Note: This is a reference cited in *AP 42, Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources.* AP42 is located on the EPA web site at www.epa.gov/ttn/chief/ap42/

The file name refers to the reference number, the AP42 chapter and section. The file name "ref02_c01s02.pdf" would mean the reference is from AP42 chapter 1 section 2. The reference may be from a previous version of the section and no longer cited. The primary source should always be checked.

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ENTROPY
ENVIRONMENTALISTS INC.

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RESEARCH TRIANGLE PARK
NORTH CAROLINA 27709-2291
919-781-3550

VOLUME I

TEXT AND APPENDIX

STATIONARY SOURCE SAMPLING FINAL REPORT

REFERENCE NO. 6549

HONOLULU RESOURCE RECOVERY FACILITY

EWA BEACH, OAHU, HAWAII

EMISSIONS TESTING FOR:
- Carbon Monoxide
- Hydrogen Fluoride
- Metals
- Nitrogen Oxides
- Particulate
- PCDD/PCDF
- Sulfur Dioxide
- Volatile Organic Compounds

UNIT NOS. 1 AND 2 RDF BOILERS
PROCESS LINE NOS. 100 AND 200 SHREDDERS

PERFORMED FOR: HONOLULU RESOURCE RECOVERY VENTURE

FEBRUARY 12 THROUGH 18, 1990

REPORT CERTIFICATION

DATE April 2, 1990

The project was carried out under my direction and supervision.

Signature Gary Williams
Gary L. Williams

The analysis performed for this report was carried out under my direction and supervision.

Signature
George W. Walsh

The preparation of this report was carried out under my direction and supervision.

Signature Tony Wong
Tony Wong

I hereby certify that this report is authentic and accurate.

Signature Frank J. Phoenix
Frank J. Phoenix, P.E.

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INTRODUCTION

1.1 Background. Honolulu Resource Recovery Venture has conducted an extensive air emission performance/compliance testing program (compliance tests) to quantify specific emissions at the Honolulu Resource Recovery Facility, in Ewa Beach, Oahu, Hawaii.

The facility converts municipal solid waste (MSW) into refuse derived fuel (RDF) and burns it in two identical boilers. The design capacity of the facility is 12,960 tons of MSW per week.

1.2 Outline of Test Program. This report covers stationary source sampling performed from February 12 through 18, 1990 at the Unit Nos. 1 and 2 RDF boilers and the Process Line Nos. 100 and 200 shredders. All testing was conducted in accordance with the procedures described in the pretest protocol which was reviewed by the Hawaii Department of Health (HDOH) prior to the start of testing. Observers from HDOH witnessed testing and cleanup procedures at the site. Table 1-1 is a test log which presents the sampling locations, sampling objectives, sampling methods, test dates, and run numbers.

1.3 Test Participants. Table 1-2 lists the personnel involved in the test program.

TABLE 1-1

TEST LOG

Sampling Location	Emissions Measured	Sampling Method	Test Date	Run Numbers Repetition 1	2	3
Unit No. 1 RDF Boiler ID Fan Outlet	Hydrogen Fluoride	EPA 13B	2/12	1-M13B-1	1-M13B-2	1-M13B-3
	PCDD/PCDF	MM5	2/12	1-MM5-1	1-MM5-2	- - -
			2/16	- - -	- - -	1-MM5-3
	Particulate, Metals	EPA MMTL	2/16	1-MMTL-1	1-MMTL-2	1-MMTL-3
Unit No 1 RDF Boiler Stack	CO, NO_x, SO_2, VOC, CO_2, O_2	CEM *	2/12	1-CEM-1	1-CEM-2	- - -
			2/16	- - -	- - -	1-CEM-3
Unit No. 2 RDF Boiler ID Fan Outlet	Hydrogen Fluoride	EPA 13B	2/14	2-M13B-1	2-M13B-2	2-M13B-3
	PCDD/PCDF	MM5	2/15	2-MM5-1	2-MM5-2	2-MM5-3
	Particulate, Metals	EPA MMTL	2/15	2-MMTL-1	2-MMTL-2	2-MMTL-3
Unit No. 2 RDF Boiler Stack	CO, NO_x, SO_2, VOC, CO_2, O_2	CEM *	2/15	2-CEM-1	2-CEM-2	2-CEM-3
Process Line No. 100 Primary Shredder Baghouse Vent	Particulate	EPA 5	2/17	100-PV-M5-1	100-PV-M5-2	- - -
			2/18	- - -	- - -	100-PV-M5-3
Process Line No. 100 Secondary Shredder Baghouse Vent	Particulate	EPA 5	2/17	100-SV-M5-1	100-SV-M5-2	- - -
			2/18	- - -	- - -	100-SV-M5-3
Process Line No. 200 Primary Shredder Baghouse Vent	Particulate	EPA 5	2/17	200-PV-M5-1	200-PV-M5-2	- - -
			2/18	- - -	- - -	200-PV-M5-3
Process Line No. 200 Secondary Shredder Baghouse Vent	Particulate	EPA 5	2/17	200-SV-M5-1	200-SV-M5-2	- - -
			2/18	- - -	- - -	200-SV-M5-3

* Continuous emissions monitoring using EPA Methods 3A, 6C, 7E, 10, and 25A.

Note: Run numbers reflect: unit number, sampling location code, sampling method, and repetition number.

TABLE 1-2
TEST PARTICIPANTS

Honolulu Resource Recovery Venture	Beth Moore Test Coordinator
	Jim Mahoney Test Coordinator
	Mike Smith HRRV Project Manager
Black and Veatch	Steve Clark Test Observer
Hawaii Department of Health	Tyler Sugihara Test Observer
	Queenie Tan Test Observer
	Rhan Yi Test Observer
	Carl Ibaou Test Observer
	Glen Kashiwabara Test Observer
Entropy Environmentalists Inc.	Gary L. Williams Project Manager
	Anthony L. Mastrianni Sampling Team Leader
	Leslie C. Murray Sampling Team Leader
	Barry F. Rudd Sampling Team Leader
	Kent Spears Sampling Team Leader
	J. Andrews Tillman Engineering Technician
	Mark Winters Instrument Technician
	Patrick F. Daley Laboratory Technician

SUMMARY OF RESULTS

2.1 Presentation. Table 2-1 presents the emission rates and concentrations for the compounds listed in the permit. Tables 2-2 and 2-3 present the Unit Nos. 1 and 2 RDF boilers PCDD/PCDF 2,3,7,8-TCDD EPA toxic equivalencies. Tables 2-4 and 2-5 present the Unit Nos. 1 and 2 RDF boilers PCDD/PCDF three-run average emissions. Tables 2-6 through 2-17 present run-by-run test summaries. Refer to the "List of Tables and Figures" on pages v and vi of the Table of Contents for a cross reference.

Detailed results of all the testing can be found in Appendix A; field and analytical data are provided in Appendix B. Process data supplied by Honolulu Resource Recovery Venture is provided in Volume II. The chromatogram data generated for the Unit Nos. 1 and 2 RDF boilers PCDD/PCDF analyses are presented in Volume III.

2.2 Discussion

2.2.1 Run 1-MMTL-3 Results. Due to an apparent filter tare weight discrepancy, the reported particulate catch was -70.7 milligrams. The cause for the discrepancy could not be determined; therefore, the particulate results for this run cannot be used. Only the particulate results for runs 1-MMTL-1 and 1-MMTL-2 are reported and averaged. Since the filter tare is not needed for metals analyses, the metals results for all three runs are valid.

2.2.2 Primary Shredders Sampling. Because of the potential for explosions which would endanger the lives of the individuals conducting the sampling, the metering console was operated at a location away from the shredders and sampling was single-point, isokinetic. While the shredders were inoperative and only the ID fans were running, pretest velocity traverses were conducted to determine the point of average velocity. When the actual emissions testing was conducted, sampling was conducted at this point for all runs. The emission rates (lb/hr) were calculated using the volumetric air flow rate (SCFM) calculated using the average delta P and flue gas temperature from the pretest velocity traverses.

2.2.3 Secondary Shredders Sampling. During sampling, some zero delta P readings (no flow) were observed on the "B" axis for Process Line 100 and on the

(continued on page 2-22)

TABLE 2-1

COMPLIANCE EMISSION RATES AND CONCENTRATIONS

	Repetition 1	Repetition 2	Repetition 3	Average	Permitted Compliance Emissions Limits
Unit No. 1 RDF Boiler					
Concentration, ppmvd at 12% CO_2					
Carbon Monoxide	121	130	155	135	377
Nitrogen Oxides	220	222	196	213	260
Sulfur Dioxide, 24-hour *	- -	- -	- -	14.5	30
Volatile Organic Compounds	3.52	1.30	3.03	2.61	21
Concentration, gr/DSCF at 12% CO_2					
Particulate	0.000989	0.00273	- -	0.00186	0.015
Emission Rate, lb/hr					
Beryllium	ND	ND	ND	ND	0.000450
Carbon Monoxide	56.0	57.8	68.9	60.9	150
Hydrogen Fluoride	0.0259	0.0100	0.0185	0.0182	1.3
Lead	0.0192	0.0128	0.0121	0.0147	0.10
Nitrogen Oxides	168	162	144	158	170
Mercury	0.00413	0.000726	0.00113	0.00199	0.08
Volatile Organic Compounds	0.698	0.248	0.578	0.508	9.0
Emission Rate, lb/ton RDF					
Beryllium	ND	ND	ND	ND	0.0000130
Hydrogen Fluoride	0.000741	0.000286	0.000529	0.000519	0.036
Lead	0.000563	0.000365	0.000335	0.000421	0.0028
Mercury	0.000121	0.0000208	0.0000313	0.0000578	0.0022
Unit No. 2 RDF Boiler					
Concentration, ppmvd at 12% CO_2					
Carbon Monoxide	132	95.8	93.9	107	377
Nitrogen Oxides	207	215	211	211	260
Sulfur Dioxide, 24-hour *	- -	- -	- -	22.1	30
Volatile Organic Compounds	2.02	2.32	6.47	3.60	21
Concentration, gr/DSCF at 12% CO_2					
Particulate	0.000849	0.000708	0.00233	0.00129	0.015

* Actually a 9-hour average.

ND = Not detected.

(continued next page)

TABLE 2-1 (continued)
COMPLIANCE EMISSION RATES AND CONCENTRATIONS

Unit No. 2 RDF Boiler	Repetition 1	Repetition 2	Repetition 3	Average	Permitted Compliance Emissions Limits
Emission Rate, lb/hr					
Beryllium	ND	ND	ND	ND	0.000450
Carbon Monoxide	61.1	43.7	45.8	50.2	150
Hydrogen Fluoride	0.0930	0.0123	0.00766	0.0377	1.3
Lead	0.0161	0.0195	0.0233	0.0197	0.10
Nitrogen Oxides	158	161	169	163	170
Mercury	0.00111	0.00327	0.00393	0.00277	0.08
Volatile Organic Compounds	0.401	0.453	1.35	0.735	9.0
Emission Rate, lb/ton RDF					
Beryllium	ND	ND	ND	ND	0.0000130
Hydrogen Fluoride	0.00258	0.000352	0.000213	0.00105	0.036
Lead	0.000461	0.000543	0.000648	0.000550	0.0028
Mercury	0.0000316	0.0000907	0.000109	0.0000772	0.0022
Process Line No. 100 Primary Shredder					
Emission Rate, lb/hr					
Particulate	0.0192	0.0232	0.0262	0.0229	1.02
Process Line No. 100 Secondary Shredder					
Emission Rate, lb/hr					
Particulate	0.272	0.192	0.281	0.248	1.02
Process Line No. 200 Primary Shredder					
Emission Rate, lb/hr					
Particulate	0.0740	0.0400	0.0576	0.0572	1.02
Process Line No. 200 Secondary Shredder					
Emission Rate, lb/hr					
Particulate	0.411	0.202	0.486	0.366	1.02

ND = Not detected.

TABLE 2-2

PCDD/PCDF, TOXIC EQUIVALENCIES

Unit No. 1 RDF Boiler

	Concen., ng/DSCM* at 12% CO_2			EPA 2378-TCDD Toxic Equiv. Factor	2378-TCDD Toxic Equivalencies Concen., ng/DSCM* at 12% CO_2		
	1-MM5-1	1-MM5-2	1-MM5-3		1-MM5-1	1-MM5-2	1-MM5-3
PCDD							

2378-TCDD	ND	ND	ND	1.00000	ND	ND	ND
Other TCDD	1.72E-01	3.05E-01	1.40E-01	0.01000	1.72E-03	3.05E-03	1.40E-03
12378-PeCDD	ND	5.91E-02	ND	0.50000	ND	2.96E-02	ND
Other PeCDD	2.31E-01	5.92E-01	8.18E-01	0.00500	1.16E-03	2.96E-03	4.09E-03
123478-HxCDD	ND	7.89E-02	4.24E-02	0.04000	ND	3.16E-03	1.70E-03
123678-HxCDD	4.61E-02	2.45E-01	1.60E-01	0.04000	1.84E-03	9.80E-03	6.40E-03
123789-HxCDD	ND	2.84E-01	1.95E-01	0.04000	ND	1.14E-02	7.80E-03
Other HxCDD	4.20E-01	1.82E+00	1.26E+00	0.00040	1.68E-04	7.28E-04	5.04E-04
1234678-HpCDD	4.07E-01	1.78E+00	7.80E-01	0.00100	4.07E-04	1.78E-03	7.80E-04
Other HpCDD	3.26E-01	1.59E+00	8.31E-01	0.00001	3.26E-06	1.59E-05	8.31E-06
OCDD	8.81E-01	4.93E+00	9.09E-01	0.00000	0.00E+00	0.00E+00	0.00E+00
	--------	--------	--------		--------	--------	--------
Total PCDD	2.48E+00	1.17E+01	5.14E+00		5.30E-03	6.25E-02	2.27E-02
PCDF							

2378-TCDF	2.54E-02	4.86E-02	4.30E-02	0.10000	2.54E-03	4.86E-03	4.30E-03
Other TCDF	6.37E-01	7.74E-01	8.72E-01	0.00100	6.37E-04	7.74E-04	8.72E-04
12378-PeCDF	3.26E-02	6.59E-02	ND	0.10000	3.26E-03	6.59E-03	ND
23478-PeCDF	5.63E-02	1.71E-01	1.50E-01	0.10000	5.63E-03	1.71E-02	1.50E-02
Other PeCDF	3.91E-01	9.81E-01	9.98E-01	0.00100	3.91E-04	9.81E-04	9.98E-04
123478-HxCDF	ND	2.37E-01	1.86E-01	0.01000	ND	2.37E-03	1.86E-03
123678-HxCDF	ND	ND	1.07E-01	0.01000	ND	ND	1.07E-03
234678-HxCDF	6.76E-02	2.55E-01	1.63E-01	0.01000	6.76E-04	2.55E-03	1.63E-03
123789-HxCDF	ND	ND	ND	0.01000	ND	ND	ND
Other HxCDF	0.00E+00	5.39E-01	3.47E-01	0.00010	0.00E+00	5.39E-05	3.47E-05
1234678-HpCDF	1.87E-01	5.17E-01	3.15E-01	0.00010	1.87E-05	5.17E-05	3.15E-05
1234789-HpCDF	ND	1.32E-01	5.00E-02	0.00010	ND	1.32E-05	5.00E-06
Other HpCDF	9.40E-02	1.19E-01	2.42E-01	0.00001	9.40E-07	1.19E-06	2.42E-06
OCDF	1.01E-01	1.23E+00	2.31E-01	0.00000	0.00E+00	0.00E+00	0.00E+00
	--------	--------	--------		--------	--------	--------
Total PCDF	1.59E+00	5.07E+00	3.70E+00		1.32E-02	3.53E-02	2.58E-02
Total PCDD/PCDF	4.07E+00	1.67E+01	8.84E+00		1.85E-02	9.78E-02	4.85E-02

* 32 Deg. F -- 29.92 inches Hg

ND = Not detected or EMPC catches; used as zero (0)

TABLE 2-3
PCDD/PCDF, TOXIC EQUIVALENCIES
Unit No. 2 RDF Boiler

	Concen., ng/DSCM* at 12% CO_2			EPA 2378-TCDD Toxic Equiv. Factor	2378-TCDD Toxic Equivalencies Concen., ng/DSCM* at 12% CO_2		
	2-MM5-1	2-MM5-2	2-MM5-3		2-MM5-1	2-MM5-2	2-MM5-3
PCDD							

2378-TCDD	ND	ND	ND	1.00000	ND	ND	ND
Other TCDD	8.33E-02	1.23E-01	1.66E-01	0.01000	8.33E-04	1.23E-03	1.66E-03
12378-PeCDD	ND	2.42E-02	1.20E-02	0.50000	ND	1.21E-02	6.00E-03
Other PeCDD	3.91E-02	2.47E-01	1.84E-01	0.00500	1.96E-04	1.24E-03	9.20E-04
123478-HxCDD	ND	ND	ND	0.04000	ND	ND	ND
123678-HxCDD	2.43E-02	6.12E-02	4.01E-02	0.04000	9.72E-04	2.45E-03	1.60E-03
123789-HxCDD	ND	7.32E-02	4.75E-02	0.04000	ND	2.93E-03	1.90E-03
Other HxCDD	2.21E-01	2.84E-01	3.76E-01	0.00040	8.84E-05	1.14E-04	1.50E-04
1234678-HpCDD	1.43E-01	3.91E-01	2.81E-01	0.00100	1.43E-04	3.91E-04	2.81E-04
Other HpCDD	0.00E+00	3.14E-01	2.42E-01	0.00001	0.00E+00	3.14E-06	2.42E-06
OCDD	2.39E-01	4.83E-01	4.81E-01	0.00000	0.00E+00	0.00E+00	0.00E+00
	--------	--------	--------		--------	--------	--------
Total PCDD	7.49E-01	2.00E+00	1.83E+00		2.23E-03	2.05E-02	1.25E-02
PCDF							

2378-TCDF	2.25E-02	3.46E-02	2.32E-02	0.10000	2.25E-03	3.46E-03	2.32E-03
Other TCDF	3.82E-01	4.97E-01	4.45E-01	0.00100	3.82E-04	4.97E-04	4.45E-04
12378-PeCDF	ND	3.82E-02	2.21E-02	0.10000	ND	3.82E-03	2.21E-03
23478-PeCDF	ND	8.36E-02	4.88E-02	0.10000	ND	8.36E-03	4.88E-03
Other PeCDF	4.58E-02	5.44E-01	2.85E-01	0.00100	4.58E-05	5.44E-04	2.85E-04
123478-HxCDF	4.17E-02	8.51E-02	6.79E-02	0.01000	4.17E-04	8.51E-04	6.79E-04
123678-HxCDF	2.07E-02	5.40E-02	3.93E-02	0.01000	2.07E-04	5.40E-04	3.93E-04
234678-HxCDF	3.23E-02	8.87E-02	5.97E-02	0.01000	3.23E-04	8.87E-04	5.97E-04
123789-HxCDF	ND	ND	ND	0.01000	ND	ND	ND
Other HxCDF	8.33E-02	1.98E-01	1.60E-01	0.00010	8.33E-06	1.98E-05	1.60E-05
1234678-HpCDF	6.94E-02	ND	1.40E-01	0.00010	6.94E-06	ND	1.40E-05
1234789-HpCDF	ND	3.22E-02	ND	0.00010	ND	3.22E-06	ND
Other HpCDF	2.15E-02	2.15E-02	7.20E-02	0.00001	2.15E-07	2.15E-07	7.20E-07
OCDF	5.07E-02	1.41E-01	1.12E-01	0.00000	0.00E+00	0.00E+00	0.00E+00
	--------	--------	--------		--------	--------	--------
Total PCDF	7.70E-01	1.82E+00	1.48E+00		3.64E-03	1.90E-02	1.18E-02
Total PCDD/PCDF	1.52E+00	3.82E+00	3.30E+00		5.87E-03	3.94E-02	2.44E-02

* 32 Deg. F -- 29.92 inches Hg

ND = Not detected or EMPC catches; used as zero (0)

TABLE 2-4

PCDD/PCDF, THREE-RUN AVERAGE EMISSIONS

Unit No. 1 RDF Boiler

	-------- Concentration	--------	--------	--- Emission Rate ---	
	ng/DSCM$^{(a)}$	ng/DSCM at 12% CO2	ng/DSCM at 7% O2	lbs/hr	Grams/Second
PCDD					

2378-TCDD	ND	ND	ND	ND	ND
Other TCDD	1.92E-01	2.06E-01	2.18E-01	7.47E-08	9.39E-09
12378-PeCDD	1.84E-02	1.97E-02	2.09E-02	7.07E-09	8.93E-10
Other PeCDD	5.01E-01	5.47E-01	5.78E-01	1.96E-07	2.47E-08
123478-HxCDD	3.70E-02	4.04E-02	4.28E-02	1.45E-08	1.82E-09
123678-HxCDD	1.38E-01	1.50E-01	1.59E-01	5.40E-08	6.79E-09
123789-HxCDD	1.46E-01	1.60E-01	1.69E-01	5.70E-08	7.20E-09
Other HxCDD	1.07E+00	1.17E+00	1.23E+00	4.18E-07	5.27E-08
1234678-HpCDD	9.15E-01	9.89E-01	1.05E+00	3.56E-07	4.49E-08
Other HpCDD	8.44E-01	9.16E-01	9.69E-01	3.28E-07	4.14E-08
OCDD	2.09E+00	2.24E+00	2.38E+00	8.07E-07	1.02E-07
	--------	--------	--------	--------	--------
Total PCDD	5.95E+00	6.44E+00	6.82E+00	2.31E-06	2.92E-07
PCDF					

2378-TCDF	3.61E-02	3.90E-02	4.12E-02	1.41E-08	1.77E-09
Other TCDF	7.05E-01	7.61E-01	8.04E-01	2.75E-07	3.46E-08
12378-PeCDF	3.11E-02	3.28E-02	3.48E-02	1.20E-08	1.51E-09
23478-PeCDF	1.15E-01	1.26E-01	1.33E-01	4.51E-08	5.69E-09
Other PeCDF	7.26E-01	7.90E-01	8.35E-01	2.84E-07	3.58E-08
123478-HxCDF	1.28E-01	1.41E-01	1.49E-01	5.02E-08	6.32E-09
123678-HxCDF	3.14E-02	3.57E-02	3.73E-02	1.25E-08	1.58E-09
234678-HxCDF	1.49E-01	1.62E-01	1.72E-01	5.82E-08	7.35E-09
123789-HxCDF	ND	ND	ND	ND	ND
Other HxCDF	2.70E-01	2.95E-01	3.12E-01	1.05E-07	1.33E-08
1234678-HpCDF	3.15E-01	3.40E-01	3.60E-01	1.22E-07	1.54E-08
1234789-HpCDF	5.57E-02	6.07E-02	6.41E-02	2.17E-08	2.73E-09
Other HpCDF	1.39E-01	1.52E-01	1.60E-01	5.45E-08	6.88E-09
OCDF	4.84E-01	5.21E-01	5.53E-01	1.87E-07	2.36E-08
	--------	--------	--------	--------	--------
Total PCDF	3.19E+00	3.46E+00	3.66E+00	1.24E-06	1.57E-07
Total PCDD/PCDF	9.14E+00	9.89E+00	1.05E+01	3.55E-06	4.48E-07

(a) 32 Deg. F -- 29.92 inches Hg

ND = Not detected or EMPC catches; used as zero (0)

TABLE 2-5

PCDD/PCDF, THREE-RUN AVERAGE EMISSIONS

Unit No. 2 RDF Boiler

	-------- Concentration --------			--- Emission Rate ---	
	ng/DSCM (a)	ng/DSCM at 12% CO2	ng/DSCM at 7% O2	lbs/hr	Grams/Second
PCDD					
2378-TCDD	ND	ND	ND	ND	ND
Other TCDD	1.19E-01	1.24E-01	1.29E-01	4.70E-08	5.92E-09
12378-PeCDD	1.15E-02	1.21E-02	1.24E-02	4.51E-09	5.67E-10
Other PeCDD	1.50E-01	1.57E-01	1.62E-01	5.89E-08	7.43E-09
123478-HxCDD	ND	ND	ND	ND	ND
123678-HxCDD	3.98E-02	4.19E-02	4.32E-02	1.57E-08	1.97E-09
123789-HxCDD	3.84E-02	4.02E-02	4.16E-02	1.51E-08	1.90E-09
Other HxCDD	2.80E-01	2.94E-01	3.04E-01	1.11E-07	1.40E-08
1234678-HpCDD	2.59E-01	2.72E-01	2.81E-01	1.02E-07	1.29E-08
Other HpCDD	1.77E-01	1.85E-01	1.92E-01	7.00E-08	8.80E-09
OCDD	3.82E-01	4.01E-01	4.15E-01	1.51E-07	1.91E-08
Total PCDD	1.46E+00	1.53E+00	1.58E+00	5.75E-07	7.26E-08
PCDF					
2378-TCDF	2.54E-02	2.68E-02	2.77E-02	1.00E-08	1.26E-09
Other TCDF	4.20E-01	4.41E-01	4.56E-01	1.66E-07	2.09E-08
12378-PeCDF	1.92E-02	2.01E-02	2.08E-02	7.52E-09	9.47E-10
23478-PeCDF	4.21E-02	4.41E-02	4.56E-02	1.66E-08	2.09E-09
Other PeCDF	2.78E-01	2.92E-01	3.01E-01	1.09E-07	1.37E-08
123478-HxCDF	6.17E-02	6.49E-02	6.71E-02	2.43E-08	3.07E-09
123678-HxCDF	3.62E-02	3.80E-02	3.93E-02	1.43E-08	1.80E-09
234678-HxCDF	5.73E-02	6.02E-02	6.23E-02	2.26E-08	2.85E-09
123789-HxCDF	ND	ND	ND	ND	ND
Other HxCDF	1.40E-01	1.47E-01	1.52E-01	5.53E-08	6.97E-09
1234678-HpCDF	6.72E-02	6.98E-02	7.28E-02	2.70E-08	3.41E-09
1234789-HpCDF	1.01E-02	1.07E-02	1.10E-02	3.90E-09	4.90E-10
Other HpCDF	3.68E-02	3.83E-02	3.99E-02	1.48E-08	1.86E-09
OCDF	9.64E-02	1.01E-01	1.05E-01	3.81E-08	4.80E-09
Total PCDF	1.29E+00	1.35E+00	1.40E+00	5.09E-07	6.41E-08
Total PCDD/PCDF	2.75E+00	2.88E+00	2.98E+00	1.08E-06	1.37E-07

(a) 32 Deg. F -- 29.92 inches Hg

ND = Not detected or EMPC catches; used as zero (0)

TABLE 2-6

CARBON MONOXIDE, NITROGEN OXIDES, SULFUR DIOXIDE AND VOLATILE ORGANIC COMPOUNDS TESTS SUMMARY

Unit No. 1 RDF Boiler

	1-CEM-1	1-CEM-2	1-CEM-3	Average
Test Date	2/12/90	2/12/90	2/16/90	
Run Start Time	1030	1605	1305	
Run Finish Time	1406	1938	1838	
Carbon Dioxide, % by Volume, dry	11.6	11.1	10.7	
Oxygen, % by Volume, dry	8.0	8.6	9.0	
Volumetric Air Flow Rate, SCFM*	109,807	110,398	114,481	111,562
<u>Carbon Monoxide Results</u>				
Concentration, ppmvd	117	120	138	125
Concentration, ppmvd @ 12% CO_2	121	130	155	135
Concentration, ppmvd @ 7% O_2	126	135	161	141
Emission Rate, lb/hr	56.0	57.8	68.9	60.9
<u>Nitrogen Oxides, as NO_2 Results</u>				
Concentration, ppmvd	213	205	175	198
Concentration, ppmvd @ 12% CO_2	220	222	196	213
Concentration, ppmvd @ 7% O_2	229	231	204	222
Emission Rate, lb/hr	168	162	144	158
<u>Sulfur Dioxide Results</u>				
Concentration, ppmvd	14	7	19	13.3
Concentration, ppmvd @ 12% CO_2	14.5	7.57	21.3	14.5
Concentration, ppmvd @ 7% O_2	15.1	7.90	22.2	15.0
Emission Rate, lb/hr	15.3	7.71	21.7	14.9
<u>Volatile Organic Compounds, as Carbon Results</u>				
Concentration, ppmvd	3.4	1.2	2.7	2.43
Concentration, ppmvd @ 12% CO_2	3.52	1.30	3.03	2.61
Concentration, ppmvd @ 7% O_2	3.66	1.35	3.15	2.72
Emission Rate, lb/hr	0.698	0.248	0.578	0.508

* From Runs 1-MM5-1, 1-MM5-2, and 1-MM5-3, Respectively.

TABLE 2-7

HYDROGEN FLUORIDE TESTS SUMMARY

Unit No. 1 RDF Boiler

	1-M13B-1	1-M13B-2	1-M13B-3	Average
Test Date	2/12/90	2/12/90	2/12/90	
Run Start Time	1031	1330	1716	
Run Finish Time	1156	1648	1849	
Test Train Parameters				
Volume Of Dry Gas Sampled, SCF*	48.774	50.253	51.155	
Percent Isokinetic	98.9	99.3	98.5	
Flue Gas Parameters				
Volumetric Air Flow Rates				
SCFM*, Dry	109,851	112,705	115,662	112,739
ACFM, Wet	193,834	197,127	197,539	196,167
Temperature, Degrees F	288	290	276	285
Hydrogen Fluoride Results				
Concentration, gr/DSCF*	2.75E-05	1.04E-05	1.87E-05	1.89E-05
Concentration, gr/DSCF @ 12% CO2	2.90E-05	1.11E-05	2.04E-05	2.02E-05
Concentration, gr/DSCF @ 7% O2	3.01E-05	1.18E-05	2.18E-05	2.12E-05
Emission Rate, lb/hr	0.0259	0.0100	0.0185	0.0182
Emission Rate, lb/ton RDF	0.000741	0.000286	0.000529	0.000519

* 68 Degrees F -- 29.92 Inches of Mercury (Hg)

TABLE 2-8

PARTICULATE AND METALS TESTS SUMMARY

Unit No. 1 RDF Boiler

	1-MMTL-1	1-MMTL-2	1-MMTL-3	Average
Test Date	2/16/90	2/16/90	2/16/90	
Run Start Time	1246	1770	2230	
Run Finish Time	1716	2218	0045	
Test Train Parameters				
Volume Of Dry Gas Sampled, SCF				
at 68 Degrees F--29.92 in. Hg	86.388	88.510	87.578	
at 32 Degrees F--29.92 in. Hg	80.530	82.508	81.639	
Percent Isokinetic	100.0	98.3	99.9	
Flue Gas Parameters				
Carbon Dioxide, % By Volume, Dry	11.7	10.9	11.5	11.4
Oxygen, % By Volume, Dry	7.8	8.9	8.4	8.4
Volumetric Air Flow Rates				
SCFM, Dry				
at 68 Degrees F--29.92 in. Hg	107,839	113,307	109,355	110,167
at 32 Degrees F--29.92 in. Hg	100,486	105,582	101,899	102,656
ACFM, Wet	186,484	192,188	185,485	188,052
Temperature, Degrees F	292	281	281	285
Particulate Results				
Concentration, gr/DSCF	0.000965	0.00248	---	0.00172
Concentration, gr/DSCF @ 12% CO2	0.000989	0.00273	---	0.00186
Concentration, gr/DSCF @ 7% O2	0.00102	0.00286	---	0.00194
Emission Rate, lb/hr	0.892	2.40	---	1.65
Beryllium Results				
at 68 Degrees F				
Concentration, gr/DSCF	ND	ND	ND	ND
Concentration, gr/DSCF @ 12% CO2	ND	ND	ND	ND
Concentration, gr/DSCF @ 7% O2	ND	ND	ND	ND
Emission Rate, lb/hr	ND	ND	ND	ND
Emission Rate, lb/ton RDF	ND	ND	ND	ND
at 32 Degrees F				
Concentration, mg/DSCM	ND	ND	ND	ND
Concentration, mg/DSCM at 12% CO2	ND	ND	ND	ND
Concentration, mg/DSCM at 7% O2	ND	ND	ND	ND
Lead Results				
at 68 Degrees F				
Concentration, gr/DSCF	2.07E-05	1.32E-05	1.29E-05	1.56E-05
Concentration, gr/DSCF @ 12% CO2	2.13E-05	1.45E-05	1.34E-05	1.64E-05
Concentration, gr/DSCF @ 7% O2	2.20E-05	1.52E-05	1.43E-05	1.72E-05
Emission Rate, lb/hr	0.0192	0.0128	0.0121	0.0147
Emission Rate, lb/ton RDF	0.000563	0.000365	0.000335	0.000421
at 32 Degrees F				
Concentration, mg/DSCM	0.0509	0.0323	0.0316	0.0382
Concentration, mg/DSCM at 12% CO2	0.0522	0.0356	0.0329	0.0402
Concentration, mg/DSCM at 7% O2	0.0539	0.0374	0.0351	0.0421

(Continued next page)

TABLE 2-8 (continued)

PARTICULATE AND METALS TESTS SUMMARY

Unit No. 1 RDF Boiler

	1-MMTL-1	1-MMTL-2	1-MMTL-3	Average
<u>Mercury Results</u>				
at 68 Degrees F				
Concentration, gr/DSCF	4.47E-06	7.48E-07	1.20E-06	2.14E-06
Concentration, gr/DSCF @ 12% CO2	4.58E-06	8.23E-07	1.26E-06	2.22E-06
Concentration, gr/DSCF @ 7% O2	4.74E-06	8.65E-07	1.34E-06	2.31E-06
Emission Rate, lb/hr	0.00413	0.000726	0.00113	0.00199
Emission Rate, lb/ton RDF	1.21E-04	2.08E-05	3.13E-05	5.78E-05
at 32 Degrees F				
Concentration, mg/DSCM	0.0110	0.00184	0.00295	0.00525
Concentration, mg/DSCM at 12% CO2	0.0112	0.00202	0.00308	0.00545
Concentration, mg/DSCM at 7% O2	0.0116	0.00212	0.00328	0.00568

TABLE 2-9

PCDD/PCDF SAMPLE TRAIN AND FLUE GAS PARAMETERS SUMMARY

Unit No. 1 RDF Boiler

	1-MM5-1	1-MM5-2	1-MM5-3	Average
Run Date	2/12/90	2/12/90	2/16/90	
Run Start Time	1030	1605	1305	
Run Finish Time	1406	1938	1838	
Net Run Time, Minutes	187.5	187.5	187.5	
Test Train Parameters				
Volume of Gas Sampled *				
Dry Stand. Cubic Feet	121.003	133.863	143.213	
Dry Stand. Cubic Meters	3.427	3.791	4.056	
Average Sampling Rate *				
Dry Stand. Cubic Feet/min	0.645	0.714	0.764	
Dry Stand. Cubic Meters/min	0.0183	0.0202	0.0216	
Percent Isokinetic	97.6	99.0	110.8	
Flue Gas Parameters				
Combustion Products				
Percent CO_2 by Volume	11.7	11.2	10.6	11.2
Percent O_2 by Volume	8.1	8.7	9.2	8.7
Temperature				
Degrees Fahrenheit	286	286	279	284
Degrees Celsius	141	141	137	140
Volumetric Flow Rates				
Dry Stand. Cubic Ft/Min. *	102,320	102,871	106,676	103,956
Dry Stand. Cubic Meters/Min	2,898	2,913	3,021	2,944
Actual Cubic Ft/Min.	191,688	189,512	189,689	190,296
Actual Cubic Meters/Min.	5,429	5,367	5,372	5,389
Moisture Percent by Volume	20.0	18.7	17.0	18.6

* 32 Deg. F -- 29.92 inches Mercury

TABLE 2-10

CARBON MONOXIDE, NITROGEN OXIDES, SULFUR DIOXIDE AND VOLATILE ORGANIC COMPOUNDS TESTS SUMMARY

Unit No. 2 RDF Boiler

	2-CEM-1	2-CEM-2	2-CEM-3	Average
Test Date	2/15/90	2/15/90	2/15/90	
Run Start Time	1035	1450	1847	
Run Finish Time	1409	1820	0021	
Carbon Dioxide, % by Volume, dry	11.3	11.4	11.5	
Oxygen, % by Volume, dry	8.4	8.2	8.0	
Volumetric Air Flow Rate, SCFM*	112,973	110,211	116,557	113,247
<u>Carbon Monoxide Results</u>				
Concentration, ppmvd	124	91	90	102
Concentration, ppmvd @ 12% CO2	132	95.8	93.9	107
Concentration, ppmvd @ 7% O2	138	99.5	96.9	111
Emission Rate, lb/hr	61.1	43.7	45.8	50.2
<u>Nitrogen Oxides, as NO2 Results</u>				
Concentration, ppmvd	195	204	202	200
Concentration, ppmvd @ 12% CO2	207	215	211	211
Concentration, ppmvd @ 7% O2	217	223	218	219
Emission Rate, lb/hr	158	161	169	163
<u>Sulfur Dioxide Results</u>				
Concentration, ppmvd	15	22	26	21.0
Concentration, ppmvd @ 12% CO2	15.9	23.2	27.1	22.1
Concentration, ppmvd @ 7% O2	16.7	24.1	28.0	22.9
Emission Rate, lb/hr	16.9	24.2	30.2	23.8
<u>Volatile Organic Compounds, as Carbon Results</u>				
Concentration, ppmvd	1.9	2.2	6.2	3.43
Concentration, ppmvd @ 12% CO2	2.02	2.32	6.47	3.60
Concentration, ppmvd @ 7% O2	2.11	2.41	6.68	3.73
Emission Rate, lb/hr	0.401	0.453	1.35	0.735

* From Runs 2-MM5-1, 2-MM5-2, and 2-MM5-3, Respectively.

TABLE 2-11

HYDROGEN FLUORIDE TESTS SUMMARY

Unit No. 2 RDF Boiler

	2-M13B-1	2-M13B-2	2-M13B-3	Average
Test Date	2/14/90	2/14/90	2/14/90	
Run Start Time	1325	1500	1600	
Run Finish Time	1440	1612	1734	
Test Train Parameters				
Volume Of Dry Gas Sampled, SCF*	47.990	47.578	49.159	
Percent Isokinetic	98.1	94.8	98.5	
Flue Gas Parameters				
Volumetric Air Flow Rates				
SCFM*, Dry	108,945	109,255	111,157	109,786
ACFM, Wet	185,455	187,190	188,248	186,964
Temperature, Degrees F	276	276	277	276
Hydrogen Fluoride Results				
Concentration, gr/DSCF*	9.96E-05	1.32E-05	8.04E-06	4.03E-05
Concentration, gr/DSCF @ 12% CO2	1.07E-04	1.48E-05	8.77E-06	4.34E-05
Concentration, gr/DSCF @ 7% O2	1.07E-04	1.52E-05	9.30E-06	4.39E-05
Emission Rate, lb/hr	0.0930	0.0123	0.00766	0.0377
Emission Rate, lb/ton RDF	0.00258	0.000352	0.000213	0.00105

* 68 Degrees F -- 29.92 Inches of Mercury (Hg)

TABLE 2-12

PARTICULATE AND METALS TESTS SUMMARY

Unit No. 2 RDF Boiler

Test Date	2-MMTL-1 2/15/90	2-MMTL-2 2/15/90	2-MMTL-3 2/15/90	Average
Run Start Time	1035	1649	1932	
Run Finish Time	1302	1916	2300	
Test Train Parameters				
Volume Of Dry Gas Sampled, SCF				
at 68 Degrees F--29.92 in. Hg	86.812	94.277	89.757	
at 32 Degrees F--29.92 in. Hg	80.925	87.884	83.670	
Percent Isokinetic	96.2	101.3	99.2	
Flue Gas Parameters				
Carbon Dioxide, % By Volume, Dry	10.8	11.1	11.7	11.2
Oxygen, % By Volume, Dry	8.5	8.8	8.3	8.5
Volumetric Air Flow Rates				
SCFM, Dry				
at 68 Degrees F--29.92 in. Hg	112,616	116,082	113,832	114,177
at 32 Degrees F--29.92 in. Hg	104,937	108,167	106,071	106,392
ACFM, Wet	190,100	201,919	192,305	194,775
Temperature, Degrees F	276	280	277	278
Particulate Results				
Concentration, gr/DSCF	0.000764	0.000655	0.00227	0.00123
Concentration, gr/DSCF @ 12% CO2	0.000849	0.000708	0.00233	0.00129
Concentration, gr/DSCF @ 7% O2	0.000856	0.000751	0.00250	0.00137
Emission Rate, lb/hr	0.738	0.651	2.21	1.20
Beryllium Results				
at 68 Degrees F				
Concentration, gr/DSCF	ND	ND	ND	ND
Concentration, gr/DSCF @ 12% CO2	ND	ND	ND	ND
Concentration, gr/DSCF @ 7% O2	ND	ND	ND	ND
Emission Rate, lb/hr	ND	ND	ND	ND
Emission Rate, lb/ton RDF	ND	ND	ND	ND
at 32 Degrees F				
Concentration, mg/DSCM	ND	ND	ND	ND
Concentration, mg/DSCM at 12% CO2	ND	ND	ND	ND
Concentration, mg/DSCM at 7% O2	ND	ND	ND	ND
Lead Results				
at 68 Degrees F				
Concentration, gr/DSCF	1.67E-05	1.96E-05	2.39E-05	2.01E-05
Concentration, gr/DSCF @ 12% CO2	1.86E-05	2.12E-05	2.45E-05	2.14E-05
Concentration, gr/DSCF @ 7% O2	1.87E-05	2.25E-05	2.63E-05	2.25E-05
Emission Rate, lb/hr	0.0161	0.0195	0.0233	0.0197
Emission Rate, lb/ton RDF	0.000461	0.000543	0.000648	0.000550
at 32 Degrees F				
Concentration, mg/DSCM	0.0410	0.0482	0.0587	0.0493
Concentration, mg/DSCM at 12% CO2	0.0456	0.0521	0.0602	0.0526
Concentration, mg/DSCM at 7% O2	0.0459	0.0553	0.0647	0.0553

(Continued next page)

TABLE 2-12 (continued)

PARTICULATE AND METALS TESTS SUMMARY

Unit No. 2 RDF Boiler

<u>Mercury Results</u>	2-MMTL-1	2-MMTL-2	2-MMTL-3	Average
at 68 Degrees F				
Concentration, gr/DSCF	1.14E-06	3.28E-06	4.03E-06	2.82E-06
Concentration, gr/DSCF @ 12% CO2	1.27E-06	3.55E-06	4.13E-06	2.98E-06
Concentration, gr/DSCF @ 7% O2	1.28E-06	3.77E-06	4.44E-06	3.16E-06
Emission Rate, lb/hr	0.00111	0.00327	0.00393	0.00277
Emission Rate, lb/ton RDF	3.16E-05	9.07E-05	1.09E-04	7.72E-05
at 32 Degrees F				
Concentration, mg/DSCM	0.00281	0.00806	0.00989	0.00692
Concentration, mg/DSCM at 12% CO2	0.00312	0.00871	0.0101	0.00732
Concentration, mg/DSCM at 7% O2	0.00315	0.00924	0.0109	0.00776

TABLE 2-13
PCDD/PCDF SAMPLE TRAIN AND FLUE GAS PARAMETERS SUMMARY
Unit No. 2 RDF Boiler

	2-MM5-1	2-MM5-2	2-MM5-3	Average
Run Date	2/15/90	2/15/90	2/15/90	
Run Start Time	1035	1450	1847	
Run Finish Time	1410	1821	0021	
Net Run Time, Minutes	187.5	187.5	187.5	
Test Train Parameters				
Volume of Gas Sampled *				
Dry Stand. Cubic Feet	146.192	125.581	132.779	
Dry Stand. Cubic Meters	4.140	3.556	3.760	
Average Sampling Rate *				
Dry Stand. Cubic Feet/min	0.780	0.670	0.708	
Dry Stand. Cubic Meters/min	0.0221	0.0190	0.0201	
Percent Isokinetic	97.7	100.9	100.9	
Flue Gas Parameters				
Combustion Products				
Percent CO_2 by Volume	11.2	11.3	11.7	11.4
Percent O_2 by Volume	8.3	8.1	8.0	8.1
Temperature				
Degrees Fahrenheit	279	283	280	281
Degrees Celsius	137	139	138	138
Volumetric Flow Rates				
Dry Stand. Cubic Ft/Min. *	105,271	102,697	108,610	105,526
Dry Stand. Cubic Meters/Min	2,981	2,908	3,076	2,988
Actual Cubic Ft/Min.	191,717	188,042	200,038	193,266
Actual Cubic Meters/Min.	5,429	5,325	5,665	5,473
Moisture Percent by Volume	18.8	18.8	19.6	19.1

* 32 Deg. F -- 29.92 inches Mercury

TABLE 2-14

PARTICULATE TESTS SUMMARY

Process Line No. 100, Primary Shredder

	100-PV-M5-1	100-PV-M5-2	100-PV-M5-3	Average
Test Date	2/17/90	2/17/90	2/18/90	
Run Start Time	1350	1550	950	
Run Finish Time	1623	1712	1125	
Test Train Parameters				
Volume Of Dry Gas Sampled, SCF*	45.331	45.432	45.225	
Percent Isokinetic	104.0	103.3	104.5	
Flue Gas Parameters				
Volumetric Air Flow Rates				
SCFM*, Dry	1,609	1,623	1,598	1,610
ACFM, Wet	1,707	1,703	1,711	1,707
Temperature, Degrees F	92	92	92	92
Particulate Results				
Concentration, gr/DSCF*	0.00140	0.00166	0.00191	0.00166
Emission Rate, lb/hr	0.0192	0.0232	0.0262	0.0229

* 68 Degrees F -- 29.92 Inches of Mercury (Hg)

TABLE 2-15

PARTICULATE TESTS SUMMARY

Process Line No. 100, Secondary Shredder

	100-SV-M5-1	100-SV-M5-2	100-SV-M5-3	Average
Test Date	2/17/90	2/17/90	2/18/90	
Run Start Time	1350	1550	950	
Run Finish Time	1517	1703	1115	
Test Train Parameters				
Volume Of Dry Gas Sampled, SCF*	45.165	40.505	40.249	
Percent Isokinetic	103.8	100.6	100.5	
Flue Gas Parameters				
Volumetric Air Flow Rates				
SCFM*, Dry	48,821	45,183	44,965	46,323
ACFM, Wet	51,728	48,523	47,098	49,116
Temperature, Degrees F	105	105	86	99
Particulate Results				
Concentration, gr/DSCF*	0.000649	0.000495	0.000729	0.000624
Emission Rate, lb/hr	0.272	0.192	0.281	0.248

* 68 Degrees F -- 29.92 Inches of Mercury (Hg)

TABLE 2-16

PARTICULATE TESTS SUMMARY

Process Line No. 200, Primary Shredder

	200-PV-M5-1	200-PV-M5-2	200-PV-M5-3	Average
Test Date	2/17/90	2/17/90	2/18/90	
Run Start Time	1155	1350	945	
Run Finish Time	1328	1544	1118	
Test Train Parameters				
Volume Of Dry Gas Sampled, SCF*	45.935	46.272	46.134	
Percent Isokinetic	101.2	101.5	101.3	
Flue Gas Parameters				
Volumetric Air Flow Rates				
SCFM*, Dry	4,353	4,371	4,367	4,364
ACFM, Wet	4,543	4,539	4,540	4,541
Temperature, Degrees F	77	77	77	77
Particulate Results				
Concentration, gr/DSCF*	0.00198	0.00107	0.00154	0.00153
Emission Rate, lb/hr	0.0740	0.0400	0.0576	0.0572

* 68 Degrees F -- 29.92 Inches of Mercury (Hg)

TABLE 2-17

PARTICULATE TESTS SUMMARY

Process Line No. 200, Secondary Shredder

	200-SV-M5-1	200-SV-M5-2	200-SV-M5-3	Average
Test Date	2/17/90	2/17/90	2/18/90	
Run Start Time	1155	1405	944	
Run Finish Time	1319	1537	1113	
Test Train Parameters				
Volume Of Dry Gas Sampled, SCF*	34.149	33.704	35.611	
Percent Isokinetic	103.9	105.8	106.2	
Flue Gas Parameters				
Volumetric Air Flow Rates				
SCFM*, Dry	44,218	42,855	45,098	44,057
ACFM, Wet	47,279	45,846	47,882	47,002
Temperature, Degrees F	94	95	92	94
Particulate Results				
Concentration, gr/DSCF*	0.00108	0.000549	0.00126	0.000964
Emission Rate, lb/hr	0.411	0.202	0.486	0.366

* 68 Degrees F -- 29.92 Inches of Mercury (Hg)

"A" axis for Process Line 200. When points with no flow are encountered, the probe is moved to the following points until a positive flow is indicated and sampling is continued at the point where positive flow is restored. To establish the average delta P, the zero readings are averaged in with the positive readings.

2.2.4 EPA Method 3 Flue Gas Composition. For runs 1-M13B-1, 1-M13B-2, and 2-MMTL-3, there were sampling problems with the EPA Method 3 flue gas samples collected for flue gas composition analysis. The oxygen and carbon dioxide results used for these runs were taken from the concurrent continuous emissions monitoring testing.

2.2.5 Run 1-MM5-3 Isokinetic Sampling Rate. The run was conducted at an isokinetic sampling rate of 110.8%, which is slightly higher than the acceptable upper limit of 110%. This causes a slight negative bias in the results for the run.

2.2.6 Duplicate Analyses. The results of duplicate analyses performed on the metals samples were averaged for calculation purposes.

2.2.7 Cyclonic Flow Checks. Prior to testing, Entropy conducted checks at the Unit Nos. 1 and 2 RDF boilers ID fan outlets and the Process Line Nos. 100 and 200 secondary shredder baghouse vents to determine if any cyclonic flow existed. For each location, the average yaw angle was less than 20°, indicating acceptable locations with respect to EPA Method 1 requirements.

2.2.8 Analytical Results Prefixes. Two symbols are used in the presentation of the analytical results. The symbols indicate results that have special significance and require different procedures in calculations and data interpretation. The less than (<) symbol is used to indicate that a compound was not detected and that the reported catch value is a detection limit. The estimation (~) symbol indicates values that are either an estimated maximum possible concentration (EMPC) or a positive result that is below the quantitation limit assigned to the compound.

PCDD/PCDF. The data reporting procedures outlined in the Environmental Standards Workshop (ESW) method for analysis of PCDD/PCDF emissions (September 18, 1984; revised December 31, 1984) was used for presenting all analytical results. The ESW was sponsored by the American Society of Mechanical Engineers, U.S. Department of Energy, and U.S. Environmental Protection Agency.

A number of sample analyses yielded results for specific PCDD/PCDF isomers that were below the detection limit (BDL) or were an EMPC. These BDL and EMPC data do not meet reporting criteria given in section 8.5 of the ESW Analytical Procedures. All BDL and EMPC results are considered as ND (not detected; zero value) in the summary tables. The PCDD/PCDF emission concentration totals therefore include only data not reported as ND in accordance with procedures described in section 10.1.5 of the ESW method.

On pages 23 and 46 of the Appendix section, each isomer result value shown as ND followed by a value enclosed in parentheses represents the detection limit for the isomer. All isomer results shown as ND in these tables and followed by a value enclosed in brackets represents an EMPC catch value. An EMPC is reported for GC/MS signals eluting within the PCDD/PCDF retention time windows established with the daily GC/MS performance analyses but not meeting the ion abundance ratio criteria of the analytical method.

Others. In all other cases where BDL values were determined, the results are presented as ND in the summary tables. The worst case results are presented in the appendices using the detection limit as a positive value to calculate the emissions.

PROCESS DESCRIPTION AND OPERATION

3.1 Source Description. Honolulu Resource Recovery Facility (H-Power) located in Ewa Beach, Oahu, Hawaii is designed, constructed, and operated by the Honolulu Resource Recovery Venture. H-Power is a refuse derived fuel (RDF) type of resource recovery facility comprised of two parts; the power block facility (Unit Nos. 1 and 2 RDF boilers) and the waste processing facility (Process Line Nos. 100 and 200 shredders). Figures 3-1 and 3-2 are air flow schematics which show the passage of flue gases exhausted from the RDF boilers and shredders, respectively.

The power block facility has two VU-40 RDF-fired boilers which produce up to 57 MW of electricity for internal use and sale. Each boiler is equipped with a spray dryer absorber (SDA) for acid gas removal. The SDA is followed by a 5-field electrostatic precipitator (ESP) for control of suspended particulate emissions. Each ESP is followed by an induced draft fan which directs the flue gas to a reinforced, self-supporting cement stack.

The waste processing facility (WPF) has two separate but identical process lines which are designed to receive and process 12,960 tons of municipal solid waste (MSW) per week. Each of the processing lines in the WPF has a fabric filter system for particulate control. One control system receives dust-laden air from the secondary shredder, trommel dust hoods, and the ferrous metal air classifier. The majority of the particulate is removed from the air stream in the cyclone where it is collected and discharged through an air lock to the RDF transport conveyor. Final cleaning of the air stream occurs in the fabric filter where clean air is discharged to the atmosphere in a series of vents on top of the WPF. The primary shredders have their own separate dust control systems with an exhaust fan and separate fabric filter for each of the process lines.

3.2 Boiler Operation During Testing. Process data supplied by Honolulu Resource Recovery Venture is provided in Volume II. Opacity data is included with the boiler process data. Opacity was monitored by the continuous opacity monitor for boiler No. 1. EnvironMETeo Service, Inc. conducted a visual emissions evaluation for boiler No. 2.

The results of the RDF higher heating value (HHV) sampling program conducted by Commercial Testing & Engineering Co., South Holland, Illinois, is provided in Volume II.

(continued on page 3-4)

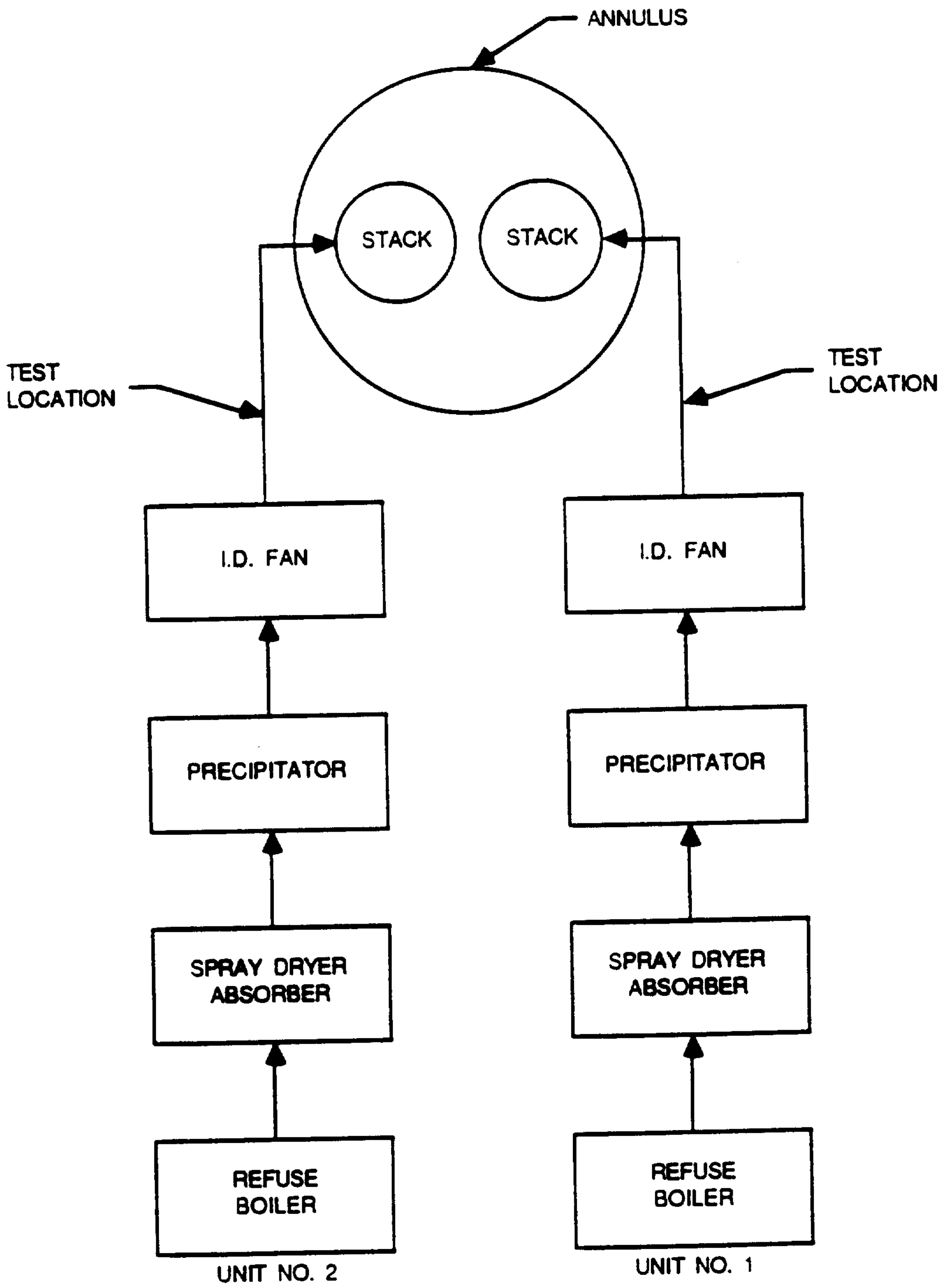


FIGURE 3-1. UNIT NOS. 1 AND 2 RDF BOILERS AIR FLOW SCHEMATIC.

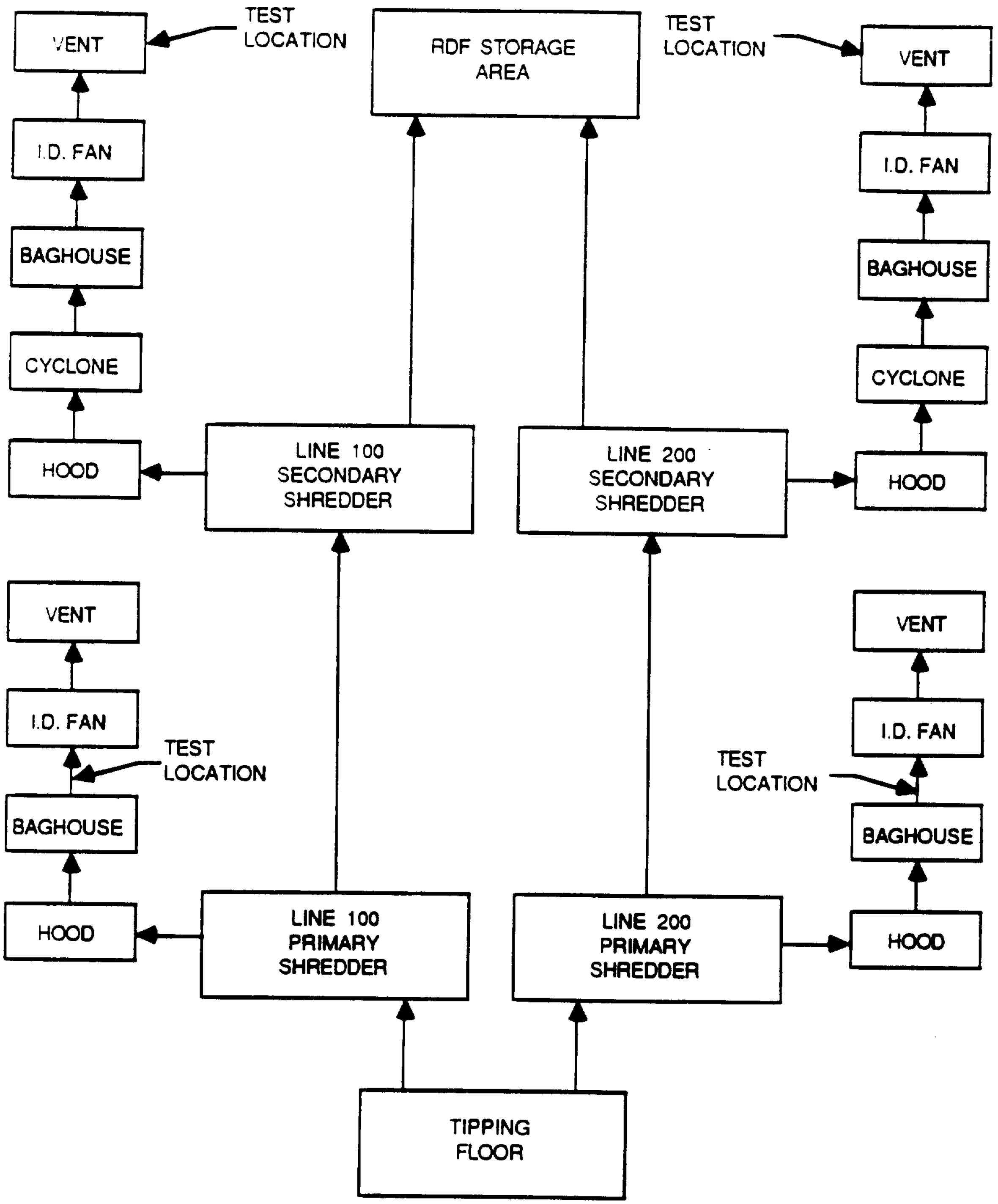


FIGURE 3-2. PROCESS LINE NOS. 100 AND 200 AIR FLOW SCHEMATIC.

The RDF HHV of 5,066 Btu/lb was determined by the sampling program conducted in February and March of 1990. The RDF feed rates provided in the summary of boiler operating parameters process data were calculated from the gross heat input, excess air, actual boiler thermal efficiency, and HHV from the sampling program. These RDF feed rates were used to calculate the lb/ton of RDF emission rates. The RDF HHV of 5,137 Btu/lb, which was used in the boiler compliance test report process data, was used as a replacement value until the RDF sampling program results were completed.

Temperature measurement verification for furnace temperature conducted by ABB Combustion Engineering, Inc., Performance Testing Services, Windsor, Connecticut, is included in Volume II.

3.3 Waste Processing Facility Operation During Testing. Process data supplied by Honolulu Resource Recovery Venture is provided in Volume II. The MSW infeed conveyors of Process Lines 100 and 200 are designated 101 and 201, respectively. The burden depth on the infeed conveyors is typically maintained at a level even with to 1 to 2 feet above the tipping floor. These burden depths are refered to as "0" to "+1" or "+2", etc. on the raw process data sheets. Since the infeed conveyor is approximately 3 feet below the tipping floor, a level feed means a burden depth of approximately 3 feet on the conveyor.

The second set of MSW conveyors following the infeed conveyors include the inclined leveling conveyors 102 and 202, respectively, and the third conveyors on each line are the primary shredder feed conveyors 103 and 203, respectively. These conveyors are normally operated at full speed, with feed control regulated by burden depth and speed control of 101 and 201. A burden depth of +1 feet on 101 and 201 and full speed of these conveyors is equivalent to the rated capacity of the WPF. If the burden depths are greater, the conveyor speed may be adjusted to control the feed rate to specified amounts.

SAMPLING AND ANALYTICAL PROCEDURES

4.1 **General.** All sampling and analytical procedures were those recommended by the United States Environmental Protection Agency and the Hawaii State Department of Health. This section provides brief descriptions of the sampling and analytical procedures. Detailed descriptions of the procedures are provided in Appendix D.

4.2 **Sampling Points.** For the methods incorporating multipoint sampling, the number and location of the sampling points were determined according to EPA Method 1. As shown in Figures 4-1 and 4-2, the RDF boiler's ID fan outlet duct cross sections were divided into 25 equal areas with five sampling points on each of five traverse axes. As shown in Figures 4-3 and 4-5, the primary shredder's baghouse outlet duct cross sections were set up for single-point sampling. As shown in Figures 4-4 and 4-6, the secondary shredder's baghouse outlet duct cross sections were divided into 24 equal areas with 12 sampling points on each of two traverse axes.

4.3 **Cyclonic Flow Checks.** A Type S pitot tube assembly, Magnehelic gauges, and a universal protractor (angle finder) were used to determine the flow angles at each of the sampling points. At each point, the pitot tube was positioned at a right angle to the air flow. The flow angles were determined by rotating the pitot tube until a null reading was obtained on the Magnehelic gauges. When the null reading was obtained, the angle of the pitot tube was recorded.

4.4 Volumetric Air Flow Rates

4.4.1 **Flue Gas Velocity.** EPA Method 2 was used to take the velocity measurements during the traverses of the duct and stack cross sections.

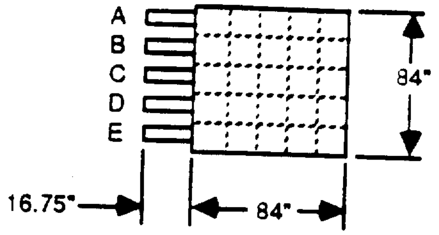
4.4.2 **Flue Gas Composition.** Multipoint, integrated flue gas samples were collected at the Unit Nos. 1 and 2 RDF boilers during each test set and analyzed using EPA Method 3. The results were used to determine the flue gas composition, molecular weight, excess air, or emissions correction factors for each of the concurrent runs conducted during the test sets.

At the Process Line Nos. 100 and 200 shredders, the flue gas composition and molecular weight were assumed to be that of ambient air.

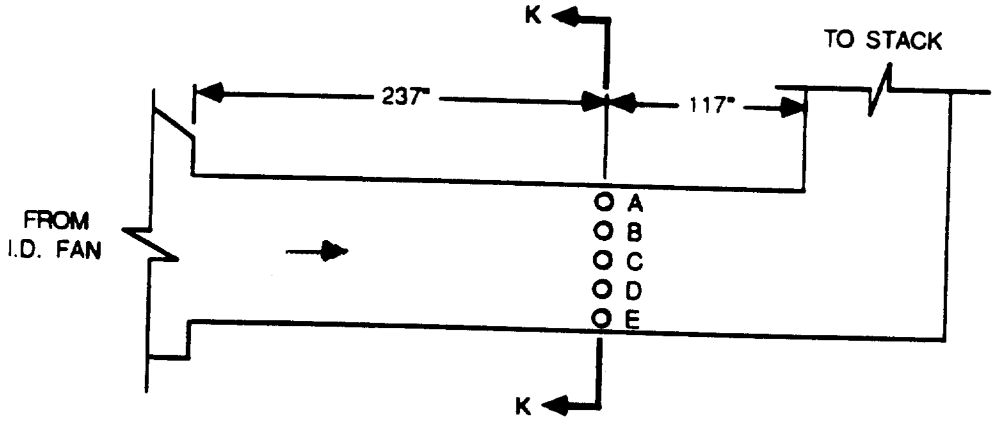
(continued on page 4-8)

TRAVERSE POINTS

5 AXES
5 POINTS / AXIS
25 TOTAL POINTS



SECTION K-K

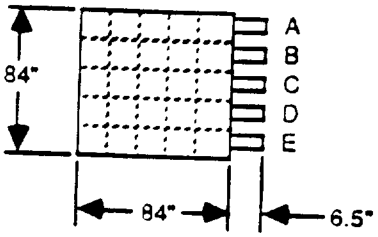


SIDE VIEW

FIGURE 4-1. UNIT NO. 1 RDF BOILER I.D. FAN OUTLET TEST LOCATION.

TRAVERSE POINTS

5 AXES
5 POINTS / AXIS
25 TOTAL POINTS



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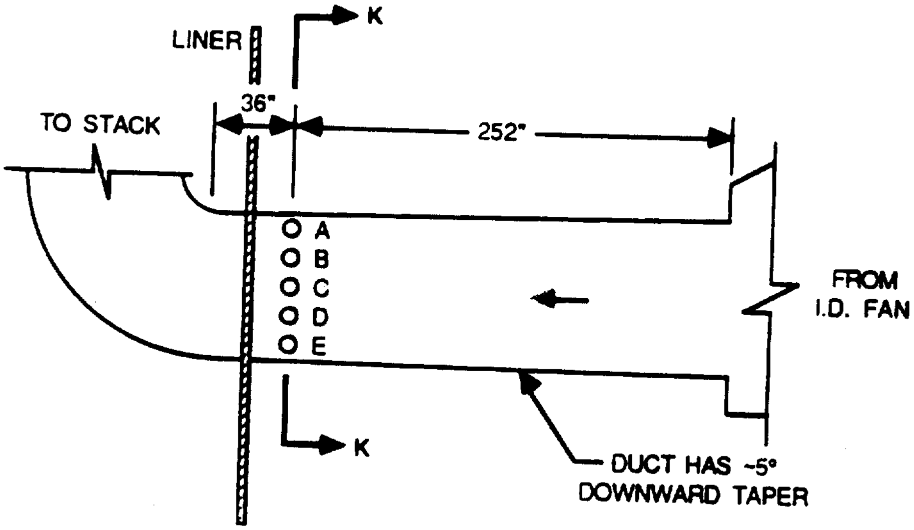
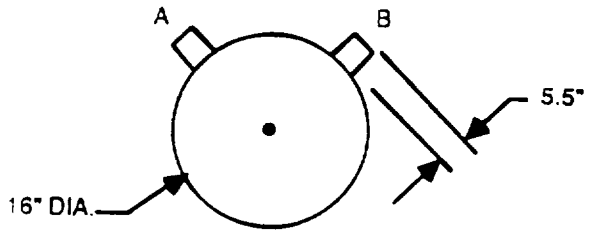


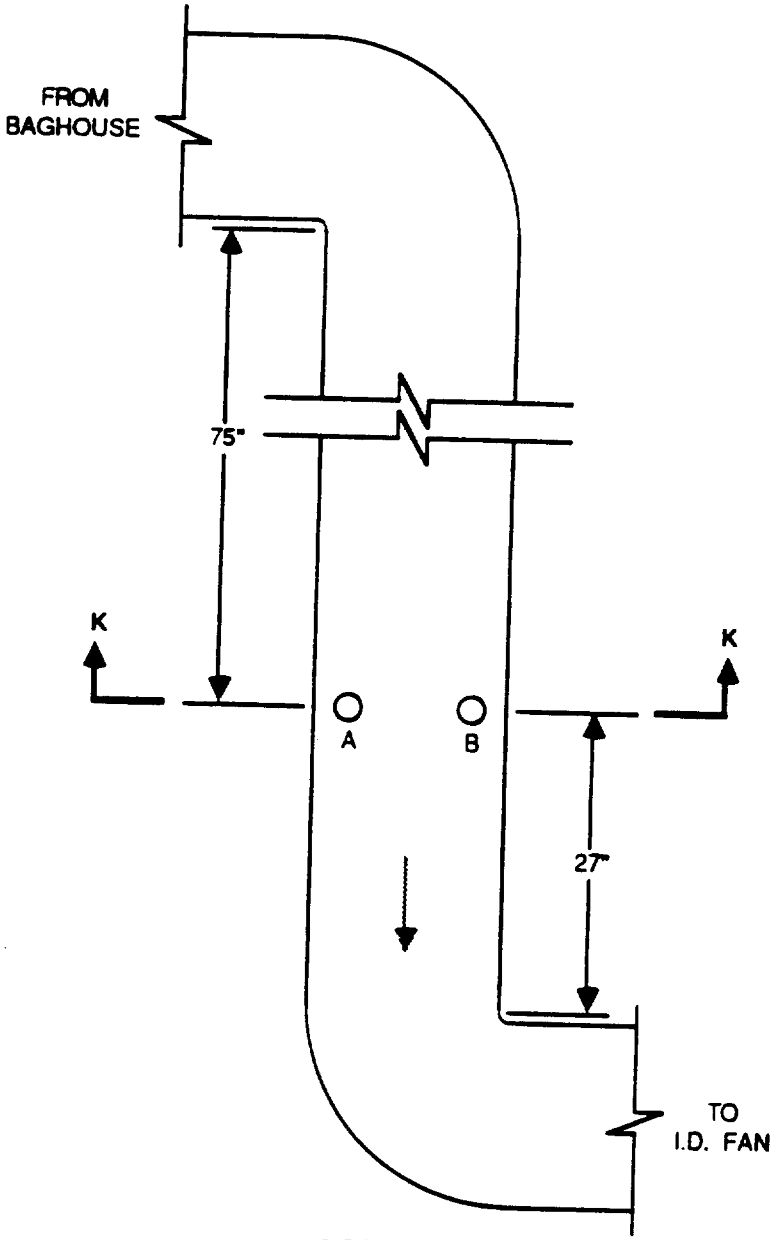
SIDE VIEW

FIGURE 4-2. UNIT NO. 2 RDF BOILER I.D. FAN OUTLET TEST LOCATION.

SINGLE-POINT SAMPLING IN PORT B

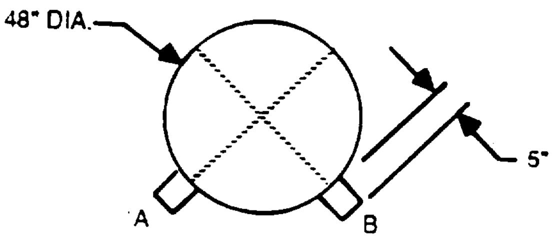


SECTION K-K



SIDE VIEW

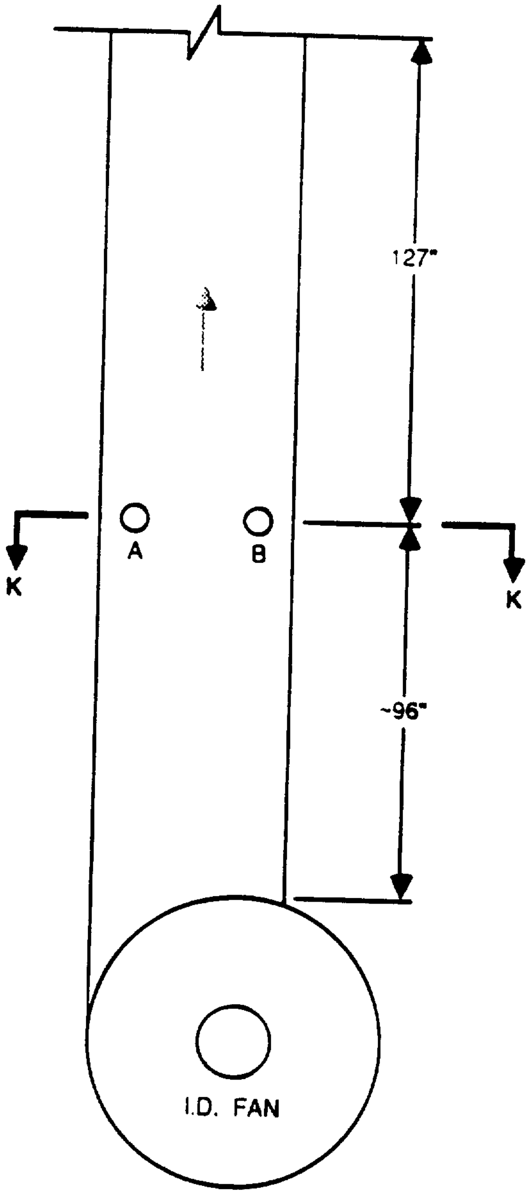
FIGURE 4-3. NO. 100 PRIMARY SHREDDER BAGHOUSE VENT TEST LOCATION.



TRAVERSE POINTS

2 AXES
12 POINTS / AXIS
24 TOTAL POINTS

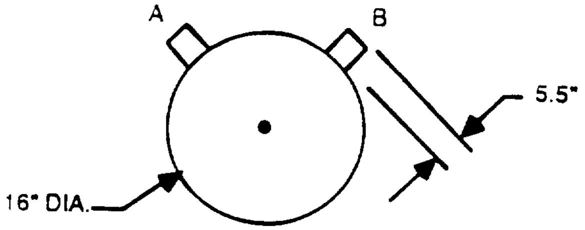
SECTION K-K



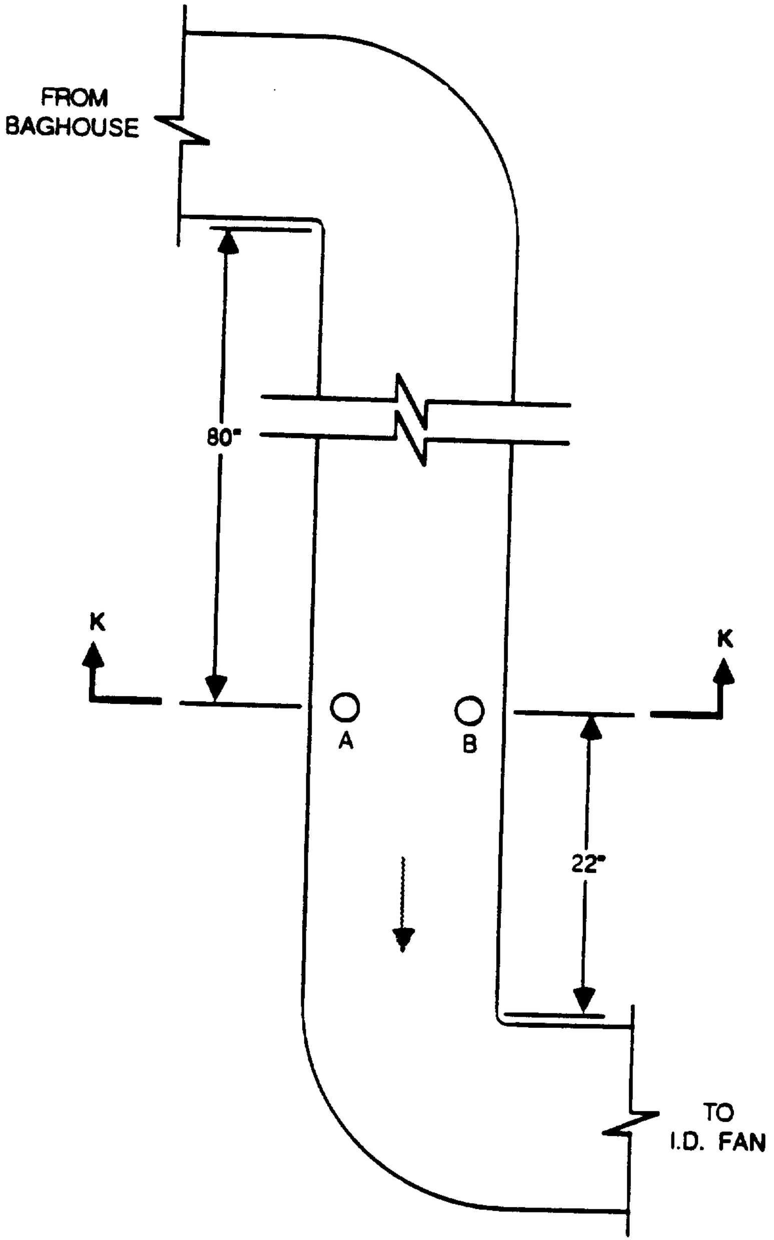
SIDE VIEW

FIGURE 4-4. NO. 100 SECONDARY SHREDDER BAGHOUSE VENT TEST LOCATION.

SINGLE-POINT SAMPLING IN PORT B



SECTION K-K

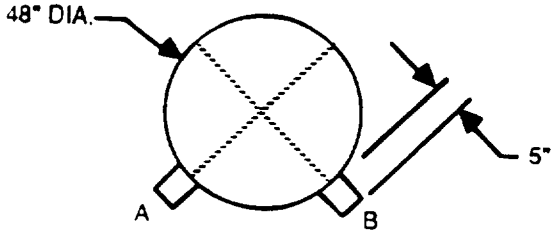


SIDE VIEW

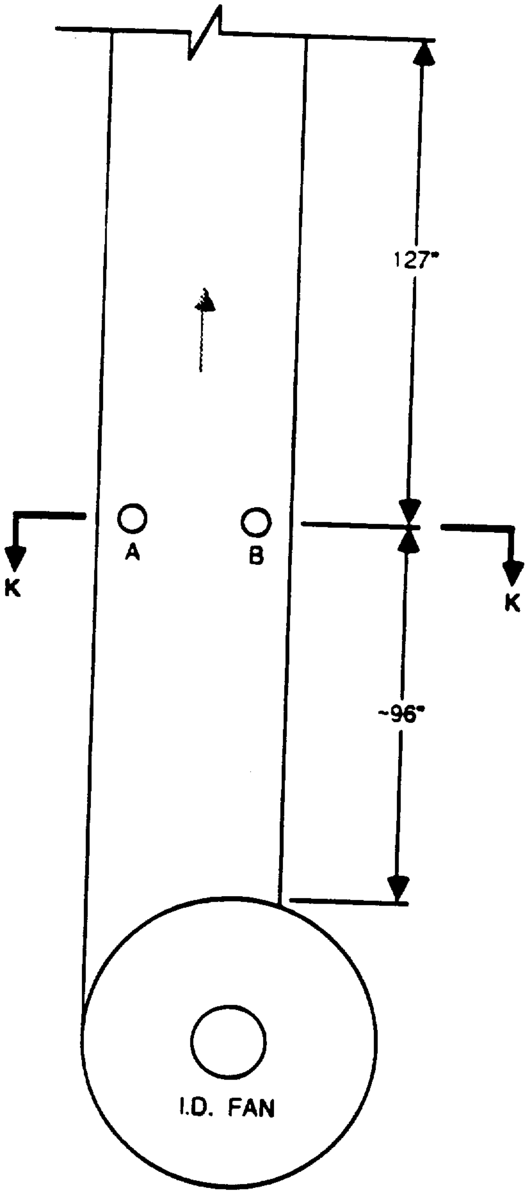
FIGURE 4-5. NO. 200 PRIMARY SHREDDER BAGHOUSE VENT TEST LOCATION.

TRAVERSE POINTS

2 AXES
12 POINTS / AXIS
24 TOTAL POINTS



SECTION K-K



SIDE VIEW

FIGURE 4-6. NO. 200 SECONDARY SHREDDER BAGHOUSE VENT TEST LOCATION.

4.4.3 Flue Gas Moisture Content. Moisture content was determined by analyzing the sampling train impinger reagents according to the procedures outlined in the respective EPA Methods.

4.5 Emissions Determinations. Table 4-1 outlines the sampling parameters used for the test program.

TABLE 4-1

TEST PROGRAM SAMPLING PARAMETERS

Sampling Method	-- Number Of -- Axes	Points	Total Points	Minutes Per Point	Total Minutes
EPA 3A, 6C, 7E, 10, 25A	1	1	1	NA	*
EPA 13B	5	5	25	2.5	62.5
EPA 5					
Primary Shredders	1	1	1	60	60
Secondary Shredders	2	12	24	2.5	60
EPA MMTL	5	5	25	5.0	125
Modified 5	5	5	25	7.5	187.5

* Simultaneous with the Modified 5 runs.

4.5.1 Carbon Monoxide, Nitrogen Oxides, Sulfur Dioxide, and Volatile Organic Compounds. Continuous emissions monitoring (CEM) was conducted for carbon monoxide (CO), nitrogen oxides (NO_x), sulfur dioxide (SO_2), volatile organic compounds (VOC) emissions and carbon dioxide (CO_2) and oxygen (O_2) concentrations. Sampling and analytical procedures for CO, NO_x, SO_2, VOC, and CO_2/O_2 were in accordance with EPA Methods 10, 7E, 6C, 25A, 3A, respectively.

The extractive analyzers require that the effluent gas sample be conditioned to eliminate any possible interference (i.e., water vapor and particulate matter) before being transported and injected into each analyzer. All components of the sampling system which contact the sample are constructed of Type 316 stainless steel or Teflon. The outputs from the analyzers were connected to a computerized data acquisition system (DAS). The DAS integrated the real-time measurements and provided printouts of 1-minute, 15-minute, and hourly averaged emissions.

The Methods 10, 7E, 6C, and 3A sample collection system consists of: a heated probe with an in-stack glass wool particulate filter, heated sample lines, a moisture removal trap, an out-of-stack secondary particulate filter, and a sample pump. The Method 25A sample collection system is the same except it has no moisture removal trap or secondary particulate filter. All samples are routed through a distribution manifold board for delivery to the analyzers. The configuration of the sampling system allows for the injection of calibration gases either directly to the analyzers or through the sampling system. A Thomas Model 2107CA 18-TFE pump is used to move the effluent sample through the system. The operation of each analyzer and the DAS is described below.

ACS FuJi 3300 CO/CO2 Analyzer. This nondispersive infrared analyzer automatically and continuously monitors the CO and CO_2 concentrations. The theory of operation is based on the principle that both gases have a unique absorption line spectrum in the infrared region. The instrument consists of an infrared light source, a chopper, a measuring cell, and a two-chamber, sealed detector.

The infrared light beam emitted by the source passes through the measuring cell which is filled with a continuously flowing gas sample. Before reaching the front chamber of the detector, the light beam is partially absorbed or attenuated by the gas species of interest in the cell. Both the front and rear chambers of the detector are filled with a reference gas. The difference in the amount of light absorbed between the front and rear chambers is dependent on the concentration of the gas species of interest within the measuring cell and creates a pressure differential between the two chambers. This pressure differential is then observed as gas flow by the micro-flow sensor located in a channel communicating the two chambers. The resulting AC signal from the sensor is rectified, amplified, and linearized into a DC voltage signal for output.

Teledyne Model 320P-4 O2 Analyzer. This analyzer was designed specifically to measure O_2 in flue gas streams. It utilizes a patented micro-fuel cell which consumes O_2 from the atmosphere surrounding the measuring probe. The consumption of O_2 generates a proportional electrical current which is amplified and used to drive a built-in front panel meter with a scale of 0 to 25%. The analyzer incorporates its own integral pump and power system.

Maihak UNOR SO2 Analyzer. This nondispersive infrared analyzer automatically and continuously monitors the SO_2 concentration. The theory of operation is based on the principle that SO_2 has a unique absorption line spectrum in the infrared region. The instrument consists of an infrared light source, a chopper, a reference and measurement cell, two absorption chambers, and a two-chamber, sealed detector. The infrared light beam passes alternately through the reference cell and the measurement cell, which is filled with a continuously flowing gas sample. In the measurement cell, the light beam is partially absorbed or attenuated by the gas species of interest before reaching the front chamber of the detector. Both the front and rear chambers of the detector are filled with a reference gas. The greater depth of the rear chamber allows absorption of the weaker edges of the spectra, which increases the instrument's sensitivity. The difference in the amount of light absorbed between the front and rear chambers is dependent on the concentration of the gas species of interest within the measurement cell; a pressure differential is thus created between the two chambers. This pressure differential is detected by a differential-type diaphragm capacitor located in a channel connecting the two chambers. The variations in capacitance are amplified and converted into a concentration-proportional DC voltage signal for output.

Beckman Model 951A NO/NOx Analyzer. The analyzer automatically and continuously determines the concentration of NO or NO_x in a flowing gas mixture. The analytical technique is chemiluminescence. The sample is routed through a converter where the NO_2 is dissociated to form NO. The sample is then passed through a reaction chamber where the NO is quantitatively converted to NO_2 by gas phase oxidation with molecular ozone produced within the analyzer. In this reaction, the NO_2 molecules are elevated to an electronically excited state and immediately reverted to a nonexcited ground state. This reversion is accompanied by emission of photons, which impinge on a photomultiplier detector and generate a low level DC current. The current is then amplified and used to drive a front panel meter and a data recorder. The NO_x concentration seen by the instrument includes the contributions of both the NO in the sample and the NO resulting from the dissociation of the NO_2 in the sample.

Ratfisch Model RS-55 VOC Analyzer. This analyzer continuously monitors VOC concentrations of a flowing gas mixture. The theory of operation is based on the principle of flame ionization detection. In the flame ionization detector, hydrogen is mixed with sample gas and is burned in a small jet. The ionization current in the hydrogen flame is measured. In a pure hydrogen flame, very few ions are produced, but as an organic sample component or hydrocarbon is burned in the flame, the ion current is greatly increased. The current provides a quantitative measure of the amount of hydrocarbons in the flame. The current is converted to a voltage output and is continuously monitored by the DAS. The hydrogen flame ionization detector is extremely sensitive and is capable of detecting hydrocarbon levels in the low parts per million range and is insensitive to inorganic gases such as nitrogen, carbon dioxide, and water vapor.

Data Acquisition System. The DAS uses a Compaq portable computer with a 20MB hard disk and an internal 12-bit analog-to-digital converter with a 16 channel multiplexer. In addition to providing an instantaneous display of the analyzer responses, the DAS compiles the analyzer data collected once every second and averages them, calculates emission rates, and documents analyzer calibrations. The test data and calibrations are stored on the hard disk and printed using an Epson dot matrix printer.

4.5.2 Hydrogen Fluoride. The sampling train outlined in EPA Method 13B was modified and used to capture the hydrogen fluoride (HF) emissions.

Sample Collection. Stainless steel nozzles and borosilicate glass probes were used. A Whatman #541 paper filter (supported by a Teflon frit) was installed in a heated compartment between the probe and first impinger. The first two impingers each contained 100 mL of 0.1 N NaOH instead of DI water, the third was empty, the fourth contained preweighed silica gel. Sampling was conducted isokinetically and the sampling rate was not allowed to exceed 1.00 cubic foot per minute.

Sample Recovery. The filter was removed from the filter holder and placed in a glass jar. The NaOH reagent was returned to the original tared quart jar, weighed, and the weight recorded on the jar lid. The nozzle, probe, filter holder, and impingers were rinsed three times with DI water into the quart jar containing the NaOH reagent. The silica gel was placed in the original container, weighed, and the weight recorded on the container lid.

Sample Analysis. Prior to analysis, the filter was added to the quart jar containing the NaOH reagent and sample train component rinsings. An aliquot was analyzed for HF content using the specific ion electrode method.

4.5.3 Particulate. At the primary and secondary shredders, the sampling train outlined in EPA Method 5 was used to capture the particulate emissions.

Sample Collection. Stainless steel nozzles and borosilicate glass probes were used. A Whatman EPM2000 glass mat filter was installed in a heated compartment between the probe and first impinger. The first two impingers each contained 100 mL of DI water, the third was empty, the fourth contained preweighed silica gel. Sampling was conducted isokinetically.

Sample Recovery. The filter was removed from the filter holder and placed in a glass jar. The DI water reagent was returned to the original tared quart jar, weighed, and the weight recorded on the jar lid. The nozzle, probe, and filter holder, were rinsed three times with acetone into a pint jar. The silica gel was placed in the original container, weighed, and the weight recorded on the container lid.

Sample Analysis. The filter and acetone rinsings were analyzed for particulate as outlined in EPA Method 5.

4.5.4 Particulate and Metals. At the RDF boilers, a combined EPA Method 5 and EPA Research & Development Multimetals sampling train was used to capture the particulate and metals emissions.

Sample Collection. In order to avoid possible contamination of the samples, borosilicate glass nozzles and probe liners were used and all sample train glassware was precleaned by rinsing with 10% HNO_3. A low metal content Pallflex 2500QAT-UP quartz filter (supported by a Teflon frit) was installed in a heated compartment between the probe and the first impinger. The first two impingers each contained 100 mL of 5% HNO_3/10% H_2O_2, the third was empty, the fourth contained 100 mL of 4% $KMnO_4$/10% H_2SO_4, and the fifth contained preweighed silica gel. Sampling was conducted isokinetically.

Sample Recovery. Using a Teflon spatula and Teflon coated tweezers, the filter was removed and placed in a glass jar. The reagents were returned to the original tared quart jars, weighed, and the weights were recorded on the jar lids. The silica gel was placed in the original container, weighed, and the weight recorded on the container lid.

All fronthalf components of the sampling train including the nozzle, probe, and filter holder were rinsed with acetone into a pint jar followed by rinsing with 0.1N HNO_3 into a second pint jar. A Teflon probe brush was used for cleaning of the probe.

The backhalf of the filter holder and the first, second, and third impingers were rinsed with 0.1N HNO_3 into the quart jar containing the HNO_3/H_2O_2 reagent. The fourth impinger was rinsed first with acidified $KMnO_4$ followed by 8N HCl into the quart jar containing the $KMnO_4/H_2SO_4$ reagent.

Sample Analyses. EPA Method 5 analytical procedures were used to analyze the filter and acetone rinsings for particulate.

For the metals analyses, the fronthalf acetone and HNO_3 rinses were evaporated to near dryness in a Teflon beaker. The filter, loose particulate, 3 mL of concentrated HNO3, and 5 mL of concentrated HF were added to the beaker. The sample was digested on a hotplate until brown fumes were evident, indicating the destruction of organic matter. After the addition of concentrated HNO3, the HNO3/H2O2 reagent and impinger rinses were evaporated to near dryness in a Teflon beaker on a hotplate. After cooling, 3 mL of concentrated HNO3 and 5 mL of concentrated HF were added to the beaker and the sample was fumed on a hotplate to destroy organic residue. The prepared filter and HNO3/H2O2 reagent samples were combined, brought to a final volume of 100 mL with 10% HNO_3, and analyzed for all metals with a Perkin Elmer 3030 atomic absorption analyzer using the appropriate SW-846 methods. Cold vapor atomic absorption techniques were used to analyze the $KMnO_4/H_2SO_4$ reagent for mercury.

4.5.5 PCDD/PCDF. A Modified Method 5 sampling train was used to determine the PCDD/PCDF emissions. Sampling and analysis were performed according to the procedures outlined in SW-846 Method 0010. Instead of hexane, methylene chloride was used as the final rinse solvent. The change from hexane to methylene chloride was made to improve recovery of higher molecular weight PCDD/PCDF. Sample train components were prepared as follows:

Filter. Prior to use in the field, the glass fiber filters (EPM2000) were precleaned and checked for contamination. A total of up to 50 filters from the same lot were extracted simultaneously with methylene chloride in a Soxhlet extractor for a period of 24 hours. Triangle Laboratories, Inc. analyzed the filter extract by gas chromatography/mass spectrometry to verify that the filters were free of contamination. The precleaned filters were used in the field for sample collection. To prevent contamination, the filters were placed in a precleaned petri dish and sealed with military specification Teflon tape.

XAD-2 Resin. Precleaned XAD-2 resin was purchased from Supelco Chromatography Products. Care was taken to ensure that the resin was kept at temperatures below 120°F before and after sample collection to prevent resin decomposition. The sorbent tube was charged with 20 to 30 grams of the precleaned resin. Prior to field use, the resin was spiked with PCDD/PCDF surrogates. The period of time between charging the sorbent tube and use in the field was minimized and was not allowed to exceed 14 days.

Glassware. All glass components of the sample train, including the sorbent tube, were precleaned prior to sampling according to the procedures listed in Table 4-2. Cleaned glassware was sealed with precleaned foil until sample train assembly. Assembly of the sample trains was conducted in the laboratory. Following sample recovery, the glassware was reused at the same sampling location.

TABLE 4-2

MM5 GLASSWARE PRECLEANING PROCEDURES

1. Soaked in hot soapy water (Alconox) 50°C or higher.
2. Rinsed three times with tap H_2O.
3. Rinsed three times with DI H_2O.
4. Rinsed three times with pesticide grade acetone.
5. Rinsed three times with pesticide grade methylene chloride.
6. Baked at 450°F for two hours.
7. Capped with methylene chloride rinsed aluminum foil.

4.5.5.1 Sample Collection. Flue gas was pulled from the stack through a glass nozzle and a glass probe. Particulate matter was removed from the gas stream by means of a glass fiber filter housed in a glass holder maintained at 248 ± 25°F. The filter holder contained a Teflon frit to support the filter. The gas passed through a condenser and into a sorbent trap for removal of organic constituents. A chilled impinger train was used to remove water from the flue gas, and a dry gas meter was used to measure the sample gas flow. Sampling was conducted isokinetically.

4.5.5.2 Sample Recovery. Recovery of the samples was conducted in the laboratory located at the plant site. Access to this area was limited to those individuals involved in the sample recovery process.

The solvents used for rinsing were pesticide grade acetone and methylene chloride. Each sample train component was rinsed first with acetone followed by methylene chloride. Acetone and methylene chloride rinses were combined in the same containers. All sample containers containing water were extracted for analysis by Triangle Laboratories, Inc. within 7 to 14 days after sample collection.

4.5.5.3 Sample Analysis. All analyses were performed using accepted laboratory procedures in accordance with SW-846 Method 8290E.

4.6 Equipment Calibration. Pertinent calibration data are provided in Appendix C.

4.7 Analytical Laboratories. Table 4-3 lists the laboratories used for this test program along with the analytical responsibilities.

TABLE 4-3

LABORATORIES ANALYTICAL RESPONSIBILITIES

Name of Laboratory	Analyses Performed
Entropy	Carbon Monoxide Hydrogen Fluoride Nitrogen Oxides Particulate Sulfur Dioxide Volatile Organic Compounds
Triangle Labs	PCDD/PCDF
Oxford Labs	Metals

QUALITY ASSURANCE/QUALITY CONTROL

5.1 **General.** Entropy Environmentalists Inc. (EEI) is committed to the continued implementation of a Quality Assurance Program to assure the quality of sampling and analytical procedures of environmental measurement data. The Quality Assurance measures taken during this test project equals or exceeds the minimum QA/QC recommendations as set forth by the U.S. Environmental Protection Agency (EPA) for a particular method.

The following sections outline the QA program implemented by EEI to justify the validity of the test procedures. The QA system for this test program addresses the following areas:

- Project Organization
- Preventive Maintenance & Equipment Calibration
- QA Sample Processing
- Analytical Instrument Calibration
- Blanks and Spiked Samples
- Internal/External System Checks
- Data Reduction & Validation
- Continuous Emissions Monitoring
- QA/QC Summary

5.2 Project Organization. The organization of the project team, including QA functions, are shown in Figure 5-1. Note that the QA structure is independent of the organizational groups which generate measurement data during the test program.

5.3 **Preventive Maintenance and Equipment Calibration.** An effective preventive maintenance program decreases downtime and thus increases data completeness and quality. Pretest and posttest equipment calibrations are conducted in a manner and at a frequency which meets or exceeds U.S. EPA specifications.

Each item transported to the field is inspected to detect equipment problems which may originate during periods of storage. All equipment returning from the field are cleaned, repaired, reconditioned, and recalibrated as necessary. Routine maintenance on equipment (dry gas meters, pumps, magnehelics/manometers, pitot tubes, and nozzles) is carried out periodically for leaks, corrosion, dents, or any other damage. Table 5-1 shows the activities for equipment calibration.

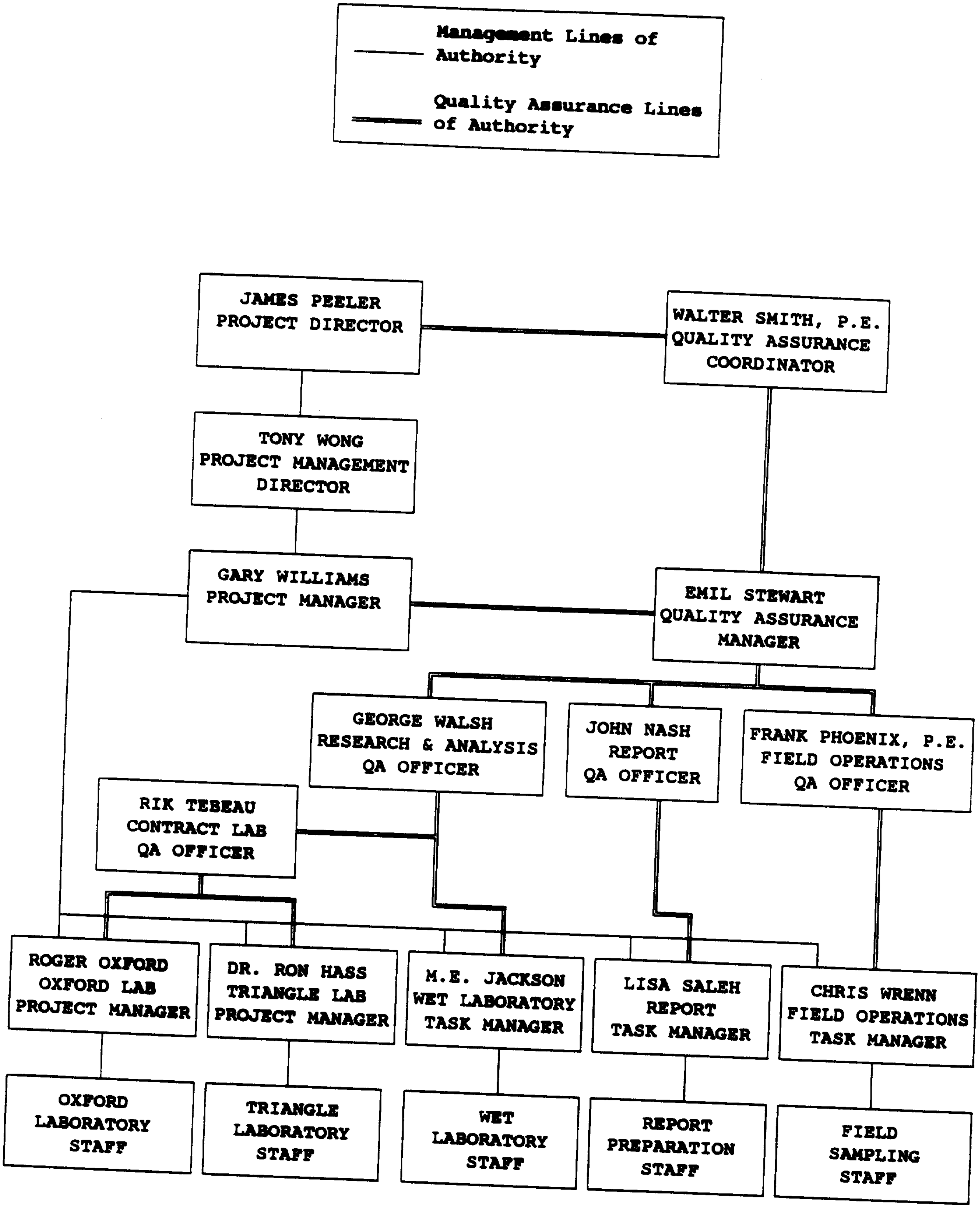


FIGURE 5-1 PROJECT ORGANIZATION

TABLE 5-1

IN-HOUSE EQUIPMENT CALIBRATION

Apparatus	Calibration Method And Frequency	Specifications	Corrective Action
Type S Pitot Tubes	Standards contained in EPA Method 2.	Coefficient of 0.84 ± 0.02	Refurbish or recalibrate.
	Visual inspection prior to shipment to test site and again prior to each day of testing.		
Manometers	Leak checked before and after each field use.		Repair or replace
Magnehelic Gauges	Initially calibrated over full range.	0-10" water column	
	After each field use, checked against inclined manometer at average settings encountered during testing.	Within ± 5%	Repair and Recalibrate.
Thermometers -Impinger -Dry Gas Meter -Filter Box	After purchase and prior to each field use, using ASTM mercury-in-glass thermometer.	Imp = ± 2°F DGM = ± 5.4°F FB = ± 5.4°F	Adjust, determine correction factor, or reject.
Thermocouple/ Potentiometer	After purchase. 3-point (ice bath, boiling water, and hot oil) using ASTM mercury-in-glass thermometer.	± 1.5% of absolute temperature.	Adjust, determine correction factor, or reject.
	Before and after each field use, compared to ASTM mercury-in-glass thermometer at ambient conditions.		
Dry Gas Meter and Orifice	Full calibration (every 6 months) over wide range of orifice settings to obtain calibration factor.	DGM = ± 0.02 from avg.coeff. for each run. Ori. = ± 0.15" H20 over delta H range of 0.4" to 4.0".	Adjust or replace
	10-minute quick calibration before sending to test site and again prior to each day of field use.	± 3% of full. ± 5% of full.	Use if no backup. Do not use.
	Posttest (at average delta H and highest vacuum) to determine if meter gamma has changed.	± 5% of full calibration. Factor (initial or recalibration) that yields the lowest sample volume for the testing is used.	Meter calibration, meter coefficient
Dry Gas Meter Transfer Standard	Annual calibrations conducted in triplicate using EPA wet test meter. Calibrations conducted at 7 flow rates from 0.25 to 1.40 cfm.	± 2% of average factor for each calibration run.	Adjust and recalibrate.
Barometer	Before and after each field use against an aneroid barometer.	± 0.1" mercury.	Adjust to agree.
	Reference barometer adjusted for elevation differences.		
Probe Nozzle	Average of 5 I.D. measurements using a micrometer. Visual inspection before and after each field use.	Difference between high and low measurement < 0.004"	Repair and recalibrate.

5.4 Sample Processing. Entropy employs systems which ensure the integrity of an environmental sample from the time of acquisition, through analysis, and ultimately to proper disposal. These systems are necessary to allow valid conclusions to be drawn from analytical results separated in time and space from the sampling operation. In addition, these systems recognize that samples are occasionally of value even after analytical results have been reported.

Samples are collected, transported, and stored in clean containers which are constructed of materials inert to the analytical matrix. Containers are used which allow air tight seals. When necessary, containers are employed which prevent photochemical reactions. All sample containers are labeled with the following information:

- » Unique source identifier
- » Sample run identifier
- » Analyte identifier
- » Sample matrix identifier
- » Sample analyst identifier

Additional information relating to the sample is recorded on the data sheet for the sampling run that afforded the subject sample. Accordingly, the sampling data sheet contains all the information listed above, plus the date and time the sample was acquired and supplemental information such as observations pertinent to the quality of the sample. For condensed samples, e.g., samples in liquid media, the sample levels are marked on the outside of the container; this mark is used to indicate sample loss, and as such, may serve as a reference in adjusting results accordingly.

For transport from the field to the laboratory, samples are stored in locked boxes and secured in a fashion which minimizes movement and thus prevents breakage of containers. Boxes used for transporting glass containers are packed with foam.

Samples remain in the custody of the sampler from acquisition until conveyance to the laboratory analyst, if the analyst is different from the sampler. The sampler initiates a sample chain of custody record at the time of sample collection in the field. All custody transfers are documented on the chain of custody form, which remains with the sample at all times.

Analytical data are identified in a manner identical to that of the sampling data. Accordingly, all data generated from the analysis of samples are documented with the following information:

- Source identifier
- Sample run identifier
- Analyte identifier
- Sample matrix identifier
- Analyst identifier
- Analysis date

Portions of samples remaining after analysis are returned to their original sample containers. These samples are stored in designated storage areas until their destruction is authorized.

5.5 Instrument Calibration. Instrument calibration is one of the most important functions in generating precise and accurate quality data. A listing of major in-house instrumentation and the corresponding Quality Assurance program is given in Table 5-2.

All of the contract laboratories involved in the analytical testing for the test program maintained rigorous QA programs for instrument calibration.

5.6 Blanks and Spikes. Field blanks, method blanks, trip blanks, lab-proof blanks and filter blanks are obtained, digested and analyzed when applicable. The blanks reflect the background contamination obtained from the various sources during the sampling and analysis. Thus, data adjustment or correction can be made accordingly.

In most cases, it is not necessary to digest and analyze the method blanks, reagent blanks or the lab-proof blanks unless the field blank shows a high level of contamination. If a high level of contamination is present, it is imperative to individually analyze the above blanks to help determine the cause of contamination.

Spiked samples are used to check on the performance of a routine analysis or the recovery efficiency of a method. During spiking, a known amount of stock solutions of the substance of interest is added to the sample prior to sample extraction, digestion, and analysis.

TABLE 5-2

IN-HOUSE INSTRUMENT CALIBRATION

Apparatus	Calibration Method And Frequency	Specifications	Corrective Action
Analytical & Top Loading Balance	Daily and monthly checks with a series of class S weights. Balance serviced annually by a qualified service representative and checked with a series of NBS weights.	± 1 mg of class S weights.	Adjust or repair.
Gas Chromatograph	3-point calibration curve at the expected range. Duplicate injection of the sample until ± 5% variation is achieved. Calibration repeated at the end of each test series.		
HPLC/Ion Chromatograph	Calibrations conducted at the beginning, after the first injection, and after the second injection.		
Fisher Accument 925 pH/Selective Ion Meter	5-point calibration prior to analyzing the samples for the specific ions.		

5.7 Internal/External System Audit Checks. System and performance audits are routine elements of all Entropy QA/QC programs.

Internal Systems Audit: The following sampling equipment checks were conducted prior to sample collection.

- All sampling equipment was thoroughly checked to ensure clean and operable components.
- Equipment was inspected for possible damage from shipment.
- The oil manometers or Magnehelic gauges were leveled and zeroed.
- The temperature measurement systems were checked for damage and operability by measuring the ambient temperature.

Performance Audits: Performance audits of the laboratory are conducted prior to the processing of any compliance samples for analysis. Audit materials typically include samples available from the EPA prior to new source testing. Also, samples of known concentration are specially prepared in-house or obtained from the EPA for Internal QA checks.

External Systems Audits: Entropy is subject to a system audit each time a test is conducted for any Air Pollution Control agency. This procedure entails an EPA observer on-site to do qualitative evaluation of performance to demonstrate compliance with the applicable regulations.

5.8 Data Reduction and Validation. The test team leader is responsible for reviewing and validating data as they are acquired. Each team leader has extensive knowledge of sampling methodology and the characteristic of the process being measured and is capable of evaluating the accuracy, representativeness, and completeness of raw data on-site, where action to replace inadequate data can be taken immediately.

Data obtained during calibrations and test runs are recorded on standardized forms which are checked twice for completeness and accuracy by the QA Director. Data reduction and consistency are achieved by using the standardized forms and using Entropy's in-house computer facilities.

5.9 QA/QC Summary. The following sections outline the most significant QA parameters used during this test program. All chemicals used were American Chemical Society (ACS), High Purity Liquid Chromatography (HPLC), or pesticide grade. The distilled, deionized water utilized met or exceeded the American Society for Testing and Materials (ASTM) specifications for Type-I reagent water. Refer to Table 5-3 for a list of blanks prepared and analyzed for the various sampling trains.

TABLE 5-3
FIELD, REAGENT, FILTER, AND TRIP BLANKS

Method	Field Blank	Reagent Blank	Filter Blank	Trip Blank
EPA 13B	Yes	Yes	Yes*	No
EPA 5&MMTL	Yes	Yes	Yes	No
Modified 5	Yes	Yes*	Yes*	Yes*

* These blanks were collected but not analyzed.

<u>EPA Method 13B</u>: Fluoride calibration curves were generated prior to sample analysis. A reagent blank was analyzed with results of < 21.1 µg of fluorides detected. Two field blanks (one per RDF boiler) were collected and analyzed with results of < 10.5 and 19.1 µg of HF detected for Unit Nos. 1 and 2, respectively. Samples 2-M13B-1 and 2-M13B-3 were spiked and analyzed for HF, with spike recoveries of 94% and 98%, respectively.

<u>EPA M5&MMTL</u>: Two field blanks (one per RDF boiler), two reagent blanks, and a filter blank were prepared for metals analysis. A sample was spiked and analyzed for metals. Refer to Table 5-4 for the blanks analytical results and spike recoveries.

Duplicate metals analyses were conducted on run 1-MMTL-2 and the average of these results were used to calculate the emissions. See Table 5-5 for the duplicate analyses results.

<u>Modified Method 5</u>: The surrogate, alterante, and internal standards were added prior to analysis. PCDD/PCDF surrogate and alternate standards recoveries are presented in Table 5-6 and PCDD/PCDF internal standards recoveries are presented in Table 5-7.

<u>EPA Method 25A</u>: The 3-point linearity checks were all within 3% of the known cylinder gas concentrations.

<u>EPA Methods 3A, 6C, 7E, and 10</u>: 3-point analyzer calibration error checks were conducted before initiating any testing. Zero and upscale calibration drift checks were conducted for each run. The calibration error, percent of span drift, and percent of span system calibration checks met the ±2%, ±3%, and ± 5%, respectively.

TABLE 5-4

MMTL BLANKS ANALYTICAL RESULTS AND SPIKE RECOVERY

	------------- Blanks Micrograms -------------					
	-- Field Blank --					
Unit No. 1	Unit 1	Unit 2	HNO_3/ H_2O_2 Reagent	$KMnO_4$ Reagent	Filter Blank	Spike Recovery, %
Arsenic	1.3	2.60	< 0.500	- -	< 0.500	92.0
Beryllium	< 0.500	< 0.500	< 0.500	- -	< 0.500	97.6
Cadmium	0.520	1.31	< 0.200	- -	< 0.200	89.3
Chromium	< 3.33	3.81	< 0.500	- -	1.67	100.3
Lead	3.20	5.40	< 3.00	- -	< 3.00	90.0
Mercury	< 0.300	< 0.300	< 0.300	< 0.300	< 0.300	98.0
Nickel	< 5.00	3.83	< 5.00	- -	< 5.00	91.9

TABLE 5-5

MMTL DUPLICATE ANALYSES RESULTS

	-- Micrograms Catch --		
	First Analysis	Duplicate Analysis	Duplicate Relative % Difference
Filter Plus HNO_3/H_2O_2 Reagent			
Arsenic	5.60	6.40	13.3
Beryllium	< 0.500	< 0.500	*
Cadmium	6.37	5.95	6.8
Chromium	5.83	5.33	9.0
Lead	72.0	79.0	9.3
Mercury	1.18	1.18	0.0
Nickel	< 5.00	< 5.00	*
$KMnO_4/H_2SO_4$ Reagent			
Mercury	3.11	3.11	0.0

* Not applicable for results below the detection limit.

TABLE 5-6

PCDD/PCDF SURROGATES AND ALTERNATE STANDARDS RECOVERY

	Recovery, %						
	Surrogate					Alternate	
Sample ID	37CL-TCDD	13C12-PeCDF 234	13C12-HxCDF 478	13C12-HxCDD 478	13C12-HpCDF 789	13C12-HxCDF 789	13C12-HxCDF 234
1-MM5-1	119	111	84.8	80.5	118	86.8	93.2
1-MM5-1-CF	87.8	- -	- -	- -	- -	- -	- -
1-MM5-2	97.0	103	95.1	89.0	102	45.1	47.6
1-MM5-2-CF	93.1	- -	- -	- -	- -	- -	- -
1-MM5-3	98.4	107	98.1	83.4	106	84.8	91.1
1-MM5-3-CF	76.1	- -	- -	- -	- -	- -	- -
2-MM5-1	102	105	88.9	81.1	119	64.8	70.1
2-MM5-1-CF	80.1	- -	- -	- -	- -	- -	- -
2-MM5-2	105	111	84.5	76.6	105	84.9	104
2-MM5-2-CF	83.2	- -	- -	- -	- -	- -	- -
2-MM5-3	102	107	86.5	80.4	103	87.4	91.4
2-MM5-3-CF	95.0	- -	- -	- -	- -	- -	- -
1-MM5-FB	105	112	85.8	82.5	126	80.5	85.7
2-MM5-FB	106	108	86.0	79.8	112	91.1	92.3
TLI Blank	82.3	109	90.9	73.4	108	85.3	89.3
TLI Blank-CF	93.6	- -	- -	- -	- -	- -	- -

CF = Confirmation Analysis

TABLE 5-7

PCDD/PCDF INTERNAL STANDARDS RECOVERIES

Sample ID	Recovery, %								
	13C12-2378-TCDF	13C12-2378-TCDD	13C12-PeCDF 123	13C12-PeCDD 123	13C12-HxCDF 678	13C12-HxCDD 678	13C12-HpCDF 678	13C12-HpCDD 678	13C12 OCDD
1-MM5-1	79.1	67.1	107	117	91.8	110	94.3	121	113
1-MM5-1-CF	94.8	83.6	- -	- -	- -	- -	- -	- -	- -
1-MM5-2	42.6	49.9	46.2	50.0	47.7	61.6	42.0	53.4	17.1
1-MM5-2-CF	104	91.2	- -	- -	- -	- -	- -	- -	- -
1-MM5-3	67.6	63.0	93.9	102	94.0	103	81.8	83.7	60.1
1-MM5-3-CF	83.7	74.1	- -	- -	- -	- -	- -	- -	- -
2-MM5-1	67.9	69.5	85.6	96.7	79.0	92.2	84.5	111	97.9
2-MM5-1-CF	88.7	77.3	- -	- -	- -	- -	- -	- -	- -
2-MM5-2	67.6	69.7	105	126	93.0	124	93.4	115	100
2-MM5-2-CF	91.0	81.5	- -	- -	- -	- -	- -	- -	- -
2-MM5-3	75.8	73.9	95.7	103	94.8	111	101	120	108
2-MM5-3-CF	104	94.1	- -	- -	- -	- -	- -	- -	- -
1-MM5-FB	70.5	70.1	92.0	107	84.4	102	82.0	112	96.8
2-MM5-FB	73.5	70.8	87.3	95.1	97.1	115	102	120	109
TLI Blank	88.5	94.2	118	140	83.4	115	109	124	118
TLI Blank-CF	102	91.4	- -	- -	- -	- -	- -	- -	- -

CF = Confirmation Analysis