COMMENTS TO EMISSION FACTOR DOCUMENTATION FOR

AP-42 SECTION 2.1

REFUSE COMBUSTION

Prepared by

Westinghouse Electric Corporation
Environmental Affairs

March 1993

EN5698ES.WPF

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1.0 INTRODUCTION

This document transmits additional data for the Emission Factor Documentation for AP-42, Section 2.1, Refuse Combustion. This additional data is from the York County Pennsylvania and Delaware County Pennsylvania Waste-to-Energy Facilities. Additionally, this document provides two papers that summarize emissions data. The papers are titled "Air Emissions Test Results From Two Operating Waste-To-Energy Facilities" by J. Joseph and D. Beachler, A&WMA Specialty Conference, November 1992, and "Nitrogen Oxide (NOx) Emission Pates From Three Waste-To-Energy Plants Using Westinghouse O'Connor Rotary Combustors", D. Beachler et al, October 1990.

2.0 ADDITIONAL DATA

Additional data is provided in Attachment A and include emission data for Particulate Matter (PM), Arsenic, Beryllium, Cadmium, Hexavalent Chromium, Lead, Mercury, Nickel, Zinc, and PCDD's and PCDF's. The data includes combustor unit, test data, test method used, emission rates and emission concentration levels.

2.1 York County Data

The York County Facility has three Westinghouse/O'Connor combustor/boilers each rated at 448 tons per day (TPD) at 4500 BTU/lb waste. The flue gas from the combustor/boilers exhaust into a spray dryer/fabric filter. The spray dryer utilizes a rotary atomizer to spray a lime slurry to neutralize the acid gases in the flue gas. The flue gas then enters a six compartment fabric filter for removal of particulate matter and metals. The flue gas is then exhausted out the stack. Tables 1 through 10 summarize stack testing conducted between 8/90 and 1/93, by Entropy, ETS, Inc., or Roy F. Weston.

2.2 Delaware County

The Delaware County Resource Recovery Facility consists of six Westinghouse/O'Connor combustor/boilers, each rated at 448 TPD at 5200 BTU/lb. The flue gas from the combustor/boilers exhausts into a spray dryer/fabric filter. The spray dryer utilizes a rotary atomizer to spray a lime slurry to neutralize the acid gases in the flue gas. The six compartment fabric filter removes the particulate matter, including metals. The flue gas is exhausted out the stack. Tables 11 through 20 summarize the stack testing conducted between 12/91-8/92, conducted by ETS, Inc. of Roanoke, Virginia.

3.0 COMMENTS TO AP-42

Tables 4-2, and 4-8 of the draft AP-42 should be updated to include the enclosed data. These tables list the emissions for Arsenic (As) at the Dutchess County Facility (Unit 1 and 2) as non-detect ND and is averaged as zero. Instead of zero, the detection limit of 5.36×10^{-6} lb/hr (0.134 ug/m^3) and 5.0×10^{-26} lb/hr (0.134 ug/m^3) should be used. This Dutchess test data is from the Dutchess County Resource Recovery Facility Emission Compliance Test Report, June 15, 1989 (Beachler, D.S.).

TABLE 1

YORK FACILITY EMISSION TEST RESULTS

PARTICULATE MATTER (PM)

Unit #	Test Date	Test Method	lb/hr	gr/dscf @ 7% O2
1	08/04/90	RM 5	2.31	0.00541
	08/04/90	RM 5	3.49	0.00713
	08/04/90	RM 5	3.13	0.00732
2	08/03/90	RM 5	2.55	0.00745
	08/03/90	RM 5	2.04	0.00512
	08/03/90	RM 5	1.94	0.00539
3	08/02/90	RM 5	1.37	0.00346
	08/02/90	RM 5	1.80	0.00478
	08/02/90	RM 5	1.60	0.00405
1	02/11/91	RM 5	1.67	0.0047
	02/11/91	RM 5	2.02	0.0057
	02/11/91	RM 5	2.28	0.0093
2	02/11/91	RM 5	1.03	0.0030
	02/11/91	RM 5	1.36	0.0038
	02/11/91	RM 5	0.74	0.0018
3	02/12/91	RM 5	3.03	0.0077
	02/12/91	RM 5	2.62	0.0070
	02/12/91	RM 5	2.65	0.0074
1	09/12/91	RM 5	5.09	0.0143
	09/12/91	RM 5	6.17	0.0150
	09/12/91	RM 5	4.31	0.0115
2	09/12/91	RM 5	2.99	0.0091
	09/12/91	RM 5	4.83	0.0127
	09/12/91	RM 5	3.09	0.0088
3	09/12/91	RM 5	2.76	0.0074
	09/12/91	RM 5	5.58	0.0128
	09/12/91	RM 5	4.07	0.0112

TABLE 1 (continued)

YORK FACILITY EMISSION TEST RESULTS

PARTICULATE MATTER (PM)

Unit #	Test Date	Test Method	lb/hr	gr/dscf @ 7% O2
1	02/20/92	RM 5	0.47	0.0014
	02/20/92	RM 5	0.86	0.0028
	02/21/92	RM 5	0.48	0.0015
2	02/21/92	RM 5	8.32	0.028
	02/21/92	RM 5	11.05	0.030
	02/24/92	RM 5	3.97	0.010
3	02/19/92	RM 5	7.30	0.019
	02/19/92	RM 5	5.13	0.015
	02/19/92	RM 5	5.17	0.016
2*	05/01/92	RM 5	0.93	0.0021
	05/01/92	RM 5	1.26	0.0029
	05/01/92	RM 5	0.99	0.0023
3*	04/02/92	RM 5	2.23	0.0065
	04/02/92	RM 5	2.30	0.0063
	04/02/92	RM 5	1.26	0.0033
1	10/06/92	RM 5	0.58	0.0016
	10/06/92	RM 5	0.09	0.0002
	10/06/92	RM 5	0.08	0.0002
2	10/05/92	RM 5	0.60	0.0015
	10/05/92	RM 5	1.47	0.0040
	10/05/92	RM 5	0.19	0.0020
3	10/07/92	RM 5	0.10	0.0003
	10/07/92	RM 5	0.14	0.0004
	10/07/92	RM 5	0.13	0.0004
1	01/12/93	RM 5	0.49	0.00159
	01/12/93	RM 5	0.32	0.00093
	01/12/93	RM 5	0.21	0.00062
2	01/13/93	RM 5	0.34	0.0010
	01/13/93	RM 5	0.43	0.00126
	01/13/93	RM 5	0.23	0.00074
3	01/11/93	RM 5	2.52	0.00718
	01/11/93	RM 5	0.85	0.00264
	01/11/93	RM 5	0.35	0.00116

* Re-test of 2/92 Testing

TABLE 2

YORK FACILITY EMISSION TEST RESULTS

ARSENIC (As)

Unit #	Test Date	Test Method	lb/hr	ug/m3 @ 7% O2
1	07/31/90	MMTL	<6.81E-05	<0.36
	07/30/90	MMTL	8.71E-05	0.44
	07/31/90	MMTL	8.16E-05	0.43
2	08/03/90	MMTL	7.71E-05	0.43
	08/03/90	MMTL	1.45E-04	0.83
	08/03/90	MMTL	1.42E-04	0.85
3	08/01/90	MMTL	<7.12E-05	<0.40
	08/01/90	MMTL	<7.39E-05	<0.41
	08/01/90	MMTL	<7.08E-05	<0.42
1	12/31/90	MMTL	<1.74E-04	<1.32
	12/31/90	MMTL	<4.11E-05	<0.27
	12/31/90	MMTL	<4.35E-05	<0.28
2	12/14/90	MMTL	2.32E-05	0.13
	12/14/90	MMTL	4.09E-05	0.23
	12/14/90	MMTL	4.59E-05	0.24
3	12/15/90	MMTL	1.34E-04	0.74
	12/15/90	MMTL	8.65E-05	0.48
	12/15/90	MMTL	4.50E-05	0.23
1	02/13/91	MMTL	<5.20E-05	<0.37
	02/13/91	MMTL	<4.48E-05	<0.33
	02/14/91	MMTL	<4.74E-05	<0.30
2	02/15/91	MMTL	2.86E-05	0.20
	02/16/91	MMTL	3.10E-05	0.17
	02/16/91	MMTL	<4.59E-05	<0.25
3	02/14/91	MMTL	5.00E-05	0.32
	02/14/91	MMTL	4.33E-05	0.27
	02/15/91	MMTL	2.49E-05	0.16
1	09/12/91	MMTL	1.07E-04	0.74
	09/12/91	MMTL	1.24E-04	0.74
	09/12/91	MMTL	2.71E-04	1.78
2	09/11/91	MMTL	3.36E-05	0.25
	09/11/91	MMTL	6.47E-05	0.42
	09/11/91	MMTL	6.13E-05	0.43
3	09/10/91	MMTL	6.95E-05	0.46
	09/10/91	MMTL	9.60E-05	0.54
	09/10/91	MMTL	8.12E-05	0.55

TABLE 2 (continued)

YORK FACILITY EMISSION TEST RESULTS

ARSENIC (As)

Unit #	Test Date	Test Method	lb/hr	ug/m3 @ 7% O2
1	02/20/92	MMTL	1.92E-04	1.43
	02/20/92	MMTL	6.35E-05	0.50
	02/21/92	MMTL	1.34E-04	1.02
2	02/21/92	MMTL	3.08E-04	2.57
	02/21/92	MMTL	1.16E-03	7.75
	02/24/92	MMTL	1.15E-04	0.72
3	02/19/92	MMTL	1.33E-03	8.42
	02/19/92	MMTL	2.74E-04	1.98
	02/19/92	MMTL	2.91E-04	2.21
1	10/06/92	MMTL	<6.01E-04	<3.90
	10/06/92	MMTL	<9.13E-05	<0.61
	10/06/92	MMTL	<8.98E-05	<0.59
2	10/05/92	MMTL	<8.81E-05	<0.49
	10/05/92	MMTL	<8.86E-05	<0.55
	10/05/92	MMTL	1.11E-04	0.77
3	10/07/92	MMTL	<8.73E-05	<0.61
	10/07/92	MMTL	<9.04E-05	<0.57
	10/07/92	MMTL	<8.78E-05	<0.59
1	01/12/93	MMTL	3.27E-05	0.24
	01/12/93	MMTL	<8.97E-05	<0.59
	01/12/93	MMTL	<9.06E-05	<0.57
2	01/13/93	MMTL	<9.50E-05	<0.65
	01/13/93	MMTL	<9.29E-05	<0.62
	01/13/93	MMTL	5.98E-05	0.43
3	01/11/93	MMTL	1.38E-04	0.90
	01/11/93	MMTL	8.80E-05	0.63
	01/11/93	MMTL	5.98E-05	0.45

TABLE 3

YORK FACILITY EMISSION TEST RESULTS

BERYLLIUM (Be)

Unit #	Test Date	Test Method	lb/hr	ug/m3 @ 7% O2
1	07/31/90	MMTL	<6.81E-06	<0.036
	07/31/90	MMTL	<7.08E-06	<0.035
	07/31/90	MMTL	<6.80E-06	<0.036
2	08/03/90	MMTL	<6.89E-06	<0.038
	08/03/90	MMTL	<7.17E-06	<0.041
	08/03/90	MMTL	<7.24E-06	<0.044
3	08/01/90	MMTL	<7.12E-06	<0.040
	08/01/90	MMTL	<7.39E-06	<0.041
	08/01/90	MMTL	<7.08E-06	<0.042
1	12/13/90	MMTL	<3.72E-06	<0.028
	12/13/90	MMTL	<3.80E-06	<0.025
	12/13/90	MMTL	<3.75E-06	<0.024
2	12/14/90	MMTL	<3.41E-06	<0.019
	12/14/90	MMTL	<4.72E-06	<0.026
	12/14/90	MMTL	<3.70E-06	<0.019
3	12/15/90	MMTL	<3.75E-06	<0.021
	12/15/90	MMTL	<3.60E-06	<0.020
	12/15/90	MMTL	<3.63E-06	<0.019
1	02/13/91	MMTL	<5.11E-06	<0.036
	02/13/91	MMTL	<4.31E-06	<0.031
	02/14/91	MMTL	<5.27E-06	<0.033
2	02/15/91	MMTL	7.57E-06	0.052
	02/16/91	MMTL	<4.20E-06	<0.024
	02/16/91	MMTL	<6.80E-06	<0.038
3	02/14/91	MMTL	1.85E-06	0.012
	02/14/91	MMTL	2.76E-06	0.018
	02/15/91	MMTL	1.84E-06	0.012
1	09/12/91	MMTL	2.61E-06	0.02
	09/12/91	MMTL	3.52E-06	0.02
	09/12/91	MMTL	2.65E-06	0.02
2	09/11/91	MMTL	2.65E-06	0.02
	09/11/91	MMTL	<4.37E-06	<0.03
	09/11 91	MMTL	<4.38E-06	<0.03
3	09/10/91	MMTL	6.49E-06	0.04
	09/10/91	MMTL	2.74E-06	0.02
	09/10/91	MMTL	3.65E-06	0.02

TABLE 3 (continued)

YORK FACILITY EMISSION TEST RESULTS

BERYLLIUM (Be)

Unit #	Test Date	Test Method	lb/hr	ug/m3 @ 7% O2
1	02/20/92	MMTL	1.86E-06	0.014
	02/20/92	MMTL	1.70E-06	0.013
	02/21/92	MMTL	1.07E-06	0.08
2	02/21/92	MMTL	4.70E-06	0.04
	02/21/92	MMTL	5.40E-06	0.04
	02/24/92	MMTL	2.69E-06	0.02
3	02/19/92	MMTL	5.31E-06	0.03
	02/19/92	MMTL	4.18E-06	0.03
	02/19/92	MMTL	5.35E-06	0.04
1	10/06/92	MMTL	<4.74E-06	<0.03
	10/06/92	MMTL	4.80E-06	0.03
	10/06/92	MMTL	4.73E-06	0.03
2	10/05/92	MMTL	7.50E-06	0.04
	10/05/92	MMTL	<4.66E-06	<0.03
	10/05/92	MMTL	1.82E-06	0.01
3	10/07/92	MMTL	4.59E-06	0.03
	10/07/92	MMTL	2.86E-06	0.02
	10/07/92	MMTL	<4.67E-06	<0.03
1	01/12/93	MMTL	<4.68E-06	<0.03
	01/12/93	MMTL	<4.72E-06	<0.03
	01/12/93	MMTL	<4.77E-06	<0.03
2	01/13/93	MMTL	<5.00E-06	<0.03
	01/13/93	MMTL	<4.89E-06	<0.03
	01/13/93	MMTL	<4.75E-06	<0.03
3	01/11/93	MMTL	<4.68E-06	<0.03
	01/11/93	MMTL	<4.59E-06	<0.03
	01/11/93	MMTL	<4.53E-06	<0.03

TABLE 4

YORK FACILITY EMISSION TEST RESULTS

CADMIUM (Cd)

Unit #	Test Date	Test Method	lb/hr	ug/m3 @ 7% O2
1	07/31/90	MMTL	8.18E-04	4.38
	07/31/90	MMTL	8.50E-04	4.27
	07/31/90	MMTL	<6.80E-04	<3.58
2	08/03/90	MMTL	<6.89E-04	<3.85
	08/03/90	MMTL	<7.17E-04	<4.11
	08/03/90	MMTL	<7.24E-04	<4.38
3	08/01/90	MMTL	<7.12E-04	<3.51
	08/01/90	MMTL	<7.39E-04	<3.46
	08/01/90	MMTL	<7.08E-04	<3.44
1	12/13/90	MMTL	<6.11E-05	<0.47
	12/13/90	MMTL	2.15E-05	0.14
	12/13/90	MMTL	3.60E-05	0.23
2	12/14/90	MMTL	2.03E-04	1.17
	12/14/90	MMTL	2.62E-04	1.48
	12/14/90	MMTL	1.92E-04	1.00
3	12/15/90	MMTL	5.71E-04	3.19
	12/15/90	MMTL	4.30E-04	2.39
	12/15/90	MMTL	3.21E-04	1.65
1	02/13/91	MMTL	1.29E-04	0.92
	02/13/91	MMTL	7.59E-05	0.55
	02/14/91	MMTL	1.67E-05	0.10
2	02/15/91	MMTL	1.09E-04	0.75
	02/16/91	MMTL	1.52E-04	0.84
	02/16/91	MMTL	1.18E-04	0.65
3	02/14/91	MMTL	2.64E-04	1.88
	02/14/91	MMTL	1.87E-04	1.19
	02/15/91	MMTL	1.72E-04	1.12
1	09/12/91	MMTL	3.75E-04	2.59
	09/12/91	MMTL	4.05E-04	2.41
	09/12/91	MMTL	3.13E-04	2.06
2	09/11/91	MMTL	2.77E-04	2.06
	09/11/91	MMTL	2.81E-04	1.81
	09/11/91	MMTL	2.68E-04	1.87
3	09/10/91	MMTL	3.32E-04	2.18
	09/10/91	MMTL	4.01E-04	2.25
	09/10/91	MMTL	3.67E-04	2.47

TABLE 4 (continued)

YORK FACILITY EMISSION TEST RESULTS

CADMIUM (Cd)

Unit #	Test Date	Test Method	lb/hr	ug/m3 @ 7% O2
1	02/20/92	MMTL	2.59E-04	1.93
	02/20/92	MMTL	1.73E-04	1.36
	02/21/92	MMTL	1.18E-04	0.89
2	02/21/92	MMTL	2.66E-03	22.17
	02/21/92	MMTL	2.54E-03	17.03
	02/24/92	MMTL	7.23E-03	4.51
3	02/19/92	MMTL	8.77E-04	5.55
	02/19/92	MMTL	6.48E-04	4.70
	02/19/92	MMTL	8.06E-04	6.12
1	10/06/92	MMTL	<2.25E-04	<1.46
	10/06/92	MMTL	<2.29E-04	<1.52
	10/06/92	MMTL	<2.24E-04	<1.48
2	10/05/92	MMTL	8.25E-05	0.46
	10/05/92	MMTL	1.85E-04	1.15
	10/05/92	MMTL	1.45E-04	1.00
3	10/07/92	MMTL	<2.19E-04	<1.54
	10/07/92	MMTL	<2.25E-04	<1.41
	10/07/92	MMTL	<2.20E-04	<1.47
1	01/12/93	MMTL	2.05E-04	1.51
	01/12/93	MMTL	<2.23E-04	<1.46
	01/12/93	MMTL	<2.25E-04	<1.41
2	01/13/93	MMTL	9.60E-05	0.65
	01/13/93	MMTL	<2.32E-04	<1.54
	01/13/93	MMTL	<2.25E-04	<1.62
3	01/11/93	MMTL	8.40E-04	5.47
	01/11/93	MMTL	<2.18E-04	<1.56
	01/11/93	MMTL	2.23E-04	1.66

TABLE 5

YORK FACILITY EMISSION TEST RESULTS

HEXAVALENT CHROMIUM (Cr+6)

Unit #	Test Date	Test Method	lb/hr	ug/m3 @ 7% O2
1	07/31/90	PCR6	3.32E-04	1.73
	07/31/90	PCR6	1.76E-04	0.90
	07/31/90	PCR6	2.03E-04	1.06
2	08/03/90	PCR6	2.63E-04	1.40
	08/03/90	PCR6	4.40E-05	0.24
	08/03/90	PCR6	1.37E-04	0.80
3	08/01/90	PCR6	2.84E-04	1.58
	08/01/90	PCR6	3.37E-04	1.79
	08/01/90	PCR6	9.88E-05	0.57
1	02/14/91	PCR6	9.34E-06	0.06 (12%CO2)
	02/14/91	PCR6	3.10E-05	0.20 (12%CO2)
	02/14/91	PCR6	3.12E-05	0.17 (12%CO2)
2	02/16/91	PCR6	2.14E-05	0.12 (12%CO2)
	02/16/91	PCR6	2.55E-05	0.14 (12%CO2)
	02/16/91	PCR6	2.64E-05	0.18 (12%CO2)
3	12/15/91	PCR6	2.52E-05	0.15 (12%CO2)
	12/15/91	PCR6	<6.29E-05	<0.50 (12%CO2)
	12/15/91	PCR6	7.77E-05	0.07 (12%CO2)
1	09/12/91	EPA IC/PCR	<1.63E-04	<0.94 (12%CO2)
	09/12/91	EPA IC/PCR	<1.69E-04	<0.97 (12%CO2)
	09/12/91	EPA IC/PCR	<1.59E-04	<0.87 (12%CO2)
2	09/11/91	EPA IC/PCR	<1.60E-04	<0.82 (12%CO2)
	09/11/91	EPA IC/PCR	<1.36E-04	<0.90 (12%CO2)
	09/11/91	EPA IC/PCR	<1.45E-04	<0.89 (12%CO2)
3	09/10/91	EPA IC/PCR	1.61E-04	0.88 (12%CO2)
	09/10/91	EPA IC/PCR	<1.65E-04	<0.93 (12%CO2)
	09/10/91	EPA IC/PCR	<1.72E-04	<0.94 (12%CO2)
1	10/06/92	EPA IC/PCR	<1.46E-04	<0.97
	10/07/92	EPA IC/PCR	<1.47E-04	<0.96
	10/07/92	EPA IC/PCR	<1.45E-04	<1.08
2	10/06/92	EPA IC/PCR	<1.45E-04	<1.02
	10/06/92	EPA IC/PCR	<1.26E-04	<0.72
	10/06/92	EPA IC/PCR	<1.48E-04	<0.95
3	10/05/92	EPA IC/PCR	2.08E-04	1.41
	10/05/92	EPA IC/PCR	1.40E-04	0.81
	10/05/92	EPA IC/PCR	<1.37E-04	<0.92

TABLE 5 (continued)

YORK FACILITY EMISSION TEST RESULTS

HEXAVALENT CHROMIUM (Cr+6)

Unit #	Test Date	Test Method	lb/hr	ug/m3 @7% O2
1	01/11/93	EPA IC/PCR	1.50E-03	7.31
	01/11/93	EPA IC/PCR	7.52E-04	4.89
	01/11/93	EPA IC/PCR	3.88E-04	2.38
2	01/12/93	EPA IC/PCR	1.91E-04	1.15
	01/12/93	EPA IC/PCR	2.34E-04	1.50
	01/12/93	EPA IC/PCR	1.86E-04	1.18
3	01/13/93	EPA IC/PCR	<1.24E-04	<0.88
	01/13/93	EPA IC/PCR	<1.30E-04	<0.87
	01/13/93	EPA IC/PCR	<1.16E-04	<0.79

TABLE 6

YORK FACILITY EMISSION TEST RESULTS

LEAD (Pb)

Unit #	Test Date	Test Method	lb/hr	ug/m3 @ 7% O2
1	07/31/90	MMTL	5.45E-03	29.31
	07/31/90	MMTL	5.38E-03	27.00
	07/31/90	MMTL	1.90E-03	10.02
2	08/03/90	MMTL	2.07E-03	11.59
	08/03/90	MMTL	<1.43E-03	<8.22
	08/03/90	MMTL	<1.45E-03	<8.79
3	08/01/90	MMTL	<1.42E-03	<7.99
	08/01/90	MMTL	<1.48E-03	<8.19
	08/01/90	MMTL	<1.42E-03	<8.52
1	12/13/90	MMTL	5.48E-04	4.16
	12/13/90	MMTL	4.29E-04	2.88
	12/13/90	MMTL	3.90E-04	2.46
2	12/14/90	MMTL	5.92E-03	34.04
	12/14/90	MMTL	6.90E-03	38.98
	12/14/90	MMTL	7.95E-03	41.57
3	12/15/90	MMTL	1.72E-02	96.16
	12/15/90	MMTL	1.14E-02	63.51
	12/15/90	MMTL	1.03E-02	53.00
1	02/13/91	MMTL	1.76E-03	12.63
	02/13/91	MMTL	1.36E-03	10.07
	02/14/91	MMTL	2.63E-03	16.60
2	02/15/91	MMTL	1.48E-03	10.25
	02/16/91	MMTL	3.82E-03	21.28
	02/16/91	MMTL	2.12E-03	11.70
3	02/14/91	MMTL	4.23E-03	27.53
	02/14/91	MMTL	4.37E-03	27.79
	02/15/91	MMTL	2.59E-03	16.90
1	09/12/91	MMTL	7.87E-03	54.45
	09/12/91	MMTL	8.59E-03	51.14
	09/12/91	MMTL	5.58E-03	36.64
2	09/11/91	MMTL	5.53E-03	41.15
	09/11/91	MMTL	6.33E-03	40.86
	09/11/91	MMTL	7.65E-03	53.31
3	09/10/91	MMTL	9.49E-03	62.27
	09/10/91	MMTL	9.95E-03	56.00
	09/10/91	MMTL	7.95E-03	53.56

TABLE 6 (continued)

YORK FACILITY EMISSION TEST RESULTS

LEAD (Pb)

Unit #	Test Date	Test Method	lb/hr	ug/m3 @ 7% O2
1	02/20/92	MMTL	1.39E-03	10.35
	02/20/92	MMTL	2.83E-03	22.31
	02/21/92	MMTL	1.50E-03	11.43
2	02/21/92	MMTL	5.66E-02	472.32
	02/21/92	MMTL	4.25E-02	284.69
	02/24/92	MMTL	1.64E-02	102.23
3	02/19/92	MMTL	2.08E-02	131.61
	02/19/92	MMTL	1.17E-02	84.73
	02/19/92	MMTL	9.72E-03	73.79
1	10/06/92	MMTL	2.16E-03	13.99
	10/06/92	MMTL	5.89E-04	3.92
	10/06/92	MMTL	3.45E-04	2.28
2	10/05/92	MMTL	1.21E-03	6.72
	10/05/92	MMTL	5.35E-04	3.33
	10/05/92	MMTL	5.88E-04	4.07
3	10/07/92	MMTL	7.64E-04	5.36
	10/07/92	MMTL	8.01E-04	5.03
	10/07/92	MMTL	7.84E-04	5.24
1	01/12/93	MMTL	6.71E-04	4.94
	01/12/93	MMTL	2.35E-04	1.54
	01/12/93	MMTL	2.99E-04	1.87
2	01/13/93	MMTL	3.39E-04	2.30
	01/13/93	MMTL	4.11E-04	2.73
	01/13/93	MMTL	1.74E-03	12.59
3	01/11/93	MMTL	7.65E-03	49.87
	01/11/93	MMTL	3.00E-03	21.43
	01/11/93	MMTL	2.15E-03	16.06

TABLE 7

YORK FACILITY EMISSION TEST RESULTS

MERCURY (Hg)

Unit #	Test Date	Test Method	lb/hr	ug/m3 @ 7% O2
1	07/31/90	MMTL	0.0242	128.6
	07/31/90	MMTL	0.0240	119.7
	07/31/90	MMTL	0.0433	226.1
2	08/03/90	MMTL	0.0191	106.2
	08/03/90	MMTL	0.0281	159.2
	08/03/90	MMTL	0.0309	185.8
3	08/01/91	MMTL	0.0169	93.8
	08/01/91	MMTL	0.0123	67.9
	08/01/91	MMTL	0.0128	76.2
1	12/13/90	MMTL	0.0148	112.3
	12/13/90	MMTL	0.0240	159.9
	12/13/90	MMTL	0.0283	179.4
2	12/14/90	MMTL	0.0310	176.7
	12/14/90	MMTL	0.0316	176.9
	12/14/90	MMTL	0.0285	147.9
3	12/15/90	MMTL	0.0351	194.8
	12/15/90	MMTL	0.0188	103.9
	12/15/90	MMTL	0.0215	109.6
1	02/13/91	MMTL	0.0177	127.0
	02/13/91	MMTL	0.0365	270.4
	02/14/91	MMTL	0.0107	67.5
2	02/15/91	MMTL	0.0264	182.7
	02/16/91	MMTL	0.0302	168.3
	02/16/91	MMTL	0.0229	149.0
3	02/14/91	MMTL	0.0156	101.6
	02/14/91	MMTL	0.0172	109.4
	02/15/91	MMTL	0.0301	196.5
1	09/12/91	MMTL	8.22E-03	56.8
	09/12/91	MMTL	5.80E-03	34.6
	09/12/91	MMTL	2.57E-03	16.9
2	09/11/91	MMTL	6.30E-03	46.9
	09/11/91	MMTL	9.23E-03	59.5
	09/11/91	MMTL	7.55E-03	52.7
3	09/10/91	MMTL	0.0122	80.2
	09/10/91	MMTL	0.0182	102.4
	09/10/91	MMTL	0.0264	177.6

TABLE 7 (continued)

YORK FACILITY EMISSION TEST RESULTS

MERCURY (Hg)

Unit #	Test Date	Test Method	lb/hr	ug/m3 @ 7% O2
1	02/20/92	MMTL	7.48E-03	55.81
	02/20/92	MMTL	7.27E-03	57.32
	02/21/92	MMTL	4.23E-03	32.12
2	02/21/92	MMTL	1.64E-02	136.79
	02/21/92	MMTL	1.12E-02	75.30
	02/24/92	MMTL	3.37E-02	210.05
3	02/19/92	MMTL	2.09E-02	132.02
	02/19/92	MMTL	1.24E-02	89.74
	02/19/92	MMTL	1.00E-02	76.14
1	10/06/92	MMTL	7.96E-03	51.61
	10/06/92	MMTL	6.55E-03	43.67
	10/06/92	MMTL	1.01E-02	66.60
2	10/05/92	MMTL	1.89E-02	104.52
	10/05/92	MMTL	4.86E-03	30.30
	10/05/92	MMTL	4.53E-03	31.36
3	10/07/92	MMTL	7.50E-03	52.68
	10/07/92	MMTL	4.28E-03	26.88
	10/07/92	MMTL	6.09E-03	40.71
1	01/12/93	MMTL	2.03E-02	149.37
	01/12/93	MMTL	2.24E-02	147.00
	01/12/93	MMTL	2.62E-02	163.75
2	01/13/93	MMTL	9.80E-03	66.55
	01/13/93	MMTL	1.18E-02	78.54
	01/13/93	MMTL	1.28E-02	92.61
3	01/11/93	MMTL	4.41E-02	287.11
	01/11/93	MMTL	7.68E-03	54.82
	01/11/93	MMTL	1.44E-02	107.23

TABLE 8

YORK FACILITY EMISSION TEST RESULTS

NICKEL (Ni)

Unit #	Test Date	Test Method	lb/hr	ug/m3 @ 7% O2
1	07/31/90	MMTL	6.50E-04	3.46
	07/31/90	MMTL	9.63E-04	4.81
	07/31/90	MMTL	4.73E-04	2.48
2	08/03/90	MMTL	4.88E-04	2.70
	08/03/90	MMTL	3.74E-04	2.13
	08/03/90	MMTL	2.66E-04	1.60
3	08/01/90	MMTL	5.29E-04	2.96
	08/01/90	MMTL	7.36E-04	4.06
	08/01/90	MMTL	5.56E-04	3.32
1	12/13/90	MMTL	1.13E-04	0.86
	12/13/90	MMTL	1.89E-04	1.26
	12/13/90	MMTL	1.37E-04	0.87
2	12/14/90	MMTL	1.94E-04	1.11
	12/14/90	MMTL	9.26E-04	5.19
	12/14/90	MMTL	5.96E-04	3.10
3	12/15/90	MMTL	4.71E-04	2.61
	12/15/90	MMTL	3.08E-04	1.71
	12/15/90	MMTL	5.22E-04	2.67
1	02/13/91	MMTL	2.45E-04	1.75
	02/13/91	MMTL	1.25E-04	0.93
	02/14/91	MMTL	9.57E-04	0.60
2	02/15/91	MMTL	1.07E-04	0.74
	02/16/91	MMTL	1.66E-04	0.92
	02/16/91	MMTL	1.08E-04	0.60
3	02/14/91	MMTL	3.74E-04	2.44
	02/14/91	MMTL	1.09E-04	0.70
	02/15/91	MMTL	6.18E-04	0.41
1	09/12/91	MMTL	2.72E-04	1.88
	09/12/91	MMTL	3.49E-04	2.08
	09/12/91	MMTL	1.53E-04	1.01
2	09/11/91	MMTL	2.21E-04	1.64
	09/11/91	MMTL	1.42E-04	0.91
	09/11/91	MMTL	1.05E-04	0.73
3	09/10/91	MMTL	2.84E-04	1.86
	09/10/91	MMTL	2.38E-04	1.34
	09/10/91	MMTL	1.87E-04	1.26

TABLE 8 (continued)

YORK FACILITY EMISSION TEST RESULTS

NICKEL (Ni)

Unit #	Test Date	Test Method	lb/hr	ug/m3 @ 7% O2
1	02/20/92	MMTL	1.03E-04	0.77
	02/20/92	MMTL	2.05E-04	1.61
	02/21/92	MMTL	9.27E-05	0.71
2	02/21/92	MMTL	1.44E-03	12.03
	02/21/92	MMTL	2.07E-03	13.90
	02/24/92	MMTL	4.29E-04	2.67
3	02/19/92	MMTL	7.31E-04	4.62
	02/19/92	MMTL	5.30E-04	3.84
	02/19/92	MMTL	4.05E-04	3.08
1	10/06/92	MMTL	7.09E-04	4.60
	10/06/92	MMTL	4.20E-04	2.80
	10/06/92	MMTL	6.52E-05	0.43
2	10/05/92	MMTL	3.94E-04	2.18
	10/05/92	MMTL	3.32E-04	2.07
	10/05/92	MMTL	3.06E-04	2.12
3	10/07/92	MMTL	4.78E-05	0.34
	10/07/92	MMTL	6.66E-06	0.04
	10/07/92	MMTL	7.28E-05	0.49
1	01/12/93	MMTL	1.73E-04	1.27
	01/12/93	MMTL	5.38E-05	0.35
	01/12/93	MMTL	3.55E-04	2.22
2	01/13/93	MMTL	2.74E-04	1.86
	01/13/93	MMTL	4.11E-05	0.27
	01/13/93	MMTL	4.98E-04	3.60
3	01/11/93	MMTL	2.49E-03	16.21
	01/11/93	MMTL	8.39E-04	5.99
	01/11/93	MMTL	1.41E-04	1.05

TABLE 9

YORK FACILITY EMISSION TEST RESULTS

ZINC (Zn)

Unit #	Test Date	Test Method	lb/hr	ug/m3 @ 7% O2
1	07/31/90	MMTL	1.58E-02	84.11
	07/31/90	MMTL	1.37E-02	68.52
	07/31/90	MMTL	9.79E-03	51.11
2	08/03/90	MMTL	9.37E-03	52.25
	08/03/90	MMTL	7.75E-03	44.00
	08/03/90	MMTL	9.27E-03	55.92
3	08/01/90	MMTL	2.28E-03	12.67
	08/01/90	MMTL	3.25E-03	17.90
	08/01/90	MMTL	2.55E-03	15.22
1	12/13/90	MMTL	1.76E-03	13.38
	12/13/90	MMTL	2.46E-03	16.42
	12/13/90	MMTL	2.00E-03	12.68
2	12/14/90	MMTL	1.21E-02	69.08
	12/14/90	MMTL	1.83E-02	102.65
	12/14/90	MMTL	1.75E-02	91.00
3	12/15/90	MMTL	3.77E-02	209.27
	12/15/90	MMTL	2.79E-02	154.45
	12/15/90	MMTL	1.94E-02	91.12
1	02/13/91	MMTL	7.78E-03	55.81
	02/13/91	MMTL	6.08E-03	45.05
	02/14/91	MMTL	3.92E-03	24.73
2	02/15/91	MMTL	3.60E-03	24.91
	02/16/91	MMTL	7.55E-03	42.06
	02/16/91	MMTL	4.65E-03	25.67
3	02/14/91	MMTL	1.39E-02	90.50
	02/14/91	MMTL	1.02E-02	64.87
	02/15/91	MMTL	5.66E-02	369.36
1	09/12/91	MMTL	1.69E-02	116.68
	09/12/91	MMTL	2.42E-02	144.32
	09/12/91	MMTL	1.40E-02	92.26
2	09/11/91	MMTL	1.20E-02	89.29
	09/11/91	MMTL	1.73E-02	111.46
	09/11/91	MMTL	1.68E-02	116.91
3	09/10/91	MMTL	1.57E-02	102.88
	09/10/91	MMTL	1.92E-02	107.87
	09/10/91	MMTL	1.80E-02	111.96

TABLE 9 (continued)

YORK FACILITY EMISSION TEST RESULTS

ZINC (Zn)

Unit #	Test Date	Test Method	lb/hr	ug/m3 @ 7% O2
1	02/20/92	MMTL	7.29E-03	54.39
	02/20/92	MMTL	1.82E-02	143.82
	02/21/92	MMTL	8.12E-03	61.73
2	02/21/92	MMTL	1.06E-01	886.87
	02/21/92	MMTL	1.31E-01	880.26
	02/24/92	MMTL	3.01E-02	187.56
3	02/19/92	MMTL	5.15E-02	325.30
	02/19/92	MMTL	6.54E-02	473.61
	02/19/92	MMTL	4.02E-02	305.04
1	10/06/92	MMTL	6.79E-03	44.05
	10/06/92	MMTL	4.25E-03	28.30
	10/06/92	MMTL	2.53E-03	16.76
2	10/05/92	MMTL	1.42E-02	78.51
	10/05/92	MMTL	9.69E-03	60.42
	10/05/92	MMTL	3.57E-03	24.76
3	10/07/92	MMTL	2.58E-03	18.13
	10/07/92	MMTL	3.49E-03	21.91
	10/07/92	MMTL	2.84E-03	18.97
1	01/12/93	MMTL	6.56E-03	48.28
	01/12/93	MMTL	3.25E-03	21.35
	01/12/93	MMTL	3.27E-03	20.48
2	01/13/93	MMTL	4.60E-03	31.25
	01/13/93	MMTL	3.52E-03	23.43
	01/13/93	MMTL	3.35E-03	24.20
3	01/11/93	MMTL	8.03E-02	523.36
	01/11/93	MMTL	2.35E-02	167.68
	01/11/93	MMTL	1.15E-02	86.09

TABLE 10

YORK COUNTY FACILITY EMISSIONS TEST RESUTLS

PCDD + PCDF

UNIT	TEST DATE	TEST METHOD		ng/dscm @ 7% O2 TOTAL
1	02/01/90	RM 23		4.000
1	02/02/90	RM 23		3.410
1	02/03/90	RM 23		5.400
1	02/04/90	RM 23		4.460
2	01/31/90	RM 23		9.130
2	02/01/90	RM 23		4.490
2	02/02/90	RM 23		3.210
3	01/30/90	RM 23		3.050
3	01/31/90	RM 23		4.940
3	01/31/90	RM 23		2.750
1	02/11/91	RM 23		16.190
1	02/12/91	RM 23		7.934
1	02/13/91	RM 23		17.121
2	02/12/91	RM 23		2.799
2	02/15/91	RM 23	*	772.410
2	02/16/91	RM 23		96.065
3	02/13/91	RM 23		5.776
3	02/13/91	RM 23		24.008
3	02/14/91	RM 23		7.284
1	02/21/92	RM 23		1.258
1	02/24/92	RM 23		2.436
1	02/24/92	RM 23		1.359
2	02/19/92	RM 23		8.170
2	02/19/92	RM 23		3.947
2	02/25/92	RM 23		3.219
3	02/20/92	RM 23		3.249
3	02/21/92	RM 23		3.166
3	02/25/92	RM 23		6.562
1	01/13/93	RM 23		5.099
1	01/13/93	RM 23		11.093
1	01/14/93	RM 23		0.004
2	01/11/93	RM 23		11.873
2	01/14/93	RM 23		5.202
2	01/14/93	RM 23		5.459
3	01/12/93	RM 23		9.323
3	01/12/93	RM 23		6.606
3	01/14/93	RM 23		8.091
AVERAGE WITH PROBLEM RUN			*	29.474
		AVERAGE		9.090

* POTENTIAL PROBLEM RUN

TABLE 11

DELAWARE COUNTY FACILITY EMISSIONS TEST RESUTLS

PARTICULATE MATTER (PM)

UNIT	TEST DATE	TEST METHOD	lb/hr	gr/dscf @ 7% O2
1	01/18/92	RM5	0.43	0.0013
1	01/21/92	RM5	0.22	0.0006
1	01/21/92	RM5	0.27	0.0006
2	01/15/92	RM5	4.75	0.0126
2	01/15/92	RM5	0.30	0.0007
2	01/16/92	RM5	0.36	0.0009
3	12/12/91	RM5	0.61	0.0013
3	12/13/91	RM5	0.34	0.0008
3	12/13/91	RM5	0.23	0.0005
4	01/17/92	RM5	0.26	0.0006
4	01/21/92	RM5	2.25	0.0051
4	01/22/92	RM5	0.22	0.0005
5	12/12/91	RM5	0.59	0.0016
5	12/13/91	RM5	0.87	0.0021
5	12/13/91	RM5	0.10	0.0003
6	12/11/91	RM5	2.02	0.0057
6	12/11/91	RM5	0.82	0.0020
6	12/12/91	RM5	0.85	0.0021
1	08/06/92	RM5	0.62	0.0014
1	08/07/92	RM5	1.23	0.0028
1	08/08/92	RM5	1.33	0.0031
2	08/05/92	RM5	0.20	0.0005
2	08/06/92	RM5	0.33	0.0008
2	08/06/92	RM5	0.47	0.0011
3	08/04/92	RM5	0.40	0.0010
3	08/04/92	RM5	0.51	0.0012
3	08/04/92	RM5	0.45	0.0011
4	08/07/92	RM5	0.58	0.0015
4	08/08/92	RM5	0.55	0.0015
4	08/08/92	RM5	0.32	0.0008
5	08/05/92	RM5	0.27	0.0006
5	08/05/92	RM5	0.48	0.0011
5	08/05/92	RM5	0.78	0.0019
6	08/03/92	RM5	0.12	0.0002
6	08/03/92	RM5	0.26	0.0006
6	08/03/92	RM5	0.15	0.0003
		AVERAGE	0.68	0.0017

TABLE 12

DELAWARE COUNTY FACILITY EMISSIONS TEST RESUTLS

ARSENIC (As)

UNIT	TEST DATE	TEST METHOD		lb/hr		ug/dscm @ 7
1	01/18/92	MMTL	<	4.44E-05	<	0.03
1	01/21/92	MMTL	<	3.99E-05	<	0.24
1	01/21/92	MMTL	<	4.35E-05	<	0.22
2	01/15/92	MMTL	<	4.59E-05	<	0.28
2	01/15/92	MMTL	<	4.18E-05	<	0.22
2	01/16/92	MMTL	<	4.43E-05	<	0.26
3	12/12/91	MMTL		1.82E-05		0.09
3	12/13/91	MMTL		1.89E-05		0.11
3	12/13/91	MMTL	<	7.36E-05	<	0.38
4	01/17/92	MMTL	<	4.12E-05	<	0.23
4	01/21/92	MMTL	<	4.08E-05	<	0.21
4	01/22/92	MMTL	<	4.49E-05	<	0.23
5	12/12/91	MMTL		1.95E-05		0.12
5	12/13/91	MMTL	<	7.72E-05	<	0.42
5	12/13/91	MMTL	<	7.66E-05	<	0.49
6	12/11/91	MMTL		2.04E-05		0.01
6	12/11/91	MMTL	<	7.30E-05	<	0.40
6	12/12/91	MMTL		1.93E-05		0.11
1	08/06/92	MMTL	<	4.76E-05	<	0.25
1	08/07/92	MMTL	<	4.82E-05	<	0.25
1	08/08/92	MMTL	<	5.17E-05	<	0.28
2	08/05/92	MMTL	<	4.18E-05	<	0.28
2	08/06/92	MMTL	<	4.71E-05	<	0.28
2	08/06/92	MMTL	<	4.86E-05	<	0.27
3	08/04/92	MMTL	<	4.53E-05	<	0.25
3	08/04/92	MMTL	<	4.72E-05	<	0.25
3	08/04/92	MMTL	<	4.58E-05	<	0.25
4	08/07/92	MMTL	<	4.53E-05	<	0.27
4	08/08/92	MMTL	<	4.18E-05	<	0.29
4	08/08/92	MMTL	<	4.72E-05	<	0.28
5	08/05/92	MMTL	<	4.92E-05	<	0.26
5	08/05/92	MMTL	<	4.84E-05	<	0.24
5	08/05/92	MMTL	<	4.86E-05	<	0.27
6	08/03/92	MMTL	<	3.93E-05	<	0.18
6	08/03/92	MMTL	<	5.28E-05	<	0.27
6	08/03/92	MMTL	<	5.05E-05	<	0.26
		AVERAGE		4.53E-05		0.24

TABLE 13

DELAWARE COUNTY FACILITY EMISSIONS TEST RESUTLS

BERYLLIUM (Be)

UNIT	TEST DATE	TEST METHOD		lb/hr		ug/dscm @ 7%
1	01/18/92	MMTL	<	4.27E-06	<	0.03
1	01/21/92	MMTL		3.83E-06		0.02
1	01/21/92	MMTL		2.51E-06		0.01
2	01/15/92	MMTL	<	4.33E-06	<	0.03
2	01/15/92	MMTL		4.02E-06		0.02
2	01/16/92	MMTL	<	4.26E-06	<	0.03
3	12/12/91	MMTL	<	6.95E-06	<	0.03
3	12/13/91	MMTL	<	6.87E-06	<	0.04
3	12/13/91	MMTL	<	6.93E-06	<	0.04
4	01/17/92	MMTL	<	3.96E-06	<	0.02
4	01/21/92	MMTL		1.57E-06		0.01
4	01/22/92	MMTL		1.73E-06		0.01
5	12/12/91	MMTL	<	7.08E-06	<	0.05
5	12/13/91	MMTL	<	7.19E-06	<	0.04
5	12/13/91	MMTL	<	7.92E-06	<	0.05
6	12/11/91	MMTL	<	6.79E-06	<	0.04
6	12/11/91	MMTL	<	6.79E-06	<	0.04
6	12/12/91	MMTL	<	6.72E-06	<	0.04
1	08/06/92	MMTL	<	2.38E-05	<	0.12
1	08/07/92	MMTL	<	2.37E-05	<	0.12
1	08/08/92	MMTL	<	2.55E-05	<	0.14
2	08/05/92	MMTL	<	2.49E-05	<	0.15
2	08/06/92	MMTL	<	2.36E-05	<	0.13
2	08/06/92	MMTL	<	2.39E-05	<	0.13
3	08/04/92	MMTL	<	2.30E-05	<	0.13
3	08/04/92	MMTL	<	2.40E-05	<	0.13
3	08/04/92	MMTL	<	2.25E-05	<	0.12
4	08/07/92	MMTL	<	2.26E-05	<	0.13
4	08/08/92	MMTL	<	2.49E-05	<	0.15
4	08/08/92	MMTL	<	2.32E-05	<	0.14
5	08/05/92	MMTL	<	2.42E-05	<	0.13
5	08/05/92	MMTL	<	2.42E-05	<	0.12
5	08/05/92	MMTL	<	2.38E-05	<	0.13
6	08/03/92	MMTL	<	2.00E-05	<	0.09
6	08/03/92	MMTL	<	2.74E-05	<	0.14
6	08/03/92	MMTL	<	2.57E-05	<	0.13
		AVERAGE		1.46E-05		0.08

TABLE 14

DELAWARE COUNTY FACILITY EMISSIONS TEST RESUTLS

CADMIUM (Cd)

UNIT	TEST DATE	TEST METHOD		lb/hr		ug/dscm @ 7%
1	01/18/92	MMTL	<	8.97E-05	<	0.62
1	01/21/92	MMTL	<	8.05E-05	<	0.48
1	01/21/92	MMTL		6.02E-05		0.30
2	01/15/92	MMTL		4.33E-05		0.26
2	01/15/92	MMTL	<	8.45E-05	<	0.45
2	01/16/92	MMTL	<	8.95E-05	<	0.53
3	12/12/91	MMTL	<	1.09E-04	<	0.53
3	12/13/91	MMTL		3.35E-05		0.19
3	12/13/91	MMTL		5.11E-05		0.26
4	01/17/92	MMTL	<	8.32E-05	<	0.47
4	01/21/92	MMTL		3.37E-05		0.02
4	01/22/92	MMTL		9.32E-05		0.47
5	12/12/91	MMTL	<	1.15E-04	<	0.73
5	12/13/91	MMTL		1.94E-04		1.06
5	12/13/91	MMTL	<	1.16E-04	<	0.74
6	12/11/91	MMTL		1.07E-04		0.69
6	12/11/91	MMTL	<	1.09E-04	<	0.60
6	12/12/91	MMTL	<	1.08E-04	<	0.60
1	08/06/92	MMTL	<	1.19E-04	<	0.62
1	08/07/92	MMTL	<	1.19E-04	<	0.62
1	08/08/92	MMTL	<	1.28E-04	<	0.69
2	08/05/92	MMTL	<	1.21E-04	<	0.71
2	08/06/92	MMTL		1.73E-04		0.93
2	08/06/92	MMTL		8.95E-05		0.50
3	08/04/92	MMTL	<	1.14E-04	<	0.63
3	08/04/92	MMTL	<	1.19E-04	<	0.62
3	08/04/92	MMTL	<	1.14E-04	<	0.62
4	08/07/92	MMTL	<	1.15E-04	<	0.67
4	08/08/92	MMTL	<	1.21E-04	<	0.74
4	08/08/92	MMTL	<	1.18E-04	<	0.69
5	08/05/92	MMTL	<	1.23E-04	<	0.65
5	08/05/92	MMTL	<	1.21E-04	<	0.60
5	08/05/92	MMTL	<	1.20E-04	<	0.67
6	08/03/92	MMTL	<	1.00E-04	<	0.46
6	08/03/92	MMTL	<	1.34E-04	<	0.69
6	08/03/92	MMTL	<	1.28E-04	<	0.66
		AVERAGE		1.05E-04		0.58

TABLE 15

DELAWARE COUNTY FACILITY EMISSIONS TEST RESUTLS

LEAD (Pb)

UNIT	TEST DATE	TEST METHOD	lb/hr	ug/dscm @ 7%
1	01/18/92	MMTL	< 1.02E-03	< 7.02
1	01/21/92	MMTL	< 9.42E-04	< 5.58
1	01/21/92	MMTL	1.72E-03	8.60
2	01/15/92	MMTL	< 1.07E-03	< 6.50
2	01/15/92	MMTL	< 9.89E-04	< 5.24
2	01/16/92	MMTL	< 1.05E-03	< 6.22
3	12/12/91	MMTL	< 1.57E-03	< 7.62
3	12/13/91	MMTL	< 1.58E-03	< 8.81
3	12/13/91	MMTL	< 1.58E-03	< 8.12
4	01/17/92	MMTL	< 9.37E-01	< 5.49
4	01/21/92	MMTL	< 9.59E-04	< 4.94
4	01/22/92	MMTL	< 1.06E-03	< 5.40
5	12/12/91	MMTL	< 1.65E-03	< 10.53
5	12/13/91	MMTL	< 1.67E-06	< 9.08
5	12/13/91	MMTL	< 1.66E-03	< 10.61
6	12/11/91	MMTL	4.14E-04	2.67
6	12/11/91	MMTL	1.17E-03	6.44
6	12/12/91	MMTL	< 1.56E-03	< 8.60
1	08/06/92	MMTL	9.33E-04	4.88
1	08/07/92	MMTL	8.10E-04	4.23
1	08/08/92	MMTL	4.76E-04	2.57
2	08/05/92	MMTL	4.15E-04	2.44
2	08/06/92	MMTL	3.44E-03	18.45
2	08/06/92	MMTL	4.36E-03	24.17
3	08/04/92	MMTL	5.36E-04	2.99
3	08/04/92	MMTL	3.13E-04	1.63
3	08/04/92	MMTL	3.76E-04	2.05
4	08/07/92	MMTL	3.16E-04	1.85
4	08/08/92	MMTL	3.81E-04	2.32
4	08/08/92	MMTL	1.53E-04	0.89
5	08/05/92	MMTL	2.99E-04	1.57
5	08/05/92	MMTL	2.58E-04	1.29
5	08/05/92	MMTL	2.14E-04	1.20
6	08/03/92	MMTL	7.47E-04	3.46
6	08/03/92	MMTL	1.25E-03	6.45
6	08/03/92	MMTL	4.25E-04	2.20
		AVERAGE	2.70E-02	5.89

TABLE 16

DELAWARE COUNTY FACILITY EMISSIONS TEST RESUTLS

MERCURY (Hg)

UNIT	TEST DATE	TEST METHOD	lb/hr	ug/dscm @ 7%
1	01/18/92	MMTL	9.42E-03	64.99
1	01/21/92	MMTL	4.27E-03	25.27
1	01/21/92	MMTL	6.32E-03	31.57
2	01/15/92	MMTL	2.97E-03	18.00
2	01/15/92	MMTL	5.34E-03	28.32
2	01/16/92	MMTL	3.71E-03	22.05
3	12/12/91	MMTL	5.19E-03	25.15
3	12/13/91	MMTL	6.42E-03	35.74
3	12/13/91	MMTL	5.95E-03	30.54
4	01/17/92	MMTL	5.61E-03	31.61
4	01/21/92	MMTL	6.87E-03	35.44
4	01/22/92	MMTL	2.92E-03	14.88
5	12/12/91	MMTL	9.05E-03	57.77
5	12/13/91	MMTL	5.88E-03	46.62
5	12/13/91	MMTL	9.14E-03	58.51
6	12/11/91	MMTL	1.64E-02	105.88
6	12/11/91	MMTL	1.21E-02	66.69
6	12/12/91	MMTL	1.44E-02	79.83
1	08/06/92	MMTL	6.35E-03	33.15
1	08/07/92	MMTL	7.06E-03	36.88
1	08/08/92	MMTL	3.73E-03	20.16
2	08/05/92	MMTL	1.35E-02	79.41
2	08/06/92	MMTL	5.84E-03	31.36
2	08/06/92	MMTL	7.16E-03	39.72
3	08/04/92	MMTL	1.40E-02	78.35
3	08/04/92	MMTL	8.66E-03	45.15
3	08/04/92	MMTL	9.02E-03	49.20
4	08/07/92	MMTL	1.15E-02	67.16
4	08/08/92	MMTL	2.37E-02	143.98
4	08/08/92	MMTL	8.55E-03	49.94
5	08/05/92	MMTL	8.29E-03	43.58
5	08/05/92	MMTL	7.80E-03	38.92
5	08/05/92	MMTL	7.19E-03	40.34
6	08/03/92	MMTL	6.51E-03	30.13
6	08/03/92	MMTL	1.05E-02	54.41
6	08/03/92	MMTL	8.43E-03	43.95
		AVERAGE	8.33E-03	47.35

TABLE 17

DELAWARE COUNTY FACILITY EMISSIONS TEST RESUTLS

NICKEL (Ni)

UNIT	TEST DATE	TEST METHOD	lb/hr	ug/dscm @ 7%
1	01/18/92	MMTL	4.50E-04	3.11
1	01/21/92	MMTL	1.12E-04	0.66
1	01/21/92	MMTL	2.11E-04	1.06
2	01/15/92	MMTL	2.47E-03	15.00
2	01/15/92	MMTL	3.47E-04	1.84
2	01/16/92	MMTL	6.82E-05	0.41
3	12/12/91	MMTL	1.64E-04	0.80
3	12/13/91	MMTL	2.52E-04	1.40
3	12/13/91	MMTL	4.35E-04	2.23
4	01/17/92	MMTL	1.39E-04	0.79
4	01/21/92	MMTL	1.89E-03	9.74
4	01/22/92	MMTL	2.62E-03	13.34
5	12/12/91	MMTL	2.44E-04	1.56
5	12/13/91	MMTL	2.29E-04	1.25
5	12/13/91	MMTL	5.12E-04	3.28
6	12/11/91	MMTL	5.09E-04	3.29
6	12/11/91	MMTL	1.15E-03	6.30
6	12/12/91	MMTL	8.90E-05	0.49
1	08/06/92	MMTL	1.99E-04	1.04
1	08/07/92	MMTL	< 3.09E-04	< 1.61
1	08/08/92	MMTL	8.02E-03	43.32
2	08/05/92	MMTL	7.50E-04	4.41
2	08/06/92	MMTL	< 3.08E-04	< 1.65
2	08/06/92	MMTL	< 3.12E-04	< 1.73
3	08/04/92	MMTL	3.74E-04	2.08
3	08/04/92	MMTL	1.45E-04	0.76
3	08/04/92	MMTL	3.54E-03	19.33
4	08/07/92	MMTL	3.60E-04	2.11
4	08/08/92	MMTL	2.52E-04	1.53
4	08/08/92	MMTL	4.40E-04	2.57
5	08/05/92	MMTL	6.57E-04	3.46
5	08/05/92	MMTL	4.78E-04	2.39
5	08/05/92	MMTL	4.20E-04	2.36
6	08/03/92	MMTL	4.07E-04	1.89
6	08/03/92	MMTL	6.51E-04	3.36
6	08/03/92	MMTL	5.45E-04	2.82
		AVERAGE	8.35E-04	4.58

TABLE 18

DELAWARE COUNTY FACILITY EMISSIONS TEST RESUTLS

ZINC (Zn)

UNIT	TEST DATE	TEST METHOD	lb/hr	ug/dscm @ 7%
1	01/18/92	MMTL	1.57E-03	10.55
1	01/21/92	MMTL	1.53E-03	9.06
1	01/21/92	MMTL	2.06E-03	10.27
2	01/15/92	MMTL	1.82E-03	11.03
2	01/15/92	MMTL	1.06E-03	5.62
2	01/16/92	MMTL	1.31E-03	7.81
3	12/12/91	MMTL	1.27E-03	6.17
3	12/13/91	MMTL	1.55E-03	8.63
3	12/13/91	MMTL	2.42E-03	12.41
4	01/17/92	MMTL	2.21E-03	12.47
4	01/21/92	MMTL	2.51E-03	12.95
4	01/22/92	MMTL	1.85E-03	9.43
5	12/12/91	MMTL	1.71E-03	10.94
5	12/13/91	MMTL	2.37E-03	12.94
5	12/13/91	MMTL	2.04E-03	13.09
6	12/11/91	MMTL	4.50E-03	29.06
6	12/11/91	MMTL	2.43E-03	13.36
6	12/12/91	MMTL	2.48E-03	13.69
		AVERAGE	2.04E-03	11.64

TABLE 19

DELAWARE COUNTY FACILITY EMISSIONS TEST RESUTLS

HEXAVALENT CHROMIUM

UNIT	TEST DATE	TEST METHOD	lb/hr	ug/dscm @ 7%
1	01/18/92	EPA IC/PCR	< 9.31E-05	< 0.469
1	01/21/92	EPA IC/PCR	< 1.50E-04	< 0.983
1	01/21/92	EPA IC/PCR	< 1.02E-04	< 0.516
2	01/15/92	EPA IC/PCR	< 1.06E-04	< 0.563
2	01/15/92	EPA IC/PCR	< 1.09E-04	< 0.649
2	01/16/92	EPA IC/PCR	< 1.08E-04	< 0.599
3	12/12/91	EPA IC/PCR	< 1.06E-04	< 0.570
3	12/13/91	EPA IC/PCR	< 1.03E-04	< 0.640
3	12/13/91	EPA IC/PCR	< 1.03E-04	< 0.580
4	01/17/92	EPA IC/PCR	< 1.13E-04	< 0.636
4	01/21/92	EPA IC/PCR	< 1.09E-04	< 0.556
4	01/22/92	EPA IC/PCR	< 1.20E-04	< 6.240
5	12/12/91	EPA IC/PCR	< 1.19E-04	< 0.690
5	12/13/91	EPA IC/PCR	< 1.04E-04	< 0.620
5	12/13/91	EPA IC/PCR	< 1.10E-04	< 0.590
6	12/11/91	EPA IC/PCR	< 1.01E-04	< 0.640
6	12/11/91	EPA IC/PCR	< 1.05E-04	< 0.610
6	12/12/91	EPA IC/PCR	< 1.02E-04	< 0.550
1	08/05/92	EPA IC/PCR	1.23E-04	0.760
1	08/06/92	EPA IC/PCR	9.03E-05	0.480
1	08/06/92	EPA IC/PCR	9.04E-05	0.480
2	08/07/92	EPA IC/PCR	< 1.39E-07	< 7.85E-04
2	08/08/92	EPA IC/PCR	< 1.32E-07	< 7.57E-04
2	08/08/92	EPA IC/PCR	< 1.34E-07	< 7.39E-04
3	08/05/92	EPA IC/PCR	1.07E-04	0.600
3	08/05/92	EPA IC/PCR	1.13E-04	0.660
3	08/05/92	EPA IC/PCR	1.20E-04	0.620
4	08/06/92	EPA IC/PCR	8.84E-05	0.540
4	08/07/92	EPA IC/PCR	2.68E-04	1.540
4	08/07/92	EPA IC/PCR	9.86E-05	0.540
5	08/03/92	EPA IC/PCR	9.34E-05	0.570
5	08/03/92	EPA IC/PCR	1.32E-04	0.780
5	08/03/92	EPA IC/PCR	8.98E-05	0.490
6	08/04/92	EPA IC/PCR	1.37E-04	0.770
6	08/04/92	EPA IC/PCR	8.83E-05	0.460
6	08/03/92	EPA IC/PCR	1.18E-04	0.650
		AVERAGE	1.03E-04	0.74

TABLE 20

DELAWARE COUNTY FACILITY EMISSIONS TEST RESUTLS

PCDD + PCDF

UNIT	TEST DATE	TEST METHOD	ng/dscm @ 7% O2 TOTAL	PADER 2378 TEF
1	01/15/92	RM 23	1.437	0.0182
1	01/16/92	RM 23	2.433	0.0247
1	01/17/92	RM 23	1.285	0.0073
2	01/17/92	RM 23	3.865	0.0290
2	01/18/92	RM 23	2.728	0.0385
2	01/18/92	RM 23	4.931	0.0446
3	12/10/91	RM 23	12.829	0.1439
3	12/11/91	RM 23	12.541	0.1410
3	12/11/91	RM 23	4.285	0.0338
4	01/19/92	RM 23	4.806	0.0479
4	01/22/92	RM 23	17.693	0.1560
4	01/22/92	RM 23	9.856	0.0964
5	12/12/91	RM 23	2.872	0.0306
5	12/13/91	RM 23	2.919	0.0233
5	12/13/91	RM 23	6.036	0.1548
6	12/11/91	RM 23	18.118	0.2299
6	12/12/91	RM 23	4.467	0.0397
6	12/13/91	RM 23	6.825	0.0744
		AVERAGE	6.663	0.0741

NITROGEN OXIDE (NO_X) EMISSION RATES FROM THREE WASTE-TO-ENERGY PLANTS USING WESTINGHOUSE O'CONNOR (ROTARY) COMBUSTORS

David S. Beachler, Manager, Environmental Engineering
Nancy M. Hirko, Senior Environmental Engineer
Jerry Joseph, Senior Environmental Engineer
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OCTOBER 1990

WESTINGHOUSE ELECTRIC CORPORATION
RESOURCE ENERGY SYSTEMS DIVISION
PITTSBURGH, PA

INTRODUCTION

In waste-to-energy (WTE) facilities, air pollution emissions are perceived to be a significant environmental concern. When municipal solid waste (MSW) is combusted, air emissions including CO, NOx, SO_2, HCl, particulate matter, trace metals, and trace organic compounds are generated. Many of the air pollutants are currently regulated by federal and state environmental agencies. Resource recovery vendors design facilities to achieve low emissions by using good combustion design and practices and by using effective add-on air pollution control equipment. Recently, regulatory agencies are beginning to require resource recovery vendors to consider various technologies to reduce nitrogen oxide emissions from WTE facilities.

In the permitting process, vendors of WTE facilities propose Best Available Control Technology (BACT) as part of the Prevention of Significant Deterioration (PSD) permit application. In almost every PSD permit determination issued by EPA or the designated state agency, BACT for NOx emissions has not required add-on control equipment for NOx emissions. Three WTE facilities have installed ammonia injection processes to reduce NOx emissions to meet lowest achievable emission rate (LAER) requirements. All three of these facilities are in California where the plants are located in non-attainment areas for NOx and/or ozone.

A few plants now in the final design or construction phase have agreed to install NOx emission control technology, specifically Selective Noncatalytic Reduction (SNCR) technology. The SNCR technology utilizes the injection of an ammonia/air or ammonia/steam mixture into the radiant section of the boiler. The injected ammonia promotes a gas-phase homogeneous reaction of NH_3 and the NOx in the flue gas to produce nitrogen and water.

Two PSD permits were issued in late 1988 and early 1989 (Pennsauken, NJ and Huntington, NY) for facilities in which ammonia injection will be used to control NOx emissions. Two PSD permits have been issued after the Pennsauken permit, namely Pasco County, Florida (early 1989) and San Juan, Puerto Rico (September 1989) that have not required ammonia injection as BACT for NOx.

The U.S. EPA is currently developing new source performance standards (NSPS) for municipal waste combustion facilities. The NSPS was proposed in the Federal Register on December 20, 1989. EPA stated that the NOx limit will be set in a range from 120 to 200 ppmdv corrected to 7% O_2, and averaged over a 24-hour period.

EPA has stated that MSW combustion facilities can achieve these NOx emission levels using various control techniques including two-stage combustion, low excess air, flue gas recirculation, gas reburning, urea injection and ammonia injection. EPA also stated that vendors of WTE plants can decide on the appropriate technology to meet the NOx emission level. The remainder of this paper discusses the formation of NOx emissions and the emission data collected from WTE facilities using Westinghouse O'Connor combustors.

Nitrogen Oxide Emissions Formation

Nitrogen oxides (NOx) are products of all conventional combustion processes. Nitric oxide (NO) is the predominant form of NOx produced along with lesser amounts of nitrogen dioxide (NO_2). However, once emitted, NO converts to NO_2 in the atmosphere. Hence, NO and NO_2 are referred to collectively as NOx. The generation of NOx from solid waste combustion is a result of two formation mechanisms, namely thermal NOx formation and fuel NOx formation. The NOx produced by exposing the nitrogen contained in the combustion air supply (ambient air contains 79% nitrogen by volume) to the high temperatures of combustion is referred to as thermal NOx. Fuel NOx is formed when the nitrogen in the fuel is oxidized to NOx.

Because of the abundance of available nitrogen, thermal NOx formation is primarily a function of temperature and excess air (oxygen availability).

Fuel NOx formation is strongly affected by the local oxygen concentration present in the flame and also by the mixing rate of the fuel (MSW) and combustion air. Thus, like thermal NOx, formation of fuel NOx is dominated by the local combustion conditions. Combustion modification techniques typically used on combustion sources include using low excess air firing, optimum burner designs, and staged combustion. These techniques have been shown to be effective in reducing NOx levels. (Beachler, 1984).

The fuel/air mixing process in the rotary combustor is completely different from that found in a traditional MWC system. The rotary combustor uses a staged-combustion technique along with low excess air to control both CO and NOx emissions. The overfire air in the rotary combustor enters with very low radial velocity and slowly mixes with hot fuel gases coming up from the burning bed. The volatile fuel fragments, including volatile fuel nitrogen components, are driven from the bed early--near the entrance to the barrel--and then must flow down the barrel toward the radiant chamber. Not only does the overfire air slowly mix but the more slowly evolving fuel fragments are constantly being added to the gases, giving an excellent opportunity for the fuel-bound nitrogen to be converted to N_2.

The control of both fuel and thermal NOx is accomplished by the water-cooled rotary combustor. Heat generated by the burning solid waste is transferred to the water circulating inside the tubes which along with the perforated webs make up the combustor barrel. This heat removal mechanism moderates peak combustion temperatures, alleviating the need for large amounts of excess air. Since less excess air is required for rotary combustors, (50% to 70% versus 80 to 100%) than other mass-burn systems, less oxygen is available for NOx production. Although very complex, the formation reactions of NOx are mainly dominated by the local mixing rate of O_2 with the volatiles as well as the local temperature at which the mixing occurs. Therefore, maintaining lower peak temperatures in the combustor without supplying large amounts of combustion air in the zones where waste is initially burned provides for the control of NOx emissions. Higher instantaneous local temperatures may exist within the combustor, but NOx formation rates are relatively slow requiring a certain residence time. The rotary combustor design includes a forced draft fan and dampers to control the amount and distribution of excess air delivered to the various windbox sections along the length of the combustor.

Bay County, Florida WTE Facility Testing

The Bay Resource Management Center (BRMC) is a 510 ton-per-day (TPD), or 464 metric TPD, waste-to-energy facility located in Panama City, Florida. The BRMC uses two Westinghouse O'Connor combustors each designed to burn 255 TPD (232 metric TPD) of MSW having a higher heating value of 4500 Btu/lb (2500 cal/g). A number of test programs have been conducted at the BMRC. In March of 1988, testing was conducted as part of a comprehensive research program to characterize the thermal performance and emission levels of the combustor/boiler system at a number of varying operating conditions, including burning at high and low feed rates, burning a small amount of sewage sludge, burning high- and low-Btu value waste, and burning waste containing alkali compounds (CaO, CaOH, and $CaCO_3$). Figures 1-3 show NOx, CO, and O_2 concentration levels as measured during the MSW-only set-points. Measurements were made using continuous emission monitors (CEMS) that were calibrated before and after each day of sampling. Emission concentration levels were measured every minute and reported as hourly averages. As can be seen in Figures 1-3, NOx emission levels averaged in the range of 100 to 140 ppm corrected to 7% O_2 (hourly averages). The CO emissions were typically between 100 and 200 ppm corrected to 7% O_2 while the excess air was approximately 50 percent. The permit limit for CO at the BRMC is 800 ppm. Figure 2 shows a direct correlation between NOx emission levels and excess air levels However, Figures 1 and 3 do not show this correlation as strongly. The graphs also indicate that the NOx emission levels were fairly steady despite corresponding low and high levels of CO emissions.

A CEM was installed to continuously measure NOx emissions during the summer of 1989. The NOx monitor passed the relative accuracy test in September 1989. The NOx emission levels ranged from 60 to 112 ppmdv corrected to 7% O_2 during the relative accuracy test. Data from the facility-installed NOx monitor during August through October 1989 show that the NOx levels are in the range of 60 to 140 ppm, as shown in Figure 4. Figure 5 shows NOx data collected from late October 1989 through April 1990. Data for January 1990 was not reported because of combustor and/or data acquisition down-time. The data for Figures 4 and 5 were corrected to 7% O_2 by assuming an average oxygen concentration of 9 percent at the point of measurement which is typical for this unit. These data are similar to the levels reported from the March 1988 test program.

Dutchess County, New York WTE Facility Testing

The Dutchess County Resource Recovery Facility (DCRRF) was designed and constructed by Pennsylvania Resource Systems, Inc. The facility was constructed to use two Westinghouse O'Connor RC-120 combustors (the same design as those used at the Bay County Facility.) Westinghouse was awarded a contract by the Dutchess County Resource Recovery Agency in August 1988 to complete the construction of the DCRRF and to conduct the acceptance tests. As part of the acceptance test conducted in early 1989, a number of emission parameters were measured including NOx, CO and oxygen (Beachler and Hirko, 1990). The NOx levels typically averaged between 90 and 110 ppm corrected to 7% O_2. The CO hourly average emission levels (actual readings) were typically between 50 and 200 ppm.

In the summer of 1989, a NOx CEM was installed to continuously measure NOx emissions from both units. Final calibration was completed in late 1989 and relative accuracy tests on the NOx monitor were conducted in early February 1990. Table 1 shows the NOx emission levels for Unit 1 and Unit 2 to be 99 and 106 ppm corrected to 7% O_2. The range falls between 70 and 134 ppm corrected to 7% O_2 for the samples that were taken for 20 min. periods. These NOx emission levels are similar to the values that were measured during the January/February 1989 test program.

York County, Pennsylvania WTE Facility Testing

The York County Resource Recovery Facility (YCRRF), a 1344 TPD (1222 metric TPD) plant using three 448 TPD (407 metric TPD) rotary water-cooled combustors, began start-up operations in November, 1989. Figures 6 through 9 show the hourly NOx emission levels as measured by the plant's installed CEM system for Units 1, 2 and 3 ranging between 100 and 160 ppm corrected to 7% O_2 while the CO emission levels were less than 100 ppm corrected to 7% O_2. The excess air levels used at the York facility are slightly higher than the rate used at the Bay and Dutchess facilities, ranging from 50 to 70% (daily average). A major portion of combustion air (at York) is provided in the fourth zone through the windbox sections and the overfire air duct. Figure 9 shows the NOx data for all 3 units from January 30 through March 30, 1990. The NOx levels are typically between 110 and 140 ppmdv corrected to 7% O_2. Data for summer operations will be reported as they become available.

Variations in NOx Emissions

The NOx emissions from the Bay facility are generally higher than those from the Dutchess facility. The waste composition burned at the Bay facility contains more wood, tree branches, and grass clippings than the waste burned at the Dutchess facility. Similar results were reported by Radian (1989) and Hahn (1989). These reports indicated higher NOx emissions in the spring and summer months when the waste contains a larger proportion of yard wastes, which generally have a high nitrogen content. Hahn reported a NOx emission increase of approximately 23% during summer months versus winter months. The Bay facility data shows an increase in NOx emissions of approximately 10 to 15% during the summer months versus the winter months. For the Dutchess facility, the summertime data are too limited to draw any conclusions.

SUMMARY

The data reported from rotary combustors have shown NOx levels typically in the range of 100 to 140 ppm corrected to 7% O_2. These low levels are achieved by using low levels of excess air generally around 50% to 70%. In addition, heat generated by the burning of solid waste is transferred to water inside the tubes of the water-cooled rotary combustor. This heat removal mechanism moderates peak flame temperatures during the combustion process. The main NOx control mechanism is the manner in which combustion air (O_2) is introduced into the rotary combustor, a staged combustion technique.

As can be seen from the figures presented in this paper, NOx emission levels do not directly correlate with the levels of CO leaving the combustor/boiler as is observed in other MWC systems. Emission data measured at the Bay, Dutchess and York County facilities show low NOx and CO emission levels. The design of the water-cooled rotary combustor provides for very good combustion, while simultaneously keeping NOx emissions extremely low.

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TABLE 1

DUTCHESS COUNTY RESOURCE RECOVERY FACILITY
RELATIVE ACCURACY RESULTS
NOx EMISSIONS
2/5/90 - 2/6/90

	UNIT 1			UNIT 2		
Run	NOx (ppm)	O2 (%)	NOx (ppmc) @ 7% O2	NOx (ppm)	O2 (%)	NOx (ppmc) @ 7% O2
1	56.17	11.76	85.42	83.33	12.25	133.91
2	58.51	12.5	96.82	76.93	12.30	124.38
3	73.68	10.7	100.41	78.31	12.23	125.55
4	58.45	11.94	90.68	76.3	11.69	115.15
5	64.03	11.54	95.09	74.57	10.95	104.17
6	70.2	11.61	105.04	85.15	11.92	131.80
7	76.11	12.54	126.55	75.56	11.26	108.95
8	65.96	11.81	100.86	69.53	10.35	91.61
9	70.72	11.2	101.34	69.52	9.5	84.77
10	61.25	12.73	104.21	70.99	9.24	84.63
11	65.33	10.64	88.51	81.6	9.4	98.63
12				63.19	8.46	70.61
Avg	65.49	11.72	99.54	75.42	10.80	106.18

Figure 1. Bay County Data - Unit 2

March 9, 1988

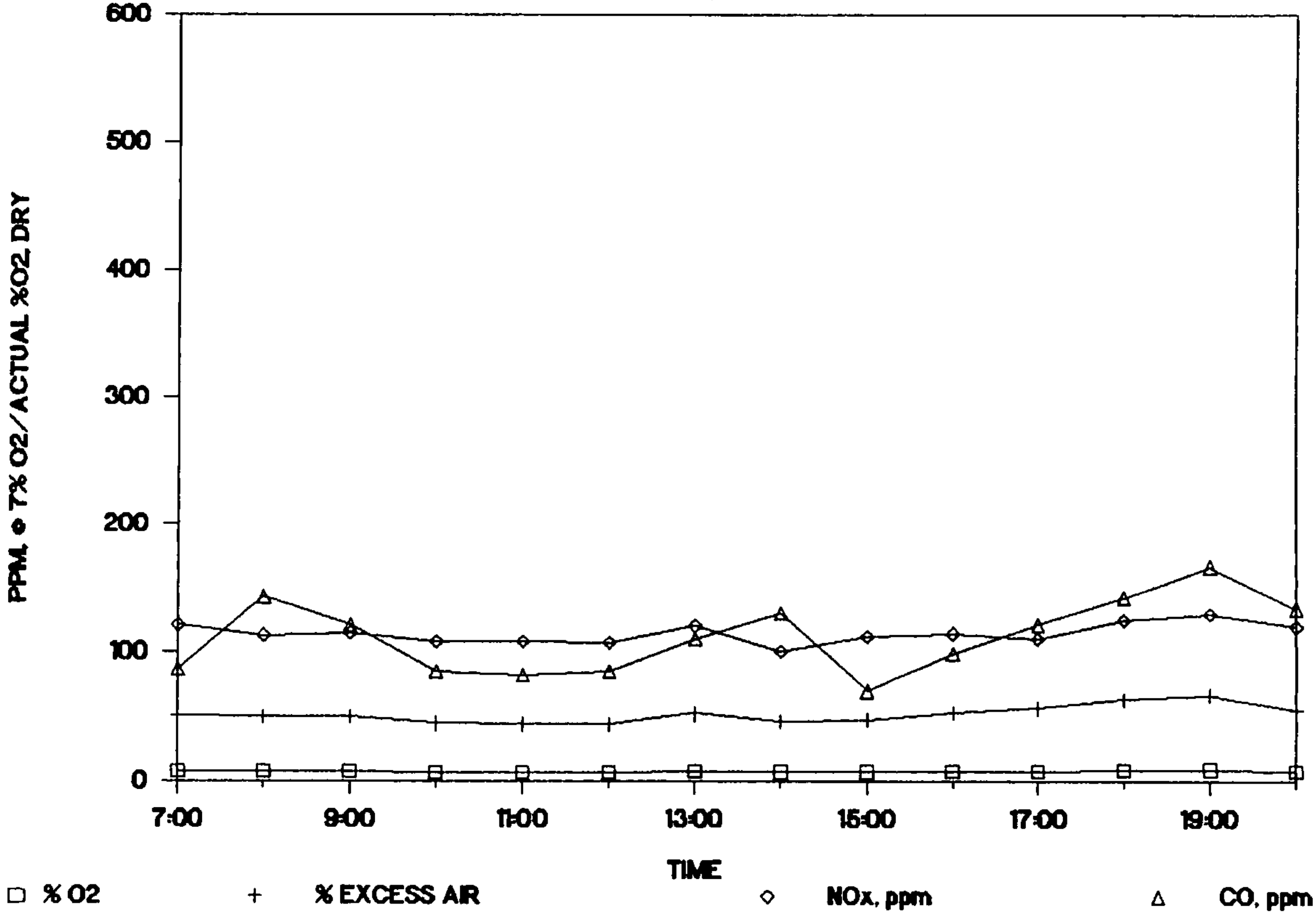


Figure 2. Bay County Data - Unit 2

March 11, 1988

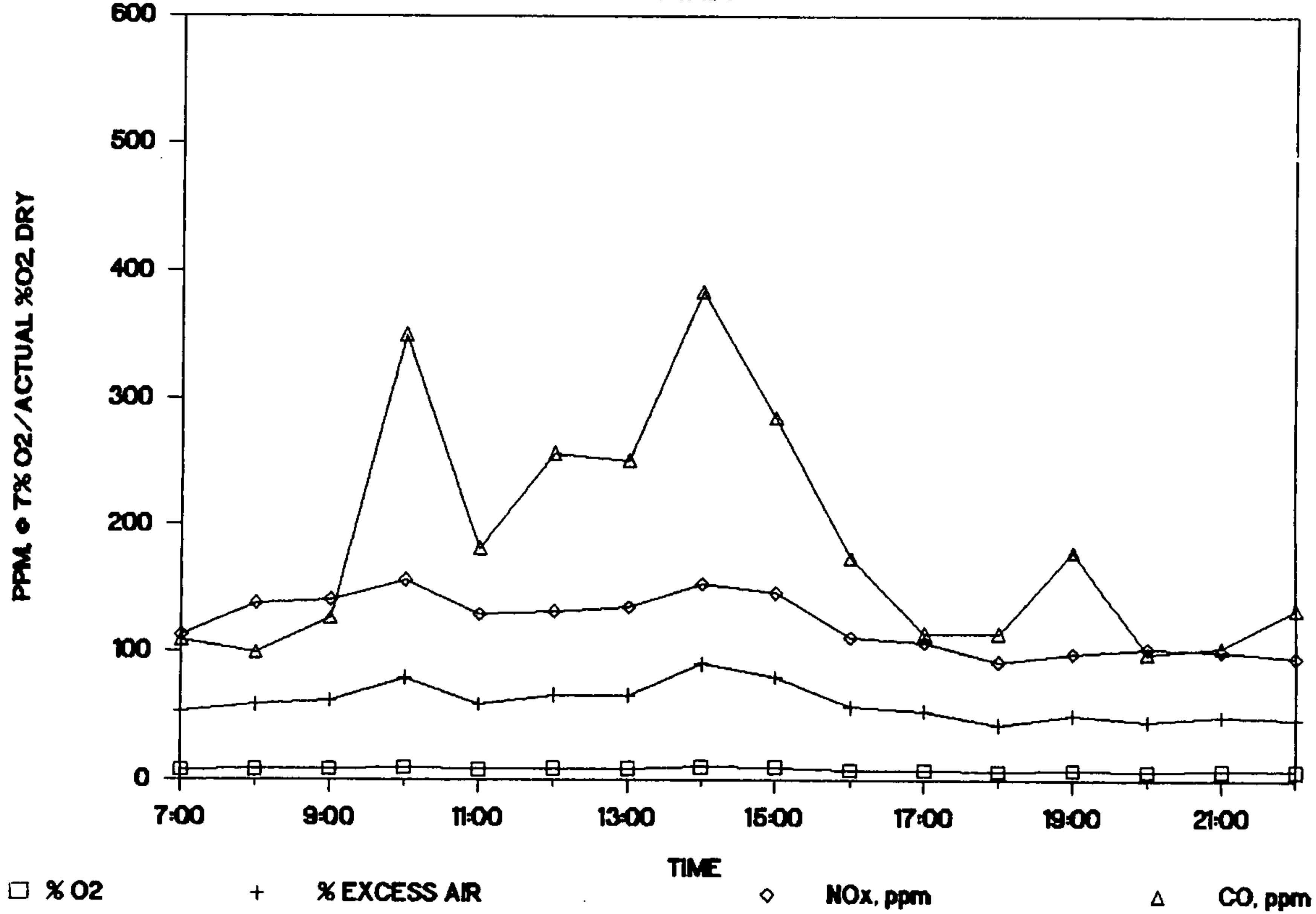


Figure 3. Bay County Data - Unit 2

March 17, 1988

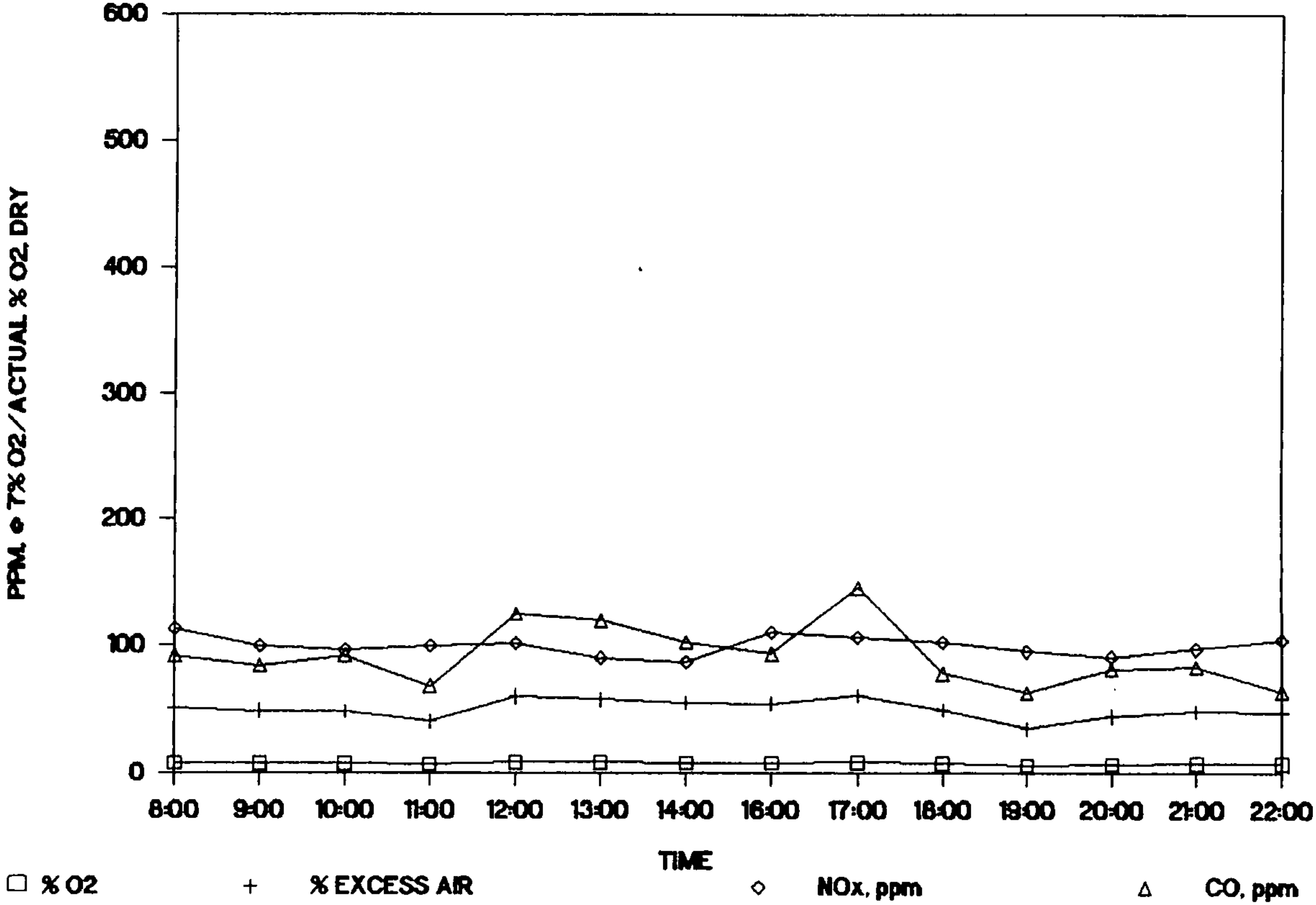


Figure 4. Bay County NOx Emission Data

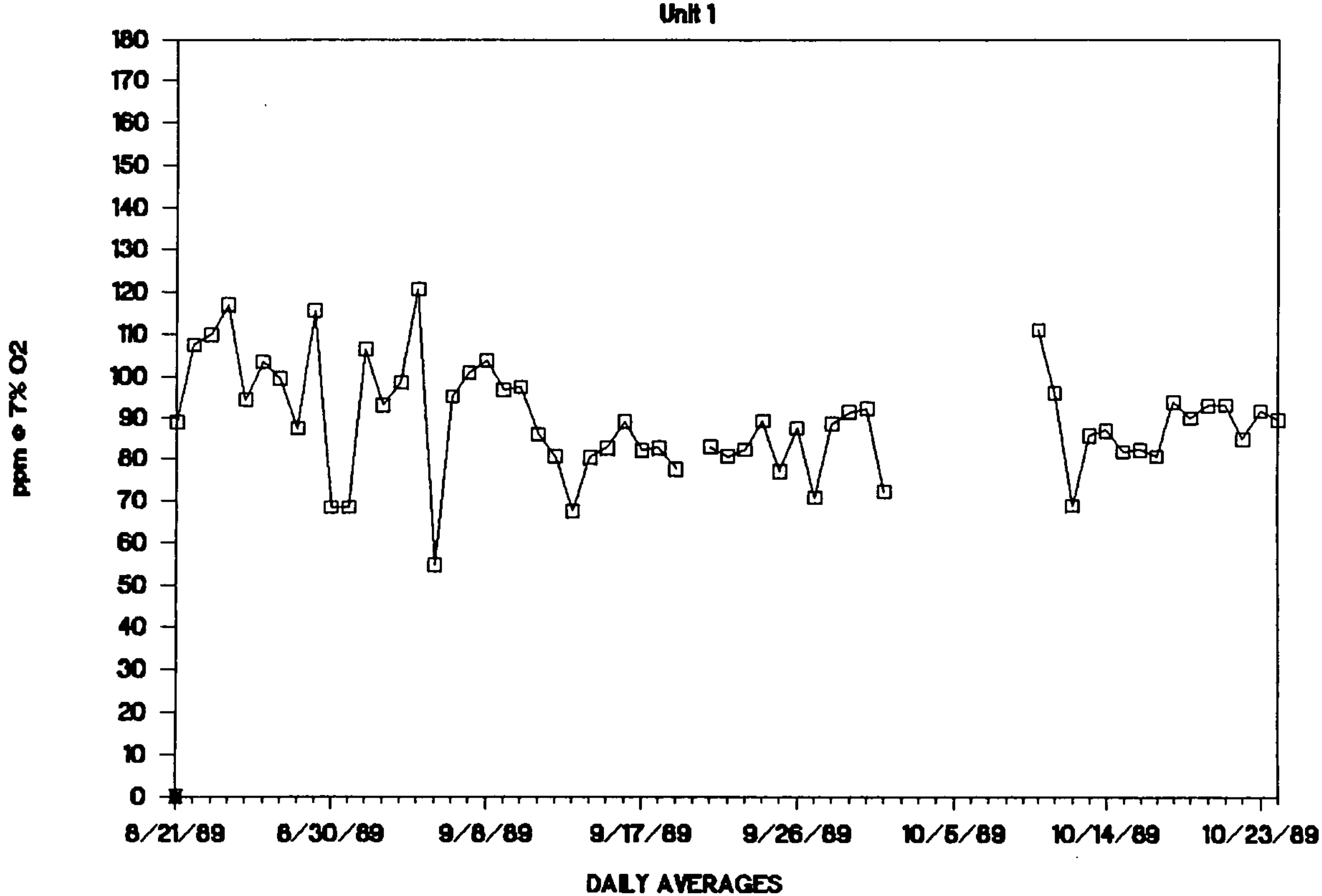


Figure 5. Bay County NOx Emission Data

Unit 1

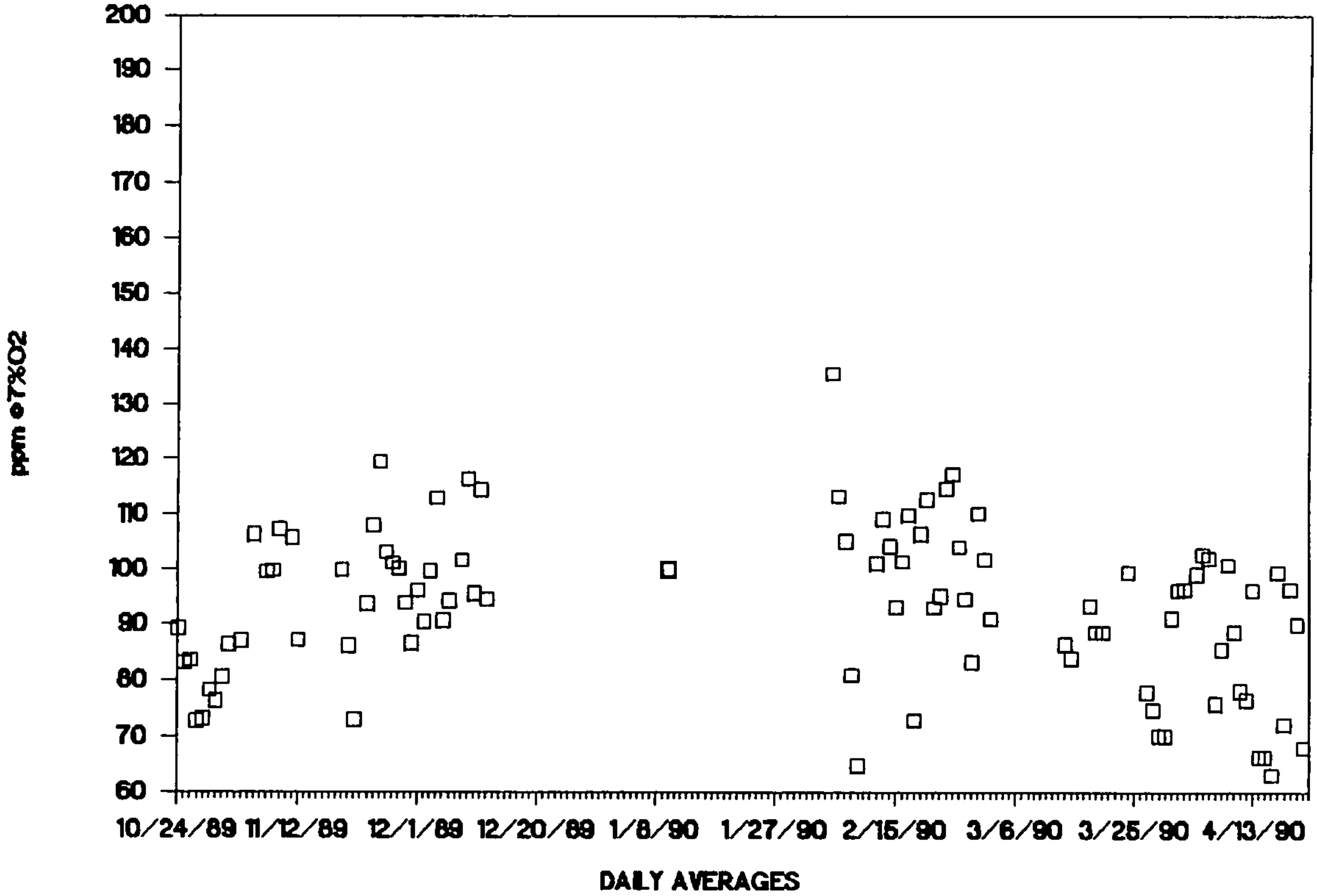


Figure 6. York County Data - Unit 1

February 22, 1990

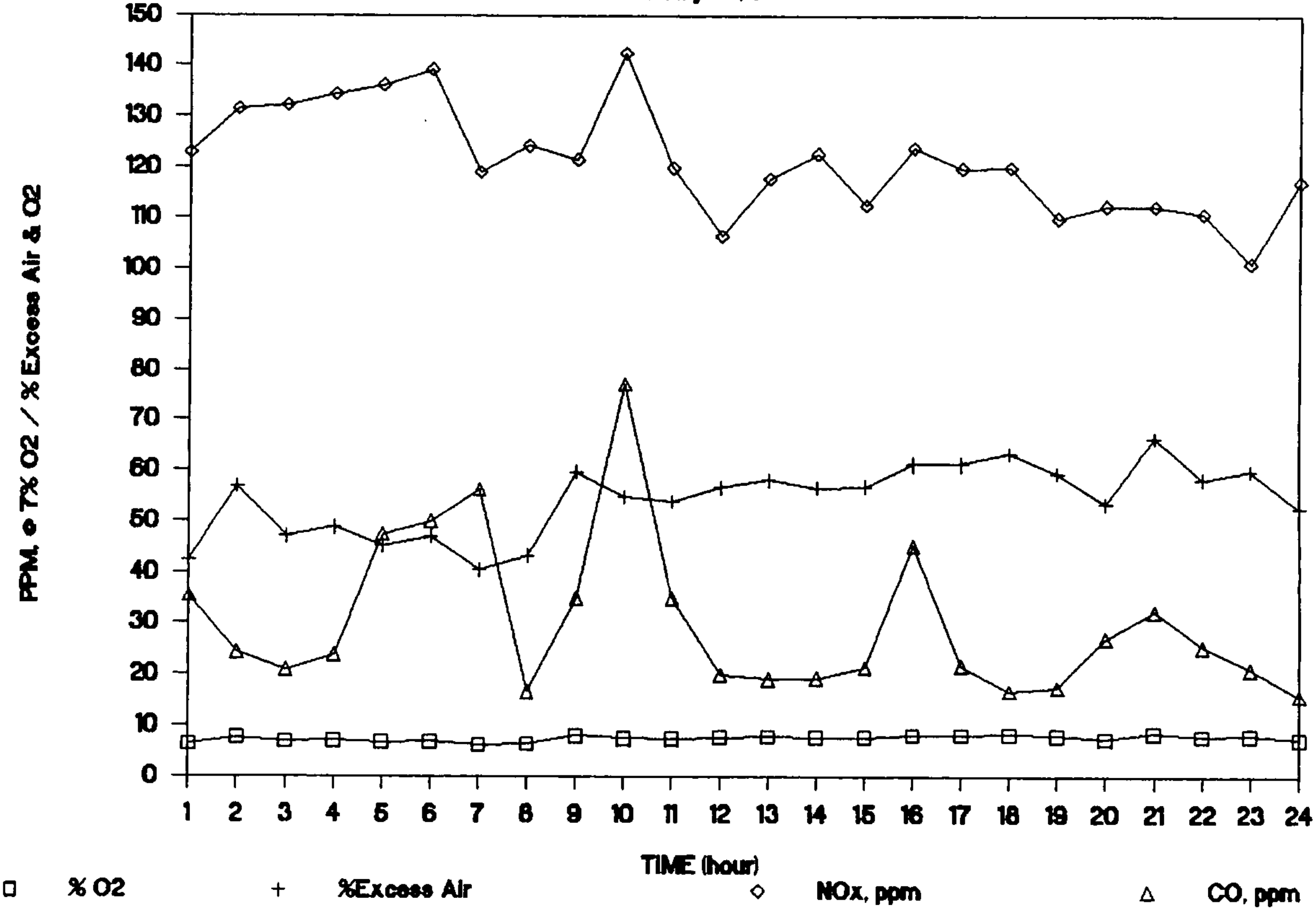


Figure 7. York County Data - Unit 2

February 22, 1990

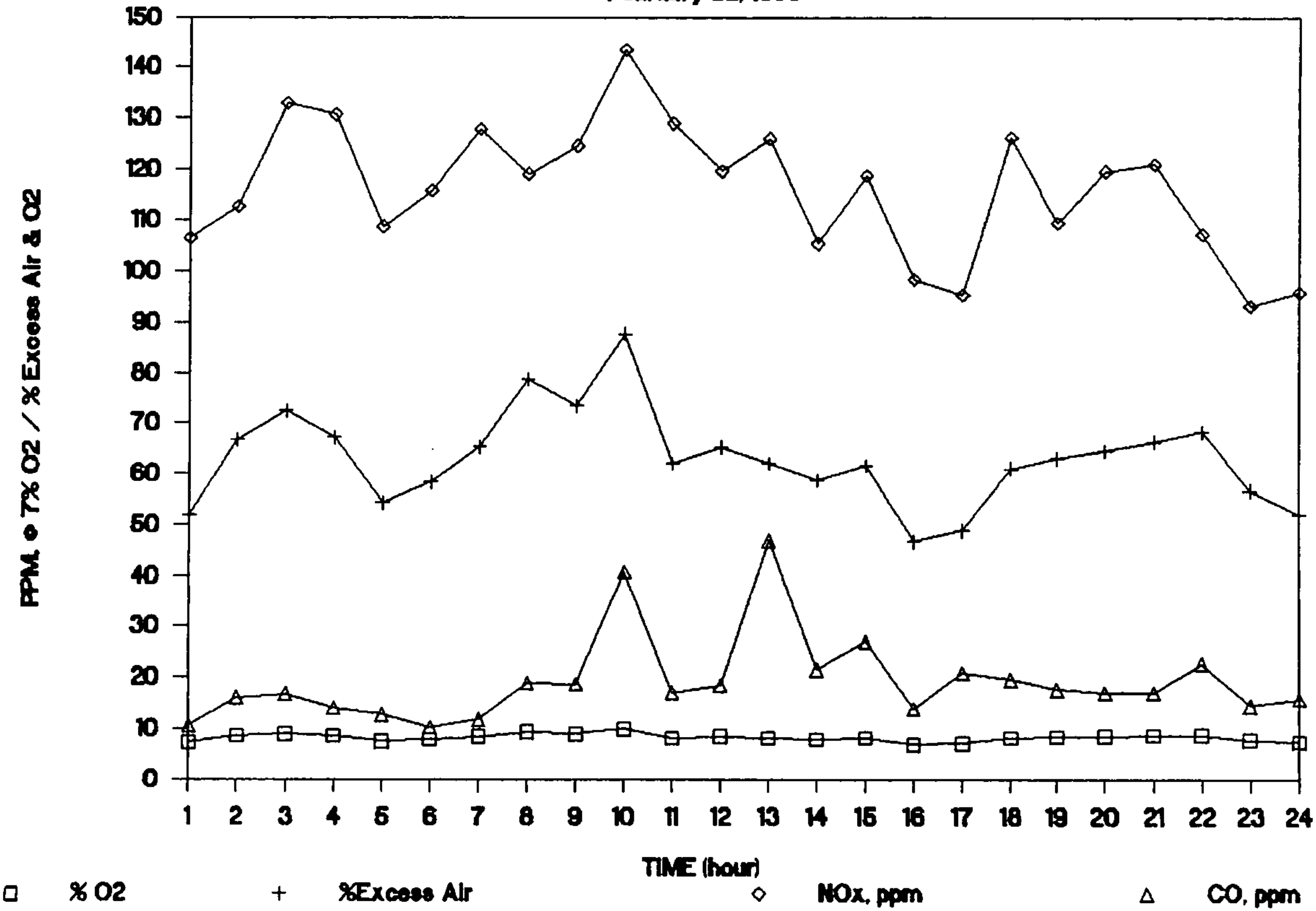


Figure 8. York County Data - Unit 3

February 16, 1990

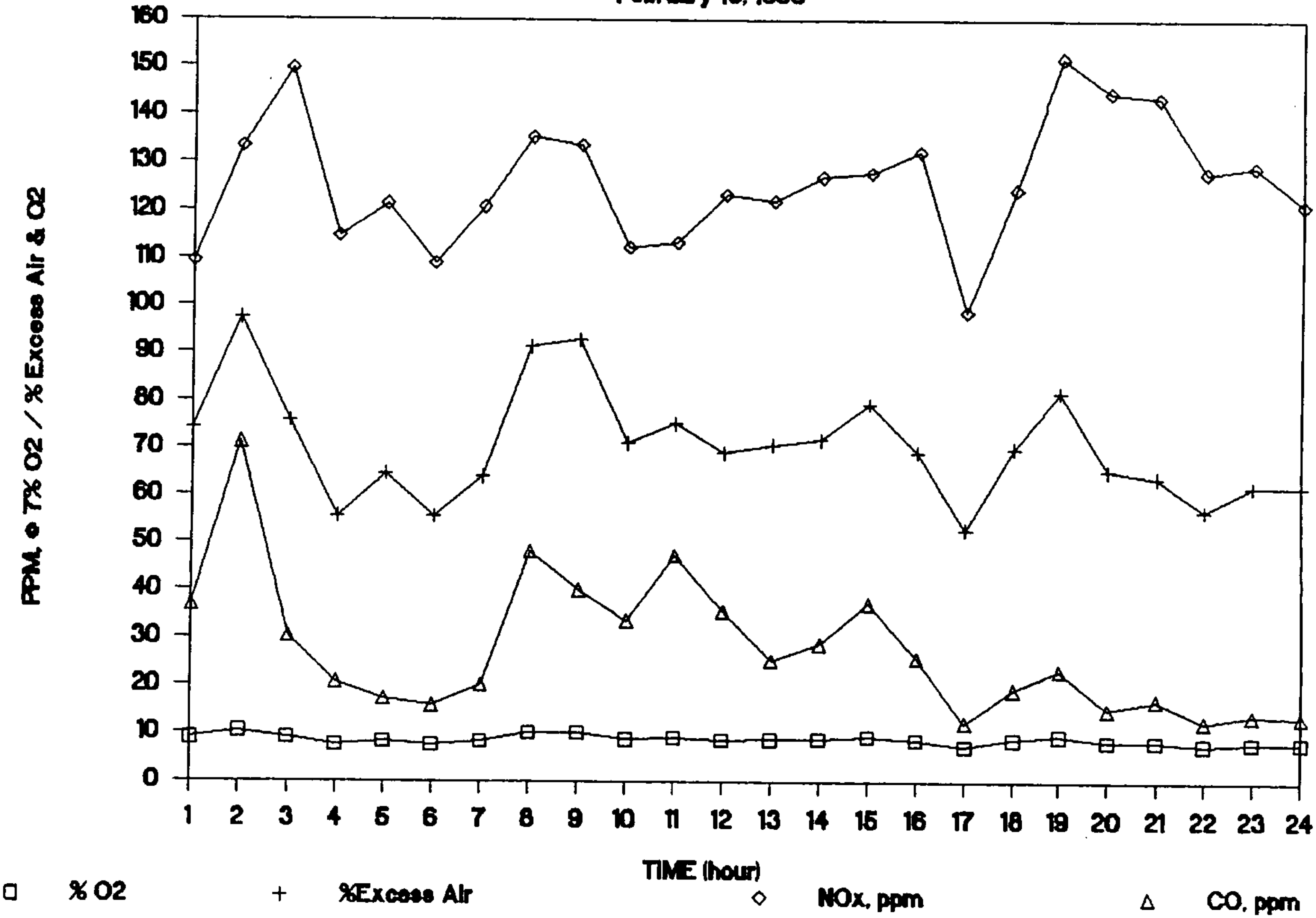
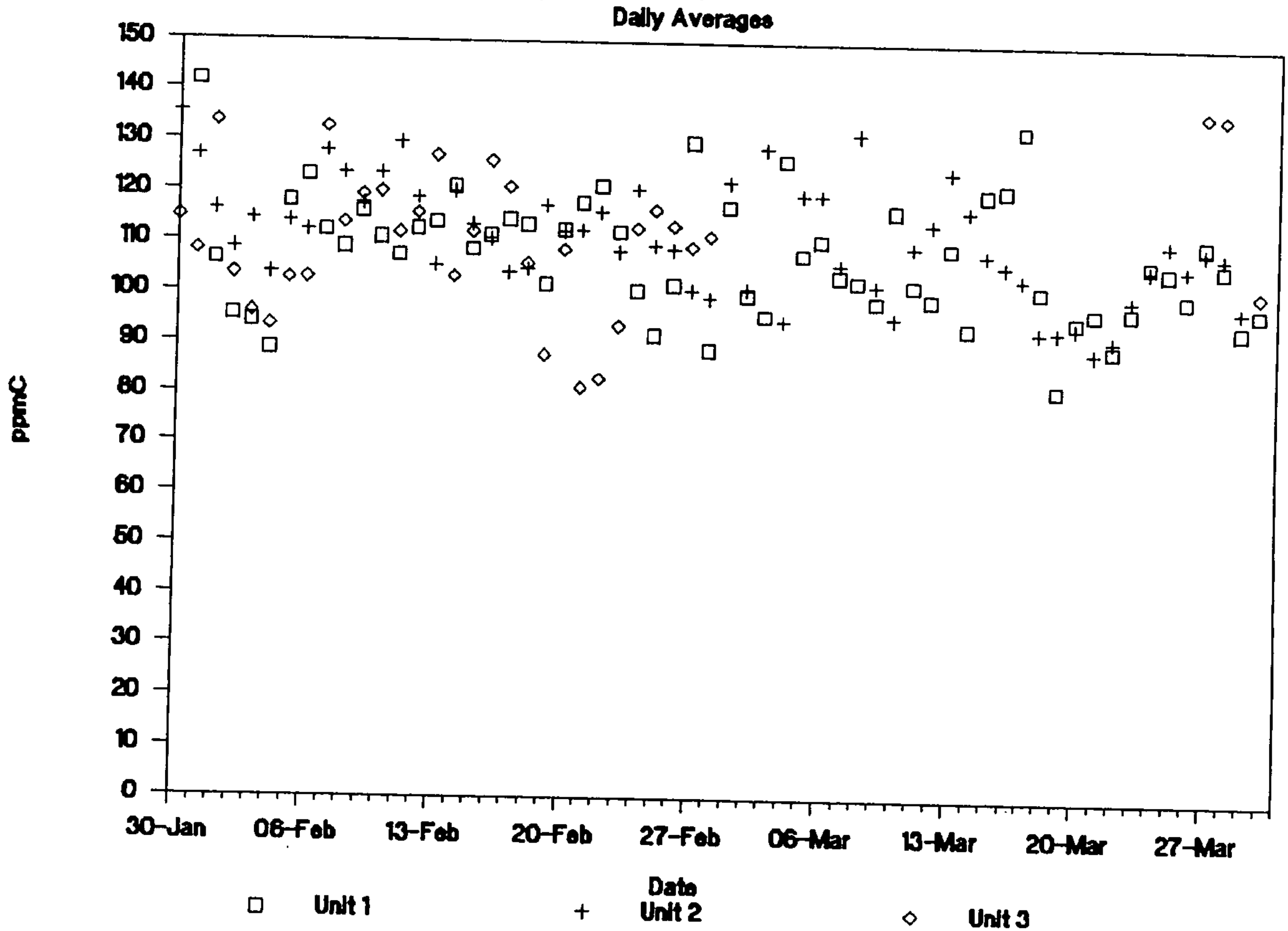


Figure 9. York County NOx Emission Data



AIR EMISSION TEST RESULTS FROM TWO OPERATING WASTE-TO-ENERGY FACILITIES

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1.0 ABSTRACT

This paper presents the results of air emission compliance tests conducted at the York County Recovery Center and Delaware County Resource Recovery Facility located in Pennsylvania. The tests were conducted to measure the concentration of particular matter, SO_2, NOx, CO, HCl, metals, dioxins and furans.

The York County Facility is a 1344 ton-per-day plant using three Westinghouse-O'Connor combustor/boiler trains to burn municipal solid waste (MSW) and recover approximately 35 megawatts of electricity. The Delaware County Facility is a 2688 ton-per-day Facility using six Westinghouse-O'Connor combustor/boiler trains to burn MSW and generate approximately 80 megawatts of electricity. Each facility's combustor/boiler train is equipped with a spray dryer and baghouse system to remove acid gases and particulate matter.

This paper also presents the proposed changes to the NSPS, the 1990 Clean Air Act Amendment MACT requirements, and the proposed PaDER Best Available Technology requirements for municipal waste combustors.

2.0 INTRODUCTION

Each year over 180 million tons of garbage are produced in the United States (approximately 20 million in Pennsylvania), adding to the solid waste already choking landfills and threatening the quality of air and groundwater. By the turn of the century, with more and more landfills reaching capacity or closing for environmental reasons, the quantity of municipal solid waste (MSW) generated by our population will have increased dramatically posing an even greater potential concern to the environment. Motivated by these concerns, many communities have adopted an integrated approach to waste disposal which includes controlled landfill, recycling and resource recovery through the burning of municipal waste and recovery of useful electric or thermal (steam) energy.

For regulatory purposes, Municipal Solid Waste (MSW) is defined as household, commercial/retail and/or institutional waste. MSW includes wastes such as appliances, newspaper, yard wastes, clothing, food scraps, cardboard boxes, office and classroom paper, wood, glass, and goods containing metals. A survey released by the USEPA (EPA, June 1990) showed the breakdown of the typical waste stream (See Figure 1). This survey conducted in 1988 showed that the major waste stream component was paper and paper board products (40 percent). Other components include yard wastes (18%), glass (7%), plastics (8%), food wastes (7.4%), and metals (8.5%0. The remaining components (labeled other in Figure 1) include rubber, leather, textiles, wood and small amounts of miscellaneous wastes. In EPA's definition of MSW, specifically excluded are sewage, wood pallets, construction and demolition wastes, industrial process or manufacturing wastes or motor vehicle maintenance materials (oil, batteries and tires).

The EPA projects that the amount of waste generated in the U.S. will increase by the year 2000. The projected breakdown of the various components is given in Figure 2.

Westinghouse operates two waste-to-energy facilities in Pennsylvania, located in York County and Delaware County. Together these facilities are designed to burn approximately 1.5 million tons of MSW per year. PaDER has passed a Best Available Technology (BAT) Criteria that lists specific emission limits the operating requirements for the facilities. In addition, these facilities must meet the USEPA Emission Guidelines emission limits promulgated on February 11, 1991 and the Maximum Available Control Technology (MACT) requirements as spelled out in the 1990 Clean Air Act Amendments.

3.0 FACILITY DESCRIPTIONS

The York County Facility began startup operations in late 1989 while the Delaware County Facility commenced start operations in mid-1991. The facilities are similar in design except for size and MSW handling; a pit and crane is used at the York Facility while the Delaware Facility has a tipping floor and conveyor. The York Facility burns up to 1344 tons per day (TPD) of MSW having a higher heating value of 4500 Btu/lb using three Westinghouse-O'Connor water-walled rotary combustors. The Delaware County Facility is permitted to burn up to 2688 tons per day (TPD) of MSW having a higher heating value of 5200 Btu/lb using six Westinghouse-O'Connor water-walled rotary combustors.

Each facility consists of the respective number of combustor/boiler units, a turbine generator, a truck scale, tipping hall and MSW feeding system, spray dryer and baghouse for emission control, ash handling equipment, a control room, and all required ancillary equipment. The process flow diagram for each plant is shown in Figure 3. The facilities also have administration offices, change rooms, parking areas, roadways, and security fencing.

The heat released from the combustion process is recovered in the rotary combustor walls, boiler water walls and tubes, primary and secondary superheater, and the economizer. To expedite combustion of high-moisture waste, steam air heaters preheat the incoming combustion air to approximately 450°F (204°C).

Air Pollution Control System

After passing through the heat recovery equipment the flue gas enters the air pollution control system at a temperature of 350°F to 400°F. The facility uses a spray dryer absorber (SDA, also called a dry scrubber) to remove acid gas, followed by a baghouse to remove particulate matter including acid gas reaction products, unreacted reagent, flyash and trace metals (See Table 1 for details). A lime slaking system prepares the lime slurry.

Lime Slurry Preparation System. One of the two paste slakers prepares the lime slurry by slaking pebble lime (CaO) with potable water. The slaking system consists of a slaking compartment with two (2) sets of counter-rotating paddles acting as a pug mill for mixing. Water and pebble lime, usually at a low ratio of 2:1, continuously feed lime into the slaker. A torque-actuated water inlet valve automatically controls the proportion of lime to water ratio.

As the paste discharges over a weir into a dilution compartment, a continuous water spray dilutes the paste to a slurry. Moving rakes mounted on the same shaft as the mixing paddles separate the grit while keeping lime particles suspended. The slurry then flows directly onto the screen of a vibrating separator. A stainless steel wire mesh vibrating screen removes inert particles larger than 20 mesh from the lime slurry. A warm water mist washes the screen to remove the grit particles. The slurry exits the screen and enters the lime feed tank. A screw conveyor discharges the grit from the screen storage tank. The storage tank holds a 6-hour supply of slurry for all trains.

Centrifugal slurry pumps convey the lime slurry from the storage tank to the spray dryer's head tank. Each spray dryer has its own slurry pump with spare pumps available to be used as a replacement in the event of a pump failure.

<u>Spray Dryer</u>. Each of the combustor/boiler trains includes a spray dryer absorber (SDA). A rotary atomizer injects calcium hydroxide ($Ca(OH)_2$) slurry, frequently referred to as lime slurry, into the spray dryer. The atomized lime slurry absorbs acid gases (mainly HCl and SO_2). The hot flue gas causes the water in the droplets to evaporate and leave behind dry reaction products (calcium salts).

The spray dryers operate at flue gas temperatures adequate to produce a dry reactant product. The SDA operates with an inlet (flue gas) temperature of approximately 350°F and outlet temperature of 260°F to 300°F. Final dilution of the slurry occurs at the head tank located directly above the rotary atomizer in the SDA penthouse. The ratio of lime slurry and water dilution is based on inlet and outlet signals as measured by the continuous HCl and SO_2 emission monitor system.

Pneumatically operated double-dump valves remove solids from the spray dryers' hoppers. Each hopper has a 12-inch outlet, two 4-inch poke holes, a 24-inch diameter access door, hopper level detectors, and a strike plate.

Fabric Filter. A fabric filter (commonly called a baghouse) located downstream of the SDA, collects the reactant products, unreacted sorbent, and fly ash. The pulse jet baghouse uses cylindrical bags, made of fiberglass, to remove the particulate matter from the flue gas stream. The baghouse acts as secondary acid gas collector because the dust cake that builds on the bags contains some unreacted sorbent that provides a surface to neutralize some acid gas passing through the cake.

Each baghouse contains six compartments where bag cleaning is performed off-line by a pulse jet cleaning system. During the cleaning cycle, one compartment is off line while the other five remain on line. A compressed air header and air manifold system supplies pulsing air (approximately 40 to 60 psig) to the top of each bag. A blast of compressed air causes a shock wave, or bubble, to travel down the bag, rapidly distending the fabric and dust cake. The dust cake cracks from the fabric surface, falling into the hopper below.

The outside surface of the baghouse collects the dust and clean gas passes up the center of the bag into a clean air walk-in plenum. A single 18"x48" door allows access to the walk-in plenum for bag maintenance.

Each of the six compartments can be completely isolated so that maintenance can be performed on one compartment while the unit is still on-line. The gross air-to-cloth (A/C) ratio and the net A/C ratio (with one compartment off-line) for both facilities are given in Table 1. The baghouse is designed to operate with an outlet temperature of 250°F to 290°F.

The baghouse hoppers have a minimum side slope of 55 degrees. Hoppers have a 24-inch access opening, two 4-inch diameter poke holes, level detectors, a strike plate, and thermostatically controlled heaters. Pneumatically operated double-dump valves remove flyash from the hoppers. A mechanical drag conveyor transports flyash from both the baghouse and spray dryer hoppers.

4.0 AIR QUALITY REGULATORY REQUIREMENTS

In Pennsylvania municipal waste combustors (MWCs) are regulated by the Environmental Protection Agency as given in the Code of Federal Regulations (CFR) and by Pennsylvania Department of Environmental Resources (PaDER) as given in the Pennsylvania Air Pollution Control Regulations (Pa Code Title 25, Part 1).

4.1 EPA Standards

Regulations are listed in 40 CFR part 60 Subpart Ea and Ca. These sections contain the recently promulgated (February 11, 1991) New Source Performance Standards (NSPS) for new MWCs and Emission Guidelines (EG) for existing MWCs. States are required to set standards for existing MWCs using the EG as the basis of their standard. In addition, the 1990 Clear Air Act Amendments (CAAA), require EPA to set new emission limits for nine pollutants based on Maximum Achievable Control Technology (MACT). EPA is in the process of preparing the proposed revisions to the NSPS and EG for MWCs, and will likely propose standards for these nine pollutants in late 1992.

For Pennsylvania facilities, emission limits for MWCs are listed in Chapter 127 of Pa Code 25. PaDER has developed Best Available Technology (BAT) Criteria that gives specific emission limits and operating requirements for MWCs. PaDER is in the process of revising the 1989 BAT Criteria for MWCs to incorporate many of the emission limits that were promulgated in the 1991 EPA NSPS and EG. Table 2 gives the emission limits required by the BAT and EPA's EG.

PaDER has also issued a Compliance Assurance Policy (CAP) for MWCs on July 12, 1989. The CAP is PaDER's "strategy and policy to achieve compliance effectively and uniformly for new incinerators" (PaDER CAP 1989). The CAP addresses how PaDER intends to enforce the requirements of the BAT Criteria with specific operating restrictions and monetary penalties for periods of non-compliance.

5.0 EMISSION TEST RESULTS

Stack emission tests are required to measure particulate emissions, particulate matter less than 10 micrometers in diameter (PM-10), and heavy metals semi-annually and dioxins and furans annually. Continuous emission monitors (CEMs) are used to continuously demonstrate compliance with permit limits for SO_2, CO, HCl and NOx emissions.

Stack testing at the York County Facility was conducted twice in 1990, 1991 and 1992. The average results along with the ranges of the various test runs are given in Table 3. Stack testing at the Delaware County Facility was conducted twice in 1992. The test results for the Delaware County Facility is given in Table 4.

In addition to the stack emission test results, Table 5 provides ranges for the gaseous pollutants emission as measured and recorded by the facilities' CEM system. The ranges of ppm levels shown in Table 5 are typical of normal facility operating conditions. However, during periods of startup, shutdown or equipment upsets the measured levels vary outside the ranges indicated in Table 5.

6.0 SUMMARY OF RESULTS

As can be seen from Tables 3 through 5, the levels of the pollutants emitted are extremely low. These results show that well designed and operated facilities can meet very stringent emission limits. However, the emission levels do vary over time and with changes in operating conditions, by an order of magnitude or more. Therefore, regulatory agencies must carefully examine all emission data when finalizing permit limits or setting MACT Standards. Statistical analyses of numerous data points must be completed in order for agencies to set realistic and achievable emission standards that facilities must continuously meet for the life of their plants.

Finally, permit limits need to be set at a level to allow the facility operating flexibility in order to react to any changes while still maintaining compliance. An appropriate margin between test levels and permit limits is essential. Also, permit limits are often order of magnitude below emission levels used in PSD Permit Applications and health risk modeling as can be seen in Table 6. Therefore, establishing regulatory limits at operating or at the lowest test values achieved does not add to environment safety; it merely puts unmanageable compliance exceedance risk on the facility while affecting no additional benefit to the environment.

FIGURE 1. Process Flow Diagram for the Delaware County Resource Recovery Facility

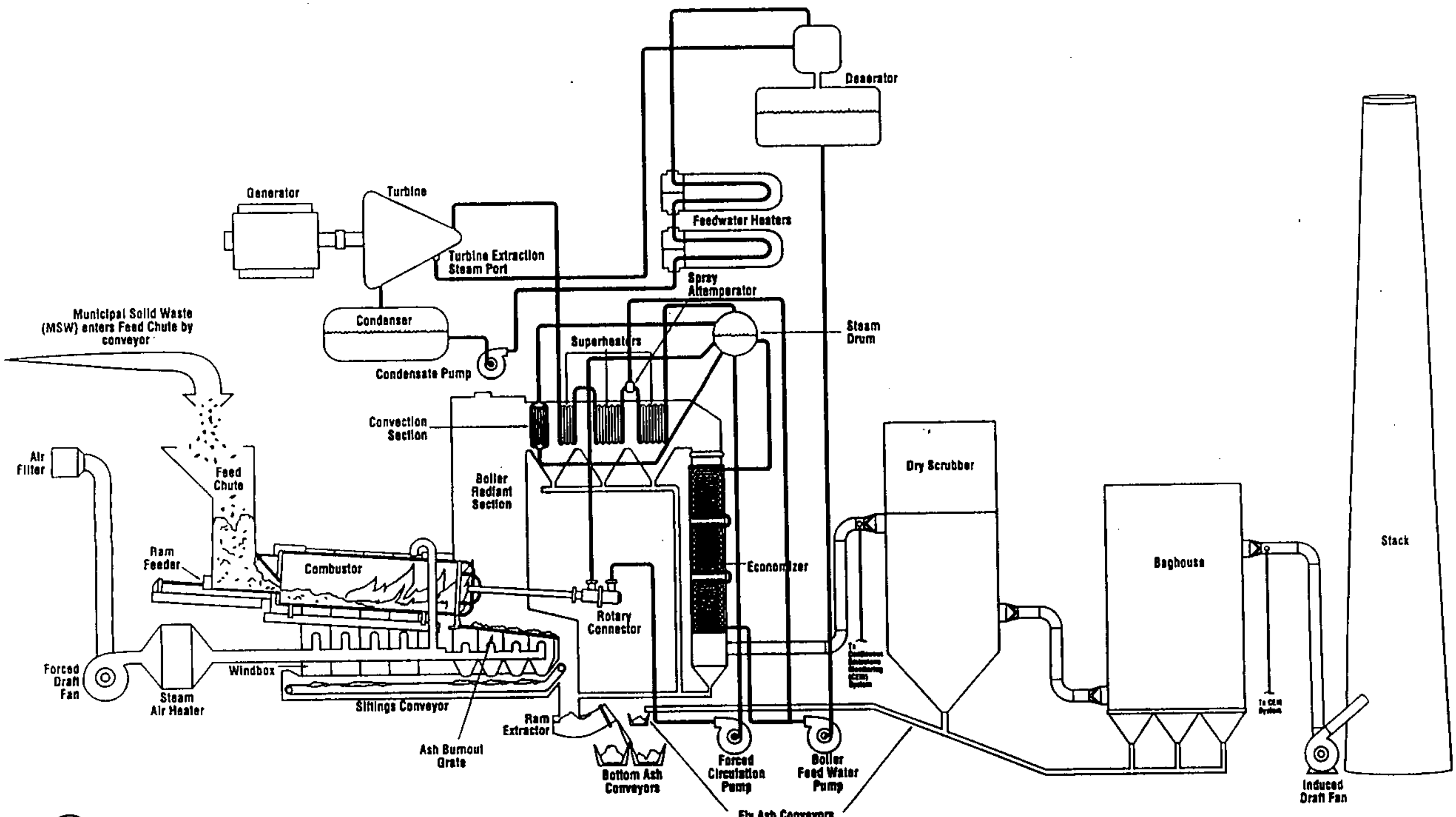

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TABLE 1
SYSTEM FEATURES AND DESIGN PARAMETERS

	YORK FACILITY	DELAWARE FACILITY
Spray Dryer		
Inlet Designs	Top Roof Gas Disperser	Top Roof Gas Disperser
Atomization Type	Rotary Atomizer	Rotary Atomizer
Residence Time (sec)	17.95 normal	17.95 normal
Inlet Temperature (°F)	350	350
Inlet Volume (ACFM)	73,404 normal, 95,155 max.	102,736 normal, 122,690 max.
Outlet Temperature (°F)	300-270	300-270
Stoichiometry	1.6 to 3.0	1.6 to 3.0
Baghouse		
Inlet Temperature (°F)	300-260	300-260
Outlet Temperature (°F)	290-250	290-250
Type	Pulse Jet with Walk-in Plenum	Pulse Jet with Walk-in Plenum
# Modules	6	6
Bag Size	6" dia. x 16' lg.	6" dia. x 16' lg.
Number of Bags per Module	192	240
Cage	Single Piece, 20 Wires	Single piece, 20 Wires
Fabric	16 oz. Woven Glass with Teflon B Coating	16 oz. Woven Glass with Teflon B Coating
A/C Gross	2.5 normal, 3.2 maximum	2.6 normal, 3.0 maximum
A/C Net	3.0 normal, 3.8 maximum	3.2 normal, 3.7 maximum
Pulsing Pressure (psig)	40	40
Hopper Discharge Flange	12" x 12"	12" x 12"
NOTE: Design Conditions		
Normal	Maximum	
50% Excess Air	100 % Excess Air	
100% Rated Waste Feed	100% Rated Waste Feed	
150 ppm - SO_2	300 ppm - SO_2	
500 ppm - HCl	1000 ppm - HCl	

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TABLE 2
COMPARISON OF EPA EMISSION GUIDELINES (2/11/91)
AND PaDER BAT CRITERIA (8/89) MWCs

CRITERIA	EMISSION GUIDELINES (2/91)	PaDER BAT (8/89)
SO_2	30 ppm or 80% - 24 hr ave; CEM	30 ppm or 75% - 8 hr ave; CEM
HCl	25 ppm or 95% - yearly test	30 ppm or 90% - 1 hr ave; CEM
Particulate	0.015 gr/dscf	0.015 gr/dscf
Dioxin	30 ng/dscm - total	2.0 ng/Nm^3 - TEF
Opacity	10% - 6 min blocks CEM	10% - 3 min blocks CEM
CO	250 ppm dry @ 7% O_2 - 24 hr ave; CEM	100 ppm - 8 hr ave; CEM 200 ppm - 1 hr ave; CEM
Temperature	Inlet APC limit	None
Monitoring/Testing	Yearly Stack Tests QA/QC for CEM	Yearly and semi-annual testing results - CEM Requirements
Mercury	MACT	Ambient limits using modeled stack test results - PaDER TMEL
Lead	MACT	PaDER TMEL
Cadmium	MACT	PaDER TMEL
Other Metals	None	PaDER TMEL
NOx	None	300 ppm 24 hr ave; CEM
Operator Certification	Yes	No

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TABLE 3
YORK COUNTY RESOURCE RECOVERY FACILITY
STACK EMISSION TEST RESULTS

Pollutant	Permit Limit	Average	Range
PCDD/PCDF as 2378-TCDD Toxic Equiv. - ng/Nm3 @ 7% O_2	2.0	0.16	0.0081 - 3.2
Particulates (PM) gr/dscf @ 7% O_2	0.015	0.0083	0.0014 - 0.030
Metals (ug/dscm @ 7% O_2)			
Arsenic (As)	4.13	0.96	0.013 - 8.42
Beryllium (Be)	0.0642	0.030	0.012 - 0.080
Cadmium (Cd)	30.71	3.08	0.10 - 22.17
Lead (Pb)	355.82	50.09	2.46 - 472.32
Mercury (Hg)	170.6	119.8	16.9 - 270.4
Nickel (Ni)	0.43	2.49	0.41 - 13.9
Zinc (Zn)	N/A	138.15	12.67 - 886.87
Hexavalent Chromium (Cr+6)	2.52	0.80	0.06 - 1.79

TABLE 4
DELAWARE COUNTY RESOURCE RECOVERY FACILITY
STACK EMISSION TEST RESULTS

Pollutant	Permit Limit	Average	Range
PCDD/PCDF as 2378-TCDD Toxic Equiv. - ng/Nm3 @ 7% O_2	2.0	0.075	0.017 - 0.11
Particulates (PM) gr/dscf @ 7% O_2	0.015	0.0017	0.0002 - 0.0047
PM-10 gr/dscf @ 7% O_2	0.012	0.0031	0.008 - 0.0091
Metals (ug/dscm @ 7% O_2)			
Arsenic (As)	N/A	<0.26	<0.18 - 0.34
Beryllium (Be)	N/A	<0.08	<0.01 - 0.14
Cadmium (Cd)	N/A	<0.58	<0.33 - 0.93
Lead (Pb)	N/A	<5.92	<0.89 - 24.19
Mercury (Hg)	N/A	47.20	20.15 - 144.18
Nickel (Ni)	N/A	4.54	0.76 - 43.32
Zinc (Zn)	N/A	11.65	8.15 - 18.70
Hexavalent Chromium (Cr+6)	N/A	<0.59	<0.1 - 1.54

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TABLE 5
CONTINUOUS EMISSION MONITOR SYSTEM RESULTS
AVERAGE LEVELS AND RANGES

POLLUTANT	YORK FACILITY*	DELAWARE FACILITY*	PaDER BAT LIMITS
CO (ppm)	40 (20-400)	40 (20-300)	100 (8 hr)
NOx (ppm)	85 (60-140)	95 (60-150)	300 (24 hr)
SO_2 (ppm)	4 (0-150)	18 (0-150)	30 (1 hr)
SO_2 RE (%)	80-90%	80-90%	75% (8 hr)
HCl	<5	<5	30

* Emission level concentration 1991

TABLE 6
YORK AND DELAWARE FACILITIES
AVERAGE EMISSION RESULTS

POLLUTANT	PSD MODELED VALUES	PERMIT LIMITS	ACTUAL RESULTS (Average)
PCDD/PCDF (ng/m3) TEF	4.3	2.0	0.12
Particulates (gr/dscf)	0.015	0.015	0.005
Lead (ug/m3)	355	NA	28
Cadmium (ug/m3)	31	NA	1.8
Mercury (ug/m3)	171	NA	83.5
SO_2 (ppm)	50	30 (75% RE)	6-8 (80-90% RE)
NOx (ppm)	150	300	100
CO (ppm)	400	100	50
HCl	50	30 (90% RE)	4-5

NA - Not Applicable -- PaDER will set permit limits for each Facility when the BAT is revised and when the NSPS/EG is promulgated.