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A-91-61

IV B 048

Date: May 20, 1996

Subject: Wet Scrubber Performance Memorandum
Medical Waste Pyrolysis (Dibenzofurans, HCl, Hg): Response to Comments
EPA Contract No. 68-D1-0115; Work Assignment No. IV-108
ESD Project No. 90/17; MRI Project No. 6504-08

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I. Introduction

The purpose of this memorandum is to (1) provide background information on how wet scrubbers were factored into the proposed regulation for medical waste incinerators (MWI's) and the subsequent availability of new test data; (2) describe the quality of the new wet scrubber emission test data; (3) quantify the performance of wet scrubbers in controlling emissions from MWI's based on these data; and (4) develop achievable emission levels that could be applied to MWI's controlled by wet scrubbers. The remainder of this memorandum is organized into the following sections: Background, Emission Test Data Quality, Wet Scrubber Performance, and Achievable Wet Scrubber Emission Levels.

II. Background

In the development of the proposed regulation for MWI's, the U. S. Environmental Protection Agency (EPA) emission test program included one test on a wet scrubber controlling emissions from a MWI. Additionally, prior to proposal, EPA had reviewed several emission tests on other wet scrubbers controlling MWI's, but had discarded these data because the test reports and/or test data were incomplete. In its review of the test data from the test program and in the absence of other MWI/wet scrubber test data, EPA concluded that the performance of wet scrubbers in controlling emissions from MWI's was significantly lower than the performance of dry scrubber systems. Leading up to and after proposal, several comments were received from wet scrubber vendors and others about wet scrubber performance in MWI applications. In subsequent meetings, these commenters suggested that properly designed wet scrubbers can meet the proposed

emission limits for MWI's. In response to these claims, EPA requested that the commenters, including wet scrubber vendors, submit emission test reports to document their performance claims. Three wet scrubber vendors and other commenters supplied a total of 24 emission test reports for wet scrubbers controlling MWI's. These test reports covered wet scrubbers with a range of design characteristics so that EPA could compare the resulting emission profiles for the pollutants of interest.

III. Emission Test Data Quality

Upon receipt of the emission test reports from the commenters, the reports were submitted to the EPA's Emission Measurements Center (EMC) for a review for completeness. This review is typical of the type of review that is commonly done to approve the use of emission test data in setting air emission standards. The results of this review are found in reference 1. Additionally, reference 1 describes the general selection rules that were used in qualifying and accepting the available emission test data for use in the reanalysis of wet scrubber performance.

IV. Wet Scrubber Performance

Midwest Research Institute developed wet scrubber performance graphs for particulate matter (PM), polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (CDD/CDF), CDD/CDF toxic equivalency (TEQ), hydrogen chloride (HCl), lead (Pb), cadmium (Cd), and mercury (Hg). These graphs are depicted in Figures 1 through 7, respectively, and were developed using the qualified data from the analysis described in reference 1. All emission test data is corrected to 7 percent oxygen. The data were arranged on each graph based on the typical PM guarantee offered by the wet scrubber vendors. Therefore, on each graph, data are grouped based on the ability of the wet scrubber system to remove PM into either high efficiency (guarantee of 0.015 grains per dry standard cubic foot [gr/dscf] corrected to 7 percent oxygen), moderate efficiency (guarantee of 0.030 gr/dscf corrected to 7 percent oxygen), or low efficiency (guarantee greater than 0.030 gr/dscf corrected to 7 percent oxygen) groups. The following paragraphs briefly describe the performance of the wet scrubber systems in removing emissions of each pollutant listed above.

Figure 1 shows the performance of the wet scrubber systems in controlling PM emissions. It is clear from Figure 1 that wet scrubbers produce PM removal performance that exceeds the guarantees set by the vendors. Additionally, there is a definite trend of increasing PM emissions in moving from the high to moderate to low efficiency wet scrubbers. Emissions from the high efficiency systems ranged from 0.004 to 0.013 gr/dscf. Emissions from the moderate efficiency systems ranged from 0.011 to 0.018 gr/dscf. Finally, the only low efficiency wet scrubber data point showed emissions of 0.039 gr/dscf.

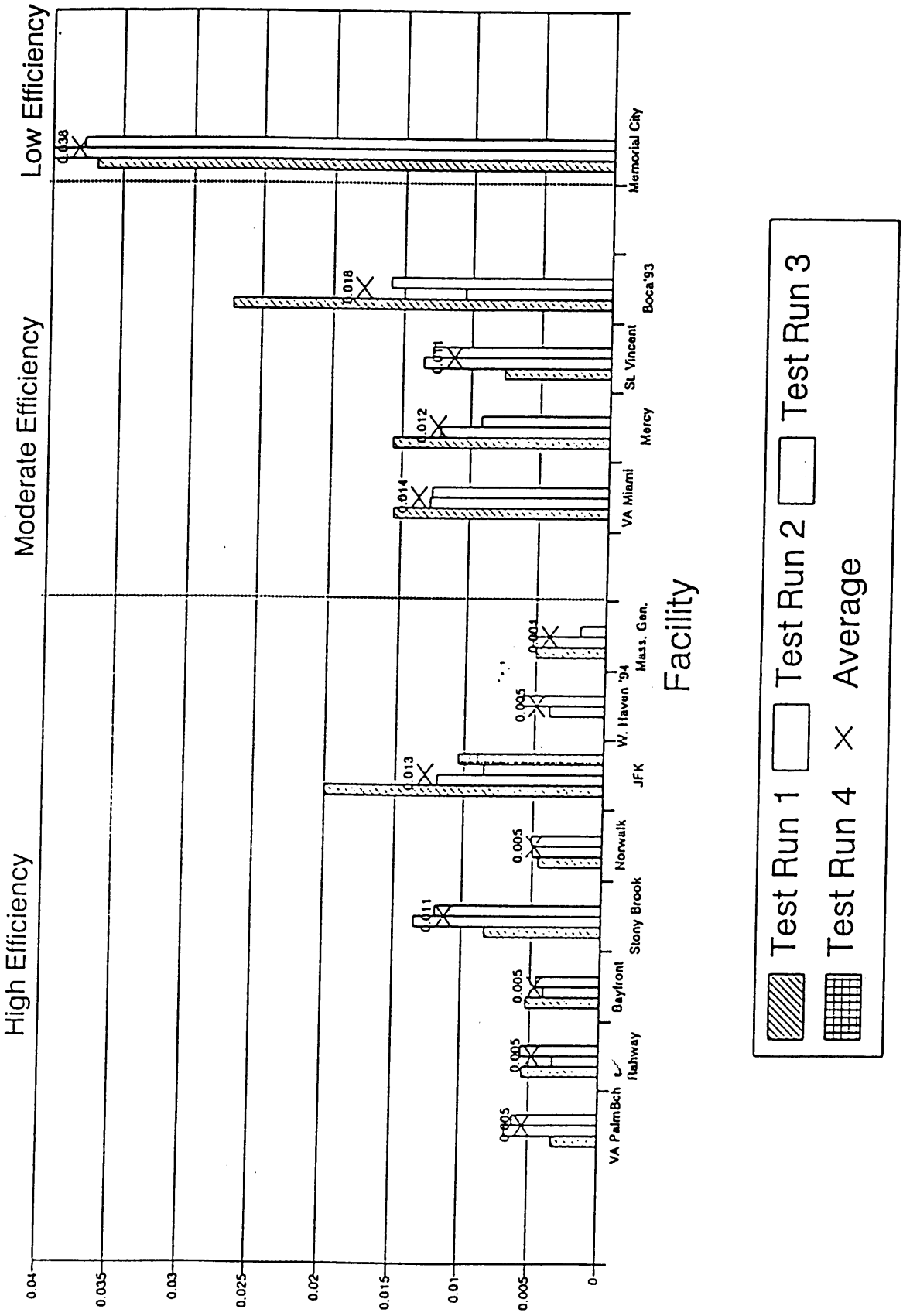

Figure 1. Particulate emissions for wet scrubbers (corrected to 7 percent oxygen).

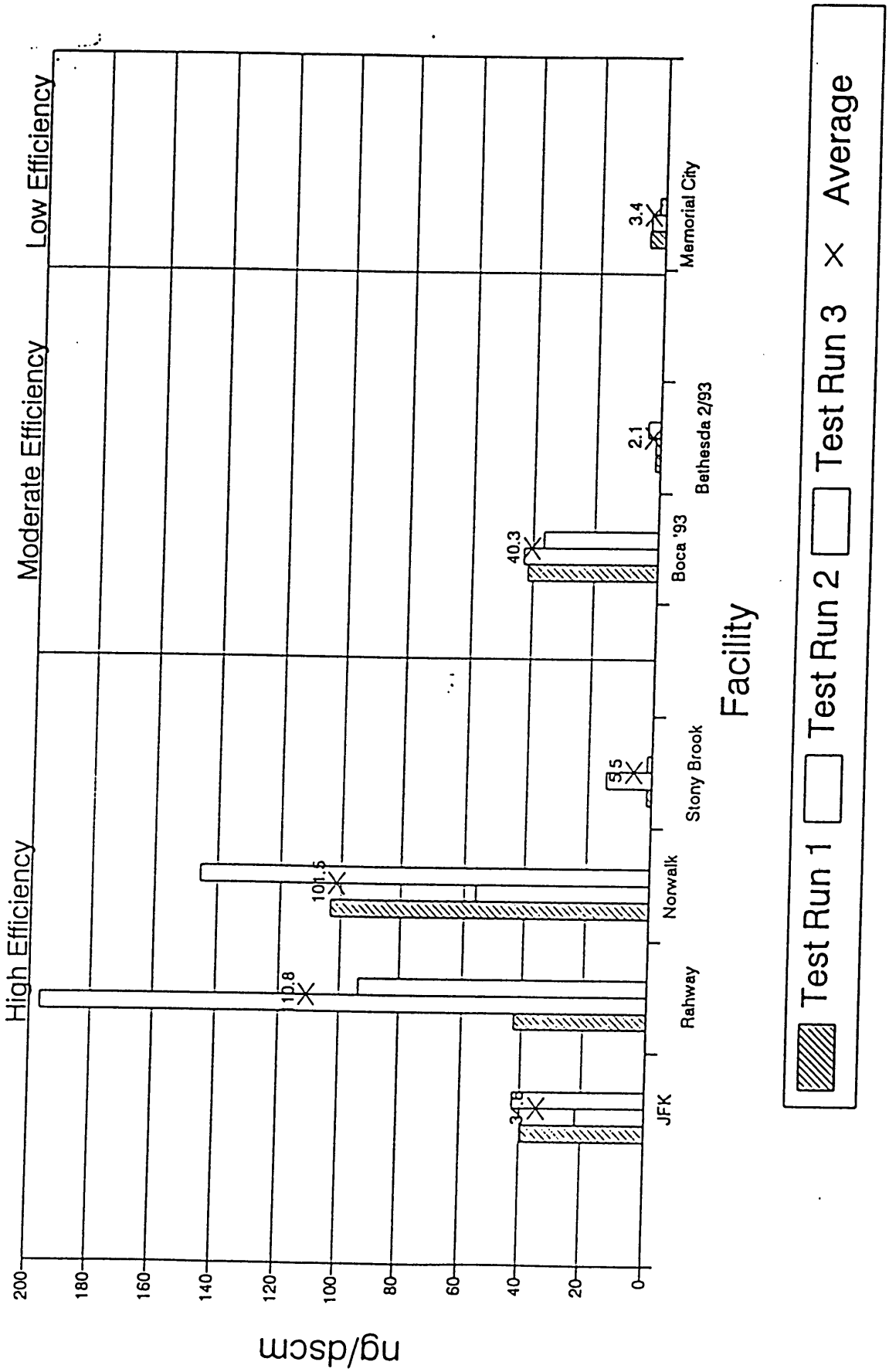

Figure 2. CDD/CDF emissions for wet scrubbers (corrected to 7 percent oxygen).

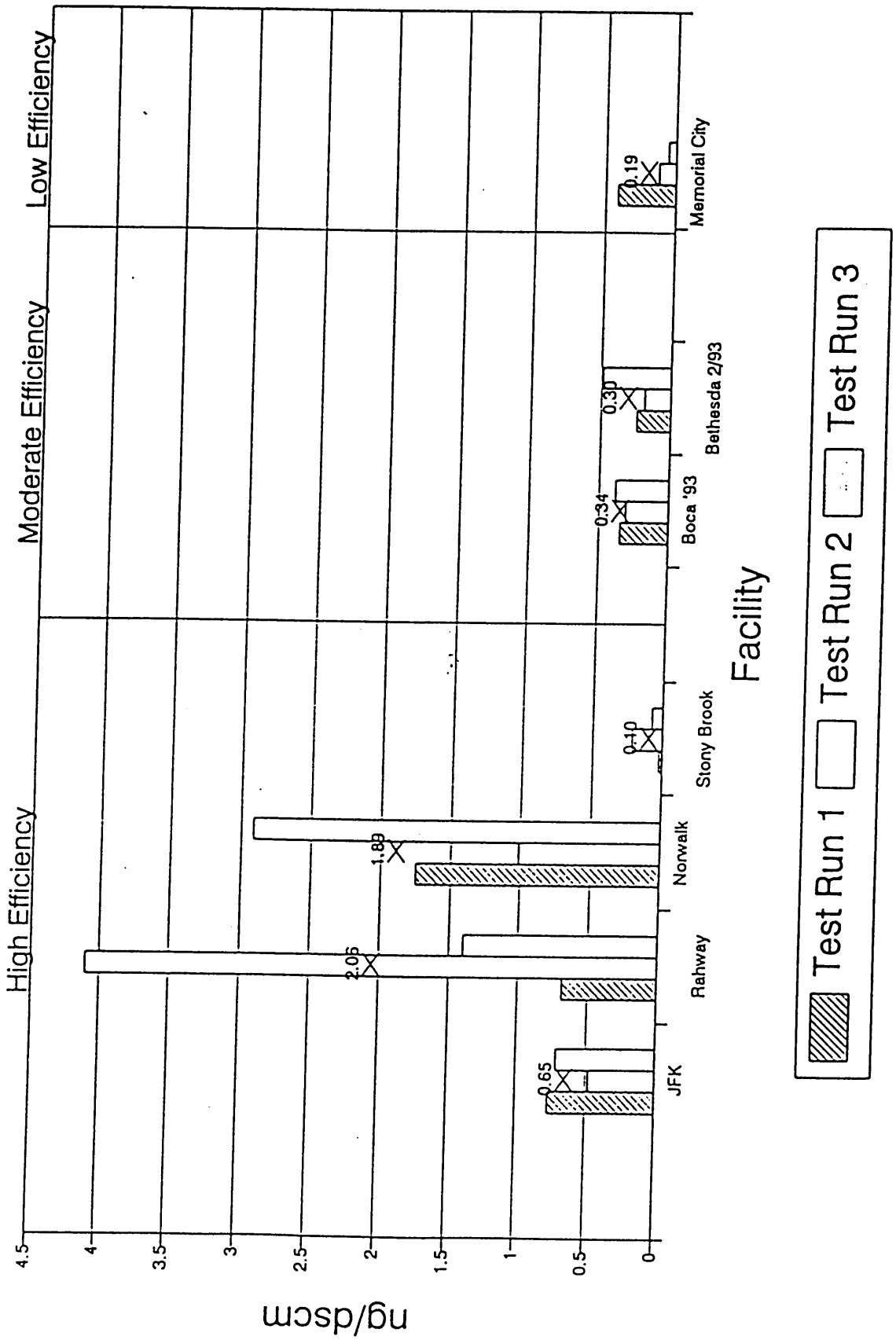

Figure 3. TEQ CDD/CDF emissions for wet scrubbers (corrected to 7 percent oxygen).

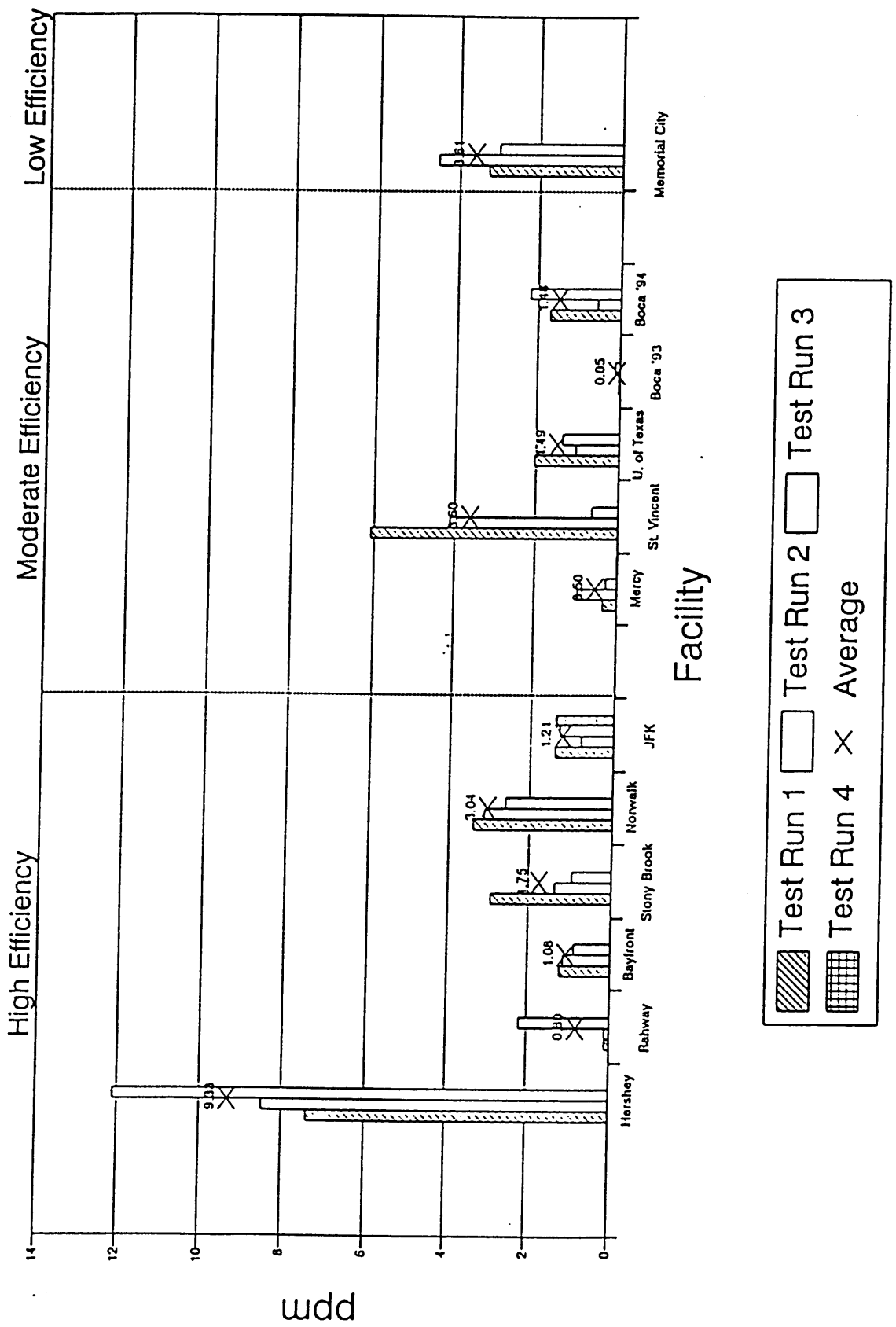

Figure 4. HCI emissions for wet scrubbers (corrected to 7 percent oxygen).

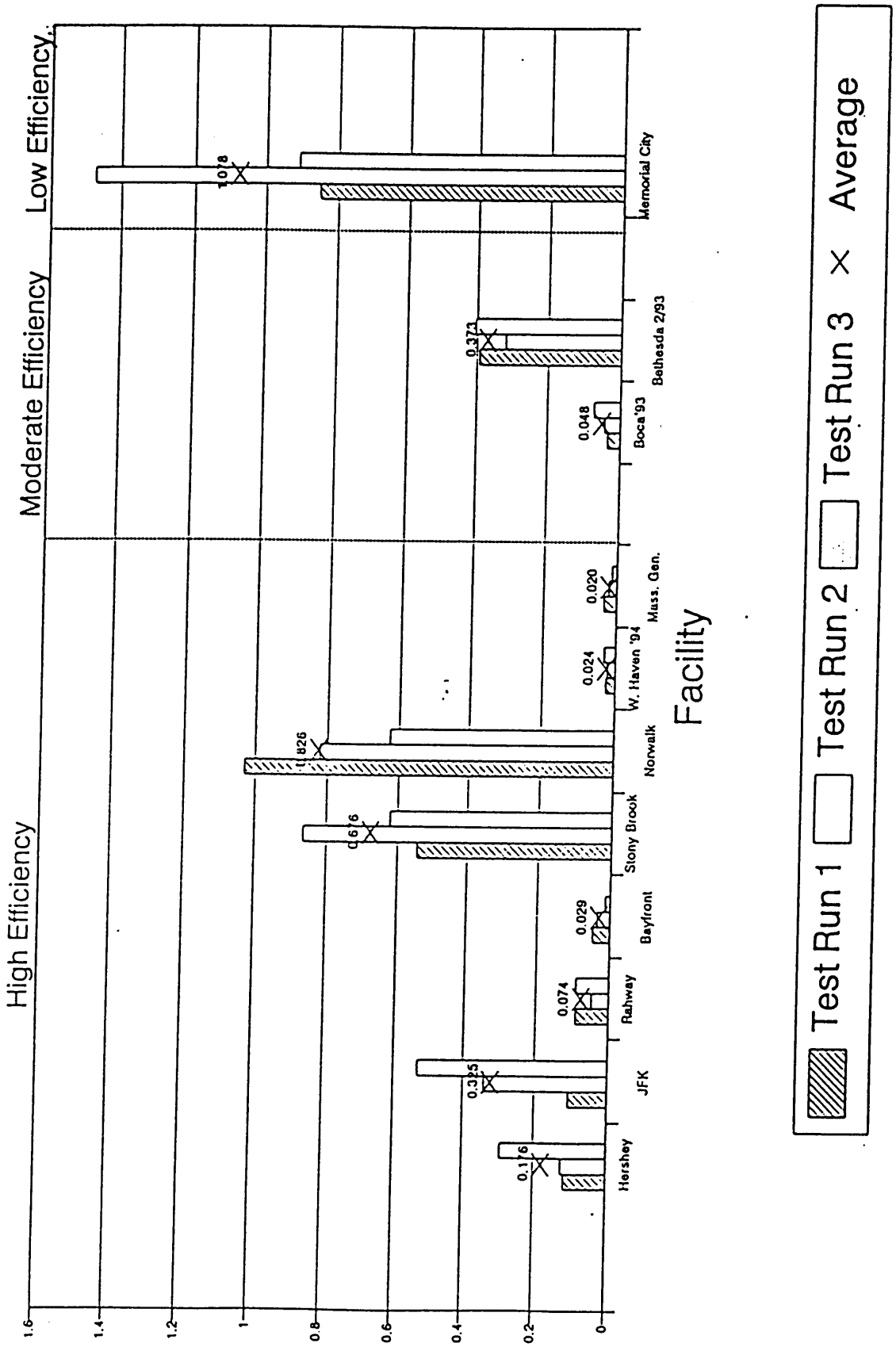

Figure 5. Lead emissions for wet scrubbers (corrected to 7% oxygen).

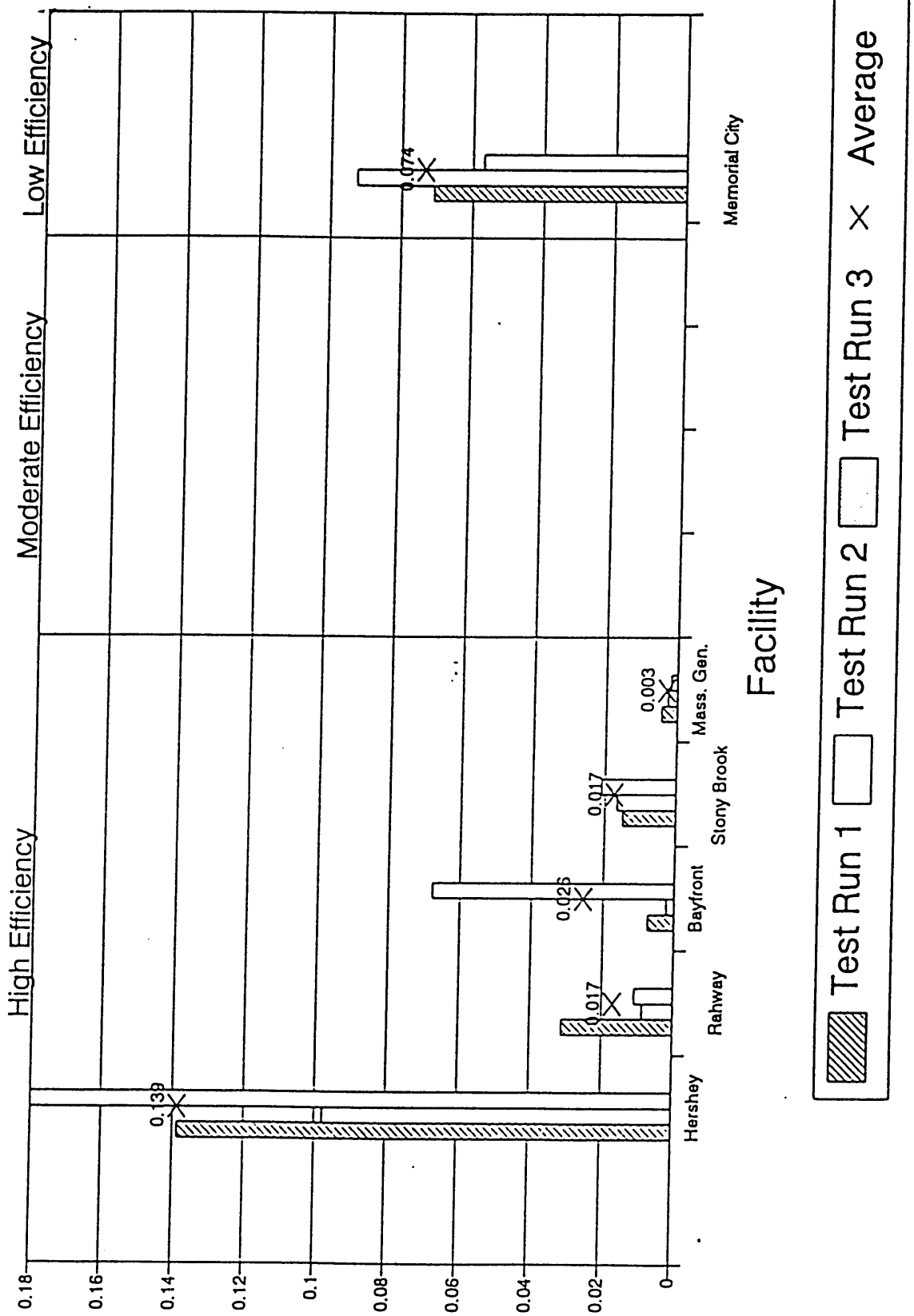

Figure 6. Cadmium emissions for wet scrubbers (corrected to 7 percent oxygen).

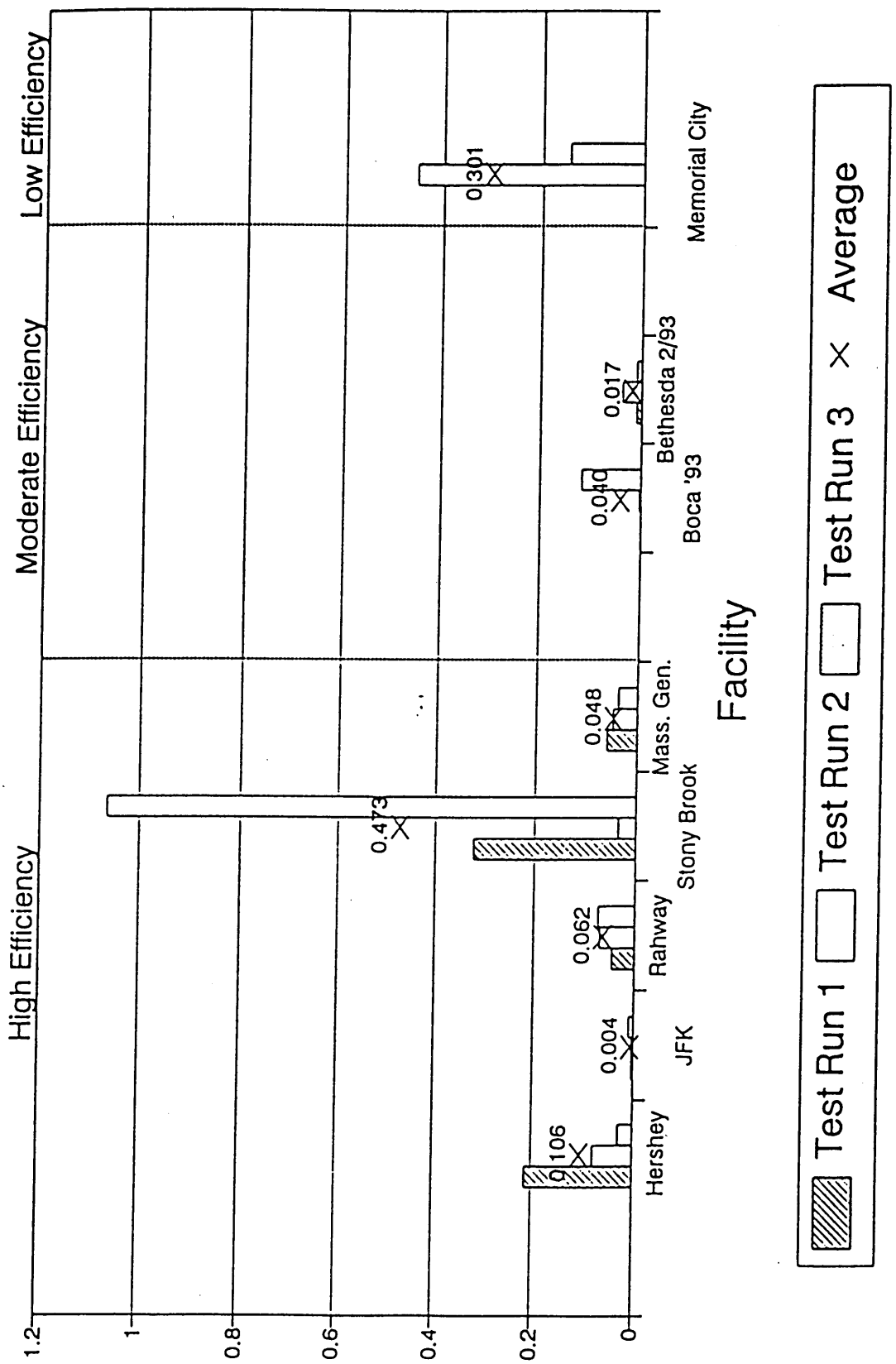

Figure 7. Mercury emissions for wet scrubbers (corrected to 7 percent oxygen).

Figure 2 shows the performance of the wet scrubber systems in controlling CDD/CDF emissions. Figure 3 shows the resulting CDD/CDF emission in terms of TEQ. There appears to be no trend in CDD/CDF emissions with respect to wet scrubber PM removal efficiency. Emissions range from 2.1 to 110.8 nanograms per dry standard cubic meter (ng/dscm) and from 0.10 to 2.06 ng/dscm TEQ.

Figure 4 shows the performance of the wet scrubber systems in controlling HCl emissions. As expected, all of the wet scrubbers perform extremely well in removing HCl emissions. There are no trends in HCl emissions with respect to wet scrubber PM removal efficiency. Emissions range from 0.05 to 9.33 ppm.

Figures 5, 6, and 7 show the performance of the wet scrubber systems in controlling Pb, Cd, and Hg emissions. Emissions of these metals are dependent on the amount of these metals present in the waste processed by MWI's. For each of these metals, the graphs show that there are no trends in emissions of the metals with respect to wet scrubber PM removal efficiency. For Pb, emissions range from 0.020 milligrams (mg)/dscm at Massachusetts General (high efficiency) to 1.078 mg/dscm at Memorial City (low efficiency). For Cd, emissions range from 0.003 to 0.139 mg/dscm. Finally, for Hg, emissions range from 0.004 to 0.473 mg/dscm.

V. Achievable Wet Scrubber Emission Levels

After reassessing the performance of wet scrubbers, EPA has developed achievable wet scrubber emission levels based on the data presented above. These achievable emission levels are listed in Table 1 for each pollutant and for the high, moderate, and low efficiency wet scrubbers. Table 1 also shows how the achievable emission levels were developed for each pollutant in each wet scrubber efficiency category.

The basic process for developing the achievable emission levels was to identify the highest data point in a given group of data, to increase the highest data point by 10 percent, and then to round up the result to an appropriate round number to obtain the achievable emission level. Table 1 shows the highest data point for the given ranges for each pollutant, the result of the 10 percent increase operation, and the subsequent achievable emission level obtained through rounding. For PM, achievable emission levels were developed for each of the wet scrubber efficiency groups of data because there was a definite trend of increasing PM emissions with increasing outlet guarantee. However, because no trend in emissions existed with respect to scrubber PM removal efficiency for any of the other pollutants, a single achievable emission level was developed for each pollutant that spanned the range of wet scrubber PM removal efficiencies.

The achievable emission levels for PM for the high and moderate efficiency systems reflect the guarantees offered by the

TABLE 1. DEVELOPMENT OF ACHIEVABLE EMISSION LEVELS FOR WET SCRUBBERS

Pollutant	Low efficiency			Moderate efficiency			High efficiency		
	Highest data point	10% operation	Achievable emission level (rounded)	Highest data point	10% operation	Achievable emission level (rounded)	Highest data point	10% operation	Achievable emission level (rounded)
PM, gr/dscf	0.038	0.0418	0.05	0.018	0.0198	0.03	0.013	0.0143	0.015
CDD/CDF, ng/dscm	110.8	121.88	125	110.8	121.88	125	110.8	121.88	125
TEQ, ng/dscm	2.06	2.266	2.3	2.06	2.266	2.3	2.06	2.266	2.3
HCl, ppmv	9.33	10.263	15	9.33	10.263	15	9.33	10.263	15
Pb, mg/dscm	1.078	1.1858	1.2	1.078	1.1858	1.2	1.078	1.1858	1.2
Cd, mg/dscm	0.139	0.1529	0.16	0.139	0.1529	0.16	0.139	0.1529	0.16
Hg, mg/dscm	0.473	0.5203	0.55	0.473	0.5203	0.55	0.473	0.5203	0.55

wet scrubber vendors. Because the data support the ability of these systems to meet their guarantees, EPA considered the guarantees to be the achievable emission level. For the low efficiency systems, the achievable PM emission level was developed using the basic approach described above.

For comparative purposes, Table 2 shows the achievable emission levels for high, moderate, and low efficiency scrubbers and the typical performance of scrubbers in these categories. The typical performance emissions were developed by taking an average of the given groups of data for which achievable emission levels were developed. It should be noted that several of the wet scrubbers perform at levels considerably below the achievable emission levels.

Additionally, Table 2 shows the achievable emission levels for the waste-related pollutants (HCl, Pb, Cd, and Hg) as a numerical concentration or as a percent reduction. In discussions with the wet and dry scrubber vendors, the vendors indicated that while they could guarantee the achievable emission levels, a percent reduction alternative would be important because they have no control over the waste input to the MWI, and that slugs of these pollutants could make it difficult for their equipment to meet the emission level only.

VI. Achievable Emission Levels for Batch MWI's Controlled By Wet Scrubbers

All of the available emission test data for wet scrubber systems controlling emissions from MWI's are for nonbatch MWI's; no test data are available for wet scrubbers controlling emissions from batch MWI's. Therefore, the wet scrubber data for the nonbatch MWI's were used to generate achievable emission levels for batch MWI's. Table 3 presents the achievable PM emission levels for batch MWI's controlled by wet scrubbers for the low, moderate, and high efficiency systems; these levels are identical to those for the nonbatch MWI's. Table 3 also presents the typical performance levels for wet scrubbers controlling emissions from batch MWI's. The typical performance levels for wet scrubbers controlling emissions during the burn and burndown/cooldown periods of a batch cycle were developed by taking the typical performance levels without controls developed for the burn and burndown/cooldown periods and multiplying these two numbers by the ratio of the achievable emission level for good combustion and the typical wet scrubber performance level for each efficiency category (low, moderate, and high efficiency).

TABLE 2. ACHIEVABLE EMISSION LEVELS AND TYPICAL PERFORMANCE FOR WET SCRUBBERS

Pollutant	Achievable emission levels			Typical performance		
	Low	Moderate	High	Low	Moderate	High
PM, gr/dscf	0.05	0.03	0.015	0.038	0.014	0.007
CDD/CDF, ng/dscm	125	125	125	42.614	42.614	42.614
TEQ, ng/dscm	2.3	2.3	2.3	0.79	0.79	0.79
HCl, ppmv	15 or 99%	15 or 99%	15 or 99%	2.328	2.328	2.328
Pb, mg/dscm	1.2 or 70%	1.2 or 70%	1.2 or 70%	0.332	0.332	0.332
Cd, mg/dscm	0.16 or 65%	0.16 or 65%	0.16 or 65%	0.046	0.046	0.046
Hg, mg/dscm	0.55 or 85%	0.55 or 85%	0.55 or 85%	0.131	0.131	0.131

TABLE 3. ACHIEVABLE PM EMISISON LEVELS FOR BATCH MWI'S CONTROLLED BY WET SCRUBBERS

Wet scrubber	Batch cycle	Rounded Achievable Emission Levels (gr/dscf @ 7% O_2)	Typical Performance (gr/dscf @7% O_2)
Low efficiency	Burn Burndown/cooldown	0.05 0.05	0.0045 0.0129
Moderate efficiency	Burn Burndown/cooldown	0.03 0.03	0.0017 0.005
High efficiency	Burn Burndown/cooldown	0.015 0.015	0.0008 0.0023

VII. References

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