RTI INTERNATIONAL | Memorandum

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Subject: Analysis of Beyond the Floor Options
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I. Background

In response to the remand of the September 15, 1997 regulation for hospital/medical/ infectious waste incinerators (HMIWI), the U.S. Environmental Protection Agency (EPA) is re-determining the maximum achievable control technology (MACT) floors for the nine pollutants plus opacity that EPA is required to regulate under sections 111 and 129 of the Clean Air Act (CAA). The nine pollutants are 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). MACT floors are being re-determined using emissions data obtained over the last several years (initial and annual performance tests) for currently operating HMIWI. These MACT floor options are discussed in a separate memorandum.[1] The purpose of this memorandum is to explore options "beyond" (i.e., more stringent than) the MACT floor for existing and new HMIWI for the HMIWI size subcategories (large, medium, small non-rural [also called "small"], and small rural) and summarize the costs and impacts estimated for those options. (Note: Small rural HMIWI are not included as a subcategory for new sources.) For all subcategories, the beyond-the-floor (BTF) options did not include implementation of waste segregation practices because, as indicated in the industry responses to a waste segregation information collection request that was carried out by EPA, all facilities already practice waste segregation.[2]

II. Existing Sources

A. Large HMIWI

For all 36 existing large HMIWI, we looked at applying the new source MACT floor emission limits for large units as a BTF option. Table 1 presents the BTF emission limits that we selected for existing large HMIWI. We also looked at requiring installation of NO_X emission controls, i.e., selective noncatalytic reduction (SNCR) systems, for all existing large HMIWI, including those 27 large units with average NO_X emissions below the new source MACT floor NO_X emission limit.

B. Medium HMIWI

For all 17 existing medium HMIWI, we looked at applying the new source MACT floor emission limits for medium units as a BTF option. Table 1 presents the BTF emission limits that we selected for existing medium HMIWI. In the case of Hg and CDD/CDF toxic equivalents (TEQ), the existing source MACT floor emission limits were slightly more stringent than the new source limits. This unusual situation occurred due to a difference in the size of the datasets used to determine the MACT floor emission limits for existing and new medium HMIWI.[1] In these two cases, we decided to use existing source limits as the BTF option where they are lower than new source limits. Similar to the large HMIWI, we also looked at requiring installation of SNCR systems for all existing medium HMIWI, including the one medium unit with average NO_X emissions below the new source MACT floor NO_X emission limit.

C. Small HMIWI

For both existing small HMIWI, we looked at applying the new source MACT floor emission limits for medium units as a BTF option, except in the one case (TEQ) where the new source MACT floor limit for small units is more stringent. Table 1 presents the BTF emission limits that we selected for existing small HMIWI. We chose to apply the new source limits for medium units, rather than small units, for the following reasons:

- The new source limits for small units would require only minor control beyond the MACT floor, i.e., adding SNCR for NO_X control and caustic for SO_2 control.
- The new source limits for medium units are more stringent and, in addition to the controls listed above, would require installing a fabric filter with dry sorbent injection (DIFF) to improve PM and metals control, installing activated carbon injection (ACI) to improve Hg control (if not already required at the MACT floor), and using more natural gas to improve CO control.
- There were insufficient NO_X and SO_2 data for small non-rural units to determine new source emission limits for those pollutants.

D. Small Rural HMIWI

For both existing small rural HMIWI, we looked at applying the new source MACT floor emission limits for small non-rural units as a BTF option, except in the one case (Hg) where the existing source MACT floor limit for small rural units is more stringent. Table 1 presents the BTF emission limits that we selected for existing small rural HMIWI. We chose to apply the new source limits for small non-rural units for the following reasons:

- There are no new source limits for small rural HMIWI, because there is no small rural size category for new sources.
- The existing source limits for small rural units would require no additional control beyond the MACT floor.

The new source limits for small non-rural units are more stringent and would potentially require installing a DIFF, packed-bed scrubber, ACI, and SNCR (if not already required at the

MACT floor). (Note: Although the small non-rural HMIWI would be able to achieve these new source limits with wet scrubbers and SNCR, the small rural units would have difficulty meeting the metals and CDD/CDF limits without some further control (e.g., DIFF and ACI).)

E. Summary of Beyond-the-Floor Costs and Impacts

Once we developed the BTF options for existing sources, we estimated the compliance costs, emissions reductions, and secondary impacts associated with these options for each HMIWI currently operating. Secondary impacts include energy, solid waste, and wastewater impacts, and secondary emissions of PM, CO, NO_X, and SO_2. These costs and impacts are addressed in greater detail in other memoranda.[4-6] Table 2 presents the nationwide totals of the BTF costs and impacts relative to the MACT floor and to baseline.

As shown in Table 2, compliance with the BTF options would cost existing HMIWI an additional $16.4 million per year (yr) relative to the MACT floor, including $14 million/yr for large units; $1.2 million for medium units; $500,000/yr for small units; and $390,000/yr for small rural units. The BTF options would reduce emissions by 340,000 pounds per year (lb/yr) more than the MACT floor, including 300,000 lb/yr from large units; 32,000 lb/yr from medium units; 3,800 from small units; and 820 lb/yr from small rural units. Table 2 presents the emission reductions broken down by individual pollutant (HCl, CO, Pb, Cd, Hg, PM, CDD/CDF, NO_X, and SO_2). Combining the costs and emissions reductions calculated for each unit, the average per-unit cost effectiveness of the BTF options is estimated to be $197,000/ton relative to the MACT floor for all HMIWI; $167,000/ton for large units; $118,000/ton for medium units; $325,000/ton for small units; and $1.27 million/ton for small rural units.

Relative to the MACT floor, the BTF options would increase energy use by 78,000 million British thermal units per year (MM Btu/yr), including 70,000 MM Btu/yr from large units; 6,300 MM Btu/yr from medium units; 1,400 MM Btu/yr from small units; and 56 MM Btu/yr from small rural units. The solid waste impacts would increase by 2,300 tons per year (tpy) for all HMIWI; 2,200 tpy for large units; 42 tpy for medium units; 14 tpy for small units; and 2.9 tpy for small rural units compared to the MACT floor. Wastewater impacts would increase by 230,000 gallons per year (gpy) relative to the MACT floor, including 220,000 gpy from large units; 5,600 gpy from medium units; 94 gpy from small units; and 4,300 gpy from small rural units. The BTF options would increase total secondary emissions (PM, CO, NO_X, and SO_2) by 15,000 lb/yr for all HMIWI; 14,000 lb/yr for large units; 1,200 lb/yr for medium units; 280 lb/yr for small units; and 18 lb/yr for small rural units.

III. New Sources

Beyond-the-floor options for new sources are based on the best performance for each subcategory. Table 3 presents the BTF options that we selected for new sources.

For large HMIWI, SNCR is the only BTF option. There are no other additional controls available, and we, therefore, did not identify any other BTF options. The BTF emission limits for new large units are the same as those at the MACT floor, except that the BTF NO_X limit (60.5 parts per million by volume, dry basis [ppmvd]) was determined by applying the level of NO_X

control expected to be achieved with SNCR (i.e., 45 percent) to the NO_X MACT floor limit (110 ppmvd).[3]

For medium HMIWI, there are no additional controls available, and we, therefore, did not identify any BTF options. Consequently, the BTF emission limits for new medium units are the same as those at the MACT floor.

For small HMIWI, we looked at adding a DIFF with ACI as the BTF option. There are no other controls available, and we, therefore, did not identify any other BTF options. Because HCl, metals, PM, and CDD/CDF are all affected by those two controls, the BTF limits for those pollutants for new small units were assumed to be equivalent to the more stringent BTF limits for new medium units, except where the limits for small units were more stringent (TEQ), or where the pollutants were not affected by those two controls (CO). (Note: New source NO_X and SO_2 limits for medium units were used because NO_X and SO_2 data are missing for small units.)

Once we determined the additional controls to assess as beyond the floor options for new sources, we estimated the costs and impacts associated with these controls for the three new HMIWI projected to be installed over the next several years. These costs and impacts are addressed in greater detail in other memoranda.[6-8] Table 4 presents the nationwide totals of the BTF costs and impacts relative to the MACT floor and to baseline.

Table 4 shows that compliance with the BTF options would cost new sources an additional $320,000/yr relative to the MACT floor, including $110,000/yr for the large unit and $210,000/yr for the small unit. There are no BTF costs for the medium unit. The BTF options would reduce emissions by 7,900 lb/yr more than the MACT floor, with essentially all of the emissions reduction coming from the reduction of the large unit's NO_X emissions (less than 0.5 lb/yr of Pb, Hg, and CDD/CDF reductions is obtained from the small unit). Combining these costs and emissions reductions, the cost effectiveness of the BTF options is estimated to be $27,000/ton for new large HMIWI and $940 million/ton for new small HMIWI.

The BTF options would increase energy impacts by 74 MM Btu/yr, with 5.1 MM Btu/yr attributed to the large unit and 69 MM Btu/yr to the small unit. The solid waste impacts would increase by 7.9 tpy, due to the installation of DIFF and ACI on the small unit. Total secondary emissions would increase by 23 lb/yr relative to the MACT floor, including 1.6 lb/yr from large units and 22 lb/yr from small units. There are no additional wastewater impacts beyond the floor.

IV. 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. *Summary of Industry Responses to EPA's Waste Segregation Information Collection Request.*

3. 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.

4. Memorandum from Thomas Holloway, RTI, to Mary Johnson, EPA. October 24, 2008. *Compliance Costs and Economic Inputs for Existing HMIWI.*

5. Memorandum from Thomas Holloway, RTI, to Mary Johnson, EPA. October 24, 2008. *Secondary Environmental and Energy Impacts for Existing HMIWI.*

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

7. Memorandum from Thomas Holloway, RTI, to Mary Johnson, EPA. October 24, 2008. *Compliance Costs for New HMIWI.*

8. Memorandum from Thomas Holloway, RTI, to Mary Johnson, EPA. October 24, 2008. *Secondary Environmental and Energy Impacts for New HMIWI.*

Table 1. Beyond-the-Floor Options for Existing Sources

Size	Beyond-the-floor options	Beyond-the-floor limits									
		HCl (ppmvd)	CO (ppmvd)	Pb (mg/dscm)	Cd (mg/dscm)	Hg (mg/dscm)	PM (gr/dscf)	CDD/CDF (ng/dscm)	TEQ (ng/dscm)	NO_X (ppmvd)	SO_2 (ppmvd)
Large	New source limits for large units + SNCR if not otherwise required	0.75	2.9	0.00047	0.00012	0.00093	0.0048	0.60	0.014	110	1.9
Medium	New source limits for medium units (except where less stringent than existing source limits--Cd, TEQ) + SNCR if not otherwise required	1.8	1.9	0.016	0.0071	0.0020	0.0099	0.35	0.0097	38	0.78
Small	New source limits for medium units (except where less stringent than limits for small units--TEQ) [a]	1.8	1.9	0.016	0.0071	0.0020	0.0099	0.35	0.0080	38	0.78
Small rural	New source limits for small non-rural units (except where less stringent than limits for small rural units--Hg)	4.5	8.2	0.18	0.012	0.0040	0.017	8.3	0.0080	38	0.78

[a] New source NO_X and SO_2 limits for medium units used because NO_X and SO_2 data are missing for small non-rural units.

Table 2. Beyond-the-Floor Costs and Impacts for Existing Sources

Parameters	Large	Medium	Small	Small rural	Total
	Relative to MACT floor				
Costs					
Emission controls, $/yr	$14,180,328	$1,136,546	$479,910	$355,911	$16,152,695
Monitoring, $/yr	$111,300	$55,900	$24,200	$23,400	$214,800
Testing, $/yr	$17,860	$12,297	$0	$5,783	$35,939
Recordkeeping and reporting, $/yr	$916	$0	$0	$785	$1,700
Total costs, $/yr	$14,310,403	$1,204,743	$504,110	$385,878	$16,405,135
Unit average cost effectiveness, $/ton	$167,000	$118,000	$325,000	$1,270,000	$197,000
Emission reductions					
HCl, lb/yr	7,973	115	0	569	8,657
CO, lb/yr	1,912	157	57.4	0	2,126
Pb, lb/yr	46.9	0.230	3.42	0.318	50.9
Cd, lb/yr	10.7	0	0	0.180	10.8
Hg, lb/yr	38.9	0.846	0.120	0	39.9
PM, lb/yr	5,449	1,062	178	0	6,690
Total CDD/CDF, g/yr	1.89	0.0323	0.0327	0.208	2.16
CDD/CDF TEQ, g/yr	0.0271	0	0	0.00473	0.0318
NO_X, lb/yr	277,601	29,612	3,373	192	310,778
SO_2, lb/yr	6,747	1,038	141	58.4	7,985
Total emission reductions, lb/yr	299,778	31,985	3,754	820	336,337
Secondary impacts					
Energy, MM Btu/yr	69,984	6,304	1,354	56.2	77,697
Solid waste, tpy	2,232	41.5	14.1	2.90	2,290
Wastewater, gpy	222,126	5,645	94.1	4,312	232,176
Secondary PM, lb/yr	213	12.7	5.70	0.917	232
Secondary CO, lb/yr	6,072	531	121	6.68	6,731
Secondary NO_X, lb/yr	6,777	628	127	3.38	7,535
Secondary SO_2, lb/yr	690	9.59	26.1	6.59	732
Total secondary emissions, lb/yr	13,752	1,182	280	17.6	15,231
Parameters	Relative to baseline[a]				
Costs					
Emission controls, $/yr	$30,597,330	$4,822,267	$513,006	$517,681	$36,450,284
Monitoring, $/yr	$509,200	$199,600	$29,200	$30,200	$768,200
Testing, $/yr	$124,712	$64,347	$3,118	$44,080	$236,257
Recordkeeping and reporting, $/yr	$45,520	$21,496	$2,529	$6,802	$76,346
Total costs, $/yr	$31,276,762	$5,107,709	$547,853	$598,762	$37,531,087
Unit average cost effectiveness, $/ton	$268,000	$350,000	$342,000	$1,700,000	$345,000
Emission reductions					
HCl, lb/yr	191,327	1,012	0	569	192,908
CO, lb/yr	8,163	731	87.8	0	8,981
Pb, lb/yr	340	67.7	3.42	0.318	412
Cd, lb/yr	26.3	6.31	0	0.180	32.8
Hg, lb/yr	670	6.20	0.202	0.283	677
PM, lb/yr	28,508	5,318	178	0	34,005
Total CDD/CDF, g/yr	38.5	4.62	0.0327	0.208	43.3
CDD/CDF TEQ, g/yr	0.733	0.0607	0.000508	0.00473	0.798
NO_X, lb/yr	426,017	29,612	3,373	192	459,194
SO_2, lb/yr	104,910	2,882	191	58.4	108,041
Total emission reductions, lb/yr	759,961	39,635	3,834	820	804,251
Secondary impacts					
Energy, MM Btu/yr	159,227	11,280	1,922	87.7	172,517
Solid waste, tpy	6,521	168	16.4	5.23	6,710
Wastewater, MM gpy	405,053	9,878	188	4,312	419,431
Secondary PM, lb/yr	1,120	44.7	6.78	1.43	1,173
Secondary CO, lb/yr	14,418	1,004	169	10.4	15,602
Secondary NO_X, lb/yr	15,576	1,064	184	5.27	16,828
Secondary SO_2, lb/yr	2,377	195	26.4	10.3	2,609
Total secondary emissions, lb/yr	33,492	2,307	386	27.4	36,212

[a] Equal to the sum of the MACT floor costs/impacts and the BTF costs/impacts relative to the MACT floor.

Table 3. Beyond-the-Floor Options for New Sources

Size	Beyond-the-floor options	Beyond-the-floor limits									
		HCl (ppmvd)	CO (ppmvd)	Pb (mg/dscm)	Cd (mg/dscm)	Hg (mg/dscm)	PM (gr/dscf)	CDD/CDF (ng/dscm)	TEQ (ng/dscm)	NO_X (ppmvd)	SO_2 (ppmvd)
Large	SNCR (assuming 45% reduction of NO_X with SNCR)	0.75	2.9	0.00047	0.00012	0.00093	0.0048	0.60	0.014	60.5	1.9
Medium	None (BTF limits same as MACT floor limits)	1.8	1.9	0.016	0.0071	0.0020	0.0099	0.35	0.0097	38	0.78
Small	DIFF and ACI (based on new source HCl, metals, PM, and CDD/CDF limits for medium units) [a]	1.8	8.2	0.016	0.0071	0.0020	0.0099	0.35	0.0080	38	0.78

[a] New source NO_X and SO_2 limits for medium units used because NO_X and SO_2 data are missing for small units.

Table 4. Beyond-the-Floor Costs and Impacts for New Sources

Parameters	Large	Medium	Small	Total
	Relative to MACT floor			
Costs				
Emission controls, $/yr	$102,144	$0	$195,611	$297,756
Monitoring, $/yr	$3,100	$0	$17,400	$20,500
Testing, $/yr	$0	$0	$0	$0
Recordkeeping and reporting, $/yr	$349	$0	$349	$698
Total costs, $/yr	$105,593	$0	$213,360	$318,953
Cost effectiveness, $/ton	$27,000	--	$940,000,000	$470,000,000
Emission reductions				
HCl, lb/yr	0	0	0	0
CO, lb/yr	0	0	0	0
Pb, lb/yr	0	0	0.446	0.446
Cd, lb/yr	0	0	0	0
Hg, lb/yr	0	0	0.00726	0.00726
PM, lb/yr	0	0	0	0
Total CDD/CDF, g/yr	0	0	0.00905	0.00905
CDD/CDF TEQ, g/yr	0	0	0	0
NO_X, lb/yr	7,910	0	0	7,910
SO_2, lb/yr	0	0	0	0
Total emission reductions, lb/yr	7,910	0	0.5	7,910
Secondary impacts				
Energy, MM Btu/yr	5.05	0	69.1	74.1
Solid waste, tpy	0	0	7.88	7.88
Wastewater, gpy	0	0	0	0
Secondary PM	0.0824	0	1.13	1.21
Secondary CO	0.601	0	8.21	8.81
Secondary NO_X	0.304	0	4.15	4.45
Secondary SO_2	0.593	0	8.10	8.70
Total secondary emissions	1.58	0	21.6	23.2
Parameters	Relative to baseline[a]			
Costs				
Emission controls, $/yr	$528,482	$142,377	$277,287	$948,146
Monitoring, $/yr	$43,700	$43,700	$47,700	$135,100
Testing, $/yr	$1,225	$1,225	$1,225	$3,674
Recordkeeping and reporting, $/yr	$7,810	$7,810	$7,112	$22,733
Total costs, $/yr	$581,217	$195,112	$333,324	$1,109,653
Cost effectiveness, $/ton	$91,000	$113,000	$707,000	$304,000
Emission reductions				
HCl, lb/yr	2,341	262	0	2,603
CO, lb/yr	124	5.15	30.5	159
Pb, lb/yr	3.82	0	0.446	4.27
Cd, lb/yr	0.296	0	0	0.296
Hg, lb/yr	2.51	0.245	0.00726	2.76
PM, lb/yr	2,364	0	0	2,364
Total CDD/CDF, g/yr	0	0.244	0.00905	0.253
CDD/CDF TEQ, g/yr	0	0.00280	0	0.00280
NO_X, lb/yr	7,910	3,119	863	11,892
SO_2, lb/yr	0	71.9	48.8	121
Total emission reductions, lb/yr	12,745	3,459	943	17,147
Secondary impacts				
Energy, MM Btu/yr	13,594	1,530	435	15,559
Solid waste, tpy	50.8	5.72	7.88	64.4
Wastewater, MM gpy	7,117	877	29.7	8,024
Secondary PM	39.7	4.47	2.31	46.4
Secondary CO	1,175	132	40.1	1,348
Secondary NO_X	1,321	149	39.3	1,509
Secondary SO_2	120	13.5	12.3	146
Total secondary emissions	2,656	299	94.0	3,049

[a] Equal to the sum of the MACT floor costs/impacts and the BTF costs/impacts relative to the MACT floor.