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Medical Waste Incinerators - Background Information for Proposed Standards and Guidelines:

Environmental Impacts Report for New and Existing Facilities

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Office of Air and Radiation
Office of Air Quality Planning and Standards
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ENVIRONMENTAL IMPACTS REPORT

This report is one of a series of reports prepared to support the development of standards of performance for new medical waste incinerators (MWI's) and guidelines for States to develop specific emission standards for existing MWI's. The other reports in the series provide background information on the medical waste incineration industry and on the process description, the emission control technologies, the emission control costs, and the model plants for the medical waste incineration process.

This report presents the environmental impacts associated with the control technologies for controlling emissions from MWI's. The incremental increase or decrease in air pollution, water pollution, solid waste generation, and energy consumption for each control technology relative to baseline is discussed. All impacts are based on representative model plant parameters presented in the Model Plant Description and Cost Report for New and Existing Facilities, on control technologies presented in the Control Technology Performance Report for New and Existing Facilities, and on baseline emissions and controlled emissions defined in the Average Emission Rates for MWI's memorandum.[1-3] These impacts are evaluated in Sections 1.0 and 2.0 for model plants representing new and existing MWI's, respectively.

1.0 NEW MWI's

1.1 BACKGROUND INFORMATION

Seven model combustors were developed to represent new MWI's. These specific combustors represent the most common types of combustor design and the most typical charging capacities. They include two continuous, three intermittent, one batch, and one pathological model combustors with 1-second (sec) gas residence times in the secondary chamber. Table 1 summarizes the new model combustor population, size, type, application, and operating parameters. The most common type of auxiliary fuel used, natural gas, has been specified for all of the model combustors.

Table 2 summarizes the control technologies, both combustion and add-on, that are combined with the selected model combustors to comprise the new model plants that are evaluated. The first control technology examined is 1-sec combustion control, which is considered baseline for new MWI's. Baseline reflects the level of emissions in the absence of any Federal regulations for new MWI's. The second control technology examined is 2-sec combustion control with no add-on control device. The remaining control technologies examined are based on combinations of 2-sec combustion control and an add-on control device from either wet systems or fabric filter systems (with or without activated carbon injection). Wet systems include a venturi scrubber (VS) alone or in combination with a packed bed absorber (PB). Fabric filter systems include a fabric filter/packed bed absorber (FF/PB), a dry injection/fabric filter (DI/FF), and a spray dryer/fabric filter (SD/FF).

1.2 AIR POLLUTION IMPACTS

This section describes the primary and secondary air pollution impacts associated with each control technology for new MWI's. Section 1.2.1 presents estimates of annual primary emissions and performance for each control device. Section 1.2.2 presents estimates of annual secondary emissions and the sources and impacts of these emissions.

1.2.1 Primary Emissions

The primary pollutants to be evaluated are total particulate matter (PM), carbon monoxide (CO), chlorinated dioxins and furans (CDD/CDF), hydrogen chloride (HCl), sulfur dioxide (SO_2), nitrogen oxides (NO_x), lead (Pb), cadmium (Cd), and mercury (Hg). Table 3 presents the pollutant concentrations for new MWI's at baseline conditions and for each control technology.[3] The 1-sec baseline concentrations for these pollutants are based on emission test data from an MWI with 1-sec combustion control. The pollutant concentration estimates for the 2-sec combustion control technology are based on incinerator outlet test data from one MWI with 2-sec combustion control. Generally, combustion control reduces PM, CDD/CDF, and CO emissions but does not reduce the emissions of any other pollutants.

The concentration estimates for the remaining control technologies are based on emission test data from MWI's with add-on control devices and on achievable emission levels associated with each device. The wet system concentration estimates are based on achievable emission levels associated with the VS/PB control device.

Table 4 presents estimates of the annual primary emissions in tons per year (ton/yr) for each new model plant. Table 5 presents the annual nationwide estimates of these emissions based on an estimated number of new model plants.[1] Control device performances used to determine the pollutant emissions are presented in the following paragraphs. The performances are presented relative to 2-sec combustion control because the add-on control technologies evaluated include 2-sec combustion control.

For new continuous, intermittent, and pathological MWI's, the PM emission reduction for wet systems is based on a 50 percent removal efficiency associated with a VS/PB. Wet systems are not expected to achieve 50 percent removal of PM emissions from batch MWI's because inlet PM emissions from these units are very low. As a result, the lowest concentration believed to be achievable with wet systems (0.015 grains per dry standard cubic foot [gr/dscf] was used to determine the PM emissions from batch MWI's.

For all types of MWI's, the PM emission reduction for the fabric filter systems is based on the constant PM outlet level achievable with those systems. Based on particle sizing conducted during emission tests, emissions of PM smaller than 10 microns (PM_{10}) are approximately 83 percent of PM emissions, and the reductions are the same as those of PM.

Carbon monoxide emissions, which are affected by combustion practices, are reduced by 95 percent from baseline (1-sec combustion control) under 2-sec combustion control for all model types. No further reduction is achieved by any of the add-on control devices.

Dioxin and furan emissions are also affected by combustion practices; however, unlike CO emissions, CDD/CDF emissions can be reduced further by add-on control devices. Those reductions are based on the following CDD/CDF removal efficiencies: 70 percent for wet systems and 98 percent for DI/FF or SD/FF systems with carbon injection. The DI/FF and SD/FF systems without carbon injection are not effective in reducing CDD/CDF emissions. The FF/PB system without carbon injection may actually generate CDD/CDF. It is not known whether adding carbon to the FF/FB can reduce CDD/CDF emissions to the same level as that achieved by the other fabric filter systems with carbon injection.

Acid gas emissions (i.e., HCl, SO_2, NO_x) are not affected by combustion practices; therefore, no reduction of acid gases is achieved under 2-sec combustion control. Add-on control devices, however, do provide HCl control. The fabric filter systems (with and without activated carbon) and the wet systems reduce HCl emissions by 95 percent. Nitrogen oxide and SO_2 emissions are not affected by any of the control devices.

Metal emissions are also not affected by combustion practices; therefore, no reduction of metal emissions is achieved under 2-sec combustion. However, add-on controls are effective in reducing metal emissions. The wet systems reduce Pb emissions by 45 percent and Cd emissions by 40 percent. The fabric filter systems (with and without activated carbon) reduce Pb emissions by 98 percent and Cd emissions by 96 percent. The DI/FF and SD/FF systems with activated carbon are the only control technologies which have been evaluated that are effective in reducing Hg emissions, with a reduction of 90 percent.

1.2.2 Secondary Emissions

Secondary emissions of air pollutants result from the generation of energy required to operate add-on control devices. Most of the electrical energy is needed (1) to operate the induced draft (ID) fans used to control airflow through the systems and (2) to operate the scrubber water pumps used in wet systems including a VS or VS/PB. The generation of power required to operate these control devices produces PM, SO_2, and NO_x emissions.

Secondary emissions were calculated assuming that the electric power needed to operate the add-on control devices is supplied by a coal-fired power plant. (Electricity requirements for each model plant are discussed in Section 1.5.) The thermal efficiency of this generator is estimated to be 38 percent.[4] The average heat content of bituminous coal is approximately 12,600 British thermal units per pound (Btu/lb).[5] Also for this analysis, the emission rates in pounds per ton (lb/ton) of coal combusted from controlled facilities are estimated to be 0.76 lb/ton for PM, 15.13 lb/ton for SO_2, and 15.13 lb/ton for NO_x.[6]

The annual secondary emissions in ton/yr for each new model plant are presented in Table 6. The annual nationwide secondary emissions, which are based on an estimated number of new model plants, are presented in Table 7. For all model plants, the wet systems have the most significant impact on secondary emissions because the VS/PB system on which their impacts are based consumes more energy than any of the fabric filter systems.

The magnitude of the secondary pollutants generated by operating any of the control devices is much smaller than the magnitude of pollutants being recovered. For example, by installing wet systems on all new 1,500 lb/hr continuous MWI's, approximately 280 tons of secondary pollutants would be emitted annually nationwide, while HCl emissions alone would be reduced by approximately 5,600 ton/yr nationwide.

1.3 WATER POLLUTION IMPACTS

This section describes the water pollution impacts of each MWI control technology. Section 1.3.1 describes the sources, volume, and composition of wastewater. Section 1.3.2 describes regulations that apply to wastewater discharges. Section 1.3.3 describes alternative control system designs that minimize or eliminate wastewater discharges.

1.3.1 Wastewater Sources, Volume, and Composition

Wastewater is generated by the wet control systems and by the FF/PB system. The FF/PB system discharges wastewater from the mist eliminator in the packed bed. The concentrations of pollutants (metals) in the wastewater are expected to be low because the pollutants are removed by the fabric filter. In the VS/PB wet control system, an alkaline (usually caustic) solution is circulated through the quench, venturi, and packed bed. Typically, the solution is pumped from a common sump to all of the components. Some of the liquid evaporates in the quench, which cools and saturates the exhaust gas stream. In the venturi, droplets collect particulate and condensed metals by impaction and diffusion. Acid gases are absorbed by the circulating solution, primarily in the packed bed, and react with the dissolved caustic to produce soluble salts.

Evaporation of water in the quench increases the concentration of dissolved and suspended solids in the circulating solution. This process eventually causes the dissolved salts to reach their solubility limit and begin to precipitate. It also increases the concentration of suspended solids, which increases the amount of abrasion and erosion of the venturi and other control system components. To maintain the concentrations of dissolved and suspended solids at acceptable levels, a small amount of the recirculating solution is withdrawn and discharged. This wastewater discharge is called the system blowdown.

Four VS/PB vendors provided blowdown rates for a range of facility sizes. A summary of the data is presented in the Model Plant Description and Cost Report for New and Existing Facilities.[1] Annual wastewater discharges and the amount of pollutants contained in the wastewater were estimated for each of the new model plants, and the results are presented in Table 8. The annual wastewater discharges are based on estimated blowdown rates, and the amount of pollutants in the wastewater is based on the removal efficiency associated with the VS/PB system. All pollutants removed from the gas stream are assumed to be transferred to the wastewater. Table 9 presents the nationwide amount of pollutants contained in the wastewater for each new model plant.

In the VS/PB control system, PM, organics, and metals are transferred directly to the wastewater; most of the acid gases are converted to sodium salts (or calcium salts, if lime is used as the alkaline reagent).

The wastewater from one VS/PB system that is used to control emissions from an MWI was analyzed for eight metals. Salt concentrations were not analyzed, but they were estimated based on an estimated blowdown rate, the acid gas removal efficiency in the VS/PB, and the inlet and outlet gas flow rates. The blowdown rate is equal to the makeup rate minus the amount of evaporated water. The makeup rate was measured during the test, and the amount of water evaporated in the system was estimated based on the inlet and outlet gas flow rates and moisture levels. The actual metal and estimated salt concentrations are presented in Table 10.

Mass balances were performed that show the amount of most metals discharged to the wastewater to be less than or equal to the amount removed from the gas stream. The metal discharge rates were determined based on the estimated blowdown rate and the concentrations presented in Table 10. The amounts removed from the gas were estimated based on the inlet and outlet gas flow rates, oxygen concentrations, and metal concentrations. The mass emission and discharge rates and the percentage differences are shown in Table 11.

1.3.2 <u>Wastewater Regulations</u>[7]

A wet system, such as a VS/PB control device, transfers certain pollutants (CDD/CDF and metals) from the stack gas to scrubber water. Typically, the scrubber water is discharged to the publicly owned treatment works (POTW's). All wastewater from MWI control systems that is discharged to POTW's must meet the General Pretreatment Regulations set forth in 40 CFR Part 403. These regulations contain both general and specific prohibitions. The general prohibitions stipulate that users may not introduce into a POTW any pollutant(s) that cause "pass through" or "interference." "Pass through" means a discharge from the POTW that causes a violation of the POTW's National Pollution Discharge Elimination System (NPDES) permit. "Interference" means a discharge that inhibits or disrupts (1) the operation of the POTW such that the NPDES permit is violated or (2) the use or disposal of the sludge that is generated by the POTW.

The specific prohibitions would not be violated by the CDD/CDF or metal discharges that might occur from MWI control systems. There are also several categorical (industry-specific) pretreatment standards, one of which applies to hospital discharges. However, the hospital pretreatment standard only addresses biochemical oxygen demand (BOD), total suspended solids (TSS), and pH; none of these parameters is affected by CDD/CDF or metal discharges that might occur from MWI control systems.

Under 40 CFR Part 403, each POTW is charged with developing effluent limits to implement the general and specific prohibitions. These limits are subject to approval by the appropriate "Approval Authority"--either the Director in States with an approved NPDES permit program or the U. S. Environmental Protection Agency (EPA) Regional Administrator in other States. Since effluent limits are set by individual POTW's, the limits vary among POTW's, depending on such factors as the type of treatment system, the nature of the effluent from other discharges, and the local conditions.

Although effluent limits among POTW's nationwide vary significantly, only a few POTW's are known to have imposed limits that MWI facilities have not been able to meet. The wastewater discharges from MWI's that are known not to have met POTW-imposed limits contain metal concentrations above POTW standards. Currently, no POTW's are known to have imposed regulations for CDD/CDF on wastewater discharges from MWI's. The MWI's that have not met POTW limits have been required to install pretreatment facilities. These pretreatment facilities remove the offending contaminants before they are discharged to the sewer system.

1.3.3 Alternative Wet Scrubber Designs That Minimize Wastewater Discharges

At least three wet scrubber vendors have developed control systems that minimize or eliminate wastewater discharges. Descriptions of the design and operation of these systems are presented in the following sections.

1.3.3.1 Filter System.[8] One vendor manufactures two wet control systems that are designed to have no liquid discharge. The design differences between the two control systems are in the equipment to reduce emissions into the air. The procedure for eliminating blowdown is the same for both systems. In both systems, liquid used in the venturi is circulated from a sump that is separate from the sparger/neutralization system. Makeup water is added to the sump, and a slip stream from the sump is pumped to the sparger section to replenish evaporative losses. As the water evaporates in the sparger, the concentration of dissolved salts and suspended solids increases. After reaching the solubility limit, further concentration of the dissolved salts in the liquid causes them to precipitate. Suspended solids naturally settle in the tank. The sparger/neutralization tank is designed such that precipitating salts and settling suspended solids are directed to a drain from which they are pumped (as a wet sludge) to a filtering system. The solids are then removed on a slowly moving disposable filter medium, and the filtrate is pumped back to the sparger.

1.3.3.2 Spray dryer. One vendor manufactures a VS/PB control system that uses a spray dryer to eliminate liquid discharges. This control system consists of a spray dryer, condensing heat exchanger (optional) or quench, venturi, absorber, ID fan, and stack. Blowdown from the neutralization system is pumped to the spray dryer, where it is injected and dried by the hot incinerator exhaust gas. A cyclone collector is incorporated in the bottom section of the dryer so that solids are removed from the gas stream before they are discharged to the condensing heat exchanger and scrubbing system.

1.3.3.3 Concentrated brine. One vendor manufactures a wet scrubber control system that minimizes liquid discharges by generating a concentrated brine solution. A number of options are available to remove certain suspended and dissolved solids from the brine or to eliminate all liquid discharges. The control system consists of a quench vessel (on systems without a waste heat recovery boiler [WHRB]), a prespray tower, a rotary atomizer, a mist eliminator, a liquid recirculation system, an ID fan, and a stack.

The liquid recirculation system is designed with three circulating liquid loops, with the liquid being staged in a countercurrent direction relative to the gas flow. The cleanest circulating water and makeup water enters the mist eliminator and rotary atomizer section. Overflow from the tank in this loop is piped to the second stage, which circulates liquid through the prespray tower. Some of the liquid in this stage is diverted to the third stage, which circulates liquid through the quench. As water evaporates in the quench, the concentration of dissolved solids increases. When the concentration is about 15 percent, a blowdown stream is activated. The blowdown rate is about 0.5 percent of the total scrubber recirculating flow.

The blowdown brine solution can be treated by a process that, the manufacturer claims, produces a nonleaching filter cake and a "clean" brine.[9] In the treatment process, colloidal clay, sodium hydroxide, and sodium sulfide are mixed with the brine solution from the control system. The mixture is filtered, and the heavy metals, flyash (suspended solids), and organics are removed into the filter cake. The filtrate is a "clean" brine, which reportedly can be sent to a sanitary sewer or evaporated to dryness. The vendor provided the data in Table 12, which shows the composition of the brine before and after treatment. The filter cake is a nonhazardous waste that can be transported to a sanitary landfill for disposal.[10]

1.4 SOLIDS DISPOSAL IMPACTS

This section describes the solid waste impacts for new MWI's. Section 1.4.1 describes the quantity of waste that is incinerated in new MWI's. Section 1.4.2 describes the types, quantities, and composition of ash captured by fabric filter control devices. Section 1.4.3 describes existing regulations that apply to solid waste disposal.

1.4.1 Medical Waste Incineration Rates

The nationwide quantity of medical waste incinerated in new MWI's is a function of the number of new MWI's and their waste charging rates, operating hours per day, and operating days per year. These parameters are presented in the Model Plant Description and Cost Report.[1] The resulting annual waste incineration rates for individual model MWI plants are shown in Table 13. The annual nationwide incineration rates for all model plants are shown in Table 14, and the total is 465,000 tons/yr. These rates are unaffected by the type of air pollution control device that is used.

1.4.2 Fabric Filter Ash

Fabric filter ash is generated by all of the control systems which use a fabric filter to control PM emissions. When the exhaust gas stream from the incinerator is drawn through the fabric filter, particle emissions are retained on the fabric material. The cleaned gas passes through to the atmosphere. The collected particles are then removed from the filter by a cleaning mechanism, and the removed particles are stored for proper disposal. Fabric filters are typically combined with another type of control device that is effective in reducing acid gas emissions. In the FF/PB system, the acid gases are neutralized with alkaline scrubber liquid and removed by the packed bed into the wastewater. In the DI/FF system, dry scrubbers use an alkaline sorbent, such as lime, to react with and neutralize the acid gases. The reaction product is a dry salt, which can be collected with the unreacted sorbent by the fabric filter. In the SD/FF system, a wet alkaline slurry is atomized into the gas stream in the spray dryer, where the slurry droplets absorb and react with the acid gases. The droplets evaporate to dryness prior to collection by the fabric filter. All of the pollutants that are removed by the DI/FF and SD/FF systems (PM, metals, acid gas-base reaction products, and organics) are collected by the fabric filter.

Activated carbon can be injected into the fabric filter systems to control Hg and CDD/CDF emissions. The amount of carbon injected is based on carbon concentrations used in controlled emission tests at MWI facilities A and M. All of the carbon injected, as well as all of the unreacted sorbent and all of the acid gas-base reaction products (i.e., $CaCl_2$) are assumed to be removed by the fabric filter.

Increased annual solid waste generation rates for each of the new model plants were estimated based on the removal efficiencies associated with the fabric filter systems and on the types of pollutants collected by the fabric filter. The results are presented in Table 13. Table 14 presents the annual nationwide amount of fabric filter ash generated for each new model plant.

The fabric filter ash from the test at Facility A, which uses a DI/FF system, was analyzed for organics and eight metals; these results are presented in Table 15. The lime used at this facility was also analyzed for eight metals; these results are presented in Table 16.

1.4.3 Solid Waste Regulations

The possibility that fabric filter ash could be considered hazardous must be addressed when investigating the impacts of fabric filter systems. Under the Toxicity Characteristic Leaching Procedure (TCLP) Rule, facilities are required to determine if the fabric filter ash is considered hazardous, either by testing the waste or by providing information that will exclude them from complying with this regulation. The TCLP rule was promulgated on September 25, 1990, for small generators (100 to 1,000 kilograms [kg] of waste per month) and on March 29, 1991, for large generators (>1,000 kg/month). The sludge generated by wet control systems with no wastewater discharges is also covered under the TCLP rule. In the TCLP test the leachate concentrations for contaminants listed under Subpart C--Characteristics of Hazardous Waste, Toxicity Characteristic (Section 261.24) are measured. If the concentrations exceed the regulatory level stated in Table 1 of that section, the ash or sludge, including subsequent mixtures containing the ash or sludge, is considered hazardous. This waste is subject to the Land Disposal Restrictions in 40 CFR Part 268. Under these restrictions, the waste is prohibited from land disposal unless it is treated using technology specified in Section 268.40. For those metals anticipated to be present in the ash or sludge, the maximum concentrations allowable under Section 261.24 are presented in Table 17.

Most facilities mix the flyash with the bottom ash and consider the mixture nonhazardous. It is not known whether the flyash is tested prior to mixing with the bottom ash.[11-15] One company that operates commercial facilities has determined that the material captured in the fabric filter typically tests as hazardous in the TCLP test due to the presence of Pb.[16] One hospital also indicated that the material collected in the fabric filter is hazardous because the Pb content in the lime is high.[11]

1.5 ENERGY IMPACTS

Additional auxiliary fuel is required for combustion controls, and additional electrical energy is required to operate the add-on control devices. Under 2-sec combustion, the additional auxiliary fuel is used to maintain the secondary chamber temperature at 1800°F (100°F higher than baseline) for all model plants during the preheat, burn, and burndown phases and for batch and intermittent model plants during the cooldown phase. The same amount of auxiliary fuel is also required for the remaining control technologies, since they include 2-sec combustion at 1800°F and have no additional auxiliary fuel requirements. Electrical energy is used primarily to operate the ID fan in all of the control devices and the recirculating liquid pumps in the wet control systems. The additional flue gas flow rate associated with the additional auxiliary fuel use is assumed to be negligible.

Table 18 shows the baseline electrical and auxiliary fuel requirements for each of the new model combustors and the requirements for the control technologies that are applied to those combustors. Table 19 presents the annual nationwide energy requirements for each new model plant. As mentioned in Section 1.2.2, the VS/PB (used to calculate impacts for the wet systems) consumes the most electricity.

1.6 OTHER ENVIRONMENTAL IMPACTS

Other potential environmental impacts include noise impacts. For all MWI size categories, 2-sec combustion control will have no effect on noise levels. The remaining control technologies might present some incremental increase in noise levels depending on the type of control device used. Add-on control devices require additional equipment (larger ID fans to overcome pressure drops, and pumps) that will increase noise levels. These noise impacts, however, are expected to be insignificant.

2.0 EXISTING MWI's

2.1 BACKGROUND INFORMATION

Seven model combustors were developed to represent existing MWI's. These specific combustors represent the most common types of combustor design and the most typical charging capacities. They include one continuous, three intermittent, one batch, and one pathological model combustors with 0.25-sec gas residence times in the secondary chamber, and one continuous model combustor with a 1-sec gas residence time in the secondary chamber. Table 20 summarizes the model combustor population, size, type, application, and operating parameters. As with new MWI's, the most common type of auxiliary fuel used, natural gas, has been specified for all of the model combustors.

Baseline reflects the level of emissions in the absence of any Federal guidelines for existing MWI's. The baseline is 0.25-sec combustion control for all existing model combustors except for the 1,500 lb/hr continuous unit. The baseline for this model is 1-sec combustion control. Table 2 summarizes the control technologies, both combustion and add-on, that are combined with the selected model combustors to comprise the existing model plants that are evaluated.

2.2 AIR POLLUTION IMPACTS

This section describes the primary and secondary air pollution impacts associated with each control technology for existing MWI's. Section 2.2.1 presents estimates of annual primary emissions and performance for each control device. Section 2.2.2 presents estimates of annual secondary emissions and the sources and impacts of these emissions.

2.2.1 Primary Emissions

The primary pollutants to be evaluated are the same as those for new MWI's that were presented in Section 1.2.1. Table 21 presents the pollutant concentrations for existing MWI's at baseline conditions and for each control technology.[3] The concentrations for these pollutants under 0.25-sec and 1-sec combustion control are based on emission test data from MWI's with 0.25-sec and 1-sec combustion control, respectively. The pollutant concentration estimates for the 2-sec combustion control technology are based on incinerator outlet test data from one MWI with 2-sec combustion control. Generally, combustion control reduces PM, CDD/CDF, and CO emissions but does not reduce the emissions of any other pollutants.

The concentration estimates for the remaining control technologies are based on emission test data from MWI's with add-on control devices and on achievable emission levels associated with each device. As with new MWI's, the concentration estimates for wet systems installed on existing MWI's are based on achievable emission levels associated with the VS/PB control device.

Table 22 presents estimates of the annual primary emissions in ton/yr for each existing model plant. Table 23 presents the annual nationwide estimates of these emissions based on an estimated number of existing model plants.[1] The pollutant removal efficiencies and achievable outlet levels associated with the control technologies for existing MWI's are the same as those associated with the 1-sec baseline and control technologies for new MWI's and were discussed in Section 1.2.1.

2.2.2 Secondary Emissions

Secondary emissions of air pollutants result from the generation of energy required to operate add-on control devices. The assumptions used in calculating these emissions were presented in Section 1.2.2. Based on these assumptions, the annual secondary emissions in ton/yr for each existing model plant are presented in Table 24, and the annual nationwide secondary emissions, which are based on an estimated number of existing model plants, are presented in Table 25. For all model plants, the wet systems have the most significant impact on secondary emissions because the VS/PB system on which their impacts are based consumes more energy than any of the fabric filter systems.

The magnitude of the secondary pollutants generated by operating any of the control devices is much smaller than the magnitude of pollutants being recovered. For example, by installing wet systems on all existing 1,500 lb/hr continuous MWI's, approximately 570 tons of secondary pollutants would be emitted annually nationwide, while HCl emissions alone would be reduced by approximately 11,000 ton/yr nationwide.

2.3 WATER POLLUTION IMPACTS

This section describes the water pollution impacts of each MWI control technology. The sources and composition of the wastewater discharges from existing MWI's are the same as those described in Section 1.3.1 for new MWI's. Regulations that apply to wastewater discharges and alternative control system designs that minimize or eliminate wastewater discharges are the same as those for new MWI's and were previously discussed in Sections 1.3.2 and 1.3.3, respectively.

Based on assumptions made in Section 1.3.1 for new MWI's, the annual wastewater discharges and the amount of pollutants contained in the wastewater were estimated for each of the existing model plants, and the results are presented in Table 26. The annual wastewater discharges are based on estimated blowdown rates, and the amount of pollutants in the wastewater is based on the removal efficiency associated with the VS/PB system. All pollutants removed from the gas stream are assumed to be transferred to the wastewater. Table 27 presents the nationwide amount of pollutants contained in the wastewater for each existing model plant.

2.4 SOLIDS DISPOSAL IMPACTS

This section describes the solid waste impacts for existing MWI's. The types and composition of the ash captured by the fabric filter control devices are the same as those discussed in Section 1.4.2 for new MWI's. Existing regulations that apply to solid waste disposal are the same as those for new MWI's and were previously discussed in Section 1.4.3.

The medical waste incineration rates for individual existing MWI model plants are the same as those for new MWI model plants; these rates are shown in Table 28. The annual nationwide incineration rates for all existing models are shown in Table 29, and the total is 1.8 million tons/yr. This quantity is unaffected by the type of air pollution control device that is used.

The increased annual solid waste generation rates for each of the existing model plants were estimated based on the removal efficiencies associated with the fabric filter systems and on the types of pollutants collected by the fabric filter. The results are presented in Table 28. Table 29 presents the annual nationwide amount of fabric filter ash generated for each existing model plant.

2.5 ENERGY IMPACTS

As discussed in Section 1.5 for new MWI's, additional auxiliary fuel is required for combustion controls, and additional electrical energy is required to operate the add-on control devices. Table 30 shows the baseline electrical and auxiliary fuel requirements for each of the existing model combustors and the requirements for the control technologies that are applied to those combustors. Table 31 presents the annual nationwide energy requirements for each existing model plant.

The additional fuel usage over baseline for each existing model plant is the same as that for each corresponding new model plant for all of the control technologies. The additional electricity usage is most significant for the VS/PB representing wet systems, which requires both ID fans and liquid pumps.

2.6 OTHER ENVIRONMENTAL IMPACTS

Other potential environmental impacts for existing units are the same as those described in Section 1.6 for new MWI's.

TABLE 1. SUMMARY OF MODEL COMBUSTORS FOR NEW MWI MODEL PLANTS

MWI type	Model design capacity, lb/hr or batch	No. of units[a]	Secondary chamber gas residence time, sec	Exhaust gas flow rate, dscfm[b]	Operating parameters			Applicable industries
					Total, hr/d	d/yr	hr/yr[c]	
Continuous	1,500	77	1	4,747	24	324	7,760	C[d]
Continuous	1,000	60	1	3,165	11.5	324	3,564	H,L[e]
Intermittent	1,500	20	1	4,747	14	312	4,212	H,N,L,V[f]
Intermittent	600	95	1	1,899	14	312	4,212	H,N,L,V
Intermittent	200	280	1	633	12	312	3,588	H,N,L,V
Batch	500	165	1	455	22.5	160	3,520	H
Pathological	200	5	1	730	10	312	2,964	H,N,L,V

[a]Between 1991 and 1995.
[b]Actual exhaust gas flow rate out of the incinerator, at 14 percent O_2.
[c]Includes charging and burndown hours but not preheat hours for the intermittent and continuous units. Preheat hours are estimated to be 0.5 hr at the beginning of each cycle. For the continuous units it is assumed that there are 26 cycles per year. Also includes cooldown hours for the batch and intermittent units. Cooldown hours are estimated to be 10 hr/d for batch units and 2 hr/d for intermittent units.
[d]Code represents commercial facilities.
[e]Code represents hospitals and laboratories.
[f]Codes represent hospitals, nursing homes, laboratories, and veterinary hospitals.

TABLE 2. CONTROL TECHNOLOGIES FOR MEDICAL WASTE INCINERATORS

1-sec combustion control (1700°F) No add-on control device
2-sec combustion control (1800°F) No add-on control device
2-sec combustion control (1800°F) Wet control systems
2-sec combustion control (1800°F) FF/PB
2-sec combustion control (1800°F) DI/FF
2-sec combustion control (1800°F) SD/FF
2-sec combustion control (1800°F) FF/PB (with activated carbon injection) 2-sec combustion control (1800°F) DI/FF (with activated carbon injection) 2-sec combustion control (1800°F) SD/FF (with activated carbon injection)

FF/PB = Fabric filter/packed bed absorber.
DI/FF = Dry injection/fabric filter.
SD/FF = Spray dryer/fabric filter.

TABLE 3. POLLUTANT CONCENTRATIONS FOR NEW MWI's

	Pollutant concentrations at 7 percent O_2								
	PM, gr/dscf	CO, ppmdv	CDD/CDF, ng/dscm	HCL, ppmdv	SO_2, ppmdv	NO_x, ppmdv	Pb, µg/dscm	Cd, µg/dscm	Hg, µg/dscm
Continuous and Intermittent MWI's									
Baseline	0.16	300	4,500	1,460	16	140	4,100	300	3,100
2-sec combustion	0.10	16	440	1,460	16	140	4,100	300	3,100
Wet systems	0.05	16	132	74	16	140	2,255	180	3,100
FF/PB no carbon	0.01	16	3,482	74	16	140	82	12	3,100
DI/FF no carbon	0.01	16	440	74	16	140	82	12	3,100
SD/FF no carbon	0.01	16	88	74	16	140	82	12	3,100
FF systems with carbon[a]	0.01	16	9	74	16	140	82	12	310
Batch MWI's									
Baseline	0.044	200	6,392	200	20	86	3,200	120	2,300
2-sec combustion	0.027	10	625	200	20	86	3,200	120	2,300
Wet systems	0.015	10	188	10	20	86	1,760	72	2,300
FF/PB no carbon	0.01	10	4,948	10	20	86	64	5	2,300
DI/FF no carbon	0.01	10	625	10	20	86	64	5	2,300
SD/FF no carbon	0.01	10	124	10	20	86	64	5	2,300
FF systems with carbon[a]	0.01	10	13	10	20	86	64	5	230
Pathological MWI's									
Baseline	0.024	48	184	120	110	350	380	100	50
2-sec combustion	0.015	2	18	120	110	350	380	100	50
Wet systems	0.015	2	5	6	110	350	210	60	50
FF/PB no carbon	0.01	2	143	6	110	350	8	4	50
DI/FF no carbon	0.01	2	18	6	110	350	8	4	50
SD/FF no carbon	0.01	2	4	6	110	350	8	4	50
FF systems with carbon[a]	0.01	2	0.36	6	110	350	8	4	5

[a]The performance of FF/PB systems with carbon is unknown.

TABLE 4. ANNUAL PRIMARY EMISSIONS FOR EACH NEW MODEL PLANT

Parameters\model combustors	Continuous models		Intermittent models			Batch model	Path. model
Capacity, lb/hr or batch	1,500	1,000	1,500	600	200	500	200
Exhaust flow rate, dscfm (a)	4,747	3,165	4,747	1,899	633	455	730
Operating hours, hr/yr	7,760	3,564	4,212	4,212	3,588	3,520	2,964
Pollutant, ton/yr							
PM							
1-sec (baseline)	12.63	3.87	6.86	2.74	0.78	0.15	0.21
2-sec	7.89	2.42	4.28	1.71	0.49	9.3E-02	0.21
Wet systems	3.95	1.21	2.14	0.86	0.24	5.1E-02	0.10
FF/PB no carbon	0.79	0.24	0.43	0.17	4.9E-02	3.4E-02	4.6E-02
DI/FF no carbon	0.79	0.24	0.43	0.17	4.9E-02	3.4E-02	4.6E-02
SD/FF no carbon	0.79	0.24	0.43	0.17	4.9E-02	3.4E-02	4.6E-02
FF systems with carbon (b)	0.79	0.24	0.43	0.17	4.9E-02	3.4E-02	4.6E-02
CO							
1-sec (baseline)	12.05	3.69	6.54	2.62	0.74	0.35	0.11
2-sec	0.60	0.18	0.33	0.13	3.7E-02	1.7E-02	5.6E-03
Wet systems	0.60	0.18	0.33	0.13	3.7E-02	1.7E-02	5.6E-03
FF/PB no carbon	0.60	0.18	0.33	0.13	3.7E-02	1.7E-02	5.6E-03
DI/FF no carbon	0.60	0.18	0.33	0.13	3.7E-02	1.7E-02	5.6E-03
SD/FF no carbon	0.60	0.18	0.33	0.13	3.7E-02	1.7E-02	5.6E-03
FF systems with carbon (b)	0.60	0.18	0.33	0.13	3.7E-02	1.7E-02	5.6E-03
CDD/CDF							
1-sec (baseline)	1.6E-04	4.8E-05	8.4E-05	3.4E-05	9.6E-06	9.6E-06	3.7E-07
2-sec	1.5E-05	4.6E-06	8.2E-06	3.3E-06	9.4E-07	9.4E-07	3.7E-08
Wet systems	4.6E-06	1.4E-06	2.5E-06	9.9E-07	2.8E-07	2.8E-07	1.1E-08
FF/PB no carbon	1.2E-04	3.7E-05	6.5E-05	2.6E-05	7.4E-06	7.4E-06	2.9E-07
DI/FF no carbon	1.5E-05	4.6E-06	8.2E-06	3.3E-06	9.4E-07	9.4E-07	3.7E-08
SD/FF no carbon	1.5E-05	4.6E-06	8.2E-06	3.3E-06	9.4E-07	9.4E-07	3.7E-08
FF systems with carbon (b), (c)	3.0E-07	9.3E-08	1.6E-07	6.6E-08	1.9E-08	1.9E-08	7.3E-10
HCl							
1-sec (baseline)	76.33	23.37	41.43	16.57	4.71	0.45	0.37
2-sec	76.33	23.37	41.43	16.57	4.71	0.45	0.37
Wet systems	3.82	1.17	2.07	0.83	0.24	2.3E-02	1.8E-02
FF/PB no carbon	3.82	1.17	2.07	0.83	0.24	2.3E-02	1.8E-02
DI/FF no carbon	3.82	1.17	2.07	0.83	0.24	2.3E-02	1.8E-02
SD/FF no carbon	3.82	1.17	2.07	0.83	0.24	2.3E-02	1.8E-02
FF systems with carbon (b)	3.82	1.17	2.07	0.83	0.24	2.3E-02	1.8E-02
SO2							
1-sec (baseline)	1.38	0.42	0.75	0.30	8.5E-02	8.0E-02	0.59
2-sec	1.38	0.42	0.75	0.30	8.5E-02	8.0E-02	0.59
Wet systems	1.38	0.42	0.75	0.30	8.5E-02	8.0E-02	0.59
FF/PB no carbon	1.38	0.42	0.75	0.30	8.5E-02	8.0E-02	0.59
DI/FF no carbon	1.38	0.42	0.75	0.30	8.5E-02	8.0E-02	0.59
SD/FF no carbon	1.38	0.42	0.75	0.30	8.5E-02	8.0E-02	0.59
FF systems with carbon (b)	1.38	0.42	0.75	0.30	8.5E-02	8.0E-02	0.59
NOx							
1-sec (baseline)	9.24	2.83	5.01	2.01	0.57	0.24	1.36
2-sec	9.24	2.83	5.01	2.01	0.57	0.24	1.36
Wet systems	9.24	2.83	5.01	2.01	0.57	0.24	1.36
FF/PB no carbon	9.24	2.83	5.01	2.01	0.57	0.24	1.36
DI/FF no carbon	9.24	2.83	5.01	2.01	0.57	0.24	1.36
SD/FF no carbon	9.24	2.83	5.01	2.01	0.57	0.24	1.36
FF systems with carbon (b)	9.24	2.83	5.01	2.01	0.57	0.24	1.36

TABLE 4. (continued)

Parameters\model combustors	Continuous models		Intermittent models			Batch model	Path. model
Capacity, lb/hr or batch	1,500	1,000	1,500	600	200	500	200
Exhaust flow rate, dscfm (a)	4,747	3,165	4,747	1,899	633	455	730
Operating hours, hr/yr	7,760	3,564	4,212	4,212	3,588	3,520	2,964
Pollutant, ton/yr							
Pb							
1-sec (baseline)	0.14	4.3E-02	7.7E-02	3.1E-02	8.7E-03	4.8E-03	7.7E-04
2-sec	0.14	4.3E-02	7.7E-02	3.1E-02	8.7E-03	4.8E-03	7.7E-04
Wet systems	7.8E-02	2.4E-02	4.2E-02	1.7E-02	4.8E-03	2.6E-03	4.2E-04
FF/PB no carbon	2.8E-03	8.7E-04	1.5E-03	6.1E-04	1.7E-04	9.6E-05	1.5E-05
DI/FF no carbon	2.8E-03	8.7E-04	1.5E-03	6.1E-04	1.7E-04	9.6E-05	1.5E-05
SD/FF no carbon	2.8E-03	8.7E-04	1.5E-03	6.1E-04	1.7E-04	9.6E-05	1.5E-05
FF systems with carbon (b)	2.8E-03	8.7E-04	1.5E-03	6.1E-04	1.7E-04	9.6E-05	1.5E-05
Cd							
1-sec (baseline)	1.0E-02	3.2E-03	5.6E-03	2.2E-03	6.4E-04	1.8E-04	2.0E-04
2-sec	1.0E-02	3.2E-03	5.6E-03	2.2E-03	6.4E-04	1.8E-04	2.0E-04
Wet systems	6.2E-03	1.9E-03	3.4E-03	1.3E-03	3.8E-04	1.1E-04	1.2E-04
FF/PB no carbon	4.1E-04	1.3E-04	2.2E-04	9.0E-05	2.6E-05	7.2E-06	8.1E-06
DI/FF no carbon	4.1E-04	1.3E-04	2.2E-04	9.0E-05	2.6E-05	7.2E-06	8.1E-06
SD/FF no carbon	4.1E-04	1.3E-04	2.2E-04	9.0E-05	2.6E-05	7.2E-06	8.1E-06
FF systems with carbon (b)	4.1E-04	1.3E-04	2.2E-04	9.0E-05	2.6E-05	7.2E-06	8.1E-06
Hg							
1-sec (baseline)	0.11	3.3E-02	5.8E-02	2.3E-02	6.6E-03	3.4E-03	1.0E-04
2-sec	0.11	3.3E-02	5.8E-02	2.3E-02	6.6E-03	3.4E-03	1.0E-04
Wet systems	0.11	3.3E-02	5.8E-02	2.3E-02	6.6E-03	3.4E-03	1.0E-04
FF/PB no carbon	0.11	3.3E-02	5.8E-02	2.3E-02	6.6E-03	3.4E-03	1.0E-04
DI/FF no carbon	0.11	3.3E-02	5.8E-02	2.3E-02	6.6E-03	3.4E-03	1.0E-04
SD/FF no carbon	0.11	3.3E-02	5.8E-02	2.3E-02	6.6E-03	3.4E-03	1.0E-04
FF systems with carbon (b)	1.1E-02	3.3E-03	5.8E-03	2.3E-03	6.6E-04	3.4E-04	1.0E-05

(a) Actual exhaust gas flow rate out of the incinerator, at 14 percent O2.

(b) Activated carbon concentration is 338 mg/dscm (0.0000211 lb/dscf) for the DI/FF and 188 mg/dscm (0.0000117 lb/dscf) for the SD/FF, based on emission test data from Facility A, which uses a DI/FF, and Facility M, which uses an SD/FF.

(c) The performance of the FF/PB with activated carbon injection in reducing CDD/CDF is unknown.

TABLE 5. ANNUAL NATIONWIDE PRIMARY EMISSIONS FOR EACH NEW MODEL PLANT

Parameters\model combustors	Continuous models		Intermittent models			Batch model	Path. model
Capacity, lb/hr or batch	1,500	1,000	1,500	600	200	500	200
Exhaust flow rate, dscfm (a)	4,747	3,165	4,747	1,899	633	455	730
Operating hours, hr/yr	7,760	3,564	4,212	4,212	3,588	3,520	2,964
Number of plants	77	60	20	95	280	165	5
Pollutant, ton/yr							
PM							
1-sec (baseline)	972.49	232.05	137.10	260.53	218.04	24.46	1.04
2-sec	607.81	145.03	85.69	162.83	136.27	15.29	1.04
Wet systems	303.90	72.51	42.85	81.41	68.14	8.49	0.52
FF/PB no carbon	60.78	14.50	8.57	16.28	13.63	5.66	0.23
DI/FF no carbon	60.78	14.50	8.57	16.28	13.63	5.66	0.23
SD/FF no carbon	60.78	14.50	8.57	16.28	13.63	5.66	0.23
FF systems with carbon (b)	60.78	14.50	8.57	16.28	13.63	5.66	0.23
CO							
1-sec (baseline)	927.79	221.38	130.80	248.55	208.01	57.63	0.56
2-sec	46.39	11.07	6.54	12.43	10.40	2.88	2.8E-02
Wet systems	46.39	11.07	6.54	12.43	10.40	2.88	2.8E-02
FF/PB no carbon	46.39	11.07	6.54	12.43	10.40	2.88	2.8E-02
DI/FF no carbon	46.39	11.07	6.54	12.43	10.40	2.88	2.8E-02
SD/FF no carbon	46.39	11.07	6.54	12.43	10.40	2.88	2.8E-02
FF systems with carbon (b)	46.39	11.07	6.54	12.43	10.40	2.88	2.8E-02
CDD/CDF							
1-sec (baseline)	1.2E-02	2.9E-03	1.7E-03	3.2E-03	2.7E-03	1.6E-03	1.9E-06
2-sec	1.2E-03	2.8E-04	1.6E-04	3.1E-04	2.6E-04	1.5E-04	1.8E-07
Wet systems	3.5E-04	8.4E-05	4.9E-05	9.4E-05	7.9E-05	4.6E-05	5.5E-08
FF/PB no carbon	9.3E-03	2.2E-03	1.3E-03	2.5E-03	2.1E-03	1.2E-03	1.4E-06
DI/FF no carbon	1.2E-03	2.8E-04	1.6E-04	3.1E-04	2.6E-04	1.5E-04	1.8E-07
SD/FF no carbon	1.2E-03	2.8E-04	1.6E-04	3.1E-04	2.6E-04	1.5E-04	1.8E-07
FF systems with carbon (b), (c)	2.3E-05	5.6E-06	3.3E-06	6.3E-06	5.2E-06	3.1E-06	3.7E-09
HCl							
1-sec (baseline)	5,877.41	1,402.42	828.61	1,574.53	1,317.74	75.01	1.84
2-sec	5,877.41	1,402.42	828.61	1,574.53	1,317.74	75.01	1.84
Wet systems	293.87	70.12	41.43	78.73	65.89	3.75	9.2E-02
FF/PB no carbon	293.87	70.12	41.43	78.73	65.89	3.75	9.2E-02
DI/FF no carbon	293.87	70.12	41.43	78.73	65.89	3.75	9.2E-02
SD/FF no carbon	293.87	70.12	41.43	78.73	65.89	3.75	9.2E-02
FF systems with carbon (b)	293.87	70.12	41.43	78.73	65.89	3.75	9.2E-02
SO2							
1-sec (baseline)	106.11	25.32	14.96	28.43	23.79	13.18	2.97
2-sec	106.11	25.32	14.96	28.43	23.79	13.18	2.97
Wet systems	106.11	25.32	14.96	28.43	23.79	13.18	2.97
FF/PB no carbon	106.11	25.32	14.96	28.43	23.79	13.18	2.97
DI/FF no carbon	106.11	25.32	14.96	28.43	23.79	13.18	2.97
SD/FF no carbon	106.11	25.32	14.96	28.43	23.79	13.18	2.97
FF systems with carbon (b)	106.11	25.32	14.96	28.43	23.79	13.18	2.97
NOx							
1-sec (baseline)	711.21	169.70	100.27	190.53	159.46	40.23	6.78
2-sec	711.21	169.70	100.27	190.53	159.46	40.23	6.78
Wet systems	711.21	169.70	100.27	190.53	159.46	40.23	6.78
FF/PB no carbon	711.21	169.70	100.27	190.53	159.46	40.23	6.78
DI/FF no carbon	711.21	169.70	100.27	190.53	159.46	40.23	6.78
SD/FF no carbon	711.21	169.70	100.27	190.53	159.46	40.23	6.78
FF systems with carbon (b)	711.21	169.70	100.27	190.53	159.46	40.23	6.78

TABLE 5. (continued)

Parameters\model combustors	Continuous models		Intermittent models			Batch model	Path. model
Capacity, lb/hr or batch	1,500	1,000	1,500	600	200	500	200
Exhaust flow rate, dscfm (a)	4,747	3,165	4,747	1,899	633	455	730
Operating hours, hr/yr	7,760	3,564	4,212	4,212	3,588	3,520	2,964
Number of plants	77	60	20	95	280	165	5
Pollutant, ton/yr							
Pb							
1-sec (baseline)	10.89	2.60	1.54	2.92	2.44	0.79	3.8E-03
2-sec	10.89	2.60	1.54	2.92	2.44	0.79	3.8E-03
Wet systems	5.99	1.43	0.84	1.60	1.34	0.44	2.1E-03
FF/PB no carbon	0.22	5.2E-02	3.1E-02	5.8E-02	4.9E-02	1.6E-02	7.7E-05
DI/FF no carbon	0.22	5.2E-02	3.1E-02	5.8E-02	4.9E-02	1.6E-02	7.7E-05
SD/FF no carbon	0.22	5.2E-02	3.1E-02	5.8E-02	4.9E-02	1.6E-02	7.7E-05
FF systems with carbon (b)	0.22	5.2E-02	3.1E-02	5.8E-02	4.9E-02	1.6E-02	7.7E-05
Cd							
1-sec (baseline)	0.80	0.19	0.11	0.21	0.18	3.0E-02	1.0E-03
2-sec	0.80	0.19	0.11	0.21	0.18	3.0E-02	1.0E-03
Wet systems	0.48	0.11	6.7E-02	0.13	0.11	1.8E-02	6.1E-04
FF/PB no carbon	3.2E-02	7.6E-03	4.5E-03	8.5E-03	7.1E-03	1.2E-03	4.1E-05
DI/FF no carbon	3.2E-02	7.6E-03	4.5E-03	8.5E-03	7.1E-03	1.2E-03	4.1E-05
SD/FF no carbon	3.2E-02	7.6E-03	4.5E-03	8.5E-03	7.1E-03	1.2E-03	4.1E-05
FF systems with carbon (b)	3.2E-02	7.6E-03	4.5E-03	8.5E-03	7.1E-03	1.2E-03	4.1E-05
Hg							
1-sec (baseline)	8.23	1.96	1.16	2.21	1.85	0.57	5.1E-04
2-sec	8.23	1.96	1.16	2.21	1.85	0.57	5.1E-04
Wet systems	8.23	1.96	1.16	2.21	1.85	0.57	5.1E-04
FF/PB no carbon	8.23	1.96	1.16	2.21	1.85	0.57	5.1E-04
DI/FF no carbon	8.23	1.96	1.16	2.21	1.85	0.57	5.1E-04
SD/FF no carbon	8.23	1.96	1.16	2.21	1.85	0.57	5.1E-04
FF systems with carbon (b)	0.82	0.20	0.12	0.22	0.18	5.7E-02	5.1E-05

(a) Actual exhaust gas flow rate out of the incinerator, at 14 percent O2.
(b) Activated carbon concentration is 338 mg/dscm (0.0000211 lb/dscf) for the DI/FF and 188 mg/dscm (0.0000117 lb/dscf) for the SD/FF, based on emission test data from Facility A, which uses a DI/FF, and Facility M, which uses an SD/FF.
(c) The performance of the FF/PB with activated carbon injection in reducing CDD/CDF is unknown.

TABLE 6. ANNUAL SECONDARY EMISSIONS FOR EACH NEW MODEL PLANT

Parameters\model combustors	Continuous models		Intermittent models			Batch model	Path. model
Capacity, lb/hr or batch	1,500	1,000	1,500	600	200	500	200
Exhaust flow rate, dscfm (a)	4,747	3,165	4,747	1,899	633	455	730
Operating hours, hr/yr	7,776	3,726	4,368	4,368	3,744	3,600	3,120
Pollutant, ton/yr							
PM							
Baseline	0	0	0	0	0	0	0
2-sec combustion	0	0	0	0	0	0	0
Wet systems	9.0E-02	2.9E-02	5.0E-02	2.1E-02	7.2E-03	5.5E-03	6.7E-03
FF/PB (b)	4.7E-02	1.6E-02	2.7E-02	1.2E-02	4.1E-03	3.1E-03	3.8E-03
DI/FF (b)	3.2E-02	1.1E-02	1.8E-02	8.2E-03	3.2E-03	2.6E-03	2.9E-03
SD/FF (b)	3.2E-02	1.1E-02	1.8E-02	8.2E-03	3.2E-03	2.6E-03	2.9E-03
SO2							
Baseline	0	0	0	0	0	0	0
2-sec combustion	0	0	0	0	0	0	0
Wet systems	1.79	0.58	1.01	0.43	0.14	0.11	0.13
FF/PB (b)	0.95	0.31	0.53	0.23	8.2E-02	6.3E-02	7.5E-02
DI/FF (b)	0.64	0.21	0.36	0.16	6.4E-02	5.2E-02	5.8E-02
SD/FF (b)	0.64	0.21	0.36	0.16	6.4E-02	5.2E-02	5.8E-02
NOx							
Baseline	0	0	0	0	0	0	0
2-sec combustion	0	0	0	0	0	0	0
Wet systems	1.79	0.58	1.01	0.43	0.14	0.11	0.13
FF/PB (b)	0.95	0.31	0.53	0.23	8.2E-02	6.3E-02	7.5E-02
DI/FF (b)	0.64	0.21	0.36	0.16	6.4E-02	5.2E-02	5.8E-02
SD/FF (b)	0.64	0.21	0.36	0.16	6.4E-02	5.2E-02	5.8E-02

(a) Actual exhaust gas flow rate out of the incinerator, at 14 percent O2.
(b) Values apply to the system both with and without activated carbon injection.

TABLE 7. ANNUAL NATIONWIDE SECONDARY EMISSIONS FOR EACH NEW MODEL PLANT

Parameters\model combustors	Continuous models		Intermittent models			Batch model	Path. model
Capacity, lb/hr or batch	1,500	1,000	1,500	600	200	500	200
Exhaust flow rate, dscfm (a)	4,747	3,165	4,747	1,899	633	455	730
Operating hours, hr/yr	7,776	3,726	4,368	4,368	3744	3,600	3,120
Number of plants	77	60	20	95	280	165	5
Pollutant, ton/yr							
PM							
Baseline	0	0	0	0	0	0	0
2-sec combustion	0	0	0	0	0	0	0
Wet systems	6.89	1.75	1.01	2.03	2.03	0.90	0.03
FF/PB (b)	3.65	0.93	0.53	1.09	1.14	0.52	0.02
DI/FF (b)	2.48	0.64	0.36	0.77	0.90	0.43	0.01
SD/FF (b)	2.48	0.64	0.36	0.77	0.90	0.43	0.01
SO2							
Baseline	0	0	0	0	0	0	0
2-sec combustion	0	0	0	0	0	0	0
Wet systems	138	35	20	41	41	18	0.67
FF/PB (b)	73	19	11	22	23	10	0.38
DI/FF (b)	50	13	7	15	18	8.5	0.29
SD/FF (b)	50	13	7	15	18	8.5	0.29
NOx							
Baseline	0	0	0	0	0	0	0
2-sec combustion	0	0	0	0	0	0	0
Wet systems	138	35	20	41	41	18	0.67
FF/PB (b)	73	19	11	22	23	10	0.38
DI/FF (b)	50	13	7	15	18	8.5	0.29
SD/FF (b)	50	13	7	15	18	8.5	0.29

(a) Actual exhaust gas flow rate out of the incinerator, at 14 percent O2.
(b) Values apply to the system both with and without activated carbon injection.

TABLE 8. ANNUAL AMOUNT OF POLLUTANTS IN WASTEWATER EFFLUENT FOR EACH NEW MODEL PLANT

Parameters\model combustors	Continuous models		Intermittent models			Batch model	Path. model
Capacity, lb/hr	1,500	1,000	1,500	600	200	500	200
Exhaust flow rate, dscfm (a)	4,747	3,165	4,747	1,899	633	455	730
Operating hours, hr/yr	7,760	3,564	4,212	4,212	3,588	3,520	2,964
Venturi blowdown, gal/yr	1.7E+06	5.1E+05	9.0E+05	3.6E+05	1.0E+05	7.2E+04	9.7E+04
Pollutant, ton/yr							
Wet systems							
CDD/CDF	1.1E-05	3.3E-06	5.8E-06	2.3E-06	6.6E-07	6.6E-07	2.6E-08
Pb	6.4E-02	1.9E-02	3.5E-02	1.4E-02	3.9E-03	2.2E-03	3.5E-04
Cd	4.1E-03	1.3E-03	2.2E-03	9.0E-04	2.6E-04	7.2E-05	8.1E-05

(a) Actual exhaust gas flow rate out of the incinerator, at 14 percent O2.

TABLE 9. ANNUAL NATIONWIDE AMOUNT OF POLLUTANTS IN WASTEWATER EFFLUENT FOR EACH NEW MODEL PLANT

Parameters\model combustors	Continuous models		Intermittent models			Batch model	Path. model
Capacity, lb/hr	1,500	1,000	1,500	600	200	500	200
Exhaust flow rate, dscfm (a)	4,747	3,165	4,747	1,899	633	455	730
Operating hours, hr/yr	7,760	3,564	4,212	4,212	3,588	3,520	2,964
Number of plants	77	60	20	95	280	165	5
Venturi blowdown, gal/yr	1.3E+08	3.0E+07	1.8E+07	3.4E+07	2.9E+07	1.2E+07	4.9E+05
Pollutant, ton/yr							
Wet systems							
CDD/CDF	8.2E-04	2.0E-04	1.2E-04	2.2E-04	1.8E-04	1.1E-04	1.3E-07
Pb	4.90	1.17	0.69	1.31	1.10	0.36	1.7E-03
Cd	0.32	7.6E-02	4.5E-02	8.5E-02	7.1E-02	1.2E-02	4.1E-04

(a) Actual exhaust gas flow rate out of the incinerator, at 14 percent O_2.

TABLE 10. FACILITY B WATER ANALYSIS

Pollutant	Pollutant concentration, μg/g	
	Blowdown	Makeup
Arsenic	0.066	<0.005
Cadmium	0.718	<0.005
Chromium	0.0856	<0.01
Iron	2.98	<0.06
Lead	6.511	<0.03
Manganese	0.1522	<0.0068
Mercury	0.0354	<0.0002
Nickel	0.0017	<0.01
Total metals	10.55	<0.127
Total CDD	N/A[a]	N/A
Total CDF	N/A	N/A
Estimated NaCl	18,000[b]	N/A

[a]Not available.

[b]Concentration was estimated based on the assumptions that the blowdown is 6 gal/min, the density of the wastewater is 8.33 lb/gal, and the concentration in the makeup water is zero. It is also based on the test data which show the inlet HCl concentration is 1,258 ppmdv at 7 percent O_2, essentially all of the HCl is removed, and the exhaust gas flow rate is 4,714 dscfm. The blowdown rate is equal to the makeup water minus the amount of water evaporated. The makeup rate was 10 gal/min during the test. The amount of water evaporated was estimated to be 4 gal/min based on the inlet and outlet gas flow rate (4,714 dscfm and 5,509 dscfm, respectively) and moisture concentrations (9.34 percent and 17.9 percent, respectively).

TABLE 11. POLLUTANT MASS EMISSION AND DISCHARGE RATES

Pollutant	Amount removed from gas stream, µg/min	Amount discharged in blowdown, µg/min	Percentage difference, percent[a]
Arsenic	1,470	1,500	-2
Cadmium	12,900	16,300	-26
Chromium	2,140	1,940	9.0
Iron	68,500	67,600	0.9
Lead	121,000	148,000	-22
Manganese	11,100	3,450	69
Mercury	4,030	800	80
Nickel	920	40	96
Total metals	221,000	239,000	-8

[a]Percentage difference is calculated as 100 x (amount removed from gas stream-amount discharged in blowdown)/(amount removed from gas stream).

TABLE 12. COMPOSITION OF CONCENTRATED BRINE

Pollutant, units	Pollutant concentration	
	Before treatment	After treatment
Suspended solids, mg/L	>2,000	<10
Oil and grease, mg/L	>1,000	<10
pH	6.0	8.6
Dissolved heavy metals, units		
Copper, ppm	3.5	0.18
Zinc, ppm	450	0.13
Lead, ppm	53	<1
Cadmium, ppm	N/A	0.38
Chromium, ppm	0.7	0.46

TABLE 13. ANNUAL AMOUNT OF WASTE BURNED AND FLY ASH GENERATED BY EACH NEW MODEL PLANT WITH FABRIC FILTER SYSTEMS WITH AND WITHOUT CARBON INJECTION

Parameters\model combustors	Continuous models		Intermittent models			Batch model	Path. model
Capacity, lb/hr or batch	1,500	1,000	1,500	600	200	500	200
Exhaust flow rate, dscfm (a)	4,747	3,165	4,747	1,899	633	455	730
Operating hours, hr/yr	7,760	3,564	4,212	4,212	3,588	3,520	2,964
Waste incinerated, ton/yr	3,907	977	1,176	470	115	27	172
Pollutant capture per APCD, ton/yr							
DI/FF							
PM	7.10	2.18	3.86	1.54	0.44	5.8E-02	0.16
CDD/CDF	0	0	0	0	0	0	0
CaCl2	110.48	33.83	59.97	23.99	6.81	0.66	0.53
Pb	0.14	4.2E-02	7.5E-02	3.0E-02	8.5E-03	4.7E-03	7.5E-04
Cd	9.9E-03	3.0E-03	5.4E-03	2.2E-03	6.1E-04	1.7E-04	1.9E-04
Hg	0	0	0	0	0	0	0
Unreacted lime (no SO2 removal)	119.96	36.73	65.11	26.05	7.40	0.71	0.58
Total fabric filter ash no carbon	238	72.8	129	51.6	14.7	1.44	1.28
Addition of carbon							
carbon (b)	23.31	7.14	12.65	5.06	1.44	1.01	1.37
CDD/CDF	1.5E-05	4.6E-06	8.1E-06	3.2E-06	9.2E-07	9.2E-07	3.6E-08
Hg	9.6E-02	2.9E-02	5.2E-02	2.1E-02	5.9E-03	3.1E-03	9.1E-05
Total fabric filter ash with carbon	261.10	79.95	141.72	56.69	16.10	2.45	2.64
FF/PB							
PM	7.10	2.18	3.86	1.54	0.44	5.8E-02	0.16
CDD/CDF	0	0	0	0	0	0	0
Pb	0.14	4.2E-02	7.5E-02	3.0E-02	8.5E-03	4.7E-03	7.5E-04
Cd	9.9E-03	3.0E-03	5.4E-03	2.2E-03	6.1E-04	1.7E-04	1.9E-04
Hg	0	0	0	0	0	0	0
Total fabric filter ash no carbon	7.25	2.22	3.94	1.57	0.45	6.3E-02	0.16
Addition of carbon							
carbon (b)	23.31	7.14	12.65	5.06	1.44	1.01	1.37
CDD/CDF	1.2E-04	3.7E-05	6.5E-05	2.6E-05	7.4E-06	7.4E-06	2.9E-07
Hg	9.6E-02	2.9E-02	5.2E-02	2.1E-02	5.9E-03	3.1E-03	9.1E-05
Total fabric filter ash with carbon	30.66	9.39	16.64	6.66	1.89	1.08	1.53
SD/FF							
PM	7.10	2.18	3.86	1.54	0.44	5.8E-02	0.16
CDD/CDF	0	0	0	0	0	0	0
CaCl2	110.48	33.83	59.97	23.99	6.81	0.66	0.53
Pb	0.14	4.2E-02	7.5E-02	3.0E-02	8.5E-03	4.7E-03	7.5E-04
Cd	9.9E-03	3.0E-03	5.4E-03	2.2E-03	6.1E-04	1.7E-04	1.9E-04
Hg	0	0	0	0	0	0	0
Unreacted lime (no SO2 removal)	119.96	36.73	65.11	26.05	7.40	0.71	0.58
Total fabric filter ash no carbon	237.69	72.79	129.02	51.61	14.66	1.44	1.28
Addition of carbon							
carbon (c)	12.98	3.97	7.04	2.82	0.80	0.56	0.76
CDD/CDF (additional)	1.5E-05	4.6E-06	8.1E-06	3.2E-06	9.2E-07	9.2E-07	3.6E-08
Hg	9.6E-02	2.9E-02	5.2E-02	2.1E-02	5.9E-03	3.1E-03	9.1E-05
Total fabric filter ash with carbon	250.77	76.79	136.11	54.45	15.46	2.00	2.04

(a) Actual exhaust gas flow rate out of the incinerator, at 14 percent O2.

(b) An activated carbon concentration of 338 mg/dscm (0.0000211 lb/dscf) is used for the DI/FF and FF/PB, based on emission test data from Facility A, which uses a DI/FF.

(c) An activated carbon concentration of 188 mg/dscm (0.0000117 lb/dscf) is used for the SD/FF, based on emission test data from Facility M, which uses an SD/FF.

TABLE 14. ANNUAL NATIONWIDE AMOUNT OF WASTE BURNED AND FLY ASH GENERATED BY EACH NEW MODEL PLANT WITH FABRIC FILTER SYSTEMS WITH AND WITHOUT CARBON INJECTION

Parameters\model combustors	Continuous models		Intermittent models			Batch model	Path. model
Capacity, lb/hr or batch	1,500	1,000	1,500	600	200	500	200
Exhaust flow rate, dscfm (a)	4,747	3,165	4,747	1,899	633	455	730
Operating hours, hr/yr	7,760	3,564	4,212	4,212	3,588	3,520	2,964
Number of plants	77	60	20	95	280	165	5
Waste incinerated, ton/yr	300,839	58,620	23,520	44,650	32,200	4,455	860
Pollutant capture per APCD, ton/yr							
DI/FF							
PM	547.03	130.53	77.12	146.55	122.65	9.63	0.81
CDD/CDF	0	0	0	0	0	0	0
CaCl2	8,507.03	2,029.87	1,199.34	2,278.99	1,907.31	108.57	2.67
Pb	10.67	2.55	1.50	2.86	2.39	0.78	3.8E-03
Cd	0.76	0.18	0.11	0.20	0.17	2.9E-02	9.7E-04
Hg	0	0	0	0	0	0	0
Unreacted lime (no SO2 removal)	9,236.91	2,204.03	1,302.24	2,474.53	2,070.95	117.89	2.90
Total fabric filter ash no carbon	18,302.40	4,367.16	2,580.32	4,903.13	4,103.46	236.89	6.38
Addition of carbon							
carbon (b)	1,794.70	428.24	253.02	480.79	402.38	167.21	6.85
CDD/CDF	1.1E-03	2.7E-04	1.6E-04	3.1E-04	2.6E-04	1.5E-04	1.8E-07
Hg	7.41	1.77	1.04	1.99	1.66	0.51	4.6E-04
Total fabric filter ash with carbon	20,104.51	4,797.16	2,834.39	5,385.91	4,507.50	404.61	13.22
FF/PB							
PM	547.03	130.53	77.12	146.55	122.65	9.63	0.81
CDD/CDF	0	0	0	0	0	0	0
Pb	10.67	2.55	1.50	2.86	2.39	0.78	3.8E-03
Cd	0.76	0.18	0.11	0.20	0.17	2.9E-02	9.7E-04
Hg	0	0	0	0	0	0	0
Total fabric filter ash no carbon	558.46	133.26	78.73	149.61	125.21	10.43	0.82
Addition of carbon							
carbon (b)	1,794.70	428.24	253.02	480.79	402.38	167.21	6.85
CDD/CDF	9.2E-03	2.2E-03	1.3E-03	2.5E-03	2.1E-03	1.2E-03	1.4E-06
Hg	7.41	1.77	1.04	1.99	1.66	0.51	4.6E-04
Total fabric filter ash with carbon	2,360.58	563.26	332.80	632.39	529.25	178.15	7.66
SD/FF							
PM	547.03	130.53	77.12	146.55	122.65	9.63	0.81
CDD/CDF	0	0	0	0	0	0	0
CaCl2	8,507.03	2,029.87	1,199.34	2,278.99	1,907.31	108.57	2.67
Pb	10.67	2.55	1.50	2.86	2.39	0.78	3.8E-03
Cd	0.76	0.18	0.11	0.20	0.17	2.9E-02	9.7E-04
Hg	0	0	0	0	0	0	0
Unreacted lime (no SO2 removal)	9,236.91	2,204.03	1,302.24	2,474.53	2,070.95	117.89	2.90
Total fabric filter ash no carbon	18,302.40	4,367.16	2,580.32	4,903.13	4,103.46	236.89	6.38
Addition of carbon							
carbon (c)	999.27	238.44	140.88	267.70	224.04	93.10	3.81
CDD/CDF (additional)	1.1E-03	2.7E-04	1.6E-04	3.1E-04	2.6E-04	1.5E-04	1.8E-07
Hg	7.41	1.77	1.04	1.99	1.66	0.51	4.6E-04
Total fabric filter ash with carbon	19,309.08	4,607.36	2,722.25	5,172.81	4,329.16	330.50	10.19

(a) Actual exhaust gas flow rate out of the incinerator, at 14 percent O2.
(b) An activated carbon concentration of 338 mg/dscm (0.0000211 lb/dscf) is used for the DI/FF and FF/PB, based on emission test data from Facility A, which uses a DI/FF.
(c) An activated carbon concentration of 188 mg/dscm (0.0000117 lb/dscf) is used for the SD/FF, based on emission test data from Facility M, which uses an SD/FF.

TABLE 15. FACILITY A BAGHOUSE ASH ANALYSIS

Pollutants, units	Concentration
Total, CDD/CDF, ng/g	29.28
Arsenic, μg/g	12.03
Cadmium, μg/g	44.43
Chromium, μg/g	23.43
Iron, μg/g	715.71
Lead, μg/g	582.86
Manganese, μg/g	33.71
Mercury, μg/g	5.64
Nickel, μg/g	6.37
Total metals, μg/g	1,424.29

TABLE 16. FACILITY A METALS CONCENTRATION OF LIME, μg/g

Pollutants	Concentration
Arsenic	1.8
Cadmium	1.0
Chromium	16.0
Iron	480
Lead	6.1
Manganese	21.0
Mercury	0.03
Nickel	4.5

TABLE 17. TCLP RULE ALLOWABLE POLLUTANT CONCENTRATIONS IN LEACHATE

Pollutants	Concentration, mg/ℓ
Arsenic	5.0
Cadmium	1.0
Chromium	5.0
Lead	5.0
Mercury	0.2

TABLE 18. ANNUAL ENERGY REQUIREMENTS TO OPERATE CONTROL EQUIPMENT FOR EACH NEW MODEL PLANT

Model plants	Fuel Usage, mmft3/yr	Electricity Usage, Mwh/yr
I. Continuous MWI's		
A. 1,500 lb/hr		
a. Baseline	10.3	173.5
b. 2-sec combustion	16.6	173.5
c. Wet systems	16.6	837.8
d. FF/PB (a)	16.6	525.6
e. DI/FF (a)	16.6	412.2
f. SD/FF (a)	16.6	412.2
B. 1,000 lb/hr		
a. Baseline	5.14	65.1
b. 2-sec combustion	7.13	65.1
c. Wet systems	7.13	281.5
d. FF/PB (a)	7.13	180.5
e. DI/FF (a)	7.13	144.6
f. SD/FF (a)	7.13	144.6
II. Intermittent MWI's		
A. 1,500 lb/hr		
a. Baseline	5.86	54.8
b. 2-sec combustion	8.87	54.8
c. Wet systems	8.87	427.9
d. FF/PB (a)	8.87	252.6
e. DI/FF (a)	8.87	188.9
f. SD/FF (a)	8.87	188.9
B. 600 lb/hr		
a. Baseline	2.89	25.2
b. 2-sec combustion	4.10	25.2
c. Wet systems	4.10	183.4
d. FF/PB (a)	4.10	110.6
e. DI/FF (a)	4.10	85.7
f. SD/FF (a)	4.10	85.7
C. 200 lb/hr		
a. Baseline	1.40	10.3
b. 2-sec combustion	1.73	10.3
c. Wet systems	1.73	64.0
d. FF/PB (a)	1.73	40.6
e. DI/FF (a)	1.73	34.1
f. SD/FF (a)	1.73	34.1
III. Batch MWI's		
A. 500 lb/batch		
a. Baseline	1.81	2.73
b. 2-sec combustion	1.97	2.73
c. Wet systems	1.97	43.26
d. FF/PB (a)	1.97	26.09
e. DI/FF (a)	1.97	21.85
f. SD/FF (a)	1.97	21.85
IV. Pathological MWI's		
A. 200 lb/hr		
a. Baseline	2.65	8.6
b. 2-sec combustion	3.04	8.6
c. Wet systems	3.04	58.55
d. FF/PB (a)	3.04	36.60
e. DI/FF (a)	3.04	30.25
f. SD/FF (a)	3.04	30.25

(a) Values apply to the system both with and without activated carbon injection.

TABLE 19. ANNUAL NATIONWIDE ENERGY REQUIREMENTS TO OPERATE CONTROL EQUIPMENT FOR EACH NEW MODEL PLANT

Model plants	Number of Facilities	Fuel Usage, mmft3/yr	Electricity Usage, Mwh/yr
I. Continuous MWI's			
A. 1,500 lb/hr	77		
a. Baseline		795	13,360
b. 2-sec combustion		1,277	13,360
c. Wet systems		1,277	64,507
d. FF/PB (a)		1,277	40,472
e. DI/FF (a)		1,277	31,738
f. SD/FF (a)		1,277	31,738
B. 1,000 lb/hr	60		
a. Baseline		308	3,905
b. 2-sec combustion		428	3,905
c. Wet systems		428	16,890
d. FF/PB (a)		428	10,831
e. DI/FF (a)		428	8,675
f. SD/FF (a)		428	8,675
II. Intermittent MWI's			
A. 1,500 lb/hr	20		
a. Baseline		117	1,096
b. 2-sec combustion		177	1,096
c. Wet systems		177	8,559
d. FF/PB (a)		177	5,052
e. DI/FF (a)		177	3,778
f. SD/FF (a)		177	3,778
B. 600 lb/hr	95		
a. Baseline		275	2,394
b. 2-sec combustion		389	2,394
c. Wet systems		389	17,420
d. FF/PB (a)		389	10,503
e. DI/FF (a)		389	8,142
f. SD/FF (a)		389	8,142
C. 200 lb/hr	280		
a. Baseline		392	2,890
b. 2-sec combustion		486	2,890
c. Wet systems		486	17,917
d. FF/PB (a)		486	11,380
e. DI/FF (a)		486	9,562
f. SD/FF (a)		486	9,562
I. Batch MWI's			
A. 500 lb/batch	165		
a. Baseline		299	450
b. 2-sec combustion		324	450
c. Wet systems		324	7,137
d. FF/PB (a)		324	4,304
e. DI/FF (a)		324	3,604
f. SD/FF (a)		324	3,604
IV. Pathological MWI's			
A. 200 lb/hr	5		
a. Baseline		13	43
b. 2-sec combustion		15	43
c. Wet systems		15	293
d. FF/PB (a)		15	183
e. DI/FF (a)		15	151
f. SD/FF (a)		15	151

(a) Values apply to the system both with and without activated carbon injection.

TABLE 20. SUMMARY OF MODEL COMBUSTORS FOR EXISTING MWI MODEL PLANTS

MWI type	Model design capacity, lb/hr of batch	No. of units	Secondary chamber gas residence time, sec	Exhaust gas flow rate, dscfm[a]	Operating parameters			Applicable industries
					Total, hr/d	d/yr	hr/yr[b]	
Continuous	1,500	154	1	4,747	24	324	7,760	C
Continuous	1,000	182	0.25	3,165	11.5	324	3,564	H,L
Intermittent	1,500	171	0.25	4,747	14	312	4,212	H,N,L,V
Intermittent	600	742	0.25	1,899	14	312	4,212	H,N,L,V
Intermittent	200	2,097	0.25	633	12	312	3,588	H,N,L,V
Batch	500	335	0.25	455	22.5	160	3,520	H
Pathological	200	1,305	0.25	730	10	312	2,964	H,N,L,V

[a]Actual exhaust gas flow rate out of the incinerator, at 14 percent O_2.

[b]Includes charging and burndown hours but not preheat hours for the intermittent and continuous units. Preheat hours are estimated to be 0.5 hr at the beginning of each cycle. For the continuous units it is assumed that there are 26 cycles per year. Also includes cooldown hours for the batch and intermittent units. Cooldown hours are estimated to be 10 hr/d for batch units and 2 hr/d for intermittent units.

TABLE 21. POLLUTANT CONCENTRATIONS FOR EXISTING MWI's

	Pollutant Concentrations at 7 percent O_2								
	PM gr/dscf	CO, ppmdv	CDD/CDF, ng/dscm	HCL, ppmdv	SO_2, ppmdv	NO_x, ppmdv	Pb, μg/dscm	Cd, μg/dscm	Hg, μg/dscm
Continuous and Intermittent MWI's									
Baseline (1/4 sec)	0.3	700	18,300	1,460	16	140	4,100	300	3,100
1-sec combustion/baseline (1 sec)[a]	0.16	300	4,500	1,460	16	140	4,100	300	3,100
2-sec combustion	0.10	16	440	1,460	16	140	4,100	300	3,100
Wet systems	0.05	16	132	74	16	140	2,255	180	3,100
FF/PB no carbon	0.01	16	3,482	74	16	140	82	12	3,100
DI/FF no carbon	0.01	16	440	74	16	140	82	12	3,100
SD/FF no carbon	0.01	16	440	74	16	140	82	12	3,100
FF systems with carbon[b]	0.01	16	9	74	16	140	82	12	310
Batch MWI's									
Baseline (1/4 sec)	0.082	466	25,994	200	20	86	3,200	120	2,300
1-sec combustion	0.044	200	6,392	200	20	86	3,200	120	2,300
2-sec combustion	0.027	10	625	200	20	86	3,200	120	2,300
Wet systems	0.015	10	188	10	20	86	1,760	72	2,300
FF/PB no carbon	0.01	10	4,948	10	20	86	64	5	2,300
DI/FF no carbon	0.01	10	625	10	20	86	64	5	2,300
SD/FF no carbon	0.01	10	625	10	20	86	64	5	2,300
FF systems with carbon[b]	0.01	10	13	10	20	86	64	5	230
Pathological MWI's									
Baseline (1/4 sec)	0.045	110	750	120	110	350	380	100	50
1-sec combustion	0.045	48	184	120	110	350	380	100	50
2-sec combustion	0.045	2	18	120	110	350	380	100	50
Wet systems	0.023	2	5	6	110	350	210	60	50
FF/PB no carbon	0.01	2	143	6	110	350	8	4	50
DI/FF no carbon	0.01	2	18	6	110	350	8	4	50
SD/FF no carbon	0.01	2	18	6	110	350	8	4	50
FF systems with carbon[b]	0.01	2	0.36	6	110	350	8	4	5

[a]Baseline applies to the 1,500 lb/hr continuous model plant only.
[b]The performance of FF/PB systems with carbon is unknown.

TABLE 22. ANNUAL PRIMARY EMISSIONS FOR EACH EXISTING MODEL PLANT

Parameters\model combustors	Continuous models		Intermittent models			Batch model	Path. model
Capacity, lb/hr or batch	1,500	1,000	1,500	600	200	500	200
Exhaust flow rate, dscfm (a)	4,747	3,165	4,747	1,899	633	455	730
Operating hours, hr/yr	7,760	3,564	4,212	4,212	3,588	3,520	2,964
Pollutant, ton/yr							
PM							
1/4-sec (b)		7.25	12.85	5.14	1.46	0.28	0.21
1-sec (c)	12.63	3.87	6.86	2.74	0.78	0.15	0.21
2-sec	7.89	2.42	4.28	1.71	0.49	9.3E-02	0.21
Wet systems	3.95	1.21	2.14	0.86	0.24	5.1E-02	0.10
FF/PB no carbon	0.79	0.24	0.43	0.17	4.9E-02	3.4E-02	4.6E-02
DI/FF no carbon	0.79	0.24	0.43	0.17	4.9E-02	3.4E-02	4.6E-02
SD/FF no carbon	0.79	0.24	0.43	0.17	4.9E-02	3.4E-02	4.6E-02
FF systems with carbon (d)	0.79	0.24	0.43	0.17	4.9E-02	3.4E-02	4.6E-02
CO							
1/4-sec (b)		8.61	15.26	6.10	1.73	0.81	0.26
1-sec (c)	12.05	3.69	6.54	2.62	0.74	0.35	0.11
2-sec	0.60	0.18	0.33	0.13	3.7E-02	1.7E-02	5.6E-03
Wet systems	0.60	0.18	0.33	0.13	3.7E-02	1.7E-02	5.6E-03
FF/PB no carbon	0.60	0.18	0.33	0.13	3.7E-02	1.7E-02	5.6E-03
DI/FF no carbon	0.60	0.18	0.33	0.13	3.7E-02	1.7E-02	5.6E-03
SD/FF no carbon	0.60	0.18	0.33	0.13	3.7E-02	1.7E-02	5.6E-03
FF systems with carbon (d)	0.60	0.18	0.33	0.13	3.7E-02	1.7E-02	5.6E-03
CDD/CDF							
1/4-sec (b)		1.9E-04	3.4E-04	1.4E-04	3.9E-05	3.9E-05	1.5E-06
1-sec (c)	1.6E-04	4.8E-05	8.4E-05	3.4E-05	9.6E-06	9.6E-06	3.7E-07
2-sec	1.5E-05	4.6E-06	8.2E-06	3.3E-06	9.4E-07	9.4E-07	3.7E-08
Wet systems	4.6E-06	1.4E-06	2.5E-06	9.9E-07	2.8E-07	2.8E-07	1.1E-08
FF/PB no carbon	1.2E-04	3.7E-05	6.5E-05	2.6E-05	7.4E-06	7.4E-06	2.9E-07
DI/FF no carbon	1.5E-05	4.6E-06	8.2E-06	3.3E-06	9.4E-07	9.4E-07	3.7E-08
SD/FF no carbon	1.5E-05	4.6E-06	8.2E-06	3.3E-06	9.4E-07	9.4E-07	3.7E-08
FF systems with carbon (d), (e)	3.0E-07	9.3E-08	1.6E-07	6.6E-08	1.9E-08	1.9E-08	7.3E-10
HCl							
1/4-sec (b)		23.37	41.43	16.57	4.71	0.45	0.37
1-sec (c)	76.33	23.37	41.43	16.57	4.71	0.45	0.37
2-sec	76.33	23.37	41.43	16.57	4.71	0.45	0.37
Wet systems	3.82	1.17	2.07	0.83	0.24	2.3E-02	1.8E-02
FF/PB no carbon	3.82	1.17	2.07	0.83	0.24	2.3E-02	1.8E-02
DI/FF no carbon	3.82	1.17	2.07	0.83	0.24	2.3E-02	1.8E-02
SD/FF no carbon	3.82	1.17	2.07	0.83	0.24	2.3E-02	1.8E-02
FF systems with carbon (d)	3.82	1.17	2.07	0.83	0.24	2.3E-02	1.8E-02
SO2							
1/4-sec (b)		0.42	0.75	0.30	8.5E-02	8.0E-02	0.59
1-sec (c)	1.38	0.42	0.75	0.30	8.5E-02	8.0E-02	0.59
2-sec	1.38	0.42	0.75	0.30	8.5E-02	8.0E-02	0.59
Wet systems	1.38	0.42	0.75	0.30	8.5E-02	8.0E-02	0.59
FF/PB no carbon	1.38	0.42	0.75	0.30	8.5E-02	8.0E-02	0.59
DI/FF no carbon	1.38	0.42	0.75	0.30	8.5E-02	8.0E-02	0.59
SD/FF no carbon	1.38	0.42	0.75	0.30	8.5E-02	8.0E-02	0.59
FF systems with carbon (d)	1.38	0.42	0.75	0.30	8.5E-02	8.0E-02	0.59

TABLE 22. (continued)

Parameters\model combustors	Continuous models		Intermittent models			Batch model	Path. model
Capacity, lb/hr or batch	1,500	1,000	1,500	600	200	500	200
Exhaust flow rate, dscfm (a)	4,747	3,165	4,747	1,899	633	455	730
Operating hours, hr/yr	7,760	3,564	4,212	4,212	3,588	3,520	2,964
Pollutant, ton/yr							
NOx							
1/4-sec (b)		2.83	5.01	2.01	0.57	0.24	1.36
1-sec (c)	9.24	2.83	5.01	2.01	0.57	0.24	1.36
2-sec	9.24	2.83	5.01	2.01	0.57	0.24	1.36
Wet systems	9.24	2.83	5.01	2.01	0.57	0.24	1.36
FF/PB no carbon	9.24	2.83	5.01	2.01	0.57	0.24	1.36
DI/FF no carbon	9.24	2.83	5.01	2.01	0.57	0.24	1.36
SD/FF no carbon	9.24	2.83	5.01	2.01	0.57	0.24	1.36
FF systems with carbon (d)	9.24	2.83	5.01	2.01	0.57	0.24	1.36
Pb							
1/4-sec (b)		4.3E-02	7.7E-02	3.1E-02	8.7E-03	4.8E-03	7.7E-04
1-sec (c)	0.14	4.3E-02	7.7E-02	3.1E-02	8.7E-03	4.8E-03	7.7E-04
2-sec	0.14	4.3E-02	7.7E-02	3.1E-02	8.7E-03	4.8E-03	7.7E-04
Wet systems	7.8E-02	2.4E-02	4.2E-02	1.7E-02	4.8E-03	2.6E-03	4.2E-04
FF/PB no carbon	2.8E-03	8.7E-04	1.5E-03	6.1E-04	1.7E-04	9.6E-05	1.5E-05
DI/FF no carbon	2.8E-03	8.7E-04	1.5E-03	6.1E-04	1.7E-04	9.6E-05	1.5E-05
SD/FF no carbon	2.8E-03	8.7E-04	1.5E-03	6.1E-04	1.7E-04	9.6E-05	1.5E-05
FF systems with carbon (d)	2.8E-03	8.7E-04	1.5E-03	6.1E-04	1.7E-04	9.6E-05	1.5E-05
Cd							
1/4-sec (b)		3.2E-03	5.6E-03	2.2E-03	6.4E-04	1.8E-04	2.0E-04
1-sec (c)	1.0E-02	3.2E-03	5.6E-03	2.2E-03	6.4E-04	1.8E-04	2.0E-04
2-sec	1.0E-02	3.2E-03	5.6E-03	2.2E-03	6.4E-04	1.8E-04	2.0E-04
Wet systems	6.2E-03	1.9E-03	3.4E-03	1.3E-03	3.8E-04	1.1E-04	1.2E-04
FF/PB no carbon	4.1E-04	1.3E-04	2.2E-04	9.0E-05	2.6E-05	7.2E-06	8.1E-06
DI/FF no carbon	4.1E-04	1.3E-04	2.2E-04	9.0E-05	2.6E-05	7.2E-06	8.1E-06
SD/FF no carbon	4.1E-04	1.3E-04	2.2E-04	9.0E-05	2.6E-05	7.2E-06	8.1E-06
FF systems with carbon (d)	4.1E-04	1.3E-04	2.2E-04	9.0E-05	2.6E-05	7.2E-06	8.1E-06
Hg							
1/4-sec (b)		3.3E-02	5.8E-02	2.3E-02	6.6E-03	3.4E-03	1.0E-04
1-sec (c)	0.11	3.3E-02	5.8E-02	2.3E-02	6.6E-03	3.4E-03	1.0E-04
2-sec	0.11	3.3E-02	5.8E-02	2.3E-02	6.6E-03	3.4E-03	1.0E-04
Wet systems	0.11	3.3E-02	5.8E-02	2.3E-02	6.6E-03	3.4E-03	1.0E-04
FF/PB no carbon	0.11	3.3E-02	5.8E-02	2.3E-02	6.6E-03	3.4E-03	1.0E-04
DI/FF no carbon	0.11	3.3E-02	5.8E-02	2.3E-02	6.6E-03	3.4E-03	1.0E-04
SD/FF no carbon	0.11	3.3E-02	5.8E-02	2.3E-02	6.6E-03	3.4E-03	1.0E-04
FF systems with carbon (d)	1.1E-02	3.3E-03	5.8E-03	2.3E-03	6.6E-04	3.4E-04	1.0E-05

(a) Actual exhaust gas flow rate out of the incinerator, at 14 percent O2.
(b) Baseline for all models except the 1,500 lb/hr continuous model.
(c) Baseline for the 1,500 lb/hr continuous model.
(d) Activated carbon concentration is 338 mg/dscm (0.0000211 lb/dscf) for the DI/FF and 188 mg/dscm (0.0000117 lb/dscf) for the SD/FF, based on emission test data from Facility A, which uses a DI/FF, and Facility M, which uses an SD/FF.
(e) The performance of the FF/PB with activated carbon injection in reducing CDD/CDF is unknown.

TABLE 23. ANNUAL NATIONWIDE PRIMARY EMISSIONS FOR EACH EXISTING MODEL PLANT

Parameters\model combustors	Continuous models		Intermittent models			Batch model	Path. model
Capacity, lb/hr or batch	1,500	1,000	1,500	600	200	500	200
Exhaust flow rate, dscfm (a)	4,747	3,165	4,747	1,899	633	455	730
Operating hours, hr/yr	7,760	3,564	4,212	4,212	3,588	3,520	2,964
Number of plants	154	182	171	742	2,097	335	1,305
Pollutant, ton/yr							
PM							
1/4-sec (b)		1,319.77	2,197.95	3,815.33	3,061.75	93.13	272.28
1-sec (c)	1,944.98	703.88	1,172.24	2,034.84	1,632.93	49.67	272.28
2-sec	1,215.61	439.92	732.65	1,271.78	1,020.58	31.04	272.28
Wet systems	607.81	219.96	366.33	635.89	510.29	17.25	136.14
FF/PB no carbon	121.56	43.99	73.27	127.18	102.06	11.50	60.51
DI/FF no carbon	121.56	43.99	73.27	127.18	102.06	11.50	60.51
SD/FF no carbon	121.56	43.99	73.27	127.18	102.06	11.50	60.51
FF systems with carbon (d)	121.56	43.99	73.27	127.18	102.06	11.50	60.51
CO							
1/4-sec (b)		1,566.89	2,609.51	4,529.74	3,635.05	273.00	338.66
1-sec (c)	1,855.58	671.52	1,118.36	1,941.32	1,557.88	117.00	145.14
2-sec	92.78	33.58	55.92	97.07	77.89	5.85	7.26
Wet systems	92.78	33.58	55.92	97.07	77.89	5.85	7.26
FF/PB no carbon	92.78	33.58	55.92	97.07	77.89	5.85	7.26
DI/FF no carbon	92.78	33.58	55.92	97.07	77.89	5.85	7.26
SD/FF no carbon	92.78	33.58	55.92	97.07	77.89	5.85	7.26
FF systems with carbon (d)	92.78	33.58	55.92	97.07	77.89	5.85	7.26
CDD/CDF							
1/4-sec (b)		3.5E-02	5.9E-02	0.10	8.2E-02	1.3E-02	2.0E-03
1-sec (c)	2.4E-02	8.7E-03	1.4E-02	2.5E-02	2.0E-02	3.2E-03	4.9E-04
2-sec	2.3E-03	8.5E-04	1.4E-03	2.4E-03	2.0E-03	3.1E-04	4.8E-05
Wet systems	7.0E-04	2.5E-04	4.2E-04	7.3E-04	5.9E-04	9.4E-05	1.4E-05
FF/PB no carbon	1.9E-02	6.7E-03	1.1E-02	1.9E-02	1.6E-02	2.5E-03	3.8E-04
DI/FF no carbon	2.3E-03	8.5E-04	1.4E-03	2.4E-03	2.0E-03	3.1E-04	4.8E-05
SD/FF no carbon	2.3E-03	8.5E-04	1.4E-03	2.4E-03	2.0E-03	3.1E-04	4.8E-05
FF systems with carbon (d), (e)	4.7E-05	1.7E-05	2.8E-05	4.9E-05	3.9E-05	6.3E-06	9.5E-07
HCl							
1/4-sec (b)		4,253.99	7,084.64	12,297.91	9,868.90	152.30	480.90
1-sec (c)	11,754.81	4,253.99	7,084.64	12,297.91	9,868.90	152.30	480.90
2-sec	11,754.81	4,253.99	7,084.64	12,297.91	9,868.90	152.30	480.90
Wet systems	587.74	212.70	354.23	614.90	493.44	7.61	24.04
FF/PB no carbon	587.74	212.70	354.23	614.90	493.44	7.61	24.04
DI/FF no carbon	587.74	212.70	354.23	614.90	493.44	7.61	24.04
SD/FF no carbon	587.74	212.70	354.23	614.90	493.44	7.61	24.04
FF systems with carbon (d)	587.74	212.70	354.23	614.90	493.44	7.61	24.04
SO2							
1/4-sec (b)		76.80	127.91	222.03	178.17	26.76	774.65
1-sec (c)	212.22	76.80	127.91	222.03	178.17	26.76	774.65
2-sec	212.22	76.80	127.91	222.03	178.17	26.76	774.65
Wet systems	212.22	76.80	127.91	222.03	178.17	26.76	774.65
FF/PB no carbon	212.22	76.80	127.91	222.03	178.17	26.76	774.65
DI/FF no carbon	212.22	76.80	127.91	222.03	178.17	26.76	774.65
SD/FF no carbon	212.22	76.80	127.91	222.03	178.17	26.76	774.65
FF systems with carbon (d)	212.22	76.80	127.91	222.03	178.17	26.76	774.65

TABLE 23. (continued)

Parameters\model combustors	Continuous models		Intermittent models			Batch model	Path. model
Capacity, lb/hr or batch	1,500	1,000	1,500	600	200	500	200
Exhaust flow rate, dscfm (a)	4,747	3,165	4,747	1,899	633	455	730
Operating hours, hr/yr	7,760	3,564	4,212	4,212	3,588	3,520	2,964
Number of plants	154	182	171	742	2,097	335	1,305
Pollutant, ton/yr							
NOx							
1/4-sec (b)		514.76	857.29	1,488.13	1,194.21	81.68	1,770.01
1-sec (c)	1,422.42	514.76	857.29	1,488.13	1,194.21	81.68	1,770.01
2-sec	1,422.42	514.76	857.29	1,488.13	1,194.21	81.68	1,770.01
Wet systems	1,422.42	514.76	857.29	1,488.13	1,194.21	81.68	1,770.01
FF/PB no carbon	1,422.42	514.76	857.29	1,488.13	1,194.21	81.68	1,770.01
DI/FF no carbon	1,422.42	514.76	857.29	1,488.13	1,194.21	81.68	1,770.01
SD/FF no carbon	1,422.42	514.76	857.29	1,488.13	1,194.21	81.68	1,770.01
FF systems with carbon (d)	1,422.42	514.76	857.29	1,488.13	1,194.21	81.68	1,770.01
Pb							
1/4-sec (b)		7.88	13.13	22.79	18.29	1.61	1.00
1-sec (c)	21.78	7.88	13.13	22.79	18.29	1.61	1.00
2-sec	21.78	7.88	13.13	22.79	18.29	1.61	1.00
Wet systems	11.98	4.34	7.22	12.53	10.06	0.88	0.55
FF/PB no carbon	0.44	0.16	0.26	0.46	0.37	3.2E-02	2.0E-02
DI/FF no carbon	0.44	0.16	0.26	0.46	0.37	3.2E-02	2.0E-02
SD/FF no carbon	0.44	0.16	0.26	0.46	0.37	3.2E-02	2.0E-02
FF systems with carbon (d)	0.44	0.16	0.26	0.46	0.37	3.2E-02	2.0E-02
Cd							
1/4-sec (b)		0.58	0.96	1.67	1.34	6.0E-02	0.26
1-sec (c)	1.59	0.58	0.96	1.67	1.34	6.0E-02	0.26
2-sec	1.59	0.58	0.96	1.67	1.34	6.0E-02	0.26
Wet systems	0.96	0.35	0.58	1.00	0.80	3.6E-02	0.16
FF/PB no carbon	6.4E-02	2.3E-02	3.8E-02	6.7E-02	5.4E-02	2.4E-03	1.1E-02
DI/FF no carbon	6.4E-02	2.3E-02	3.8E-02	6.7E-02	5.4E-02	2.4E-03	1.1E-02
SD/FF no carbon	6.4E-02	2.3E-02	3.8E-02	6.7E-02	5.4E-02	2.4E-03	1.1E-02
FF systems with carbon (d)	6.4E-02	2.3E-02	3.8E-02	6.7E-02	5.4E-02	2.4E-03	1.1E-02
Hg							
1/4-sec (b)		5.96	9.93	17.23	13.83	1.16	0.13
1-sec (c)	16.47	5.96	9.93	17.23	13.83	1.16	0.13
2-sec	16.47	5.96	9.93	17.23	13.83	1.16	0.13
Wet systems	16.47	5.96	9.93	17.23	13.83	1.16	0.13
FF/PB no carbon	16.47	5.96	9.93	17.23	13.83	1.16	0.13
DI/FF no carbon	16.47	5.96	9.93	17.23	13.83	1.16	0.13
SD/FF no carbon	16.47	5.96	9.93	17.23	13.83	1.16	0.13
FF systems with carbon (d)	1.65	0.60	0.99	1.72	1.38	0.12	1.3E-02

(a) Actual exhaust gas flow rate out of the incinerator, at 14 percent O_2.
(b) Baseline for all models except the 1,500 lb/hr continuous model.
(c) Baseline for the 1,500 lb/hr model.
(d) Activated carbon concentration is 338 mg/dscm (0.0000211 lb/dscf) for the DI/FF and 188 mg/dscm (0.0000117 lb/dscf) for the SD/FF, based on emission test data from Facility A, which uses a DI/FF, and Facility M, which uses an SD/FF.
(e) The performance of the FF/PB with activated carbon injection in reducing CDD/CDF is unknown.

TABLE 24. ANNUAL SECONDARY EMISSIONS FOR EACH EXISTING MODEL PLANT

Parameters\model combustors	Continuous models		Intermittent models			Batch model	Path. model
Capacity, lb/hr or batch	1,500	1,000	1,500	600	200	500	200
Exhaust flow rate, dscfm (a)	4,747	3,165	4,747	1,899	633	455	730
Operating hours, hr/yr	7,776	3,726	4,368	4,368	3,744	3,600	3,120
Pollutant, ton/yr							
PM							
Baseline (b)	0	0	0	0	0	0	0
2-sec combustion	0	0	0	0	0	0	0
Wet systems	9.0E-02	2.9E-02	5.0E-02	2.1E-02	7.2E-03	5.5E-03	6.7E-03
FF/PB (c)	4.7E-02	1.6E-02	2.7E-02	1.2E-02	4.1E-03	3.1E-03	3.8E-03
DI/FF (c)	3.2E-02	1.1E-02	1.8E-02	8.2E-03	3.2E-03	2.6E-03	2.9E-03
SD/FF (c)	3.2E-02	1.1E-02	1.8E-02	8.2E-03	3.2E-03	2.6E-03	2.9E-03
SO2							
Baseline (b)	0	0	0	0	0	0	0
2-sec combustion	0	0	0	0	0	0	0
Wet systems	1.79	0.58	1.01	0.43	0.14	0.11	0.13
FF/PB (c)	0.95	0.31	0.53	0.23	8.2E-02	6.3E-02	7.5E-02
DI/FF (c)	0.64	0.21	0.36	0.16	6.4E-02	5.2E-02	5.8E-02
SD/FF (c)	0.64	0.21	0.36	0.16	6.4E-02	5.2E-02	5.8E-02
NOx							
Baseline (b)	0	0	0	0	0	0	0
2-sec combustion	0	0	0	0	0	0	0
Wet systems	1.79	0.58	1.01	0.43	0.14	0.11	0.13
FF/PB (c)	0.95	0.31	0.53	0.23	8.2E-02	6.3E-02	7.5E-02
DI/FF (c)	0.64	0.21	0.36	0.16	6.4E-02	5.2E-02	5.8E-02
SD/FF (c)	0.64	0.21	0.36	0.16	6.4E-02	5.2E-02	5.8E-02

(a) Actual exhaust gas flow rate out of the incinerator, at 14 percent O2.
(b) Baseline numbers apply to both units with 0.25-sec secondary chamber residence times and units with 1-sec secondary chamber residence times.
(c) Values apply to the system both with and without activated carbon injection.

TABLE 25. ANNUAL NATIONWIDE SECONDARY EMISSIONS FOR EACH EXISTING MODEL PLANT

Parameters\model combustors	Continuous models		Intermittent models			Batch model	Path. model
Capacity, lb/hr or batch	1,500	1,000	1,500	600	200	500	200
Exhaust flow rate, dscfm (a)	4,747	3,165	4,747	1,899	633	455	730
Operating hours, hr/yr	7,776	3,726	4,368	4,368	3,744	3,600	3,120
Number of plants	154	182	171	742	2,097	335	1,305
Pollutant, ton/yr							
PM							
Baseline (b)	0	0	0	0	0	0	0
2-sec combustion	0	0	0	0	0	0	0
Wet systems	14	5.3	8.6	16	15	1.8	8.8
FF/PB (c)	7.3	2.8	4.6	8.5	8.6	1.1	4.9
DI/FF (c)	5.0	2.0	3.1	6.1	6.7	0.86	3.8
SD/FF (c)	5.0	2.0	3.1	6.1	6.7	0.86	3.8
SO2							
Baseline (b)	0	0	0	0	0	0	0
2-sec combustion	0	0	0	0	0	0	0
Wet systems	276	106	172	316	303	37	176
FF/PB (c)	146	57	91	171	171	21	99
DI/FF (c)	99	39	62	121	135	17	76
SD/FF (c)	99	39	62	121	135	17	76
NOx							
Baseline (b)	0	0	0	0	0	0	0
2-sec combustion	0	0	0	0	0	0	0
Wet systems	276	106	172	316	303	37	176
FF/PB (c)	146	57	91	171	171	21	99
DI/FF (c)	99	39	62	121	135	17	76
SD/FF (c)	99	39	62	121	135	17	76

(a) Actual exhaust gas flow rate out of the incinerator, at 14 percent O2.
(b) Baseline numbers apply to both units with 0.25-sec secondary chamber residence times and units with 1-sec secondary chamber residence times.
(c) Values apply to the system both with and without activated carbon injection.

TABLE 26. ANNUAL AMOUNT OF POLLUTANTS IN WASTEWATER EFFLUENTS FOR EACH EXISTING MODEL PLANT

Parameters/model combustors	Continuous models		Intermittent models			Batch model	Path. model
Capacity, lb/hr	1,500	1,000	1,500	600	200	500	200
Exhaust flow rate, dscfm (a)	4,747	3,165	4,747	1,899	633	455	730
Operating hours, hr/yr	7,760	3,564	4,212	4,212	3,588	3,520	2,964
Venturi blowdown, gal/yr	1.7E+06	5.1E+05	9.0E+05	3.6E+05	1.0E+05	7.2E+04	9.7E+04
Pollutant, ton/yr							
Wet systems							
CDD/CDF	1.1E-05	3.3E-06	5.8E-06	2.3E-06	6.6E-07	6.6E-07	2.6E-08
Pb	6.4E-02	1.9E-02	3.5E-02	1.4E-02	3.9E-03	2.2E-03	3.5E-04
Cd	4.1E-03	1.3E-03	2.2E-03	9.0E-04	2.6E-04	7.2E-05	8.1E-05

(a) Actual exhaust gas flow rate out of the incinerator, at 14 percent O_2.

TABLE 27. ANNUAL NATIONWIDE AMOUNT OF POLLUTANTS IN WASTEWATER EFFLUENTS FOR EACH EXISTING MODEL PLANT

Parameters\model combustors	Continuous models		Intermittent models			Batch model	Path. model
Capacity, lb/hr	1,500	1,000	1,500	600	200	500	200
Exhaust flow rate, dscfm (a)	4,747	3,165	4,747	1,899	633	455	730
Operating hours, hr/yr	7,760	3,564	4,212	4,212	3,588	3,520	2,964
Number of plants	154	182	171	742	2,097	335	1,305
Venturi blowdown, gal/yr	2.5E+08	9.2E+07	1.5E+08	2.7E+08	2.1E+08	2.4E+07	1.27E+08
Pollutant, ton/yr							
Wet systems							
CDD/CDF	1.6E-03	5.9E-04	9.9E-04	1.7E-03	1.4E-03	2.2E-04	3.3E-05
Pb	9.80	3.55	5.91	10.25	8.23	0.72	0.45
Cd	0.64	0.23	0.38	0.67	0.54	2.4E-02	0.11

(a) Actual exhaust gas flow rate out of the incinerator, at 14 percent O2.

TABLE 28. ANNUAL AMOUNT OF WASTE BURNED AND FLY ASH GENERATED BY EACH EXISTING MODEL PLANT WITH FABRIC FILTER SYSTEMS WITH AND WITHOUT CARBON INJECTION

Parameters\model combustors	Continuous models		Intermittent models			Batch model	Path. model
Capacity, lb/hr or batch	1,500	1,000	1,500	600	200	500	200
Exhaust flow rate, dscfm (a)	4,747	3,165	4,747	1,899	633	455	730
Operating hours, hr/yr	7,760	3,564	4,212	4,212	3,588	3,520	2,964
Waste incinerated, ton/yr	3,907	977	1,176	470	115	27	172
Pollutant capture per APCD, ton/yr							
DI/FF							
PM	7.10	2.18	3.86	1.54	0.44	5.8E-02	0.16
CDD/CDF	0	0	0	0	0	0	0
CaCl2	110.48	33.83	59.97	23.99	6.81	0.66	0.53
Pb	0.14	4.2E-02	7.5E-02	3.0E-02	8.5E-03	4.7E-03	7.5E-04
Cd	9.9E-03	3.0E-03	5.4E-03	2.2E-03	6.1E-04	1.7E-04	1.9E-04
Hg	0	0	0	0	0	0	0
Unreacted lime (no SO2 removal)	119.96	36.73	65.11	26.05	7.40	0.71	0.58
Total fabric filter ash no carbon	238	72.8	129	51.6	14.7	1.44	1.28
Addition of carbon							
carbon (b)	23.31	7.14	12.65	5.06	1.44	1.01	1.37
CDD/CDF	1.5E-05	4.6E-06	8.1E-06	3.2E-06	9.2E-07	9.2E-07	3.6E-08
Hg	9.6E-02	2.9E-02	5.2E-02	2.1E-02	5.9E-03	3.1E-03	9.1E-05
Total fabric filter ash with carbon	261.10	79.95	141.72	56.69	16.10	2.45	2.64
FF/PB							
PM	7.10	2.18	3.86	1.54	0.44	5.8E-02	0.16
CDD/CDF	0	0	0	0	0	0	0
Pb	0.14	4.2E-02	7.5E-02	3.0E-02	8.5E-03	4.7E-03	7.5E-04
Cd	9.9E-03	3.0E-03	5.4E-03	2.2E-03	6.1E-04	1.7E-04	1.9E-04
Hg	0	0	0	0	0	0	0
Total fabric filter ash no carbon	7.25	2.22	3.94	1.57	0.45	6.3E-02	0.16
Addition of carbon							
carbon (b)	23.31	7.14	12.65	5.06	1.44	1.01	1.37
CDD/CDF	1.2E-04	3.7E-05	6.5E-05	2.6E-05	7.4E-06	7.4E-06	2.9E-07
Hg	9.6E-02	2.9E-02	5.2E-02	2.1E-02	5.9E-03	3.1E-03	9.1E-05
Total fabric filter ash with carbon	30.66	9.39	16.64	6.66	1.89	1.08	1.53
SD/FF							
PM	7.10	2.18	3.86	1.54	0.44	5.8E-02	0.16
CDD/CDF	0	0	0	0	0	0	0
CaCl2	110.48	33.83	59.97	23.99	6.81	0.66	0.53
Pb	0.14	4.2E-02	7.5E-02	3.0E-02	8.5E-03	4.7E-03	7.5E-04
Cd	9.9E-03	3.0E-03	5.4E-03	2.2E-03	6.1E-04	1.7E-04	1.9E-04
Hg	0	0	0	0	0	0	0
Unreacted lime (no SO2 removal)	119.96	36.73	65.11	26.05	7.40	0.71	0.58
Total fabric filter ash no carbon	237.69	72.79	129.02	51.61	14.66	1.44	1.28
Addition of carbon							
carbon (c)	12.98	3.97	7.04	2.82	0.80	0.56	0.76
CDD/CDF (additional)	1.5E-05	4.6E-06	8.1E-06	3.2E-06	9.2E-07	9.2E-07	3.6E-08
Hg	9.6E-02	2.9E-02	5.2E-02	2.1E-02	5.9E-03	3.1E-03	9.1E-05
Total fabric filter ash with carbon	250.77	76.79	136.11	54.45	15.46	2.00	2.04

(a) Actual exhaust gas flow rate out of the incinerator, at 14 percent O2.

(b) An activated carbon concentration of 338 mg/dscm (0.0000211 lb/dscf) is used for the DI/FF and FF/PB, based on emission test data from Facility A, which uses a DI/FF.

(c) An activated carbon concentration of 188 mg/dscm (0.0000117 lb/dscf) is used for the SD/FF, based on emission test data from Facility M, which uses an SD/FF.

TABLE 29. ANNUAL NATIONWIDE AMOUNT OF WASTE INCINERATED AND FLY ASH GENERATED BY EACH EXISTING MODEL PLANT WITH FABRIC FILTER SYSTEMS WITH AND WITHOUT CARBON INJECTION

Parameters\model combustors	Continuous models		Intermittent models			Batch model	Path. model
Capacity, lb/hr or batch	1,500	1,000	1,500	600	200	500	200
Exhaust flow rate, dscfm (a)	4,747	3,165	4,747	1,899	633	455	730
Operating hours, hr/yr	7,760	3,564	4,212	4,212	3,588	3,520	2,964
Number of plants	154	182	171	742	2,097	335	1,305
Waste incinerated, ton/yr	601,678	177,814	201,096	348,740	241,155	9,045	224,460
Pollutant capture per APCD, ton/yr							
DI/FF							
PM	1,094.05	395.93	659.39	1,144.60	918.52	19.55	211.77
CDD/CDF	0	0	0	0	0	0	0
CaCl2	17,014.05	6,157.28	10,254.39	17,800.14	14,284.36	220.44	696.06
Pb	21.34	7.72	12.86	22.33	17.92	1.58	0.98
Cd	1.53	0.55	0.92	1.60	1.28	5.8E-02	0.25
Hg	0	0	0	0	0	0	0
Unreacted lime (no SO2 removal)	18,473.82	6,685.56	11,134.19	19,327.35	15,509.92	239.35	755.78
Total fabric filter ash no carbon	36,604.80	13,247.05	22,061.76	38,296.02	30,732.01	480.96	1,664.85
Addition of carbon							
carbon (b)	3,589.40	1,298.98	2,163.33	3,755.23	3,013.52	339.48	1,786.62
CDD/CDF	2.3E-03	8.3E-04	1.4E-03	2.4E-03	1.9E-03	3.1E-04	4.7E-05
Hg	14.82	5.36	8.93	15.51	12.44	1.04	0.12
Total fabric filter ash with carbon	40,209.02	14,551.39	24,234.02	42,066.76	33,757.98	821.49	3,451.59
FF/PB							
PM	1,094.05	395.93	659.39	1,144.60	918.52	19.55	211.77
CDD/CDF	0	0	0	0	0	0	0
Pb	21.34	7.72	12.86	22.33	17.92	1.58	0.98
Cd	1.53	0.55	0.92	1.60	1.28	5.8E-02	0.25
Hg	0	0	0	0	0	0	0
Total fabric filter ash no carbon	1,116.92	404.21	673.17	1,168.53	937.73	21.18	213.01
Addition of carbon							
carbon (b)	3,589.40	1,298.98	2,163.33	3,755.23	3,013.52	339.48	1,786.62
CDD/CDF	1.8E-02	6.7E-03	1.1E-02	1.9E-02	1.5E-02	2.5E-03	3.8E-04
Hg	14.82	5.36	8.93	15.51	12.44	1.04	0.12
Total fabric filter ash with carbon	4,721.16	1,708.56	2,845.45	4,939.29	3,963.71	361.70	1,999.75
SD/FF							
PM	1,094.05	395.93	659.39	1,144.60	918.52	19.55	211.77
CDD/CDF	0	0	0	0	0	0	0
CaCl2	17,014.05	6,157.28	10,254.39	17,800.14	14,284.36	220.44	696.06
Pb	21.34	7.72	12.86	22.33	17.92	1.58	0.98
Cd	1.53	0.55	0.92	1.60	1.28	5.8E-02	0.25
Hg	0	0	0	0	0	0	0
Unreacted lime (no SO2 removal)	18,473.82	6,685.56	11,134.19	19,327.35	15,509.92	239.35	755.78
Total fabric filter ash no carbon	36,604.80	13,247.05	22,061.76	38,296.02	30,732.01	480.96	1,664.85
Addition of carbon							
carbon (c)	1,998.53	723.26	1,204.52	2,090.87	1,677.89	189.02	994.77
CDD/CDF (additional)	2.3E-03	8.3E-04	1.4E-03	2.4E-03	1.9E-03	3.1E-04	4.7E-05
Hg	14.82	5.36	8.93	15.51	12.44	1.04	0.12
Total fabric filter ash with carbon	38,618.16	13,975.67	23,275.21	40,402.40	32,422.35	671.02	2,659.74

(a) Actual exhaust gas flow rate out of the incinerator, at 14 percent O2.

(b) An activated carbon concentration of 338 mg/dscm (0.0000211 lb/dscf) is used for the DI/FF and FF/PB, based on emission test data from Facility A, which uses a DI/FF.

(c) An activated carbon concentration of 188 mg/dscm (0.0000117 lb/dscf) is used for the SD/FF, based on emission test data from Facility M, which uses an SD/FF.

TABLE 30. ANNUAL ENERGY REQUIREMENTS TO OPERATE CONTROL EQUIPMENT FOR EACH EXISTING MODEL PLANT CARBON INJECTION

Model plants	Fuel Usage, mmft3/yr	Electricity Usage, Mwh/yr
I. Continuous MWI's		
A. 1,500 lb/hr		
a. Baseline	10.3	173.5
b. 2-sec combustion	16.6	173.5
c. Wet systems	16.6	837.8
d. FF/PB (a)	16.6	525.6
e. DI/FF (a)	16.6	412.2
f. SD/FF (a)	16.6	412.2
B. 1,000 lb/hr		
a. Baseline	5.14	65.1
b. 2-sec combustion	7.13	65.1
c. Wet systems	7.13	281.5
d. FF/PB (a)	7.13	180.5
e. DI/FF (a)	7.13	144.6
f. SD/FF (a)	7.13	144.6
II. Intermittent MWI's		
A. 1,500 lb/hr		
a. Baseline	5.86	54.8
b. 2-sec combustion	8.87	54.8
c. Wet systems	8.87	427.9
d. FF/PB (a)	8.87	252.6
e. DI/FF (a)	8.87	188.9
f. SD/FF (a)	8.87	188.9
B. 600 lb/hr		
a. Baseline	2.89	25.2
b. 2-sec combustion	4.10	25.2
c. Wet systems	4.10	183.4
d. FF/PB (a)	4.10	110.6
e. DI/FF (a)	4.10	85.7
f. SD/FF (a)	4.10	85.7
C. 200 lb/hr		
a. Baseline	1.40	10.3
b. 2-sec combustion	1.73	10.3
c. Wet systems	1.73	64.0
d. FF/PB (a)	1.73	40.6
e. DI/FF (a)	1.73	34.1
f. SD/FF (a)	1.73	34.1
III. Batch MWI's		
A. 500 lb/batch		
a. Baseline	1.81	2.73
b. 2-sec combustion	1.97	2.73
c. Wet systems	1.97	43.26
d. FF/PB (a)	1.97	26.09
e. DI/FF (a)	1.97	21.85
f. SD/FF (a)	1.97	21.85
IV. Pathological MWI's		
A. 200 lb/hr		
a. Baseline	2.65	8.6
b. 2-sec combustion	3.04	8.6
c. Wet systems	3.04	58.55
d. FF/PB (a)	3.04	36.60
e. DI/FF (a)	3.04	30.25
f. SD/FF (a)	3.04	30.25

(a) Values apply to the system both with and without activated carbon injection.

TABLE 31. ANNUAL NATIONWIDE ENERGY REQUIREMENTS TO OPERATE CONTROL EQUIPMENT FOR EACH EXISTING MODEL PLANT

Model plants	Number of Facilities	Fuel Usage, mmft3/yr	Electricity Usage, Mwh/yr
I. Continuous MWI's			
A. 1,500 lb/hr	154		
a. Baseline		1,591	26,720
b. 2-sec combustion		2,554	26,720
c. Wet systems		2,554	129,014
d. FF/PB (a)		2,554	80,944
e. DI/FF (a)		2,554	63,477
f. SD/FF (a)		2,554	63,477
B. 1,000 lb/hr	182		
a. Baseline		935	11,844
b. 2-sec combustion		1,298	11,844
c. Wet systems		1,298	51,234
d. FF/PB (a)		1,298	32,855
e. DI/FF (a)		1,298	26,314
f. SD/FF (a)		1,298	26,314
II. Intermittent MWI's			
A. 1,500 lb/hr	171		
a. Baseline		1,003	9,373
b. 2-sec combustion		1,517	9,373
c. Wet systems		1,517	73,177
d. FF/PB (a)		1,517	43,195
e. DI/FF (a)		1,517	32,299
f. SD/FF (a)		1,517	32,299
B. 600 lb/hr	742		
a. Baseline		2,147	18,701
b. 2-sec combustion		3,041	18,701
c. Wet systems		3,041	136,060
d. FF/PB (a)		3,041	82,033
e. DI/FF (a)		3,041	63,593
f. SD/FF (a)		3,041	63,593
C. 200 lb/hr	2,097		
a. Baseline		2,937	21,647
b. 2-sec combustion		3,638	21,647
c. Wet systems		3,638	134,187
d. FF/PB (a)		3,638	85,229
e. DI/FF (a)		3,638	71,611
f. SD/FF (a)		3,638	71,611
III. Batch MWI's			
A. 500 lb/batch	335		
a. Baseline		607	913
b. 2-sec combustion		659	913
c. Wet systems		659	14,491
d. FF/PB (a)		659	8,739
e. DI/FF (a)		659	7,318
f. SD/FF (a)		659	7,318
IV. Pathological MWI's			
A. 200 lb/hr	1,305		
a. Baseline		3,462	11,226
b. 2-sec combustion		3,965	11,226
c. Wet systems		3,965	76,413
d. FF/PB (a)		3,965	47,769
e. DI/FF (b)		3,965	39,473
f. SD/FF (b)		3,965	39,473

(a) Values apply to the system both with and without activated carbon injection.

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Published in conjunction with proposed air emission standards and guidelines for medical waste incinerators

16. ABSTRACT
This report presents the environmental impacts associated with the control technologies for controlling emissions from MWI's. The incremental increase or decrease in air pollution, water pollution, solid waste generation, and energy consumption for each technology relative to baseline is discussed. This is one in a series of reports used as background information in developing air emission standards and guidelines for new and existing MWI's.

17. KEY WORDS AND DOCUMENT ANALYSIS

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