	SD/ESP	As	1.10E+00	µg/dscm
Semass	RDF	SD/ESP	CDD/CDF	9.30E-03	µg/dscm
Semass	RDF	SD/ESP	CDD/CDF	1.23E-02	µg/dscm
Semass average	RDF	SD/ESP	CDD/CDF	1.08E-02	µg/dscm
Semass	RDF	SD/ESP	Cd	1.00E+01	µg/dscm
Semass	RDF	SD/ESP	Cd	7.00E+00	µg/dscm
Semass average	RDF	SD/ESP	Cd	8.50E+00	µg/dscm
Semass	RDF	SD/ESP	Cr	6.50E+00	µg/dscm
Semass	RDF	SD/ESP	Cr	1.56E+01	µg/dscm
Semass average	RDF	SD/ESP	Cr	1.11E+01	µg/dscm
Honolulu, Unit 1	RDF	SD/ESP	Hg	5.28E+00	µg/dscm
Honolulu, Unit 2	RDF	SD/ESP	Hg	7.25E+00	µg/dscm
Honolulu average	RDF	SD/ESP	Hg	6.27E+00	µg/dscm
Semass, Unit 1	RDF	SD/ESP	Hg	5.93E+01	µg/dscm
Semass, Unit 2	RDF	SD/ESP	Hg	1.05E+02	µg/dscm
Semass average	RDF	SD/ESP	Hg	8.22E+01	µg/dscm
West Palm Beach, Unit 1	RDF	SD/ESP	Hg	5.56E+01	µg/dscm
West Palm Beach, Unit 2	RDF	SD/ESP	Hg	2.32E+01	µg/dscm
West Palm Beach average	RDF	SD/ESP	Hg	3.94E+01	µg/dscm
AVERAGE	RDF	SD/ESP	Hg	4.26E+01	µg/dscm
Semass	RDF	SD/ESP	Ni	6.80E+00	µg/dscm
Semass	RDF	SD/ESP	Ni	3.24E+01	µg/dscm
Semass average	RDF	SD/ESP	Ni	1.96E+01	µg/dscm
Honolulu	RDF	SD/ESP	PM	4.35E+00	mg/dscm
Honolulu	RDF	SD/ESP	PM	2.97E+00	mg/dscm
Honolulu average	RDF	SD/ESP	PM	3.66E+00	mg/dscm
Semass	RDF	SD/ESP	PM	1.83E+01	mg/dscm
Semass	RDF	SD/ESP	PM	2.75E+01	mg/dscm
Semass average	RDF	SD/ESP	PM	2.29E+01	mg/dscm
West Palm Beach	RDF	SD/ESP	PM	2.97E+00	mg/dscm
West Palm Beach	RDF	SD/ESP	PM	2.75E+00	mg/dscm
West Palm Beach average	RDF	SD/ESP	PM	2.86E+00	mg/dscm
AVERAGE	RDF	SD/ESP	PM	9.80E+00	mg/dscm

TABLE 4-4. (CONTINUED)

Facility Name	Combustor Type ^a	Control Technology ^b	Pollutant ^c	Concentration ^{d,e}	Units
Honolulu	RDF	SD/ESP	Pb	5.10E+01	µg/dscm
Honolulu	RDF	SD/ESP	Pb	3.90E+01	µg/dscm
Honolulu average	RDF	SD/ESP	Pb	4.50E+01	µg/dscm
Semass	RDF	SD/ESP	Pb	3.00E+02	µg/dscm
Semass	RDF	SD/ESP	Pb	2.40E+02	µg/dscm
Semass average	RDF	SD/ESP	Pb	2.70E+02	µg/dscm
West Palm Beach	RDF	SD/ESP	Pb	2.40E+01	µg/dscm
West Palm Beach	RDF	SD/ESP	Pb	5.00E+01	µg/dscm
West Palm Beach	RDF	SD/ESP	Pb	3.70E+01	µg/dscm
AVERAGE	RDF	SD/ESP	Pb	1.17E+02	µg/dscm
Semass	RDF	SD/ESP	SO ₂	6.70E+01	ppmv
Semass	RDF	SD/ESP	SO ₂	5.50E+01	ppmv
AVERAGE	RDF	SD/ESP	SO ₂	6.10E+01	ppmv
NSP Red Wing	RDF	ESP	As	3.30E+00	µg/dscm
NSP Red Wing	RDF	ESP	As	1.30E+01	µg/dscm
NSP Red Wing average	RDF	ESP	As	8.15E+00	µg/dscm
Albany	RDF	ESP	As	1.91E+01	µg/dscm
AVERAGE	RDF	ESP	As	1.36E+01	µg/dscm
Lawrence	RDF	ESP	CCD/CDF	1.11E-01	µg/dscm
Lawrence	RDF	ESP	CCD/CDF	3.30E+00	µg/dscm
Lawrence average	RDF	ESP	CCD/CDF	1.71E+00	µg/dscm
NSP Red Wing	RDF	ESP	CCD/CDF	3.27E-02	µg/dscm
NSP Red Wing	RDF	ESP	CCD/CDF	2.93E-02	µg/dscm
NSP Red Wing average	RDF	ESP	CCD/CDF	3.10E-02	µg/dscm
Niagara Falls	RDF	ESP	CCD/CDF	2.56E+00	µg/dscm
Niagara Falls	RDF	ESP	CCD/CDF	4.29E+00	µg/dscm
Niagara Falls average	RDF	ESP	CCD/CDF	3.43E+00	µg/dscm
AVERAGE	RDF	ESP	CCD/CDF	1.72E+00	µg/dscm
Detroit	RDF	ESP	Cd	1.15E+01	µg/dscm ^f
Detroit	RDF	ESP	Cd	8.34E+00	µg/dscm ^f
Detroit	RDF	ESP	Cd	1.26E+01	µg/dscm ^f
Detroit average	RDF	ESP	Cd	1.06E+01	µg/dscm
Albany	RDF	ESP	Cd	3.37E+01	µg/dscm
AVERAGE	RDF	ESP	Cd	2.23E+01	µg/dscm
NSP Red Wing	RDF	ESP	Cr	2.00E+01	µg/dscm
NSP Red Wing	RDF	ESP	Cr	7.50E+01	µg/dscm
NSP Red Wing average	RDF	ESP	Cr	4.75E+01	µg/dscm
Detroit (3/90)	RDF	ESP	Hg	1.94E+02	µg/dscm
Detroit (7/89)	RDF	ESP	Hg	6.53E+02	µg/dscm
Detroit average	RDF	ESP	Hg	4.24E+02	µg/dscm
Albany	RDF	ESP	Hg	4.41E+02	µg/dscm
AVERAGE	RDF	ESP	Hg	4.32E+02	µg/dscm
NSP Red Wing	RDF	ESP	Ni	1.29E+02	µg/dscm
NSP Red Wing	RDF	ESP	Ni	3.40E+01	µg/dscm
NSP Red Wing average	RDF	ESP	Ni	8.15E+01	µg/dscm
Albany	RDF	ESP	Ni	3.56E+03	µg/dscm
AVERAGE	RDF	ESP	Ni	1.84E+03	µg/dscm
Detroit	RDF	ESP	PM	1.03E+01	mg/dscm
Detroit	RDF	ESP	PM	4.81E+00	mg/dscm
Detroit	RDF	ESP	PM	6.41E+00	mg/dscm
Detroit average	RDF	ESP	PM	7.17E+00	mg/dscm
Lawrence	RDF	ESP	PM	2.29E+01	mg/dscm
Albany	RDF	ESP	PM	3.18E+02	mg/dscm

TABLE 4-4. (CONTINUED)

Facility Name	Combustor Type ^a	Control Technology ^b	Pollutant ^c	Concentration ^{d,e}	Units
NSP Red Wing	RDF	ESP	PM	5.49E+01	mg/dscm
NSP Red Wing	RDF	ESP	PM	9.38E+01	mg/dscm
NSP Red Wing average	RDF	ESP	PM	7.44E+01	mg/dscm
Niagara Falls	RDF	ESP	PM	5.72E+01	mg/dscm
Niagara Falls	RDF	ESP	PM	2.20E+02	mg/dscm
Niagara Falls	RDF	ESP	PM	3.66E+01	mg/dscm
Niagara Falls	RDF	ESP	PM	1.05E+02	mg/dscm
AVERAGE	RDF	ESP	PM	1.05E+02	mg/dscm
Detroit	RDF	ESP	Pb	2.37E+02	µg/dscm ^f
Detroit	RDF	ESP	Pb	1.02E+02	µg/dscm ^f
Detroit	RDF	ESP	Pb	2.10E+02	µg/dscm ^f
Detroit average	RDF	ESP	Pb	1.83E+02	µg/dscm
Albany	RDF	NA	CO	3.46E+02	ppmv
Maine	RDF	NA	CO	8.10E+01	ppmv
Mid-Connecticut	RDF	NA	CO	1.31E+02	ppmv
Mid-Connecticut	RDF	NA	CO	1.99E+02	ppmv
Mid-Connecticut	RDF	NA	CO	1.98E+02	ppmv
Mid-Connecticut	RDF	NA	CO	7.10E+01	ppmv
Mid-Connecticut	RDF	NA	CO	1.09E+02	ppmv
Mid-Connecticut	RDF	NA	CO	9.30E+01	ppmv
Mid-Connecticut	RDF	NA	CO	7.50E+01	ppmv
Mid-Connecticut	RDF	NA	CO	9.60E+01	ppmv
Mid-Connecticut	RDF	NA	CO	1.01E+02	ppmv
Mid-Connecticut average	RDF	NA	CO	1.19E+02	ppmv
NSP Red Wing	RDF	NA	CO	9.90E+01	ppmv
Penobscot	RDF	NA	CO	1.91E+02	ppmv
AVERAGE	RDF	NA	CO	1.87E+02	ppmv
Albany	RDF	NA	NO _x	2.93E+02	ppmv
Biddeford	RDF	NA	NO _x	2.28E+02	ppmv
Lawrence	RDF	NA	NO _x	3.45E+02	ppmv
Mid-Connecticut 11	RDF	NA	NO _x	1.95E+02	ppmv
Niagara Falls	RDF	NA	NO _x	2.68E+02	ppmv
AVERAGE	RDF	NA	NO _x	2.66E+02	ppmv

^a RDF = Refuse-Derived Fuel.

^b U = Uncontrolled (prior to pollution control equipment).

SD/FF = Spray Dryer/Fabric Filter.

SD/ESP = Spray Dryer/Electrostatic Precipitator.

ESP = Electrostatic Precipitator.

NA = Not Applicable. Control of CO and NO_x is not tied to traditional acid gas/PM control devices; therefore, the pollution control device is not specified.

^c CDD/CDF levels are for the sum of all tetra- through octa- CDD and CDF homologues. PM levels are for total particulate.

^d All concentrations corrected to 7 percent O₂ on a dry basis.

^e ND = Non-detect. Detection limits were not given. Considered zero when calculating averages.

^f Results were less than the detection limit; therefore, the detection limit is shown and is used in calculating averages.

TABLE 4-5. MODULAR EXCESS AIR COMBUSTOR DATA

Facility Name	Combustor Type ^a	Control Technology ^b	Pollutant ^c	Concentration ^d	Units
St. Croix	MOD/EA	U	HCl	7.43E+02	ppmv
St. Croix	MOD/EA	U	HCl	7.06E+02	ppmv
St. Croix	MOD/EA	U	HCl	4.86E+02	ppmv
St. Croix	MOD/EA	U	HCl	7.50E+01	ppmv
St. Croix	MOD/EA	U	HCl	4.00E+01	ppmv
St. Croix	MOD/EA	U	HCl	5.70E+02	ppmv
St. Croix	MOD/EA	U	HCl	4.93E+02	ppmv
St. Croix average	MOD/EA	U	HCl	4.45E+02	ppmv
Pigeon Point	MOD/EA	U	PM	9.89E+02	mg/dscm
Pigeon Point	MOD/EA	U	PM	2.05E+03	mg/dscm
Pigeon Point	MOD/EA	U	PM	2.38E+03	mg/dscm
Pigeon Point	MOD/EA	U	PM	2.36E+03	mg/dscm
Pigeon Point average	MOD/EA	U	PM	1.95E+03	mg/dscm
St. Croix	MOD/EA	U	SO ₂	9.00E+00	ppmv
St. Croix	MOD/EA	U	SO ₂	1.77E+02	ppmv
St. Croix	MOD/EA	U	SO ₂	1.20E+02	ppmv
St. Croix	MOD/EA	U	SO ₂	8.80E+01	ppmv
St. Croix	MOD/EA	U	SO ₂	5.00E+01	ppmv
St. Croix	MOD/EA	U	SO ₂	7.90E+01	ppmv
St. Croix	MOD/EA	U	SO ₂	9.90E+01	ppmv
St. Croix average	MOD/EA	U	SO ₂	8.86E+01	ppmv
Pigeon Point	MOD/EA	ESP	As	8.33E-01	μg/dscm
Pope/Douglas	MOD/EA	ESP	As	1.15E+00	μg/dscm
AVERAGE	MOD/EA	ESP	As	9.92E-01	μg/dscm
Pigeon Point	MOD/EA	ESP	CDD/CDF	1.06E-01	μg/dscm
Pope/Douglas	MOD/EA	ESP	CDD/CDF	4.48E-01	μg/dscm
AVERAGE	MOD/EA	ESP	CDD/CDF	2.76E-01	μg/dscm
Pigeon Point	MOD/EA	ESP	Cr	2.37E+01	μg/dscm
Pigeon Point	MOD/EA	ESP	Hg	3.63E+02	μg/dscm
Pope/Douglas	MOD/EA	ESP	Hg	1.33E+02	μg/dscm
AVERAGE	MOD/EA	ESP	Hg	2.48E+02	μg/dscm
Pigeon Point	MOD/EA	ESP	Ni	4.39E+01	μg/dscm
Pigeon Point	MOD/EA	ESP	PM	3.43E+00	mg/dscm
Pigeon Point	MOD/EA	ESP	PM	1.21E+01	mg/dscm
Pigeon Point	MOD/EA	ESP	PM	4.35E+00	mg/dscm
Pigeon Point	MOD/EA	ESP	PM	6.64E+00	mg/dscm
Pigeon Point	MOD/EA	ESP	PM	6.87E+00	mg/dscm
Pigeon Point average	MOD/EA	ESP	PM	6.681982	mg/dscm
Pope/Douglas	MOD/EA	ESP	PM	8.47E+01	mg/dscm
Pope/Douglas	MOD/EA	ESP	PM	5.72E+01	mg/dscm
Pope/Douglas average	MOD/EA	ESP	PM	70.93885	mg/dscm
AVERAGE	MOD/EA	ESP	PM	3.88E+01	mg/dscm
Pigeon Point	MOD/EA	ESP	Pb	1.50E+02	μg/dscm
St. Croix	MOD/EA	DSI/FF	As	2.10E+00	μg/dscm
St. Croix	MOD/EA	DSI/FF	CDD/CDF	7.73E-03	μg/dscm
St. Croix	MOD/EA	DSI/FF	Cd	2.00E+00	μg/dscm
St. Croix	MOD/EA	DSI/FF	Cr	2.60E+01	μg/dscm

TABLE 4-5. (CONTINUED)

Facility Name	Combustor Type ^a	Control Technology ^b	Pollutant ^c	Concentration ^d	Units
St. Croix	MOD/EA	DSI/FF	HCl	1.60E-02	ppmv ^e
St. Croix	MOD/EA	DSI/FF	HCl	2.20E-02	ppmv ^e
St. Croix	MOD/EA	DSI/FF	HCl	7.50E-01	ppmv
St. Croix	MOD/EA	DSI/FF	HCl	2.20E-02	ppmv ^e
St. Croix average	MOD/EA	DSI/FF	HCl	2.03E-01	ppmv
St. Croix	MOD/EA	DSI/FF	NI	3.20E+01	µg/dscm
St. Croix	MOD/EA	DSI/FF	PM	3.43E+01	mg/dscm
St. Croix	MOD/EA	DSI/FF	PM	2.75E+01	mg/dscm
St. Croix average	MOD/EA	DSI/FF	PM	3.09E+01	mg/dscm
St. Croix	MOD/EA	DSI/FF	Pb	1.80E+01	µg/dscm
St. Croix	MOD/EA	DSI/FF	SO ₂	1.50E+00	ppmv ^e
St. Croix	MOD/EA	DSI/FF	SO ₂	5.00E+00	ppmv
St. Croix	MOD/EA	DSI/FF	SO ₂	3.40E+01	ppmv
St. Croix	MOD/EA	DSI/FF	SO ₂	2.80E+01	ppmv
St. Croix average	MOD/EA	DSI/FF	SO ₂	1.71E+01	ppmv
North Aroostook	MOD/EA	NA	NO _x	1.12E+02	ppmv
Pigeon Point (Unit 1)	MOD/EA	NA	NO _x	1.26E+02	ppmv
Pigeon Point (Unit 2)	MOD/EA	NA	NO _x	1.05E+02	ppmv
Pigeon Point (Unit 3)	MOD/EA	NA	NO _x	1.14E+02	ppmv
Pigeon Point (Unit 4)	MOD/EA	NA	NO _x	1.17E+02	ppmv
Pigeon Point average	MOD/EA	NA	NO _x	115.3	ppmv
Pittsfield	MOD/EA	NA	NO _x	1.39E+02	ppmv
Pittsfield	MOD/EA	NA	NO _x	1.29E+02	ppmv
Pittsfield average	MOD/EA	NA	NO _x	133.9	ppmv
Pope/Douglas	MOD/EA	NA	NO _x	2.82E+02	ppmv
AVERAGE	MOD/EA	NA	NO _x	1.61E+02	ppmv

^a MOD/EA = Modular Excess Air.

^b U = Uncontrolled.

ESP = Electrostatic Precipitator.

DSI/FF = Duct Sorbent Injection/Fabric Filter.

NA = Not Applicable. Control of NO_x is not tied to traditional acid gas/PM control devices; therefore, the pollution control device is not specified.

^c CDD/CDF levels are for the sum of all tetra- through octa-CDD/CDF homologues.
PM levels are for total particulate.

^d All concentrations corrected to 7 percent O₂ on a dry basis.

^e Results were less than the detection limit; therefore, the detection limit is shown and is used in calculating averages.

TABLE 4-6. MODULAR/STARVED AIR COMBUSTOR DATA

Facility Name	Combustor Type ^a	Control Technology ^b	Pollutant ^c	Concentration ^d	Units
Cattaraugus County	MOD/SA	U	As	3.40E+01	µg/dscm
Dyersburg	MOD/SA	U	As	1.16E+02	µg/dscm
Tuscaloosa	MOD/SA	U	As	9.90E+01	µg/dscm
AVERAGE	MOD/SA	U	As	8.30E+01	µg/dscm
Oswego County	MOD/SA	U	CDD/CDF	1.95E-01	µg/dscm
Oswego County	MOD/SA	U	CDD/CDF	3.59E-01	µg/dscm
Oswego County	MOD/SA	U	CDD/CDF	7.32E-01	µg/dscm
Oswego County	MOD/SA	U	CDD/CDF	1.75E-01	µg/dscm
Oswego County average	MOD/SA	U	CDD/CDF	3.65E-01	µg/dscm
Dyersburg	MOD/SA	U	Cd	2.38E+02	µg/dscm
N. Little Rock	MOD/SA	U	Cd	3.60E+02	µg/dscm
AVERAGE	MOD/SA	U	Cd	2.99E+02	µg/dscm
Cattaraugus County	MOD/SA	U	Cr	1.21E+03	µg/dscm
Dyersburg	MOD/SA	U	Cr	3.94E+02	µg/dscm
N. Little Rock	MOD/SA	U	Cr	3.23E+00	µg/dscm
Tuscaloosa	MOD/SA	U	Cr	3.40E+01	µg/dscm
AVERAGE	MOD/SA	U	Cr	4.10E+02	µg/dscm
Cattaraugus	MOD/SA	U	HCl	1.90E+02	ppmv
Dyersburg	MOD/SA	U	HCl	1.59E+02	ppmv
AVERAGE	MOD/SA	U	HCl	1.75E+02	ppmv
Dyersburg	MOD/SA	U	Hg	1.30E+02	µg/dscm
Cattaraugus County	MOD/SA	U	Ni	1.26E+03	µg/dscm
Dyersburg	MOD/SA	U	Ni	1.09E+02	µg/dscm
AVERAGE	MOD/SA	U	Ni	6.85E+02	µg/dscm
Dyersburg	MOD/SA	U	PM	3.03E+02	mg/dscm
N. Little Rock	MOD/SA	U	PM	3.27E+02	mg/dscm
N. Little Rock	MOD/SA	U	PM	4.36E+02	mg/dscm
N. Little Rock	MOD/SA	U	PM	2.97E+02	mg/dscm
N. Little Rock average	MOD/SA	U	PM	3.53E+02	mg/dscm
Oswego County	MOD/SA	U	PM	7.87E+02	mg/dscm
Oswego County	MOD/SA	U	PM	4.85E+02	mg/dscm
Oswego County	MOD/SA	U	PM	4.28E+02	mg/dscm
Oswego County	MOD/SA	U	PM	7.85E+02	mg/dscm
Oswego County average	MOD/SA	U	PM	6.21E+02	mg/dscm
AVERAGE	MOD/SA	U	PM	4.28E+02	mg/dscm
Cattaraugus	MOD/SA	U	SO ₂	1.50E+02	ppmv
Barron County	MOD/SA	ESP	As	2.10E+01	µg/dscm
Oneida County	MOD/SA	ESP	As	5.03E+00	µg/dscm
AVERAGE	MOD/SA	ESP	As	1.30E+01	µg/dscm
Oneida County	MOD/SA	ESP	CDD/CDF	4.62E-01	µg/dscm
Oswego County	MOD/SA	ESP	CDD/CDF	8.19E-01	µg/dscm
Oswego County	MOD/SA	ESP	CDD/CDF	3.53E-01	µg/dscm
Oswego County	MOD/SA	ESP	CDD/CDF	3.01E-01	µg/dscm
Oswego County	MOD/SA	ESP	CDD/CDF	4.12E-01	µg/dscm
Oswego County average	MOD/SA	ESP	CDD/CDF	4.71E-01	µg/dscm
AVERAGE	MOD/SA	ESP	CDD/CDF	4.67E-01	µg/dscm
Barron County	MOD/SA	ESP	Cd	2.20E+01	µg/dscm
Oneida County	MOD/SA	ESP	Cd	9.20E+01	µg/dscm
AVERAGE	MOD/SA	ESP	Cd	5.70E+01	µg/dscm
Barron County	MOD/SA	ESP	Cr	2.90E+00	µg/dscm
Oneida County	MOD/SA	ESP	Cr	1.50E+02	µg/dscm
AVERAGE	MOD/SA	ESP	Cr	7.65E+01	µg/dscm
Oneida County	MOD/SA	ESP	Hg	2.06E+03	µg/dscm

TABLE 4-6. (CONTINUED)

Facility Name	Combustor Type ^a	Control Technology ^b	Pollutant ^c	Concentration ^d	Units
Oneida County	MOD/SA	ESP	Ni	1.25E+02	µg/dscm
Barron County	MOD/SA	ESP	PM	2.29E+01	mg/dscm
Oneida County	MOD/SA	ESP	PM	6.02E+01	mg/dscm
Oswego County	MOD/SA	ESP	PM	6.41E+01	mg/dscm
Oswego County	MOD/SA	ESP	PM	2.75E+01	mg/dscm
Oswego County	MOD/SA	ESP	PM	5.72E+01	mg/dscm
Oswego County	MOD/SA	ESP	PM	3.66E+01	mg/dscm
Oswego County average	MOD/SA	ESP	PM	4.63E+01	mg/dscm
AVERAGE	MOD/SA	ESP	PM	4.31E+01	mg/dscm
Barron County	MOD/SA	ESP	Pb	2.70E+02	µg/dscm
Oneida County	MOD/SA	ESP	Pb	4.30E+02	µg/dscm
AVERAGE	MOD/SA	ESP	Pb	3.50E+02	µg/dscm
Barron County	MOD/SA	NA	CO	3.24E+00	ppmv
N. Little Rock	MOD/SA	NA	CO	8.49E+01	ppmv
Oswego County	MOD/SA	NA	CO	3.00E+00	ppmv
Oswego County	MOD/SA	NA	CO	0.00E+00	ppmv
Oswego County	MOD/SA	NA	CO	2.00E+00	ppmv
Oswego County	MOD/SA	NA	CO	5.00E+00	ppmv
Oswego County	MOD/SA	NA	CO	2.00E+01	ppmv
Oswego County	MOD/SA	NA	CO	1.40E+01	ppmv
Oswego County average	MOD/SA	NA	CO	7.33E+00	ppmv
AVERAGE	MOD/SA	NA	CO	3.18E+01	ppmv
NSP Red Wing	MOD/SA	NA	NO _x	2.60E+02	ppmv
N. Little Rock	MOD/SA	NA	NO _x	2.40E+02	ppmv
Oneida	MOD/SA	NA	NO _x	8.64E+01	ppmv
Tuscaloosa	MOD/SA	NA	NO _x	2.35E+02	ppmv
AVERAGE	MOD/SA	NA	NO _x	2.05E+02	ppmv

^a MOD/SA = Modular Starved Air.

^b U = Uncontrolled (prior to pollution control equipment).

ESP = Electrostatic Precipitator.

NA = Not Applicable. Control of CO and NO_x is not tied to traditional acid gas/PM control devices; therefore, the pollution control device is not specified.

^c CDD/CDF levels are for the sum of all tetra- through octa- CDD and CDF homologues. PM levels are for total particulate.

^d All concentrations corrected to 7 percent O₂ on a dry basis.

The data were then grouped by combustor type, type of control technology, and pollutant. Combustor type and pollutant-specific tables were generated to: 1) list results for uncontrolled and controlled emission levels for the various combustor types and APCDs, and 2) present emission results as a concentration from which an emission factor in pollutant mass per mass of MWC feed could be derived. Following this grouping, the arithmetic mean of all facility-averaged data was again computed.

As noted in Section 4.2, the emissions data in Tables 4-1 through 4-6 are expressed as concentrations, which is how they were often expressed in the individual test reports. Data on As, Cd, Cr, Pb, Hg, Ni, and CDD/CDF are expressed in units of micrograms per dry standard cubic meter ($\mu\text{g/dscm}$). Particulate matter data are expressed as milligrams per dscm (mg/dscm), and SO_2 , HCl, NO_x , and CO are expressed as ppmv. All concentration values shown have been corrected to 7 percent O_2 .

In order to convert these concentrations to emission factors expressed on a pound of pollutant per ton of refuse fed-basis, information on the amount of refuse fed into each combustor unit during each test run is needed. Unfortunately, over half of the test reports reviewed did not measure or report refuse feed rates. Nor were data provided on the British thermal unit (Btu) output from the combustor unit, which could be used to derive a feed rate if an assumed fuel heating value were assumed.

Data on refuse feed rates are often subjective and of poor quality, due to the methodology for determining the feed rates. Often an operator merely counts the number of grapple loads fed into the combustor during a test run and estimates the total amount fed based on an estimate of each grapple's weight. Feed rates may also be determined by estimating the percent of capacity at which the unit was operating during the test run. This is also quite subjective, and often depends on the operator's interpretation of "capacity."

It was concluded that the development of emission factors for MWCs only from the test reports that estimated feed rates would eliminate so many facilities, especially key facilities,

that the values derived were not likely to be representative of the entire MWC population. In addition, the subjective nature of the refuse feed rates calls into question the validity of the limited data. An approach was selected, therefore, for developing emission factors on a pound of pollutant per ton of refuse fed basis, that does not rely on the refuse feed rates estimated by the facility operators. The emission factors were developed using the F-factor, which is the ratio of the gas volume of the products of combustion to the heating value of the fuel, developed by the EPA (EPA Method 19).⁷ For MWCs, an F-factor of 9,570 dscf/10⁶ Btu is assigned.⁸ To convert the concentration values to pound per ton values using the F-factor, a heating value of the waste is needed. For all combustor types except RDF combustors, a heating value of 4,500 Btu/lb of refuse was assumed. For RDF combustor units, the processed refuse typically has a higher heating value, therefore a heating value of 5,500 Btu/lb was assumed. Overall, these heating values are representative of average values for MWCs. Example F-factor conversion equations using the 4,500 Btu/lb heating value are provided below. These equations are for all combustor types except RDF combustors. Conversions for RDF combustors are identical but a heating value of 5,500 Btu/lb is substituted. If the heating value at a particular facility is different from these assumed values, the actual heating value can be substituted in the equations to calculate the emission factors.

4.3.1.1 Conversion of $\mu\text{g}/\text{dscm}$ (for As, Cd, Cr, Hg, Ni, and CDD/CDF)

To convert from $\mu\text{g}/\text{dscm}$ to lb/ton refuse, the following equation was used:

$$1 \mu\text{g}/\text{dscm} \text{ (at 7\% O}_2\text{)} * [(21-0)/(21-7)] * (\text{m}^3/35.31 \text{ ft}^3) * [\text{g}/(10^6 \mu\text{g})] * (\text{lb}/454 \text{ g}) * (9570 \text{ dscf}/10^6 \text{ Btu}) * (4500 \text{ Btu}/\text{lb}) * (2000 \text{ lb}/\text{ton})$$

where:

$$[(21-0)/(21-7)] = \text{conversion from 7 percent to 0 percent O}_2$$

$$(9570 \text{ dscf}/10^6 \text{ Btu}) = \text{F-factor}$$

$$(4500 \text{ Btu}/\text{lb}) = \text{heating value of MSW}$$

4.3.1.2 Conversion of mg/dscm (for PM)

To convert from mg/dscm to lb/ton refuse, the following equation was used:

$$1 \text{ mg/dscm (at 7\% O}_2\text{)} * [(21-0)/(21-7)] * (\text{m}^3/35.31 \text{ ft}^3) * (\text{g}/10^3 \text{ mg}) * (\text{lb}/454 \text{ g}) * (9570 \text{ dscf}/10^6 \text{ Btu}) * (4500 \text{ Btu}/\text{lb}) * (2000 \text{ lb}/\text{ton})$$

where:

$$[(21-0)/(21-7)] = \text{conversion from 7 percent to 0 percent O}_2 \\ (9570 \text{ dscf}/10^6 \text{ Btu}) = \text{F-factor} \\ (4500 \text{ Btu}/\text{lb}) = \text{heating value of MSW}$$

4.3.1.3 Conversion of ppmv (for HCl)

To convert from ppmv to lb/ton refuse, the following equation was used:

$$\frac{1 \text{ ppmv HCl (at 7\% O}_2\text{)} \times 36.5 \text{ lb}/\text{lb-mole} * [(21-0)/(21-7)] *}{385 \text{ ft}^3/\text{lb-mole} \times 10^6}$$

$$(9570 \text{ dscf}/10^6 \text{ Btu}) * (4500 \text{ Btu}/\text{lb}) * (2000 \text{ lb}/\text{ton})$$

where:

$$36.5 \text{ lb}/\text{lb-mole} = \text{molecular weight of HCl} \\ [(21-0)/(21-7)] = \text{conversion from 7 percent to 0 percent O}_2 \\ (9570 \text{ dscf}/10^6 \text{ Btu}) = \text{F-factor} \\ (4500 \text{ Btu}/\text{lb}) = \text{heating value of MSW}$$

4.3.1.4 Conversion of ppmv (for SO₂)

To convert from ppmv to lb/ton refuse, the following equation was used:

$$\frac{1 \text{ ppmv SO}_2 \text{ (at 7\% O}_2\text{)} * 64 \text{ lb}/\text{lb-mole} * [(21-0)/(21-7)] *}{385 \text{ ft}^3/\text{lb-mole} \times 10^6}$$

$$(9570 \text{ dscf}/10^6 \text{ Btu}) * (4500 \text{ Btu}/\text{lb}) * (2000 \text{ lb}/\text{ton})$$

where:

$$64 \text{ lb}/\text{lb-mole} = \text{molecular weight of SO}_2 \\ [(21-0)/(21-7)] = \text{conversion from 7 percent to 0 percent O}_2 \\ (9570 \text{ dscf}/10^6 \text{ Btu}) = \text{F-factor} \\ (4500 \text{ Btu}/\text{lb}) = \text{heating value of MSW}$$

4.3.1.5 Conversion of ppmv (for NO_x)

To convert from ppmv to lb/ton refuse, the following equation was used:

$$\frac{1 \text{ ppmv NO}_2 \text{ (at 7\% O}_2\text{)} * 46 \text{ lb/lb-mole} * [(21-0)/(21-7)] *}{385 \text{ ft}^3/\text{lb-mole} * 10^6} \\ (9570 \text{ dscf}/10^6 \text{ Btu}) * (4500 \text{ Btu/lb}) * (2000 \text{ lb/ton})$$

where:

46 lb/lb-mole = molecular weight of NO₂
[(21-0)/(21-7)] = conversion from 7 percent to 0 percent O₂
(9570 dscf/10⁶ Btu) = F-factor
(4500 Btu/lb) = heating value of MSW

4.3.1.6 Conversion of ppmv (for CO)

To convert from ppmv to lb/ton refuse, the following equation was used:

$$\frac{1 \text{ ppmv CO (at 7\% O}_2\text{)} * 28 \text{ lb/lb-mole} * [(21-0)/(21-7)] *}{385 \text{ ft}^3/\text{lb-mole} * 10^6} \\ (9570 \text{ dscf}/10^6 \text{ Btu}) * (4500 \text{ Btu/lb}) * (2000 \text{ lb/ton})$$

where:

28/lb-mole = molecular weight of CO
[(21-0)/(21-7)] = conversion from 7 percent to 0 percent O₂
(9570 dscf/10⁶ Btu) = F-factor
(4500 Btu/lb) = heating value of MSW

Tables 4-7 through 4-9 present emissions by average concentration and by pound of pollutant per ton of refuse for mass burn MWCs. Table 4-10 presents the same information for RDF MWCs. Emission factors for modular MWCs are presented in Tables 4-11 and 4-12. All emission factors were derived by converting the average emissions data in Table 4-1 through 4-6 to a pound per ton basis using the equations shown above.

TABLE 4-7. MASS BURN/WATERWALL COMBUSTOR EMISSION FACTORS

Control Technology ^a	Pollutant ^b	Concentration ^c	Units	Emission Factor (lb/ton) ^{d,e,f}
U	As	5.43E+02	µg/dscm	4.37E-03
U	CDD/CDF	2.07E-01	µg/dscm	1.67E-06
U	Cd	1.35E+03	µg/dscm	1.09E-02
U	Cr	1.11E+03	µg/dscm	8.97E-03
U	HCl	5.20E+02	ppmv	6.40E+00
U	Hg	5.94E+02	µg/dscm	4.79E-03
U	Ni	9.74E+02	µg/dscm	7.85E-03
U	PM	3.12E+03	mg/dscm	2.51E+01
U	Pb	2.64E+04	µg/dscm	2.13E-01
U	SO ₂	1.61E+02	ppmv	3.46E+00
SD/FF	As	5.25E-01	µg/dscm	4.23E-06
SD/FF	CDD/CDF	8.20E-03	µg/dscm	6.61E-08
SD/FF	Cd	3.37E+00	µg/dscm	2.71E-05
SD/FF	Cr	3.72E+00	µg/dscm	3.00E-05
SD/FF	HCl	1.71E+01	ppmv	2.11E-01
SD/FF	Hg	2.73E+02	µg/dscm	2.20E-03
SD/FF	Ni	6.40E+00	µg/dscm	5.16E-05
SD/FF	PM	7.70E+00	mg/dscm	6.20E-02
SD/FF	Pb	3.24E+01	µg/dscm	2.61E-04
SD/FF	SO ₂	2.58E+01	ppmv	5.54E-01
SD/ESP	As	1.69E+00	µg/dscm	1.37E-05
SD/ESP	CDD/CDF	7.71E-02	µg/dscm	6.21E-07
SD/ESP	Cd	9.31E+00	µg/dscm	7.51E-05
SD/ESP	Cr	3.22E+01	µg/dscm	2.59E-04
SD/ESP	HCl	1.28E+01	ppmv	1.58E-01
SD/ESP	Hg	4.05E+02	µg/dscm	3.26E-03
SD/ESP	Ni	3.35E+01	µg/dscm	2.70E-04
SD/ESP	PM	8.72E+00	mg/dscm	7.03E-02
SD/ESP	Pb	1.14E+02	µg/dscm	9.15E-04
SD/ESP	SO ₂	3.04E+01	ppmv	6.53E-01
ESP	As	2.70E+00	µg/dscm	2.17E-05
ESP	CDD/CDF	1.45E-01	µg/dscm	1.17E-06
ESP	Cd	8.02E+01	µg/dscm	6.46E-04
ESP	Cr	1.40E+01	µg/dscm	1.13E-04
ESP	Hg	8.21E+02	µg/dscm	6.62E-03
ESP	Ni	1.39E+01	µg/dscm	1.12E-04
ESP	PM	2.61E+01	mg/dscm	2.10E-01
ESP	Pb	3.72E+02	µg/dscm	3.00E-03
DSI/FF	As	1.28E+00	µg/dscm	1.03E-05
DSI/FF	CDD/CDF	1.98E-02	µg/dscm	1.60E-07
DSI/FF	Cd	2.90E+00	µg/dscm	2.34E-05

TABLE 4-7. (CONTINUED)

Control Technology ^a	Pollutant ^b	Concentration ^c	Units	Emission Factor (lb/ton) ^{d,e,f}
DSI/FF	Cr	2.48E+01	μg/dscm	2.00E-04
DSI/FF	HCl	5.17E+01	ppmv	6.36E-01
DSI/FF	Hg	2.73E+02	μg/dscm	2.20E-03
DSI/FF	Ni	1.77E+01	μg/dscm	1.43E-04
DSI/FF	PM	2.22E+01	mg/dscm	1.79E-01
DSI/FF	Pb	3.69E+01	μg/dscm	2.97E-04
DSI/FF	SO ₂	6.63E+01	ppmv	1.43E+00
NA	CO	4.93E+01	ppmv	4.63E-01
NA	NO _x	2.31E+02	ppmv	3.56E+00

^a U = Uncontrolled (prior to pollution control equipment).

SD/FF = Spray Dryer/Fabric Filter.

SD/ESP = Spray Dryer/Electrostatic Precipitator.

ESP = Electrostatic Precipitator.

DSI/FF = Duct Sorbent Injection/Fabric Filter.

NA = Not Applicable. Control of CO and NO_x is not tied to traditional acid gas/PM control devices; therefore, the pollution control device is not specified.

^b CDD/CDF levels are for the sum of all tetra- through octa- CDD and CDF homologues.
PM levels are for total particulate.

^c All concentrations are corrected to 7 percent O₂ on a dry basis.

^d Emission factors were calculated using an F-factor of 9570 Btu/lb and a heating value of 4500 Btu/lb.
Other heating values can be substituted by multiplying the emission factor by the new heating value and dividing by 4500 Btu/lb.

^e Emission factors should be used for estimating long-term, not short-term, emission levels.
This particularly applies to pollutants measured with a continuous emission monitoring system (e.g., SO₂, CO, NO_x).

^f Emission factors for PM, metals, SO₂ and HCl are based on data from mass burn combustors and MOD/EA combustors. For Hg, MOD/SA data were also included.

TABLE 4-8. MASS BURN/ROTARY WATERWALL COMBUSTOR EMISSION FACTORS

Control Technology ^a	Pollutant ^b	Concentration ^c	Units	Emission Factor (lb/ton) ^{d,e,f}
U	As	5.43E+02	µg/dscm	4.37E-03
U	Cr	1.11E+03	µg/dscm	8.97E-03
U	SO ₂	1.61E+02	ppmv	3.46E+00
SD/FF	As	5.25E-01	µg/dscm	4.23E-06
SD/FF	Cd	3.37E+00	µg/dscm	2.71E-05
SD/FF	CDD/CDF	6.59E-03	µg/dscm	5.31E-08
SD/FF	Hg	2.73E+02	µg/dscm	2.20E-03
SD/FF	Ni	6.40E+00	µg/dscm	5.16E-05
SD/FF	Pb	3.24E+01	µg/dscm	2.61E-04
SD/FF	PM	7.70E+00	mg/dscm	6.20E-02
ESP	PM	2.61E+01	mg/dscm	2.10E-01
DSI/FF	As	1.28E+00	µg/dscm	1.03E-05
DSI/FF	CDD/CDF	1.14E-02	µg/dscm	9.16E-08
DSI/FF	Cd	2.90E+00	µg/dscm	2.34E-05
DSI/FF	Cr	2.48E+01	µg/dscm	2.00E-04
DSI/FF	HCl	5.17E+01	ppmv	6.36E-01
DSI/FF	Hg	2.73E+02	µg/dscm	2.20E-03
DSI/FF	Ni	1.77E+01	µg/dscm	1.43E-04
DSI/FF	PM	2.22E+01	mg/dscm	1.79E-01
DSI/FF	Pb	3.69E+01	µg/dscm	2.97E-04
DSI/FF	SO ₂	6.63E+01	ppmv	1.43E+00
NA	CO	8.15E+01	ppmv	7.66E-01
NA	NO _x	1.46E+02	ppmv	2.25E+00

^a U = Uncontrolled (prior to pollution control equipment).

SD/FF = Spray Dryer/Fabric Filter

ESP = Electrostatic Precipitator

DSI/FF = Duct Sorbent Injection/Fabric Filter

NA = Not Applicable. Control of NO_x is not tied to traditional acid gas/PM control devices; therefore, the pollution control device is not specified.

^b CDD/CDF levels are for the sum of all tetra- through octa- CDD and CDF homologues.

PM levels are for total particulate.

^c All concentrations are corrected to 7 percent O₂ on a dry basis.

^d Emission factors were calculated using an F-factor of 9570 Btu/lb and a heating value of 4500 Btu/lb.

Other heating values can be substituted by multiplying the emission factor by the new heating value and dividing by 4500 Btu/lb.

^e Emission factors should be used for estimating long-term, not short-term, emission levels.

This particularly applies to pollutants measured with a continuous emission monitoring system (e.g., SO₂, CO, NO_x).

^f Emission factors for PM, metals, SO₂ and HCl are based on data from mass burn combustors and MOD/EA combustors. For Hg, MOD/SA data were also included.

TABLE 4-9. MASS BURN/REFRACTORY WALL COMBUSTOR EMISSION FACTORS

Control Technology ^a	Pollutant ^b	Concentration ^c	Units	Emission Factor (lb/ton) ^{e,f,g}
U	As	5.43E+02	µg/dscm	4.37E-03
U	CDD/CDF	1.86E+00	µg/dscm	1.50E-05
U	Cd	1.35E+03	µg/dscm	1.09E-02
U	Cr	1.11E+03	µg/dscm	8.97E-03
U	HCl	5.20E+02	ppmv	6.40E+00
U	Hg	5.94E+02	µg/dscm	4.79E-03
U	Ni	9.74E+02	µg/dscm	7.85E-03
U	PM	3.12E+03	mg/dscm	2.51E+01
U	Pb	2.64E+04	µg/dscm	2.13E-01
U	SO ₂	1.61E+02	ppmv	3.46E+00
ESP	As	2.70E+00	µg/dscm	2.17E-05
ESP	CDD/CDF	8.99E+00	µg/dscm	7.25E-05
ESP	Cd	8.02E+01	µg/dscm	6.46E-04
ESP	Cr	1.40E+01	µg/dscm	1.13E-04
ESP	Hg	8.21E+02	µg/dscm	6.62E-03
ESP	Ni	1.39E+01	µg/dscm	1.12E-04
ESP	PM	2.61E+01	mg/dscm	2.10E-01
ESP	Pb	3.72E+02	µg/dscm	3.00E-03
DSI/ESP	As	2.00E+00	µg/dscm ^d	1.61E-05
DSI/ESP	CDD/CDF	5.72E-02	µg/dscm	4.61E-07
DSI/ESP	Cd	1.10E+01	µg/dscm	8.87E-05
DSI/ESP	Cr	3.83E+00	µg/dscm	3.09E-05
DSI/ESP	HCl	2.26E+01	ppmv	2.78E-01
DSI/ESP	Hg	4.91E+02	µg/dscm	3.96E-03
DSI/ESP	Ni	4.00E+00	µg/dscm	3.22E-05
DSI/ESP	PM	7.32E+00	mg/dscm	5.90E-02
DSI/ESP	Pb	3.60E+02	µg/dscm	2.90E-03
DSI/ESP	SO ₂	4.42E+01	ppmv	9.51E-01

TABLE 4-9. (CONTINUED)

Control Technology ^a	Pollutant ^b	Concentration ^c	Units	Emission Factor (lb/ton) ^{e,f,g}
NA	CO	1.46E+02	ppmv	1.37E+00
NA	NO _x	1.60E+02	ppmv	2.46E+00

^a U = Uncontrolled (prior to pollution control equipment).

ESP = Electrostatic Precipitator

DS/ESP = Duct Sorbent Injection/Electrostatic Precipitator

NA = Not Applicable. Control of CO and NO_x is not tied to traditional acid gas/PM control devices; therefore, the pollution control device is not specified.

^b CDD/CDF levels are for the sum of all tetra- through octa- CDD and CDF homologues.
PM levels are for total particulate.

^c All concentrations are corrected to 7 percent O₂ on a dry basis.

^d Level measured was below detection limit (based on one data point). Detection limit is shown.

^e Emission factors were calculated using an F-factor of 9570 Btu/lb and a heating value of 4500 Btu/lb.
Other heating values can be substituted by multiplying the emission factor by the new heating value and dividing by 4500 Btu/lb.

^f Emission factors should be used for estimating long-term, not short-term, emission levels.
This particularly applies to pollutants measured with a continuous emission monitoring system (e.g., SO₂, CO, NO_x).

^g Emission factors for PM, metals, SO₂ and HCl are based on data from mass burn combustors and MOD/EA combustors. For Hg, MOD/SA data were also included.

TABLE 4-10. REFUSE-DERIVED FUEL-FIRED COMBUSTOR EMISSION FACTORS

Control Technology ^a	Pollutant ^b	Concentration ^c	Units	Emission Factor (lb/ton) ^{f,g}
U	As	6.03E+02	µg/dscm	5.94E-03
U	CDD/CDF	9.61E-01	µg/dscm	9.47E-06
U	Cd	8.88E+02	µg/dscm	8.75E-03
U	Cr	1.42E+03	µg/dscm	1.40E-02
U	HCl	4.65E+02	ppmv	6.97E+00
U	Hg	6.21E+02	µg/dscm	6.12E-03
U	Ni	4.43E+02	µg/dscm	4.36E-03
U	PM	7.07E+03	mg/dscm	6.96E+01
U	Pb	2.04E+04	µg/dscm	2.01E-01
U	SO ₂	1.49E+02	ppmv	3.90E+00
SD/FF	As	5.25E-01	µg/dscm ^d	5.17E-06
SD/FF	CDD/CDF	2.48E-03	µg/dscm	2.44E-08
SD/FF	Cd	3.37E+00	µg/dscm ^d	3.32E-05
SD/FF	Cr	4.14E+00	µg/dscm	4.07E-05
SD/FF	HCl	3.52E+00	ppmv	5.28E-02
SD/FF	Hg	2.96E+01	µg/dscm	2.92E-04
SD/FF	Ni	6.40E+00	µg/dscm ^e	6.30E-05
SD/FF	PM	1.35E+01	mg/dscm	1.33E-01
SD/FF	Pb	1.05E+02	µg/dscm	1.04E-03
SD/FF	SO ₂	1.69E+01	ppmv	4.41E-01
SD/ESP	As	1.10E+00	µg/dscm	1.08E-05
SD/ESP	CDD/CDF	1.08E-02	µg/dscm	1.06E-07
SD/ESP	Cd	8.50E+00	µg/dscm	8.37E-05
SD/ESP	Cr	1.11E+01	µg/dscm	1.09E-04
SD/ESP	Hg	4.26E+01	µg/dscm	4.20E-04
SD/ESP	Ni	1.96E+01	µg/dscm	1.93E-04
SD/ESP	PM	9.80E+00	mg/dscm	9.65E-02
SD/ESP	Pb	1.17E+02	µg/dscm	1.16E-03
SD/ESP	SO ₂	6.10E+01	ppmv	1.60E+00
ESP	As	1.36E+01	µg/dscm	1.34E-04
ESP	CDD/CDF	1.72E+00	µg/dscm	1.69E-05
ESP	Cd	2.23E+01	µg/dscm	2.20E-04
ESP	Cr	4.75E+01	µg/dscm	4.68E-04
ESP	Hg	4.32E+02	µg/dscm	4.26E-03
ESP	Ni	1.84E+03	µg/dscm	1.81E-02
ESP	PM	1.05E+02	mg/dscm	1.04E+00
ESP	Pb	3.72E+02	µg/dscm ^d	3.66E-03

TABLE 4-10. (CONTINUED)

Control Technology ^a	Pollutant ^b	Concentration ^c	Units	Emission Factor (lb/ton) ^{f,g}
NA	CO	1.67E+02	ppmv	1.92E+00
NA	NO _x	2.66E+02	ppmv	5.02E+00

^a U = Uncontrolled (prior to pollution control equipment)

SD/FF = Spray Dryer/Fabric Filter

SD/ESP = Spray Dryer/Electrostatic Precipitator

ESP = Electrostatic Precipitator

NA = Not Applicable. Control of CO and NO_x is not tied to traditional acid gas/PM control devices; therefore, the pollution control device is not specified.

^b CDD/CDF levels are for the sum of all tetra- through octa- CDD and CDF homologues. PM levels are for total particulate.

^c All concentrations are corrected to 7 percent O₂ on a dry basis.

^d Levels were measured at non-detect levels, where the detection limit was higher than levels measured at other similarly equipped MWCs. Values shown are based on emission levels from similarly equipped mass burn and MOD/EA combustors.

^e No data available. Values shown are based on emission levels from SD/FF-equipped mass burn combustors.

^f Emission factors were calculated using an F-factor of 9570 Btu/lb and a heating value of 5500 Btu/lb. Other heating values can be substituted by multiplying the emission factor by the new heating value and dividing by 5500 Btu/lb.

^g Emission factors should be used for estimating long-term, not short-term, emission levels. This particularly applies to pollutants measured with a continuous emission monitoring system (e.g., SO₂, CO, NO_x).

TABLE 4-11. MODULAR EXCESS AIR COMBUSTOR EMISSION FACTORS

Control Technology ^a	Pollutant ^b	Concentration ^b	Units	Emission Factors (lb/ton) ^{d,e,f}
U	HCl	5.20E+02	ppmv	6.40E+00
U	PM	3.12E+03	mg/dscm	2.51E+01
U	SO ₂	1.61E+02	ppmv	3.46E+00
ESP	As	2.70E+00	μg/dscm	2.17E-05
ESP	CDD/CDF	2.76E-01	μg/dscm	2.22E-06
ESP	Cr	1.40E+01	μg/dscm	1.13E-04
ESP	Hg	8.21E+02	μg/dscm	6.62E-03
ESP	Ni	1.39E+01	μg/dscm	1.12E-04
ESP	PM	2.61E+01	mg/dscm	2.10E-01
ESP	Pb	3.72E+02	μg/dscm	3.00E-03
DSI/FF	As	1.28E+00	μg/dscm	1.03E-05
DSI/FF	CDD/CDF	7.73E-03	μg/dscm	6.23E-08
DSI/FF	Cr	2.48E+01	μg/dscm	2.00E-04
DSI/FF	HCl	5.17E+01	ppmv	6.36E-01
DSI/FF	Ni	1.77E+01	μg/dscm	1.43E-04
DSI/FF	PM	2.22E+01	mg/dscm	1.79E-01
DSI/FF	Pb	3.69E+01	μg/dscm	2.97E-04
DSI/FF	SO ₂	6.63E+01	ppmv	1.43E+00
NA	NO _x	1.61E+02	ppmv	2.47E+00

^a U = Uncontrolled (prior to pollution control equipment).

ESP = Electrostatic Precipitator.

DSI/FF = Duct Sorbent Injection/Fabric Filter.

NA = Not Applicable. Control of CO and NO_x is not tied to traditional acid gas/PM control devices; therefore, the pollution control device is not specified.

^b CDD/CDF levels are for the sum of all tetra- through octa- CDD and CDF homologues.
PM levels are for total particulate.

^c All concentrations are corrected to 7 percent O₂ on a dry basis.

^d Emission factors were calculated using an F-factor of 9570 Btu/lb and a heating value of 4500 Btu/lb. Other heating values can be substituted by multiplying the emission factor by the new heating value and dividing by 4500 Btu/lb.

^e Emission factors should be used for estimating long-term, not short-term, emission levels. This particularly applies to pollutants measured with a continuous emission monitoring system (e.g., SO₂, CO, NO_x).

^f Emission factors for PM, metals, SO₂ and HCl are based on data from mass burn combustors and MOD/EA combustors. For Hg, MOD/SA data were also included.

TABLE 4-12. MODULAR STARVED AIR COMBUSTOR EMISSION FACTORS

Control Technology ^a	Pollutant ^b	Concentration ^c	Units	Emission Factors (lb/ton) ^{d,e,f}
U	As	8.30E+01	μg/dscm	6.69E-04
U	CDD/CDF	3.65E-01	μg/dscm	2.94E-06
U	Cd	2.99E+02	μg/dscm	2.41E-03
U	Cr	4.10E+02	μg/dscm	3.31E-03
U	HCl	1.75E+02	ppmv	2.15E+00
U	Hg	5.94E+02	μg/dscm	4.79E-03
U	Ni	6.85E+02	μg/dscm	5.52E-03
U	PM	4.26E+02	mg/dscm	3.43E+00
U	SO ₂	1.50E+02	ppmv	3.23E+00
ESP	As	1.30E+01	μg/dscm	1.05E-04
ESP	CDD/CDF	4.67E-01	μg/dscm	3.76E-06
ESP	Cd	5.70E+01	μg/dscm	4.59E-04
ESP	Cr	7.65E+01	μg/dscm	6.16E-04
ESP	Hg	8.21E+02	μg/dscm	6.62E-03
ESP	Ni	1.25E+02	μg/dscm	1.01E-03
ESP	PM	4.31E+01	mg/dscm	3.48E-01
ESP	Pb	3.50E+02	μg/dscm	2.82E-03
NA	CO	3.18E+01	ppmv	2.99E-01
NA	NO _x	2.05E+02	ppmv	3.16E+00

^a U = Uncontrolled (prior to pollution control equipment).

ESP = Electrostatic Precipitator.

NA = Not Applicable. Control of CO and NO_x is not tied to traditional acid gas/PM control devices; therefore, the pollution control device is not specified.

^b CDD/CDF levels are for the sum of all tetra- through octa- CDD and CDF homologues.
PM levels are for total particulate.

^c All concentrations are corrected to 7 percent O₂ on a dry basis.

^d Emission factors were calculated using an F-factor of 9570 Btu/lb and a heating value of 4500 Btu/lb. Other heating values can be substituted by multiplying the emission factor by the new heating value and dividing by 4500 Btu/lb.

^e Emission factors should be used for estimating long-term, not short-term, emission levels. This particularly applies to pollutants measured with a continuous emission monitoring system (e.g., SO₂, CO, NO_x).

^f Mercury levels based on emission levels measured at mass burn, MOD/EA, and MOD/SA combustors.

For MB combustors (MB/WW, MB/RC, MB/REF) and MOD/EA combustors, emission factors for all metals were derived by combining data from all of these combustors, since metal emissions from these combustors are independent of combustor type. For Hg, data from MOD/SA combustors were also included.

If the emission factor for a pollutant for a certain combustor type is based on only detection limits, the emission factor may not be included in the tables. Instead, an emission factor based on actual data for the pollutant for a similar, representative facility will be shown. For example, the As data for SD/FF-equipped RDF combustors are limited to only detection limits. Since the As data for the mass burn SD/FF-equipped combustors are based on numerous data points, and emissions should generally be similar to RDF performance, the mass burn emission factor would be shown in place of the RDF-derived emission factor. In all cases like this, footnotes are included to explain the reasoning behind replacing the emission factor.

Note that for the continuous emissions monitoring data (SO₂, NO_x, and CO), the data presented by the emission factors represent long-term averages, and should not be used to estimate short-term emissions.

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5.0 AP-42 SECTION 2.1

Section 2.1 of AP-42 is presented in the following pages as it would appear in the document.