RTI INTERNATIONAL | Memorandum

Date: October 24, 2008

Subject: Compliance Costs for New HMIWI
EPA Contract No. EP-D-06-118; Work Assignment No. 2-03; SPPD No. 02/30
RTI Project No. 0210426.002.003

From: Thomas Holloway

To: Mary Johnson
OAQPS/SPPD/ESG (D243-01)
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

I. Background

The U.S. Environmental Protection Agency (EPA), under sections 111 and 129 of the Clean Air Act (CAA), is required to regulate emissions of nine pollutants from hospital/medical/infectious waste incinerators (HMIWI): hydrogen chloride (HCl), carbon monoxide (CO), lead (Pb), cadmium (Cd), mercury (Hg), particulate matter (PM), dioxins/furans (CDD/CDF), nitrogen oxides (NO_X), and sulfur dioxide (SO_2). To respond to concerns raised by the U.S. Court of Appeals for the D.C. Circuit regarding the methodology originally used to develop the regulation, EPA is re-developing the HMIWI standards. The EPA has developed a series of maximum achievable control technology (MACT) floor and beyond-the-floor (BTF) options to support that re-development. These options are discussed further in separate memoranda.[1,2] The purpose of this memorandum is to present for projected new sources the model costs, nationwide costs, and nationwide cost effectiveness associated with these compliance options and with alternatives to compliance.

II. Model Costs

This section presents the costs estimated for a series of model new HMIWI for (1) the emission controls used to comply with the MACT floor and BTF options; (2) the monitoring, testing, recordkeeping, and reporting activities used to demonstrate compliance; and (3) the alternatives to compliance. The model new HMIWI include large, medium, and small units, which were patterned after HMIWI that have been installed over the last 10 years. Table 1 shows the basis for the development of the parameters for the model HMIWI (e.g., incinerator charge rate, stack gas flow rate, incinerator operating hours, and concentrations) were developed. Table 2 presents a summary of the model costs for each emission control and alternative to compliance.

A. Emission Controls

Emission control technologies and other control measures that can be used to comply with the MACT floor and BTF options for new HMIWI include packed-bed wet scrubbers, dry scrubbers, selective noncatalytic reduction (SNCR), activated carbon injection (ACI), and various

other control measures designed to obtain incremental emission reductions. This section presents the model costs that were estimated for these control measures.

1. Packed-bed wet scrubbers. Packed-bed wet scrubbers are especially effective at reducing emissions of acid gases such as HCl, and also provide provide limited control of PM, metals, and SO_2 (if present at high enough concentrations). These wet scrubbers can be installed either alone or after a dry scrubber/fabric filter. Wet scrubber costs are presented for each model HMIWI in Table 3 and were estimated based on algorithms in the *Model Plant Description and Control Cost Report* for HMIWI and a memo update.[3,4] The wet scrubber capital costs from these algorithms were updated to 2007 dollars using the Chemical Engineering Plant Cost Index (CEPCI) and range from approximately $265,000 to $793,000.

The wet scrubber annual costs were updated to 2007 dollars using current estimates for unit costs and labor rates and range from approximately $56,800 to $184,000 per year (yr). The updated unit costs for electricity and caustic were obtained from online sources.[5,6] Unit costs for water and sewage disposal were obtained from the latest version of EPA's Air Compliance Advisor.[7] Current operating labor rates were estimated based on occupational employment statistics available online from the U.S. Bureau of Labor Statistics for several industries that use HMIWI, specifically the May 2007 mean hourly wage estimates for Stationary Engineers and Boiler Operators in the following sectors: General Medical and Surgical Hospitals; Waste Treatment and Disposal; Pharmaceutical and Medicine Manufacturing; and Colleges, Universities, and Professional Schools.[8] To determine an average operating labor rate for all HMIWI, a weighted average was taken of the aforementioned mean hourly wage estimates using the fraction of HMIWI located in each of those sectors.

2. Dry scrubbers. A dry scrubber can be used in concert with a fabric filter to reduce emissions of PM, as well as emissions of acid gases such as HCl. The predominant type of dry system used at HMIWI is a dry sorbent injection system followed by a fabric filter (DIFF). DIFF costs are presented for each model HMIWI in Table 4 and were estimated based on algorithms in the *Model Plant Description and Control Cost Report* for HMIWI and a memo update.[3,9] The DIFF capital costs from these algorithms were updated to 2007 dollars using the CEPCI and range from approximately $930,000 to $2.15 million.

The DIFF annual costs were updated to 2007 dollars using current estimates for unit costs and labor rates and range from approximately $186,000/yr to $708,000/yr. Updated unit costs for electricity, lime, compressed air, and dust disposal were obtained from online sources.[5,10-12] A unit cost for water was obtained from the latest version of EPA's Air Compliance Advisor.[7] Current operating labor rates were estimated based on the aforementioned occupational employment statistics available online from the U.S. Bureau of Labor Statistics.[8]

3. Selective noncatalytic reduction. SNCR systems have been used for NO_X emission control on industrial boilers, electric utility steam generators, thermal incinerators, and municipal solid waste energy recovery facilities.[13] NO_X reductions of 45 percent or higher are estimated for HMIWI using SNCR systems.[14] The costs for an SNCR system are presented for each model HMIWI in Table 5 and were estimated based on algorithms in the *OAQPS Control Cost Manual*.[13]

The SNCR capital costs from these algorithms were updated to 2007 dollars using the CEPCI and range from approximately $186,000 to $887,000.

The SNCR annual costs were updated to 2007 dollars using current estimates for unit costs and labor rates and range from approximately $22,300/yr to $102,000/yr. The unit cost for a 50 percent urea solution ($0.85/gallon [gal]) was also taken from the *OAQPS Control Cost Manual*.[13] Two other unit costs for urea were found online, but one cost (up to $0.46/gal) was based on delivery of dry urea (with the urea solution later mixed onsite), while the other cost ($0.60/gal) was over 5 years old.[15,16] To be conservative, the higher unit cost from the *OAQPS Control Cost Manual* was used. An updated unit cost for electricity was obtained from an online source.[5] A unit cost for water was obtained from the latest version of EPA's Air Compliance Advisor.[7] The average heating value of 8,500 British thermal units per pound (Btu/lb) of medical waste was obtained from the *Process Description Report* for HMIWI.[17]

The annual electricity cost for SNCR systems is dependent on the NO_X concentration at the inlet to the SNCR system, which was estimated to be 0.28 lb/million Btu (MM Btu), based on the average of the NO_X concentration data for currently operating HMIWI. The NO_X concentration for each HMIWI was estimated (as shown in the following equation) using baseline emissions estimates developed in a separate memorandum:[18]

NO_X concentration (lb/MM Btu) = NO_X baseline emissions (lb/yr) / [operating hours per year (hr/yr) x incinerator charge rate (lb waste/hr) x heating value (8,500 Btu/lb waste)] x 10^6 Btu/MM Btu

4. <u>Activated carbon injection system</u>. Injecting activated carbon before the fabric filter has been demonstrated to improve the removal efficiency of both Hg and CDD/CDF from HMIWI. Activated carbon injection costs are presented for each model HMIWI in Table 6 and were estimated based on algorithms in the *Model Plant Description and Control Cost Report* for HMIWI.[3] Capital costs for the ACI system from these algorithms were updated to 2007 dollars using the CEPCI and range from approximately $4,200 to $20,800.

Annual costs for the ACI system were updated to 2007 dollars using current estimates for unit costs and labor rates and range from approximately $9,800/yr to $162,000/yr. Updated unit costs for activated carbon and dust disposal were obtained from online sources.[11,19-21] Current operating labor rates were estimated based on the occupational employment statistics available online from the U.S. Bureau of Labor Statistics.[8]

The factor of 0.00127 in the annual cost equation for dust disposal is based on an ACI rate capable of producing a carbon concentration of 338 milligrams per dry standard cubic meter (mg/dscm), which is expected to achieve reductions of 90 percent for Hg and 98 percent for CDD/CDF relative to inlet levels.[3]

7. <u>Incremental controls</u>. In some instances, it may not be necessary to install a new control system to achieve the emissions reductions necessary to comply with the control options. An incremental reduction in emissions may be achievable by simply increasing the flow of activated carbon prior to the fabric filter or increasing the amount of natural gas used in the incinerator. Table 7 presents model costs for each of these incremental control measures, and the following sections discuss how the model costs were estimated for these controls.

a. Increase activated carbon flow. As noted previously, injecting activated carbon before the fabric filter has been demonstrated to improve the removal efficiency of both Hg and CDD/CDF from HMIWI. Model costs to increase activated carbon flow were estimated using the same equations for activated carbon and dust disposal employed for installing an ACI system and range from approximately $3,700/yr to $142,000/yr.[3]

b. Increase natural gas use. One strategy to reduce CO and CDD/CDF emissions further is to increase the amount of natural gas fired in the secondary chamber and consequently increase the temperature in the secondary chamber. Carbon monoxide is a product of incomplete combustion, and increasing the temperature in the secondary chamber should subsequently increase the degree of combustion in the chamber; higher temperatures in the secondary chamber should also contribute to the decomposition of CDD/CDF compounds.[22] Combustion can be improved in other ways (e.g., tuning up burners or improving mixing in the secondary chamber), but for purposes of this memorandum, analyses were conservatively based on increased natural gas use. Model costs to fire additional natural gas were estimated based on an algorithm in the *Model Plant Description and Control Cost Report* for HMIWI using an updated unit cost for natural gas obtained from an online source.[3,23] The model costs range from $2,600/yr to $101,000/yr.

B. Monitoring

1. Inspections. Under the 1997 HMIWI regulation, existing small rural HMIWI were required to conduct annual equipment inspections to compensate for the lack of annual emissions testing at those sources. The inspections would include the incinerator, control device (if any), and monitoring equipment. For the re-developed regulation, EPA has determined that annual control device inspections should be expanded to all other HMIWI to demonstrate that the control devices are operating sufficiently well to allow compliance with the tighter emission limits under the re-developed regulation.

Information on maintenance inspections was gathered for the 1997 regulation.[24] Four companies (one incinerator dealer, one maintenance contractor, and two incinerator manufacturers) were contacted for information on the types of activities normally conducted during a maintenance inspection, including control device inspections; the companies provided inspection cost estimates ranging from $350 to $800.[24] These costs were averaged and updated to 2007 dollars using the CEPCI to develop the inspection cost ($900). (See Table 8.) This inspection cost was estimated for all model HMIWI regardless of size.

2. Parameter monitors. Monitoring of operating parameters can be used to indicate whether air pollution control equipment and practices are functioning properly to minimize air pollution. The 1997 HMIWI regulation included parameter monitoring requirements for good combustion, wet scrubbers, and dry scrubbers with fabric filters. For the re-developed regulation, EPA is keeping these parameter monitoring requirements and adding an additional parameter monitoring requirement for those HMIWI that are expected to install SNCR systems in order to comply with the more stringent NO_X limits. The model costs associated with these parameter monitoring requirements are presented in Table 9.

The 1997 regulation required all HMIWI to monitor charge rate and secondary chamber temperature to demonstrate good combustion practices. Because HMIWI are already monitoring these parameters, the monitoring costs presented in this memorandum only include the costs to monitor additional (e.g., wet scrubber, DIFF, ACI, and SNCR) parameters, plus any ancillary equipment costs (e.g., computer, data logger/computer interface, logging and reporting software, and printer) and other costs. (Some of the other costs include planning, selecting the type of equipment, providing support facilities, installing and checking the equipment, conducting performance specification tests, preparing a quality assurance/quality control [QA/QC] plan, and recordkeeping and reporting.)

The 1997 regulation required HMIWI equipped with wet scrubbers, DIFF, and ACI to monitor the following:

- Wet scrubbers: flue gas temperature, pressure drop across the wet scrubber (or the horsepower or amperage to the wet scrubber), scrubber liquor flow rate, and scrubber liquor pH
- DIFF: fabric filter inlet temperature, and HCl sorbent (i.e., lime) flow rate
- ACI: Hg and CDD/CDF sorbent (i.e., activated carbon) flow rate

Consequently, the wet scrubber monitoring costs developed for the 1997 regulation included costs for (1) thermocouple wire, (2) signal wire, (3) pressure transducer, (4) liquid flow transducers, and (5) controller element and transmitter for pH meter; the DIFF monitoring costs included costs for (1) thermocouple wire and (2) labor to monitor and record lime flow; and the ACI monitoring costs included labor costs to monitor and record activated carbon flow.[25] The wet scrubber, DIFF, and ACI monitoring costs estimated for the 1997 regulation were updated to 2007 dollars using the CEPCI and latest labor rates and rounded to the nearest $100. Total monitoring costs were estimated at $5,000/yr for wet scrubbers, $6,600/yr for DIFF, and $2,400/yr for ACI.

Under the re-developed HMIWI regulation, those HMIWI equipped with SNCR systems will be required to monitor ammonia or urea injection rate. SNCR monitoring costs estimated by EPA in August 2008 include costs to purchase and install an ammonia injection rate sensor with data acquisition system and data reduction.[26] These SNCR monitoring costs were adapted to include the cost items in Table 9 and rounded to the nearest $100. The total SNCR monitoring cost was estimated to be $3,100/yr.

3. Bag leak detector. Under the re-developed HMIWI regulation, all newly installed HMIWI equipped with fabric filters will be required to install bag leak detectors. Since the 1997 regulation, bag leak detectors have been shown to be an effective method for demonstrating continuous compliance for sources equipped with fabric filters. Bag leak detector costs estimated by EPA in July 2006 were updated to 2007 dollars using the CEPCI, and rounded to the nearest $100.[27] The total cost for this monitor was estimated to be $8,400/yr. (See Table 9.)

There are no parameter monitoring requirements for which bag leak detectors can be substituted. However, in the re-developed regulation, EPA would allow sources to use bag leak detectors to replace annual opacity testing, which would reduce the bag leak detector cost.

4. Continuous emissions monitoring systems (CEMS). The most direct means of monitoring compliance is the use of CEMS to measure the emissions of a pollutant on a continuous basis. The following sections discuss the mandatory and voluntary CEMS options for new HMIWI that will be included in the re-developed regulation. The costs for the various CEMS are presented in Table 9.

a. CO CEMS. Under the re-developed HMIWI regulation, all newly installed HMIWI will be required to install CO CEMS to ensure compliance with the tighter CO emission limit and serve as an indicator of good combustion. At the time of the 1997 regulation, CO CEMS were rejected in favor of parameter monitoring and opacity testing because of cost. However, several HMIWI (including most of the newer units) use CO CEMS, and EPA believes they would be a useful measure of continuous compliance for newly installed HMIWI. The CO CEMS costs estimated by EPA in September 2006 were updated to 2007 dollars using the CEPCI and rounded to the nearest $100.[28] The total CO CEMS cost was estimated to be $26,300/yr. (See Table 9.)

In the re-developed regulation, EPA would allow sources to use CO CEMS to replace annual CO testing and monitoring of secondary chamber temperature, which would reduce the cost of the CEMS. A CO CEMS could provide the information on combustion efficiency that monitoring secondary chamber temperature is intended to do.

b. Other CEMS. Although the re-developed regulation is not requiring HCl, PM, Hg, or multi-metal CEMS for newly installed HMIWI, such systems are presented as an option for all sources. The costs for these CEMS, estimated by EPA in July 2006, were updated to 2007 dollars using the CEPCI and rounded to the nearest $100.[27] The total costs for these CEMS were estimated to be $42,400/yr for HCl CEMS; $51,200/yr for PM CEMS; $102,900/yr for Hg CEMS; and $57,800/yr for multi-metal CEMS. (See Table 9.)

In the re-developed regulation, EPA would allow sources to use these CEMS to replace the following annual tests and parameter monitoring to reduce the cost of the CEMS:

- HCl CEMS: replace annual HCl testing and monitoring of HCl sorbent (e.g., lime) flow rate for dry scrubbers and scrubber liquor pH for wet scrubbers
- PM CEMS: replace annual PM and opacity testing and monitoring of pressure drop (or horsepower or amperage) for wet scrubbers
- Multi-metals/Hg CEMS: replace flue gas temperature (there are no annual metals/Hg tests to replace)

5. Sorbent trap biweekly monitoring. Although EPA is not requiring sorbent trap biweekly monitoring of CDD/CDF or Hg emissions for newly installed HMIWI, such a system is presented as an option for all sources. The costs for this monitoring system, estimated by EPA in July 2006, were updated to 2007 dollars using the CEPCI and rounded to the nearest $100.[27] The total cost for a sorbent trap biweekly monitoring system was estimated to be $37,900/yr. (See Table 9.)

a. CDD/CDF sorbent trap monitoring. In the re-developed regulation, EPA would allow sources to use sorbent trap biweekly monitoring of CDD/CDF to replace monitoring of fabric filter inlet temperature to reduce the cost of the monitor. None of the other parameter monitoring requirements associated with CDD/CDF emissions, which include monitoring of CDD/CDF sorbent (i.e., activated carbon) flow rate, waste charge rate, and secondary chamber temperature, can afford to be replaced. (In addition to CDD/CDF, activated carbon flow rate also serves to demonstrate compliance with the Hg emission limit, and monitoring of charge rate and secondary chamber temperature also serves to demonstrate compliance with the PM and CO emission limits.) Furthermore, there is no annual CDD/CDF stack test that could be replaced with sorbent trap biweekly monitoring.

If sorbent trap biweekly monitoring of CDD/CDF was combined with a multi-metals or Hg CEMS, or Hg sorbent trap monitoring, additional parameter monitors could be eliminated. For HMIWI equipped with a dry scrubber or a dry/wet scrubber system, such a combination could be used to replace monitoring of fabric filter inlet temperature and monitoring of Hg and CDD/CDF sorbent flow rate (i.e., activated carbon). For HMIWI equipped with a wet scrubber, such a combination could be used to replace monitoring of flue gas temperature.

b. Hg sorbent trap monitoring. In the re-developed regulation, EPA would allow sources to use sorbent trap biweekly monitoring of Hg to replace monitoring of wet scrubber outlet flue gas temperature to reduce the cost of the monitor. None of the other parameter monitoring requirements associated with Hg emissions, which include monitoring of Hg sorbent (i.e., activated carbon) flow rate, waste charge rate, and secondary chamber temperature, can afford to be replaced. (In addition to Hg, activated carbon flow rate also serves to demonstrate compliance with the CDD/CDF emission limit, and monitoring of charge rate and secondary chamber temperature also serves to demonstrate compliance with the PM and CO emission limits.) Furthermore, there is no annual Hg stack test that could be replaced with sorbent trap biweekly monitoring.

If sorbent trap biweekly monitoring of Hg was combined with CDD/CDF sorbent trap monitoring, additional parameter monitors could be eliminated. For HMIWI equipped with a dry scrubber or a dry/wet scrubber system, such a combination could be used to replace monitoring of fabric filter inlet temperature and monitoring of Hg and CDD/CDF sorbent flow rate (i.e., activated carbon). For HMIWI equipped with a wet scrubber, such a combination could be used to replace monitoring of flue gas temperature.

C. Testing

1. Stack testing. Under the 1997 HMIWI regulation, new HMIWI were required to:

- Demonstrate initial compliance with the emission limits for HCl, CO, Pb, Cd, Hg, PM, CDD/CDF, and opacity by conducting an initial stack test for those pollutants; and
- Demonstrate ongoing compliance with the emission limits for HCl, CO, PM, and opacity by conducting annual stack tests for those pollutants.

The re-developed regulation will keep these requirements and also require those HMIWI to demonstrate initial compliance with the revised limits for NO_X and SO_2 by conducting an initial stack test for those two pollutants. Stack test costs developed for each EPA test method for the 1997 regulation were updated to 2007 dollars using the CEPCI, adjusted as necessary to conform to the range of more recent, typical test costs, and rounded to the nearest $1,000 (except for the less expensive opacity test, which was rounded to the nearest $100).[25,29,30] The updated and adjusted stack test costs are presented in Table 10 for all model HMIWI. Stack test costs were estimated at $12,000 for EPA Method 5 (PM); $2,500 for EPA Method 9 (opacity); $26,000 for EPA Method 23 (CDD/CDF); $14,000 for EPA Method 29 (metals); and $7,000 each for EPA Methods 6C (SO_2), 7E (NO_X), 10 (CO), and 26 (HCl).

2. Visible emissions testing. Under the 1997 HMIWI regulation, new large HMIWI were subject to a 5 percent visible emissions (VE) limit for fugitive emissions generated during ash handling. To demonstrate compliance with this emission limit, new large HMIWI were required to conduct annual performance tests for fugitive emissions from ash handling using EPA Method 22. For the re-developed regulation, EPA has determined that this minimal testing requirement should be extended to include all new HMIWI to determine whether fugitive emissions are a concern from these sources. Because of its simple requirements, Method 22 VE testing is expected to be conducted in-house by operating personnel at the HMIWI facility. Certification training is not required for this test method.

A Method 22 VE test requires only one stopwatch to monitor the duration of the observation period, another stopwatch to observe the emissions, a light meter to monitor illuminance indoors (if necessary), and an anemometer to monitor wind speed and wind direction. Capital costs for the equipment were obtained online from two vendors: (1) Professional Equipment, which provided a wide range of models and costs for light meters and anemometers, and (2) Cole-Parmer, which provided a wide range of models and costs for stopwatches.[31,32] The median costs for the equipment ($200 for a combination light meter/anemometer, $50 for two digital stopwatches) were used to develop the Method 22 capital cost ($250).

The Method 22 annual costs (including labor, overhead, taxes, insurance, administration, capital recovery) were estimated using standard EPA cost procedures and the latest labor rates, assuming 1 hr/reading, and 3 readings/test. Rounded to the nearest $100, the total annual test cost was estimated at $200. (See Table 11.) This test cost was estimated for all model HMIWI regardless of size.

D. Recordkeeping and Reporting Costs

The additional recordkeeping and reporting burden needed to comply with the re-developed regulation includes the following:

- Initial demonstrations of continuous monitoring systems (CMS) to develop new parameter limits (including reports of the results)—16 person-hours
- Notifications of initial performance tests—2 person-hours
- Notifications of CMS demonstrations—2 person-hours
- Reports of initial performance tests—8 person-hours

- Annual report, including (1) records of CMS parameters—32 person-hours; (2) report of any/no exceedances—8 person-hours per monitor; and (3) results of performance tests conducted during the year—40 person-hours
- Weekly records of operating parameters—1.5 person-hours
- Daily records of CMS operation and maintenance—0.025 person-hours

One of these burden items only applies to certain HMIWI. There are different burden estimates for the report of no exceedances, depending on the additional CMS the HMIWI would need to install to demonstrate compliance (e.g., wet scrubber or SNCR monitoring system). The recordkeeping and reporting burden for control equipment inspections is already included with the monitoring.

The burden estimate for initial CMS demonstrations (16 person-hours) was determined by dividing the cost to certify CMS by the composite hourly labor rate. The cost to certify CMS was based on an estimate for the 1997 regulation.[25] That cost estimate was updated to 2007 dollars using the CEPCI. The composite hourly labor rate was determined (as shown in the following bullets) based on occupational employment statistics available online from the U.S. Bureau of Labor Statistics which were adjusted upwards by 60 percent to include overhead and profit.[8]

- Technical labor rate (natural resources, construction, and maintenance) = (total compensation of $23.47/hr) x (overhead and profit rate of 1.6) = $37.55/hr
- Management labor rate (management, professional, and related) = (total compensation of $49.23/hr) x (overhead and profit rate of 1.6) = $78.76/hr
- Clerical labor rate (sales and office) = (total compensation of $13.19/hr) x (overhead and profit rate of 1.6) = $21.10/hr
- Composite hourly labor rate = (technical labor rate) + (0.05 x management labor rate) + (0.1 x clerical labor rate) = $43.60/hr

The management and clerical burden for each HMIWI were estimated at 5 and 10 percent of the technical burden, respectively. The recordkeeping and reporting costs for each HMIWI were estimated by multiplying the technical, management, and clerical burden estimates by their respective labor rates and summing the costs. The results are presented in Table 12.

E. Alternatives to Compliance

In addition to the compliance options listed above, alternatives to compliance have also been developed, including autoclaving and landfilling the waste, hauling the waste to a municipal waste combustor (MWC), and contracting with a commercial medical waste disposal company. This section presents the model costs that were estimated for these alternatives.

1. Autoclave/landfill. The cost to comply with the re-developed HMIWI regulation may lead some facilities (e.g., hospitals) to use other waste treatment and disposal methods, such as onsite autoclaving, followed by landfilling the waste. Costs for this option are presented for each model HMIWI in Table 13 and were estimated using cost estimates provided by an autoclave vendor and an online source.[33,34]

Cost estimates from the vendor included capital costs for the sterilizer and compactor; operational costs for chamber liners, labor, capital expense, maintenance, steam, and electricity; and hauling costs; the vendor also provided costs for a biological indicators test (including test kit).[33] Inspection costs and permit fees were obtained from an online source.[34]

The hauling costs from the vendor were revised to extract landfill costs. National average landfill tip fees from the 2005 Tip Fee Survey prepared by the National Solid Wastes Management Association (NSWMA) were then used to estimate model landfill costs.[11] The total annual autoclave/landfill costs in Table 13 are presented in $/lb of waste and in $/yr. Calculation of the costs in $/yr assumes each HMIWI operates at two-thirds of its capacity. The $/yr costs range from $14,600/yr to $730,000/yr.

2. Hauling waste to municipal waste combustor. Rather than treat their waste onsite, some facilities may decide to haul the waste to the nearest MWC. Costs for this option are presented for each model HMIWI in Table 14 and were estimated using the national average incineration tip fee ($61.64/ton) from NSWMA's 2005 Tip Fee Survey and the national average hauling cost ($0.27/ton-mile) from the U.S. Bureau of Transportation Statistics, assuming 50 miles/trip to reach the nearest MWC.[11,35] The total annual costs in Table 14 are presented in $/ton of waste and in $/yr. Calculation of the costs in $/yr assumes each HMIWI operates at two-thirds of its capacity. The $/yr costs range from $7,500/yr to $803,000/yr. Because these costs overlap significantly with the autoclave/landfill costs and because some MWCs may not accept medical waste, EPA decided to use the autoclave/landfill costs as a means of comparison to the compliance costs on a nationwide basis.

3. Commercial medical waste disposal. Some facilities may decide to contract with a commercial medical waste disposal company to pick up and dispose of the waste, instead of treating or hauling the waste themselves. Cost for this option are presented for each model HMIWI in Table 15 and were estimated using a commercial disposal fee of $0.24/lb of waste from a memorandum prepared for the 1997 HMIWI regulation.[36] Although this cost is about 10 years old, it is still in the range of recent cost estimates found online: [37-39]

a. $0.16/lb for 2006 contract for pickup and disposal of medical waste from sources at University of Kentucky
b. $0.35/lb for 2007 pickup and disposal of medical waste from sources at University of Texas at San Antonio
c. $0.22 to $0.27/lb for 2004 pickup and disposal of medical waste from hospitals in Maine

The model costs in Table 15 are presented in $/lb of waste and in $/yr. Calculation of the costs in $/yr assumes each HMIWI operates at two-thirds of its capacity. The $/yr costs range from $48,200/yr to $5.15 million/yr. Because these costs are more expensive than the autoclave/landfill costs, EPA decided to use the autoclave/landfill costs as a means of comparison to the compliance costs on a nationwide basis.

III. Nationwide Costs

To determine nationwide costs for the three projected new HMIWI, model emission estimates for each pollutant and each new HMIWI were first compared to the MACT floor emission limits to determine which new HMIWI would potentially be impacted for a particular pollutant, and by how much. Then, the type of emission control needed to bring the HMIWI into compliance with the emission limit was determined. For example, if it appeared that a new HMIWI equipped with a DIFF would be impacted for HCl by a substantial amount, then it was determined that a packed-bed scrubber should be installed to bring the new HMIWI into compliance with the HCl limit. This approach was taken with each pollutant individually, and the results were compared across all pollutants to determine the best combination of emission controls needed to ensure the new HMIWI would be in compliance with all of the MACT floor emission limits. See Table 16 for this list of emission controls.

Once the best combination of emission controls was determined, the model costs associated with those emission controls were assigned to the impacted HMIWI, based on which HMIWI size category (large, medium, small) the impacted HMIWI belonged. For example, large model costs for packed-bed scrubbers would be applied to the large HMIWI that needs to install that emission control to comply with the HCl emission limit. The model costs that would be applied would include the control costs and monitoring costs associated with packed-bed scrubbers. Table 16 shows the control/monitoring cost estimates applied to each HMIWI at the floor and presents nationwide totals. Control costs were estimated to be approximately $650,000/yr (including $430,000/yr for the large; $140,000/yr for the medium; and $82,000/yr for the small unit). Monitoring costs were estimated to be approximately $110,000/yr (including $41,000/yr for the large; $44,000/yr for the medium; and $30,000/yr for the small unit).

Because new HMIWI are already required under the 1997 HMIWI regulation to conduct initial compliance tests for seven of the nine section 129 pollutants (HCl, CO, Pb, Cd, Hg, PM, and CDD/CDF), no stack testing costs needed to be assigned for those pollutants for purposes of estimating the costs for the re-developed HMIWI regulation. Stack testing costs were only assigned for the two pollutants (NO_X and SO_2) that new HMIWI would, for the first time, be required to test for, under the re-developed HMIWI regulation. The total cost for these two stack tests was adjusted by two-thirds to account for travel, accommodations, test methods/sampling trains, etc. that are common to the two tests.[30] Because these two stack tests would only be conducted once, their costs were annualized over 15 years at 7 percent interest. Annual fugitive ash testing costs were assigned to all three projected new HMIWI. Table 16 presents the testing costs assigned to the new HMIWI (approximately $1,200/yr for each size category and $3,700/yr nationwide).

Recordkeeping and reporting costs were assigned to all three new HMIWI, with the only differences coming from the varying number of CMS that a particular HMIWI would require to demonstrate compliance. For the three new HMIWI, costs were assigned for conducting CMS demonstrations, submitting notifications of performance tests and CMS demonstrations, submitting reports of the initial performance tests, submitting annual reports, and keeping records of operating parameters and CMS operation and maintenance. Table 16 presents the recordkeeping and reporting costs assigned to impacted HMIWI (approximately $7,500/yr for the

large; $7,800/yr for the medium; and $6,800/yr for the small unit, for a nationwide total of $22,000/yr).

Including the costs of emission controls, monitoring, testing, and recordkeeping/reporting, the total nationwide costs at the MACT floor were estimated at approximately $790,000/yr (including $480,000/yr for the large; $200,000/yr for the medium; and $120,000/yr for the small unit).

A different approach from the one described above was used to estimate compliance costs for the BTF options. For the BTF options, the type of control assigned was determined based on the additional emission controls available (i.e., those controls not already installed at the MACT floor), and not based on a BTF emission limit. For new large HMIWI, the only additional emission control available was SNCR, so only the additional compliance costs associated with SNCR were applied to the new large HMIWI. (Those compliance costs include costs to install and operate the SNCR system; monitor the ammonia/urea injection rate; and report whether or not there were SNCR monitoring exceedances.) No additional emission controls were available for new medium HMIWI beyond the floor, so no compliance costs were applied to that source. For new small HMIWI, a DIFF and ACI system were still available (i.e., not already required at the MACT floor) and could be installed beyond the floor. Consequently, the compliance costs associated with those controls were applied to the new small HMIWI. (Those compliance costs include costs to install and operate the DIFF, ACI system, and bag leak detector; monitor fabric filter inlet temperature, lime flow rate, and activated carbon flow rate; and report whether or not there were bag leak detector exceedances.) Beyond-the-floor costs are presented in Table 17 as both an incremental increase over the MACT floor costs and as an overall total that includes both the MACT floor costs and incremental BTF increase. The incremental increase in control costs beyond the floor was estimated at approximately $300,000/yr (including $100,000/yr for the large unit and $200,000/yr for the small unit), while the incremental increase in associated monitoring costs was estimated at approximately $21,000/yr (including $3,100/yr for the large unit and $17,000/yr for the small unit). There are no testing costs beyond the floor. Recordkeeping costs beyond the floor were estimated to increase by approximately $700/yr ($350/yr each for the large and small units). Overall, costs were estimated to increase by approximately $320,000/yr beyond the floor, which includes cost increases of $110,000/yr for the large unit and $210,000/yr for the small unit.

Costs for the primary alternative to compliance (i.e., autoclaving and landfilling the waste) were also assigned to each HMIWI, so that the costs for this alternative option could be compared to the total compliance costs for each HMIWI at the floor and beyond the floor. Similar to the model costs, nationwide average landfill tip fees from NSWMA's 2005 Tip Fee Survey were used in estimating the nationwide autoclave/landfill costs.[11] An autoclave/landfill cost (in $/yr) was calculated for each HMIWI by taking the applicable model autoclave cost (in $/lb of waste) and nationwide average tip fee (in $/ton of waste), converting them into compatible units, and multiplying them by the annual operating hours and charge rate for the HMIWI (assuming the HMIWI operates at two-thirds of its capacity). See Tables 16 and 17 for a comparison of autoclave/landfill costs with MACT floor and BTF compliance costs for each HMIWI and nationwide. As shown in Tables 16 and 17, nationwide autoclave/landfill costs are approximately $790,000/yr (including $730,000/yr for the large; $50,000/yr for the medium; and $15,000/yr for

the small unit). The autoclave/landfill costs are about 25 to 50 percent higher than the MACT floor and BTF compliance costs for the large unit but about 75 to 95 percent lower than the MACT floor and BTF compliance costs for the medium and small units.

IV. Cost Effectiveness

The cost effectiveness of the MACT floor and BTF options was calculated for each unit by dividing the estimated total compliance cost (emission control, monitoring, testing, recordkeeping, and reporting) for each unit by the estimated total emission reduction (HCl, CO, Pb, Cd, Hg, PM, CDD/CDF, NO_X, and SO_2) for each unit needed to meet the revised emission limits for those options. Emission reductions are discussed in a separate memorandum.[18] Table 18 presents the estimated cost effectiveness values at the floor and beyond the floor. Beyond-the-floor cost effectiveness values are presented as the incremental increase over the MACT floor and as an overall total that includes the MACT floor. As shown in Table 18, the cost effectiveness of the MACT floor options was estimated to be $197,000/ton for the large; $113,000/ton for the medium; and $255,000/ton for the small unit. The cost effectiveness of the incremental BTF increase was estimated to be $27,000/ton for the large unit and $940 million/ton for the small unit. There was no BTF option for the medium unit.

V. References

1. Memorandum from Thomas Holloway, RTI, to Mary Johnson, EPA. October 24, 2008. *MACT Floors, Data Variability Analysis, and Emission Limits for Existing and New HMIWI.*

2. Memorandum from Thomas Holloway, RTI, to Mary Johnson, EPA. October 24, 2008. *Analysis of Beyond-the-Floor Options.*

3. U.S. Environmental Protection Agency. July 1994. *Medical Waste Incinerators--Background Information for Proposed Standards and Guidelines: Model Plant Description and Cost Report for New and Existing Facilities.* Publication Number EPA-453/R-94-045a. (Docket item no. II-A-112)

4. Memorandum from Thomas Holloway, RTI, to MWI Project File. September 7, 1995. *Approach Used to Estimate the Capital and Annual Costs for MWI Wet Scrubbers.* (Docket item no. IV-B-30)

5. Energy Information Administration. 2007. *Average Retail Price of Electricity to Ultimate Customers by End-Use Sector.* Industrial Sector, 2006. Web site: http://www.eia.doe.gov/cneaf/electricity/epa/epat7p4.html. Accessed July 8, 2008.

6. Purchasing Staff. 2007. *Caustic Soda Price Hike Is On The Horizon.* Web site: http://www.purchasing.com/article/CA6472577.html. Accessed July 8, 2008.

7. U.S. Environmental Protection Agency. 2003. *Air Compliance Advisor (ACA) Air Pollution Control Technology Evaluation Model version 7.5.* (Technology Transfer Network, Clean

Air Technology Center.) Website: http://www.epa.gov/ttncatc1/products.html. Accessed July 8, 2008.

8. Bureau of Labor Statistics. 2007. *May 2007 National Industry-Specific Occupational Employment and Wage Estimates.* Web site: http://www.bls.gov/oes/current/oessrci.htm. Accessed July 8, 2008.

9. Memorandum from David Randall, RTI, to Rick Copland, EPA. January 29, 1996. *Revised Costs for Dry Injection/Fabric Filter Controls for MWI's.* (Docket item no. IV-B-32)

10. Pollution Prevention (P2) Pays, NC Division of Pollution Prevention and Environmental Assistance. 2004. *Determine the Cost of Compressed Air for Your Plant.* Energy Tips – Compressed Air, Compressed Air Tip Sheet #1. August. Web site: http://www.p2pays.org/ref/40/39536.pdf. Accessed July 9, 2008.

11. Edward W. Repa. 2005. *NSWMA's 2005 Tip Fee Survey.* NSWMA Research Bulletin 05-3. Web site: http://wastec.isproductions.net/webmodules/webarticles/articlefiles/478-Tipping%20Fee%20Bulletin%202005.pdf. Accessed July 8, 2008.

12. U.S. Geological Survey. 2008. *Mineral Commodity Summaries 2008: Lime, 2007.* Web site: http://minerals.usgs.gov/minerals/pubs/commodity/lime/mcs-2008-lime.pdf. Accessed July 16, 2008.

13. U.S. Environmental Protection Agency. October 2000. *OAQPS Control Cost Manual.* Section 4.2: NO_X Post-Combustion. Chapter 1: Selective Noncatalytic Reduction. Publication Number EPA/452/B-02-001.

14. U.S. Environmental Protection Agency. November 1999. *EPA Technical Bulletin: Nitrogen Oxides (NO_X)--Why and How They Are Controlled.* Clean Air Technology Center. Publication Number EPA/456/F-99-006R.

15. De-NO_X Technologies, LLC. 2008. *On-Site Urea Dissolving Systems.* Web site: http://www.de-nox.com/bulk%20urea.htm. Accessed July 25, 2008.

16. EPRI. September 2002. *Design and Cost Estimating Procedures for SCR and SNCR Retrofits on Gas- and Oil-Fired Boilers.*

17. U.S. Environmental Protection Agency. July 1994. *Medical Waste Incinerators--Background Information for Proposed Standards and Guidelines: Process Description Report for New and Existing Facilities.* Publication Number EPA-453/R-94-043a. (Docket item no. II-A-110)

18. Memorandum from Thomas Holloway, RTI, to Mary Johnson, EPA. October 24, 2008. *Baseline Emissions and Emissions Reductions for Existing and New HMIWI.*

19. The Innovation Group. 2003. *Chemical Profiles: Activated Carbon*. Current (2002) Price. Web site: http://www.the-innovation-group.com/ChemProfiles/Activated%20Carbon.htm. Accessed July 8, 2008.

20. Norit Americas. 2006. *2007 Price Announcement.* Web site: http://www.norit-americas.com/pressrelease1.html. Accessed July 15, 2008.

21. Norit Americas. 2007. *Norit Americas Announces 2008 Price Increase.* Web site: http://www.norit-americas.com/pressrelease11.html. Accessed July 15, 2008.

22. U.S. Environmental Protection Agency. July 1994. *Medical Waste Incinerators--Background Information for Proposed Standards and Guidelines: Control Technology Performance Report for New and Existing Facilities.* Publication Number EPA-453/R-94-044a. (Docket item no. II-A-111)

23. Energy Information Administration. 2007. *Natural Gas Prices.* Industrial Price, December 2007. Web site: http://www.eia.doe.gov/oil_gas/natural_gas/info_glance/natural_gas.html. Accessed July 8, 2008.

24. Memorandum from Thomas Holloway, RTI, to Rick Copland, EPA. August 31, 1992. *Industry Comments on Maintenance/Inspection and Monitoring Programs for Medical Waste Incinerators.* (Docket item no. II-B-88)

25. Memorandum from Thomas Holloway, RTI, to Rick Copland, EPA. March 17, 1997. *Revised Testing and Monitoring Options and Costs for Medical Waste Incinerators (MWI's)—Methodology and Assumptions.* (Docket item no. IV-B-66)

26. Memorandum from Peter Westlin, EPA, to Mary Johnson, EPA. August 19, 2008. *Monitoring approaches and associated costs for medical waste incinerator NO_X emissions control (SNCR).* August 19.

27. E-mail from Dan Bivins, EPA, to Mary Johnson, EPA. July 28, 2006. "Some Preliminary Thoughts on the HWI Monitoring."

28. E-mail from Dan Bivins, EPA, to Mary Johnson, EPA. September 27, 2006. "Cost of CO CEMS."

29. E-mail from Jason Dewees, EPA, to Peter Westlin, EPA. August 20, 2008. "Monitoring Options for SNCR & Test Cost Questions."

30. E-mail from Jason Dewees, EPA, to Mary Johnson, EPA. August 20, 2008. *Re: Monitoring Options for SNCR & Test Cost Questions*.

31. Professional Equipment. 2008. *Light Meters Industrial and Professional: Digital Light Meter.* Website: http://www.professionalequipment.com. Accessed July 24, 2008.

32. Cole-Parmer. 2008. *Digital Stopwatches -Cole Parmer Instrument Catalog*. Website: http://www.coleparmer.com. Accessed July 24, 2008.

33. Contact report from Thomas Holloway, RTI, to project file. July 28, 2008. Summary of telephone conversation with Arthur McCoy, San-I-Pak, Inc. *Autoclave Cost Estimates for Large, Medium, and Small Models.*

34. Association of Bay Area Governments. 2003. *Bay Area Dioxins Project, Autoclaving Cost Worksheet, June 2003*. Web site: http://dioxin.abag.ca.gov/pilot_projs/AutoclavingCostWorksheet.xls. Accessed July 21, 2008.

35. Bureau of Transportation Statistics. 2006. *Table 3-17: Average Freight Revenue Per Ton-mile*. Truck, 2001 (latest year). Web site: http://www.bts.gov/publications/national_transportation_statistics/html/table_03_17.html. Accessed July 8, 2008.

36. Memorandum from Brian Hardee, MRI, to Richard Copland, EPA. May 20, 1996. *Switching Scenarios for New and Existing Medical Waste Incinerators.*

37. University of Kentucky Purchasing Division. 2006. *Notice of Award of Pricing Contract: Darob Incorporated*. Pick-up and disposal of contaminated, infectious, regulated bio-hazardous and/or medical waste for the University of Kentucky. Web site: http://www.uky.edu/Purchasing/uk-0492-5pct.pdf. Accessed July 8, 2008.

38. Richard M. Garza, Wendy McCoy, and J. Brian Moroney, University of Texas at San Antonio. 2007. *Biological Waste Management Program – A Better Way*. Web site: http://www.sacubo.org/sacubo_resources/best_practices_files/2007_files/UnivofTexasSanAntonio-BiologicalWasteCollection.pdf. Accessed July 21, 2008.

39. Bruce Geiselman. April 26, 2004. "Maine Dumps Stericycle; State's 39 Hospitals Set Up Less Costly Disposal Options." *Waste News.*

Table 1. Basis for Model HMIWI Parameters

Parameters	City	State	Category	APCD code	APCD type	APCD description	Max charge rate (lb/hr)	Stack gas flow rate (dscfm)	Operating hours (hr/yr)	HCl (ppmvd)	CO (ppmvd)	Pb (mg/dscm)
Basis for Models												
Municipality of Chambers County, Resource Recovery Center, Unit 1	Anahuac	TX	L	DIFF	Dry	Secondary chamber, baghouse with virgin lime injection, urea injection, and activated carbon injection	4,167	10,031	7,896	11.0	3.96	0.019
Municipality of Chambers County, Resource Recovery Center, Unit 2	Anahuac	TX	L	DIFF	Dry	Secondary chamber, baghouse with virgin lime injection, urea injection, and activated carbon injection	4,167	9,028	7,896	5.30	2.86	0.0078
Municipality of Chambers County, Resource Recovery Center, Average	Anahuac	TX	L	DIFF	Dry	Secondary chamber, baghouse with virgin lime injection, urea injection, and activated carbon injection	4,167	9,529	7,896	8.17	3.41	0.013
Wilkes-Barre General Hospital	Wilkes-Barre	PA	M	DIFF	Dry	Secondary/tertiary chambers (1800F, 2.85 sec) and dry scrubber/baghouse with lime and activated carbon injection	400	2,063	4,472	8.95	2.08	0.0041
Centers for Disease Control and Prevention--Clifton, Building 18, Unit 3	Atlanta	GA	S	WS	Wet	Secondary chamber (1800F, 1.68 sec) and rotary atomizing wet scrubber	120	717	2,920	1.30	12.1	0.073
Models												
Facility A			L	DIFF	Dry	Secondary chamber, baghouse with virgin lime injection, urea injection, and activated carbon injection	4,000	10,000	8,000	8.17	3.41	0.013
New source MACT floor limit										0.75	2.9	0.00047
Meets limit (0 = yes, 1 = no)										1	1	1
% improvement needed										989%	18%	2714%
Facility B			M	DIFF	Dry	Secondary/tertiary chambers (1800F, 2.85 sec) and dry scrubber/baghouse with lime and activated carbon injection	400	2,000	4,500	8.95	2.08	0.0041
New source MACT floor limit										1.8	1.9	0.016
Meets limit (0 = yes, 1 = no)										1	1	0
% improvement needed										397%	10%	-75%
Facility C			S	WS	Wet	Secondary chamber (1800F, 1.68 sec) and rotary atomizing wet scrubber	100	700	3,000	1.30	12.1	0.073
New source MACT floor limit										4.5	8.2	0.18
Meets limit (0 = yes, 1 = no)										0	1	0
% improvement needed										-71%	48%	-60%

Notes:
1. Patterned new source models after those new HMIWI installed in last 10 years.
2. If emissions data unavailable, used average emissions estimates for similar units (APCD, size) to determine impact status.

Key:
Emissions data unavailable; used average

Table 1. Basis for Model HMIWI Parameters

Parameters	City	State	Category	Cd (mg/dscm)	Hg (mg/dscm)	PM (gr/dscf)	Total CDD/CDF (ng/dscm)	CDD/CDF TEQ (ng/dscm)	NO_X (ppmvd)	NO_X (lb/MMBtu)	SO_2 (ppmvd)
Basis for Models											
Municipality of Chambers County, Resource Recovery Center, Unit 1	Anahuac	TX	L	0.0013	0.0130	0.0070	0.50	0.0081	72	0.10	1.21
Municipality of Chambers County, Resource Recovery Center, Unit 2	Anahuac	TX	L	0.00089	0.0056	0.0095	0.15	0.0038	88	0.11	0.46
Municipality of Chambers County, Resource Recovery Center, Average	Anahuac	TX	L	0.0011	0.0093	0.0082	0.32	0.0059	80	0.11	0.84
Wilkes-Barre General Hospital	Wilkes-Barre	PA	M	0.0011	0.0093	0.0040	16	0.19	no data	0.28	1.90
Centers for Disease Control and Prevention--Clifton, Building 18, Unit 3	Atlanta	GA	S	0.0055	0.0029	0.0076	no data	0.0045	no data	0.28	no data
Models											
Facility A			L	0.0011	0.0093	0.0082	0.32	0.0059	80	0.11	0.84
New source MACT floor limit				0.00012	0.00093	0.0048	0.60	0.014	110		1.9
Meets limit (0 = yes, 1 = no)				1	1	1	0	0	0		0
% improvement needed				822%	900%	72%	-46%	-58%	-27%		-56%
Facility B			M	0.0011	0.0093	0.0040	16	0.19	105	0.28	1.90
New source MACT floor limit				0.0071	0.0020	0.0099	0.35	0.0097	38		0.78
Meets limit (0 = yes, 1 = no)				0	1	0	1	1	1		1
% improvement needed				-85%	363%	-60%	4557%	1885%	177%		143%
Facility C			S	0.0055	0.0029	0.0076	2.89	0.0045	105	0.28	3.52
New source MACT floor limit				0.012	0.0075	0.017	8.3	0.0080	38		0.78
Meets limit (0 = yes, 1 = no)				0	0	0	0	0	1		1
% improvement needed				-55%	-61%	-55%	-65%	-43%	177%		351%

Notes:
1. Patterned new source models after those new HMIWI installed in last 10 years.
2. If emissions data unavailable, used average emissions estimates for similar units (APCD, size) to determine impact status.

Key:
Emissions data unavailable; used average

Table 2. Summary of HMIWI Control Option Costs

Control Option	Pollutants Controlled	Large	Medium	Small
A. Total Capital Investment, $				
1. Packed-bed scrubber	HCl, SO_2	$793,382	$339,084	$265,260
2. Dry injection fabric filter	HCl, Pb, Cd, Hg, PM, CDD/CDF, SO_2	$2,151,123	$1,100,970	$930,320
3. Selective noncatalytic reduction	NO_X	$886,832	$334,906	$186,362
4. Activated carbon injection system	Hg, CDD/CDF	$20,775	$7,910	$4,213
B. Annual Costs, $/yr				
1. Packed-bed scrubber	HCl, SO_2	$183,697	$75,595	$56,754
2. Dry injection fabric filter	HCl, Pb, Cd, Hg, PM, CDD/CDF, SO_2	$708,357	$262,029	$185,831
3. Selective noncatalytic reduction	NO_X	$102,144	$39,484	$22,279
4. Activated carbon injection system	Hg, CDD/CDF	$162,430	$25,773	$9,781
5. Increase carbon flow	Hg, CDD/CDF	$141,950	$15,969	$3,726
6. Increase natural gas	PM, CO, CDD/CDF	$100,691	$11,328	$2,643
7. Autoclave	Alternative to compliance	$729,858	$49,964	$14,623
8. Haul waste to municipal waste combustor	Alternative to compliance	$803,357	$45,189	$7,531
9. Commercial medical waste disposal	Alternative to compliance	$5,145,600	$289,440	$48,240

Notes:
1. National average landfill tip fees used to estimate autoclave cost.
2. National average incinerator tip fees used to estimate cost to haul to municipal waste combustor.

Table 3. Packed Bed Scrubber Costs

Parameters/Costs	Equation	Large	Medium	Small
A. Parameters				
1. Incinerator capacity, lb/hr (C)		4,000	400	100
2. Temperature into quench, F (T1)		300	300	130
3. Temperature out of PB to ID fan, F (T2)		130	130	130
4. Annual operating hours, hr/yr (H)		8,000	4,500	3,000
5. Exhaust gas flow rate, dscfm (Qd)		10,000	2,000	700
6. Assumed moisture content in gas entering quench, % (M)		10	10	10
7. Exhaust gas flow rate, scfm (Qw)	= (Qd) / (1 - M/100)	11,111	2,222	778
8. Water added in quench, scfm (Qh)	= ((7.010 x (T1 - 77°F) - 6.958 x (T2 - 77°F)) x 0.9 + (8.154 x (T1 - 77°F) - 8.064 x (T2 - 77°F)) x 0.1) x (lb-mole/385 scf) x Qw / (1,160 Btu/lb) / (18 lb/lb-mole) x (0.7302 ft^3-atm/lb-mol-°R) x 528°R / 1 atm	647	129	0
9. Actual flow out of PB, acfm (Qa)	= (Qw + Qh) x (460°F + T2)/(528°R)	13,139	2,628	869
10. HCl concentration, ppmvd (HCl)		8.17	8.95	1.30
11. Operating labor rate, $/hr (LR)		$24	$24	$24
12. Electricity cost, $/kWh (EC)		$0.06	$0.06	$0.06
13. Caustic cost, $/ton (CC)		$357	$357	$357
14. Sewage disposal cost, $/1,000 gal (SDC)		$3.80	$3.80	$3.80
15. Water cost, $/1,000 gal (WC)		$0.20	$0.20	$0.20
16. Assumed pressure drop through control system, inches of water (ΔP)		15	15	15
17. Surface area-to-volume ratio for 1" dia. Ceramic Raschig rings, ft^2/ft^3 (SAV)		58	58	58
18. Minimum packing wetting rate, ft^2/hr (WR)		1	1	1
19. Water density, lb/ft^3 (Wd)		62.4	62.4	62.4
20. Water circulation flow rate, lb/hr-ft^2 (Gs)	= SAV x Wd x WR	4,705	4,705	4,705
21. Estimated column cross-sectional area from separate analysis, ft^2 (A)		48	9.6	8.5
22. Water circulation rate, gpm (GPM)	= Gs x A x (1 hr/60 min) x (1 gal/8.33 lb)	452	90	80
23. Water head, ft of water (Head)		60	60	60
24. Wastewater (blowdown) flow, gpm (B)	= (HCl/1000000) x (Qd) x (lb-mole/385 ft^3) x (1 lb-mole NaCl/1 lb-mole HCl) x (58.2 lb NaCl/lb-mole NaCl) x (1 lb wastewater/0.1 lb NaCl) x (1 gal/8.33 lb)	0.015	0.003	0.0002
25. Capital recovery factor, 15-yr equipment life, 7% interest (CRF)	= $[i \times (1 + i)^a] / [(1 + i)^a - 1]$, where i = interest rate, a = equipment life	0.10979	0.10979	0.10979
26. Chemical Engineering plant cost index				
a. 2007		525.4	525.4	525.4
b. 1989		357.5	357.5	357.5

Table 3. Packed Bed Scrubber Costs

Parameters/Costs	Equation	Large	Medium	Small
B. Total Capital Investment, $	= (27.6 x Qd + 109,603) x (525.4/357.5) x (1.4 retrofit factor)	$793,382	$339,084	$265,260
C. Direct Annual Costs, $/yr				
1. Operating labor	= (if Qa < 20,000, then 0, otherwise 0.5 hr/shift) x H x LR	$0	$0	$0
2. Supervisory labor	= 0.15 x (operating labor)	$0	$0	$0
3. Maintenance labor	= (0.5 hr/8-hr shift) x H x (LR x 1.1)	$13,200	$7,425	$4,950
4. Maintenance materials	= 0.02 x TCI	$15,868	$6,782	$5,305
5. Electricity	= (0.000181 x Qa x ΔP x H x EC) + (0.000289 x GPM x Head x H x EC)	$17,241	$1,940	$608
6. Caustic	= HCl x (3.117E-9) x Q x H x CC	$726	$90	$3
7. Sewage disposal	= B x (gal/8.33 lb) x (60 min/hr) x H x SDC	$27	$3	$0.1
8. Makeup water	= (B + Qh x (lb-mole/385 scf) x (18 lb/lb-mole) x (gal/8.33 lb)) x (60 min/hr) x H x WC	$350	$39	$0
D. Indirect Annual Costs, $/yr				
1. Overhead	= 0.6 x (labor + maintenance materials)	$17,441	$8,524	$6,153
2. Property taxes, insurance, and administration	= 0.04 x TCI	$31,735	$13,563	$10,610
3. Capital recovery	= CRF x TCI	$87,109	$37,230	$29,124
E. Total Annual Cost	= Direct Annual Costs + Indirect Annual Costs	$183,697	$75,595	$56,754

Sources:

1. Cost equations: Model Plant Description and Cost Report (II-A-112); and Wet Scrubber Cost Memorandum (IV-B-30).
2. Operating labor rate: Bureau of Labor Statistics, Occupational Employment Statistics, May 2007 National Industry-Specific Occupational Employment and Wage Estimates.
3. Electricity cost: Energy Information Administration. Average Retail Price of Electricity: 2006.
4. Caustic cost: Purchasing.com. Caustic soda price hike is on the horizon. August 29, 2007.
5. Sewage disposal cost, water cost: Air Compliance Advisor, version 7.5.

Table 4. Dry Injection Fabric Filter Costs

Parameters/Costs	Equation	Large	Medium	Small
A. Parameters				
1. Incinerator capacity, lb/hr (C)		4,000	400	100
2. Annual operating hours, hr/yr (H)		8,000	4,500	3,000
3. Exhaust gas flow rate, dscfm (Q)		10,000	2,000	700
4. HCl concentration, ppmvd (HCl)	= (Outlet HCl conc.) / (1 - % HCl control)	163	179	130
5. PM concentration, gr/dscf (PM)	= (Outlet PM conc.) / (1 - % PM control)	10	15	0.5
6. Water vapor in gas from incinerator (10% by weight)				
a. lb/min	= Q / (385 ft^3/lb-mol) x (29 lb/lb-mol) x moisture content (0.10)	75.3	15.1	5.3
b. scfm	= (lb/min) / (18 lb/lb-mol) x (385 ft^3/lb-mol)	1,611	322	113
7. Enthalpy change in quench (1800°F to 300°F)				
a. Dry gas from incinerator, Btu/lb air	= [7.010 x (300°F - 77°F) - 7.554 x (1800°F - 77°F)] / (29 lb/lb-mol)	395	395	395
b. Water vapor from incinerator, Btu/lb water vapor	= [8.154 x (300°F - 77°F) - 9.215 x (1800°F - 77°F)] / (18 lb/lb-mol)	781	781	781
c. Total gas stream, Btu/yr	= [(Btu/lb air) x Q / (385 ft^3/lb-mol) x (29 lb/lb-mol) x (60 min/hr) x H] + [(Btu/lb water vapor) x Q x (0.00753 lb water vapor/ft^3) x (60 min/hr) x H]	1.71E+11	1.92E+10	4.49E+09
d. Cooling water				
i. Heat of vaporization at 77°F, Btu/lb		1,050	1,050	1,050
ii. Sensible heat for vapor, Btu/lb		85	85	85
iii. Total, Btu/lb water		1,135	1,135	1,135
8. Cooling water evaporated, lb/yr				
a. lb/yr	= [enthalpy change (total gas stream, Btu/yr)] / [enthalpy change (cooling water, Btu/lb)]	1.51E+08	1.70E+07	3.96E+06
b. scfm	= [cooling water evaporated (lb/yr)] / (18 lb/lb-mol) x (385 ft^3/lb-mol) / (H x 60 min/hr)	6,714	1,343	470
9. Actual gas flow into fabric filter, acfm (AQ)	= [Q + (water vapor in gas from incinerator, scfm) + (water vapor added in quench, i.e., cooling water evaporated, scfm)] x [(300°F + 460°F)/528°R]	26,377	5,275	1,846
10. Operating labor rate, $/hr (LR)		$24	$24	$24
11. Electricity cost, $/kWh (EC)		$0.06	$0.06	$0.06
12. Lime cost, $/ton (LC)		$95	$95	$95
13. Water cost, $/1,000 gal (WC)		$0.20	$0.20	$0.20
14. Compressed air cost, $/1,000 ft^3 (CAC)		$0.24	$0.24	$0.24
15. Dust disposal cost, $/ton (DDC)		$34.29	$34.29	$34.29
16. Capital recovery factors (CRF)	= $[i \times (1 + i)^a] / [(1 + i)^a - 1]$, where i = interest rate, a = equipment life			

Table 4. Dry Injection Fabric Filter Costs

Parameters/Costs	Equation	Large	Medium	Small
a. Bag CRF, 2-yr life, 7% interest		0.55309	0.55309	0.55309
b. Cage CRF, 4-yr life, 7% interest		0.29523	0.29523	0.29523
c. Equipment CRF, 20-yr life, 7% interest		0.09439	0.09439	0.09439
17. Cost index				
a. 2007		525.4	525.4	525.4
b. 1989		357.5	357.5	357.5
B. Total Capital Investment, $	= (63.8 x Q + 407,498) x (1.4 retrofit cost factor) x (525.4/357.5)	$2,151,123	$1,100,970	$930,320
C. Direct Annual Operating Costs, $/yr				
1. Electricity	= (0.746 kW/hp) x hp (0.0079 x Q + 3.51) x H x EC	$30,333	$3,993	$1,246
2. Makeup lime	= (2.4E-7 lb/dscf x HCl x Q) x (1 ton/2,000 lb) x (60 min/hr) x H x LC	$8,941	$1,102	$187
3. Evaporative cooler water	= (0.1007 x Q + 23.1506) gal/min x (60 min/hr) x H x WC	$98,894	$12,126	$3,371
4. Operating labor	= (1 hr/shift) x (1 shift/8 hr) x H x LR	$24,000	$13,500	$9,000
5. Supervisory labor	= 0.15 x (operating labor)	$3,600	$2,025	$1,350
6. Maintenance labor	= (0.5 hr/shift) x (1 shift/8 hr) x H x (LR x 1.1)	$13,200	$7,425	$4,950
7. Maintenance materials	= 0.02 x TCI	$43,022	$22,019	$18,606
8. Compressed air	= AQ x (2 ft^3 air/1,000 ft^3 filtered) x (60 min/hr) x H x CAC	$6,077	$684	$160
9. Dust disposal	= [(PM gr/dscf x Q x 60 min/hr x 1 lb/7,000 gr) + (HCl x Q x 60 min/hr x 2.86E-7 lb/dscf)] x (1 ton/2,000 lb) x H x DDC	$121,412	$20,313	$224
10. Bag replacement				
a. Bag cost	= AQ x ($2.5/$ft^2$) x (525.4/317.4) x (1.08 taxes and freight ratio)/(3.5 ft/min G/C ratio)	$33,683	$6,737	$2,358
b. Bag replacement labor cost	= AQ x (0.15 hr/bag)/(18 ft^2 bag area)/(3.5 ft/min G/C ratio) x LR	$1,507	$301	$106
c. Bag replacement cost	= Bag CRF x [(total bag cost) + (bag replacement labor cost)]	$19,463	$3,893	$1,362
11. Cage replacement				
a. Number of bags	= AQ/(3.5 ft/min G/C ratio)/(18 ft^2 bag area)	419	84	29
b. Cage replacement labor cost	= bag replacement labor cost	$1,507	$301	$106
c. Cage replacement cost	= Cage CRF x [single-cage cost (4.941+ 0.163 x 18 ft^2 bag area) x (number of bags) x (525.4/317.4) + (cage replacement labor cost)]	$2,056	$411	$144
D. Indirect Annual Costs, $/yr				
1. Overhead	= 0.6 x (labor + maintenance materials)	$50,293	$26,982	$20,344

Table 4. Dry Injection Fabric Filter Costs

Parameters/Costs	Equation	Large	Medium	Small
2. Property taxes, insurance, and administration	= 0.04 x TCI	$86,045	$44,039	$37,213
3. Capital recovery	= Equipment CRF x (TCI - bag replacement cost - cage replacement cost)	$201,020	$103,517	$87,673
E. Total Annual Cost	= Direct Annual Costs + Indirect Annual Costs	$708,357	$262,029	$185,831

Sources:

1. Cost equations: Model Plant Description and Cost Report (II-A-112); and Dry Injection Fabric Filter Cost Memorandum (IV-B-32).
2. Operating labor rate: Bureau of Labor Statistics, Occupational Employment Statistics, May 2007 National Industry-Specific Occupational Employment and Wage Estimates
3. Electricity cost: Energy Information Administration. Average Retail Price of Electricity: 2006.
4. Lime cost: U.S. Geological Survey. Mineral Commodity Summaries 2008. Hydrated Lime Average Value, 2007.
5. Water cost: Air Compliance Advisor, version 7.5.
6. Compressed air cost: P2Pays.org. Energy Tips – Compressed Air. Compressed Air Tip Sheet #1. August 2004.
7. Dust disposal cost: NSWMA's 2005 Tip Fee Survey.

Table 5. Selective Noncatalytic Reduction Costs

Parameters/Costs	Equation	Large	Medium	Small
A. Parameters				
1. Incinerator capacity, lb/hr (C)		4,000	400	100
2. Annual operating hours, hr/yr (H)		8,000	4,500	3,000
3. Exhaust gas flow rate, dscfm (Q)		10,000	2,000	700
4. NO_X, lb/MMBtu		0.11	0.28	0.28
5. Heating value, Btu/lb (HV)		8,500	8,500	8,500
6. Urea solution cost, $/gal (U)		$0.85	$0.85	$0.85
7. Electricity cost, $/kWh (EC)		$0.06	$0.06	$0.06
8. Water cost, $/1,000 gal (WC)		$0.20	$0.20	$0.20
9. Capital recovery factor, 20-yr equipment life, 7% interest (CRF)	= $[i \times (1 + i)^a] / [(1 + i)^a - 1]$, where i = interest rate, a = equipment life	0.09439	0.09439	0.09439
10. Cost index				
a. 2007		525.4	525.4	525.4
b. 1998		390.6	390.6	390.6
B. Total Capital Investment, $ (TCI)				
1. Total Direct Capital Cost (DC)	= [$950/(MMBtu/hr)] x [(C x HV) / 10^6] x [(2,375 MMBtu/hr / (C x HV)]$^{0.577}$ x (0.66 + 0.85 x 45% NO_X removal efficiency) x (1.2 retrofit factor) x (525.4/390.6)	$629,959	$237,855	$132,325
2. Indirect Installation Costs, $ (IC)	= 0.2 x DC	$125,992	$47,571	$26,465
3. Other Capital Costs, $ (OC)	= [0.173 x (DC + IC)] + (119.3 gal x U)	$130,881	$49,480	$27,572
4. Total	= DC + IC + OC	$886,832	$334,906	$186,362
C. Direct Annual Costs, $/yr				
1. Maintenance	= 0.015 x TCI	$13,302	$5,024	$2,795
2. Reagent	= (0.36 gal/hr) x H x U	$2,448	$1,377	$918
3. Electricity	= kW [0.47 x NO_X x (C x HV) / 10^6] / 9.5 x H x EC	$91	$13	$2
4. Water	= 1.62 gal/hr x H x WC	$2,592	$1,458	$972
D. Indirect Annual Costs, $/yr				
1. Capital recovery	= CRF x TCI	$83,711	$31,613	$17,591
E. Total Annual Cost	= Direct Annual Costs + Indirect Annual Costs	$102,144	$39,484	$22,279

Sources:

1. Cost equations, urea solution cost: OAQPS Control Cost Manual. Section 4.2: NO_X Post-Combustion, Chapter 1: Selective Noncatalytic Reduction.
2. Heating value: Process Description Report (II-A-110).
3. Electricity cost: Energy Information Administration. Average Retail Price of Electricity: 2006.
4. Water cost: Air Compliance Advisor, version 7.5.
5. NO_X removal efficiency: Clean Air Technology Center. EPA Technical Bulletin: Nitrogen Oxides (NO_X)--Why and How They Are Controlled. 456/F-99-006R. November 1999.

Table 6. Activated Carbon Injection Costs

Parameters/Costs	Equation	Large	Medium	Small
A. Parameters				
1. Incinerator capacity, lb/hr (C)		4,000	400	100
2. Annual operating hours, hr/yr (H)		8,000	4,500	3,000
3. Exhaust gas flow rate, dscfm (Q)		10,000	2,000	700
4. Operating labor rate, $/hr (LR)		$24	$24	$24
5. Activated carbon cost, $/lb (ACC)		$1.38	$1.38	$1.38
6. Dust disposal cost, $/ton (DDC)		$34.29	$34.29	$34.29
7. Capital recovery factor, 20-yr equipment life, 7% interest (CRF)	$= [i \times (1 + i)^a] / [(1 + i)^a - 1]$, where i = interest rate, a = equipment life	0.09439	0.09439	0.09439
8. Cost index				
a. 2007		525.4	525.4	525.4
b. 1990		361.3	361.3	361.3
B. Total Capital Investment, $	$= 4{,}500 \times (Q/1{,}976)^{0.6} \times$ (1.2 retrofit factor) x (525.4/361.3)	$20,775	$7,910	$4,213
C. Direct Annual Costs, $/yr				
1. Operating labor	= (0.25 hr/8-hr shift) x H x LR	$6,000	$3,375	$2,250
2. Supervisory labor	= 0.15 x (operating labor)	$900	$506	$338
3. Maintenance	= 0.2 x TCI	$4,155	$1,582	$843
4. Activated carbon	= 0.00127 x Q x H x ACC	$140,208	$15,773	$3,680
5. Dust disposal	= 0.00127 x Q x (1 ton/2,000 lb) x H x DDC	$1,742	$196	$46
D. Indirect Annual Costs, $/yr				
1. Overhead	= 0.6 x (labor + maintenance materials)	$6,633	$3,278	$2,058
2. Property taxes, insurance, and administration	= 0.04 x TCI	$831	$316	$169
3. Capital recovery	= CRF x TCI	$1,961	$747	$398
E. Total Annual Cost, $/yr	= Direct Annual Costs + Indirect Annual Costs	$162,430	$25,773	$9,781

Note:
Factor of 1.27×10^{-3} for activated carbon is based on injecting carbon at a rate to achieve a carbon concentration of 338 mg/dscm (achieving reductions of 90% for Hg, 98% for CDD/CDF).

Sources:
1. Cost equations: Model Plant Description and Cost Report (II-A-112).
2. Operating labor rate: Bureau of Labor Statistics, Occupational Employment Statistics, May 2007 National Industry-Specific Occupational Employment and Wage Estimates.
3. Activated carbon cost: The Innovation Group. Chemical Profiles: Carbon, Activated. 2002. Assumed 20% price increase based on online information from Norit, an activated carbon vendor.
4. Dust disposal cost: NSWMA's 2005 Tip Fee Survey.

Table 7. Incremental Control Costs

Parameters/Costs	Equation	Large	Medium	Small
A. Parameters				
1. Incinerator capacity, lb/hr (C)		4,000	400	100
2. Annual operating hours, hr/yr (H)		8,000	4,500	3,000
3. Exhaust gas flow rate, dscfm (Q)		10,000	2,000	700
5. Dust disposal cost, $/ton (DDC)		$34.29	$34.29	$34.29
6. Activated carbon cost, $/lb (ACC)		$1.38	$1.38	$1.38
7. Natural gas cost, $/1,000 ft^3 (NGC)		$7.97	$7.97	$7.97
B. Increase Carbon Flow				
1. Activated carbon, $/yr	= (1.27E-3) x Q x H x ACC	$140,208	$15,773	$3,680
2. Dust disposal, $/yr	= (1.27E-3) x Q x (1 ton/2,000 lb) x H x DDC	$1,742	$196	$46
3. Total cost	= Activated carbon + Dust disposal	$141,950	$15,969	$3,726
C. Increase Natural Gas				
1. Natural gas	= (0.32 Btu/lb/°F) x (28.5 lb/lbmole) x (100°F) x (lbmole/385 ft^3) x (ft^3/1,000 Btu) x (Q/0.9) x (60 min/hr) x H x NGC	$100,691	$11,328	$2,643

Sources:

1. Cost equations: Model Plant Description and Cost Report (II-A-112); Dry Injection Fabric Filter Cost Memorandum (IV-B-32); and Secondary Chamber Retrofit Cost Memorandum (IV-B-33).
2. Operating labor rate: Bureau of Labor Statistics, Occupational Employment Statistics, May 2007 National Industry-Specific Occupational Employment and Wage Estimates.
3. Dust disposal cost: NSWMA's 2005 Tip Fee Survey.
4. Natural gas cost: Energy Information Administration. Natural Gas Prices: December 2007.
5. Activated carbon cost: The Innovation Group. Chemical Profiles: Carbon, Activated. 2002. Assumed 20% price increase based on online information from Norit, an activated carbon vendor.

Table 8. Maintenance and Inspection Costs

Parameters	Equation	Values
A. Parameters		
1. Cost index		
a. 2007		525.4
d. 1992		358.2
B. Maintenance/Inspection Cost, $/yr (rounded)		
1. Company A	= $500 x (525.4/358.2)	$700
2. Company B	= $350 x (525.4/358.2)	$500
3. Company C	= $800 x (525.4/358.2)	$1,200
4. Company D	= $750 x (525.4/358.2)	$1,100
5. Average	= ∑ (Companies A-D) / 4	$900

Note:
Maintenance/inspection costs have been rounded to the nearest $100 to be consistent with level of rounding in original costs.

Source:
Maintenance/Inspection Programs Memorandum (II-B-88).

Table 9. Monitoring Costs

Parameters/Costs	Equation	DIFF	WS	ACI	SNCR	Bag leak detector	CO CEMS	HCl CEMS	PM CEMS	Hg CEMS	Multi-metal CEMS
A. Parameters											
1. Cost index											
a. 2007		525.4	525.4	525.4	525.4	525.4	525.4	525.4	525.4	525.4	525.4
b. 2006		499.6	499.6	499.6	499.6	499.6	499.6	499.6	499.6	499.6	499.6
c. 1997		386.5	386.5	386.5	386.5	386.5	386.5	386.5	386.5	386.5	386.5
d. 1993		359.2	359.2	359.2	359.2	359.2	359.2	359.2	359.2	359.2	359.2
2. Operating labor wage rate, $/hr (LR)		$24.00	$24.00	$24.00	$24.00	$24.00	$24.00	$24.00	$24.00	$24.00	$24.00
3. Capital recovery factor, 20-yr equipment life, 7% interest (CRF)	= [i x $(1 + i)^a$] / [$(1 + i)^a$ - 1], where i = interest rate, a = equipment life	0.09439	0.09439	0.09439	0.09439	0.09439	0.09439	0.09439	0.09439	0.09439	0.09439
C. Total Capital Investment, $ (TCI)											
1. Planning		$700	$700		$700	$700	$3,700	$3,000	$800	$3,000	
2. Select type of equipment		$400	$400		$400	$4,100	$9,100	$14,700	$11,100	$14,700	
3. Provide support facilities		$1,400	$1,400		$1,400	$400	$18,800	$18,800	$400	$18,800	
4. Purchased equipment cost (PEC)		$11,900	$17,500		$5,300	$12,800	$44,200	$47,400	$67,100	$100,300	
5. Install and check equipment		$1,000	$1,000		$1,000	$4,400	$16,600	$17,700	$17,800	$19,700	
6. Perf. spec. tests (certif.)		$700	$700		$700	$0	$14,300	$11,700	$32,400	$38,600	
7. Prepare QA/QC plan		$700	$700		$700	$700	$16,000	$16,000	$14,100	$16,000	
8. Total capital cost	= Planning + selecting equipment + support facilities + PEC + installation + perf. spec. tests + QA/QC plan	$16,800	$22,400		$10,200	$23,100	$123,000	$129,000	$144,000	$211,000	$210,000
D. Annual Costs, $/yr											
1. Operating labor	= (5 min to record lime/carbon flow/4-hr period) x (1 hr/60 min) x (3,000 hr/yr for small model) x LR	$1,500		$1,500							
2. Maintenance materials	= 0.02 x TCI	$300	$400		$200						
3. Operation & maintenance	= Day-to-day activities + annual RATA + CGA + annual QA + O&M review and update					$5,000	$25,200	$22,500	$24,900	$71,300	
4. Recordkeeping and reporting		$1,400	$1,400		$1,400	$200	$1,100	$1,500	$5,800	$1,500	
5. Overhead	= 0.6 x (labor + maintenance materials)	$1,100	$200	$900	$100						
6. Property taxes, insurance, and administration	= 0.04 x TCI	$700	$900		$400						
7. Capital recovery	= CRF x TCI	$1,600	$2,100		$1,000	$3,200		$18,400	$20,500	$30,100	
8. Total annual cost	= Operating labor + maintenance materials + operation & maintenance + recordkeeping and reporting + overhead + property taxes, insurance, and administration + capital recovery	$6,600	$5,000	$2,400	$3,100	$8,400	$26,300	$42,400	$51,200	$102,900	$57,800

Notes:

1. Monitoring costs have been rounded to the nearest $100 to be consistent with level of rounding in original costs.
2. Costs to be replaced include: (a) bag leak detector replacing opacity test; (b) CO CEMS replacing CO test and secondary chamber temperature monitor; (c) HCl CEMS replacing HCl test, HCl sorbent monitor (dry scrubbers) and scrubber liquor pH monitor (wet scrubbers); (d) PM CEMS replacing PM and opacity tests and and pressure drop monitor (wet scrubbers); (e) multi-metal/Hg CEMS replacing flue gas temperature monitor (wet scrubbers); (f) dioxin sorbent trap biweekly monitoring replacing fabric filter inlet temperature monitor; and (g) Hg sorbent trap biweekly monitoring replacing flue gas temperature monitor (wet scrubbers).

Sources:

1. Testing and Monitoring Options and Costs Memo (IV-B-66).
2. E-mail and attachment from Peter Westlin, EPA, to Mary Johnson, EPA. August 19, 2008. Monitoring Options for SNCR on Medical Waste Incinerators.
3. E-mail from Dan Bivins, EPA, to Mary Johnson, EPA. September 27, 2006. Cost of CO CEMS.
4. E-mail from Dan Bivins, EPA, to Mary Johnson, EPA. July 28, 2006. Some Preliminary Thoughts on the HWI Monitoring.

Table 9. Monitoring Costs

Parameters/Costs	Dioxin or Hg sorbent trap biweekly monitoring
A. Parameters	
1. Cost index	
a. 2007	525.4
b. 2006	499.6
c. 1997	386.5
d. 1993	359.2
2. Operating labor wage rate, $/hr (LR)	$24.00
3. Capital recovery factor, 20-yr equipment life, 7% interest (CRF)	0.09439
C. Total Capital Investment, $ (TCI)	
1. Planning	
2. Select type of equipment	
3. Provide support facilities	
4. Purchased equipment cost (PEC)	
5. Install and check equipment	
6. Perf. spec. tests (certif.)	
7. Prepare QA/QC plan	
8. Total capital cost	$105,000
D. Annual Costs, $/yr	
1. Operating labor	
2. Maintenance materials	
3. Operation & maintenance	
4. Recordkeeping and reporting	
5. Overhead	
6. Property taxes, insurance, and administration	
7. Capital recovery	
8. Total annual cost	$37,900

Notes:
1. Monitoring costs have been rounded to the ne
2. Costs to be replaced include: (a) bag leak det
(c) HCl CEMS replacing HCl test, HCl sorbent m
opacity tests and and pressure drop monitor (we
sorbent trap biweekly monitoring replacing fabric
monitor (wet scrubbers).

Sources:
1. Testing and Monitoring Options and Costs Me
2. E-mail and attachment from Peter Westlin, EF
3. E-mail from Dan Bivins, EPA, to Mary Johnso
4. E-mail from Dan Bivins, EPA, to Mary Johnso

Table 10. Stack Testing Costs

Parameters		Values
A. Parameters		
1. Cost index		
a. 2007		525.4
d. 1992		358.2
A. Testing Costs, $		
1. Method 5 (PM)	= $8,000 x (525.4/358.2)	$12,000
2. Method 9 (opacity)	= $1,000 x (525.4/358.2) + $1,500	$2,500
3. Method 10 (CO)	= $4,000 x (525.4/358.2) + $1,000	$7,000
4. Method 26 (HCl)	= $5,000 x (525.4/358.2)	$7,000
5. Method 29 (metals)	= $8,000 x (525.4/358.2) + $2,000	$14,000
6. Method 23 (CDD/CDF)	= $21,000 x (525.4/358.2) - $5,000	$26,000
7. Method 7E (NO_X)	= $5,000 x (525.4/358.2)	$7,000
8. Method 6C (SO_2)	= $5,000 x (525.4/358.2)	$7,000

Note:
1. Initial testing costs to be annualized over 15 years at 7% interest.
2. Testing costs have been rounded to the nearest $1,000 (except for opacity) to be consistent with level of rounding in original costs; costs also adjusted based on additional information from EPA.
3. Multiple test costs adjusted by 2/3 in nationwide cost estimates to account for travel, accommodations, methods/sampling trains, etc. common to the tests.

Sources:
1. Memorandum from R. Segall, EPA/EMB, to R. Copland, EPA/SDB. October 14, 1992. Medical Waste Incinerator Study: Emission Measurement and Continuous Monitoring. (II-B-89)
2. E-mail from Jason Dewees, EPA, to Peter Westlin, EPA. August 20, 2008. Monitoring Options for SNCR & Test Cost Questions.
3. E-mail from Jason Dewees, EPA, to Mary Johnson, EPA. August 20, 2008. Re: Monitoring Options for SNCR & Test Cost Questions.

Table 11. Visible Emissions Testing Costs

Parameters/Costs	Equation	Values
A. Parameters		
1. Operating labor rate, $/hr (LR)		$24
2. Capital recovery factor, 5-yr equipment life, 7% interest (CRF)	= $[i \times (1 + i)^a] / [(1 + i)^a - 1]$, where i = interest rate, a = equipment life	0.24389
B. Total Capital Investment, $ (TCI)	= Combination light meter/anemometer ($200) + digital stopwatches (2 each at $25)	$250
C. Direct Annual Costs, $/yr		
1. Operating labor	= (1 hr/reading) x (3 readings/test) x (1 test/yr) x LR	$72
D. Indirect Annual Costs, $/yr		
1. Overhead	= 0.6 x (operating labor)	$43
2. Property taxes, insurance, and administration	= 0.04 x TCI	$10
3. Capital recovery	= CRF x TCI	$61
E. Total Annual Cost, $/yr (rounded)	= Direct Annual Costs + Indirect Annual Costs	$200

Sources:

1. Professional Equipment. 2008. Light Meters Industrial and Professional: Digital Light Meter. Website: http://www.professionalequipment.com. Accessed July 24, 2008.
2. Cole-Parmer. 2008. Digital Stopwatches -Cole Parmer Instrument Catalog. Website: http://www.coleparmer.com. Accessed July 24, 2008.

Table 12. Recordkeeping and Reporting Costs

Burden item	(A) Person-hours per occurrence	(B) Number of occurrences per year	(C) Person-hours per respondent per year (C = A x B)	(D) Respondents per year	(E) Technical person-hours per year (E = C x D)	(F) Management person-hours per year (F = E x 0.05)	(G) Clerical person-hours per year (G = E x 0.1)	(H) Total person-hours per year (H = E + F + G)	(I) Cost, $	(J) Cost per respondent, $
A. Applications	N/A									
B. Surveys and Studies	N/A									
C. Reporting Requirements										
1. Read instructions	1.0	1	1.0	0	0.0	0.00	0.0	0.0	$0	
2. Required activities										
a. Perf. spec. tests (certif.) for CMS	16	1	16	1	16	0.8	1.6	18	$698	$698
b. Development of operating information	160	1	160	0	0	0.0	0.0	0	$0	
c. Annual update of operating information	20	1	20	0	0	0	0	0	$0	
d. Review of operating information with each operator	8.0	2	16	0	0	0	0	0	$0	
3. Write report										
a. Notification of initial performance test	2.0	1	2.0	1	2	0.1	0.2	2.3	$87	$87
b. Notification of initial CMS demonstration	2.0	1	2.0	1	2	0.1	0.2	2.3	$87	$87
c. Waste management plan	160	1	160	0	0	0.0	0.0	0.0	$0	
d. Report of initial performance test	8.0	1	8.0	1	8	0.4	0.8	9.2	$349	$349
e. Report of initial CMS demonstration	Incl. in C2									
f. Annual report										
i. CMS operating parameters	32	1	32	3	96	4.8	10	110	$4,186	$1,395
ii. Report of no exceedances										
-- CO CEMS	8	1	8	3	24	1.2	2	28	$1,046	$349
-- Scrubber monitoring	8	1	8	3	24	1.2	2	28	$1,046	$349
-- Bag leak detector	8	1	8	3	24	1.2	2	28	$1,046	$349
-- SNCR monitoring	8	1	8	3	24	1.2	2	28	$1,046	$349
iii. Results of performance tests conducted during the year	40	1	40	0	0	0.0	0	0	$0	
D. Recordkeeping Requirements										
1. Read instructions	Incl. in C1									
2. Plan activities	N/A									
3. Implement activities	N/A									
4. Develop record system	N/A									
5. Time to enter information										
a. Records of operators completing operator training requirements	2.0	2	4.0	0	0	0.0	0.0	0	$0	
b. Records of operators that have been qualified as HMIWI operators	2.0	2	4.0	0	0	0.0	0.0	0	$0	
c. Records of initial performance test	Incl. in C3									
d. Records of startup, shutdown, or malfunction	1.5	52	78	0	0	0	0	0	$0	
e. Records of persons completing review of operating information	2.0	2	4.0	0	0	0	0	0	$0	
f. Records of annual and any subsequent compliance tests	Incl. in C3									
g. Records of process and control device operating parameters	1.5	52	78	3	234	12	23	269	$10,203	$3,401
h. Records of CMS operation and maintenance	0.025	365	9.1	3	27	1	3	31	$1,194	$398
6. Time to train personnel	40	1	40	0	0	0	0	0	$0	
7. Time for audits	N/A									
E. Total Labor Burden and Cost					481	24	48	554	$20,989	

Notes:

1. An estimated 3 HMIWI are projected to be installed over the first 3 years after promulgation (1 large, 1 medium, and 1 small).
2. All 3 HMIWI will need to conduct initial stack tests, fugitive ash tests, and CMS demonstrations to demonstrate compliance.
3. Industry costs are based on the following hourly rates: technical at $37.55, management at $78.76, and clerical at $21.10 (see table below). The composite hourly labor rate is ($37.55/hr) + (0.05 x $78.76/hr) + (0.1 x $21.10/hr) = $43.60/hr. Labor rates were increased by 60% to account for overhead.
4. Person-hours per occurrence for CMS performance specification costs are based on the performance specification costs to certify CMS ($700) divided by the composite hourly labor rate ($43.60/hr).
5. Assume 160 hrs to develop the operating information; respondents already required to conduct this task.
6. Assume 20 hours to update the operating information each year; respondents already required to conduct this task.
7. Assume 8 hours to review the operating information with each operator; respondents already required to conduct this task.
8. Assume 2 operators per facility. Also assume there is no operator turnover at the affected facilities.
9. Control device inspection cost already accounted for under monitoring costs.
10. Assume 160 hours for each facility to develop the waste management plan; respondents already required to conduct this task.
11. Assume 8 hours for each facility to review the report of the initial performance test; respondents already required to conduct this task.
12. Person-hours per occurrence for CMS operating parameters are based on the reporting and recordkeeping costs for CMS ($1,400) divided by the composite hourly rate ($43.60/hr).
13. Assume 8 person-hours per report per pollutant to report no excess emissions. Additional monitoring focuses primarily on three pollutants (HCl, CO, and NO_X) and stack opacity.
14. Assume all respondents in compliance and report no exceedances.
15. Assume 40 hours to review annual compliance test report; respondents already required to conduct this task.
16. Assume facilities will need to complete initial operator training requirements; respondents already required to conduct this task.
17. Records of SSM and operating parameters are kept on a weekly basis.
18. Assume 1.5 hours per week to record operating parameters and parameter exceedances.
19. Person-hours per occurrence for daily CMS operation and maintenance (O&M) are based on the O&M cost for CMS divided by the composite hourly labor rate and the operating days per year, determined for each existing HMIWI, and then averaged.
20. Time to train personnel based on the time per year to train one person to perform the Method 9 and Method 22 tests. The labor requirements to train the personnel were estimated to be 8 hours per day for 5 days per year; respondents already required to conduct this task.
21. The average burden and cost in the first 3 years after promulgation for the sources with recurrent burden are equal to the person-hours added down each column for technical, management, and clerical and the sum of the cost column.

Sources:

1. Bureau of Labor Statistics, Occupational Employment Statistics, May 2007 National Industry-Specific Occupational Employment and Wage Estimates.
2. Testing and Monitoring Options and Costs Memo (IV-B-66).

Labor Rates:

Parameter	General Medical & Surgical Hospitals	Waste Treatment & Disposal	Colleges, Universities, & Professional Schools	Pharma-ceutical & Medicine Manufac-turing	Total	Loaded
% of industry (excluding U.S. military/gov. research facilities)	58.49%	26.42%	7.55%	7.55%	100.00%	
Technical - Stationary Engineers & Boiler Operators	$23.80	$23.31	$22.01	$22.94	$23.47	$37.55
Management - Engineering Managers	$45.95	$55.00	$47.07	$56.56	$49.23	$78.76
Clerical - Office Clerks, General	$13.16	$12.75	$12.53	$15.63	$13.19	$21.10
Composite labor rate						$43.60

Table 13. Autoclave Treatment Costs

Parameters/Costs	Equation	Large	Medium	Small
A. Parameters				
1. Incinerator capacity, lb/hr (C)		4,000	400	100
2. Annual operating hours, hr/yr (H)		8,000	4,500	3,000
3. Landfill tip fee (national average), $/ton		$34.29	$34.29	$34.29
B. Total Capital Investment, $		$1,000,000	$450,000	$350,000
C. Annual Costs, $/lb				
1. Autoclave		$0.02	$0.02	$0.06
2. Biological indicators test	= [($7/test kit) x (12 tests/yr) + (0.5 hr/test) x (12 tests/yr) x ($20/hr)]/ (312 d/yr) / (50,000 lb waste/d)	$0.000013	$0.000013	$0.000013
3. Inspections	= 2 hr/inspection x 1 inspection/yr x ($20/hr) / (312 d/yr) / (50,000 lb waste/d)	$0.000003	$0.000003	$0.000003
4. Permit fee	= ($500/yr) / (312 hr/yr) / (50,000 lb waste/d)	$0.00003	$0.00003	$0.00003
5. Total				
a. Without landfill tip fee	= Autoclave + biological indicators test + inspections + permit fee	$0.02	$0.02	$0.06
b. With landfill tip fee	= Autoclave + biological indicators test + inspections + permit fee + (landfill tip fee/2,000 lb/ton)	$0.03	$0.04	$0.07
D. Annual Costs (with landfill tip fee), $/yr	= Total annual cost x (C x 0.67) x H	$729,858	$49,964	$14,623

Notes:
1. Annual autoclave costs include operational costs (chamber liners, labor, capital expense, maintenance, steam, electricity) and hauling costs. Hauling costs from vendor were revised to extract landfill costs, which will be applied to each HMIWI on a regional basis in estimating nationwide costs. National average landfill tip fees used to estimate model costs.
2. The vendor's labor rate and operating time were used in costing the biological indicators test, inspections, and permit fee in order to be consistent with the approach used in the vendor's autoclave costs.

Sources:
1. Autoclave costs and biological indicators test (test kit): San-I-Pak, July 2008.
2. Biological indicators test (labor), inspections, and permit fee: Bay Area Dioxins Project, June 2003.

Table 14. Costs to Haul to Municipal Waste Combustor

Parameters/Costs	Equation	Large	Medium	Small
A. Parameters				
1. Incinerator capacity, lb/hr (IC)		4,000	400	100
2. Annual operating hours, hr/yr (H)		8,000	4,500	3,000
3. Incinerator tip fee (national average), $/ton		$61.64	$61.64	$61.64
B. Annual Costs, $/ton				
1. Without incinerator tip fee	= $0.266/ton-mile x 50 miles	$13.30	$13.30	$13.30
2. With incinerator tip fee	= $0.266/ton-mile x 50 miles + incinerator tip fee	$74.94	$74.94	$74.94
C. Annual Costs (with incinerator tip fee), $/yr	= Total annual cost x (C x 0.67) x H	$803,357	$45,189	$7,531

Note:
National average incinerator tip fee applied to estimate model costs.

Sources:
1. Incinerator tip fee: NSWMA's 2005 Tip Fee Survey.
2. Hauling cost: U.S. Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics. Table 3-17: Average Freight Revenue Per Ton-mile. Assume 50 mile/trip to reach an MWC.

Table 15. Costs for Commercial Medical Waste Disposal

Parameters/Costs	Large	Medium	Small
A. Parameters			
1. Incinerator capacity, lb/hr (IC)	4,000	400	100
2. Annual operating hours, hr/yr (H)	8,000	4,500	3,000
B. Annual Costs, $/lb			
1. $/lb	$0.24	$0.24	$0.24
2. $/yr	$5,145,600	$289,440	$48,240

Source:
Commercial disposal fee: Switching Scenarios Memorandum (IV-B-53); cost is in range of recent estimates online ($0.16/lb for 2006 contract for pickup and disposal of medical waste from sources at University of Kentucky; $0.35/lb for 2007 pickup and disposal of medical waste from sources at University of Texas at San Antonio; $0.22-$0.27/lb for 2004 pickup and disposal of medical waste from hospitals in Maine).

Table 16. Nationwide MACT Floor Costs for New Sources

Facility name	Category	APCD code	APCD type	APCD description	Maximum charge rate (lb/hr)	Stack gas flow rate (dscfm)	Operating hours (hr/yr)	Autoclave ($/lb)	Landfill tip fee ($/ton)	Autoclave/ landfill cost	Meets HCl Limit	Meets CO Limit	Meets Cd Limit
Facility A	L	DIFF	Dry	Secondary chamber, baghouse with virgin lime injection, urea injection, and activated carbon injection	4,000	10,000	8,000	$0.02	$34.29	**$729,858**	1	1	1
Facility B	M	DIFF	Dry	Secondary/tertiary chambers (1800F, 2.85 sec) and dry scrubber/baghouse with lime and activated carbon injection	400	2,000	4,500	$0.02	$34.29	**$49,964**	1	1	0
Facility C	S	WS	Wet	Secondary chamber (1800F, 1.68 sec) and rotary atomizing wet scrubber	100	700	3,000	$0.06	$34.29	**$14,623**	0	1	0
Total nationwide										**$794,445**			

Notes:
1. Patterned new source models after those new HMIWI installed in last 10 years.
2. If emissions data unavailable, used average emissions estimates for similar units (APCD, size) to determine impact status.
3. Assumed minimal cost associated with redesigning baghouse to improve PM/metals collection efficiency.
4. The only new testing requirements for new sources (relative to 1997 regulation) are initial NO_X and SO_2 testing and annual VE testing.

Table 16. Nationw

Facility name	Category	Meets Pb Limit	Meets Hg Limit	Meets PM Limit	Meets Total CDD/CDF Limit	Meets CDD/CDF TEQ Limit	Meets CDD/CDF Limit (Total or TEQ)	Meets NO_X Limit	Meets SO_2 Limit	HCl % Improvement Needed	MACT floor HCl control	CO % Improvement Needed	MACT floor CO control
Facility A	L	1	1	1	0	0	0	0	0	989%	include packed-bed scrubber	18%	use more natural gas
Facility B	M	0	1	0	1	1	1	1	1	397%	include packed-bed scrubber	10%	use more natural gas
Facility C	S	0	0	0	0	0	0	1	1	-71%	none	48%	use more natural gas
Total nationwide													

Notes:
1. Patterned new source r
2. If emissions data unava
units (APCD, size) to dete
3. Assumed minimal cost
PM/metals collection effic
4. The only new testing re
are initial NO_X and SO_2 te

Table 16. Nationw

Facility name	Category	Pb % Improvement Needed	MACT floor Pb control	Cd % Improvement Needed	MACT floor Cd control	Hg % Improvement Needed	MACT floor Hg control	PM % Improvement Needed	MACT floor PM control	Total CDD/CDF % Improvement Needed	MACT floor CDD/CDF control	CDD/CDF TEQ % Improvement Needed
Facility A	L	2714%	install more efficient FF	822%	install more efficient FF	900%	use more activated carbon	72%	install more efficient FF	-46%	none	-58%
Facility B	M	-75%	none	-85%	none	363%	use more activated carbon	-60%	none	4557%	use more activated carbon	1885%
Facility C	S	-60%	none	-55%	none	-61%	none	-55%	none	-65%	none	-43%
Total nationwide												

Notes:
1. Patterned new source r
2. If emissions data unava
units (APCD, size) to dete
3. Assumed minimal cost
PM/metals collection effic
4. The only new testing re
are initial NO_X and SO_2 te

Table 16. Nationw

Facility name	Category	MACT floor TEQ control	NO_X % Improvement Needed	MACT floor NO_X control	SO_2 % Improvement Needed	MACT floor SO_2 control	Consolidated MACT floor controls	APCD code with MACT floor controls	Packed-bed scrubber	SNCR	Use more carbon	Use more natural gas
Facility A	L	none	-27%	none	-56%	none	install more efficient FF, include packed-bed scrubber, use more natural gas and activated carbon	DIFF/WS	$183,697	$0	$141,950	$100,691
Facility B	M	use more activated carbon	177%	include SNCR	143%	include packed-bed scrubber	include packed-bed scrubber and SNCR, use more natural gas and activated carbon	DIFF/WS	$75,595	$39,484	$15,969	$11,328
Facility C	S	none	177%	include SNCR	351%	include packed-bed scrubber	include packed-bed scrubber and SNCR, use more natural gas	WS	$56,754	$22,279	$0	$2,643
Total nationwide												

Notes:
1. Patterned new source r
2. If emissions data unava
units (APCD, size) to dete
3. Assumed minimal cost
PM/metals collection effic
4. The only new testing re
are initial NO_X and SO_2 te

Table 16. Nationw

Facility name	Category	Install more efficient FF	Total MACT floor control cost	Maintenance/ inspection	Additional monitoring	WS monitoring	SNCR monitoring	Bag leak detector	CO CEMS	Total MACT floor monitoring cost	HCl testing	CO testing	Metals testing	PM testing
Facility A	L	$0	**$426,338**	$900	WS, BLD, CO CEMS	$5,000	$0	$8,400	$26,300	**$40,600**	$0	$0	$0	$0
Facility B	M	$0	**$142,377**	$900	WS, SNCR, BLD, CO CEMS	$5,000	$3,100	$8,400	$26,300	**$43,700**	$0	$0	$0	$0
Facility C	S	$0	**$81,676**	$900	WS, SNCR, CO CEMS	$0	$3,100	$0	$26,300	**$30,300**	$0	$0	$0	$0
Total nationwide			**$650,390**							**$114,600**				

Notes:
1. Patterned new source r
2. If emissions data unava
units (APCD, size) to dete
3. Assumed minimal cost
PM/metals collection effic
4. The only new testing re
are initial NO_X and SO_2 te

Table 16. Nationw

Facility name	Category	CDD/CDF testing	NO_X testing	SO_2 testing	Opacity testing	Initial stack testing cost	Initial VE testing cost	Annual PM testing	Annual CO testing	Annual HCl testing	Annual opacity testing	Annual stack testing cost	Annual VE testing cost	Total MACT floor testing cost	Read instructions	Performance spec test
Facility A	L	$0	$7,000	$7,000	$0	$9,333	$0	$0	$0	$0	$0	$0	$200	**$1,225**	$0	$698
Facility B	M	$0	$7,000	$7,000	$0	$9,333	$0	$0	$0	$0	$0	$0	$200	**$1,225**	$0	$698
Facility C	S	$0	$7,000	$7,000	$0	$9,333	$0	$0	$0	$0	$0	$0	$200	**$1,225**	$0	$698
Total nationwide														**$3,674**		

Notes:
1. Patterned new source r
2. If emissions data unava
units (APCD, size) to dete
3. Assumed minimal cost
PM/metals collection effic
4. The only new testing re
are initial NO_X and SO_2 te

Table 16. Nationw

Facility name	Category	Operating information	Notification of performance test	Notification of CMS demon-stration	Waste management plan	Initial test report	Compliance report	Records	Training personnel	Total MACT floor record-keeping and reporting cost	Total MACT floor cost
Facility A	L	$0	$87	$87	$0	$349	$2,442	$3,799	$0	**$7,461**	**$475,624**
Facility B	M	$0	$87	$87	$0	$349	$2,790	$3,799	$0	**$7,810**	**$195,112**
Facility C	S	$0	$87	$87	$0	$349	$1,744	$3,799	$0	**$6,764**	**$119,964**
Total nationwide										**$22,035**	**$790,700**

Notes:
1. Patterned new source r
2. If emissions data unava
units (APCD, size) to dete
3. Assumed minimal cost
PM/metals collection effic
4. The only new testing re
are initial NO_X and SO_2 te

Table 17. Nationwide Beyond-the-Floor Costs for New Sources

Facility name	Category	APCD code	APCD type	APCD description	Maximum charge rate (lb/hr)	Stack gas flow rate (dscfm)	Operating hours (hr/yr)	Autoclave ($/lb)	Landfill tip fee ($/ton)	Autoclave/ landfill cost	MACT floor controls
Facility A	L	DIFF	Dry	Secondary chamber, baghouse with virgin lime injection, urea injection, and activated carbon injection	4,000	10,000	8,000	$0.02	$34.29	**$729,858**	install more efficient FF, include packed-bed scrubber, use more natural gas and activated carbon
Facility B	M	DIFF	Dry	Secondary/tertiary chambers (1800F, 2.85 sec) and dry scrubber/baghouse with lime and activated carbon injection	400	2,000	4,500	$0.02	$34.29	**$49,964**	include packed-bed scrubber and SNCR, use more natural gas and activated carbon
Facility C	S	WS	Wet	Secondary chamber (1800F, 1.68 sec) and rotary atomizing wet scrubber	100	700	3,000	$0.06	$34.29	**$14,623**	include packed-bed scrubber and SNCR, use more natural gas
Total nationwide										**$794,445**	

Note:
1. Patterned new source models after those new HMIWI installed in last 10 years.
2. The only beyond-the-floor options available for new sources are SNCR (large HMIWI), no additional controls available (medium HMIWI), and DIFF with activated carbon (small HMIWI).
3. No additional testing needed beyond that already required at the MACT floor.

Table 17. Nationw

Facility name	Category	APCD code with MACT floor controls	Beyond-the-floor controls	APCD code with MACT floor and BTF controls	DIFF	ACI	SNCR	Total BTF control cost	MACT floor and BTF control cost	Additional monitoring	DIFF monitoring	ACI monitoring	SNCR monitoring
Facility A	L	DIFF/WS	include SNCR	DIFF/WS			$102,144	**$102,144**	**$528,482**	SNCR			$3,100
Facility B	M	DIFF/WS	none	DIFF/WS				**$0**	**$142,377**	none			
Facility C	S	WS	include DIFF and ACI	DIFF/WS	$185,831	$9,781		**$195,611**	**$277,287**	DIFF, ACI, BLD	$6,600	$2,400	
Total nationwide								**$297,756**	**$948,146**				

Note:
1. Patterned new source r
2. The only beyond-the-flo
additional controls availab
3. No additional testing ne

Table 17. Nationw

Facility name	Category	BLD monitoring	Total BTF monitoring cost	MACT floor and BTF monitoring cost	Total BTF testing cost	MACT floor and BTF testing cost	Total BTF record-keeping and reporting cost	MACT floor and BTF record-keeping and reporting cost	Total BTF cost	Total MACT floor and BTF cost
Facility A	L		$3,100	$43,700	$0	$1,225	$349	$7,810	$105,593	$581,217
Facility B	M		$0	$43,700	$0	$1,225	$0	$7,810	$0	$195,112
Facility C	S	$8,400	$17,400	$47,700	$0	$1,225	$349	$7,112	$213,360	$333,324
Total nationwide			$20,500	$135,100	$0	$3,674	$698	$22,733	$318,953	$1,109,653

Note:
1. Patterned new source r
2. The only beyond-the-flo
additional controls availab
3. No additional testing ne

Table 18. Nationwide Cost Effectiveness for New Sources

Facility name	Category	APCD description	APCD code	MACT floor controls	APCD code with MACT floor controls	MACT floor		
						Cost ($/yr)	Emission reduction (lb/yr)	Cost effectiveness ($/ton)
Facility A	L	Secondary chamber, baghouse with virgin lime injection, urea injection, and activated carbon injection	DIFF	install more efficient FF, include packed-bed scrubber, use more natural gas and activated carbon	DIFF/WS	$475,624	4,835	$196,727
Facility B	M	Secondary/tertiary chambers (1800F, 2.85 sec) and dry scrubber/baghouse with lime and activated carbon injection	DIFF	include packed-bed scrubber and SNCR, use more natural gas and activated carbon	DIFF/WS	$195,112	3,459	$112,820
Facility C	S	Secondary chamber (1800F, 1.68 sec) and rotary atomizing wet scrubber	WS	include packed-bed scrubber and SNCR, use more natural gas	WS	$119,964	942	$254,628
Overall						**$790,700**	**9,236**	**$188,058**

Table 18. Nationwide

Facility name	Category	Beyond-the-floor controls	APCD code with MACT floor and BTF controls	From MACT floor to beyond-the-floor			MACT floor + beyond-the-floor		
				Cost ($/yr)	Emission reduction (lb/yr)	Cost effectiveness ($/ton)	Cost ($/yr)	Emission reduction (lb/yr)	Cost effectiveness ($/ton)
Facility A	L	include SNCR	DIFF/WS	$105,593	7,910	$26,699	$581,217	12,745	$91,204
Facility B	M	none	DIFF/WS	$0	0		$195,112	3,459	$112,820
Facility C	S	include DIFF and ACI	DIFF/WS	$213,360	0.5	$941,622,047	$333,324	943	$707,152
Overall				**$318,953**	**7,910**	**$470,824,373**	**$1,109,653**	**17,147**	**$303,725**