COMPLIANCE
EMISSIONS
TEST REPORT
FOR
RECYCLING SOLUTIONS TECHNOLOGIES
UNIT 1

DAVELLA, KENTUCKY
September 25-26, 2008

Job # 08-293

Test Report Date: 10-30-08

APPENDIX

INTRODUCTION

INTRODUCTION

This report presents the results of the emissions tests performed for Recycling Solutions Technologies on Unit 1 in Davella, Kentucky.

The purpose of the tests was to determine the emissions of the unit for compliance. The results can be found in the Summary of Test Results section of this report.

The testing was performed by Grace Consulting, Inc., located at 510 Dickson Street - Wellington, OH, 44090. Present during the testing were Hal Stiles, Dale Vineyard, Brandon Peyton, Tony Perrin and Jason Watkins from Grace Consulting, Inc. John Burke with Recycling Solutions Technologies was present during testing. Also present during testing were John Jayne and Steve Hall with the Kentucky DEQ.

The tests were performed on September 25-26, 2008. The testing was completed in accordance with USEPA test methods as published in the July 1, 2008 Federal Register, - "Standards of Performance for New Stationary Sources" and subsequent revisions.

The sampling and analytical procedures can be found in the Sampling and Analytical Procedures section of this report. The raw field data and the equations used to determine the final results are presented in the Appendix section.

SUMMARY OF TEST RESULTS

SUMMARY OF TEST RESULTS

The following presents the results of the emissions tests performed for Recycling Solutions Technologies on Unit 1 in Davella, Kentucky.

PARTICULATE EMISSIONS

Method 5

Run #	Description	Test Date	lb/dscf	mg/DSCM	mg/DSCM Corrected 7% O2
1	Unit 1	09-25-08	4.88E-08	0.781	1.208
2	Unit 1	09-25-08	1.07E-07	1.708	3.490
3	Unit 1	09-25-08	5.89E-08	0.943	1.404
AVG.			**7.14E-08**	**1.144**	**2.034**

HCl EMISSIONS

Method 26A

Run #	Description	Test Date	lb/dscf	ppm dry	ppm @7% O2.
1	Unit 1	09-25-08	1.53E-06	16.18	25.02
2	Unit 1	09-25-08	1.31E-06	13.87	28.35
3	Unit 1	09-25-08	1.24E-06	13.12	19.52
AVG.			**1.36E-06**	**14.39**	**24.30**

TOTAL DIOXINS AND FURANS EMISSIONS

Method 23

Run #	Description	Test Date	lb/dscf	lbs/hr	ng/DSCM corrected @7% O2.
1	Unit 1	09-26-08	1.57E-13	2.18E-07	3.6372
2	Unit 1	09-26-08	1.19E-13	1.40E-07	3.0618
3	Unit 1	09-26-08	1.24E-13	1.44E-07	3.2018
4	Unit 1	09-26-08	8.76E-14	1.03E-07	2.8768
AVG.			**1.22E-13**	**1.51E-07**	**3.1944**

GASEOUS EMISSIONS

Run	Test Date	NOx ppm	NOx ppm @7% O2	SO2 ppm	SO2 ppm @7% O2	CO ppm	CO ppm @7% O2	CO2 %	O2 %
1	09-26-08	81.38	91.25	0.07	0.08	139.96	156.93	8.50	11.26
2	09-26-08	63.11	65.97	0.27	0.28	1.41	1.47	7.60	12.28
3	09-26-08	64.30	67.25	0.31	0.32	26.43	27.64	7.61	12.26
4	09-26-08	49.55	46.47	0.05	0.05	56.77	53.24	6.08	14.12
Avg.		**64.59**	**67.73**	**0.18**	**0.18**	**56.14**	**59.82**	**7.45**	**12.48**

VISIBLE EMISSIONS

Run #	Test Date	Times	%Opacity
1	09-25-08	11:34-12:34	0.00%
2	09-25-08	14:00-15:00	0.40%
3	09-25-08	15:45-16:45	0.04%

The complete results can be found on the computer printouts following.

Grace Consulting, Inc.

Particulate Analysis
Method 5

Recycling Solutions Technology, LLC
Davella, KY
Unit 1
08-293

Run Number			1	2	3
Date			9/25/2008	9/25/2008	9/25/2008
Location			Unit 1	Unit 1	Unit 1
Comment			Method 5	Method 5	Method 5
Start Time			11:35	14:00	15:45
End Time			12:48	15:05	16:48
Barometric Pressure	In. Hg.	Pb	29.53	29.53	29.53
Static Pressure	In. H2O	Pf	-0.21	-0.21	-0.21
Volume of Condensate	mls.	Vlc	141.4	124.4	190.6
Volume Sampled	dcf	Vm	36.977	38.906	54.011
Meter Correction Factor		Y	1.003	1.003	1.003
Square Root of Delta P			0.681	0.705	0.75
Orifice Pressure	In. H2O		1.24	1.38	2.685
Meter Temperature	Degree F		76	88	82
Flue Temperature	Degree F		191	193	202.4
Percent CO2	%		7.77	5.94	8.22
Percent O2	%		11.91	14.10	11.56
Diameter of Nozzle	In.		0.250	0.250	0.292
Area of Flue	Sq. ft.		12.566	12.566	12.566
Sample Time	min.		60	60	60
Weight Gain	grams		0.0008	0.0018	0.0014
Absolute Flue Pressure	in. Hg	Ps	29.51	29.51	29.51
Corrected Sample Volume	dscf	Vms	36.17	37.24	52.43
Moisture of Flue Gas	%	Bws	15.54%	13.59%	14.61%
Molecular Weight	lb/lb-mole	Ms	27.90	27.95	28.06
Velocity of Flue Gas	fps	Vs	43.48	45.04	48.17
Volume of Flue Gas	ACFM	Vo	32,785	33,961	36,318
Volume of Flue Gas	DSCFM	Qsd	22,154	23,407	24,385
Dust Concentration	lb/dscf	Wd	4.88E-08	1.07E-07	5.89E-08
Dust Concentration	lb/hr	Wh	0.06	0.15	0.09
Dust Concentration	gr/acf	Wa	2.31E-04	5.14E-04	2.77E-04
Dust Concentration	gr/dscf	Ws	3.41E-04	7.46E-04	4.12E-04
Isokinetic Rate	%	%I	100.3	97.8	96.9
PM Emissions	mg/DSCM		0.781	1.708	0.943
PM Emissions	Corrected 7% O2		1.208	3.490	1.404

Averages:	Flue Temp.:	195.467	Part. Emis:	lb/dscf	7.14E-08
	ACFM:	34,355		lb/hr	1.00E-01
	DSCFM:	23,315		mg/DSCM	1.144
	Percent O2:	12.52%		Corrected 7% O2	2.034

GRACE CONSULTING, INC.

HCl Analysis
Method 26A

Recycling Solutions Technologies, LLC
Davella, KY
Unit 1
08-293

Run Number			1	2	3
Date			9/25/2008	9/25/2008	9/25/2008
Location			Unit 1	Unit 1	Unit 1
Comment			HCl	HCl	HCl
Start Time			11:35	14:00	15:45
End Time			12:48	15:05	16:48
Barometric Pressure	In. Hg.	Pb	29.53	29.53	29.53
Static Pressure	In. H2O	Pf	-0.21	-0.21	-0.21
Volume of Condensate	mls.	Vlc	141.4	124.4	190.6
Volume Sampled	dcf	Vm	36.977	38.906	54.011
Meter Correction Factor		Y	1.003	1.003	1.003
Square Root of Delta P			0.681	0.705	0.75
Orifice Pressure	In. H2O		1.24	1.38	2.685
Meter Temperature	Degree F		76	88	82
Flue Temperature	Degree F		191	193	202.4
Percent CO2	%		7.77	5.94	8.22
Percent O2	%		11.91	14.1	11.56
Diameter of Nozzle	In.		0.250	0.250	0.292
Area of Flue	Sq. ft.		12.566	12.566	12.566
Sample Time	min.		60	60	60
HCl Collected	grams		0.0250600	0.0221100	0.0294450
Absolute Flue Pressure	in. Hg	Ps	29.51	29.51	29.51
Corrected Sample Volume	dscf	Vms	36.17	37.24	52.43
Moisture of Flue Gas	%	Bws	15.54%	13.59%	14.61%
Molecular Weight	lb/lb-mole	Ms	27.90	27.95	28.06
Velocity of Flue Gas	fps	Vs	43.48	45.04	48.17
Volume of Flue Gas	ACFM	Vo	32,785	33,961	36,318
Volume of Flue Gas	DSCFM	Qsd	22,154	23,407	24,385
HCl Concentration	lb/dscf	Wd	1.53E-06	1.31E-06	1.24E-06
HCl Concentration	ppm dry		16.18	13.87	13.12
HCl Concentration	ppm @ 7% O2		25.02	28.35	19.52
HCl Concentration	lb/hr	Wh	2.03	1.84	1.81
HCl Concentration	gr/acf	Wa	7.23E-03	6.32E-03	5.82E-03
HCl Concentration	gr/dscf	Ws	1.07E-02	9.17E-03	8.67E-03
Isokinetic Rate	%	%I	100.3	97.8	96.9
HCl Emissions	mg/DSCM		24.474	20.975	19.837
HCl Emissions	Corrected 7% O2		37.841	42.875	29.521

Averages: Flue Temp.:	195.47	HCl Emissions:	lb/dscf	1.36E-06
ACFM:	34,355		lb/hr	1.89
DSCFM:	23,315		ppm dry	14.39
Percent O2:	12.52%		ppm @ 7% O2	24.30

GRACE CONSULTING, INC.

Cl2 Analysis
Method 26A

Recycling Solutions Technologies, LLC
Davella, KY
Unit 1
08-293

Run Number			1	2	3
Date			9/25/2008	9/25/2008	9/25/2008
Location			Unit 1	Unit 1	Unit 1
Comment			Cl2	Cl2	Cl2
Start Time			11:35	14:00	15:45
End Time			12:48	15:05	16:48
Barometric Pressure	In. Hg.	Pb	29.53	29.53	29.53
Static Pressure	In. H2O	Pf	-0.21	-0.21	-0.21
Volume of Condensate	mls.	Vlc	141.4	124.4	190.6
Volume Sampled	dcf	Vm	36.977	38.906	54.011
Meter Correction Factor		Y	1.003	1.003	1.003
Square Root of Delta P			0.681	0.705	0.75
Orifice Pressure	In. H2O		1.24	1.38	2.685
Meter Temperature	Degree F		76	88	82
Flue Temperature	Degree F		191	193	202.4
Percent CO2	%		7.77	5.94	8.22
Percent O2	%		11.91	14.1	11.56
Diameter of Nozzle	In.		0.250	0.250	0.292
Area of Flue	Sq. ft.		12.566	12.566	12.566
Sample Time	min.		60	60	60
Cl2 Collected	grams		0.0125440	0.0108240	0.0135020
Absolute Flue Pressure	in. Hg	Ps	29.51	29.51	29.51
Corrected Sample Volume	dscf	Vms	36.17	37.24	52.43
Moisture of Flue Gas	%	Bws	15.54%	13.59%	14.61%
Molecular Weight	lb/lb-mole	Ms	27.90	27.95	28.06
Velocity of Flue Gas	fps	Vs	43.48	45.04	48.17
Volume of Flue Gas	ACFM	Vo	32,785	33,961	36,318
Volume of Flue Gas	DSCFM	Qsd	22,154	23,407	24,385
Cl2 Concentration	lb/dscf	Wd	7.65E-07	6.41E-07	5.68E-07
Cl2 Concentration	ppm dry		8.10	6.79	6.01
Cl2 Concentration	ppm @ 7% O2		12.53	13.88	8.95
Cl2 Concentration	lb/hr	Wh	1.02	0.90	0.83
Cl2 Concentration	gr/acf	Wa	3.62E-03	3.09E-03	2.67E-03
Cl2 Concentration	gr/dscf	Ws	5.35E-03	4.49E-03	3.97E-03
Isokinetic Rate	%	%I	100.3	97.8	96.9
Cl2 Emissions	mg/DSCM		12.251	10.268	9.096
Cl2 Emissions	Corrected 7% O2		18.942	20.990	13.537

Averages:	Flue Temp.:	195.47	Cl2 Emissions:	lb/dscf	6.58E-07
	ACFM:	34,355		lb/hr	0.92
	DSCFM:	23,315		ppm dry	6.97
	Percent O2:	12.52%		ppm @ 7% O2	11.79

TABLE 3
EPA METHOD 23
TOTAL TEQ PC DIBENZO-P-DIOXINS / PC DIBENZOFURANS (PCDD/PCDF) EMISSION TEST RESULTS

CLIENT: Recycling Solutions
SOURCE TESTED: Unit 1

PROJECT NO 08-293

INPUT DATA

Run Number	1	2	3	4
Date	09/26/08	09/26/08	09/26/08	09/26/08
Sampling Location	Unit 1	Unit 1	Unit 1	Unit 1
Test Time, Start	9:45	12:15	14:25	16:35
Stop (24 Hour)	10:50	13:23	15:30	17:44
Sampling Time (Minutes)	60	60	60	60
Stack Area (Ft²)	12.566	12.566	12.566	12.566
Pitot Tube Coefficient (Unitless)	0.84	0.84	0.84	0.84
Dry Gas Meter Correction Factor (Unitless)	1.003	1.003	1.003	1.003
Nozzle Area (Ft²)	0.000465	0.000465	0.000465	0.000465
Barometric Pressure (In. Hg)	29.27	29.27	29.27	29.27
Static Pressure (In. H2O)	-0.28	-0.28	-0.28	-0.28
Dry Gas Meter Sample Volume (DCF)	50.393	43.950	42.248	38.995
Average Dry Gas Meter Temperature (°F)	70.0	79.0	77.0	83.0
Average Orifice Meter Delta H (In. H2O)	2.350	1.754	1.595	1.417
Volume Condensate Collected (Ml)	181.4	150.6	124.7	140.1
Average CO2 Concentration (%)	8.5	7.6	7.6	6.1
Average O2 Concentration (%)	11.3	12.3	12.3	14.1
Average Square Root of Delta P (In. H2O½)	0.710	0.602	0.576	0.600
Average Stack Gas Temperature (°F)	196.0	191.0	187.0	185.0
Toxic Equivalency Factor (TEF)	n/a	n/a	n/a	n/a
TEQ PCDD/PCDF Mass Concentration (ng)	3.538964	2.281080	2.305974	1.483473

CALCULATED DATA

Absolute Pressure (In. Hg)	29.25	29.25	29.25	29.25
Dry Gas Meter Sample Volume at Standard Conditions (DSCF)	49.559	42.437	40.930	37.344
Water Vapor Volume at Standard Conditions (SCF)	8.538	7.089	5.870	6.595
Moisture Fraction (Unitless)	0.147	0.143	0.125	0.150
Dry Molecular Weight of Stack Gas (Lb/Lb-Mole)	29.81	29.71	29.71	29.54
Wet Molecular Weight of Stack Gas (Lb/Lb-Mole)	28.07	28.03	28.24	27.81
Stack Gas Velocity (FPS)	45.6	38.5	36.6	38.4
Stack Gas Flow Rate at Actual Conditions (ACFM)	34,359	29,043	27,601	28,930
Stack Gas Flow Rate at Dry Standard Conditions (DSCFM)	23,062	19,732	19,258	19,677
Isokinetic Sampling (%)	96.8	96.9	95.8	85.5
TEQ PCDD/PCDF Emission Concentration (Gr/DSCF)	1.10E-09	8.30E-10	8.70E-10	6.13E-10
TEQ PCDD/PCDF Emission Concentration (Lb/DSCF)	1.57E-13	1.19E-13	1.24E-13	8.76E-14
TEQ PCDD/PCDF Emission Rate (Lb/Hr)	2.18E-07	1.40E-07	1.44E-07	1.03E-07
TEQ PCDD/PCDF Emission Rate (Lb/Run)	6.97E-07	4.49E-07	4.59E-07	3.31E-07
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM)	2.5225	1.8987	1.9902	1.4032
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM@7% O2	3.6372	3.0618	3.2018	2.8768

TABLE 3A
EPA METHOD 23
TOTAL TEQ POLYCHLORINATED DIBENZO-P-DIOXINS (PCDD) EMISSIONS TEST RESULTS

CLIENT: Recycling Solutions
SOURCE TESTED: Unit 1

PROJECT NC 08-293

INPUT DATA

Run Number	1	2	3	4
Date	09/26/08	09/26/08	09/26/08	09/26/08
Sampling Location	Unit 1	Unit 1	Unit 1	Unit 1
Test Time, Start	9:45	12:15	14:25	16:35
Stop (24 Hour)	10:50	13:23	15:30	17:44
Sampling Time (Minutes)	60	60	60	60
Stack Area (Ft^2)	12.566	12.566	12.566	12.566
Pitot Tube Coefficient (Unitless)	0.84	0.84	0.84	0.84
Dry Gas Meter Correction Factor (Unitless)	1.003	1.003	1.003	1.003
Nozzle Area (Ft^2)	0.000465	0.000465	0.000465	0.000465
Barometric Pressure (In. Hg)	29.27	29.27	29.27	29.27
Static Pressure (In. H2O)	-0.28	-0.28	-0.28	-0.28
Dry Gas Meter Sample Volume (DCF)	50.393	43.950	42.248	38.995
Average Dry Gas Meter Temperature (°F)	70.0	79.0	77.0	83.0
Average Orifice Meter Delta H (In. H2O)	2.350	1.754	1.595	1.417
Volume Condensate Collected (Ml)	181.4	150.6	124.7	140.1
Average CO2 Concentration (%)	8.5	7.6	7.6	6.1
Average O2 Concentration (%)	11.3	12.3	12.3	14.1
Average Square Root of Delta P (In. H2O½)	0.710	0.602	0.576	0.600
Average Stack Gas Temperature (°F)	196.0	191.0	187.0	185.0
Toxic Equivalency Factor (TEF)	n/a	n/a	n/a	n/a
TEQ PCDD Mass Concentration (ng)	0.687170	0.466644	0.439586	0.284127

CALCULATED DATA

Absolute Pressure (In. Hg)	29.25	29.25	29.25	29.25
Dry Gas Meter Sample Volume at Standard Conditions (DSCF)	49.559	42.437	40.930	37.344
Water Vapor Volume at Standard Conditions (SCF)	8.538	7.089	5.870	6.595
Moisture Fraction (Unitless)	0.147	0.143	0.125	0.150
Dry Molecular Weight of Stack Gas (Lb/Lb-Mole)	29.81	29.71	29.71	29.54
Wet Molecular Weight of Stack Gas (Lb/Lb-Mole)	28.07	28.03	28.24	27.81
Stack Gas Velocity (FPS)	45.6	38.5	36.6	38.4
Stack Gas Flow Rate at Actual Conditions (ACFM)	34,359	29,043	27,601	28,930
Stack Gas Flow Rate at Dry Standard Conditions (DSCFM)	23,062	19,732	19,258	19,677
Isokinetic Sampling (%)	96.8	96.9	95.8	85.5
TEQ PCDD Emission Concentration (Gr/DSCF)	2.14E-10	1.70E-10	1.66E-10	1.17E-10
TEQ PCDD Emission Concentration (Lb/DSCF)	3.06E-14	2.42E-14	2.37E-14	1.68E-14
TEQ PCDD Emission Rate (Lb/Hr)	4.23E-08	2.87E-08	2.74E-08	1.98E-08
TEQ PCDD Emission Rate (Lb/Run)	1.35E-07	9.19E-08	8.76E-08	6.34E-08
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM)	0.4898	0.3884	0.3794	0.2688
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM@7% O2)	0.7062	0.6263	0.6104	0.5510

TABLE 3B
EPA METHOD 23
TEQ 2 3 7 8 - TETRACHLORODIBENZO-P-DIOXIN (TCDD) EMISSIONS TEST RESULTS

CLIENT: Recycling Solutions
SOURCE TESTED: Unit 1

PROJECT NO. 08-293

INPUT DATA

Run Number	1	2	3	4
Date	09/26/08	09/26/08	09/26/08	09/26/08
Sampling Location	Unit 1	Unit 1	Unit 1	Unit 1
Test Time, Start	9:45	12:15	14:25	16:35
Stop (24 Hour)	10:50	13:23	15:30	17:44
Sampling Time (Minutes)	60	60	60	60
Stack Area (Ft²)	12.566	12.566	12.566	12.566
Pitot Tube Coefficient (Unitless)	0.84	0.84	0.84	0.84
Dry Gas Meter Correction Factor (Unitless)	1.003	1.003	1.003	1.003
Nozzle Area (Ft²)	0.000465	0.000465	0.000465	0.000465
Barometric Pressure (In. Hg)	29.27	29.27	29.27	29.27
Static Pressure (In. H2O)	-0.28	-0.28	-0.28	-0.28
Dry Gas Meter Sample Volume (DCF)	50.393	43.950	42.248	38.995
Average Dry Gas Meter Temperature (°F)	70.0	79.0	77.0	83.0
Average Orifice Meter Delta H (In. H2O)	2.350	1.754	1.595	1.417
Volume Condensate Collected (Ml)	181.4	150.6	124.7	140.1
Average CO2 Concentration (%)	8.5	7.6	7.6	6.1
Average O2 Concentration (%)	11.3	12.3	12.3	14.1
Average Square Root of Delta P (In. H2O½)	0.710	0.602	0.576	0.600
Average Stack Gas Temperature (°F)	196.0	191.0	187.0	185.0
Toxic Equivalency Factor (TEF)	1.0	1.0	1.0	1.0
TEQ 2 3 7 8 - TCDD Mass Concentration (ng)	0.2680	0.2020	0.1710	0.1180

CALCULATED DATA

Absolute Pressure (In. Hg)	29.25	29.25	29.25	29.25
Dry Gas Meter Sample Volume at Standard Conditions (DSCF)	49.559	42.437	40.930	37.344
Water Vapor Volume at Standard Conditions (SCF)	8.538	7.089	5.870	6.595
Moisture Fraction (Unitless)	0.147	0.143	0.125	0.150
Dry Molecular Weight of Stack Gas (Lb/Lb-Mole)	29.81	29.71	29.71	29.54
Wet Molecular Weight of Stack Gas (Lb/Lb-Mole)	28.07	28.03	28.24	27.81
Stack Gas Velocity (FPS)	45.6	38.5	36.6	38.4
Stack Gas Flow Rate at Actual Conditions (ACFM)	34,359	29,043	27,601	28,930
Stack Gas Flow Rate at Dry Standard Conditions (DSCFM)	23,062	19,732	19,258	19,677
Isokinetic Sampling (%)	96.8	96.9	95.8	85.5
TEQ 2 3 7 8 - TCDD Emission Concentration (Gr/DSCF)	8.35E-11	7.35E-11	6.45E-11	4.88E-11
TEQ 2 3 7 8 - TCDD Emission Concentration (Lb/DSCF)	1.19E-14	1.05E-14	9.21E-15	6.97E-15
TEQ 2 3 7 8 - TCDD Emission Rate (Lb/Hr)	1.65E-08	1.24E-08	1.06E-08	8.23E-09
TEQ 2 3 7 8 - TCDD Emission Rate (Lb/Run)	5.28E-08	3.98E-08	3.41E-08	2.63E-08
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM)	0.1910	0.1681	0.1476	0.1116
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM@7% O2	0.2754	0.2711	0.2374	0.2288

TABLE 3C
EPA METHOD 23
TEQ 1 2 3 7 8 - PENTACHLORODIBENZO-P-DIOXIN (PeCDD) EMISSIONS TEST RESULTS

CLIENT:	Recycling Solutions	PROJECT NC 08-293
SOURCE TESTED:	Unit 1	

INPUT DATA

Run Number	1	2	3	4
Date	09/26/08	09/26/08	09/26/08	09/26/08
Sampling Location	Unit 1	Unit 1	Unit 1	Unit 1
Test Time, Start	9:45	12:15	14:25	16:35
Stop (24 Hour)	10:50	13:23	15:30	17:44
Sampling Time (Minutes)	60	60	60	60
Stack Area (Ft^2)	12.566	12.566	12.566	12.566
Pitot Tube Coefficient (Unitless)	0.84	0.84	0.84	0.84
Dry Gas Meter Correction Factor (Unitless)	1.003	1.003	1.003	1.003
Nozzle Area (Ft^2)	0.000465	0.000465	0.000465	0.000465
Barometric Pressure (In. Hg)	29.27	29.27	29.27	29.27
Static Pressure (In. H2O)	-0.28	-0.28	-0.28	-0.28
Dry Gas Meter Sample Volume (DCF)	50.393	43.950	42.248	38.995
Average Dry Gas Meter Temperature (°F)	70.0	79.0	77.0	83.0
Average Orifice Meter Delta H (In. H2O)	2.350	1.754	1.595	1.417
Volume Condensate Collected (Ml)	181.4	150.6	124.7	140.1
Average CO2 Concentration (%)	8.5	7.6	7.6	6.1
Average O2 Concentration (%)	11.3	12.3	12.3	14.1
Average Square Root of Delta P (In. H2O½)	0.710	0.602	0.576	0.600
Average Stack Gas Temperature (°F)	196.0	191.0	187.0	185.0
Toxic Equivalency Factor (TEF)	0.5	0.5	0.5	0.5
TEQ 1 2 3 7 8 - PeCDD Mass Concentration (ng)	0.2790	0.1865	0.1780	0.1125

CALCULATED DATA

Absolute Pressure (In. Hg)	29.25	29.25	29.25	29.25
Dry Gas Meter Sample Volume at Standard Conditions (DSCF)	49.559	42.437	40.930	37.344
Water Vapor Volume at Standard Conditions (SCF)	8.538	7.089	5.870	6.595
Moisture Fraction (Unitless)	0.147	0.143	0.125	0.150
Dry Molecular Weight of Stack Gas (Lb/Lb-Mole)	29.81	29.71	29.71	29.54
Wet Molecular Weight of Stack Gas (Lb/Lb-Mole)	28.07	28.03	28.24	27.81
Stack Gas Velocity (FPS)	45.6	38.5	36.6	38.4
Stack Gas Flow Rate at Actual Conditions (ACFM)	34,359	29,043	27,601	28,930
Stack Gas Flow Rate at Dry Standard Conditions (DSCFM)	23,062	19,732	19,258	19,677
Isokinetic Sampling (%)	96.8	96.9	95.8	85.5
TEQ 1 2 3 7 8 - PeCDD Emission Concentration (Gr/DSCF)	8.69E-11	6.78E-11	6.71E-11	4.65E-11
TEQ 1 2 3 7 8 - PeCDD Emission Concentration (Lb/DSCF)	1.24E-14	9.69E-15	9.59E-15	6.64E-15
TEQ 1 2 3 7 8 - PeCDD Emission Rate (Lb/Hr)	1.72E-08	1.15E-08	1.11E-08	7.84E-09
TEQ 1 2 3 7 8 - PeCDD Emission Rate (Lb/Run)	5.50E-08	3.67E-08	3.55E-08	2.51E-08
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM)	0.1989	0.1552	0.1536	0.1064
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM@7% O2)	0.2867	0.2503	0.2471	0.2182

TABLE 3D
EPA METHOD 23
TEQ 1 2 3 4 7 8 - HEXACHLORODIBENZO-P-DIOXIN (HxCDD) EMISSIONS TEST RESULTS

CLIENT: Recycling Solutions
SOURCE TESTED: Unit 1

PROJECT NO 08-293

INPUT DATA

Run Number	1	2	3	4
Date	09/26/08	09/26/08	09/26/08	09/26/08
Sampling Location	Unit 1	Unit 1	Unit 1	Unit 1
Test Time, Start	9:45	12:15	14:25	16:35
Stop (24 Hour)	10:50	13:23	15:30	17:44
Sampling Time (Minutes)	60	60	60	60
Stack Area (Ft²)	12.566	12.566	12.566	12.566
Pitot Tube Coefficient (Unitless)	0.84	0.84	0.84	0.84
Dry Gas Meter Correction Factor (Unitless)	1.003	1.003	1.003	1.003
Nozzle Area (Ft²)	0.000465	0.000465	0.000465	0.000465
Barometric Pressure (In. Hg)	29.27	29.27	29.27	29.27
Static Pressure (In. H2O)	-0.28	-0.28	-0.28	-0.28
Dry Gas Meter Sample Volume (DCF)	50.393	43.950	42.248	38.995
Average Dry Gas Meter Temperature (°F)	70.0	79.0	77.0	83.0
Average Orifice Meter Delta H (In. H2O)	2.350	1.754	1.595	1.417
Volume Condensate Collected (Ml)	181.4	150.6	124.7	140.1
Average CO2 Concentration (%)	8.5	7.6	7.6	6.1
Average O2 Concentration (%)	11.3	12.3	12.3	14.1
Average Square Root of Delta P (In. H2O½)	0.710	0.602	0.576	0.600
Average Stack Gas Temperature (°F)	196.0	191.0	187.0	185.0
Toxic Equivalency Factor (TEF)	0.1	0.1	0.1	0.1
TEQ 1 2 3 4 7 8 - HxCDD Mass Concentration (ng)	0.0335	0.0191	0.0216	0.0134

CALCULATED DATA

Absolute Pressure (In. Hg)	29.25	29.25	29.25	29.25
Dry Gas Meter Sample Volume at Standard Conditions (DSCF)	49.559	42.437	40.930	37.344
Water Vapor Volume at Standard Conditions (SCF)	8.538	7.089	5.870	6.595
Moisture Fraction (Unitless)	0.147	0.143	0.125	0.150
Dry Molecular Weight of Stack Gas (Lb/Lb-Mole)	29.81	29.71	29.71	29.54
Wet Molecular Weight of Stack Gas (Lb/Lb-Mole)	28.07	28.03	28.24	27.81
Stack Gas Velocity (FPS)	45.6	38.5	36.6	38.4
Stack Gas Flow Rate at Actual Conditions (ACFM)	34,359	29,043	27,601	28,930
Stack Gas Flow Rate at Dry Standard Conditions (DSCFM)	23,062	19,732	19,258	19,677
Isokinetic Sampling (%)	96.8	96.9	95.8	85.5
TEQ 1 2 3 4 7 8 - HxCDD Emission Concentration (Gr/DSCF)	1.04E-11	6.95E-12	8.15E-12	5.54E-12
TEQ 1 2 3 4 7 8 - HxCDD Emission Concentration (Lb/DSCF)	1.49E-15	9.92E-16	1.16E-15	7.91E-16
TEQ 1 2 3 4 7 8 - HxCDD Emission Rate (Lb/Hr)	2.06E-09	1.17E-09	1.34E-09	9.34E-10
TEQ 1 2 3 4 7 8 - HxCDD Emission Rata (Lb/Run)	6.60E-09	3.76E-09	4.30E-09	2.99E-09
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM)	0.0239	0.0159	0.0186	0.0127
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM@7% O2)	0.0344	0.0256	0.0300	0.0260

TABLE 3E
EPA METHOD 23
TEQ 1 2 3 6 7 8 - HEXACHLORODIBENZO-P-DIOXIN (HxCDD) EMISSIONS TEST RESULTS

CLIENT: Recycling Solutions
SOURCE TESTED: Unit 1

PROJECT NO 08-293

INPUT DATA

Run Number	1	2	3	4
Date	09/26/08	09/26/08	09/26/08	09/26/08
Sampling Location	Unit 1	Unit 1	Unit 1	Unit 1
Test Time, Start	9:45	12:15	14:25	16:35
Stop (24 Hour)	10:50	13:23	15:30	17:44
Sampling Time (Minutes)	60	60	60	60
Stack Area (Ft²)	12.566	12.566	12.566	12.566
Pitot Tube Coefficient (Unitless)	0.84	0.84	0.84	0.84
Dry Gas Meter Correction Factor (Unitless)	1.003	1.003	1.003	1.003
Nozzle Area (Ft²)	0.000465	0.000465	0.000465	0.000465
Barometric Pressure (In. Hg)	29.27	29.27	29.27	29.27
Static Pressure (In. H2O)	-0.28	-0.28	-0.28	-0.28
Dry Gas Meter Sample Volume (DCF)	50.393	43.950	42.248	38.995
Average Dry Gas Meter Temperature (°F)	70.0	79.0	77.0	83.0
Average Orifice Meter Delta H (In. H2O)	2.350	1.754	1.595	1.417
Volume Condensate Collected (Ml)	181.4	150.6	124.7	140.1
Average CO2 Concentration (%)	8.5	7.6	7.6	6.1
Average O2 Concentration (%)	11.3	12.3	12.3	14.1
Average Square Root of Delta P (In. H2O½)	0.710	0.602	0.576	0.600
Average Stack Gas Temperature (°F)	196.0	191.0	187.0	185.0
Toxic Equivalency Factor (TEF)	0.1	0.1	0.1	0.1
TEQ 1 2 3 6 7 8 - HxCDD Mass Concentration (ng)	0.0534	0.0314	0.0347	0.0204

CALCULATED DATA

Absolute Pressure (In. Hg)	29.25	29.25	29.25	29.25
Dry Gas Meter Sample Volume at Standard Conditions (DSCF)	49.559	42.437	40.930	37.344
Water Vapor Volume at Standard Conditions (SCF)	8.538	7.089	5.870	6.595
Moisture Fraction (Unitless)	0.147	0.143	0.125	0.150
Dry Molecular Weight of Stack Gas (Lb/Lb-Mole)	29.81	29.71	29.71	29.54
Wet Molecular Weight of Stack Gas (Lb/Lb-Mole)	28.07	28.03	28.24	27.81
Stack Gas Velocity (FPS)	45.6	38.5	36.6	38.4
Stack Gas Flow Rate at Actual Conditions (ACFM)	34,359	29,043	27,601	28,930
Stack Gas Flow Rate at Dry Standard Conditions (DSCFM)	23,062	19,732	19,258	19,677
Isokinetic Sampling (%)	96.8	96.9	95.8	85.5
TEQ 1 2 3 6 7 8 - HxCDD Emission Concentration (Gr/DSCF)	1.66E-11	1.14E-11	1.31E-11	8.43E-12
TEQ 1 2 3 6 7 8 - HxCDD Emission Concentration (Lb/DSCF)	2.38E-15	1.63E-15	1.87E-15	1.20E-15
TEQ 1 2 3 6 7 8 - HxCDD Emission Rate (Lb/Hr)	3.29E-09	1.93E-09	2.16E-09	1.42E-09
TEQ 1 2 3 6 7 8 - HxCDD Emission Rate (Lb/Run)	1.05E-08	6.18E-09	6.91E-09	4.55E-09
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM)	0.0381	0.0261	0.0299	0.0193
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM@7% O	0.0549	0.0421	0.0482	0.0396

TABLE 3F
EPA METHOD 23
TEQ 1 2 3 7 8 9 - HEXACHLORODIBENZO-P-DIOXIN (HxCDD) EMISSIONS TEST RESULTS

PROJECT N 08-293

CLIENT: Recycling Solutions
SOURCE TESTED: Unit 1

INPUT DATA

Run Number	1	2	3	4
Date	09/26/08	09/26/08	09/26/08	09/26/08
Sampling Location	Unit 1	Unit 1	Unit 1	Unit 1
Test Time, Start	9:45	12:15	14:25	16:35
Stop (24 Hour)	10:50	13:23	15:30	17:44
Sampling Time (Minutes)	60	60	60	60
Stack Area (Ft²)	12.566	12.566	12.566	12.566
Pitot Tube Coefficient (Unitless)	0.84	0.84	0.84	0.84
Dry Gas Meter Correction Factor (Unitless)	1.003	1.003	1.003	1.003
Nozzle Area (Ft²)	0.000465	0.000465	0.000465	0.000465
Barometric Pressure (In. Hg)	29.27	29.27	29.27	29.27
Static Pressure (In. H2O)	-0.28	-0.28	-0.28	-0.28
Dry Gas Meter Sample Volume (DCF)	50.393	43.950	42.248	38.995
Average Dry Gas Meter Temperature (°F)	70.0	79.0	77.0	83.0
Average Orifice Meter Delta H (In. H2O)	2.350	1.754	1.595	1.417
Volume Condensate Collected (Ml)	181.4	150.6	124.7	140.1
Average CO2 Concentration (%)	8.5	7.6	7.6	6.1
Average O2 Concentration (%)	11.3	12.3	12.3	14.1
Average Square Root of Delta P (In. H2O½)	0.710	0.602	0.576	0.600
Average Stack Gas Temperature (°F)	196.0	191.0	187.0	185.0
Toxic Equivalency Factor (TEF)	0.1	0.1	0.1	0.1
TEQ 1 2 3 7 8 9 - HxCDD Mass Concentration (ng)	0.0351	0.0191	0.0223	0.0128

CALCULATED DATA

Absolute Pressure (In. Hg)	29.25	29.25	29.25	29.25
Dry Gas Meter Sample Volume at Standard Conditions (DSCF)	49.559	42.437	40.930	37.344
Water Vapor Volume at Standard Conditions (SCF)	8.538	7.089	5.870	6.595
Moisture Fraction (Unitless)	0.147	0.143	0.125	0.150
Dry Molecular Weight of Stack Gas (Lb/Lb-Mole)	29.81	29.71	29.71	29.54
Wet Molecular Weight of Stack Gas (Lb/Lb-Mole)	28.07	28.03	28.24	27.81
Stack Gas Velocity (FPS)	45.6	38.5	36.6	38.4
Stack Gas Flow Rate at Actual Conditions (ACFM)	34,359	29,043	27,601	28,930
Stack Gas Flow Rate at Dry Standard Conditions (DSCFM)	23,062	19,732	19,258	19,677
Isokinetic Sampling (%)	96.8	96.9	95.8	85.5
TEQ 1 2 3 7 8 9 - HxCDD Emission Concentration (Gr/DSCF)	1.09E-11	6.95E-12	8.41E-12	5.29E-12
TEQ 1 2 3 7 8 9 - HxCDD Emission Concentration (Lb/DSCF)	1.56E-15	9.92E-16	1.20E-15	7.56E-16
TEQ 1 2 3 7 8 9 - HxCDD Emission Rate (Lb/Hr)	2.16E-09	1.17E-09	1.39E-09	8.92E-10
TEQ 1 2 3 7 8 9 - HxCDD Emission Rate (Lb/Run)	6.91E-09	3.76E-09	4.44E-09	2.86E-09
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM)	0.0250	0.0159	0.0192	0.0121
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM@7% O2	0.0361	0.0256	0.0310	0.0248

TABLE 3G
EPA METHOD 23
TEQ 1 2 3 4 6 7 8 - HEPTACHLORODIBENZO-P-DIOXIN (HpCDD) EMISSIONS TEST RESULTS

CLIENT: Recycling Solutions
SOURCE TESTED: Unit 1

PROJECT NO. 08-293

INPUT DATA

Run Number	1	2	3	4
Date	09/26/08	09/26/08	09/26/08	9/26/2008
Sampling Location	Unit 1	Unit 1	Unit 1	Unit 1
Test Time, Start	9:45	12:15	14:25	16:35
Stop (24 Hour)	10:50	13:23	15:30	17:44
Sampling Time (Minutes)	60	60	60	0:00
Stack Area (Ft²)	12.566	12.566	12.566	12.566
Pitot Tube Coefficient (Unitless)	0.84	0.84	0.84	0.84
Dry Gas Meter Correction Factor (Unitless)	1.003	1.003	1.003	1.003
Nozzle Area (Ft²)	0.000465	0.000465	0.000465	0.000465
Barometric Pressure (In. Hg)	29.27	29.27	29.27	29.27
Static Pressure (In. H2O)	-0.28	-0.28	-0.28	-0.28
Dry Gas Meter Sample Volume (DCF)	50.393	43.950	42.248	38.995
Average Dry Gas Meter Temperature (°F)	70.0	79.0	77.0	83.0
Average Orifice Meter Delta H (In. H2O)	2.350	1.754	1.595	1.417
Volume Condensate Collected (Ml)	181.4	150.6	124.7	140.1
Average CO2 Concentration (%)	8.5	7.6	7.6	6.1
Average O2 Concentration (%)	11.3	12.3	12.3	14.1
Average Square Root of Delta P (In. H2O½)	0.710	0.602	0.576	0.600
Average Stack Gas Temperature (°F)	196.0	191.0	187.0	185.0
Toxic Equivalency Factor (TEF)	0.01	0.01	0.01	0.01
TEQ 1 2 3 4 6 7 8 - HpCDD Mass Concentration (ng)	0.0170	0.0080	0.0112	0.0065

CALCULATED DATA

Absolute Pressure (In. Hg)	29.25	29.25	29.25	29.25
Dry Gas Meter Sample Volume at Standard Conditions (DSCF)	49.559	42.437	40.930	37.344
Water Vapor Volume at Standard Conditions (SCF)	8.538	7.089	5.870	6.595
Moisture Fraction (Unitless)	0.147	0.143	0.125	0.150
Dry Molecular Weight of Stack Gas (Lb/Lb-Mole)	29.81	29.71	29.71	29.54
Wet Molecular Weight of Stack Gas (Lb/Lb-Mole)	28.07	28.03	28.24	27.81
Stack Gas Velocity (FPS)	45.6	38.5	36.6	38.4
Stack Gas Flow Rate at Actual Conditions (ACFM)	34,359	29,043	27,601	28,930
Stack Gas Flow Rate at Dry Standard Conditions (DSCFM)	23,062	19,732	19,258	19,677
Isokinetic Sampling (%)	96.8	96.9	95.8	85.5
TEQ 1 2 3 4 6 7 8 - HpCDD Emission Concentration (Gr/DSCF)	5.29E-12	2.92E-12	4.22E-12	2.70E-12
TEQ 1 2 3 4 6 7 8 - HpCDD Emission Concentration (Lb/DSCF)	7.56E-16	4.17E-16	6.03E-16	3.86E-16
TEQ 1 2 3 4 6 7 8 - HpCDD Emission Rate (Lb/Hr)	1.05E-09	4.94E-10	6.97E-10	4.55E-10
TEQ 1 2 3 4 6 7 8 - HpCDD Emission Rate (Lb/Run)	3.35E-09	1.58E-09	2.23E-09	1.46E-09
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM)	0.0121	0.0067	0.0097	0.0062
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM@7	0.0175	0.0108	0.0156	0.0127

TABLE 3H
EPA METHOD 23
TEQ 1 2 3 4 6 7 8 9 - OCTACHLORODIBENZO-P-DIOXIN (OCDD) EMISSIONS TEST RESULTS

CLIENT: Recycling Solutions
SOURCE TESTED: Unit 1

PROJECT NO 08-293

INPUT DATA

Run Number	1	2	3	4
Date	09/26/08	09/26/08	09/26/08	09/26/08
Sampling Location	Unit 1	Unit 1	Unit 1	Unit 1
Test Time, Start	9:45	12:15	14:25	16:35
Stop (24 Hour)	10:50	13:23	15:30	17:44
Sampling Time (Minutes)	60	60	60	60
Stack Area (Ft^2)	12.566	12.566	12.566	12.566
Pitot Tube Coefficient (Unitless)	0.84	0.84	0.84	0.84
Dry Gas Meter Correction Factor (Unitless)	1.003	1.003	1.003	1.003
Nozzle Area (Ft^2)	0.000465	0.000465	0.000465	0.000465
Barometric Pressure (In. Hg)	29.27	29.27	29.27	29.27
Static Pressure (In. H2O)	-0.28	-0.28	-0.28	-0.28
Dry Gas Meter Sample Volume (DCF)	50.393	43.950	42.248	38.995
Average Dry Gas Meter Temperature (°F)	70.0	79.0	77.0	83.0
Average Orifice Meter Delta H (In. H2O)	2.350	1.754	1.595	1.417
Volume Condensate Collected (Ml)	181.4	150.6	124.7	140.1
Average CO2 Concentration (%)	8.5	7.6	7.6	6.1
Average O2 Concentration (%)	11.3	12.3	12.3	14.1
Average Square Root of Delta P (In. H2O½)	0.710	0.602	0.576	0.600
Average Stack Gas Temperature (°F)	196.0	191.0	187.0	185.0
Toxic Equivalency Factor (TEF)	0.001	0.001	0.001	0.001
TEQ 1 2 3 4 6 7 8 9 - OCDD Mass Concentration (ng)	0.001170	0.000514	0.000786	0.000497

CALCULATED DATA

Absolute Pressure (In. Hg)	29.25	29.25	29.25	29.25
Dry Gas Meter Sample Volume at Standard Conditions (DSCF)	49.559	42.437	40.930	37.344
Water Vapor Volume at Standard Conditions (SCF)	8.538	7.089	5.870	6.595
Moisture Fraction (Unitless)	0.147	0.143	0.125	0.150
Dry Molecular Weight of Stack Gas (Lb/Lb-Mole)	29.81	29.71	29.71	29.54
Wet Molecular Weight of Stack Gas (Lb/Lb-Mole)	28.07	28.03	28.24	27.81
Stack Gas Velocity (FPS)	45.6	38.5	36.6	38.4
Stack Gas Flow Rate at Actual Conditions (ACFM)	34,359	29,043	27,601	28,930
Stack Gas Flow Rate at Dry Standard Conditions (DSCFM)	23,062	19,732	19,258	19,677
Isokinetic Sampling (%)	96.8	96.9	95.8	85.5
TEQ 1 2 3 4 6 7 8 9 - OCDD Emission Concentration (Gr/DSCF)	3.64E-13	1.87E-13	2.96E-13	2.05E-13
TEQ 1 2 3 4 6 7 8 9 - OCDD Emission Concentration (Lb/DSCF)	5.21E-17	2.67E-17	4.23E-17	2.93E-17
TEQ 1 2 3 4 6 7 8 9 - OCDD Emission Rate (Lb/Hr)	7.20E-11	3.16E-11	4.89E-11	3.46E-11
TEQ 1 2 3 4 6 7 8 9 - OCDD Emission Rate (Lb/Run)	2.30E-10	1.01E-10	1.57E-10	1.11E-10
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM)	0.0008	0.0004	0.0007	0.0005
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM@7%	0.0012	0.0007	0.0011	0.0010

TABLE 3I
EPA METHOD 23
TOTAL TEQ POLYCHLORINATED DIBENZOFURANS (PCDF) EMISSIONS TEST RESULTS

CLIENT: Recycling Solutions
SOURCE TESTED: Unit 1

PROJECT NO 08-293

INPUT DATA

Run Number	1	2	3	4
Date	09/26/08	09/26/08	09/26/08	09/26/08
Sampling Location	Unit 1	Unit 1	Unit 1	Unit 1
Test Time, Start	9:45	12:15	14:25	16:35
Stop (24 Hour)	10:50	13:23	15:30	17:44
Sampling Time (Minutes)	60	60	60	60
Average Process Charge Rate (TPH)				
Stack Area (Ft^2)	12.566	12.566	12.566	12.566
Pitot Tube Coefficient (Unitless)	0.84	0.84	0.84	0.84
Dry Gas Meter Correction Factor (Unitless)	1.003	1.003	1.003	1.003
Nozzle Area (Ft^2)	0.000465	0.000465	0.000465	0.000465
Barometric Pressure (In. Hg)	29.27	29.27	29.27	29.27
Static Pressure (In. H2O)	-0.28	-0.28	-0.28	-0.28
Dry Gas Meter Sample Volume (DCF)	50.393	43.950	42.248	38.995
Average Dry Gas Meter Temperature (°F)	70.0	79.0	77.0	83.0
Average Orifice Meter Delta H (In. H2O)	2.350	1.754	1.595	1.417
Volume Condensate Collected (Ml)	181.4	150.6	124.7	140.1
Average CO2 Concentration (%)	8.5	7.6	7.6	6.1
Average O2 Concentration (%)	11.3	12.3	12.3	14.1
Average Square Root of Delta P (In. H2O½)	0.710	0.602	0.576	0.600
Average Stack Gas Temperature (°F)	196.0	191.0	187.0	185.0
Toxic Equivalency Factor (TEF)	n/a	n/a	n/a	n/a
TEQ PCDF Mass Concentration (ng)	2.851794	1.814436	1.866388	1.199346

CALCULATED DATA

Absolute Pressure (In. Hg)	29.25	29.25	29.25	29.25
Dry Gas Meter Sample Volume at Standard Conditions (DSCF)	49.559	42.437	40.930	37.344
Water Vapor Volume at Standard Conditions (SCF)	8.538	7.089	5.870	6.595
Moisture Fraction (Unitless)	0.147	0.143	0.125	0.150
Dry Molecular Weight of Stack Gas (Lb/Lb-Mole)	29.81	29.71	29.71	29.54
Wet Molecular Weight of Stack Gas (Lb/Lb-Mole)	28.07	28.03	28.24	27.81
Stack Gas Velocity (FPS)	45.6	38.5	36.6	38.4
Stack Gas Flow Rate at Actual Conditions (ACFM)	34,359	29,043	27,601	28,930
Stack Gas Flow Rate at Dry Standard Conditions (DSCFM)	23,062	19,732	19,258	19,677
Isokinetic Sampling (%)	96.8	96.9	95.8	85.5
TEQ PCDF Emission Concentration (Gr/DSCF)	8.88E-10	6.60E-10	7.04E-10	4.96E-10
TEQ PCDF Emission Concentration (Lb/DSCF)	1.27E-13	9.43E-14	1.01E-13	7.08E-14
TEQ PCDF Emission Rate (Lb/Hr)	1.76E-07	1.12E-07	1.16E-07	8.36E-08
TEQ PCDF Emission Rate (Lb/Run)	5.62E-07	3.57E-07	3.72E-07	2.68E-07
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM)	2.0327	1.5103	1.6108	1.1345
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM@7	2.9309	2.4354	2.5914	2.3258

TABLE 3J
EPA METHOD 23
TEQ 2 3 7 8 - TETRACHLORODIBENZOFURAN (TCDF) EMISSIONS TEST RESULTS

CLIENT: Recycling Solutions
SOURCE TESTED: Unit 1

PROJECT NO. 08-293

INPUT DATA

Run Number	1	2	3	4
Date	09/26/08	09/26/08	09/26/08	09/26/08
Sampling Location	Unit 1	Unit 1	Unit 1	Unit 1
Test Time, Start	9:45	12:15	14:25	16:35
Stop (24 Hour)	10:50	13:23	15:30	17:44
Sampling Time (Minutes)	60	60	60	60
Stack Area (Ft^2)	12.566	12.566	12.566	12.566
Pitot Tube Coefficient (Unitless)	0.84	0.84	0.84	0.84
Dry Gas Meter Correction Factor (Unitless)	1.003	1.003	1.003	1.003
Nozzle Area (Ft^2)	0.000465	0.000465	0.000465	0.000465
Barometric Pressure (In. Hg)	29.27	29.27	29.27	29.27
Static Pressure (In. H2O)	-0.28	-0.28	-0.28	-0.28
Dry Gas Meter Sample Volume (DCF)	50.393	43.950	42.248	38.995
Average Dry Gas Meter Temperature (°F)	70.0	79.0	77.0	83.0
Average Orifice Meter Delta H (In. H2O)	2.350	1.754	1.595	1.417
Volume Condensate Collected (Ml)	181.4	150.6	124.7	140.1
Average CO2 Concentration (%)	8.5	7.6	7.6	6.1
Average O2 Concentration (%)	11.3	12.3	12.3	14.1
Average Square Root of Delta P (In. H2O½)	0.710	0.602	0.576	0.600
Average Stack Gas Temperature (°F)	196.0	191.0	187.0	185.0
Toxic Equivalency Factor (TEF)	0.1	0.1	0.1	0.1
TEQ 2 3 7 8 - TCDF Mass Concentration (ng)	0.1570	0.1220	0.1030	0.0691

CALCULATED DATA

Absolute Pressure (In. Hg)	29.25	29.25	29.25	29.25
Dry Gas Meter Sample Volume at Standard Conditions (DSCF)	49.559	42.437	40.930	37.344
Water Vapor Volume at Standard Conditions (SCF)	8.538	7.089	5.870	6.595
Moisture Fraction (Unitless)	0.147	0.143	0.125	0.150
Dry Molecular Weight of Stack Gas (Lb/Lb-Mole)	29.81	29.71	29.71	29.54
Wet Molecular Weight of Stack Gas (Lb/Lb-Mole)	28.07	28.03	28.24	27.81
Stack Gas Velocity (FPS)	45.6	38.5	36.6	38.4
Stack Gas Flow Rate at Actual Conditions (ACFM)	34,359	29,043	27,601	28,930
Stack Gas Flow Rate at Dry Standard Conditions (DSCFM)	23,062	19,732	19,258	19,677
Isokinetic Sampling (%)	96.8	96.9	95.8	85.5
TEQ 2 3 7 8 - TCDF Emission Concentration (Gr/DSCF)	4.89E-11	4.44E-11	3.88E-11	2.86E-11
TEQ 2 3 7 8 - TCDF Emission Concentration (Lb/DSCF)	6.99E-15	6.34E-15	5.55E-15	4.08E-15
TEQ 2 3 7 8 - TCDF Emission Rate (Lb/Hr)	9.67E-09	7.50E-09	6.41E-09	4.82E-09
TEQ 2 3 7 8 - TCDF Emission Rate (Lb/Run)	3.09E-08	2.40E-08	2.05E-08	1.54E-08
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM)	0.1119	0.1016	0.0889	0.0654
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM@7% O2	0.1614	0.1638	0.1430	0.1340

TABLE 3K
EPA METHOD 23
TEQ 1 2 3 7 8 - PENTACHLORODIBENZOFURAN (PeCDF) EMISSIONS TEST RESULTS

CLIENT: Recycling Solutions
SOURCE TESTED: Unit 1

PROJECT NC 08-293

INPUT DATA

Run Number	1	2	3	4
Date	09/26/08	09/26/08	09/26/08	09/26/08
Sampling Location	Unit 1	Unit 1	Unit 1	Unit 1
Test Time, Start	9:45	12:15	14:25	16:35
Stop (24 Hour)	10:50	13:23	15:30	17:44
Sampling Time (Minutes)	60	60	60	60
Stack Area (Ft²)	12.566	12.566	12.566	12.566
Pitot Tube Coefficient (Unitless)	0.84	0.84	0.84	0.84
Dry Gas Meter Correction Factor (Unitless)	1.003	1.003	1.003	1.003
Nozzle Area (Ft²)	0.000465	0.000465	0.000465	0.000465
Barometric Pressure (In. Hg)	29.27	29.27	29.27	29.27
Static Pressure (In. H2O)	-0.28	-0.28	-0.28	-0.28
Dry Gas Meter Sample Volume (DCF)	50.393	43.950	42.248	38.995
Average Dry Gas Meter Temperature (°F)	70.0	79.0	77.0	83.0
Average Orifice Meter Delta H (In. H2O)	2.350	1.754	1.595	1.417
Volume Condensate Collected (Ml)	181.4	150.6	124.7	140.1
Average CO2 Concentration (%)	8.5	7.6	7.6	6.1
Average O2 Concentration (%)	11.3	12.3	12.3	14.1
Average Square Root of Delta P (In. H2O½)	0.710	0.602	0.576	0.600
Average Stack Gas Temperature (°F)	196.0	191.0	187.0	185.0
Toxic Equivalency Factor (TEF)	0.05	0.05	0.05	0.05
TEQ 1 2 3 7 8 - PeCDF Mass Concentration (ng)	0.0945	0.0665	0.0630	0.0425

CALCULATED DATA

Absolute Pressure (In. Hg)	29.25	29.25	29.25	29.25
Dry Gas Meter Sample Volume at Standard Conditions (DSCF)	49.559	42.437	40.930	37.344
Water Vapor Volume at Standard Conditions (SCF)	8.538	7.089	5.870	6.595
Moisture Fraction (Unitless)	0.147	0.143	0.125	0.150
Dry Molecular Weight of Stack Gas (Lb/Lb-Mole)	29.81	29.71	29.71	29.54
Wet Molecular Weight of Stack Gas (Lb/Lb-Mole)	28.07	28.03	28.24	27.81
Stack Gas Velocity (FPS)	45.6	38.5	36.6	38.4
Stack Gas Flow Rate at Actual Conditions (ACFM)	34,359	29,043	27,601	28,930
Stack Gas Flow Rate at Dry Standard Conditions (DSCFM)	23,062	19,732	19,258	19,677
Isokinetic Sampling (%)	96.8	96.9	95.8	85.5
TEQ 1 2 3 7 8 - PeCDF Emission Concentration (Gr/DSCF)	2.94E-11	2.42E-11	2.38E-11	1.75E-11
TEQ 1 2 3 7 8 - PeCDF Emission Concentration (Lb/DSCF)	4.20E-15	3.46E-15	3.39E-15	2.51E-15
TEQ 1 2 3 7 8 - PeCDF Emission Rate (Lb/Hr)	5.82E-09	4.09E-09	3.92E-09	2.96E-09
TEQ 1 2 3 7 8 - PeCDF Emission Rate (Lb/Run)	1.86E-08	1.31E-08	1.25E-08	9.47E-09
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM)	0.0674	0.0554	0.0544	0.0402
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM@7% O2)	0.0971	0.0893	0.0875	0.0823

TABLE 3L
EPA METHOD 23
TEQ 2 3 4 7 8 - PENTACHLORODIBENZOFURAN (PeCDF) EMISSIONS TEST RESULTS

CLIENT: Recycling Solutions
SOURCE TESTED: Unit 1

PROJECT N(08-293

INPUT DATA

Run Number	1	2	3	4
Date	09/26/08	09/26/08	09/26/08	09/26/08
Sampling Location	Unit 1	Unit 1	Unit 1	Unit 1
Test Time, Start	9:45	12:15	14:25	16:35
Stop (24 Hour)	10:50	13:23	15:30	17:44
Sampling Time (Minutes)	60	60	60	60
Stack Area (Ft²)	12.566	12.566	12.566	12.566
Pitot Tube Coefficient (Unitless)	0.84	0.84	0.84	0.84
Dry Gas Meter Correction Factor (Unitless)	1.003	1.003	1.003	1.003
Nozzle Area (Ft²)	0.000465	0.000465	0.000465	0.000465
Barometric Pressure (In. Hg)	29.27	29.27	29.27	29.27
Static Pressure (In. H2O)	-0.28	-0.28	-0.28	-0.28
Dry Gas Meter Sample Volume (DCF)	50.393	43.950	42.248	38.995
Average Dry Gas Meter Temperature (°F)	70.0	79.0	77.0	83.0
Average Orifice Meter Delta H (In. H2O)	2.350	1.754	1.595	1.417
Volume Condensate Collected (Ml)	181.4	150.6	124.7	140.1
Average CO2 Concentration (%)	8.5	7.6	7.6	6.1
Average O2 Concentration (%)	11.3	12.3	12.3	14.1
Average Square Root of Delta P (In. H2O½)	0.710	0.602	0.576	0.600
Average Stack Gas Temperature (°F)	196.0	191.0	187.0	185.0
Toxic Equivalency Factor (TEF)	0.5	0.5	0.5	0.5
TEQ 2 3 4 7 8 - PeCDF Mass Concentration (ng)	1.7350	1.1350	1.1350	0.7400

CALCULATED DATA

Absolute Pressure (In. Hg)	29.25	29.25	29.25	29.25
Dry Gas Meter Sample Volume at Standard Conditions (DSCF)	49.559	42.437	40.930	37.344
Water Vapor Volume at Standard Conditions (SCF)	8.538	7.089	5.870	6.595
Moisture Fraction (Unitless)	0.147	0.143	0.125	0.150
Dry Molecular Weight of Stack Gas (Lb/Lb-Mole)	29.81	29.71	29.71	29.54
Wet Molecular Weight of Stack Gas (Lb/Lb-Mole)	28.07	28.03	28.24	27.81
Stack Gas Velocity (FPS)	45.6	38.5	36.6	38.4
Stack Gas Flow Rate at Actual Conditions (ACFM)	34,359	29,043	27,601	28,930
Stack Gas Flow Rate at Dry Standard Conditions (DSCFM)	23,062	19,732	19,258	19,677
Isokinetic Sampling (%)	96.8	96.9	95.8	85.5
TEQ 2 3 4 7 8 - PeCDF Emission Concentration (Gr/DSCF)	5.40E-10	4.13E-10	4.28E-10	3.06E-10
TEQ 2 3 4 7 8 - PeCDF Emission Concentration (Lb/DSCF)	7.72E-14	5.90E-14	6.11E-14	4.37E-14
TEQ 2 3 4 7 8 - PeCDF Emission Rate (Lb/Hr)	1.07E-07	6.98E-08	7.07E-08	5.16E-08
TEQ 2 3 4 7 8 - PeCDF Emission Rate (Lb/Run)	3.42E-07	2.23E-07	2.26E-07	1.65E-07
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM)	1.2367	0.9448	0.9796	0.7000
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM@7% O2	1.7832	1.5234	1.5759	1.4351

TABLE 3M
EPA METHOD 23
TEQ 1 2 3 4 7 8 - HEXACHLORODIBENZOFURAN (HxCDF) EMISSIONS TEST RESULTS

CLIENT: Recycling Solutions
SOURCE TESTED: Unit 1

PROJECT NO. 08-293

INPUT DATA

Run Number	1	2	3	4
Date	09/26/08	09/26/08	09/26/08	09/26/08
Sampling Location	Unit 1	Unit 1	Unit 1	Unit 1
Test Time, Start	9:45	12:15	14:25	16:35
Stop (24 Hour)	10:50	13:23	15:30	17:44
Sampling Time (Minutes)	60	60	60	60
Stack Area (Ft²)	12.566	12.566	12.566	12.566
Pitot Tube Coefficient (Unitless)	0.84	0.84	0.84	0.84
Dry Gas Meter Correction Factor (Unitless)	1.003	1.003	1.003	1.003
Nozzle Area (Ft²)	0.000465	0.000465	0.000465	0.000465
Barometric Pressure (In. Hg)	29.27	29.27	29.27	29.27
Static Pressure (In. H2O)	-0.28	-0.28	-0.28	-0.28
Dry Gas Meter Sample Volume (DCF)	50.393	43.950	42.248	38.995
Average Dry Gas Meter Temperature (°F)	70.0	79.0	77.0	83.0
Average Orifice Meter Delta H (In. H2O)	2.350	1.754	1.595	1.417
Volume Condensate Collected (Ml)	181.4	150.6	124.7	140.1
Average CO2 Concentration (%)	8.5	7.6	7.6	6.1
Average O2 Concentration (%)	11.3	12.3	12.3	14.1
Average Square Root of Delta P (In. H2O½)	0.710	0.602	0.576	0.600
Average Stack Gas Temperature (°F)	196.0	191.0	187.0	185.0
Toxic Equivalency Factor (TEF)	0.1	0.1	0.1	0.1
TEQ 1 2 3 4 7 8 - HxCDF Mass Concentration (ng)	0.2340	0.1380	0.1530	0.0943

CALCULATED DATA

Absolute Pressure (In. Hg)	29.25	29.25	29.25	29.25
Dry Gas Meter Sample Volume at Standard Conditions (DSCF)	49.559	42.437	40.930	37.344
Water Vapor Volume at Standard Conditions (SCF)	8.538	7.089	5.870	6.595
Moisture Fraction (Unitless)	0.147	0.143	0.125	0.150
Dry Molecular Weight of Stack Gas (Lb/Lb-Mole)	29.81	29.71	29.71	29.54
Wet Molecular Weight of Stack Gas (Lb/Lb-Mole)	28.07	28.03	28.24	27.81
Stack Gas Velocity (FPS)	45.6	38.5	36.6	38.4
Stack Gas Flow Rate at Actual Conditions (ACFM)	34,359	29,043	27,601	28,930
Stack Gas Flow Rate at Dry Standard Conditions (DSCFM)	23,062	19,732	19,258	19,677
Isokinetic Sampling (%)	96.8	96.9	95.8	85.5
TEQ 1 2 3 4 7 8 - HxCDF Emission Concentration (Gr/DSCF)	7.29E-11	5.02E-11	5.77E-11	3.90E-11
TEQ 1 2 3 4 7 8 - HxCDF Emission Concentration (Lb/DSCF)	1.04E-14	7.17E-15	8.24E-15	5.57E-15
TEQ 1 2 3 4 7 8 - HxCDF Emission Rate (Lb/Hr)	1.44E-08	8.49E-09	9.52E-09	6.57E-09
TEQ 1 2 3 4 7 8 - HxCDF Emission Rate (Lb/Run)	4.61E-08	2.72E-08	3.05E-08	2.10E-08
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM)	0.1668	0.1149	0.1320	0.0892
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM@7% O2	0.2405	0.1852	0.2124	0.1829

TABLE 3N
EPA METHOD 23
TEQ 1 2 3 6 7 8 - HEXACHLORODIBENZOFURAN (HxCDF) EMISSIONS TEST RESULTS

CLIENT: Recycling Solutions
SOURCE TESTED: Unit 1

PROJECT NO.: 08-293

INPUT DATA

Run Number	1	2	3	4
Date	09/26/08	09/26/08	09/26/08	09/26/08
Sampling Location	Unit 1	Unit 1	Unit 1	Unit 1
Test Time, Start	9:45	12:15	14:25	16:35
Stop (24 Hour)	10:50	13:23	15:30	17:44
Sampling Time (Minutes)	60	60	60	60
Stack Area (Ft²)	12.566	12.566	12.566	12.566
Pitot Tube Coefficient (Unitless)	0.84	0.84	0.84	0.84
Dry Gas Meter Correction Factor (Unitless)	1.003	1.003	1.003	1.003
Nozzle Area (Ft²)	0.000465	0.000465	0.000465	0.000465
Barometric Pressure (In. Hg)	29.27	29.27	29.27	29.27
Static Pressure (In. H2O)	-0.28	-0.28	-0.28	-0.28
Dry Gas Meter Sample Volume (DCF)	50.393	43.950	42.248	38.995
Average Dry Gas Meter Temperature (°F)	70.0	79.0	77.0	83.0
Average Orifice Meter Delta H (In. H2O)	2.350	1.754	1.595	1.417
Volume Condensate Collected (Ml)	181.4	150.6	124.7	140.1
Average CO2 Concentration (%)	8.5	7.6	7.6	6.1
Average O2 Concentration (%)	11.3	12.3	12.3	14.1
Average Square Root of Delta P (In. H2O½)	0.710	0.602	0.576	0.600
Average Stack Gas Temperature (°F)	196.0	191.0	187.0	185.0
Toxic Equivalency Factor (TEF)	0.1	0.1	0.1	0.1
TEQ 1 2 3 6 7 8 - HxCDF Mass Concentration (ng)	0.2500	0.1470	0.1650	0.1010

CALCULATED DATA

Absolute Pressure (In. Hg)	29.25	29.25	29.25	29.25
Dry Gas Meter Sample Volume at Standard Conditions (DSCF)	49.559	42.437	40.930	37.344
Water Vapor Volume at Standard Conditions (SCF)	8.538	7.089	5.870	6.595
Moisture Fraction (Unitless)	0.147	0.143	0.125	0.150
Dry Molecular Weight of Stack Gas (Lb/Lb-Mole)	29.81	29.71	29.71	29.54
Wet Molecular Weight of Stack Gas (Lb/Lb-Mole)	28.07	28.03	28.24	27.81
Stack Gas Velocity (FPS)	45.6	38.5	36.6	38.4
Stack Gas Flow Rate at Actual Conditions (ACFM)	34,359	29,043	27,601	28,930
Stack Gas Flow Rate at Dry Standard Conditions (DSCFM)	23,062	19,732	19,258	19,677
Isokinetic Sampling (%)	96.8	96.9	95.8	85.5
TEQ 1 2 3 6 7 8 - HxCDF Emission Concentration (Gr/DSCF)	7.79E-11	5.35E-11	6.22E-11	4.17E-11
TEQ 1 2 3 6 7 8 - HxCDF Emission Concentration (Lb/DSCF)	1.11E-14	7.64E-15	8.89E-15	5.96E-15
TEQ 1 2 3 6 7 8 - HxCDF Emission Rate (Lb/Hr)	1.54E-08	9.04E-09	1.03E-08	7.04E-09
TEQ 1 2 3 6 7 8 - HxCDF Emission Rate (Lb/Run)	4.93E-08	2.89E-08	3.29E-08	2.25E-08
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM)	0.1782	0.1224	0.1424	0.0955
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM@7% O2)	0.2569	0.1973	0.2291	0.1959

TABLE 3O
EPA METHOD 23
TEQ 2 3 4 6 7 8 - HEXACHLORODIBENZOFURAN (HxCDF) EMISSIONS TEST RESULTS

CLIENT: Recycling Solutions
SOURCE TESTED: Unit 1

PROJECT N(08-293

INPUT DATA

Run Number	1	2	3	4
Date	09/26/08	09/26/08	09/26/08	09/26/08
Sampling Location	Unit 1	Unit 1	Unit 1	Unit 1
Test Time, Start	9:45	12:15	14:25	16:35
Stop (24 Hour)	10:50	13:23	15:30	17:44
Sampling Time (Minutes)	60	60	60	60
Stack Area (Ft²)	12.566	12.566	12.566	12.566
Pitot Tube Coefficient (Unitless)	0.84	0.84	0.84	0.84
Dry Gas Meter Correction Factor (Unitless)	1.003	1.003	1.003	1.003
Nozzle Area (Ft²)	0.000465	0.000465	0.000465	0.000465
Barometric Pressure (In. Hg)	29.27	29.27	29.27	29.27
Static Pressure (In. H2O)	-0.28	-0.28	-0.28	-0.28
Dry Gas Meter Sample Volume (DCF)	50.393	43.950	42.248	38.995
Average Dry Gas Meter Temperature (°F)	70.0	79.0	77.0	83.0
Average Orifice Meter Delta H (In. H2O)	2.350	1.754	1.595	1.417
Volume Condensate Collected (Ml)	181.4	150.6	124.7	140.1
Average CO2 Concentration (%)	8.5	7.6	7.6	6.1
Average O2 Concentration (%)	11.3	12.3	12.3	14.1
Average Square Root of Delta P (In. H2O½)	0.710	0.602	0.576	0.600
Average Stack Gas Temperature (°F)	196.0	191.0	187.0	185.0
Toxic Equivalency Factor (TEF)	0.1	0.1	0.1	0.1
TEQ 2 3 4 6 7 8 - HxCDF Mass Concentration (ng)	0.2610	0.1450	0.1710	0.1050

CALCULATED DATA

Absolute Pressure (In. Hg)	29.25	29.25	29.25	29.25
Dry Gas Meter Sample Volume at Standard Conditions (DSCF)	49.559	42.437	40.930	37.344
Water Vapor Volume at Standard Conditions (SCF)	8.538	7.089	5.870	6.595
Moisture Fraction (Unitless)	0.147	0.143	0.125	0.150
Dry Molecular Weight of Stack Gas (Lb/Lb-Mole)	29.81	29.71	29.71	29.54
Wet Molecular Weight of Stack Gas (Lb/Lb-Mole)	28.07	28.03	28.24	27.81
Stack Gas Velocity (FPS)	45.6	38.5	36.6	38.4
Stack Gas Flow Rate at Actual Conditions (ACFM)	34,359	29,043	27,601	28,930
Stack Gas Flow Rate at Dry Standard Conditions (DSCFM)	23,062	19,732	19,258	19,677
Isokinetic Sampling (%)	96.8	96.9	95.8	85.5
TEQ 2 3 4 6 7 8 - HxCDF Emission Concentration (Gr/DSCF)	8.13E-11	5.27E-11	6.45E-11	4.34E-11
TEQ 2 3 4 6 7 8 - HxCDF Emission Concentration (Lb/DSCF)	1.16E-14	7.53E-15	9.21E-15	6.20E-15
TEQ 2 3 4 6 7 8 - HxCDF Emission Rate (Lb/Hr)	1.61E-08	8.92E-09	1.06E-08	7.32E-09
TEQ 2 3 4 6 7 8 - HxCDF Emission Rate (Lb/Run)	5.14E-08	2.85E-08	3.41E-08	2.34E-08
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM)	0.1860	0.1207	0.1476	0.0993
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM@7% O2	0.2682	0.1946	0.2374	0.2036

TABLE 3P
EPA METHOD 23
TEQ 1 2 3 7 8 9 - HEXACHLORODIBENZOFURAN (HxCDF) EMISSIONS TEST RESULTS

CLIENT:	Recycling Solutions	PROJECT N(08-293
SOURCE TESTED:	Unit 1	

INPUT DATA

Run Number	1	2	3	4
Date	09/26/08	09/26/08	09/26/08	09/26/08
Sampling Location	Unit 1	Unit 1	Unit 1	Unit 1
Test Time, Start	9:45	12:15	14:25	16:35
Stop (24 Hour)	10:50	13:23	15:30	17:44
Sampling Time (Minutes)	60	60	60	60
Stack Area (Ft^2)	12.566	12.566	12.566	12.566
Pitot Tube Coefficient (Unitless)	0.84	0.84	0.84	0.84
Dry Gas Meter Correction Factor (Unitless)	1.003	1.003	1.003	1.003
Nozzle Area (Ft^2)	0.000465	0.000465	0.000465	0.000465
Barometric Pressure (In. Hg)	29.27	29.27	29.27	29.27
Static Pressure (In. H2O)	-0.28	-0.28	-0.28	-0.28
Dry Gas Meter Sample Volume (DCF)	50.393	43.950	42.248	38.995
Average Dry Gas Meter Temperature (°F)	70.0	79.0	77.0	83.0
Average Orifice Meter Delta H (In. H2O)	2.350	1.754	1.595	1.417
Volume Condensate Collected (Ml)	181.4	150.6	124.7	140.1
Average CO2 Concentration (%)	8.5	7.6	7.6	6.1
Average O2 Concentration (%)	11.3	12.3	12.3	14.1
Average Square Root of Delta P (In. H2O½)	0.710	0.602	0.576	0.600
Average Stack Gas Temperature (°F)	196.0	191.0	187.0	185.0
Toxic Equivalency Factor (TEF)	0.1	0.1	0.1	0.1
TEQ 1 2 3 7 8 9 - HxCDF Mass Concentration (ng)	0.06350	0.03330	0.03940	0.02470

CALCULATED DATA

Absolute Pressure (In. Hg)	29.25	29.25	29.25	29.25
Dry Gas Meter Sample Volume at Standard Conditions (DSCF)	49.559	42.437	40.930	37.344
Water Vapor Volume at Standard Conditions (SCF)	8.538	7.089	5.870	6.595
Moisture Fraction (Unitless)	0.147	0.143	0.125	0.150
Dry Molecular Weight of Stack Gas (Lb/Lb-Mole)	29.81	29.71	29.71	29.54
Wet Molecular Weight of Stack Gas (Lb/Lb-Mole)	28.07	28.03	28.24	27.81
Stack Gas Velocity (FPS)	45.6	38.5	36.6	38.4
Stack Gas Flow Rate at Actual Conditions (ACFM)	34,359	29,043	27,601	28,930
Stack Gas Flow Rate at Dry Standard Conditions (DSCFM)	23,062	19,732	19,258	19,677
Isokinetic Sampling (%)	96.8	96.9	95.8	85.5
TEQ 1 2 3 7 8 9 - HxCDF Emission Concentration (Gr/DSCF)	1.98E-11	1.21E-11	1.49E-11	1.02E-11
TEQ 1 2 3 7 8 9 - HxCDF Emission Concentration (Lb/DSCF)	2.83E-15	1.73E-15	2.12E-15	1.46E-15
TEQ 1 2 3 7 8 9 - HxCDF Emission Rate (Lb/Hr)	3.91E-09	2.05E-09	2.45E-09	1.72E-09
TEQ 1 2 3 7 8 9 - HxCDF Emission Rate (Lb/Run)	1.25E-08	6.56E-09	7.85E-09	5.51E-09
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM)	0.0453	0.0277	0.0340	0.0234
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM@7% O2	0.0653	0.0447	0.0547	0.0479

TABLE 3Q
EPA METHOD 23
TEQ 1 2 3 4 6 7 8 - HEPTACHLORODIBENZOFURAN (HpCDF) EMISSIONS TEST RESULTS

CLIENT:	Recycling Solutions	PROJECT N(08-293
SOURCE TESTED:	Unit 1	

INPUT DATA

Run Number	1	2	3	4
Date	09/26/08	09/26/08	09/26/08	09/26/08
Sampling Location	Unit 1	Unit 1	Unit 1	Unit 1
Test Time, Start	9:45	12:15	14:25	16:35
Stop (24 Hour)	10:50	13:23	15:30	17:44
Sampling Time (Minutes)	60	60	60	60
Stack Area (Ft²)	12.566	12.566	12.566	12.566
Pitot Tube Coefficient (Unitless)	0.84	0.84	0.84	0.84
Dry Gas Meter Correction Factor (Unitless)	1.003	1.003	1.003	1.003
Nozzle Area (Ft²)	0.000465	0.000465	0.000465	0.000465
Barometric Pressure (In. Hg)	29.27	29.27	29.27	29.27
Static Pressure (In. H2O)	-0.28	-0.28	-0.28	-0.28
Dry Gas Meter Sample Volume (DCF)	50.393	43.950	42.248	38.995
Average Dry Gas Meter Temperature (°F)	70.0	79.0	77.0	83.0
Average Orifice Meter Delta H (In. H2O)	2.350	1.754	1.595	1.417
Volume Condensate Collected (Ml)	181.4	150.6	124.7	140.1
Average CO2 Concentration (%)	8.5	7.6	7.6	6.1
Average O2 Concentration (%)	11.3	12.3	12.3	14.1
Average Square Root of Delta P (In. H2O½)	0.710	0.602	0.576	0.600
Average Stack Gas Temperature (°F)	196.0	191.0	187.0	185.0
Toxic Equivalency Factor (TEF)	0.01	0.01	0.01	0.01
TEQ 1 2 3 4 6 7 8 - HpCDF Mass Concentration (ng)	0.0511	0.0252	0.0334	0.0205

CALCULATED DATA

Absolute Pressure (In. Hg)	29.25	29.25	29.25	29.25
Dry Gas Meter Sample Volume at Standard Conditions (DSCF)	49.559	42.437	40.930	37.344
Water Vapor Volume at Standard Conditions (SCF)	8.538	7.089	5.870	6.595
Moisture Fraction (Unitless)	0.147	0.143	0.125	0.150
Dry Molecular Weight of Stack Gas (Lb/Lb-Mole)	29.81	29.71	29.71	29.54
Wet Molecular Weight of Stack Gas (Lb/Lb-Mole)	28.07	28.03	28.24	27.81
Stack Gas Velocity (FPS)	45.6	38.5	36.6	38.4
Stack Gas Flow Rate at Actual Conditions (ACFM)	34,359	29,043	27,601	28,930
Stack Gas Flow Rate at Dry Standard Conditions (DSCFM)	23,062	19,732	19,258	19,677
Isokinetic Sampling (%)	96.8	96.9	95.8	85.5
TEQ 1 2 3 4 6 7 8 - HpCDF Emission Concentration (Gr/DSCF)	1.59E-11	9.17E-12	1.26E-11	8.47E-12
TEQ 1 2 3 4 6 7 8 - HpCDF Emission Concentration (Lb/DSCF)	2.27E-15	1.31E-15	1.80E-15	1.21E-15
TEQ 1 2 3 4 6 7 8 - HpCDF Emission Rate (Lb/Hr)	3.15E-09	1.55E-09	2.08E-09	1.43E-09
TEQ 1 2 3 4 6 7 8 - HpCDF Emission Rate (Lb/Run)	1.01E-08	4.96E-09	6.65E-09	4.57E-09
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM)	0.0364	0.0210	0.0288	0.0194
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM@7% O2	0.0525	0.0338	0.0464	0.0398

TABLE 3R
EPA METHOD 23
TEQ 1 2 3 4 7 8 9 - HEPTACHLORODIBENZOFURAN (HpCDF) EMISSIONS TEST RESULTS

CLIENT: Recycling Solutions

SOURCE TESTED: Unit 1

PROJECT NO. 08-293

INPUT DATA

Run Number	1	2	3	4
Date	09/26/08	09/26/08	09/26/08	09/26/08
Sampling Location	Unit 1	Unit 1	Unit 1	Unit 1
Test Time, Start	9:45	12:15	14:25	16:35
Stop (24 Hour)	10:50	13:23	15:30	17:44
Sampling Time (Minutes)	60	60	60	60
Stack Area (Ft²)	12.566	12.566	12.566	12.566
Pitot Tube Coefficient (Unitless)	0.84	0.84	0.84	0.84
Dry Gas Meter Correction Factor (Unitless)	1.003	1.003	1.003	1.003
Nozzle Area (Ft²)	0.000465	0.000465	0.000465	0.000465
Barometric Pressure (In. Hg)	29.27	29.27	29.27	29.27
Static Pressure (In. H2O)	-0.28	-0.28	-0.28	-0.28
Dry Gas Meter Sample Volume (DCF)	50.393	43.950	42.248	38.995
Average Dry Gas Meter Temperature (°F)	70.0	79.0	77.0	83.0
Average Orifice Meter Delta H (In. H2O)	2.350	1.754	1.595	1.417
Volume Condensate Collected (Ml)	181.4	150.6	124.7	140.1
Average CO2 Concentration (%)	8.5	7.6	7.6	6.1
Average O2 Concentration (%)	11.3	12.3	12.3	14.1
Average Square Root of Delta P (In. H2O½)	0.710	0.602	0.576	0.600
Average Stack Gas Temperature (°F)	196.0	191.0	187.0	185.0
Toxic Equivalency Factor (TEF)	0.01	0.01	0.01	0.01
TEQ 1 2 3 4 7 8 9 - HpCDF Mass Concentration (ng)	0.00471	0.00206	0.00296	0.00187

CALCULATED DATA

Absolute Pressure (In. Hg)	29.25	29.25	29.25	29.25
Dry Gas Meter Sample Volume at Standard Conditions (DSCF)	49.559	42.437	40.930	37.344
Water Vapor Volume at Standard Conditions (SCF)	8.538	7.089	5.870	6.595
Moisture Fraction (Unitless)	0.147	0.143	0.125	0.150
Dry Molecular Weight of Stack Gas (Lb/Lb-Mole)	29.81	29.71	29.71	29.54
Wet Molecular Weight of Stack Gas (Lb/Lb-Mole)	28.07	28.03	28.24	27.81
Stack Gas Velocity (FPS)	45.6	38.5	36.6	38.4
Stack Gas Flow Rate at Actual Conditions (ACFM)	34,359	29,043	27,601	28,930
Stack Gas Flow Rate at Dry Standard Conditions (DSCFM)	23,062	19,732	19,258	19,677
Isokinetic Sampling (%)	96.8	96.9	95.8	85.5
TEQ 1 2 3 4 7 8 9 - HpCDF Emission Concentration (Gr/DSCF)	1.47E-12	7.49E-13	1.12E-12	7.73E-13
TEQ 1 2 3 4 7 8 9 - HpCDF Emission Concentration (Lb/DSCF)	2.10E-16	1.07E-16	1.59E-16	1.10E-16
TEQ 1 2 3 4 7 8 9 - HpCDF Emission Rate (Lb/Hr)	2.90E-10	1.27E-10	1.84E-10	1.30E-10
TEQ 1 2 3 4 7 8 9 - HpCDF Emission Rate (Lb/Run)	9.28E-10	4.06E-10	5.90E-10	4.17E-10
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM)	0.0034	0.0017	0.0026	0.0018
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM@7% O2	0.0048	0.0028	0.0041	0.0036

TABLE 3S
EPA METHOD 23
TEQ 1 2 3 4 6 7 8 9 - OCTACHLORODIBENZOFURAN (OCDF) EMISSIONS TEST RESULTS

CLIENT: Recycling Solutions
SOURCE TESTED: Unit 1

PROJECT NO. 08-293

INPUT DATA

Run Number	1	2	3	4
Date	09/26/08	09/26/08	09/26/08	09/26/08
Sampling Location	Unit 1	Unit 1	Unit 1	Unit 1
Test Time, Start	9:45	12:15	14:25	16:35
Stop (24 Hour)	10:50	13:23	15:30	17:44
Sampling Time (Minutes)	60	60	60	60
Stack Area (Ft²)	12.566	12.566	12.566	12.566
Pitot Tube Coefficient (Unitless)	0.84	0.84	0.84	0.84
Dry Gas Meter Correction Factor (Unitless)	1.003	1.003	1.003	1.003
Nozzle Area (Ft²)	0.000465	0.000465	0.000465	0.000465
Barometric Pressure (In. Hg)	29.27	29.27	29.27	29.27
Static Pressure (In. H2O)	-0.28	-0.28	-0.28	-0.28
Dry Gas Meter Sample Volume (DCF)	50.393	43.950	42.248	38.995
Average Dry Gas Meter Temperature (°F)	70.0	79.0	77.0	83.0
Average Orifice Meter Delta H (In. H2O)	2.350	1.754	1.595	1.417
Volume Condensate Collected (Ml)	181.4	150.6	124.7	140.1
Average CO2 Concentration (%)	8.5	7.6	7.6	6.1
Average O2 Concentration (%)	11.3	12.3	12.3	14.1
Average Square Root of Delta P (In. H2O½)	0.710	0.602	0.576	0.600
Average Stack Gas Temperature (°F)	196.0	191.0	187.0	185.0
Toxic Equivalency Factor (TEF)	0.001	0.001	0.001	0.001
TEQ 1 2 3 4 6 7 8 9 - OCDF Mass Concentration (ng)	0.000984	0.000376	0.000628	0.000426

CALCULATED DATA

Absolute Pressure (In. Hg)	29.25	29.25	29.25	29.25
Dry Gas Meter Sample Volume at Standard Conditions (DSCF)	49.559	42.437	40.930	37.344
Water Vapor Volume at Standard Conditions (SCF)	8.538	7.089	5.870	6.595
Moisture Fraction (Unitless)	0.147	0.143	0.125	0.150
Dry Molecular Weight of Stack Gas (Lb/Lb-Mole)	29.81	29.71	29.71	29.54
Wet Molecular Weight of Stack Gas (Lb/Lb-Mole)	28.07	28.03	28.24	27.81
Stack Gas Velocity (FPS)	45.6	38.5	36.6	38.4
Stack Gas Flow Rate at Actual Conditions (ACFM)	34,359	29,043	27,601	28,930
Stack Gas Flow Rate at Dry Standard Conditions (DSCFM)	23,062	19,732	19,258	19,677
Isokinetic Sampling (%)	96.8	96.9	95.8	85.5
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (Gr/DSCF)	3.06E-13	1.37E-13	2.37E-13	1.76E-13
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (Lb/DSCF)	4.38E-17	1.95E-17	3.38E-17	2.52E-17
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Rate (Lb/Hr)	6.06E-11	2.31E-11	3.91E-11	2.97E-11
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Rate (Lb/Run)	1.94E-10	7.40E-11	1.25E-10	9.50E-11
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM)	0.0007	0.0003	0.0005	0.0004
TEQ 1 2 3 4 6 7 8 9 - OCDF Emission Concentration (ng/DSCM@7% O2	0.0010	0.0005	0.0009	0.0008

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Sampling System Bias Check and Measured Value Correction

Recycling Solutions Technology
Davella, KY - Unit 1

Date: 9/25/2008
Pollutant: CO2
Monitor Span: 17.9

Run Number	Average Measured Percent	Initial Zero Gas Bias	Final Zero Gas Bias	Zero Gas Drift	Initial Upscale Gas Bias	Final Upscale Gas Bias	Upscale Gas Drift	Calibration Gas	Corrected Percent, Dry Basis
1	7.68	0.05	0.05	0.00	8.92	9.05	0.73	9.11	7.78
2	5.92	0.05	0.06	0.06	9.05	9.03	-0.11	9.11	5.95
3	8.15	0.06	0.04	-0.11	9.03	9.00	-0.17	9.11	8.23

$$\mathrm{Cgas} = (\mathrm{Cavg} - \mathrm{Co}) * \mathrm{Cma} / (\mathrm{Cm} - \mathrm{Co}) \qquad \text{Eq. 6C-1}$$

where:

Cgas = Effluent gas concentration, dry basis, percent
Cavg = Average gas concentration indicated by gas analyzer, dry basis, percent
Co = Average of initial and final system calibration bias check responses for the zero gas, percent
Cm = Average of initial and final system calibration bias check responses for the upscale calibration gas, percent
Cma = Actual concentration of the upscale calibration gas, percent

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Sampling System Bias Check and Measured Value Correction

Recycling Solutions Technology
Davella, KY - Unit 1

Date: 9/25/2008
Pollutant: O2
Monitor Span: 22.5

Run Number	Average Measured Percent	Initial Zero Gas Bias	Final Zero Gas Bias	Zero Gas Drift	Initial Upscale Gas Bias	Final Upscale Gas Bias	Upscale Gas Drift	Calibration Gas	Corrected Percent, Dry Basis
1	12.05	0.59	0.29	-1.33	11.13	11.00	-0.58	10.90	11.91
2	14.13	0.29	0.31	0.09	11.00	10.98	-0.09	10.90	14.10
3	11.54	0.31	0.25	-0.27	10.98	10.82	-0.71	10.90	11.56

$$\text{Cgas} = (\text{Cavg} - \text{Co}) * \text{Cma} / (\text{Cm} - \text{Co}) \qquad \text{Eq. 6C-1}$$

where:

Cgas = Effluent gas concentration, dry basis, percent
Cavg = Average gas concentration indicated by gas analyzer, dry basis, percent
Co = Average of initial and final system calibration bias check responses for the zero gas, percent
Cm = Average of initial and final system calibration bias check responses for the upscale calibration gas, percent
Cma = Actual concentration of the upscale calibration gas, percent

Grace Consulting, Inc.

Sampling System Bias Check and Measured Value Correction

Recycling Solutions Technologies
Davella, KY - Unit 1

Date: 9/26/2008
Pollutant: NOx
Monitor Span: 228

Run Number	Average Measured Value	Initial Zero Gas Bias	Final Zero Gas Bias	Zero Gas Drift	Initial Upscale Gas Bias	Final Upscale Gas Bias	Upscale Gas Drift	Calibration Gas	Corrected Value, Dry Basis
1	78.33	1.90	1.90	0.00	95.20	93.80	-0.61	98.60	81.38
2	60.80	1.90	1.80	-0.04	93.80	94.10	0.13	98.60	63.11
3	62.35	1.80	1.80	0.00	94.10	95.20	0.48	98.60	64.30
4	48.50	1.80	1.90	0.04	95.20	94.15	-0.46	98.60	49.55

$$Cgas = (Cavg - Co) * Cma / (Cm - Co) \qquad \text{Eq. 6C-1}$$

where:

Cgas = Effluent gas concentration, dry basis, ppm
Cavg = Average gas concentration indicated by gas analyzer, dry basis, ppm
Co = Average of initial and final system calibration bias check responses for the zero gas, ppm
Cm = Average of initial and final system calibration bias check responses for the upscale calibration gas, ppm
Cma = Actual concentration of the upscale calibration gas, ppm

Grace Consulting, Inc.

Sampling System Bias Check and Measured Value Correction

Recycling Solutions Technologies
Davella, KY - Unit 1

Date: 9/26/2008
Pollutant: SO2
Monitor Span: 230

Run Number	Average Measured Value	Initial Zero Gas Bias	Final Zero Gas Bias	Zero Gas Drift	Initial Upscale Gas Bias	Final Upscale Gas Bias	Upscale Gas Drift	Calibration Gas	Corrected Value, Dry Basis
1	1.06	1.20	0.79	-0.18	88.10	86.70	-0.61	95.90	0.07
2	0.69	0.79	0.11	-0.30	86.70	85.50	-0.52	95.90	0.27
3	0.58	0.11	0.50	0.17	85.50	85.00	-0.22	95.90	0.31
4	0.43	0.50	0.27	-0.10	85.00	84.80	-0.09	95.90	0.05

Cgas = (Cavg - Co) * Cma / (Cm - Co) Eq. 6C-1

where:
Cgas = Effluent gas concentration, dry basis, ppm
Cavg = Average gas concentration indicated by gas analyzer, dry basis, ppm
Co = Average of initial and final system calibration bias check responses for the zero gas, ppm
Cm = Average of initial and final system calibration bias check responses for the upscale calibration gas, ppm
Cma = Actual concentration of the upscale calibration gas, ppm

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Sampling System Bias Check and Measured Value Correction

Recycling Solutions Technologies
Davella, KY - Unit 1

Date: 9/26/2008
Pollutant: CO
Monitor Span: 453.7

Run Number	Average Measured Value	Initial Zero Gas Bias	Final Zero Gas Bias	Zero Gas Drift	Initial Upscale Gas Bias	Final Upscale Gas Bias	Upscale Gas Drift	Calibration Gas	Corrected Value, Dry Basis
1	144.55	1.10	-0.07	-0.26	215.50	215.70	0.04	209.00	139.96
2	1.38	-0.07	-0.09	0.00	215.70	218.40	0.60	209.00	1.41
3	27.51	-0.09	-0.02	0.02	218.40	217.40	-0.22	209.00	26.43
4	59.16	-0.02	-0.05	-0.01	217.40	218.40	0.22	209.00	56.77

$$Cgas = (Cavg - Co) * Cma / (Cm - Co) \qquad \text{Eq. 6C-1}$$

where:

Cgas = Effluent gas concentration, dry basis, ppm
Cavg = Average gas concentration indicated by gas analyzer, dry basis, ppm
Co = Average of initial and final system calibration bias check responses for the zero gas, ppm
Cm = Average of initial and final system calibration bias check responses for the upscale calibration gas, ppm
Cma = Actual concentration of the upscale calibration gas, ppm

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Sampling System Bias Check and Measured Value Correction

Recycling Solutions Technologies
Davella, KY - Unit 1

Date: 9/26/2008
Pollutant: CO2
Monitor Span: 17.9

Run Number	Average Measured Percent	Initial Zero Gas Bias	Final Zero Gas Bias	Zero Gas Drift	Initial Upscale Gas Bias	Final Upscale Gas Bias	Upscale Gas Drift	Calibration Gas	Corrected Percent, Dry Basis
1	8.44	0.12	0.08	-0.22	9.03	9.04	0.06	9.11	8.50
2	7.56	0.08	0.07	-0.06	9.04	9.05	0.06	9.11	7.60
3	7.58	0.07	0.08	0.06	9.05	9.07	0.11	9.11	7.61
4	6.07	0.08	0.09	0.06	9.07	9.04	-0.17	9.11	6.08

$$\mathrm{Cgas} = (\mathrm{Cavg} - \mathrm{Co}) * \mathrm{Cma} / (\mathrm{Cm} - \mathrm{Co}) \qquad \text{Eq. 6C-1}$$

where:

Cgas = Effluent gas concentration, dry basis, percent
Cavg = Average gas concentration indicated by gas analyzer, dry basis, percent
Co = Average of initial and final system calibration bias check responses for the zero gas, percent
Cm = Average of initial and final system calibration bias check responses for the upscale calibration gas, percent
Cma = Actual concentration of the upscale calibration gas, percent

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Sampling System Bias Check and Measured Value Correction

Recycling Solutions Technologies
Davella, KY - Unit 1

Date: 9/26/2008
Pollutant: O_2
Monitor Span: 22.5

Run Number	Average Measured Percent	Initial Zero Gas Bias	Final Zero Gas Bias	Zero Gas Drift	Initial Upscale Gas Bias	Final Upscale Gas Bias	Upscale Gas Drift	Calibration Gas	Corrected Percent, Dry Basis
1	11.30	0.48	0.40	-0.36	11.07	11.03	-0.18	11.00	11.26
2	12.27	0.40	0.38	-0.09	11.03	11.04	0.04	11.00	12.28
3	12.27	0.38	0.34	-0.18	11.04	11.05	0.04	11.00	12.26
4	14.07	0.34	0.36	0.09	11.05	11.03	-0.09	11.00	14.12

Cgas = (Cavg - Co) * Cma / (Cm - Co)   Eq. 6C-1

where:

Cgas = Effluent gas concentration, dry basis, percent
Cavg = Average gas concentration indicated by gas analyzer, dry basis, percent
Co = Average of initial and final system calibration bias check responses for the zero gas, percent
Cm = Average of initial and final system calibration bias check responses for the upscale calibration gas, percent
Cma = Actual concentration of the upscale calibration gas, percent

SAMPLING AND ANALYTICAL PROCEDURES

METHOD 3A - DETERMINATION OF OXYGEN AND CARBON DIOXIDE CONCENTRATIONS IN EMISSIONS FROM STATIONARY SOURCES (INSTRUMENTAL ANALYZER PROCEDURE)

1.0 Scope and Application

What is Method 3A?

Method 3A is a procedure for measuring oxygen (O_2) and carbon dioxide (CO_2) in stationary source emissions using a continuous instrumental analyzer. Quality assurance and quality control requirements are included to assure that you, the tester, collect data of known quality. You must document your adherence to these specific requirements for equipment, supplies, sample collection and analysis, calculations, and data analysis.

This method does not completely describe all equipment, supplies, and sampling and analytical procedures you will need but refers to other methods for some of the details. Therefore, to obtain reliable results, you should also have a thorough knowledge of these additional test methods which are found in appendix A to this part:

(a) Method 1—Sample and Velocity Traverses for Stationary Sources.

(b) Method 3—Gas Analysis for the Determination of Molecular Weight.

(c) Method 4—Determination of Moisture Content in Stack Gases.

(d) Method 7E—Determination of Nitrogen Oxides Emissions from Stationary Sources (Instrumental Analyzer Procedure).

1.1 Analytes. **What does this method determine?** This method measures the concentration of oxygen and carbon dioxide.

Analyte	CAS No.	Sensitivity
Oxygen (O_2)	7782-44-7	Typically <2% of Calibration Span
Carbon dioxide (CO_2)	124-38-9	Typically <2% of Calibration Span

1.2 Applicability. **When is this method required?** The use of Method 3A may be required by specific New Source Performance Standards, Clean Air Marketing rules, State Implementation Plans and permits, where measurements of O_2 and CO_2 concentrations in stationary source emissions must be made, either to determine compliance with an applicable emission standard or to conduct performance testing of a continuous emission monitoring system (CEMS). Other regulations may also require the use of Method 3A.

1.3 Data Quality Objectives. **How good must my collected data be?** Refer to Section 1.3 of Method 7E.

2.0 Summary of Method

In this method, you continuously or intermittently sample the effluent gas and convey the sample to an analyzer that measures the concentration of O_2 or CO_2. You must meet the performance requirements of this method to validate your data.

3.0 Definitions

Refer to Section 3.0 of Method 7E for the applicable definitions.

4.0 Interferences [Reserved]

5.0 Safety

Refer to Section 5.0 of Method 7E.

6.0 Equipment and Supplies

Figure 7E-1 in Method 7E is a schematic diagram of an acceptable measurement system.

6.1 **What do I need for the measurement system?** The components of the measurement system are described (as applicable) in Sections 6.1 and 6.2 of Method 7E, except that the analyzer described in Section 6.2 of this method must be used instead of the analyzer described in Method 7E. You must follow the noted specifications in Section 6.1 of Method 7E except that the requirements to use stainless steel, Teflon, or non-reactive glass filters do not apply. Also, a heated sample line is not required to transport dry gases or for systems that measure the O_2 or CO_2 concentration on a dry basis, provided that the system is not also being used to concurrently measure SO_2 and/or NO_x.

6.2 **What analyzer must I use?** You must use an analyzer that continuously measures O_2 or CO_2 in the gas stream and meets the specifications in Section 13.0.

7.0 Reagents and Standards

7.1 Calibration Gas. **What calibration gases do I need?** Refer to Section 7.1 of Method 7E for the calibration gas requirements. Example calibration gas mixtures are listed below.

(a) CO_2 in nitrogen (N_2).

(b) CO_2 in air.

(c) CO_2/SO_2 gas mixture in N_2.

(d) O_2/SO_2 gas mixture in N_2.

(e) $O_2/CO_2/SO_2$ gas mixture in N_2.

(f) CO_2/NO_x gas mixture in N_2

(g) $CO_2/SO_2/NO_x$ gas mixture in N_2

The tests for analyzer calibration error and system bias require high-, mid-, and low-level gases.

7.2 Interference Check. **What reagents do I need for the interference check?** Potential interferences may vary among available analyzers. Table 7E-3 of Method 7E lists a number of gases that should be considered in conducting the interference test.

8.0 *Sample Collection, Preservation, Storage, and Transport*

8.1 Sampling Site and Sampling Points. You must follow the procedures of Section 8.1 of Method 7E to determine the appropriate sampling points, unless you are using Method 3A only to determine the stack gas molecular weight and for no other purpose. In that case, you may use single-point integrated sampling as described in Section 8.2 of Method 3. If the stratification test provisions in Section 8.1.2 of Method 7E are used to reduce the number of required sampling points, the alternative acceptance criterion for 3-point sampling will be ± 0.5 percent CO_2 or O_2, and the alternative acceptance criterion for single-point sampling will be ± 0.3 percent CO_2 or O_2.

8.2 Initial Measurement System Performance Tests. You must follow the procedures in Section 8.2 of Method 7E. If a dilution-type measurement system is used, the special considerations in Section 8.3 of Method 7E apply.

8.3 Interference Check. The O_2 or CO_2 analyzer must be documented to show that interference effects to not exceed 2.5 percent of the calibration span. The interference test in Section 8.2.7 of Method 7E is a procedure than may be used to show this. The effects of all potential interferences at the concentrations encountered during testing must be addressed and documented. This testing and documentation may be done by the instrument manufacturer.

8.4 Sample Collection. You must follow the procedures in Section 8.4 of Method 7E.

8.5 Post-Run System Bias Check and Drift Assessment. You must follow the procedures in Sections 8.5 of Method 7E.

9.0 Quality Control

Follow quality control procedures in Section 9.0 of Method 7E.

10.0 Calibration and Standardization

Follow the procedures for calibration and standardization in Section 10.0 of Method 7E.

11.0 Analytical Procedures

Because sample collection and analysis are performed together (see Section 8), additional discussion of the analytical procedure is not necessary.

12.0 Calculations and Data Analysis

You must follow the applicable procedures for calculations and data analysis in Section 12.0 of Method 7E, substituting percent O_2 and percent CO_2 for ppmv of NO_x as appropriate.

13.0 Method Performance

The specifications for the applicable performance checks are the same as in Section 13.0 of Method 7E except for the alternative specifications for system bias, drift, and calibration error. In these alternative specifications, replace the term "0.5 ppmv" with the term "0.5 percent O_2" or "0.5 percent CO_2" (as applicable).

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 Alternative Procedures [Reserved]

17.0 References

A. "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards" September 1997 as amended, EPA-600/R-97/121

18.0 Tables, Diagrams, Flowcharts, and Validation Data

Refer to Section 18.0 of Method 7E.

METHOD 5 - DETERMINATION OF PARTICULATE MATTER EMISSIONS FROM STATIONARY SOURCES

NOTE: This method does not include all of the specifications (*e.g.*, equipment and supplies) and procedures (*e.g.*, sampling and analytical) essential to its performance. Some material is incorporated by reference from other methods in this part. Therefore, to obtain reliable results, persons using this method should have a thorough knowledge of at least the following additional test methods: Method 1, Method 2, Method 3.

1.0 Scope and Application.

1.1 Analyte. Particulate matter (PM). No CAS number assigned.

1.2 Applicability. This method is applicable for the determination of PM emissions from stationary sources.

1.3 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method.

Particulate matter is withdrawn isokinetically from the source and collected on a glass fiber filter maintained at a temperature of 120 ± 14°C (248 ± 25°F) or such other temperature as specified by an applicable subpart of the standards or approved by the Administrator for a particular application. The PM mass, which includes any material that condenses at or above the filtration temperature, is determined gravimetrically after the removal of uncombined water.

3.0 Definitions. [Reserved]

4.0 Interferences. [Reserved]

5.0 Safety.

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to performing this test method.

6.0 Equipment and Supplies.

6.1 Sample Collection. The following items are required for sample collection:

6.1.1 Sampling Train. A schematic of the sampling train used in this method is shown in Figure 5-1 in Section 18.0. Complete construction details are given in APTD-0581 (Reference 2 in Section 17.0); commercial models of this train are also available. For changes from APTD-0581 and for allowable modifications of the train shown in Figure

5-1, see the following subsections.

NOTE: The operating and maintenance procedures for the sampling train are described in APTD-0576 (Reference 3 in Section 17.0). Since correct usage is important in obtaining valid results, all users should read APTD-0576 and adopt the operating and maintenance procedures outlined in it, unless otherwise specified herein.

6.1.1.1 Probe Nozzle. Stainless steel (316) or glass with a sharp, tapered leading edge. The angle of taper shall be ≤30°, and the taper shall be on the outside to preserve a constant internal diameter. The probe nozzle shall be of the button-hook or elbow design, unless otherwise specified by the Administrator. If made of stainless steel, the nozzle shall be constructed from seamless tubing. Other materials of construction may be used, subject to the approval of the Administrator. A range of nozzle sizes suitable for isokinetic sampling should be available. Typical nozzle sizes range from 0.32 to 1.27 cm (1/8 to 1/2 in) inside diameter (ID) in increments of 0.16 cm (1/16 in). Larger nozzles sizes are also available if higher volume sampling trains are used. Each nozzle shall be calibrated, according to the procedures outlined in Section 10.1.

6.1.1.2 Probe Liner. Borosilicate or quartz glass tubing with a heating system capable of maintaining a probe gas temperature during sampling of 120 ± 14 °C (248 ± 25 °F), or such other temperature as specified by an applicable subpart of the standards or as approved by the Administrator for a particular application. Since the actual temperature at the outlet of the probe is not usually monitored during sampling, probes constructed according to APTD-0581 and utilizing the calibration curves of APTD-0576 (or calibrated according to the procedure outlined in APTD-0576) will be considered acceptable. Either borosilicate or quartz glass probe liners may be used for stack temperatures up to about 480 °C (900 °F); quartz glass liners shall be used for temperatures between 480 and 900 °C (900 and 1,650 °F). Both types of liners may be used at higher temperatures than specified for short periods of time, subject to the approval of the Administrator. The softening temperature for borosilicate glass is 820 °C (1500°F), and for quartz glass it is 1500 °C (2700 °F). Whenever practical, every effort should be made to use borosilicate or quartz glass probe liners. Alternatively, metal liners (*e.g.*, 316 stainless steel, Incoloy 825 or other corrosion resistant metals) made of seamless tubing may be used, subject to the approval of the Administrator.

6.1.1.3 Pitot Tube. Type S, as described in Section 6.1 of Method 2, or other device approved by the Administrator. The pitot tube shall be attached to the probe (as shown in Figure 5-1) to allow constant monitoring of the stack gas velocity. The impact (high pressure) opening plane of the pitot tube shall be even with or above the nozzle entry plane (see Method 2, Figure 2-7) during sampling. The Type S pitot tube assembly shall have a known coefficient, determined as outlined in Section 10.0 of Method 2.

6.1.1.4 Differential Pressure Gauge. Inclined manometer or equivalent device (two), as described in Section 6.2 of Method 2. One manometer shall be used for velocity head (Δp) readings, and the other, for orifice differential pressure readings.

6.1.1.5 Filter Holder. Borosilicate glass, with a glass frit filter support and a silicone rubber gasket. Other materials of construction (*e.g.*, stainless steel, Teflon, or Viton) may be used, subject to the approval of the Administrator. The holder design shall provide a positive seal against leakage from the outside or around the filter. The holder shall be attached immediately at the outlet of the probe (or cyclone, if used).

6.1.1.6 Filter Heating System. Any heating system capable of maintaining a temperature around the filter holder of 120 ± 14 °C (248 ± 25 °F) during sampling, or such other temperature as specified by an applicable subpart of the standards or approved by the Administrator for a particular application.

6.1.1.7 Temperature Sensor. A temperature sensor capable of measuring temperature to within ±3 °C (5.4 °F) shall be installed so that the sensing tip of the temperature sensor is in direct contact with the sample gas, and the temperature around the filter holder can be regulated and monitored during sampling.

6.1.1.8 Condenser. The following system shall be used to determine the stack gas moisture content: Four impingers connected in series with leak-free ground glass fittings or any similar leak-free noncontaminating fittings. The first, third, and fourth impingers shall be of the Greenburg-Smith design, modified by replacing the tip with a 1.3 cm (½ in.) ID glass tube extending to about 1.3 cm (½ in.) from the bottom of the flask. The second impinger shall be of the Greenburg-Smith design with the standard tip. Modifications (*e.g.*, using flexible connections between the impingers, using materials other than glass, or using flexible vacuum lines to connect the filter holder to the condenser) may be used, subject to the approval of the Administrator. The first and second impingers shall contain known quantities of water (Section 8.3.1), the third shall be empty, and the fourth shall contain a known weight of silica gel, or equivalent desiccant. A temperature sensor, capable of measuring temperature to within 1 °C (2 °F) shall be placed at the outlet of the fourth impinger for monitoring purposes. Alternatively, any system that cools the sample gas stream and allows measurement of the water condensed and moisture leaving the condenser, each to within 1 ml or 1 g may be used, subject to the approval of the Administrator. An acceptable technique involves the measurement of condensed water either gravimetrically or volumetrically and the determination of the moisture leaving the condenser by: (1) monitoring the temperature and pressure at the exit of the condenser and using Dalton's law of partial pressures; or (2) passing the sample gas stream through a tared silica gel (or equivalent desiccant) trap with exit gases kept below 20 °C (68 °F) and determining the weight gain. If means other than silica gel are used to determine the amount of moisture leaving the condenser, it is recommended that silica gel (or equivalent) still be used between the condenser system and pump to prevent moisture condensation in the pump and metering devices and to avoid the need to make corrections for moisture in the metered volume.

NOTE: If a determination of the PM collected in the impingers is desired in addition to moisture content, the impinger system described above shall be used, without modification. Individual States or control agencies requiring this information shall be contacted as to the sample recovery and analysis of the impinger contents.

6.1.1.9 Metering System. Vacuum gauge, leak-free pump, temperature sensors capable of measuring temperature to within 3 °C (5.4 °F), dry gas meter (DGM) capable of measuring volume to within 2 percent, and related equipment, as shown in Figure 5-1. Other metering systems capable of maintaining sampling rates within 10 percent of isokinetic and of determining sample volumes to within 2 percent may be used, subject to the approval of the Administrator. When the metering system is used in conjunction with a pitot tube, the system shall allow periodic checks of isokinetic rates.

6.1.1 10 Sampling trains utilizing metering systems designed for higher flow rates than that described in APTD-0581 or APTD-0576 may be used provided that the specifications of this method are met.

6.1.2 Barometer. Mercury, aneroid, or other barometer capable of measuring atmospheric pressure to within 2.5 mm Hg (0.1 in.).

NOTE: The barometric pressure reading may be obtained from a nearby National Weather Service station. In this case, the station value (which is the absolute barometric pressure) shall be requested and an adjustment for elevation differences between the weather station and sampling point shall be made at a rate of minus 2.5 mm Hg (0.1 in.) per 30 m (100 ft) elevation increase or plus 2.5 mm Hg (0.1 in) per 30 m (100 ft) elevation decrease.

6.1.3 Gas Density Determination Equipment. Temperature sensor and pressure gauge, as described in Sections 6.3 and 6.4 of Method 2, and gas analyzer, if necessary, as described in Method 3. The temperature sensor shall, preferably, be permanently attached to the pitot tube or sampling probe in a fixed configuration, such that the tip of the sensor extends beyond the leading edge of the probe sheath and does not touch any metal. Alternatively, the sensor may be attached just prior to use in the field. Note, however, that if the temperature sensor is attached in the field, the sensor must be placed in an interference-free arrangement with respect to the Type S pitot tube openings (see Method 2, Figure 2-4). As a second alternative, if a difference of not more than 1 percent in the average velocity measurement is to be introduced, the temperature sensor need not be attached to the probe or pitot tube. (This alternative is subject to the approval of the Administrator.)

6.2 Sample Recovery. The following items are required for sample recovery:

6.2.1 Probe-Liner and Probe-Nozzle Brushes. Nylon bristle brushes with stainless steel wire handles. The probe brush shall have extensions (at least as long as the probe) constructed of stainless steel, Nylon, Teflon, or similarly inert material. The brushes shall be properly sized and shaped to brush out the probe liner and nozzle.

6.2.2 Wash Bottles. Two Glass wash bottles are recommended. Alternatively, polyethylene wash bottles may be used. It is recommended that acetone not be stored in polyethylene bottles for longer than a month.

6.2.3 Glass Sample Storage Containers. Chemically resistant, borosilicate glass bottles, for acetone washes, 500 ml or 1000 ml. Screw cap liners shall either be rubber-backed Teflon or shall be constructed so as to be leak-free and resistant to chemical attack by acetone. (Narrow mouth glass bottles have been found to be less prone to leakage.) Alternatively, polyethylene bottles may be used.

6.2.4 Petri Dishes. For filter samples; glass or polyethylene, unless otherwise specified by the Administrator.

6.2.5 Graduated Cylinder and/or Balance. To measure condensed water to within 1 ml or 0.5 g. Graduated cylinders shall have subdivisions no greater than 2 ml.

6.2.6 Plastic Storage Containers. Air-tight containers to store silica gel.

6.2.7 Funnel and Rubber Policeman. To aid in transfer of silica gel to container; not necessary if silica gel is weighed in the field.

6.2.8 Funnel. Glass or polyethylene, to aid in sample recovery.

6.3 Sample Analysis. The following equipment is required for sample analysis:

6.3.1 Glass Weighing Dishes.

6.3.2 Desiccator.

6.3.3 Analytical Balance. To measure to within 0.1 mg.

6.3.4 Balance. To measure to within 0.5 g.

6.3.5 Beakers. 250 ml.

6.3.6 Hygrometer. To measure the relative humidity of the laboratory environment.

6.3.7 Temperature Sensor. To measure the temperature of the laboratory environment.

7.0 Reagents and Standards.

7.1 Sample Collection. The following reagents are required for sample collection:

7.1.1 Filters. Glass fiber filters, without organic binder, exhibiting at least 99.95 percent efficiency (<0.05 percent penetration) on 0.3 micron dioctyl phthalate smoke particles. The filter efficiency test shall be conducted in accordance with ASTM Method D 2986-71, 78, or 95a (incorporated by reference - see §60.17). Test data from the supplier's quality control program are sufficient for this purpose. In sources containing SO_2 or SO_3, the filter material must be of a type that is unreactive to SO_2 or SO_3. Reference 10 in Section 17.0 may be used to select the appropriate filter.

7.1.2 Silica Gel. Indicating type, 6 to 16 mesh. If previously used, dry at 175 °C (350 °F) for 2 hours. New silica gel may be used as received. Alternatively, other types of desiccants (equivalent or better) may be used, subject to the approval of the Administrator.

7.1.3 Water. When analysis of the material caught in the impingers is required, deionized distilled water [to conform to ASTM D 1193-77 or 91 Type 3 (incorporated by reference - see §60.17)] shall be used. Run blanks prior to field use to eliminate a high blank on test samples.

7.1.4 Crushed Ice.

7.1.5 Stopcock Grease. Acetone-insoluble, heat-stable silicone grease. This is not necessary if screw-on connectors with Teflon sleeves, or similar, are used. Alternatively, other types of stopcock grease may be used, subject to the approval of the Administrator.

7.2 Sample Recovery. Acetone, reagent grade, ≤0.001 percent residue, in glass bottles, is required. Acetone from metal containers generally has a high residue blank and should not be used. Sometimes, suppliers transfer acetone to glass bottles from metal containers; thus, acetone blanks shall be run prior to field use and only acetone with low blank values (≤0.001 percent) shall be used. In no case shall a blank value of greater than 0.001 percent of the weight of acetone used be subtracted from the sample weight.

7.3 Sample Analysis. The following reagents are required for sample analysis:

7.3.1 Acetone. Same as in Section 7.2.

7.3.2 Desiccant. Anhydrous calcium sulfate, indicating type. Alternatively, other types of desiccants may be used, subject to the approval of the Administrator.

8.0 Sample Collection, Preservation, Storage, and Transport.

8.1 Pretest Preparation. It is suggested that sampling equipment be maintained according to the procedures described in APTD-0576.

8.1.1 Place 200 to 300 g of silica gel in each of several air-tight containers. Weigh each container, including silica gel, to the nearest 0.5 g, and record this weight. As an alternative, the silica gel need not be preweighed, but may be weighed directly in its impinger or sampling holder just prior to train assembly.

8.1.2 Check filters visually against light for irregularities, flaws, or pinhole leaks. Label filters of the proper diameter on the back side near the edge using numbering machine ink. As an alternative, label the shipping containers (glass or polyethylene petri dishes), and keep each filter in its identified container at all times except during sampling.

8.1.3 Desiccate the filters at 20 ± 5.6 °C (68 ± 10 °F) and ambient pressure for at least 24 hours. Weigh each filter (or filter and shipping container) at intervals of at least 6 hours to a constant weight (*i.e.*, ≤0.5 mg change from previous weighing). Record results to the nearest 0.1 mg. During each weighing, the period for which the filter is exposed to the laboratory atmosphere shall be less than 2 minutes. Alternatively (unless otherwise specified by the Administrator), the filters may be oven dried at 105 °C (220 °F) for 2 to 3 hours, desiccated for 2 hours, and weighed. Procedures other than those described, which account for relative humidity effects, may be used, subject to the approval of the Administrator.

8.2 Preliminary Determinations.

8.2.1 Select the sampling site and the minimum number of sampling points according to Method 1 or as specified by the Administrator. Determine the stack pressure, temperature, and the range of velocity heads using Method 2; it is recommended that a leak check of the pitot lines (see Method 2, Section 8.1) be performed. Determine the moisture content using Approximation Method 4 or its alternatives for the purpose of making isokinetic sampling rate settings. Determine the stack gas dry molecular weight, as described in Method 2, Section 8.6; if integrated Method 3 sampling is used for molecular weight determination, the integrated bag sample shall be taken simultaneously with, and for the same total length of time as, the particulate sample run.

8.2.2 Select a nozzle size based on the range of velocity heads, such that it is not necessary to change the nozzle size in order to maintain isokinetic sampling rates. During the run, do not change the nozzle size. Ensure that the proper differential pressure gauge is chosen for the range of velocity heads encountered (see Section 8.3 of Method 2).

8.2.3 Select a suitable probe liner and probe length such that all traverse points can be sampled. For large stacks, consider sampling from opposite sides of the stack to reduce the required probe length.

8.2.4 Select a total sampling time greater than or equal to the minimum total sampling time specified in the test procedures for the specific industry such that (1) the sampling time per point is not less than 2 minutes (or some greater time interval as specified by the Administrator), and (2) the sample volume taken (corrected to standard conditions) will exceed the required minimum total gas sample volume. The latter is based on an approximate average sampling rate.

8.2.5 The sampling time at each point shall be the same. It is recommended that the number of minutes sampled at each point be an integer or an integer plus one-half minute, in order to avoid timekeeping errors.

8.2.6 In some circumstances (*e.g.*, batch cycles) it may be necessary to sample for shorter times at the traverse points and to obtain smaller gas sample volumes. In these cases, the Administrator's approval must first be obtained.

8.3 Preparation of Sampling Train.

8.3.1 During preparation and assembly of the sampling train, keep all openings where contamination can occur covered until just prior to assembly or until sampling is about to begin. Place 100 ml of water in each of the first two impingers, leave the third impinger empty, and transfer approximately 200 to 300 g of preweighed silica gel from its container to the fourth impinger. More silica gel may be used, but care should be taken to ensure that it is not entrained and carried out from the impinger during sampling. Place the container in a clean place for later use in the sample recovery. Alternatively, the weight of the silica gel plus impinger may be determined to the nearest 0.5 g and recorded.

8.3.2 Using a tweezer or clean disposable surgical gloves, place a labeled (identified) and weighed filter in the filter holder. Be sure that the filter is properly centered and the gasket properly placed so as to prevent the sample gas stream from circumventing the filter. Check the filter for tears after assembly is completed.

8.3.3 When glass probe liners are used, install the selected nozzle using a Viton A O-ring when stack temperatures are less than 260 °C (500 °F) or a heat-resistant string gasket when temperatures are higher. See APTD-0576 for details. Other connecting systems using either 316 stainless steel or Teflon ferrules may be used. When metal liners are used, install the nozzle as discussed above or by a leak-free direct mechanical connection. Mark the probe with heat resistant tape or by some other method to denote the proper distance into the stack or duct for each sampling point.

8.3.4 Set up the train as shown in Figure 5-1, using (if necessary) a very light coat of silicone grease on all ground glass joints, greasing only the outer portion (see APTD-0576) to avoid the possibility of contamination by the silicone grease. Subject to the approval of the Administrator, a glass cyclone may be used between the probe and filter holder when the total particulate catch is expected to exceed 100 mg or when water droplets are present in the stack gas.

8.3.5 Place crushed ice around the impingers.

8.4 Leak-Check Procedures.

8.4.1 Leak Check of Metering System Shown in Figure 5-1. That portion of the sampling train from the pump to the orifice meter should be leak-checked prior to initial use and after each shipment. Leakage after the pump will result in less volume being recorded than is actually sampled. The following procedure is suggested (see Figure 5-2): Close the main valve on the meter box. Insert a one-hole rubber stopper with rubber tubing attached into the orifice exhaust pipe. Disconnect and vent the low side of the orifice manometer. Close off the low side orifice tap. Pressurize the system to 13 to 18 cm (5 to 7 in.) water column by blowing into the rubber tubing. Pinch off the tubing, and observe the manometer for one minute. A loss of pressure on the manometer indicates a leak in the meter box; leaks, if present, must be corrected.

8.4.2 Pretest Leak Check. A pretest leak check of the sampling train is recommended, but not required. If the pretest leak check is conducted, the following procedure should be used.

8.4.2.1 After the sampling train has been assembled, turn on and set the filter and probe heating systems to the desired operating temperatures. Allow time for the temperatures to stabilize. If a Viton A O-ring or other leak-free connection is used in assembling the probe nozzle to the probe liner, leak-check the train at the sampling site by plugging the nozzle and pulling a 380 mm (15 in.) Hg vacuum.

NOTE: A lower vacuum may be used, provided that it is not exceeded during the test.

8.4.2.2 If a heat-resistant string is used, do not connect the probe to the train during the leak check. Instead, leak-check the train by first plugging the inlet to the filter holder (cyclone, if applicable) and pulling a 380 mm (15 in.) Hg vacuum (see **NOTE** in Section 8.4.2.1). Then connect the probe to the train, and leak-check at approximately 25 mm (1 in.) Hg vacuum; alternatively, the probe may be leak-checked with the rest of the sampling train, in one step, at 380 mm (15 in.) Hg vacuum. Leakage rates in excess of 4 percent of the average sampling rate or 0.00057 m^3/min (0.020 cfm), whichever is less, are unacceptable.

8.4.2.3 The following leak-check instructions for the sampling train described in APTD-0576 and APTD-0581 may be helpful. Start the pump with the bypass valve fully open and the coarse adjust valve completely closed. Partially open the coarse adjust valve, and slowly close the bypass valve until the desired vacuum is reached. <u>Do not</u> reverse the direction of the bypass valve, as this will cause water to back up into the filter holder. If the desired vacuum is exceeded, either leak-check at this higher vacuum, or end the leak check and start over.

8.4.2.4 When the leak check is completed, first slowly remove the plug from the inlet to the probe, filter holder, or cyclone (if applicable), and immediately turn off the vacuum pump. This prevents the water in the impingers from being forced backward into the filter holder and the silica gel from being entrained backward into the third impinger.

8.4.3 Leak Checks During Sample Run. If, during the sampling run, a component (*e.g.*, filter assembly or impinger) change becomes necessary, a leak check shall be conducted immediately before the change is made. The leak check shall be done according to the procedure outlined in Section 8.4.2 above, except that it shall be done at a vacuum equal to or greater than the maximum value recorded up to that point in the test. If the leakage rate is found to be no greater than 0.00057 m^3/min (0.020 cfm) or 4 percent of the average sampling rate (whichever is less), the results are acceptable, and no correction will need to be applied to the total volume of dry gas metered; if, however, a higher leakage rate is obtained, either record the leakage rate and plan to correct the sample volume as shown in Section 12.3 of this method, or void the sample run.

NOTE: Immediately after component changes, leak checks are optional. If such leak checks are done, the procedure outlined in Section 8.4.2 above should be used.

8.4.4 Post-Test Leak Check. A leak check of the sampling train is mandatory at the conclusion of each sampling run. The leak check shall be performed in accordance with the procedures outlined in Section 8.4.2, except that it shall be conducted at a vacuum equal to or greater than the maximum value reached during the sampling run. If the leakage rate is found to be no greater than 0.00057 m^3/min (0.020 cfm) or 4 percent of the average sampling rate (whichever is less), the results are acceptable, and no correction need be applied to the total volume of dry gas metered. If, however, a higher leakage rate is obtained, either record the leakage rate and correct the sample volume as shown in Section 12.3 of this method, or void the sampling run.

8.5 Sampling Train Operation. During the sampling run, maintain an isokinetic sampling rate (within 10 percent of true isokinetic unless otherwise specified by the Administrator) and a temperature around the filter of 120 ± 14 °C (248 ± 25 °F), or such other temperature as specified by an applicable subpart of the standards or approved by the Administrator.

8.5.1 For each run, record the data required on a data sheet such as the one shown in Figure 5-3. Be sure to record the initial DGM reading. Record the DGM readings at the beginning and end of each sampling time increment, when changes in flow rates are made, before and after each leak check, and when sampling is halted. Take other readings indicated by Figure 5-3 at least once at each sample point during each time increment and additional readings when significant changes (20 percent variation in velocity head readings) necessitate additional adjustments in flow rate.

Level and zero the manometer. Because the manometer level and zero may drift due to vibrations and temperature changes, make periodic checks during the traverse.

8.5.2 Clean the portholes prior to the test run to minimize the chance of collecting deposited material. To begin sampling, verify that the filter and probe heating systems are up to temperature, remove the nozzle cap, verify that the pitot tube and probe are properly positioned. Position the nozzle at the first traverse point with the tip pointing directly into the gas stream. Immediately start the pump, and adjust the flow to isokinetic conditions. Nomographs are available which aid in the rapid adjustment of the isokinetic sampling rate without excessive computations. These nomographs are designed for use when the Type S pitot tube coefficient (C_p) is 0.85 ± 0.02, and the stack gas equivalent density [dry molecular weight (M_d)] is equal to 29 ± 4. APTD-0576 details the procedure for using the nomographs. If C_p and M_d are outside the above stated ranges, do not use the nomographs unless appropriate steps (see Reference 7 in Section 17.0) are taken to compensate for the deviations.

8.5.3 When the stack is under significant negative pressure (*i.e.*, height of impinger stem), take care to close the coarse adjust valve before inserting the probe into the stack to prevent water from backing into the filter holder. If necessary, the pump may be turned on with the coarse adjust valve closed.

8.5.4 When the probe is in position, block off the openings around the probe and porthole to prevent unrepresentative dilution of the gas stream.

8.5.5 Traverse the stack cross-section, as required by Method 1 or as specified by the Administrator, being careful not to bump the probe nozzle into the stack walls when sampling near the walls or when removing or inserting the probe through the portholes; this minimizes the chance of extracting deposited material.

8.5.6 During the test run, make periodic adjustments to keep the temperature around the filter holder at the proper level; add more ice and, if necessary, salt to maintain a temperature of less than 20 °C (68 °F) at the condenser/silica gel outlet. Also, periodically check the level and zero of the manometer.

8.5.7 If the pressure drop across the filter becomes too high, making isokinetic sampling difficult to maintain, the filter may be replaced in the midst of the sample run. It is recommended that another complete filter assembly be used rather than attempting to change the filter itself. Before a new filter assembly is installed, conduct a leak check (see Section 8.4.3). The total PM weight shall include the summation of the filter assembly catches.

8.5.8 A single train shall be used for the entire sample run, except in cases where simultaneous sampling is required in two or more separate ducts or at two or more different locations within the same duct, or in cases where equipment failure necessitates a change of trains. In all other situations, the use of two or more trains will be subject to the approval of the Administrator.

NOTE: When two or more trains are used, separate analyses of the front-half and (if applicable) impinger catches from each train shall be performed, unless identical nozzle sizes were used on all trains, in which case, the front-half catches from the individual trains may be combined (as may the impinger catches) and one analysis of front-half catch and one analysis of impinger catch may be performed. Consult with the Administrator for details concerning the calculation of results when two or more trains are used.

8.5.9 At the end of the sample run, close the coarse adjust valve, remove the probe and nozzle from the stack, turn off the pump, record the final DGM meter reading, and conduct a post-test leak check, as outlined in Section 8.4.4. Also, leak-check the pitot lines as described in Method 2, Section 8.1. The lines must pass this leak check, in order to validate the velocity head data.

8.6 Calculation of Percent Isokinetic. Calculate percent isokinetic (see Calculations, Section 12.11) to determine whether the run was valid or another test run should be made. If there was difficulty in maintaining isokinetic rates because of source conditions, consult with the Administrator for possible variance on the isokinetic rates.

8.7 Sample Recovery.

8.7.1 Proper cleanup procedure begins as soon as the probe is removed from the stack at the end of the sampling period. Allow the probe to cool.

8.7.2 When the probe can be safely handled, wipe off all external PM near the tip of the probe nozzle, and place a cap over it to prevent losing or gaining PM. Do not cap off the probe tip tightly while the sampling train is cooling down. This would create a vacuum in the filter holder, thereby drawing water from the impingers into the filter holder.

8.7.3 Before moving the sample train to the cleanup site, remove the probe from the sample train, wipe off the silicone grease, and cap the open outlet of the probe. Be careful not to lose any condensate that might be present. Wipe off the silicone grease from the filter inlet where the probe was fastened, and cap it. Remove the umbilical cord from the last impinger, and cap the impinger. If a flexible line is used between the first impinger or condenser and the filter holder, disconnect the line at the filter holder, and let any condensed water or liquid drain into the impingers or condenser. After wiping off the silicone grease, cap off the filter holder outlet and impinger inlet. Either ground-glass stoppers, plastic caps, or serum caps may be used to close these openings.

8.7.4 Transfer the probe and filter-impinger assembly to the cleanup area. This area should be clean and protected from the wind so that the chances of contaminating or losing the sample will be minimized.

8.7.5 Save a portion of the acetone used for cleanup as a blank. Take 200 ml of this acetone directly from the wash bottle being used, and place it in a glass sample container labeled "acetone blank."

8.7.6 Inspect the train prior to and during disassembly, and note any abnormal conditions. Treat the samples as follows:

8.7.6.1 Container No. 1. Carefully remove the filter from the filter holder, and place it in its identified petri dish container. Use a pair of tweezers and/or clean disposable surgical gloves to handle the filter. If it is necessary to fold the filter, do so such that the PM cake is inside the fold. Using a dry Nylon bristle brush and/or a sharp-edged blade, carefully transfer to the petri dish any PM and/or filter fibers that adhere to the filter holder gasket. Seal the container.

8.7.6.2 Container No. 2. Taking care to see that dust on the outside of the probe or other exterior surfaces does not get into the sample, quantitatively recover PM or any condensate from the probe nozzle, probe fitting, probe liner, and front half of the filter holder by washing these components with acetone and placing the wash in a glass container. Deionized distilled water may be used instead of acetone when approved by the Administrator and shall be used when specified by the Administrator. In these cases, save a water blank, and follow the Administrator's directions on analysis. Perform the acetone rinse as follows:

8.7.6.2.1 Carefully remove the probe nozzle. Clean the inside surface by rinsing with acetone from a wash bottle and brushing with a Nylon bristle brush. Brush until the acetone rinse shows no visible particles, after which make a final rinse of the inside surface with acetone.

8.7.6.2.2 Brush and rinse the inside parts of the fitting with acetone in a similar way until no visible particles remain.

8.7.6.2.3 Rinse the probe liner with acetone by tilting and rotating the probe while squirting acetone into its upper end so that all inside surfaces will be wetted with acetone. Let the acetone drain from the lower end into the sample container. A funnel (glass or polyethylene) may be used to aid in transferring liquid washes to the container. Follow the acetone rinse with a probe brush. Hold the probe in an inclined position, squirt acetone into the upper end as the probe brush is being pushed with a twisting action through the probe; hold a sample container underneath the lower end of the probe, and catch any acetone and particulate matter that is brushed from the probe. Run the brush through the probe three times or more until no visible PM is carried out with the acetone or until none remains in the probe liner on visual inspection. With stainless steel or other metal probes, run the brush through in the above prescribed manner at least six times since metal probes have small crevices in which particulate matter can be entrapped. Rinse the brush with acetone, and quantitatively collect these washings in the sample container. After the brushing, make a final acetone rinse of the probe.

8.7.6.2.4 It is recommended that two people clean the probe to minimize sample losses. Between sampling runs, keep brushes clean and protected from contamination.

8.7.6.2.5 After ensuring that all joints have been wiped clean of silicone grease, clean the inside of the front half of the filter holder by rubbing the surfaces with a Nylon bristle brush and rinsing with acetone. Rinse each surface three times or more if needed to remove visible particulate. Make a final rinse of the brush and filter holder. Carefully rinse out the glass cyclone, also (if applicable). After all acetone washings and particulate matter have been collected in the sample container, tighten the lid on the sample container so that acetone will not leak out when it is shipped to the laboratory. Mark the height of the fluid level to allow determination of whether leakage occurred during transport. Label the container to identify clearly its contents.

8.7.6.3 Container No. 3. Note the color of the indicating silica gel to determine whether it has been completely spent, and make a notation of its condition. Transfer the silica gel from the fourth impinger to its original container, and seal. A funnel may make it easier to pour the silica gel without spilling. A rubber policeman may be used as an aid in removing the silica gel from the impinger. It is not necessary to remove the small amount of dust particles that may adhere to the impinger wall and are difficult to remove. Since the gain in weight is to be used for moisture calculations, do not use any water or other liquids to transfer the silica gel. If a balance is available in the field, follow the procedure for Container No. 3 in Section 11.2.3.

8.7.6.4 Impinger Water. Treat the impingers as follows: Make a notation of any color or film in the liquid catch. Measure the liquid that is in the first three impingers to within 1 ml by using a graduated cylinder or by weighing it to within 0.5 g by using a balance. Record the volume or weight of liquid present. This information is required to calculate the moisture content of the effluent gas. Discard the liquid after measuring and recording the volume or weight, unless analysis of the impinger catch is required (see **NOTE**, Section 6.1.1.8). If a different type of condenser is used, measure the amount of moisture condensed either volumetrically or gravimetrically.

8.8 Sample Transport. Whenever possible, containers should be shipped in such a way that they remain upright at all times.

9.0 Quality Control.

9.1 Miscellaneous Quality Control Measures.

Section	Quality Control Measure	Effect
8.4, 10.1-10.6	Sampling equipment leak check and calibration	Ensures accurate measurement of stack gas flow rate, sample volume

9.2 Volume Metering System Checks. The following procedures are suggested to check the volume metering system calibration values at the field test site prior to sample collection. These procedures are optional.

9.2.1 Meter Orifice Check. Using the calibration data obtained during the calibration procedure described in Section 10.3, determine the $\Delta H_@$ for the metering system orifice. The $\Delta H_@$ is the orifice pressure differential in

$$\Delta H_@ = 0.0319\ \Delta H \frac{T_M \theta^2}{P_{bar} Y^2 V_m^2}$$

units of in. H_2O that correlates to 0.75 cfm of air at 528 °R and 29.92 in. Hg. The $\Delta H_@$ is calculated as follows:where:

ΔH = Average pressure differential across the orifice meter, in. H_2O.

T_m = Absolute average DGM temperature, °R.
P_{bar} = Barometric pressure, in. Hg.
θ = Total sampling time, min.
Y = DGM calibration factor, dimensionless.
V_m = Volume of gas sample as measured by DGM, dcf.
$0.0319 = (0.0567\ \text{in. Hg/°R})(0.75\ \text{cfm})^2$

9.2.1.1 Before beginning the field test (a set of three runs usually constitutes a field test), operate the metering system (*i.e.*, pump, volume meter, and orifice) at the $\Delta H_@$ pressure differential for 10 minutes. Record the volume collected, the DGM temperature, and the barometric pressure.

$$Y_c = \frac{10}{V_m}\left[\frac{0.0319\ T_m}{P_{bar}}\right]^{\frac{1}{2}}$$

Calculate a DGM calibration check value, Y_c, as follows:
where:
Y_c = DGM calibration check value, dimensionless.
10 = Run time, min.

9.2.1.2 Compare the Y_c value with the dry gas meter calibration factor Y to determine that: $0.97Y < Y_c < 1.03Y$. If the Y_c value is not within this range, the volume metering system should be investigated before beginning the test.

9.2.2 Calibrated Critical Orifice. A critical orifice, calibrated against a wet test meter or spirometer and designed to be inserted at the inlet of the sampling meter box, may be used as a check by following the procedure of Section 16.2.

10.0 Calibration and Standardization.

NOTE: Maintain a laboratory log of all calibrations.

10.1 Probe Nozzle. Probe nozzles shall be calibrated before their initial use in the field. Using a micrometer, measure the ID of the nozzle to the nearest 0.025 mm (0.001 in.). Make three separate measurements using different diameters each time, and obtain the average of the measurements. The difference between the high and low numbers shall not exceed 0.1 mm (0.004 in.). When nozzles become nicked, dented, or corroded, they shall be reshaped, sharpened, and recalibrated before use. Each nozzle shall be permanently and uniquely identified.

10.2 Pitot Tube Assembly. The Type S pitot tube assembly shall be calibrated according to the procedure outlined in Section 10.1 of Method 2.

10.3 Metering System.

10.3.1 Calibration Prior to Use. Before its initial use in the field, the metering system shall be calibrated as follows: Connect the metering system inlet to the outlet of a wet test meter that is accurate to within 1 percent. Refer to Figure 5-4. The wet test meter should have a capacity of 30 liters/rev (1 ft^3/rev). A spirometer of 400 liters (14 ft^3) or more capacity, or equivalent, may be used for this calibration, although a wet test meter is usually more practical. The wet test meter should be periodically calibrated with a spirometer or a liquid displacement meter to ensure the accuracy of the wet test meter. Spirometers or wet test meters of other sizes may be used, provided that the specified accuracies of the procedure are maintained. Run the metering system pump for about 15 minutes with the orifice manometer indicating a median reading as expected in field use to allow the pump to warm up and to permit the interior surface of the wet test meter to be thoroughly wetted. Then, at each of a minimum of three orifice manometer settings, pass an exact quantity of gas through the wet test meter and note the gas volume indicated by the DGM. Also note the barometric pressure and the temperatures of the wet test meter, the inlet of the DGM, and the outlet of the DGM. Select the highest and lowest orifice settings to bracket the expected field operating range of the orifice. Use a minimum volume of 0.14 m^3 (5 ft^3) at all orifice settings. Record all the data on a form similar to Figure 5-5 and calculate Y, the DGM calibration factor, and $\Delta H_@$, the orifice calibration factor, at each orifice setting as shown on Figure 5-5. Allowable tolerances for individual Y and $\Delta H_@$ values are given in Figure 5-5. Use the average of the Y values in the calculations in Section 12.0.

10.3.1.1 Before calibrating the metering system, it is suggested that a leak check be conducted. For metering systems having diaphragm pumps, the normal leak-check procedure will not detect leakages within the pump. For these cases the following leak-check procedure is suggested: make a 10-minute calibration run at 0.00057 m^3/min (0.020 cfm). At the end of the run, take the difference of the measured wet test meter and DGM volumes. Divide the difference by 10 to get the leak rate. The leak rate should not exceed 0.00057 m^3/min (0.020 cfm).

10.3.2 Calibration After Use. After each field use, the calibration of the metering system shall be checked by performing three calibration runs at a single, intermediate orifice setting (based on the previous field test), with the vacuum set at the maximum value reached during the test series. To adjust the vacuum, insert a valve between the wet test meter and the inlet of the metering system. Calculate the average value of the DGM calibration factor. If the value has changed by more than 5 percent, recalibrate the meter over the full range of orifice settings, as detailed in Section 10.3.1.

NOTE: Alternative procedures (*e.g.*, rechecking the orifice meter coefficient) may be used, subject to the approval of the Administrator.

10.3.3 Acceptable Variation in Calibration. If the DGM coefficient values obtained before and after a test series differ by more than 5 percent, the test series shall either be voided, or calculations for the test series shall be performed using whichever meter coefficient value (*i.e.*, before or after) gives the lower value of total sample volume.

10.4 Probe Heater Calibration. Use a heat source to generate air heated to selected temperatures that approximate those expected to occur in the sources to be sampled. Pass this air through the probe at a typical sample flow rate while measuring the probe inlet and outlet temperatures at various probe heater settings. For each air temperature generated, construct a graph of probe heating system setting versus probe outlet temperature. The procedure outlined in APTD-0576 can also be used. Probes constructed according to APTD-0581 need not be calibrated if the calibration curves in APTD-0576 are used. Also, probes with outlet temperature monitoring capabilities do not require calibration.

NOTE: The probe heating system shall be calibrated before its initial use in the field.

10.5 Temperature Sensors. Use the procedure in Section 10.3 of Method 2 to calibrate in-stack temperature sensors. Dial thermometers, such as are used for the DGM and condenser outlet, shall be calibrated against mercury-in-glass thermometers.

10.6 Barometer. Calibrate against a mercury barometer.

11.0 Analytical Procedure.

11.1 Record the data required on a sheet such as the one shown in Figure 5-6.

11.2 Handle each sample container as follows:

11.2.1 Container No. 1. Leave the contents in the shipping container or transfer the filter and any loose PM from the sample container to a tared glass weighing dish. Desiccate for 24 hours in a desiccator containing anhydrous calcium sulfate. Weigh to a constant weight, and report the results to the nearest 0.1 mg. For the purposes of this section, the term "constant weight" means a difference of no more than 0.5 mg or 1 percent of total weight less tare weight, whichever is greater, between two consecutive weighings, with no less than 6 hours of desiccation time between weighings. Alternatively, the sample may be oven dried at 104 °C (220 °F) for 2 to 3 hours, cooled in the desiccator, and weighed to a constant weight, unless otherwise specified by the Administrator. The sample may be oven dried at 104 °C (220 °F) for 2 to 3 hours. Once the sample has cooled, weigh the sample, and use this weight as a final weight.

11.2.2 Container No. 2. Note the level of liquid in the container, and confirm on the analysis sheet whether leakage occurred during transport. If a noticeable amount of leakage has occurred, either void the sample or use methods, subject to the approval of the Administrator, to correct the final results. Measure the liquid in this container either volumetrically to ± 1 ml or gravimetrically to ± 0.5 g. Transfer the contents to a tared 250 ml beaker, and evaporate to dryness at ambient temperature and pressure. Desiccate for 24 hours, and weigh to a constant weight. Report the results to the nearest 0.1 mg.

11.2.3 Container No. 3. Weigh the spent silica gel (or silica gel plus impinger) to the nearest 0.5 g using a balance. This step may be conducted in the field.

11.2.4 Acetone Blank Container. Measure the acetone in this container either volumetrically or gravimetrically. Transfer the acetone to a tared 250 ml beaker, and evaporate to dryness at ambient temperature and pressure. Desiccate for 24 hours, and weigh to a constant weight. Report the results to the nearest 0.1 mg.

NOTE: The contents of Container No. 2 as well as the acetone blank container may be evaporated at temperatures higher than ambient. If evaporation is done at an elevated temperature, the temperature must be below the boiling point of the solvent; also, to prevent "bumping," the evaporation process must be closely supervised, and the contents of the beaker must be swirled occasionally to maintain an even temperature. Use extreme care, as acetone is highly flammable and has a low flash point.

12.0 Data Analysis and Calculations.

Carry out calculations, retaining at least one extra significant figure beyond that of the acquired data. Round off figures after the final calculation. Other forms of the equations may be used, provided that they give equivalent results.

12.1 Nomenclature.

A_n = Cross-sectional area of nozzle, m^2 (ft^2).
B_{ws} = Water vapor in the gas stream, proportion by volume.
C_a = Acetone blank residue concentration, mg/mg.
c_s = Concentration of particulate matter in stack gas, dry basis, corrected to standard

conditions, g/dscm (gr/dscf).

I = Percent of isokinetic sampling.

L_1 = Individual leakage rate observed during the leak-check conducted prior to the first component change, m^3/min (ft^3/min)

L_a = Maximum acceptable leakage rate for either a pretest leak-check or for a leak-check following a component change; equal to 0.00057 m^3/min (0.020 cfm) or 4 percent of the average sampling rate, whichever is less.

L_i = Individual leakage rate observed during the leak-check conducted prior to the "i^{th}" component change (i = 1, 2, 3...n), m^3/min (cfm).

L_p = Leakage rate observed during the post-test leak-check, m^3/min (cfm).

m_a = Mass of residue of acetone after evaporation, mg.

m_n = Total amount of particulate matter collected, mg.

M_w = Molecular weight of water, 18.0 g/g-mole (18.0 lb/lb-mole).

P_{bar} = Barometric pressure at the sampling site, mm Hg (in. Hg).

P_s = Absolute stack gas pressure, mm Hg (in. Hg).

P_{std} = Standard absolute pressure, 760 mm Hg (29.92 in. Hg).

R = Ideal gas constant, 0.06236 [(mm Hg)(m^3)]/[(K)(g-mole)] {21.85 [(in. Hg)(ft^3)]/[(°R)(lb-mole)]}.

T_m = Absolute average DGM temperature (see Figure 5-3), K (°R).

T_s = Absolute average stack gas temperature (see Figure 5-3), K (°R).

T_{std} = Standard absolute temperature, 293 K (528 °R).

V_a = Volume of acetone blank, ml.

V_{aw} = Volume of acetone used in wash, ml.

V_{lc} = Total volume of liquid collected in impingers and silica gel (see Figure 5-6), ml.

V_m = Volume of gas sample as measured by dry gas meter, dcm (dcf).

$V_{m(std)}$= Volume of gas sample measured by the dry gas meter, corrected to standard conditions, dscm (dscf).

$V_{w(std)}$= Volume of water vapor in the gas sample, corrected to standard conditions, scm (scf).

v_s = Stack gas velocity, calculated by Method 2, Equation 2-7, using data obtained from

Method 5, m/sec (ft/sec).

W_a = Weight of residue in acetone wash, mg.

Y = Dry gas meter calibration factor.

ΔH = Average pressure differential across the orifice meter (see Figure 5-4), mm H_2O (in. H_2O).

ρ_a = Density of acetone, mg/ml (see label on bottle).

ρ_w = Density of water, 0.9982 g/ml (0.002201 lb/ml).

θ = Total sampling time, min.

θ_1 = Sampling time interval, from the beginning of a run until the first component change, min.

θ_i = Sampling time interval, between two successive component changes, beginning with the interval between the first and second changes, min.

θ_p = Sampling time interval, from the final (n^{th}) component change until the end of the sampling run, min.

13.6 = Specific gravity of mercury.

60 = Sec/min.

100 = Conversion to percent.

12.2 Average Dry Gas Meter Temperature and Average Orifice Pressure Drop. See data sheet (Figure 5-3).

12.3 Dry Gas Volume. Correct the sample volume measured by the dry gas meter to standard conditions (20 °C, 760 mm Hg or 68 °F, 29.92 in. Hg) by using Equation 5-1.

$$V_{m(std)} = V_m Y \frac{T_{std} (\mathrm{PSUBbar} + \frac{\Delta H}{13.6})}{T_m P_{std}}$$

$$= K_1 V_m Y \frac{P_{bar} + (\frac{\Delta H}{13.6})}{T_m}$$

where:

K_1 = 0.3858 °K/mm Hg for metric units,

= 17.64 °R/in. Hg for English units.

NOTE: Equation 5-1 can be used as written unless the leakage rate observed during any of the mandatory leak checks (i.e., the post-test leak check or leak checks conducted prior to component changes) exceeds L_a. If L_p or L_i exceeds L_a, Equation 5-1 must be modified as follows:

(a) Case I. No component changes made during sampling run. In this case, replace V_m in Equation 5-1 with the expression:

$$[V_m - (L_p - L_a)\ \theta]$$

(b) Case II. One or more component changes made during the sampling run. In this case, replace V_m in Equation 5-1

$$\left[V_m - (L_1 - L_a)\theta_1 - \sum_{i=2}^{n}(Lsubi - L_a)\theta_i - (L_p - L_a)\theta_p\right]$$

by the expression:
and substitute only for those leakage rates (L_i or L_p) which exceed L_a.

$$V_{w(std)} = V_{lc}\frac{\rho_w R\, T_{std}}{M_w P_{std}}$$
$$= K_2 V_{lc}$$

12.4 Volume of Water Vapor Condensed.
where:
K_2 = 0.001333 m^3/ml for metric units,
= 0.04706 ft^3/ml for English units.

$$B_{ws} = \frac{V_{w(std)}}{V_{m(std)} + V_{w(std)}}$$

12.5 Moisture Content.

NOTE: In saturated or water droplet-laden gas streams, two calculations of the moisture content of the stack gas shall be made, one from the impinger analysis (Equation 5-3), and a second from the assumption of saturated conditions. The lower of the two values of B_{ws} shall be considered correct. The procedure for determining the moisture content based upon the assumption of saturated conditions is given in Section 4.0 of Method 4. For the purposes of this method, the average stack gas temperature from Figure 5-3 may be used to make this determination, provided that the accuracy of the in-stack temperature sensor is ± 1°C (2°F).

$$C_a = \frac{m_a}{V_a \rho_a}$$

12.6 Acetone Blank Concentration.
12.7 Acetone Wash Blank.

$$W_a = C_a V_{aw} \rho_a \qquad \textbf{Eq. 5-5}$$

12.8 Total Particulate Weight. Determine the total particulate matter catch from the sum of the weights obtained from Containers 1 and 2 less the acetone blank (see Figure 5-6).

NOTE: In no case shall a blank value of greater than 0.001 percent of the weight of acetone used be subtracted from the sample weight. Refer to Section 8.5.8 to assist in calculation of results involving two or more filter assemblies or two or more sampling trains.

$$C_s = \frac{K_3 m_n}{V_{m(std)}}$$

12.9 Particulate Concentration.
where:
K_3 = 0.001 g/mg for metric units.
= 0.0154 gr/mg for English units.
12.10 Conversion Factors:

From	To	Multiply by
ft^3	m^3	0.02832
gr	mg	64.80004
gr/ft^3	mg/m^3	2288.4
mg	g	0.001
gr	lb	1.429×10^{-4}

12.11 Isokinetic Variation.

12.11.1 Calculation from Raw Data.
where:
K_4 = 0.003454 [(mm Hg)(m^3)]/[(ml)(°K)] for metric units,
= 0.002669 [(in. Hg)(ft^3)]/[(ml)(°R)] for English units.

$$I = \frac{T_s V_{m(std)} P_{std} 100}{T_{std} v_s \theta A_n P_s 60 (1 - B_{ws})}$$
$$= K_5 \frac{T_s V_{m(std)}}{P_s v_s A_n \theta (1 - B_{ws})}$$

12.11.2 Calculation from Intermediate Values.
where:
K_5 = 4.320 for metric units,
= 0.09450 for English units.

12.11.3 Acceptable Results. If 90 percent ≤ I ≤ 110 percent, the results are acceptable. If the PM results are low in comparison to the standard, and "I" is over 110 percent or less than 90 percent, the Administrator may opt to accept the results. Reference 4 in Section 17.0 may be used to make acceptability judgments. If "I" is judged to be unacceptable, reject the results, and repeat the sampling run.

12.12 Stack Gas Velocity and Volumetric Flow Rate. Calculate the average stack gas velocity and volumetric flow rate, if needed, using data obtained in this method and the equations in Sections 12.3 and 12.4 of Method 2.

13.0 Method Performance. [Reserved]

14.0 Pollution Prevention. [Reserved]

15.0 Waste Management. [Reserved]

16.0 Alternative Procedures.

16.1 Dry Gas Meter as a Calibration Standard. A DGM may be used as a calibration standard for volume measurements in place of the wet test meter specified in Section 10.3, provided that it is calibrated initially and recalibrated periodically as follows:

16.1.1 Standard Dry Gas Meter Calibration.

16.1.1.1. The DGM to be calibrated and used as a secondary reference meter should be of high quality and have an appropriately sized capacity [*e.g.*, 3 liters/rev (0.1 ft^3/rev)]. A spirometer [400 liters (14 ft^3) or more capacity], or equivalent, may be used for this calibration, although a wet test meter is usually more practical. The wet test meter should have a capacity of 30 liters/rev (1 ft^3/rev) and capable of measuring volume to within 1.0 percent. Wet test meters should be checked against a spirometer or a liquid displacement meter to ensure the accuracy of the wet test meter. Spirometers or wet test meters of other sizes may be used, provided that the specified accuracies of the procedure are maintained.

16.1.1.2 Set up the components as shown in Figure 5-7. A spirometer, or equivalent, may be used in place of the wet test meter in the system. Run the pump for at least 5 minutes at a flow rate of about 10 liters/min (0.35 cfm) to condition the interior surface of the wet test meter. The pressure drop indicated by the manometer at the inlet side of the DGM should be minimized [no greater than 100 mm H_2O (4 in. H_2O) at a flow rate of 30 liters/min (1 cfm)]. This can be accomplished by using large diameter tubing connections and straight pipe fittings.

16.1.1.3 Collect the data as shown in the example data sheet (see Figure 5-8). Make triplicate runs at each of the flow rates and at no less than five different flow rates. The range of flow rates should be between 10 and 34 liters/min (0.35 and 1.2 cfm) or over the expected operating range.

16.1.1.4 Calculate flow rate, Q, for each run using the wet test meter volume, V_w, and the run time, θ. Calculate the DGM coefficient, Y_{ds}, for each run. These calculations

$$Q = K_1 \frac{P_{bar} V_w}{(T_w + T_{std})\theta}$$

are as follows:

$$Y_{ds} = \frac{V_w (T_{ds} + T_{std}) P_{bar}}{V_{ds} (T_w + T_{std}) \left(P_{bar} + \frac{\Delta p}{13.6} \right)}$$

where:

K_1 = 0.3858 °C/mm Hg for metric units
= 17.64 °F/in. Hg for English units.
V_w = Wet test meter volume, liter (ft^3).
V_{ds} = Dry gas meter volume, liter (ft^3).
T_{ds} = Average dry gas meter temperature, °C (°F).
T_{adj} = 273 °C for metric units
= 460 °F for English units.
T_w = Average wet test meter temperature, °C (°F)
P_{bar} = Barometric pressure, mm Hg (in. Hg).
Δp = Dry gas meter inlet differential pressure, mm H_2O (in. H_2O).
θ = Run time, min.

16.1.1.5 Compare the three Y_{ds} values at each of the flow rates and determine the maximum and minimum values. The difference between the maximum and minimum values at each flow rate should be no greater than 0.030. Extra sets of triplicate runs may be made in order to complete this requirement. In addition, the meter coefficients should be between 0.95 and 1.05. If these specifications cannot be met in three sets of successive triplicate runs, the meter is not suitable as a calibration standard and should not be used as such. If these specifications are met, average the three Y_{ds} values at each flow rate resulting in no less than five average meter coefficients, Y_{ds}.

16.1.1.6 Prepare a curve of meter coefficient, Y_{ds}, versus flow rate, Q, for the DGM. This curve shall be used as a reference when the meter is used to calibrate other DGMs and to determine whether recalibration is required.

16.1.2 Standard Dry Gas Meter Recalibration.

16.1.2.1 Recalibrate the standard DGM against a wet test meter or spirometer annually or after every 200 hours of operation, whichever comes first. This requirement is valid provided the standard DGM is kept in a laboratory and, if transported, cared for as any other laboratory instrument.

Abuse to the standard meter may cause a change in the calibration and will require more frequent recalibrations.

16.1.2.2 As an alternative to full recalibration, a two-point calibration check may be made. Follow the same procedure and equipment arrangement as for a full recalibration, but run the meter at only two flow rates [suggested rates are 14 and 30 liters/min (0.5 and 1.0 cfm)]. Calculate the meter coefficients for these two points, and compare the values with the meter calibration curve. If the two coefficients are within 1.5 percent of the calibration curve values at the same flow rates, the meter need not be recalibrated until the next date for a recalibration check.

16.2 Critical Orifices As Calibration Standards. Critical orifices may be used as calibration standards in place of the wet test meter specified in Section 16.1, provided that they are selected, calibrated, and used as follows:

16.2.1 Selection of Critical Orifices.

16.2.1.1 The procedure that follows describes the use of hypodermic needles or stainless steel needle tubings which have been found suitable for use as critical orifices. Other materials and critical orifice designs may be used provided the orifices act as true critical orifices (*i.e.*, a critical vacuum can be obtained, as described in Section 16.2.2.2.3). Select five critical orifices that are appropriately sized to cover the range of flow rates between 10 and 34 liters/min (0.35 and 1.2 cfm) or the expected operating range. Two of the critical orifices should bracket the expected operating range. A minimum of three critical orifices will be needed to calibrate a Method 5 DGM; the other two critical orifices can serve as spares and provide better selection for bracketing the range of operating flow rates. The needle sizes and tubing lengths shown in Table 5-1 in Section 18.0 give the approximate flow rates.

16.2.1.2 These needles can be adapted to a Method 5 type sampling train as follows: Insert a serum bottle stopper, 13 by 20 mm sleeve type, into a ½-inch Swagelok (or equivalent) quick connect. Insert the needle into the stopper as shown in Figure 5-9.

16.2.2 Critical Orifice Calibration. The procedure described in this section uses the Method 5 meter box configuration with a DGM as described in Section 6.1.1.9 to calibrate the critical orifices. Other schemes may be used, subject to the approval of the Administrator.

16.2.2.1 Calibration of Meter Box. The critical orifices must be calibrated in the same configuration as they will be used (*i.e.*, there should be no connections to the inlet of the orifice).

16.2.2.1.1 Before calibrating the meter box, leak check the system as follows: Fully open the coarse adjust valve, and completely close the by-pass valve. Plug the inlet. Then turn on the pump, and determine whether there is any leakage. The leakage rate shall be zero (*i.e.*, no detectable movement of the DGM dial shall be seen for 1 minute).

16.2.2.1.2 Check also for leakages in that portion of the sampling train between the pump and the orifice meter. See Section 8.4.1 for the procedure; make any corrections, if necessary. If leakage is detected, check for cracked gaskets, loose fittings, worn O-rings, etc., and make the necessary repairs.

16.2.2.1.3 After determining that the meter box is leakless, calibrate the meter box according to the procedure given in Section 10.3. Make sure that the wet test meter meets the requirements stated in Section 16.1.1.1. Check the water level in the wet test meter. Record the DGM calibration factor, Y.

16.2.2.2 Calibration of Critical Orifices. Set up the apparatus as shown in Figure 5-10.

16.2.2.2.1 Allow a warm-up time of 15 minutes. This step is important to equilibrate the temperature conditions through the DGM.

16.2.2.2.2 Leak check the system as in Section 16.2.2.1.1. The leakage rate shall be zero.

16.2.2.2.3 Before calibrating the critical orifice, determine its suitability and the appropriate operating vacuum as follows: Turn on the pump, fully open the coarse adjust valve, and adjust the by-pass valve to give a vacuum reading corresponding to about half of atmospheric pressure. Observe the meter box orifice manometer reading, ΔH. Slowly increase the vacuum reading until a stable reading is obtained on the meter box orifice manometer. Record the critical vacuum for each orifice. Orifices that do not reach a critical value shall not be used.

16.2.2.2.4 Obtain the barometric pressure using a barometer as described in Section 6.1.2. Record the barometric pressure, P_{bar}, in mm Hg (in. Hg).

16.2.2.2.5 Conduct duplicate runs at a vacuum of 25 to 50 mm Hg (1 to 2 in. Hg) above the critical vacuum. The runs shall be at least 5 minutes each. The DGM volume readings shall be in increments of complete revolutions of the DGM. As a guideline, the times should not differ by more than 3.0 seconds (this includes allowance for changes in the DGM temperatures) to achieve ± 0.5 percent in K' (see Eq. 5-11). Record the information listed in Figure 5-11.

$$K' = \frac{K_1 V_m Y (P_{bar} + \frac{\Delta H}{13.6}) T_{amb}^{1/2}}{P_{bar} T_m \theta}$$

16.2.2.2.6 Calculate K' using Equation 5-11.
where:

K' = Critical orifice coefficient, $[m^3)(°K)^{½}]/[(mm\ Hg)(min)]$ $\{[(ft^3)(°R)^{½})]/[(in.\ Hg)(min)]\}$.

T_{amb} = Absolute ambient temperature, °K (°R).

Calculate the arithmetic mean of the K' values. The individual K' values should not differ by more than ±0.5 percent from the mean value.

16.2.3 Using the Critical Orifices as Calibration Standards.

16.2.3.1 Record the barometric pressure.

16.2.3.2 Calibrate the metering system according to the procedure outlined in Section 16.2.2. Record the information listed in Figure 5-12.

16.2.3.3 Calculate the standard volumes of air passed through the DGM and the critical orifices, and calculate the DGM calibration factor, Y, using the equations below:

$$V_{cr(std)} = K_1 \frac{P_{bar}\,\Theta}{\sqrt{T_{amb}}}$$

$$Y = \frac{V_{cr(std)}}{V_{m(std)}}$$

where:

$V_{cr(std)}$ = Volume of gas sample passed through the critical orifice, corrected to standard conditions, dscm (dscf).

K_1 = 0.3858 K/mm Hg for metric units
= 17.64 °R/in. Hg for English units.

16.2.3.4 Average the DGM calibration values for each of the flow rates. The calibration factor, Y, at each of the flow rates should not differ by more than ± 2 percent from the average.

16.2.3.5 To determine the need for recalibrating the critical orifices, compare the DGM Y factors obtained from two adjacent orifices each time a DGM is calibrated; for example, when checking orifice 13/2.5, use orifices 12/10.2 and 13/5.1. If any critical orifice yields a DGM Y factor differing by more than 2 percent from the others, recalibrate the critical orifice according to Section 16.2.2.

17.0 References.

1. Addendum to Specifications for Incinerator Testing at Federal Facilities. PHS, NCAPC. December 6, 1967.
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9. Annual Book of ASTM Standards. Part 26. Gaseous Fuels; Coal and Coke; Atmospheric Analysis. American Society for Testing and Materials. Philadelphia, PA. 1974. pp. 617-622.
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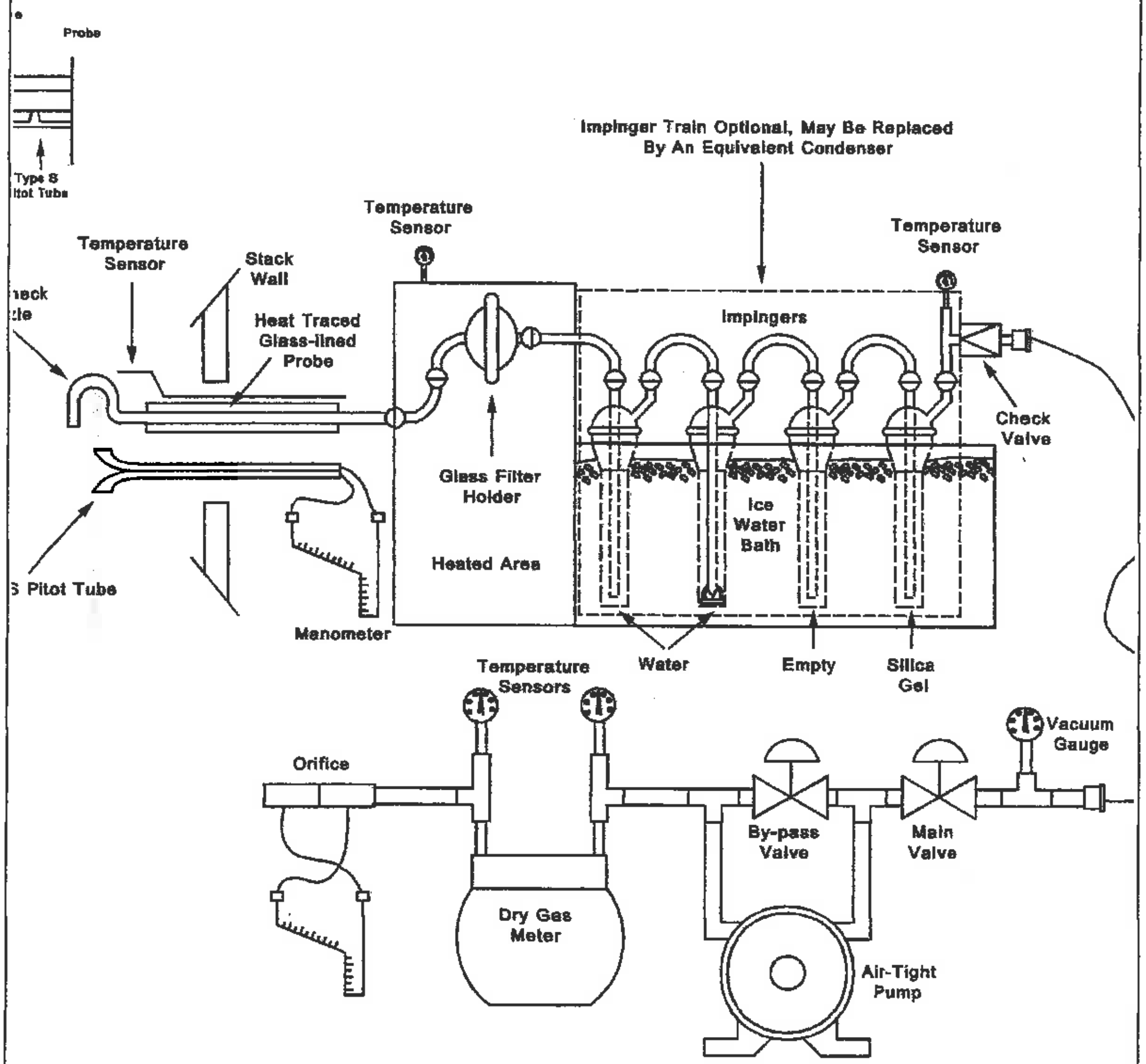
11. Westlin, P.R. and R.T. Shigehara. Procedure for Calibrating and Using Dry Gas Volume Meters as Calibration Standards. Source Evaluation Society Newsletter. 3(1):17-30. February 1978.
12. Lodge, J.P., Jr., J.B. Pate, B.E. Ammons, and G.A. Swanson. The Use of Hypodermic Needles as Critical Orifices

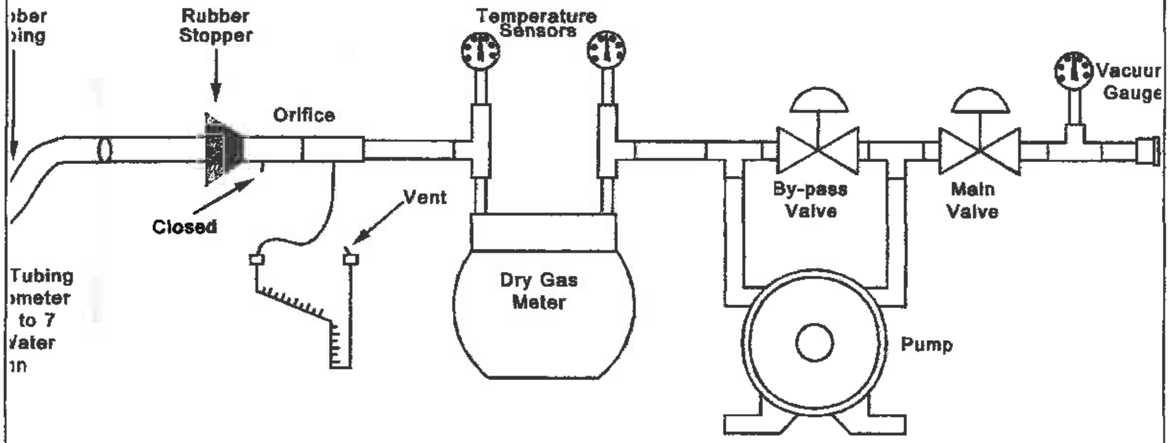
in Air Sampling. J. Air Pollution Control Association. 16:197-200. 1966.

18.0 Tables, Diagrams, Flowcharts, and Validation Data.

TABLE 5-1. FLOW RATES FOR VARIOUS NEEDLE SIZES AND TUBE LENGTHS.

Gauge/cm	Flow rate liters/min.	Gauge/cm	Flow rate liters/min.
12/7.6	32.56	14/2.5	19.54
12/10.2	30.02	14/5.1	17.27
13/2.5	25.77	14/7.6	16.14
13/5.1	23.50	15/3.2	14.16
13/7.6	22.37	15/7.6	11.61
13/10.2	20.67	15/10.2	10.48


Probe
Type S
itot Tube
Impinger Train Optional, May Be Replaced By An Equivalent Condenser
Temperature Sensor
Temperature Sensor
Temperature Sensor
Stack Wall
ieck
zle
Heat Traced Glass-lined Probe
Impingers
Check Valve
Glass Filter Holder
Heated Area
Ice Water Bath
S Pitot Tube
Manometer
Water
Empty
Silica Gel
Temperature Sensors
Vacuum Gauge
Orifice
By-pass Valve
Main Valve
Dry Gas Meter
Air-Tight Pump

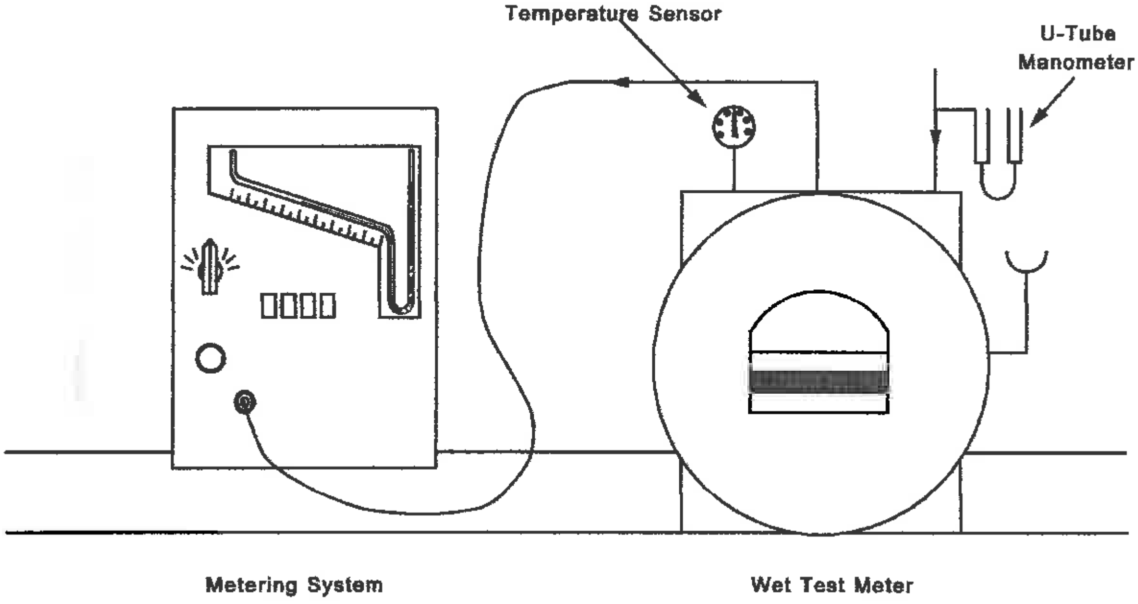

ber
ing
Rubber
Stopper
Orifice
Closed
Tubing
meter
to 7
ater
n
Vent
Temperature
Sensors
Dry Gas
Meter
By-pass
Valve
Main
Valve
Pump
Vacuur
Gauge

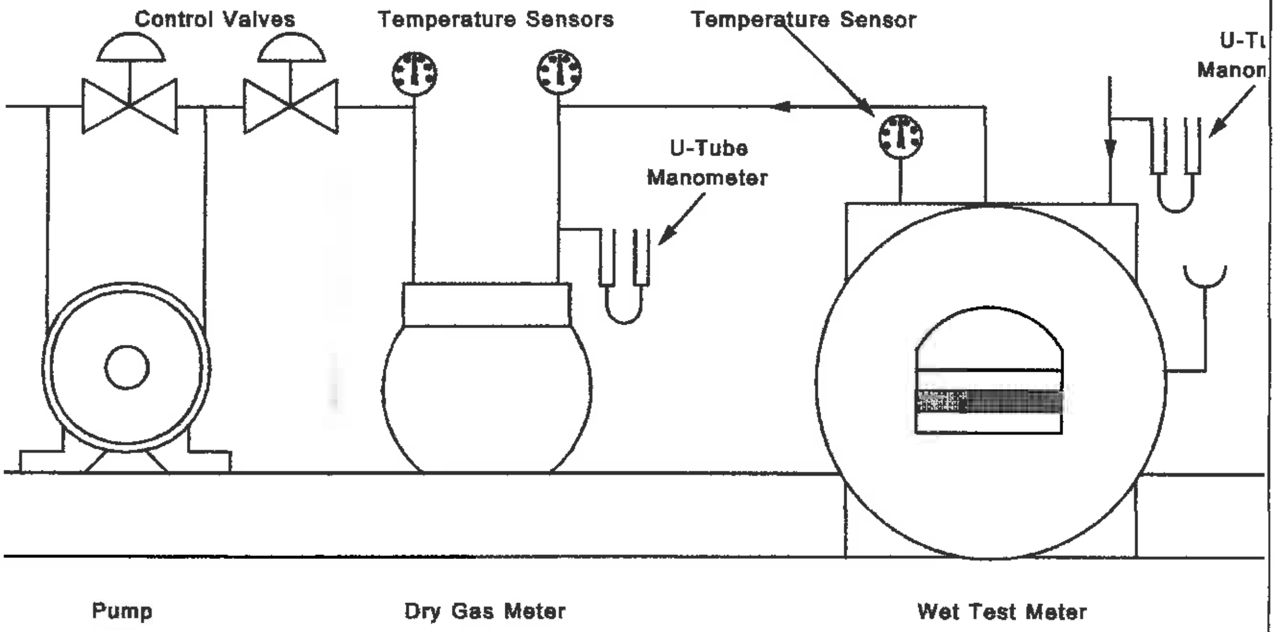
cient, Cp ____

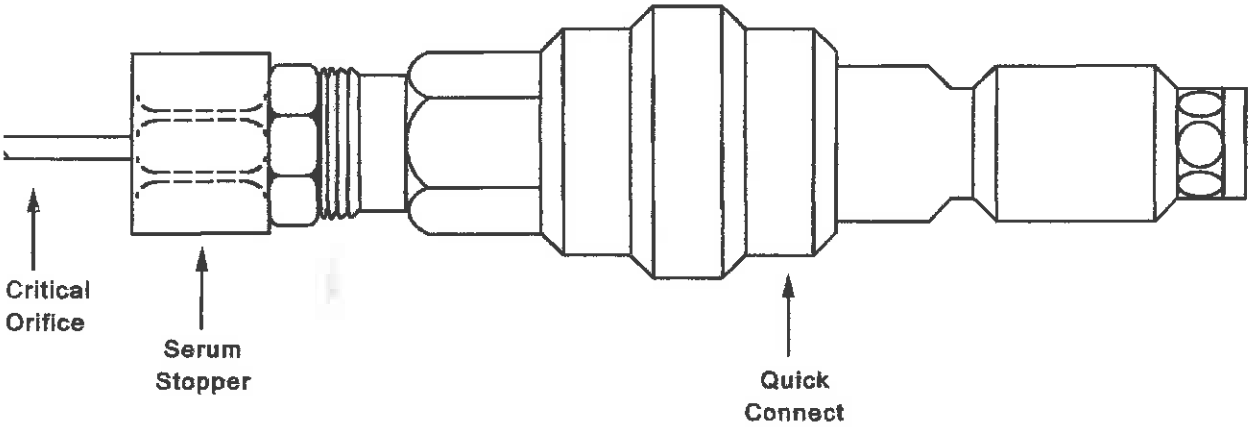
SCHEMATIC OF STACK CROSS SECTION

Ambient temperature ____
Barometric pressure ____
Assumed moisture, % ____
Probe length, (ft.) ____
Nozzle identification No. ____
Average calibrated nozzle diameter, (in.) ____
Probe heater setting ____
Leak rate, (cfm) ____
Static pressure, (in. Hg) ____
Filter No. ____

Sampling time min.	Vacuum (in.Hg)	Stack temperature (T_s) (F)	Velocity head (ΔP_s) (in. H_2O)	Pressure differential across orifice meter (in. H_2O)	Gas meter reading (ft)	Gas sample temperature at dry gas meter		Filter temperature (F)	T coi
						Inlet (F)	Outlet (F)		
						Avg.	Avg.		
						Avg.			


Temperature Sensor
U-Tube Manometer
Metering System
Wet Test Meter


Control Valves
Temperature Sensors
Temperature Sensor
U-Tu
Manon
U-Tube
Manometer
Pump
Dry Gas Meter
Wet Test Meter


Critical
Orifice
Serum
Stopper
Quick
Connect

Date: ______________________ Metering System Identification:
Barometric pressure, P_b = in. Hg

Orifice manometer setting ΔH in. H_2O	Spirometer (wet meter) gas volume, V_w ft^3	Dry gas meter volume, V_m, ft^3	Temperatures		
			Spirometer (wet meter) T_w °F	Dry Ga	
				Inlet T_i °F	Out T °

Calculations

ΔH in H_2O	Y				
Average					

Y = Ratio of reading of wet test meter to dry test meter; tolerance for individual values ± 0.02 from average.

$\Delta H_@$ = Orifice pressure differential that equates to 0.75 cfm of air @ 68°F and 29.92 inches of mercury, in. H_2O; tolerance for individual values ± 0.20 from average.

Plant ______________________________

Date ______________________________

Run No. ______________________________

Filter No. ______________________________

Amount liquid lost during transport ______________

Acetone blank volume, ml ______________

Acetone blank concentration, mg/mg (Equation 5-4) __________

Acetone wash blank, mg (Equation 5-5) __________

Container number	Weight of particulate collected, mg		
	Final weight	Tare weight	Weight gain
1.			
2.			
Total			
Less acetone blank			
Weight of particulate matter			

	Volume of liquid water collected	
	Impinger volume, ml	Silica gel weight, g
Final..........		
Initial........		
Liquid collected		
Total volume collected....		g* ml

*Convert weight of water to volume by dividing total weight

$$\frac{\text{increase, g}}{(1\text{g/ml})} = \text{Volume water, ml}$$

increase by density of water (1 g/ml).

Figure 5-6. Analytical Data Sheet.

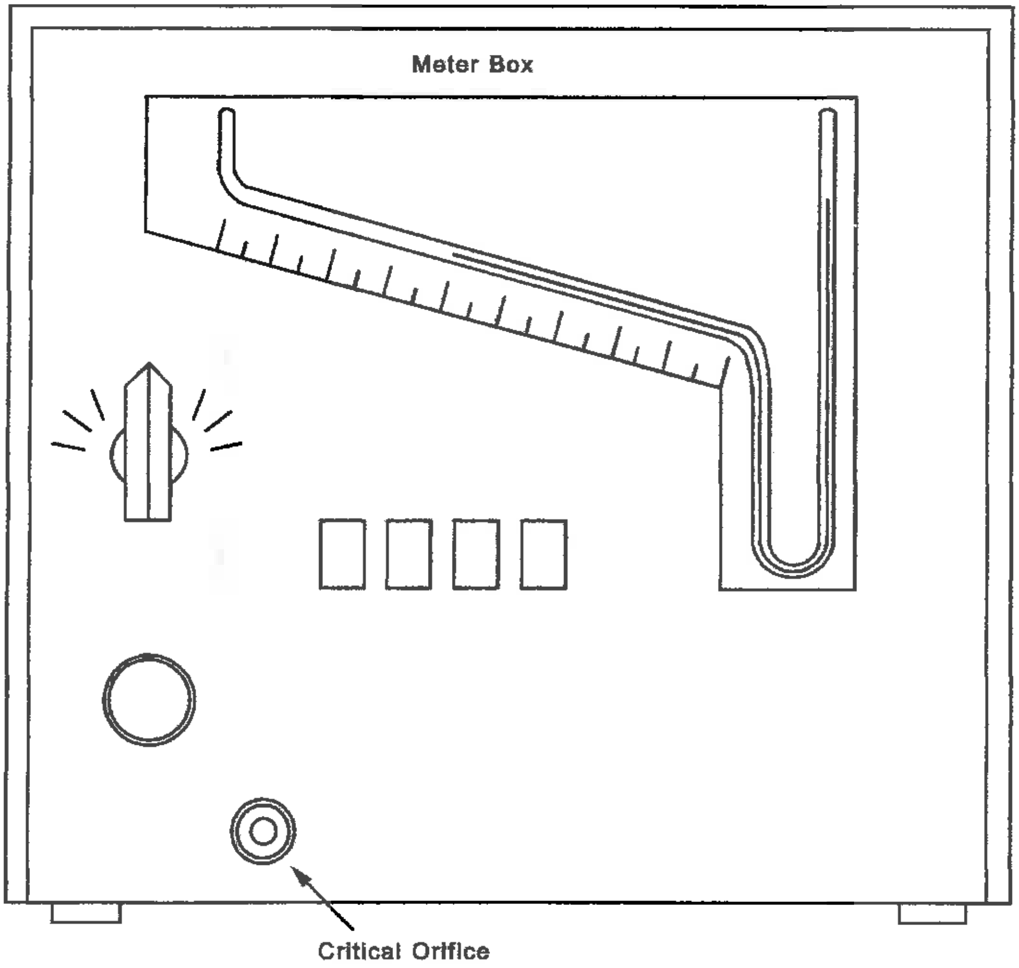
ıtification: ____________________

'e (P): ____________________ in. Hg

'ometer t Meter) Volume (V_s) ft	Dry Gas Meter Volume (V_{dg}) ft	Temperatures				Dry Gas Meter Pressure (Δp) in. H_2O	Time (q) ft	Flow Rate (Q) cfm	Meter Coefficient (Y_{ds})
		Spirometer (Wet Meter) (t_s) F	Dry Gas Meter						
			Inlet (t_i) F	Outlet (t_o) F	Average $(\bar{t}_d)$ F				

$$Q = K_1 \frac{P_{bar\,w} V}{(T_w + T_{std} \quad Q)}$$

$$Y_{ds} = \frac{V_w (T_{ds} + T_{std}) P_{bar}}{V_{ds} (T_w + T_{std}) \left(P_{bar} \frac{+\Delta}{13.6} P\right)}$$


Meter Box
Critical Orifice

Date
Train ID
DGM cal. factor
Critical orifice ID

Dry gas meter		Run number	
		1	2
inal reading..........	m^3 (ft^3).......	......	....
nitial reading........	m^3 (ft^3).......	......	....
ifference, V_m.........	m^3 (ft^3).......	......	....
nlet/Outlet			
temperatures:	°C (°F).......	/	/
Initial..............	°C (°F).......	/	/
Final................	°C (°F).......	......	....
Avg. Temperature,	min/sec.......	/	/
t_m	min...........	......	....
ime, _..............			
rifice man. rdg., _H..	mm (in.) H_2O..	......	....
ar. pressure, P_{bar}....	mm (in.) Hg...	......	....
mbient temperature,	°C (°F).......	......	....
t_{amb}	mm(in.) Hg...		
ump vacuum...........	....	......	....
' factor.............	....	......	....
Average..............		......	....

Figure 5-11. Data sheet for determining K' factor.

Date
Train ID
Critical orifice ID
Critical orifice K' factor

Dry gas meter		Run number	
		1	2
Final reading	m^3 (ft^3)	.....	.....
Initial reading	m^3 (ft^3)	.....	.....
Difference, V_m	m^3 (ft^3)	.....	.....
Inlet/outlet temperatures:	°C (°F)	/	/
Initial	°C (°F)	/	/
Final	°C (°F)	.....	.....
Avg. Temperature, t_m	min/sec	/	/
Time, _	min	.....	.....
Orifice man. rdg., _H	min	.....	.....
Bar. pressure, P_{bar}	mm (in.) H_2O	.....	.....
Ambient temperature, t_{amb}	mm (in.) Hg	.....	.....
Pump vacuum	°C (°F)	.....	.....
$V_{m(std)}$	mm (in.) Hg	.....	.....
$V_{cr(std)}$	m^3 (ft^3)	.....	.....
DGM cal. factor, Y	m^3 (ft^3)	.....	.....
		.....	.....

METHOD 6C - DETERMINATION OF SULFUR DIOXIDE EMISSIONS FROM STATIONARY SOURCES

(INSTRUMENTAL ANALYZER PROCEDURE)

1.0 Scope and Application

What is Method 6C?

Method 6C is a procedure for measuring sulfur dioxide (SO_2) in stationary source emissions using a continuous instrumental analyzer. Quality assurance and quality control requirements are included to assure that you, the tester, collect data of known quality. You must document your adherence to these specific requirements for equipment, supplies, sample collection and analysis, calculations, and data analysis.

This method does not completely describe all equipment, supplies, and sampling and analytical procedures you will need but refers to other methods for some of the details. Therefore, to obtain reliable results, you should also have a thorough knowledge of these additional test methods which are found in appendix A to this part:

(a) Method 1—Sample and Velocity Traverses for Stationary Sources.

(b) Method 4—Determination of Moisture Content in Stack Gases.

(c) Method 6—Determination of Sulfur Dioxide Emissions from Stationary Sources.

(d) Method 7E—Determination of Nitrogen Oxides Emissions from Stationary Sources (Instrumental Analyzer Procedure).

1.1 Analytes. **What does this method determine?** This method measures the concentration of sulfur dioxide.

Analyte	CAS No.	Sensitivity
SO_2	7446-09-5	Typically <2% of Calibration Span

1.2 Applicability. **When is this method required?** The use of Method 6C may be required by specific New Source Performance Standards, Clean Air Marketing rules, State Implementation Plans, and permits where SO_2 concentrations in stationary source emissions must be measured, either to determine compliance with an applicable emission standard or to conduct performance testing of a continuous emission monitoring system (CEMS). Other regulations may also require the use of Method 6C.

1.3 Data Quality Objectives. **How good must my collected data be?** Refer to Section 1.3 of Method 7E.

2.0 Summary of Method

In this method, you continuously sample the effluent gas and convey the sample to an analyzer that measures the concentration of SO_2. You must meet the performance requirements of this method to validate your data.

3.0 Definitions

Refer to Section 3.0 of Method 7E for the applicable definitions.

4.0 Interferences

Refer to Section 4.1 of Method 6.

5.0 Safety

Refer to Section 5.0 of Method 7E.

6.0 Equipment and Supplies

Figure 7E-1 of Method 7E is a schematic diagram of an acceptable measurement system.

6.1 **What do I need for the measurement system?** The essential components of the measurement system are the same as those in Sections 6.1 and 6.2 of Method 7E, except that the SO_2 analyzer described in Section 6.2 of this method must be used instead of the analyzer described in Section 6.2 of Method 7E. You must follow the noted specifications in Section 6.1 of Method 7E.

6.2 **What analyzer must I use?** You may use an instrument that uses an ultraviolet, non-dispersive infrared, fluorescence, or other detection principle to continuously measure SO_2 in the gas stream and meets the performance specifications in Section 13.0. The low-range and dual-range analyzer provisions in Section 6.2.8.1 of Method 7E apply.

7.0 Reagents and Standards

7.1 Calibration Gas. **What calibration gases do I need?** Refer to Section 7.1 of Method 7E for the calibration gas requirements. Example calibration gas mixtures are listed below.

(a) SO_2 in nitrogen (N_2).

(b) SO_2 in air.

(c) SO_2 and CO_2 in N_2.

(d) SO_2 andO_2 in N_2.

(e) $SO_2/CO_2/O_2$ gas mixture in N_2.

(f) CO_2/NO_x gas mixture in N_2

(g) $CO_2/SO_2/NO_x$ gas mixture in N_2

7.2 Interference Check. **What additional reagents do I need for the interference check?** The test gases for the interference check are listed in Table 7E-3 of Method 7E. For the alternative interference check, you must use the reagents described in Section 7.0 of Method 6.

8.0 *Sample Collection, Preservation, Storage, and Transport*

8.1 Sampling Site and Sampling Points. You must follow the procedures of Section 8.1 of Method 7E.

8.2 Initial Measurement System Performance Tests. You must follow the procedures in Section 8.2 of Method 7E. If a dilution-type measurement system is used, the special considerations in Section 8.3 of Method 7E also apply.

8.3 Interference Check. You must follow the procedures of Section 8.2.7 of Method 7E to conduct an interference check, substituting SO_2 for NO_X as the method pollutant. For dilution-type measurement systems, you must use the alternative interference check procedure in Section 16 and a co-located, unmodified Method 6 sampling train.

8.4 Sample Collection. You must follow the procedures of Section 8.4 of Method 7E.

8.5 Post-Run System Bias Check and Drift Assessment. You must follow the procedures of Section 8.5 of Method 7E.

9.0 Quality Control

Follow quality control procedures in Section 9.0 of Method 7E.

10.0 Calibration and Standardization

Follow the procedures for calibration and standardization in Section 10.0 of Method 7E.

11.0 Analytical Procedures

Because sample collection and analysis are performed together (see Section 8), additional discussion of the analytical procedure is not necessary.

12.0 Calculations and Data Analysis

You must follow the applicable procedures for calculations and data analysis in Section 12.0 of Method 7E as applicable, substituting SO_2 for NO_x as appropriate.

13.0 Method Performance

13.1 The specifications for the applicable performance checks are the same as in Section 13.0 of Method 7E.

13.2 Alternative Interference Check. When using this procedure, you must document its successful completion for each source category that you test. The results are acceptable if the difference between the Method 6C result and the modified Method 6 result is less than 7.0 percent of the Method 6 result for each of the three test runs. For the purposes of comparison, the Method 6 and 6C results must be expressed in the same units of measure.

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 Alternative Procedures

16.1 Alternative Interference Check. You may perform an alternative interference check consisting of at least three comparison runs between Method 6C and Method 6. This check validates the Method 6C results at each particular source category (type of facility) where the check is performed . When testing under conditions of low concentrations (< 15 ppm), this alternative interference check is not allowed. **Note:** The procedure described below applies to non-dilution sampling systems only. If this alternative interference check is used for a dilution sampling system, use a standard Method 6 sampling train and extract the sample directly from the exhaust stream at points collocated with the Method 6C sample probe.

Build the modified Method 6 sampling train (flow control valve, two midget impingers containing 3 percent hydrogen peroxide, and dry gas meter) shown in Figure 6C-1. Connect the sampling train to the sample bypass discharge vent. Record the dry gas meter reading before you begin sampling. Simultaneously collect modified Method 6 and Method 6C samples. Open the flow control valve in the modified Method 6 train as you begin to sample with Method 6C. Adjust the Method 6 sampling rate to 1 liter per minute (±10 percent). The sampling time per run must be the same as for Method 6 plus twice the average measurement system response time. If your modified Method 6 train does not include a pump, you risk biasing the results high if you over-pressurize the midget impingers and cause a leak. You can reduce this risk by cautiously increasing the flow rate as sampling begins.

After completing a run, record the final dry gas meter reading, meter temperature, and barometric pressure. Recover and analyze the contents of the midget impingers using the procedures in Method 6. You must analyze performance audit samples as described in Method 6 with this interference check. Determine the average gas concentration reported by Method 6C for the run.

17.0 References

1. "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards" September 1997 as amended, EPA-600/R-97/121

18.0 Tables, Diagrams, Flowcharts, and Validation Data

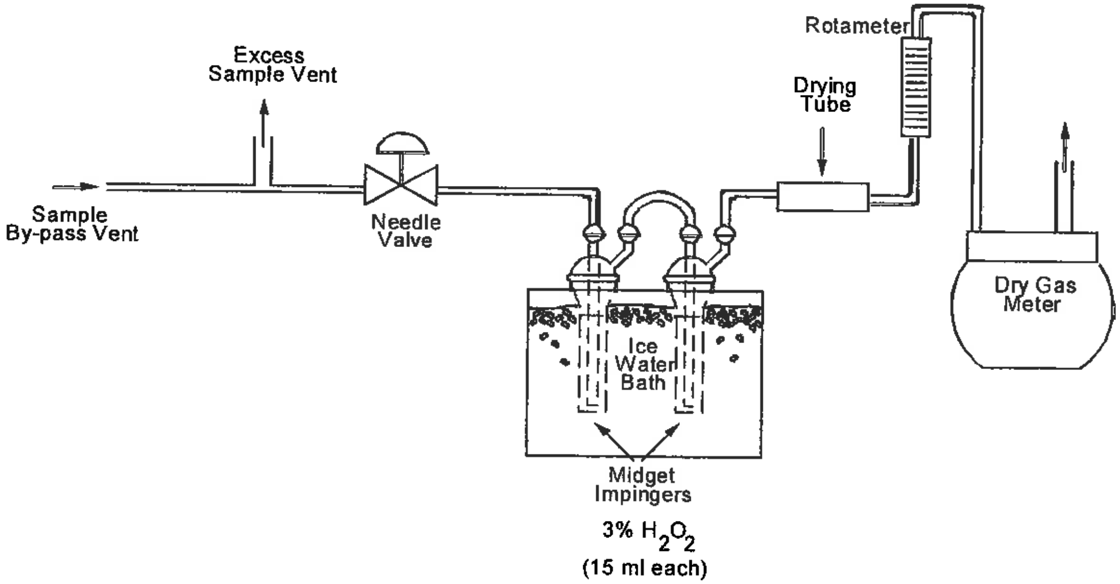


Figure 6C-1. Modified Method 6
Alternative Interference Check Sampling Train

* * * * *

METHOD 7E - DETERMINATION OF NITROGEN OXIDES EMISSIONS FROM STATIONARY SOURCES

(INSTRUMENTAL ANALYZER PROCEDURE)

1.0 Scope and Application

What is Method 7E?

Method 7E is a procedure for measuring nitrogen oxides (NO_x) in stationary source emissions using a continuous instrumental analyzer. Quality assurance and quality control requirements are included to assure that you, the tester, collect data of known quality. You must document your adherence to these specific requirements for equipment, supplies, sample collection and analysis, calculations, and data analysis.

This method does not completely describe all equipment, supplies, and sampling and analytical procedures you will need but refers to other methods for some of the details. Therefore, to obtain reliable results, you should also have a thorough knowledge of these additional test methods which are found in appendix A to this part:

(a) Method 1—Sample and Velocity Traverses for Stationary Sources.

(b) Method 4—Determination of Moisture Content in Stack Gases.

1.1 Analytes. **What does this method determine?** This method measures the concentration of nitrogen oxides as NO_2.

Analyte	CAS No.	Sensitivity
Nitric oxide (NO)	10102-43-9	Typically <2% of Calibration Span
Nitrogen dioxide (NO_2)	10102-44-0	

1.2 Applicability. **When is this method required?** The use of Method 7E may be required by specific New Source Performance Standards, Clean Air Marketing rules, State Implementation Plans, and permits where measurement of NO_x concentrations in stationary source emissions is required, either to determine compliance with an applicable emissions standard or to conduct performance testing of a continuous monitoring system (CEMS). Other regulations may also require the use of Method 7E.

1.3 Data Quality Objectives (DQO). **How good must my collected data be?** Method 7E is designed to provide high-quality data for determining compliance with Federal and State emission standards and for relative accuracy testing of CEMS. In these and other applications, the principal objective is to ensure the accuracy of the data at the actual emission levels encountered. To meet this objective, the use of EPA traceability protocol calibration gases and measurement system performance tests are required.

1.4 Data Quality Assessment for Low Emitters. **Is performance relief granted when testing low-emission units?** Yes. For low-emitting sources, there are alternative performance specifications for analyzer calibration error, system bias, drift, and response time. Also, the alternative dynamic spiking procedure in Section 16 may provide performance relief for certain low-emitting units.

2.0 Summary of Method

In this method, a sample of the effluent gas is continuously sampled and conveyed to the analyzer for measuring the concentration of NO_x. You may measure NO and NO_2 separately or simultaneously together but, for the purposes of this method, NO_x is the sum of NO and NO_2.. You must meet the performance requirements of this method to validate your data.

3.0 Definitions

3.1 *Analyzer Calibration Error*, for non-dilution systems, means the difference between the manufacturer certified concentration of a calibration gas and the measured concentration of the same gas when it is introduced into the analyzer in direct calibration mode.

3.2 *Calibration Curve* means the relationship between an analyzer's response to the injection of a series of calibration gases and the actual concentrations of those gases.

3.3 *Calibration Gas* means the gas mixture containing NO_x at a known concentration and produced and certified in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards," September 1997, as amended August 25, 1999, EPA-600/R-97/121 or more recent updates. The tests for analyzer calibration error, drift, and system bias require the use of calibration gas prepared according to this protocol.

3.3.1 *Low-Level Gas* means a calibration gas with a concentration that is less than 20 percent of the calibration span and may be a zero gas.

3.3.2 *Mid-Level Gas* means a calibration gas with a concentration that is 40 to 60 percent of the calibration span.

3.3.3 *High-Level Gas* means a calibration gas with a concentration that is equal to the calibration span.

3.4 *Calibration Span* means the upper limit of valid instrument response during sampling. To the extent practicable, the measured emissions should be between 20 to 100 percent of the selected calibration span

3.5 *Centroidal Area* means the central area of the stack or duct that is no greater than 1 percent of the stack or duct cross section. This area has the same geometric shape as the stack or duct.

3.6 *Converter Efficiency Gas* means a calibration gas with a known NO or NO_2 concentration and of Traceability Protocol quality.

3.7 *Data Recorder* means the equipment that permanently records the concentrations reported by the analyzer.

3.8 *Direct Calibration Mode* means introducing the calibration gases directly into the analyzer (or into the assembled measurement system at a point downstream of all sample conditioning equipment) according to manufacturer's recommended calibration procedure. This mode of calibration applies to non-dilution-type measurement systems.

3.9 *Drift* means the difference between the measurement system readings obtained in the pre-run and post-run system bias (or system calibration error) checks at a specific calibration gas concentration level (i.e. low-, mid-, or high-).

3.10 *Gas Analyzer* means the equipment that senses the gas being measured and generates an output proportional to its concentration.

3.11 *Interference Check* means the test to detect analyzer responses to compounds other than the compound of interest, usually a gas present in the measured gas stream, that is not adequately accounted for in the calibration procedure and may cause measurement bias.

3.12 *Low-Concentration Analyzer* means any analyzer that operates with a calibration span of 20 ppm NO_X or lower. Each analyzer model used routinely to measure low NO_x concentrations must pass a Manufacturer's Stability Test (MST). A MST subjects the analyzer to a range of potential effects to demonstrate its stability following the procedures provided in 40 CFR 53.23, 53.55, and 53.56 and provides the information in a summary format. A copy of this information must be included in each test report. Table 7E-5 lists the criteria to be met.

3.13 *Measurement System* means all of the equipment used to determine the NO_x concentration. The measurement system comprises six major subsystems: sample acquisition, sample transport, sample conditioning, calibration gas manifold, gas analyzer, and data recorder.

3.14 *Response Time* means the time it takes the measurement system to respond to a change in gas concentration occurring at the sampling point when the system is operating normally at its target sample flow rate or dilution ratio.

3.15 *Run* means a series of gas samples taken successively from the stack or duct. A test normally consists of a specific number of runs.

3.16 *System Bias* means the difference between a calibration gas measured in direct calibration mode and in system calibration mode. System bias is determined before and after each run at the low- and mid- or high-concentration levels. For dilution-type systems, pre- and post-run system calibration error is measured, rather than system bias.

3.17 *System Calibration Error* applies to dilution-type systems and means the difference between the measured concentration of low-, mid-, or high-level calibration gas and the certified concentration for each gas when introduced in system calibration mode. For dilution-type systems, a 3-point system calibration error test is conducted in lieu of the analyzer calibration error test, and 2-point system calibration error tests are conducted in lieu of system bias tests.

3.18 *System Calibration Mode* means introducing the calibration gases into the measurement system at the probe, upstream of the filter and all sample conditioning components.

3.19 *Test* refers to the series of runs required by the applicable regulation.

4.0 Interferences

Note that interferences may vary among instruments and that instrument-specific interferences must be evaluated through the interference test.

5.0 Safety

What safety measures should I consider when using this method? This method may require you to work with hazardous materials and in hazardous conditions. We encourage you to establish safety procedures before using the method. Among other precautions, you should become familiar with the safety recommendations in the gas analyzer user's manual. Occupational Safety and Health Administration (OSHA) regulations concerning cylinder and noxious gases may apply. Nitric oxide and NO_2 are toxic and dangerous gases. Nitric oxide is immediately converted to NO_2 upon reaction with air. Nitrogen dioxide is a highly poisonous and insidious gas. Inflammation of the lungs from exposure may cause only slight pain or pass unnoticed, but the resulting edema several days later may cause death. A concentration of 100 ppm is dangerous for even a short exposure, and 200 ppm may be fatal. Calibration gases must be handled with utmost care and with adequate ventilation. Emission-level exposure to these gases should be avoided.

6.0 Equipment and Supplies

The performance criteria in this method will be met or exceeded if you are properly using equipment designed for this application.

6.1 **What do I need for the measurement system?** You may use any equipment and supplies meeting the following specifications.

1) Sampling system components that are not evaluated in the system bias or system calibration error test must be glass, Teflon, or stainless steel. Other materials are potentially acceptable, subject to approval by the Administrator.

2) The interference, calibration error, and system bias criteria must be met.

3) Sample flow rate must be maintained within 10 percent of the flow rate at which the system response time was measured.

4) All system components (excluding sample conditioning components, if used) must maintain the sample temperature above the moisture dew point.

Section 6.2 provides example equipment specifications for a NO_x measurement system. Figure 7E-1 is a diagram of an example dry basis measurement system that is likely to meet the method requirements and is provided as guidance. For wet-basis systems, you may use alternative equipment and supplies as needed (some of which are described in Section 6.2), provided that the measurement system meets the applicable performance specifications of this method.

6.2 Measurement System Components

6.2.1 Sample Probe. Glass, stainless steel, or other approved material, of sufficient length to traverse the sample points.

6.2.2 Particulate Filter. An in-stack or out-of-stack filter. The filter media must be included in the system bias test and made of material that is non-reactive to the gas being sampled. This particulate filter requirement may be waived in applications where no significant particulate matter is expected (e.g., for emission testing of a combustion turbine firing natural gas).

6.2.3 Sample Line. The sample line from the probe to the conditioning system/sample pump should be made of Teflon or other material that does not absorb or otherwise alter the sample gas. For a dry-basis measurement system (as shown in Figure 7E-1), the temperature of the sample line must be maintained at a sufficiently high level to prevent condensation before the sample conditioning components. For wet-basis measurement systems, the temperature of the sample line must be maintained at a sufficiently high level to prevent condensation before the analyzer.

6.2.4 Conditioning Equipment. For dry basis measurements, a condenser, dryer or other suitable device is required to remove moisture continuously from the sample gas. Any equipment needed to heat the probe or sample line to avoid condensation prior to the sample conditioning component is also required.

For wet basis systems, you must keep the sample above its dew point either by: (1) heating the sample line and all sample transport components up to the inlet of the analyzer (and, for hot-wet extractive systems, also heating the analyzer) or (2) by diluting the sample prior to analysis using a dilution probe system. The components required to do either of the above are considered to be conditioning equipment.

6.2.5 Sampling Pump. For systems similar to the one shown in Figure 7E-1, a leak-free pump is needed to pull the sample gas through the system at a flow rate sufficient to minimize the response time of the measurement system. The pump may be constructed of any material that is non-reactive to the gas being sampled. For dilution-type measurement systems, an ejector pump (eductor) is used to create a vacuum that draws the sample through a critical orifice at a constant rate.

6.2.6 Calibration Gas Manifold. Prepare a system to allow the introduction of calibration gases either directly to the gas analyzer in direct calibration mode or into the measurement system, at the probe, in system calibration mode, or both, depending upon the type of system used. In system calibration mode, the system should be able to block the sample gas flow and flood the sampling probe. Alternatively, calibration gases may be introduced at the calibration valve following the probe. Maintain a constant pressure in the gas manifold. For in-stack dilution-type systems, a gas dilution subsystem is required to transport large volumes of purified air to the sample probe and a probe controller is needed to maintain the proper dilution ratio.

6.2.7 Sample Gas Manifold. For the type of system shown in Figure 7E-1, the sample gas manifold diverts a portion of the sample to the analyzer, delivering the remainder to the by-pass discharge vent. The manifold should also be able to introduce calibration gases directly to the analyzer (except for dilution-type systems). The manifold must be made of material that is non-reactive to the gas sampled or the calibration gas and be configured to safely discharge the bypass gas.

6.2.8 NO_x Analyzer. An instrument that continuously measures NO_x in the gas stream and meets the applicable specifications in Section 13.0. An analyzer that operates on the principle of chemiluminescence with an NO_2 to NO converter is one example of an analyzer that has been used successfully in the past. Analyzers operating on other principles may also be used provided the performance criteria in Section 13.0 are met.

6.2.8.1 Dual Range Analyzers. For certain applications, a wide range of gas concentrations may be encountered, necessitating the use of two measurement ranges. Dual-range analyzers are readily available for these applications. These analyzers are often equipped with automated range-switching capability, so that when readings exceed the full-scale of the low measurement range, they are recorded on the high range. As an alternative to using a dual-range analyzer, you may use two segments of a single, large measurement scale to serve as the low and high ranges. In all cases, when two ranges are used, you must quality-assure both ranges using the proper sets of calibration gases. You must also meet the interference, calibration error, system bias, and drift checks. However, we caution that when you use two segments of a large measurement scale for dual range purposes, it may be difficult to meet the performance specifications on the low range due to signal-to-noise ratio considerations.

6.2.8.2 Low Concentration Analyzer. When the calibration span is less than or equal to 20 ppmv, the manufacturer's stability test (MST) is required. See Table 7E-5.

6.2.9 Data Recording. A strip chart recorder, computerized data acquisition system, digital recorder, or data logger for recording measurement data may be used.

7.0 Reagents and Standards

7.1 Calibration Gas. **What calibration gases do I need?** Your calibration gas must be NO in nitrogen and certified (or recertified) within an uncertainty of 2.0 percent in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards" September 1997, as amended August 25, 1999, EPA-600/R-97/121. Blended gases meeting the Traceability Protocol are allowed if the additional gas components are shown not to interfere with the analysis. The calibration gas must not be used after its expiration date.

Except for applications under part 75 of this chapter, it is acceptable to prepare calibration gas mixtures from EPA Traceability Protocol gases in accordance with Method 205 in M to part 51 of this chapter. For part 75 applications, the use of Method 205 is subject to the approval of the Administrator. The goal and recommendation for selecting calibration gases is to bracket the sample concentrations.

The following calibration gas concentrations are required:

7.1.1 *High-Level Gas.* This concentration sets the calibration span and results in measurements being 20 to 100 percent of the calibration span.

7.1.2 *Mid-Level Gas.* 40 to 60 percent of the calibration span.

7.1.3 *Low-Level Gas.* Less than 20 percent of the calibration span.

7.1.4 *Converter Efficiency Gas.* **What reagents do I need for the converter efficiency test?** The converter efficiency gas for the test described in Section 8.2.4.1 must have a concentration of NO_2 that is between 40 and 60 ppmv. For the alternative converter efficiency tests in Section 16.2, NO is required. In either case, the test gas must be prepared according to the EPA Traceability Protocol.

7.2 Interference Check. **What reagents do I need for the interference check?** Use the appropriate test gases listed in Table 7E-3 (i.e., the potential interferents for the test facility source category, as identified by the instrument manufacturer) to conduct the interference check.

8.0 *Sample Collection, Preservation, Storage, and Transport*

Emission Test Procedure

Since you are allowed to choose different options to comply with some of the performance criteria, it is your responsibility to identify the specific options you have chosen, to document that the performance criteria for that option have been met, and to identify any deviations from the method.

8.1 **What sampling site and sampling points do I select?**

8.1.1 Unless otherwise specified in an applicable regulation or by the Administrator, when this method is used to determine compliance with an emission standard, conduct a stratification test as described in Section 8.1.2 to determine the sampling traverse points to be used. For performance testing of continuous emission monitoring systems, follow the sampling site selection and traverse point layout procedures described in the appropriate performance specification or applicable regulation (e.g., Performance Specification 2 in appendix B to this part).

8.1.2 Determination of Stratification. To test for stratification, use a probe of appropriate length to measure the NO_x (or pollutant of interest) concentration at twelve traverse points located according to Table 1-1 or Table 1-2 of Method 1. Alternatively, you may measure at three points on a line passing through the centroidal area. Space the three points at 16.7, 50.0, and 83.3 percent of the measurement line. Sample for a minimum of twice the system response time (see Section 8.2.6) at each traverse point. Calculate the individual point and mean NO_x concentrations. If the concentration at each traverse point differs from the mean concentration for all traverse points by no more than: (a) ± 5.0 percent of the mean concentration; or (b) ± 0.5 ppm (whichever is less restrictive), the gas stream is considered unstratified and you may collect samples from a single point that most closely matches the mean. If the 5.0 percent or 0.5 ppm criterion is not met, but the concentration at each traverse point differs from the mean concentration for all traverse points by no more than: (a) ± 10.0 percent of the mean; or (b) ± 1.0 ppm (whichever is less restrictive), the gas stream is considered to be minimally stratified, and you may take samples from three points. Space the three points at 16.7, 50.0, and 83.3 percent of the measurement line. Alternatively, if a twelve point stratification test was performed and the emissions shown to be minimally stratified (all points within ± 10.0 percent of their mean or within ± 1.0 ppm), and if the stack diameter (or equivalent diameter, for a rectangular stack or duct) is greater than 2.4 meters (7.8 ft), then you may use 3-point sampling and locate the three points along the measurement line exhibiting the highest average concentration during the stratification test, at 0.4, 1.0 and 2.0 meters from the stack or duct wall. If the gas stream is found to be stratified because the 10.0 percent or 1.0 ppm criterion for a 3-point test is not met, locate twelve traverse points for the test in accordance with Table 1-1 or Table 1-2 of Method 1.

8.2 Initial Measurement System Performance Tests. **What initial performance criteria must my system meet before I begin collecting samples?** Before measuring emissions, perform the following procedures:

(a) Calibration gas verification,

(b) Measurement system preparation,

(c) Calibration error test,

(d) NO_2 to NO conversion efficiency test, if applicable,

(e) System bias check,

(f) System response time test, and

(g) Interference check

8.2.1 Calibration Gas Verification. **How must I verify the concentrations of my calibration gases?** Obtain a certificate from the gas manufacturer and confirm that the documentation includes all information required by the Traceability Protocol. Confirm that the manufacturer certification is complete and current. Ensure that your calibration gases certifications have not expired. This documentation should be available on-site for inspection. To the extent practicable, select a high-level gas concentration that will result in the measured emissions being between 20 and 100 percent of the calibration span.

8.2.2 Measurement System Preparation. **How do I prepare my measurement system?** Assemble, prepare, and precondition the measurement system according to your standard operating procedure. Adjust the system to achieve the correct sampling rate or dilution ratio (as applicable).

8.2.3 Calibration Error Test. **How do I confirm my analyzer calibration is correct?** After you have assembled, prepared and calibrated your sampling system and analyzer, you must conduct a 3-point analyzer calibration error test (or a 3-point system calibration error test for dilution systems) before the first run and again after any failed system bias test (or 2-point system calibration error test for dilution systems) or failed drift test. Introduce the low-, mid-, and high-level calibration gases sequentially. For non-dilution-type measurement systems, introduce the gases in direct calibration mode. For dilution-type measurement systems, introduce the gases in system calibration mode.

For non-dilution systems, you may adjust the system to maintain the correct flow rate at the analyzer during the test, but you may not make adjustments for any other purpose. For dilution systems, you must operate the measurement system at the appropriate dilution ratio during all system calibration error checks, and may make only the adjustments necessary to maintain the proper ratio.

Record the analyzer's response to each calibration gas on a form similar to Table 7E-1. For each calibration gas, calculate the analyzer calibration error using Equation 7E-1 in Section 12.2 or the system calibration error using Equation 7E-3 in Section 12.4 (as applicable). The calibration error specification in Section 13.1 must be met for the low-, mid-, and high-level gases. If the calibration error specification is not met, take corrective action and repeat the test until an acceptable 3-point calibration is achieved.

8.2.4 NO_2 to NO Conversion Efficiency Test . Before each field test, you must conduct an NO_2 to NO conversion efficiency test if your system converts NO_2 to NO before analyzing for NO_x. Follow the procedures in Section 8.2.4.1, or 8.2.4.2. If desired, the converter efficiency factor derived from this test may be used to correct the test results for converter efficiency if the NO_2 fraction in the measured test gas is known. Use Equation 7E-8 in Section 12.8 for this correction.

8.2.4.1 Introduce a concentration of 40 to 60 ppmv NO_2 to the analyzer in direct calibration mode and record the NO_x concentration displayed by the analyzer. If a dilution-system is used, introduce the NO_2 calibration gas at a point before the dilution takes place. Calculate the converter efficiency using Equation 7E-7 in Section 12.7. The specification for converter efficiency in Section 13.5 must be met. The user is cautioned that state-of-the-art NO_2 calibration gases may not be sufficiently stable and thus make it more difficult to pass the 90 percent conversion efficiency requirement. The NO_2 must be prepared according to the EPA Traceability Protocol and have an accuracy within 2.0 percent.

8.2.4.2 Alternatively, either of the procedures for determining conversion efficiency using NO in Section 16.2 may be used.

8.2.5 Initial System Bias and System Calibration Error Checks. Before sampling begins, determine whether the high-level or mid-level calibration gas best approximates the emissions and use it as the upscale gas. Introduce the upscale gas at the probe upstream of all sample conditioning components in system calibration mode. Record the time it takes for the measured concentration to increase to a value that is within 95 percent or 0.5 ppm (whichever is less restrictive) of the certified gas concentration. Continue to observe the gas concentration reading until it has reached a final, stable value. Record this value on a form similar to Table 7E-2.

Next, introduce the low-level gas in system calibration mode and record the time required for the concentration response to decrease to a value that is within 5.0 percent or 0.5 ppm (whichever is less restrictive) of the certified low-range gas concentration. If the low-level gas is a zero gas, use the procedures described above and observe the change in concentration until the response is 0.5 ppm or 5.0 percent of the upscale gas concentration (whichever is less restrictive).

Continue to observe the low-level gas reading until it has reached a final, stable value and record the result on a form similar to Table 7E-2. Operate the measurement system at the normal sampling rate during all system bias checks. Make only the adjustments necessary to achieve proper calibration gas flow rates at the analyzer.

From these data, calculate the measurement system response time (see Section 8.2.6) and then calculate the initial system bias using Equation 7E-2 in Section 12.3. For dilution systems, calculate the system calibration error in lieu of system bias using equation 7E-3 in Section 12.4. See Section 13.2 for acceptable performance criteria for system bias and system calibration error. If the initial system bias (or system calibration error) specification is not met, take corrective action. Then, you must repeat the applicable calibration error test from Section 8.2.3 and the initial system bias (or 2-point system calibration error) check until acceptable results are achieved, after which you may begin sampling. (**Note**: For dilution-type systems, data from the 3-point system calibration error test described in Section 8.2.3 may be used to meet the initial 2-point system calibration error test requirement of this section, if the calibration gases were injected as described in this section, and if response time data were recorded).

8.2.6 Measurement System Response Time. As described in section 8.2.5, you must determine the measurement system response time during the initial system bias (or 2-point system calibration error) check. Observe the times required to achieve 95 percent of a stable response for both the low-level and upscale gases. The longer interval is the response time.

8.2.7 Interference Check. Conduct an interference response test of the gas analyzer prior to its initial use in the field. If you have multiple analyzers of the same make and model, you need only perform this alternative interference check on one analyzer. You may also meet the interference check requirement if the instrument manufacturer performs this or similar check on the same make and model of analyzer that you use and provides you with documented results.

You may introduce the appropriate interference test gases (that are potentially encountered during a test, see examples in Table 7E-3) into the analyzer (or measurement system for dilution-type systems) separately or as mixtures. This test must be performed both with and without NO_x (NO and NO_2) (the applicable pollutant gas). For analyzers measuring NOx greater than 20 ppm, use a calibration gas with an NOx concentration of 80 to 100 ppm and set this concentration equal to the calibration span. For analyzers measuring less than 20 ppm NO_x, select an NO concentration for the calibration span that reflects the emission levels at the sources to be tested, and perform the interference check at that level. Measure the total interference response of the analyzer to these gases in ppmv. Record the responses and determine the interference using Table 7E-4. The specification in Section 13.4 must be met.

A copy of this data, including the date completed and signed certification, must be available for inspection at the test site and included with each test report. This interference test is valid for the life of the instrument unless major analytical components (e.g., the detector) are replaced. If major components are replaced, the interference gas check must be repeated before returning the analyzer to service. The tester must ensure that any specific technology, equipment, or procedures that are intended to remove interference effects are operating properly during testing.

8.3 Dilution-Type Systems—Special Considerations. When a dilution-type measurement system is used, there are three important considerations that must be taken into account to ensure the quality of the emissions data. First, the critical orifice size and dilution ratio must be selected properly so that the sample dew point will be below the sample line and analyzer temperatures. Second, a high-quality, accurate probe controller must be used to maintain the dilution ratio during the test. The probe controller should be capable of monitoring the dilution air pressure, eductor vacuum, and sample flow rates. Third, differences between the molecular weight of calibration gas mixtures and the stack gas molecular weight must be addressed because these can affect the dilution ratio and introduce measurement bias.

8.4 Sample Collection. Position the probe at the first sampling point. Purge the system for at least two times the response time before recording any data. Then, traverse all required sampling points and sample at each point for an equal length of time, maintaining the appropriate sample flow rate or dilution ratio (as applicable). You must record at least one valid data point per minute during the test run. The minimum time you must sample at each point is two times the system response time. Usually the test is designed for sampling longer than this to better characterize the source's temporal variation.

After recording data for the appropriate period of time at the first traverse point, you may move to the next point and continue recording, omitting the requirement to wait for two times the system response time before recording data at the subsequent traverse points. For example, if you use a sampling system with a two-minute system response time, initially purge the system for at least four minutes, then record a minimum of four one-minute averages at each sample point. However, if you remove the probe from the stack, you must recondition the sampling system for at least two times the system response time prior to your next recording.

If at any time a measured one-minute average gas concentration exceeds the calibration span value, you must at a minimum identify and report this as a deviation from the method. Depending on the data quality objectives of the test, this event may require corrective action before proceeding. If the average of any run exceeds the calibration span value, the run is invalidated.

You may satisfy the multipoint traverse requirement by sampling sequentially using a single-hole probe or a multi-hole probe designed to sample at the prescribed points with a flow within 10 percent of mean flow rate. Notwithstanding, for applications under part 75 of this chapter, the use of multi-hole probes is subject to the approval of the Administrator.

8.5 Post-Run System Bias Check and Drift Assessment. **How do I confirm that each sample I collect is valid?** After each run, repeat the system bias check or 2-point system calibration error check (for dilution systems) to validate the run. Do not make adjustments to the measurement system (other than to maintain the target sampling rate or dilution ratio) between the end of the run and the completion of the post-run system bias or system calibration error check. Note that for all post-run system bias or 2-point system calibration error checks, you may inject the low-level gas first and the upscale gas last, or vice-versa.

If you do not pass the post-run system bias (or system calibration error) check, then the run is invalid. You must diagnose and fix the problem and pass another initial 3-point calibration error test (see Section 8.2.3) and another system bias (or 2-point system calibration error) check (see Section 8.2.5) before repeating the run. In these additional bias and calibration error tests, the gases may be injected in any order. Record the system bias (or system calibration error) check results on a form similar to Table 7E-2.

After each run, calculate the low-level and upscale drift, using Equation 7E-4 in Section 12.5. If the post-run low- and upscale bias (or 2-point system calibration error) checks are passed, but the low- or upscale drift exceeds the specification in Section 13.3, the run data are valid, but a 3-point calibration error test and a system bias (or 2-point system calibration error) check must be performed and passed before any more test runs are done.

For dilution systems, data from a 3-point system calibration error test may be used to met the pre-run 2-point system calibration error requirement for the first run in a test sequence. Also, the post-run bias (or 2-point calibration error) check data may be used as the pre-run data for the next run in the test sequence at the discretion of the tester.

8.6 Alternative Interference and System Bias Checks (Dynamic Spike Procedure). **If I want to use the dynamic spike procedure to validate my data, what procedure should I follow?** Except for applications under part 75 of this chapter, you may use the dynamic spiking procedure and requirements provided in Section 16.1 during each test as an alternative to the interference check and the pre- and post-run system bias checks. The calibration error test is still required under this option. Use of the dynamic spiking procedure for Part 75 applications is subject to the approval of the Administrator.

8.7 Moisture correction. You must determine the moisture content of the flue gas and correct the measured gas concentrations to a dry basis using Method 4 or other appropriate methods, subject to the approval of the Administrator, when the moisture basis (wet or dry) of the measurements made with this method is different from the moisture basis of either: (1) the applicable emissions limit; or (2) the CEMS being evaluated for relative accuracy. Moisture correction is also required if the applicable limit is in lb/mmBtu and the moisture basis of the Method 7E NO_x analyzer is different from the moisture basis of the Method 3A diluent gas (CO_2 or O_2) analyzer.

9.0 Quality Control

What quality control measures must I take?

The following table is a summary of the mandatory, suggested, and alternative quality assurance and quality control measures and the associated frequency and acceptance criteria. All of the QC data, along with the sample run data, must be documented and included in the test report.

Summary Table of QA/QC

Status	**Process or Element**	**QA/QC Specification**	**Acceptance Criteria**	**Checking Frequency**
S	Identify Data User		Regulatory Agency or other primary end user of data	Before designing test
S	Analyzer Design	Analyzer resolution or sensitivity	< 2.0 % of full-scale range	Manufacturer design
M		Interference gas check	Sum of responses ≤ 2.5 % of calibration span Alternatively, sum of responses: ≤ 0.5 ppmv for calibration spans of 5 to 10 ppmv ≤ 0.2 ppmv for calibration spans < 5 ppmv See Table 7E-3	
M	Calibration Gases	Traceability protocol (G1, G2)	Valid certificate required Uncertainty ≤ 2.0 % of tag value	
M		High-level gas	Equal to the calibration span	Each test
M		Mid-level gas	40 to 60% of calibration span	Each test
M		Low-level gas	< 20% of calibration span	Each test
S	Data Recorder Design	Data resolution	≤ 0.5% of full-scale range	Manufacturer design
S	Sample Extraction	Probe material	SS or quartz if stack > 500° F	Each test

M	Sample Extraction	Probe, filter and sample line temperature	For dry-basis analyzers, keep sample above the dew point by heating, prior to sample conditioning For wet-basis analyzers, keep sample above dew point at all times, by heating or dilution.	Each run
S	Sample Extraction	Calibration valve material	SS	Each test
S	Sample Extraction	Sample pump material	Inert to sample constituents	Each test
S	Sample Extraction	Manifolding material	Inert to sample constituents	Each test
S	Moisture Removal	Equipment efficiency	< 5% target compound removal	Verified through system bias check
S	Particulate Removal	Filter inertness	Pass system bias check	Each bias check
M	Analyzer & Calibration Gas Performance	Analyzer calibration error (or 3-point system calibration error for dilution systems)	Within ± 2.0 percent of the calibration span of the analyzer for the low-, mid-, and high-level calibration gases Alternative specification: ≤0.5 ppmv absolute difference	Before initial run and after a failed system bias test or drift test
M	System Performance	System bias (or pre- and post-run 2-point system calibration error for dilution Systems)	Within ± 5.0 % of the analyzer calibration span for low-scale and upscale calibration gases Alternative specification: ≤0.5 ppmv absolute difference	Before and after each run

M	System Performance	System response time	Determines minimum sampling time per point	During initial sampling system bias test
M	System Performance	Drift	≤3.0 % of calibration span for low-level and mid- or high-level gases Alternative specification: ≤0.5 ppmv absolute difference	After each test run
M	System Performance	NO_2-NO conversion efficiency	≥ 90% of certified test gas concentration	Before each test
M	System Performance	Purge time	≥ 2 times system response time	Before starting the first run and when probe is removed from and re-inserted into the stack
M	System Performance	Minimum sample time at each point	Two times the system response time	Each sample point
M	System Performance	Stable sample flow rate (surrogate for maintaining system response time)	Within 10% of flow rate established during system response time check	Each run

M	Sample Point Selection	Stratification test	All points within: ± 5% of mean for 1-point sampling ± 10% of mean for 3-point Alternatively, all points within: ± 0.5 ppm of mean for 1-point sampling ± 1.0 ppm of mean for 3-point sampling	Prior to first run
A	Multiple sample points simultaneously	No. of openings in probe	Multi-hole probe with verifiable constant flow through all holes within 10% of mean flow rate (requires Administrative approval for Part 75)	Each run
M	Data Recording	Frequency	≤1 minute average	During run
S	Data Parameters	Sample concentration range	All 1-minute averages within calibration span	Each run
M	Data Parameters	Average concentration for the run	Run average ≤ calibration span	Each run

S = Suggested
M = Mandatory
A = Alternative

10.0 Calibration and Standardization

What measurement system calibrations are required?

The initial 3-point calibration error test as described in Section 8.2.3 and the system bias (or system calibration error) checks described in Section 8.2.5 are required and must meet the specifications in Section 13 before you start the test. Make all necessary adjustments to calibrate the gas analyzer and data recorder. Then, after the test commences, the system bias or system calibration error checks described in Section 8.5 are required before and after each run. Your analyzer must be calibrated for all species of NO_x that it detects. If your analyzer measures NO and NO_2 separately, then you must use both NO and NO_2 calibration gases.

You must include a copy of the manufacturer's certification of the calibration gases used in the testing as part of the test report. This certification must include the 13 documentation requirements in the EPA Traceability Protocol For Assay and Certification of Gaseous Calibration Standards, September 1997, as amended August 25, 1999. When Method 205 is used to produce diluted calibration gases, you must document that the specifications for the gas dilution system are met for the test. You must also include the date of the most recent dilution system calibration against flow standards and the name of the person or manufacturer who carried out the calibration in the test report.

11.0 Analytical Procedures

Because sample collection and analysis are performed together (see Section 8), additional discussion of the analytical procedure is not necessary.

12.0 Calculations and Data Analysis

You must follow the procedures for calculations and data analysis listed in this section.

12.1 Nomenclature. **The terms used in the equations are defined as follows:**

ACE = Analyzer calibration error, percent of calibration span.

B_{WS} = Moisture content of sample gas as measured by Method 4 or other approved method, percent/100.

C_{Avg} = Average unadjusted gas concentration indicated by data recorder for the test run, ppmv

C_D = Pollutant concentration adjusted to dry conditions, ppmv.

C_{Dir} = Measured concentration of a calibration gas (low, mid, or high) when introduced in direct calibration mode, ppmv.

C_{Gas} = Average effluent gas concentration adjusted for bias, ppmv.

C_M = Average of initial and final system calibration bias (or 2-point system calibration error) check responses for the upscale calibration gas, ppmv.

C_{MA} = Actual concentration of the upscale calibration gas, ppmv.

C_O = Average of the initial and final system calibration bias (or 2-point system calibration error) check responses from the low-level (or zero) calibration gas, ppmv.

C_S = Measured concentration of a calibration gas (low, mid, or high) when introduced in system calibration mode, ppmv.

C_{SS} = Concentration of NO_x measured in the spiked sample, ppmv.

C_{Spike} = Concentration of NO_x in the undiluted spike gas, ppmv.

C_{Calc} = Calculated concentration of NO_x in the spike gas diluted in the sample, ppmv.

C_V = Manufacturer certified concentration of a calibration gas (low, mid, or high), ppmv.

C_W = Pollutant concentration measured under moist sample conditions, wet basis, ppmv.

CS = Calibration span, ppmv.

D = Drift assessment, percent of calibration span.

Eff_{NO2} = NO_2 to NO converter efficiency, percent.

NO_{Final} = The average NO concentration observed with the analyzer in the NO mode during the converter efficiency test in Section 16.2.2, ppmv.

NO_{XCorr}= The NO_X concentration corrected for the converter efficiency, ppmv.

NO_{XFinal} = The final NOx concentration observed during the converter efficiency test in Section 16.2.2, ppmv

NO_{XPeak} = The highest NOx concentration observed during the converter efficiency test in Section 16.2.2, ppmv

Q_{Spike} = Flow rate of spike gas introduced in system calibration mode, L/min.

Q_{Total} = Total sample flow rate during the spike test, L/min.

R = Spike recovery, percent.

SB = System bias, percent of calibration span.

SB_i = Pre-run system bias, percent of calibration span.

SB_f = Post-run system bias, percent of calibration span.

SCE = System calibration error, percent of calibration span.

SCE_i = Pre-run system calibration error, percent of calibration span.

SCE_{final} = Post-run system calibration error, percent of calibration span.

12.2 Analyzer Calibration Error. For non-dilution systems, use Equation 7E-1 to calculate the analyzer calibration error for the low-, mid-, and high-level calibration gases.

$$ACE = \frac{C_{Dir} - C_v}{CS} x\,100 \qquad \text{Eq. 7E-1}$$

12.3 System Bias. For non-dilution systems, use Equation 7E-2 to calculate the system bias separately for the low-level and upscale calibration gases.

$$SB = \frac{C_S - C_{Dir}}{CS} \; x\,100 \qquad \text{Eq. 7E-2}$$

12.4 System Calibration Error. Use Equation 7E-3 to calculate the system calibration error for dilution systems. Equation 7E-3 applies to both the initial 3-point system calibration error test and the subsequent 2-point between run tests.

$$SCE = \frac{C_S - C_V}{CS} \; x\,100 \qquad \text{Eq. 7E-3}$$

12.5 Drift Assessment. Use Equation 7E-4 to separately calculate the low-level and upscale drift over each test run. For dilution systems, replace "SB_{final}" and "SB_i" with "SCE_{final}" and "SCE_i", respectively, to calculate and evaluate drift.

$$D = \left| SB_{final} - SB_i \right| \qquad \text{Eq. 7E-4}$$

12.6 Effluent Gas Concentration. For each test run, calculate C_{avg}, the arithmetic average of all valid NO_x concentration values (e.g., 1-minute averages). Then adjust the value of C_{avg} for bias, using Equation 7E-5.

$$C_{Gas} = (C_{Avg} - C_O) \; \frac{C_{MA}}{C_M - C_O} \qquad \text{Eq. 7E-5}$$

12.7 NO_2 - NO Conversion Efficiency. If the NO_x converter efficiency test described in Section 8.2.4.1 is performed, calculate the efficiency using Equation 7E-7.

$$Eff_{NO2} = \frac{C_{Dir}}{C_V} \; x\,100 \qquad \text{Eq. 7E-7}$$

12.8 NO_2 - NO Conversion Efficiency Correction. If desired, calculate the total NO_X concentration with a correction for converter efficiency using Equations 7E-8.

$$NO_{XCorr} = NO + \frac{NO_X - NO}{Eff_{NO2}} x100 \qquad \text{Eq. 7E-8}$$

12.9 Alternative NO_2 Converter Efficiency. If the alternative procedure of Section 16.2.2 is used, calculate the converter efficiency using Equation 7E-9.

$$Eff_{NO2} = \frac{(NO_{XFinal} - NO_{Final})}{(NO_{XPeak} - NO_{XFinal})} x\ 100 \qquad \text{Eq.7E-9}$$

12.10 Moisture Correction. Use Equation 7E-10 if your measurements need to be corrected to a dry basis.

$$C_D = \frac{C_W}{1 - B_{WS}} \qquad \text{Eq. 7E-10}$$

12.11 Calculated Spike Gas Concentration and Spike Recovery for the Example Alternative Dynamic Spiking Procedure in Section 16.1.3. Use Equation 7E-11 to determine the calculated spike gas concentration. Use Equation 7E-12 to calculate the spike recovery.

$$C_{Calc} = \frac{(C_{Spike})(Q_{Spike})}{Q_{Total}} \qquad \text{Eq. 7E-11}$$

$$R = \frac{C_{SS} - C_{Avg}}{C_{Calc}} x\ 100 \qquad \text{Eq. 7E-12}$$

13.0 Method Performance

13.1 Calibration Error. This specification is applicable to both the analyzer calibration error and the 3-point system calibration error tests described in Section 8.2.3. At each calibration gas level (low, mid, and high) the calibration error must either be within ± 2.0 percent of the calibration span. Alternatively, the results are acceptable if $|C_{dir} - C_v|$ or $|C_s - C_v|$ (as applicable) is ≤ 0.5 ppmv.

13.2 System Bias. This specification is applicable to both the system bias and 2-point system calibration error tests described in Section 8.2.5 and 8.5. The pre- and post-run system bias (or system calibration error) must be within ± 5.0 percent of the calibration span for the low-level and upscale calibration gases. Alternatively, the results are acceptable if $|C_s - C_{dir}|$ is ≤ 0.5 ppmv or if $|C_s - C_v|$ is ≤ 0.5 ppmv (as applicable) .

13.3 Drift. For each run, the low-level and upscale drift must be less than or equal to 3.0 percent of the calibration span. The drift is also acceptable if the pre- and post-run bias (or the pre- and post-run system calibration error) responses do not differ by more than 0.5 ppmv at each gas concentration (i.e. $|C_{s\ \text{post-run}} - C_{s\ \text{pre-run}}| \leq 0.5$ ppmv).

13.4 Interference Check. The total interference response (i.e., the sum of the interference responses of all tested gaseous components) must not be greater than 2.50 percent of the calibration span for the analyzer tested. In summing the interferences, use the larger of the absolute values obtained for the interferent tested with and without the pollutant present. The results are also acceptable if the sum of the responses does not exceed 0.5 ppmv for a calibration span of 5 to 10 ppmv, or 0.2 ppmv for a calibration span < 5 ppmv.

13.5 NO_2 to NO Conversion Efficiency Test (as applicable). The NO_2 to NO conversion efficiency, calculated according to Equation 7E-7 or Equation 7E-9, must be greater than or equal to 90 percent.

13.6 Alternative Dynamic Spike Procedure. Recoveries of both pre-test spikes and post-test spikes must be within 100 ± 10 percent. If the absolute difference between the calculated spike value and measured spike value is equal to or less than 0.20 ppmv, then the requirements of the ADSC are met.

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 Alternative Procedures

16.1 Dynamic Spike Procedure. Except for applications under part 75 of this chapter, you may use a dynamic spiking procedure to validate your test data for a specific test matrix in place of the interference check and pre- and post-run system bias checks. For part 75 applications, use of this procedure is subject to the approval of the Administrator. Best results are obtained for this procedure when source emissions are steady and not varying. Fluctuating emissions may render this alternative procedure difficult to pass. To use this alternative, you must meet the following requirements.

16.1.1 Procedure Documentation. You must detail the procedure you followed in the test report, including how the spike was measured, added, verified during the run, and calculated after the test.

16.1.2 Spiking Procedure Requirements. The spikes must be prepared from EPA Traceability Protocol gases. Your procedure must be designed to spike field samples at two target levels both before and after the test. Your target spike levels should bracket the average sample NO_x concentrations. The higher target concentration must be less than the calibration span. You must collect at least 5 data points for each target concentration. The spiking procedure must be performed before the first run and repeated after the last run of the test program.

16.1.3 Example Spiking Procedure. Determine the NO concentration needed to generate concentrations that are 50 and 150 percent of the anticipated NO_x concentration in the stack at the total sampling flow rate while keeping the spike flow rate at or below 10 percent of this total. Use a mass flow meter (accurate within 2.0 percent) to generate these NO spike gas concentrations at a constant flow rate. Use Equation 7E-11 in Section 12.11 to determine the calculated spike concentration in the collected sample.

Prepare the measurement system and conduct the analyzer calibration error test as described in Sections 8.2.2 and 8.2.3. Following the sampling procedures in Section 8.1, determine the stack NO_x concentration and use this concentration as the average stack concentration (C_{avg}) for the first spike level, or if desired, for both pre-test spike levels. Introduce the first level spike gas into the system in system calibration mode and begin sample collection. Wait for at least two times the system response time before measuring the spiked sample concentration. Then record at least five successive 1-minute averages of the spiked sample gas. Monitor the spike gas flow rate and maintain at the determined addition rate. Average the five 1-minute averages and determine the spike recovery using Equation 7E-12. Repeat this procedure for the other pre-test spike level. The recovery at each level must be within the limits in Section 13.6 before proceeding with the test.

Conduct the number of runs required for the test. Then repeat the above procedure for the post-test spike evaluation. The last run of the test may serve as the average stack concentration for the post-test spike test calculations. The results of the post-test spikes must meet the limits in Section 13.6.

16.2 Alternative NO_2 to NO Conversion Efficiency Procedures. You may use either of the following procedures to determine converter efficiency in place of the procedure in Section 8.2.4.1.

16.2.1 The procedure for determining conversion efficiency using NO in 40 CFR 86.123-78.

16.2.2 Tedlar Bag Procedure. Perform the analyzer calibration error test to document the calibration (both NO and NO_X modes, as applicable). Fill a Tedlar bag approximately half full with either ambient air, pure oxygen, or an oxygen standard gas with at least 19.5 percent by volume oxygen content. Fill the remainder of the bag with mid-level NO in nitrogen calibration gas. (Note that the concentration of the NO standard should be sufficiently high that the diluted concentration will be easily and accurately measured on the scale used. The size of the bag should be large enough to accommodate the procedure and time required).

Immediately attach the bag to the inlet of the NO_X analyzer (or external converter if used). In the case of a dilution-system, introduce the gas at a point upstream of the dilution assembly. Measure the NO_X concentration for a period of 30 minutes. If the NO_X concentration drops more than 2 percent absolute from the peak value observed, then the NO_2 converter has failed to meet the criteria of this test. Take corrective action. The highest NO_X value observed is considered to be NO_{XPeak}. The final NO_X value observed is considered to be NO_{Xfinal}.

If the NO_X converter has met the criterion of this test, then switch the analyzer to the NO mode (note that this may not be required for analyzers with auto-switching). Document the average NO concentration for a period of 30 seconds to one minute. This average value is

NO_{final}. Switch the analyzer back to the NO_X mode and document that the analyzer still meets the criteria of not dropping more than 2 percent from the peak value.

In sequence, inject the zero and the upscale calibration gas that most closely matches the NO_X concentration observed during the converter efficiency test. Repeat this procedure in both the NO and NO_X modes. If the gases are not within 1 percent of scale of the actual values, reject the converter efficiency test and take corrective action. If the gases are within this criterion, use Equation 7E-9 to determine the converter efficiency. The converter efficiency must meet the specification in Section 13.5.

16.3 Manufacturer's Stability Test. A manufacturer's stability test is required for all analyzers that routinely measure emissions below 20 ppm and is optional but recommended for other analyzers. This test evaluates each analyzer model by subjecting it to the tests listed in Table 7E-5 following the procedures in 40 CFR Part 53.23, 53.55, and 53.56 to demonstrate its stability. A copy of this information in summary format must be included in each test report.

17.0 References

1. "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards" September 1997 as amended, EPA-600/R-97/121.

18.0 Tables, Diagrams, Flowcharts, and Validation Data

Figure 7E-1. Measurement System

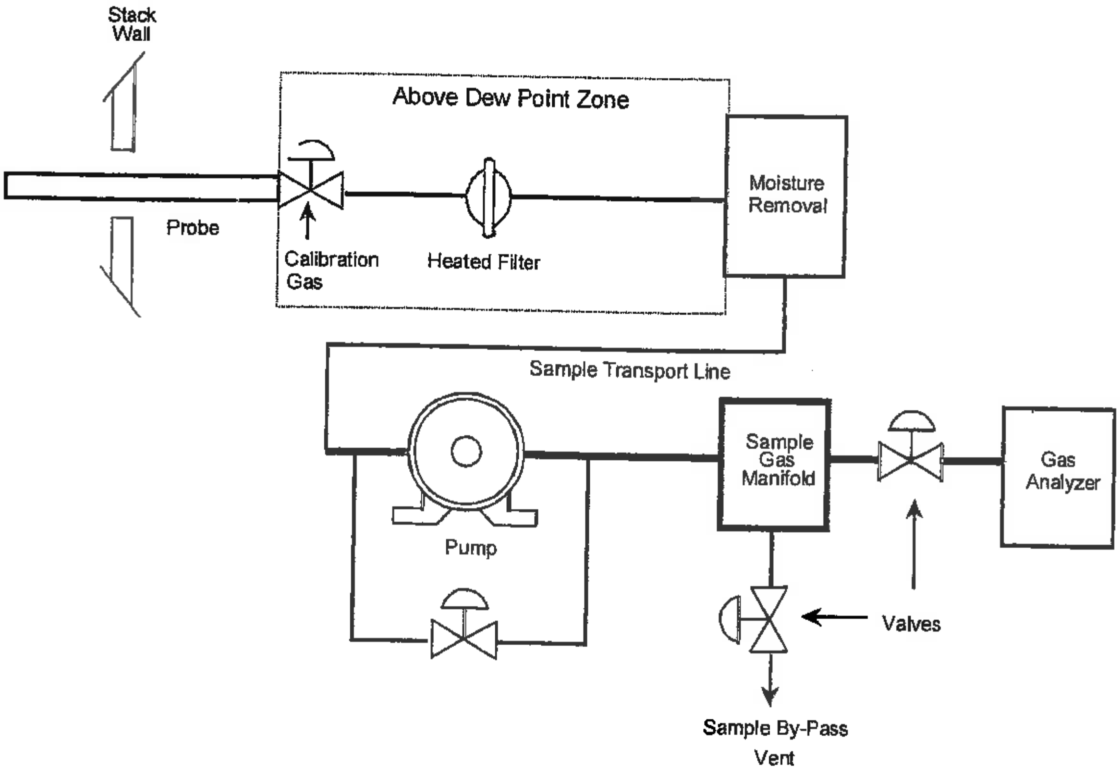
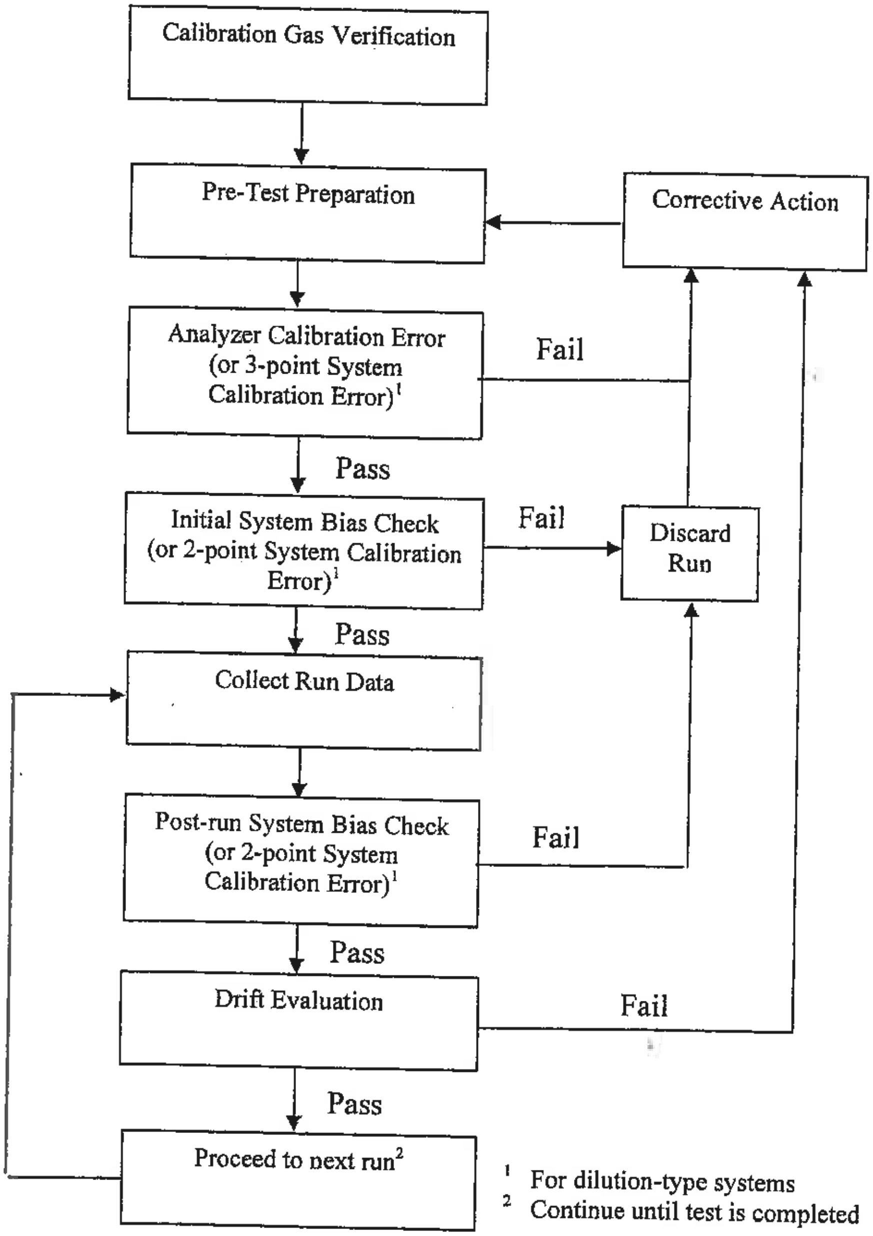


Figure 7E-2. Testing Flow Chart



[1] For dilution-type systems
[2] Continue until test is completed

Table 7E-1 - Analyzer (or System) Calibration Error Data

Source Identification: ______________
Test personnel: ______________
Date: ______________
Time: ______________

Analyzer[1] or System[2] calibration error data for sampling runs: ______________
Analyzer Model No. ______________
Serial No. ______________
Calibration Span (CS):

	Manufacturer Certified Cylinder Value (indicate units) A	Analyzer calibration response (indicate units) B	Absolute difference (indicate units) A-B	Calibration Error (percent of calibration span) $\frac{A-B}{CS} \times 100$
Low-level (or zero) calibration gas	....	....	....	....
Mid-level calibration gas......	....	....	....	....
High-level calibration gas	....	....	....	....

[1] Refers to data from the analyzer calibration error test of a non-dilution system.
[2] Refers to data from a 3-point system calibration error test of a dilution system.

Table 7E-2 - System Bias (or System Calibration Error) and Drift Data

Source Identification:__________ Run Number: ___________
Test personnel: _______________ Calibration Span:________
Date: _________________ ____ Response Time: _________
Analyzer Model No. ________________Serial No._______________

	Initial values			Final values		
Calibration Gas Level	Certified Calibration gas value (indicate units)	System Response (indicate units)	System Bias[1] or Calibration Error[2] (% of calibration span)	System response (indicate units)	System Bias[1] or Calibration Error[2] (% of calibration span)	Drift (% of calibration span)
Low-level gas	....	....	....	....	....	
Upscale (high- or mid-) level gas	....	....	....	....	....	

---

[1] Refers to the pre- and post-run system bias checks of a non-dilution system.
[2] Refers to the pre- and post-run system calibration error checks of a dilution system.

Table 7E-3. Interference Check Gas Concentrations

Potential Interferent	Sample Conditioning Type[2]	
	Hot Wet	Dried
CO2	5 and 15%	5 and 15%
H2O	25%	1 %
NO	15 ppmv	15 ppmv
NO2	15 ppmv	15 ppmv
N2O	10 ppmv	10 ppmv
CO	50 ppmv	50 ppmv
NH3	10 ppmv	10 ppmv
CH4	50 ppmv	50 ppmv
SO2	20 ppmv	20 ppmv
H2	50 ppmv	50 ppmv
HCl	10 ppmv	10 ppmv

1) Any of the above specific gases can be eliminated or tested at a lower level if the manufacturer has provided reliable means for limiting or scrubbing that gas to a specified level.

2) For dilution extractive systems, use the Hot Wet concentrations divided by the minimum targeted dilution ratio to be used during the test.

Table 7E-4 - Interference Response

Date of Test:____________________
Analyzer Type:__________________
Model No.:_____________________
Serial No:______________________
Calibration Span:________________

Test Gas Type	Concentration (ppm)	Analyzer Response
	Sum of Responses	
	% of Calibration Span	

Table 7E-5. Manufacturer Stability Test

Each Model Must Be Tested Quarterly or Once Per 50 Production Units

TEST DESCRIPTION	**Acceptance Criteria (Note 1)**
Thermal Stability	Temperature range when drift does not exceed 3.0% of analyzer range over a 12-hour run when measured with NO_x present @ ≥ 80% of calibration span.
Fault Conditions	Identify conditions which, when they occur, result in performance which is not in compliance with the Manufacturer's Stability Test criteria. These are to be indicated visually or electrically to alert the operator of the problem.
Insensitivity to Supply Voltage Variations	±10.0% (or manufacturers alternative) variation from nominal voltage must produce a drift of ≤ 2.0% of calibration span for either zero or concentration ≥ 80% NO_x present
Analyzer Calibration Error	For a low-, medium-, and high- calibration gas, the difference between the manufacturer certified value and the analyzer response in direct calibration mode, no more than 2.0% of calibration span

Note 1: If the instrument is to be used as a Low Range analyzer, all tests must be performed at a calibration span of 20 ppm or less.

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EMISSION MEASUREMENT TECHNICAL INFORMATION CENTER

NSPS TEST METHOD

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Prepared by **Emission Measurement Branch** **EMTIC TM-009**
Technical Support Division, OAQPS, EPA October 25, 1990

Method 9 - Visual Determination of the Opacity of Emissions from Stationary Sources

INTRODUCTION

(a) Many stationary sources discharge visible emissions into the atmosphere; these emissions are usually in the shape of a plume. This method involves the determination of plume opacity by qualified observers. The methods includes procedures for the training and certification of observers and procedures to be used in the field for determination of plume opacity.

(b) The appearance of a plume as viewed by an observer depends upon a number of variables, some of which may be controllable in the field. Variables which can be controlled to an extent to which they no longer exert a significant influence upon plume appearance include: angle of the observer with respect to the plume; angle of the observer with respect to the sun; point of observation of attached and detached steam plume; and angle of the observer with respect to a plume emitted from a rectangular stack with a large length to width ratio. The method includes specific criteria applicable to these variables.

(c) Other variables which may not be controllable in the field are luminescence and color contrast between the plume and the background against which the plume is viewed. These variables exert an influence upon the appearance of a plume as viewed by an observer and can affect the ability of the observer to assign accurately opacity values to the observed plume. Studies of the theory of plume opacity and field studies have demonstrated that a plume is most visible and presents the greatest apparent opacity when viewed against a contrasting background. Accordingly, the opacity of a plume viewed under conditions where a contrasting background is present can be assigned with the greatest degree of accuracy. However, the potential for a positive error is also the greatest when a plume is viewed under such contrasting conditions. Under conditions presenting a less contrasting background, the apparent opacity of a plume is less and approaches zero as the color and luminescence contrast decrease toward zero. As a result, significant negative bias and negative errors can be made when a plume is viewed under less contrasting conditions. A negative bias decreases rather than increases the possibility that a plant operator will be incorrectly cited for a violation of opacity standards as a result of observer error.

(d) Studies have been undertaken to determine the magnitude of positive errors made by qualified observers while reading plumes under contrasting conditions and using the procedures set forth in this method. The results of these studies (field trials) which involve a total of 769 sets of 25 readings each are as follows:

(1) For black plumes (133 sets at a smoke generator), 100 percent of the sets were read with a positive error of less than 7.5 percent opacity; 99 percent were read with a positive error of less than 5 percent opacity. (Note: For a set, positive error = average opacity determined by observers' 25 observations -average opacity determined from transmissometer's 25 recordings.)

(2) For white plumes (170 sets at a smoke generator, 168 sets at a coal-fired power plant, 298 sets at a sulfuric acid plant), 99 percent of the sets were read with a positive error of less than 7.5 percent opacity; 95 percent were read with a positive error of less than 5 percent opacity.

(e) The positive observational error associated with an average of twenty-five readings is therefore established. The accuracy of the method must be taken into account when determining possible violations of applicable opacity standards.

1. PRINCIPLE AND APPLICABILITY

1.1 Principle. The opacity of emissions from stationary sources is determined visually by a qualified observer.

1.2 Applicability. This method is applicable for the determination of the opacity of emissions from stationary sources pursuant to § 60.11(b) and for visually determining opacity of emissions.

2. PROCEDURES

The observer qualified in accordance with Section 3 of this method shall use the following procedures for visually determining the opacity of emissions.

2.1 Position. The qualified observer shall stand at a distance sufficient to provide a clear view of the emissions with the sun oriented in the 140° sector to his back. Consistent with maintaining the above requirement, the observer shall, as much as possible, make his observations from a position such that his line of vision is approximately perpendicular to the plume direction and, when observing opacity of emissions from rectangular outlets (e.g., roof monitors, open baghouses, noncircular stacks), approximately perpendicular to the longer axis of the outlet. The observer's line of sight should not include more than one plume at a time when multiple stacks are involved, and in any case the observer should make his observations with his line of sight perpendicular to the longer axis of such a set of multiple stacks (e.g., stub stacks on baghouses).

2.2 Field Records. The observer shall record the name of the plant, emission location, facility type, observer's name and affiliation, and the date on a field data sheet (Figure 9-1). The time, estimated distance to the emission location, approximate wind direction, estimated wind speed, description of the sky condition (presence and color of clouds), and plume background are recorded on a field data sheet at the time opacity readings are initiated and completed.

Figure 9-1. Record of visual determination of opacity.

Company________________________________
Location_______________________________
Test No._______________________________
Date___________________________________
Type Facility__________________________
Control Device_________________________
Hours of Observation___________________
Observer_______________________________
Observer Certification Date________ Observer Affiliation_____
Point of Emissions ________ Height of Discharge ____

CLOCK TIME	Initial			Final
OBSERVER LOCATION				
Distance to discharge				
Direction from				
Height of observation				
BACKGROUND DESCRIPTION				
WEATHER CONDITIONS				
Wind Direction				
Wind Speed				
Ambient Temperature				
SKY CONDITIONS (clear, overcast, % clouds, etc.)				
PLUME DESCRIPTION				
Color				
Distance Visible				
OTHER INFORMATION				

SUMMARY OF AVERAGE OPACITY

Set Number	Time	Opacity	
	Start - End	Sum	Average

Readings ranged from ___ to ___ % opacity.

The source was/was not in compliance with ___ at the time evaluation was made.

Visual Determination of Opacity

Company ______________________

Location ______________________

Job # ______________________

Run # ______________________

Observer ______________________

Date ______________________

Start Time ______________________

End Time ______________________

	0	15	30	45
0				
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				

	0	15	30	45
30				
31				
32				
33				
34				
35				
36				
37				
38				
39				
40				
41				
42				
43				
44				
45				
46				
47				
48				
49				
50				
51				
52				
53				
54				
55				
56				
57				
58				
59				

% Opacity ______________________

Comments: ____

____

____

2.3 Observations. Opacity observations shall be made at the point of greatest opacity in that portion of the plume where condensed water vapor is not present. The observer shall not look continuously at the plume but instead shall observe the plume momentarily at 15-second intervals.

2.3.1 Attached Steam Plumes. When condensed water vapor is present within the plume as it emerges from the emission outlet, opacity observations shall be made beyond the point in the plume at which condensed water vapor is no longer visible. The observer shall record the approximate distance from the emission outlet to the point in the plume at which the observations are made.

2.3.2 Detached Steam Plume. When water vapor in the plume condenses and becomes visible at a distinct distance from the emission outlet, the opacity of emissions should be evaluated at the emission outlet prior to the condensation of water vapor and the formation of the steam plume.

2.4 Recording Observations. Opacity observations shall be recorded to the nearest 5 percent at 15-second intervals on an observational record sheet. (See Figure 9-2 for an example.) A minimum of 24 observations shall be recorded. Each momentary observation recorded shall be deemed to represent the average opacity of emissions for a 15-second period.

2.5 Data Reduction. Opacity shall be determined as an average of 24 consecutive observations recorded at 15-second intervals. Divide the observations recorded on the record sheet into sets of 24 consecutive observations. A set is composed of any 24 consecutive observations. Sets need not be consecutive in time and in no case shall two sets overlap. For each set of 24 observations, calculate the average by summing the opacity of the 24 observations and dividing this sum by 24. If an applicable standard specifies an averaging time requiring more than 24 observations, calculate the average for all observations made during the specified time period. Record the average opacity on a record sheet. (See Figure 9-1 for an example.)

3. QUALIFICATION AND TESTING

3.1 Certification Requirements. To receive certification as a qualified observer, a candidate must be tested and demonstrate the ability to assign opacity readings in 5 percent increments to 25 different black plumes and 25 different white plumes, with an error not to exceed 15 percent opacity on any one reading and average error not to exceed 7.5 percent opacity in each category. Candidates shall be tested according to the procedures described in Section 3.2. Smoke generators used pursuant to Section 3.2 shall be equipped with a smoke meter which meets the requirements of Section 3.3. The certification shall be valid for a period of 6 months, at which time the qualification procedure must be repeated by any observer in order to retain certification.

3.2 Certification Procedure. The certification test consists of showing the candidate a complete run of 50 plumes--25 black plumes and 25 white plumes-generated by a smoke generator. Plumes within each set of 25 black and 25 white runs shall be presented in random order. The candidate assigns an opacity value to each plume and records his observation on a suitable form. At the completion of each run of 50 readings, the score of the candidate is determined. If a candidate fails to qualify, the complete run of 50 readings must be repeated in any retest. The smoke test may be administered as part of a smoke school or training program and may be preceded by training or familiarization runs of the smoke generator during which candidates are shown black and white plumes of known opacity.

3.3 Smoke Generator Specifications. Any smoke generator used for the purposes of Section 3.2 shall be equipped with a smoke meter installed to measure opacity across the diameter of the smoke generator stack. The smoke meter output shall display in-stack opacity based upon a pathlength equal to the stack exit diameter, on a full 0 to 100 percent chart recorder scale. The smoke meter optical design and performance shall meet the specifications shown in Table 9—1. The smoke meter shall be calibrated as prescribed in Section 3.3.1 prior to the conduct of each smoke reading test. At the completion of each test, the zero and span drift shall be checked and if the drift exceeds ±1 percent opacity, the condition shall be corrected prior to conducting any subsequent test runs. The smoke meter shall be demonstrated, at the time of installation, to meet the specifications listed in Table 9-1. This demonstration shall be repeated following any subsequent repair or replacement of the photocell or associated electronic circuitry including the chart recorder or output meter, or every 6 months, whichever occurs first.

TABLE 9-1 - SMOKE METER DESIGN AND PERFORMANCE SPECIFICATIONS

Parameter	Specification
a. Light Source	Incandescent lamp operated at nominal rated voltage
b. Spectral reponse of photocell	Photopic (daylight spectral response of the human eye - Citation 3)
c. Angle of view	15° maximum total angle
d. Angle of projection	15° maximum total angle
e. Calibration error	±3% opacity, maximum
f. Zero and span drift	±1% opacity, 30 minutes
g. Response time	5 seconds

3.3.1 Calibration. The smoke meter is calibrated after allowing a minimum of 30 minutes warmup by alternately producing simulated opacity of 0 percent and 100 percent. When stable response at 0 percent or 100 percent is noted, the smoke meter is adjusted to produce an output of 0 percent or 100 percent, as appropriate. This calibration shall be repeated until stable 0 percent and 100 percent opacity values may be produced by alternately switching the power to the light source on and off while the smoke generator is not producing smoke.

3.3.2 Smoke Meter Evaluation. The smoke meter design and performance are to be evaluated as follows:

3.3.2.1 Light Source. Verify from manufacturer's data and from voltage measurements made at the lamp, as installed, that the lamp is operated within ±5 percent of the nominal rated voltage.

3.3.2.2 Spectral Response of Photocell. Verify from manufacturer's data that the photocell has a photopic response; i.e., the spectral sensitivity of the cell shall closely approximate the standard spectral-luminosity in (b) of Table 9–1.

3.3.2.3 Angle of View. Check construction geometry to ensure that the total angle of view of the smoke plume, as seen by the photocell, does not exceed 15°. The total angle of view may be calculated from: • = 2 $\tan^{-1}$ (d/2L), where • = total angle of view; d = the sum of the photocell diameter + the diameter of the limiting aperture; and L = the distance from the photocell to the limiting aperture. The limiting aperture is the point in the path between the photocell and the smoke plume where the angle of view is most restricted. In smoke generator smoke meters this is normally an orifice plate.

3.3.2.4 Angle of Projection. Check construction geometry to ensure that the total angle of projection of the lamp on the smoke plume does not exceed 15°. The total angle of projection may be calculated from: • = 2 $\tan^{-1}$ (d/2L), where • = total angle of projection; d = the sum of the length of the lamp filament + the diameter of the limiting aperture; and L = the distance from the lamp to the limiting aperture.

3.3.2.5 Calibration Error. Using neutral-density filters of known opacity, check the error between the actual response and the theoretical linear response of the smoke meter. This check is accomplished by first calibrating the smoke meter according to Section 3.3.1 and then inserting a series of three neutral-density filters of nominal opacity of 20, 50, and 75 percent in the smoke meter pathlength. Filters calibrated within 2 percent shall be used. Care should be taken when inserting the filters to prevent stray light from affecting the meter. Make a total of five nonconsecutive readings for each filter. The maximum error on any one reading shall be 3 percent opacity.

3.3.2.6 Zero and Span Drift. Determine the zero and span drift by calibrating and operating the smoke generator in a normal manner over a 1-hour period. The drift is measured by checking the zero and span at the end of this period.

3.3.2.7 Response Time. Determine the response time by producing the series of five simulated 0 percent and 100 percent opacity values and observing the time required to reach stable response. Opacity values of 0 percent and 100 percent may be simulated by alternately switching the power to the light source off and on while the smoke generator is not operating.

4. BIBLIOGRAPHY

1. Air Pollution Control District Rules and Regulations, Los Angeles County Air Pollution Control District, Regulation IV, Prohibitions, Rule 50.

2. Weisburd, Melvin I., Field Operations and Enforcement Manual for Air, U.S. Environmental Protection Agency, Research Triangle Park, NC, APTD-1100, August 1972, pp. 4.1-4.36.

3. Condon. E.U., and Odishaw, H., Handbook of Physics, McGraw-Hill Co., New York, NY, 1958, Table 3.1, p. 6-52.

METHOD 10 - DETERMINATION OF CARBON MONOXIDE EMISSIONS FROM STATIONARY SOURCES

(INSTRUMENTAL ANALYZER PROCEDURE)

1.0 Scope and Application

What is Method 10?

Method 10 is a procedure for measuring carbon monoxide (CO) in stationary source emissions using a continuous instrumental analyzer. Quality assurance and quality control requirements are included to assure that you, the tester, collect data of known quality. You must document your adherence to these specific requirements for equipment, supplies, sample collection and analysis, calculations, and data analysis.

This method does not completely describe all equipment, supplies, and sampling and analytical procedures you will need but refers to other methods for some of the details. Therefore, to obtain reliable results, you should also have a thorough knowledge of these additional test methods which are found in appendix A to this part:

(a) Method 1—Sample and Velocity Traverses for Stationary Sources.

(b) Method 4—Determination of Moisture Content in Stack Gases.

(c) Method 7E—Determination of Nitrogen Oxides Emissions from Stationary Sources (Instrumental Analyzer Procedure).

1.1 Analytes. **What does this method determine?** This method measures the concentration of carbon monoxide.

Analyte	CAS No.	Sensitivity
CO	630-08-0	Typically <2% of Calibration Span

1.2 Applicability. **When is this method required?** The use of Method 10 may be required by specific New Source Performance Standards, State Implementation Plans, and permits where CO concentrations in stationary source emissions must be measured, either to determine compliance with an applicable emission standard or to conduct performance testing of a continuous emission monitoring system (CEMS). Other regulations may also require the use of Method 10.

1.3 Data Quality Objectives. Refer to Section 1.3 of Method 7E.

2.0 Summary of Method

In this method, you continuously or intermittently sample the effluent gas and convey the sample to an analyzer that measures the concentration of CO. You must meet the performance requirements of this method to validate your data.

3.0 Definitions

Refer to Section 3.0 of Method 7E for the applicable definitions.

4.0 Interferences

Substances having a strong absorption of infrared energy may interfere to some extent in some analyzers. Instrumental correction may be used to compensate for the interference. You may also use silica gel and ascarite traps to eliminate the interferences. If this option is used, correct the measured gas volume for the carbon dioxide (CO_2) removed in the trap.

5.0 Safety

Refer to Section 5.0 of Method 7E.

6.0 Equipment and Supplies

What do I need for the measurement system?

6.1 Continuous Sampling. Figure 7E-1 of Method 7E is a schematic diagram of an acceptable measurement system. The components are the same as those in Sections 6.1 and 6.2 of Method 7E, except that the CO analyzer described in Section 6.2 of this method must be used instead of the analyzer described in Section 6.2 of Method 7E. You must follow the noted specifications in Section 6.1 of Method 7E except that the requirements to use stainless steel, Teflon, or non-reactive glass filters do not apply. Also, a heated sample line is not required to transport dry gases or for systems that measure the CO concentration on a dry basis.

6.2 Integrated Sampling.

6.2.1 Air-Cooled Condenser or Equivalent. To remove any excess moisture.

6.2.2 Valve. Needle valve, or equivalent, to adjust flow rate.

6.2.3 Pump. Leak-free diaphragm type, or equivalent, to transport gas.

6.2.4 Rate Meter. Rotameter, or equivalent, to measure a flow range from 0 to 1.0 liter per minute (0.035 cfm).

6.2.5 Flexible Bag. Tedlar, or equivalent, with a capacity of 60 to 90 liters (2 to 3 ft^3). Leak-test the bag in the laboratory before using by evacuating with a pump followed by a dry gas meter. When the evacuation is complete, there should be no flow through the meter.

6.3 **What analyzer must I use?** You must use an instrument that continuously measures CO in the gas stream and meets the specifications in Section 13.0. The dual-range analyzer provisions in Section 6.2.8.1 of Method 7E apply.

7.0 Reagents and Standards

7.1 Calibration Gas. **What calibration gases do I need?** Refer to Section 7.1 of Method 7E for the calibration gas requirements.

7.2 Interference Check. **What additional reagents do I need for the interference check?** Use the appropriate test gases listed in Table 7E-3 of Method 7E (i.e., potential interferents, as identified by the instrument manufacturer) to conduct the interference check.

8.0 *Sample Collection, Preservation, Storage, and Transport*

Emission Test Procedure

8.1 Sampling Site and Sampling Points. You must follow Section 8.1 of Method 7E.

8.2 Initial Measurement System Performance Tests. You must follow the procedures in Section 8.2 of Method 7E. If a dilution-type measurement system is used, the special considerations in Section 8.3 of Method 7E also apply.

8.3 Interference Check. You must follow the procedures of Section 8.2.7 of Method 7E.

8.4 Sample Collection.

8.4.1 Continuous Sampling. You must follow the procedures of Section 8.4 of Method 7E.

8.4.2 Integrated Sampling. Evacuate the flexible bag. Set up the equipment as shown in Figure 10-1 with the bag disconnected. Place the probe in the stack and purge the sampling line. Connect the bag, making sure that all connections are leak-free. Sample at a rate proportional to the stack velocity. If needed, the CO_2 content of the gas may be determined by using the Method 3 integrated sample procedures, or by weighing an ascarite CO_2 removal tube used and computing CO_2 concentration from the gas volume sampled and the weight gain of the tube. Data may be recorded on a form similar to Table 10-1.

8.5 Post-Run System Bias Check, Drift Assessment, and Alternative Dynamic Spike Procedure. You must follow the procedures in Sections 8.5 and 8.6 of Method 7E.

9.0 Quality Control

Follow the quality control procedures in Section 9.0 of Method 7E.

10.0 Calibration and Standardization

Follow the procedures for calibration and standardization in Section 10.0 of Method 7E.

11.0 Analytical Procedures

Because sample collection and analysis are performed together (see Section 8), additional discussion of the analytical procedure is not necessary.

12.0 Calculations and Data Analysis

You must follow the procedures for calculations and data analysis in Section 12.0 of Method 7E, as applicable, substituting CO for NO_x as applicable.

12.1 Concentration Correction for CO_2 Removal. Correct the CO concentration for CO_2 removal (if applicable) using Eq. 10-1.

$$C_{Avg} = C_{CO\,stack}\,(1 - F_{CO2})$$

Where:

C_{Avg} = Average gas concentration for the test run, ppm.

$C_{CO\ stack}$ = Average unadjusted stack gas CO concentration indicated by the data recorder for the test run, ppmv.

F_{CO2} = Volume fraction of CO_2 in the sample, i.e., percent CO_2 from Orsat analysis divided by 100.

13.0 Method Performance

The specifications for analyzer calibration error, system bias, drift, interference check, and alternative dynamic spike procedure are the same as in Section 13.0 of Method 7E.

14.0 Pollution Prevention [Reserved]

15.0 Waste Management [Reserved]

16.0 Alternative Procedures

The dynamic spike procedure and the manufacturer stability test are the same as in Sections 16.1 and 16.3 of Method 7E

17.0 References

1. "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards" September 1997 as amended, EPA-600/R-97/121

18.0 Tables, Diagrams, Flowcharts, and Validation Data

Figure 10-1. Integrated Gas Sampling Train.

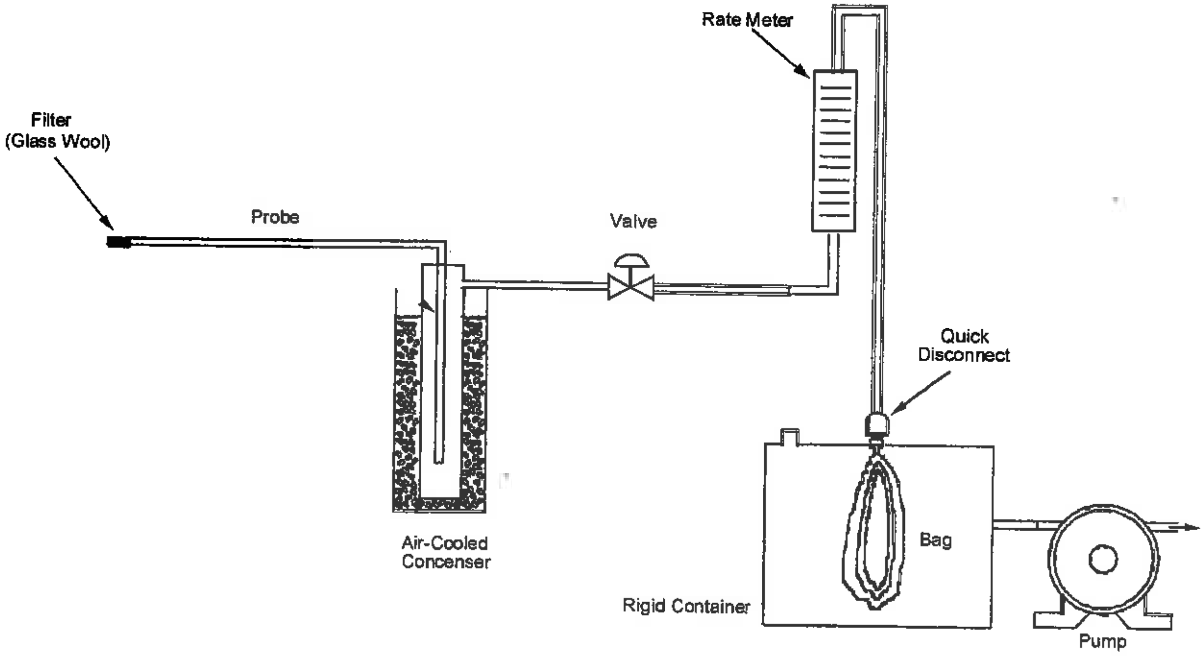

TABLE 10-1 - FIELD DATA
Integrated Sampling

Location: **Date:**

Test: **Operator:**

Clock Time	Rotameter Reading liters/min (cfm)	Comments

Method 23 - Determination of Polychlorinated Dibenzo-p-dioxins and Polychlorinated Dibenzofurans from Municipal Waste Combustors

1. APPLICABILITY AND PRINCIPLE

1.1 Applicability. This method is applicable to the determination of emissions of polychlorinated dibenzo-p-dioxins (PCDD's) and polychlorinated dibenzofurans (PCDF's) from stationary sources. Calibration standards are selected for regulated emission levels for municipal waste combustors.

1.2 Principle. A sample is withdrawn isokinetically from the gas stream and collected in the sample probe, on a glass fiber filter, and on a packed column of adsorbent material. The sample cannot be separated into a particle and vapor fraction. The PCDD's and PCDF's are extracted from the sample, separated by high resolution gas chromatography (HRCG), and measured by high resolution mass spectrometry (HRMS).

2. APPARATUS

2.1 Sampling. A schematic of the sampling train is shown in Figure 23-1. Sealing greases **shall** not be used in assembling the train. The train is identical to that described in Section 2.1 of Method 5 of this appendix with the following additions:

2.1.1 Nozzle. The nozzle shall be made of nickel, nickel-plated stainless steel, quartz, or borosilicate glass.

2.1.2 Sample Transfer Lines. The sample transfer lines, if needed, shall be heat traced, heavy walled TFE (1/2 in. OD with 1/8 in. wall) with connecting fittings that are capable of forming leak-free, vacuum-tight connections without using sealing greases. The line shall be as short as possible and must be maintained at ≥120• C.

2.1.1 Filter Support. Teflon or Teflon-coated wire.

2.1.2 Condenser. Glass, coil type with compatible fittings. A schematic diagram is shown in Figure 23-2.

2.1.3 Water Bath. Thermostatically controlled to maintain the gas temperature exiting the condenser at ≤20• C (68• F).

2.1.4 Adsorbent Module. Glass container to hold up to 40 grams of resin adsorbent. A schematic diagram is shown in Figure 23-2. Other physical configurations of the water-jacketed resin trap/condenser assembly are acceptable. The connecting fittings shall form leak-free, vacuum tight seals. A coarse glass frit is included to retain the adsorbent in the water-jacketed sorbent module.

2.1.5 Probe Liner. The probe liner shall be made of glass and a Teflon ferrule or Teflon coated O-ring shall be used to make the seal at the nozzle end of the probe.

2.2 Sample Recovery.

2.2.1 Fitting Caps. Ground glass, Teflon tape, or aluminum foil (Section 2.2.6) to cap off the sample exposed sections of the train and sorbent module.

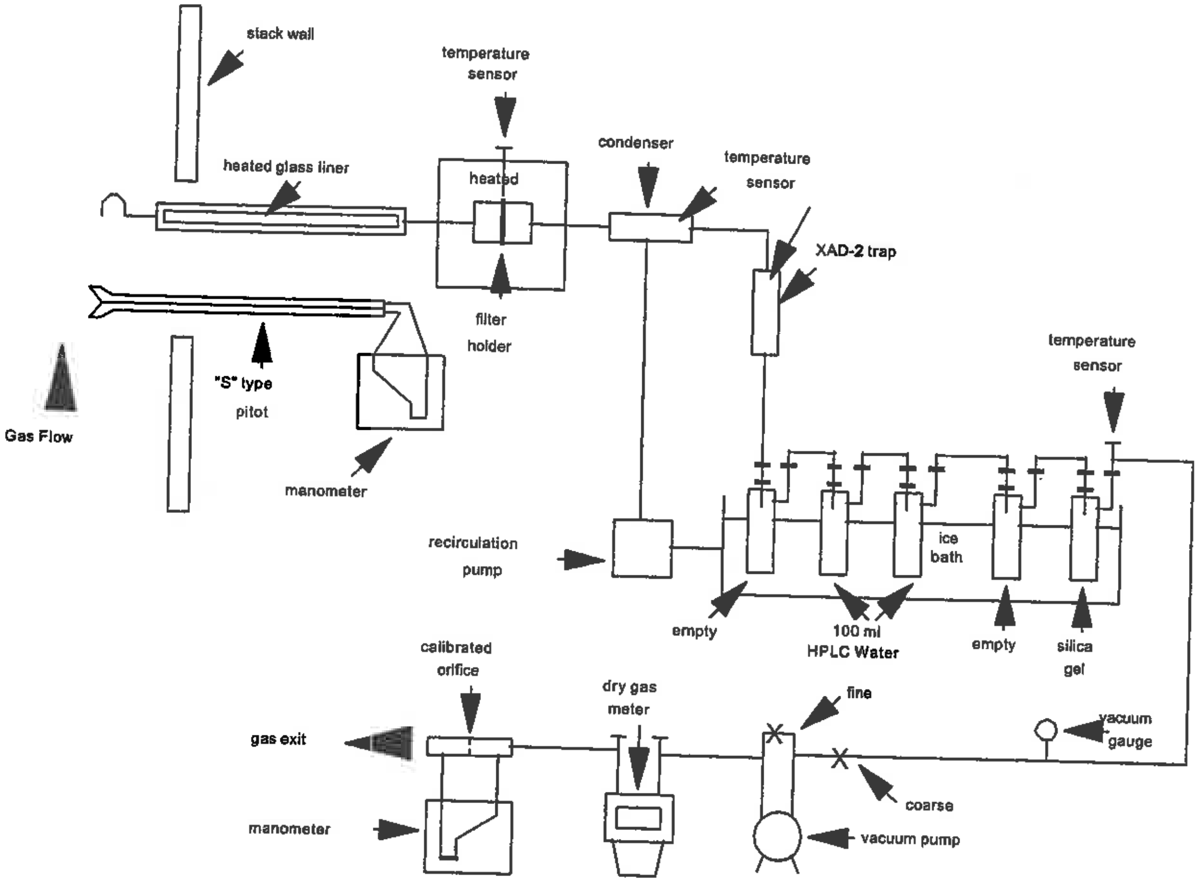

Figure 23.1 Sampling Train

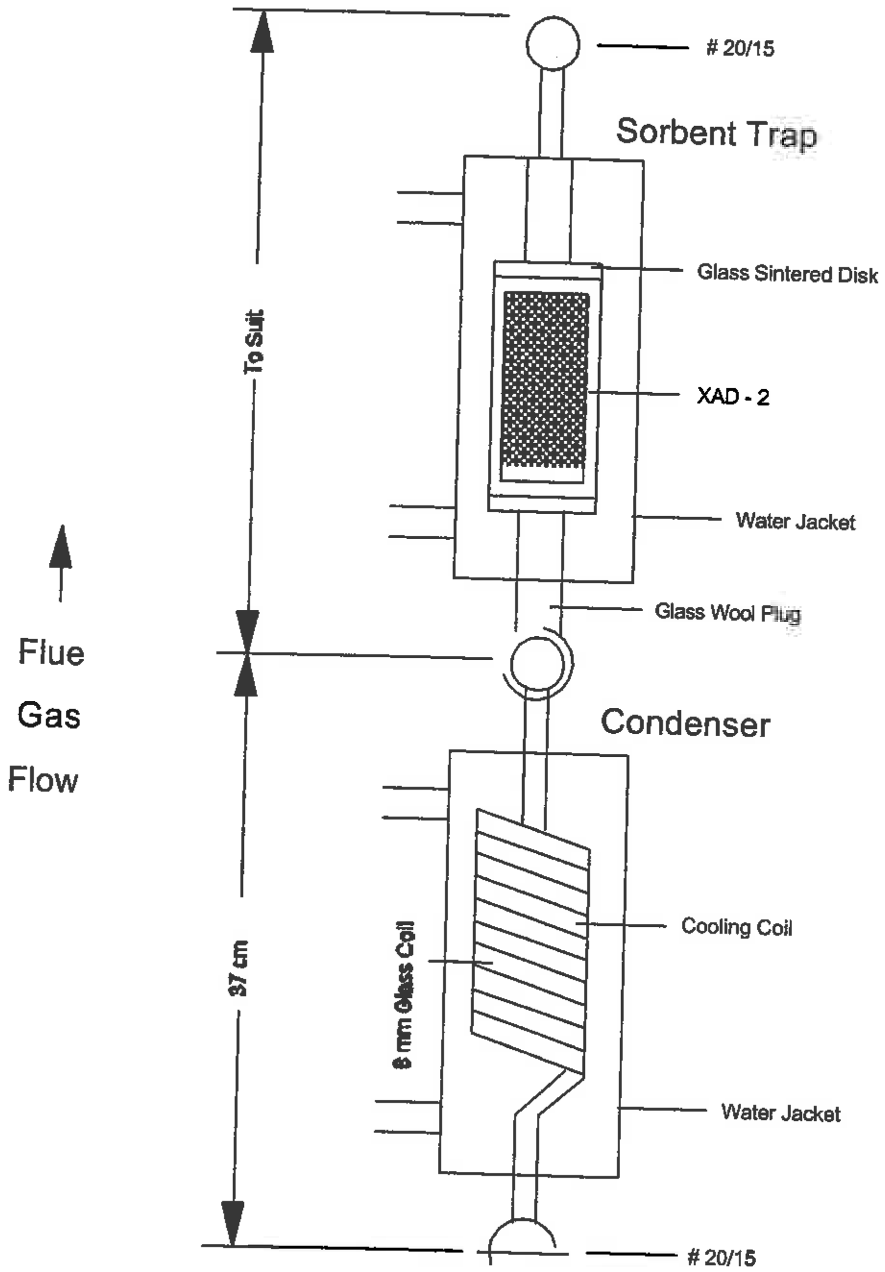

Figure 23.2 Condenser and Adsorbent Trap

2.2.2 Wash Bottles. Teflon, 500-mL.

2.2.3 Probe Liner, Probe Nozzle, and Filter Holder Brushes. Inert bristle brushes with precleaned stainless steel or Teflon handles. The probe brush shall have extensions of stainless steel or Teflon, at least as long as the probe. The brushes shall be properly sized and shaped to brush out the nozzle, probe liner, and transfer line, if used.

2.2.4 Filter Storage Container. Sealed filter holder, wide-mouth amber glass jar with Teflon-lined cap, glass petri dish, or Teflon baggie.

2.2.5 Balance. Triple beam.

2.2.6 Aluminum Foil. Heavy duty, hexane-rinsed (Do not use to wrap or ship filter samples, because it may react with particulate matter).

2.2.7 Metal Storage Container. Air tight container to store silica gel.

2.2.8 Graduated Cylinder. Glass, 250-mL with 2-mL graduations.

2.2.9 Glass Sample Storage Containers. Amber glass bottles for sample glassware washes, 500- or 1000-mL, with leak free Teflon-lined caps.

2.3 Analysis.

2.3.1 Sample Containers. 125- and 250-mL flint glass bottles with Teflon-lined caps.

2.3.2 Test Tubes. Glass.

2.3.3 Soxhlet Extraction Apparatus. Capable of holding 43 x 123 mm extraction thimbles.

2.3.4 Extraction Thimble. Glass, precleaned cellulosic, or glass fiber.

2.3.5 Pasteur Pipettes. For preparing liquid chromatographic columns.

2.3.6 Reacti-vials. Amber glass, 2-mL.

2.3.7 Rotary Evaporator. Buchi/Brinkman RF-121 or equivalent.

2.3.8 Kuderna-Danish Concentrator Apparatus.

2.3.9 Nitrogen Evaporative Concentrator. N-Evap Analytical Evaporator Model III or equivalent.

2.3.10 Separatory Funnels. Glass, 2-liter.

2.3.11 Gas Chromatograph. Consisting of the following components:

2.3.11.1 Oven. Capable of maintaining the separation column at the proper operating temperature ±10• C and performing programmed increases in temperature at rates of at least 40• C/min.

2.3.11.2 Temperature Gauges. To monitor column oven, detector, and exhaust temperatures ±1• C.

2.3.11.3 Flow Systems. Gas metering system to measure sample, fuel, combustion gas, and carrier gas flows.

2.3.11.4 Capillary Columns. A fused silica column, 60 x 0.25 mm inside diameter (ID), coated with DB-5 and a fused silica column, 30 m x 0.25 mm ID coated with DB-225. Other column systems may be substituted provided that the user is able to demonstrate,using calibration and performance checks, that the column system is able to meet the specifications of Section 6.1.2.2.

2.3.12 Mass Spectrometer. Capable of routine operation at a resolution of 1:10000 with a stability of ±5 ppm.

2.3.13 Data System. Compatible with the mass spectrometer and capable of monitoring at least five groups of 25 ions.

2.3.14 Analytical Balance. To measure within 0.1 mg.

3. REAGENTS

3.1 Sampling.

3.1.1 Filters. Glass fiber filters, without organic binder, exhibiting at least 99.95 percent efficiency (<0.05 percent penetration) on 0.3-micron dioctyl phthalate smoke particles. The filter efficiency test shall be conducted in accordance with ASTM Standard Method D 2986-71 (Reapproved 1978) (incorporated by reference - see §60.17).

3.1.1.1 Precleaning. All filters shall be cleaned before their initial use. Place a glass extraction thimble and 1 g of silica gel and a plug of glass wool into a Soxhlet apparatus, charge the apparatus with toluene, and reflux for a minimum of 3 hours. Remove the toluene and discard it, but retain the silica gel. Place no more than 50 filters in the thimble onto the silica gel bed and top with the cleaned glass wool. Charge the Soxhlet with toluene and reflux for 16 hours. After extraction, allow the Soxhlet to cool, remove the filters, and dry them under a clean nitrogen (N_2) stream. Store the filters in a glass petri dishes and seal with Teflon tape.

3.1.2 Adsorbent Resin. Amberlite XAD-2 resin. Thoroughly cleaned before initial use. Do not reuse resin. If precleaned XAD-2 resin is purchased from the manufacturer, the cleaning procedure described in Section 3.1.2.1 is not required.

3.1.2.1 Cleaning. Procedure may be carried out in a giant Soxhlet extractor. An all-glass filter thimble containing an extra-coarse frit is used for extraction of XAD-2. The frit is recessed 10-15 mm above a crenelated ring at the bottom of the thimble to facilitate drainage. The resin must be carefully retained in the extractor cup with a glass wool plug and a stainless steel ring because it floats on methylene chloride. This process involves sequential extraction in the following order.

Solvent	Procedure
Water	Initial Rinse: Place resin in a beaker, rinse once with HPLC water, and discard water. Refill beaker with water, let stand overnight, and discard water.
Water	Extract with HPLC water for 8 hours.
Methanol	Extract with methanol for 22 hours.
Methylene Chloride	Extract with methylene chloride for 22 hours.
Methylene Chloride	Extract with methylene chloride for 22 hours.

3.1.2.2 Drying.

3.1.2.2.1 Drying Column. Pyrex pipe, 10.2 cm ID by 0.6 m long, with suitable retainers.

3.1.2.2.2 Procedure. The adsorbent must be dried with clean inert gas. Liquid nitrogen from a standard commercial liquid nitrogen cylinder has proven to be a reliable source for large volumes of gas free from organic contaminants. Connect the liquid nitrogen cylinder to the column by a length of cleaned copper tubing, 0.95 cm ID, coiled to pass through a heat source. A convenient heat source is a water-bath heated from a steam line. The final nitrogen temperature should only be warm to the touch and not over 40• C. Continue flowing nitrogen through the adsorbent until all the residual solvent is removed. The flow rate should be sufficient to gently agitate the particles, but not so excessive as to cause the particles to fracture.

3.1.2.3 Quality Control Check. The adsorbent must be checked for residual methylene chloride ($MeCl_2$) as well as PCDDs and PCDFs prior to use. The analyst may opt to omit this check for precleaned XAD-2.

3.1.2.3.1 $MeCl_2$ Residue Extraction. Weigh a 1.0 g sample of dried resin into a small vial, add 3 mL of toluene, cap the vial, and shake it well.

3.1.2.3.2 $MeCl_2$ Residue Analysis. Inject a 2 µl sample of the extract into a gas chromatograph operated under the following conditions:

Column: 6 ft x 1/8 in stainless steel containing 10 percent OV-101™ on 100/120 Supelcoport.
Carrier Gas: Helium at a rate of 30 mL/min.
Detector: Flame ionization detector operated at a sensitivity of 4×10^{-11} A/mV.
Injection Port Temperature: 250• C.
Detector Temperature: 305• C.
Oven Temperature: 30• C for 4 min; programmed to rise at 40• C/min until it reaches 250• C; return to 30• C after 17 minutes.

Compare the results of the analysis to the results from the reference solution. Prepare the reference solution by injecting 4.0 µl of methylene chloride into 100 mL of toluene. This corresponds to 100 µg of methylene chloride per g of adsorbent. The maximum acceptable concentration is 1000 µg/g of adsorbent. If the adsorbent exceeds this level, drying must be continued until the excess methylene chloride is removed.

3.1.2.3.3 PCDD and PCDF Check. Extract the adsorbent sample as described in Section 5.1. Analyze the extract as described in Section 5.3. If any of the PCDDs or PCDFs (tetra through hexa) are present at concentrations above the target detection limits (TDLs), the adsorbent must be recleaned by repeating the last step of the cleaning procedure. The TDLs for the various PCDD/PCDF congeners are listed in Table 1.

3.1.2.4 Storage. After cleaning, the adsorbent may be stored in a wide mouth amber glass container with a Teflon-lined cap or placed in glass adsorbent modules tightly sealed with glass stoppers. It must be used within 4 weeks of cleaning. If precleaned adsorbent is purchased in sealed containers, it must be used within 4 weeks after the seal is broken.

3.1.3 Glass Wool. Cleaned by sequential immersion in three aliquots of methylene chloride, dried in a 110• C oven, and stored in a methylene chloride-washed glass container with a Teflon-lined screw cap.

3.1.4 Water. Deionized distilled and stored in a methylene chloride-rinsed glass container with a Teflon-lined screw cap.

3.1.5 Silica Gel. Indicating type, 6 to 16 mesh. If previously used, dry at 175• C (350• F) for two hours. New silica gel may be used as received. Alternatively, other types of desiccants (equivalent or better) may be used, subject to the approval of the Administrator.

3.1.6 Chromic Acid Cleaning Solution. Dissolve 20 g of sodium dichromate in 15 mL of water, and then carefully add 400 mL of concentrated sulfuric acid.

3.1.7 HPLC Water.

3.2 Sample Recovery.

3.2.1 Acetone. Pesticide quality.

3.2.2 Methylene Chloride. Pesticide quality.

3.2.3 Toluene. Pesticide quality.

3.3 Analysis.

3.3.1 Potassium Hydroxide. ACS grade, 2-percent (weight/volume) in water.

3.3.2 Sodium Sulfate. Granulated, reagent grade. Purify prior to use by rinsing with methylene chloride and oven drying. Store the cleaned material in a glass container with a Teflon-lined screw cap.

3.3.3 Sulfuric Acid. Reagent grade.

3.3.4 Sodium Hydroxide. 1.0 N. Weigh 40 g of sodium hydroxide into a 1-liter volumetric flask. Dilute to 1 liter with water.

3.3.5 Hexane. Pesticide grade.

3.3.6 Methylene Chloride. Pesticide grade.

3.3.7 Benzene. Pesticide grade.

3.3.8 Ethyl Acetate.

3.3.9 Methanol. Pesticide grade.

3.3.10 Toluene. Pesticide grade.

3.3.11 Nonane. Pesticide grade.

3.3.12 Cyclohexane. Pesticide Grade.

3.3.13 Basic Alumina. Activity grade 1, 100-200 mesh. Prior to use, activate the alumina by heating for 16 hours at 130• C. Store in a desiccator. Pre-activated alumina may be purchased from a supplier and may be used as received.

3.3.14 Silica Gel. Bio-Sil A, 100-200 mesh. Prior to use, activate the silica gel by heating for at least 30 minutes at 180• C. After cooling, rinse the silica gel sequentially with methanol and methylene chloride. Heat the rinsed silica gel at 50• C for 10 minutes, then increase the temperature gradually to 180• C over 25 minutes and maintain it at this temperature for 90 minutes. Cool at room temperature and store in a glass container with a Teflon-lined screw cap.

3.3.15 Silica Gel Impregnated with Sulfuric Acid. Combine 100 g of silica gel with 44 g of concentrated sulfuric acid in a screw capped glass bottle and agitate thoroughly. Disperse the solids with a stirring rod until a uniform mixture is obtained. Store the mixture in a glass container with a Teflon-lined screw cap.

3.3.16 Silica Gel Impregnated with Sodium Hydroxide. Combine 39 g of 1 N sodium hydroxide with 100 g of silica gel in a screw capped glass bottle and agitate thoroughly. Disperse solids with a stirring rod until a uniform mixture is obtained. Store the mixture in glass container with a Teflon-lined screw cap.

3.3.17 Carbon/Celite. Combine 10.7 g of AX-21 carbon with 124 g of Celite 545 in a 250-mL glass bottle with a Teflon-lined screw cap. Agitate the mixture thoroughly until a uniform mixture is obtained. Store in the glass container.

3.3.18 Nitrogen. Ultra high purity.

3.3.19 Hydrogen. Ultra high purity.

3.3.20 Internal Standard Solution. Prepare a stock standard solution containing the isotopically labelled PCDD's and PCDF's at the concentrations shown in Table 2 under the heading "Internal Standards" in 10 mL of nonane.

3.3.21 Surrogate Standard Solution. Prepare a stock standard solution containing the isotopically labelled PCDD's and PCDF's at the concentrations shown in Table 2 under the heading "Surrogate Standards" in 10 mL of nonane.

3.3.22 Recovery Standard Solution. Prepare a stock standard solution containing the isotopically labelled PCDD's and PCDF's at the concentrations shown in Table 2 under the heading "Recovery Standards" in 10 mL of nonane.

4. PROCEDURE

4.1 Sampling. The complexity of this method is such that, in order to obtain reliable results, testers and analysts should be trained and experienced with the procedures.

4.1.1 Pretest Preparation.

4.1.1.1 Cleaning Glassware. All glass components of the train upstream of and including the adsorbent module, shall be cleaned as described in Section 3A of the "Manual of Analytical Methods for the Analysis of Pesticides in Human and Environmental Samples." Special care shall be devoted to the removal of residual silicone grease sealants on ground glass connections of used glassware. Any residue shall be removed by soaking the glassware for several hours in a chromic acid cleaning solution prior to cleaning as described above.

4.1.1.2 Adsorbent Trap. The traps shall be loaded in a clean area to avoid contamination. They may not be loaded in the field. Fill a trap with 20 to 40 g of XAD-2. Follow the XAD-2 with glass wool and tightly cap both ends of the trap. Add 40 µl of the surrogate standard solution (Section 3.3.21) to each trap for a sample that will be split prior to analysis or 20 • l of the surrogate standard solution (Section 3.3.21) to each trap for samples that will not be split for analysis (Section 5.1). After addition of the surrogate standard solution, the trap must be used within 14 days. Keep the spiked sorbent under refrigeration until use.

4.1.1.3 Sampling Train. It is suggested that all components be maintained according to the procedure described in APTD-0576.

4.1.1.4 Silica Gel. Weigh several 200 to 300 g portions of silica gel in air tight containers to the nearest 0.5 g. Record the total weight of the silica gel plus container, on each container. As an alternative, the silica gel may be weighed directly in the fifth impinger just prior to sampling.

4.1.1.5 Filter. Check each filter against light for irregularities and flaws or pinhole leaks. Pack the filters flat in a clean glass container or Teflon baggie. Do not mark filter with ink or any other contaminating substance.

4.1.2 Preliminary Determinations. Same as Section 4.1.2 of Method 5.

4.1.3 Preparation of Sampling Train.

4.1.3.1 During preparation and assembly of the sampling train, keep all train openings where contamination can enter, sealed until sampling is about to begin. Wrap sorbent module with aluminum foil to shield from radiant heat of sun light. (NOTE: Do not use sealant grease in assembling the train.)

4.1.3.2 Place approximately 100 mL of water in the second and third impingers, leave the first and fourth impingers empty, and transfer approximately 200 to 300 g of preweighed silica gel from its container to the fifth impinger.

4.1.3.3 Place the silica gel container in a clean place for later use in the sample recovery. Alternatively, the weight of the silica gel plus the fifth impinger may be determined to the nearest 0.5 g and recorded.

4.1.3.4 Assemble the sampling train as shown in Figure 23-1.

4.1.3.5 Turn on the adsorbent module and condenser coil recirculating pump and begin monitoring the adsorbent module gas entry temperature. Ensure proper sorbent gas entry temperature before proceeding and before sampling is initiated. It is extremely important that the XAD-2 adsorbent resin temperature never exceed 50• C because thermal decomposition and breakthrough of surrogate standards will occur. During testing, the XAD-2 temperature must not exceed 20• C for efficient capture of the PCDD's and PCDF's.

4.1.4 Leak-Check Procedure. Same as Method 5, Section 4.1.4.

4.1.5 Sampling Train Operation. Same as Method 5, Section 4.1.5.

4.2 Sample Recovery. Proper cleanup procedure begins as soon as the probe is removed from the stack at the end of the sampling period. Seal the nozzle end of the sampling probe with Teflon tape or aluminum foil.

When the probe can be safely handled, wipe off all external particulate matter near the tip of the probe. Remove the probe from the train and close off both ends with aluminum foil. Seal off the inlet to the train with Teflon tape, a ground glass cap, or aluminum foil.

Transfer the probe and impinger assembly to the cleanup area. This area shall be clean and enclosed so that the chances of losing or contaminating the sample are minimized. Smoking, which could contaminate the sample, shall not be allowed in the cleanup area. Cleanup personnel shall wash their hands prior to sample recovery.

Inspect the train prior to and during disassembly and note any abnormal conditions, e.g., broken filters, colored impinger liquid, etc. Treat the samples as follows:

4.2.1 Container No. 1. Either seal the filter holder or carefully remove the filter from the filter holder and place it in its identified container. Do not place the filter in aluminum foil. Use a pair of cleaned tweezers to handle the filter. If it is necessary to fold the filter, do so such that the particulate cake is inside the fold. Carefully transfer to the container any particulate matter and filter fibers which adhere to the filter holder gasket, by using a dry inert bristle brush and a sharp-edged blade. Seal the container with Teflon tape.

4.2.2 Adsorbent Module. Remove the module from the train, tightly cap both ends, label it, and store it on ice for transport to the laboratory.

4.2.3 Container No. 2. Quantitatively recover material deposited in the nozzle, probe transfer lines, the front half of the filter holder, and the cyclone, if used, first, by brushing while rinsing three times with acetone and then, by rinsing the probe three times with methylene chloride. Collect all the rinses in Container No. 2.

Rinse the back half of the filter holder three times with acetone. Rinse the connecting line between the filter and the condenser three times with acetone. Soak the connecting line with three separate portions of methylene chloride for 5 minutes each. If using a separate condenser and adsorbent trap, rinse the condenser in the same manner as the connecting line. Collect all the rinses in Container No. 2 and mark the level of the liquid on the container.

4.2.4 Container No. 3. Repeat the methylene chloride-rinsing described in Section 4.2.3 using toluene as the rinse solvent. Collect the rinses in Container No. 3 and mark the level of the liquid on the container.

4.2.5 Impinger Water. Measure the liquid in the first four impingers to within 1 mL by using a graduated cylinder or by weighing it to within 0.5 g by using a balance. Record the volume or weight of liquid present. This information is required to calculate the moisture content of the effluent gas. Discard the liquid after measuring and recording the volume or weight.

4.2.6 Silica Gel. Note the color of the indicating silica gel to determine if it has been completely spent and make a mention of its condition. Transfer the silica gel from the fifth impinger to its original container and seal.

5. ANALYSIS

All glassware shall be cleaned as described in Section 3A of the "Manual of Analytical Methods for the Analysis of Pesticides in Human and Environmental Samples." All samples must be extracted within 30 days of collection and analyzed within 45 days of extraction.

5.1 Sample Extraction. The analyst may choose to split the sample extract after the completion of sample extraction procedures. One half of the sample can then be archived. Sample preparation procedures are given for using the entire sample and for splitting the sample.

5.1.1 Extraction System. Place an extraction thimble (Section 2.3.4), 1 g of silica gel, and a plug of glass wool into the Soxhlet apparatus, charge the apparatus with toluene, and reflux for a minimum of 3 hours. Remove the toluene and discard it, but retain the silica gel. Remove the extraction thimble from the extraction system and place it in a glass beaker to catch the solvent rinses.

5.1.2 Container No. 1 (Filter). Transfer the contents directly to the glass thimble of the extraction system and extract them simultaneously with the XAD-2 resin.

5.1.3 Adsorbent Cartridge. Suspend the adsorbent module directly over the extraction thimble in the beaker (See Section 5.1.1). The glass frit of the module should be in the up position. Using a Teflon squeeze bottle containing toluene, flush the XAD-2 into the thimble onto the bed of cleaned silica gel. Thoroughly rinse the glass module catching the rinsings in the beaker containing the thimble. If the resin is wet, effective extraction can be accomplished by loosely packing the resin in the thimble. Add the XAD-2 glass wool plug to the thimble.

5.1.4 Container No. 2 (Acetone and Methylene Chloride). Concentrate the sample to a volume of about 1-2 mL using a Kuderna-Danish concentrator apparatus, followed by N_2 blow down at a temperature of less than 37• C. Rinse the sample container three times with small portions of methylene chloride and add these to the concentrated solution and concentrate further to near dryness. This residue contains particulate matter removed in the rinse of the sampling train probe and nozzle.

Add the concentrate to the filter and the XAD-2 resin in the Soxhlet apparatus described in Section 5.1.1.

5.1.5 Extraction. For samples that are to be split prior to analysis add 40 µl of the internal standard solution (Section 3.3.20) to the extraction thimble containing the contents of the adsorbent cartridge, the contents of Container No. 1, and the concentrate from Section 5.1.4. Alternatively, 20 µl of the internal standard solution (Section 3.3.20) for samples that are not to be split prior to analysis. Cover the contents of the extraction thimble with the cleaned glass wool plug to prevent the XAD-2 resin from floating into the solvent reservoir of the extractor. Place the thimble in the extractor, and add the toluene contained in the beaker to the solvent reservoir. Add additional toluene to fill the reservoir approximately 2/3 full. Add Teflon boiling chips and assemble the apparatus. Adjust the heat source to cause the extractor to cycle three times per hour. Extract the sample for 16 hours. After extraction, allow the Soxhlet to cool. Transfer the toluene extract and three 10-mL rinses to the rotary evaporator. Concentrate the extract to approximately 10 mL. If decided to split the sample, store one half for future use, and analyze the other half according to the procedures in Sections 5.2 and 5.3. In either case, use a nitrogen evaporative concentrator to reduce the volume of the sample being analyzed to near dryness. Dissolve the residue in 5 mL of hexane.

5.1.6 Container No. 3 (Toluene Rinse). Add 40 µl of the internal standard solution (Section 3.3.20) for samples that are to be split prior to analysis to the contents of the container. Alternatively, add 20 µl of the internal standard solution (Section 3.3.20) for samples that are not to be split prior to analysis. Concentrate the sample to a volume of about 1-5 mL using the rotary evaporator apparatus at a temperature of less than 37• C. Rinse the sample container three times with small portions of toluene and add these to the concentrated solution and concentrate further to near dryness. Analyze the extract separately according to the procedures in Sections 5.2 and 5.3, but concentrate the solution in a rotary evaporator apparatus rather than a nitrogen evaporative concentrator.

5.2 Sample Cleanup and Fractionation.

5.2.1 Silica Gel Column. Pack one end of a glass column, 20 mm x 230 mm, with glass wool. Add in sequence, 1 g silica gel, 2 g of sodium hydroxide impregnated silica gel, 1 g silica gel, 4 g of acid-modified silica gel, and 1 g of silica gel. Wash the column with 30 mL of hexane and discard. Add the sample extract, dissolved in 5 mL of hexane to the column with two additional 5-mL rinses. Elute the column with an additional 90 mL of hexane and retain the entire eluate. Concentrate this solution to a volume of about 1 mL using the nitrogen evaporative concentrator (Section 2.3.9).

5.2.2 Basic Alumina Column. Shorten a 25-mL disposable Pasteur pipette to about 16 mL. Pack the lower section with glass wool and 12 g of basic alumina. Transfer the concentrated extract from the silica gel column to the top of the basic alumina column and elute the column sequentially with 120 mL of 0.5 percent methylene chloride in hexane followed by 120 mL of 35 percent methylene chloride in hexane. Discard the first 120 mL of eluate. Collect the second 120 mL of eluate and concentrate it to about 0.5 mL using the nitrogen evaporative concentrator. Transfer this extract with hexane to "13 mL tubes".

5.2.3 AX-21 Carbon/Celite 545 Column. Remove the bottom 0.5 in. from the tip of a 2-mL disposable Pasteur pipette. Insert a glass fiber filter disk or glass wool plug in the top of the pipette 2.5 cm from the constriction. Add sufficient carbon/Celite™ mixture to form a 2 cm column (the 0.6 mL mark column. Top with a glass wool plug. In some cases AX-21 carbon fines may wash through the glass wool plug and enter the sample. This may be prevented by adding a celite plug to the exit end of the column. Pre-elute the column with 5 mL toluene, followed by 1 mL of a 50:50 methylene chloride/cyclohexane mixture, followed by 5 mL of hexane. Load in sequence, the sample extract in 1 mL hexane, 2x0.5 mL rinses in hexane, 2 mL of 50 percent methylene chloride in hexane and 2 mL of 50 percent benzene in ethyl acetate and discard the eluates. Invert the column and elute in the reverse direction with 13 mL of toluene. Collect this eluate. Concentrate the eluate in a nitrogen evaporator at 45• C to about 1 mL. Transfer the concentrate to a Reacti-vial using a toluene rinses and concentrate to near dryness (less than 20 • l) using a stream of N_2. Store extracts at room temperature, shielded from light, until the analysis is performed.

5.3 Analysis. Analyze the sample with a gas chromatograph coupled to a mass spectrometer (GC/MS) using the instrumental parameters in Sections 5.3.1 and 5.3.2. Immediately prior to analysis, add a 20 µl aliquot of the recovery standard solution from Table 2 to each sample. A 2 µl aliquot of the extract is injected into the GC. Sample extracts are first analyzed using the DB-5 capillary column to determine the concentration of each isomer of PCDD's and PCDF's (tetra-through octa-). If 2,3,7,8-TCDF is detected in this analysis, then analyze another aliquot of the sample in a separate run, using the DB-225 column to measure the 2,3,7,8 tetra-chloro dibenzofuran isomer. Other column systems may be used, provided that it can be demonstrated using calibration and performance checks that the column system is able to meet the specifications of Section 6.1.2.

5.3.1 Gas Chromatograph Operating Conditions. The recommended conditions are shown in Table 4.

5.3.2 High Resolution Mass Spectrometer.

5.3.2.1 Resolution. 10,000 resolving power or 100 ppm mass/mass.

5.3.2.2 Ionization Mode. Electron impact.

5.3.2.3 Source Temperature 250• C.

5.3.2.4 Monitoring Mode. Selected ion monitoring. A list of the various ions to be monitored is presented in Table 5.

5.3.2.5 Identification Criteria. The following identification criteria shall be used for the characterization of polychlorinated dibenzodioxins and dibenzofurans.

1. The integrated ion-abundance ratio (M/M+2 or M+2/M+4) shall be within 15 percent of the theoretical value. The acceptable ion-abundance ratio ranges (±15%) for the identification of

chlorine-containing compounds are given in Table 6. If the ion-abundance ratio ranges are the outside those in Table 6, the source has the option of using the results if the concentration is determined using procedures in Section 9.3 or redoing the analysis to eliminate the unacceptable ion-abundance ratio.

2. The retention time for the analytes must be within 3 seconds of the corresponding ^{13}C-labeled internal standard or surrogate standard.

3. The monitored ions, shown in Table 5 for a given analyte, shall reach their maximum within 2 seconds of each other.

4. The identification of specific isomers that do not have corresponding ^{13}C-labeled standards is done by comparison of the relative retention time (RRT) of the analyte to the nearest internal standard retention time with reference (i.e., within 0.005 RRT units) to the comparable RRT's found in the continuing calibration.

5. The signal to noise ratio for all monitored ions must be greater than 2.5.

6. The confirmation of 2, 3, 7, 8-TCDF shall satisfy all of the above identification criteria.

7. Any PCDF coeluting (±2 s) with a peak in the corresponding PCDPE channel, of intensity 10% or greater compared to the analyte peak is evidence of a positive interference, the source may opt keep the value to calculate CDD/CDF concentration or conduct a complete reanalysis in an effort to remove or shift the interference. If a reanalysis is conducted, all values from the reanalyzed sample will be used for CDD/CDF concentration calculations.

8. Set the mass spectrometer lock channels as specified in Table 5. Monitor the quality control check channels specified in Table 5 to verify instrument stability during the analysis. If the signal varies by more than 25 percent from the average response, results for all isomers at corresponding residence time shall be invalid. The source has the options of conducting additional cleanup procedures on the other portion of the sample for split samples or diluting the original sample. In any case, a complete reanalysis shall be conducted and all concentration calculations shall be based on the reanalyzed sample.

5.3.2.6 Quantification. The peak areas for the two ions monitored for each analyte are summed to yield the total response for each analyte. Each internal standard is used to quantify the indigenous PCDD's or PCDF's in its homologous series. For example, the $^{13}C_{12}$-2,3,7,8-tetra chlorinated dibenzodioxin is used to calculate the concentrations of all other tetra chlorinated isomers. Recoveries of the tetra- and penta- internal standards are calculated using the $^{13}C_{12}$-1,2,3,4-TCDD. Recoveries of the hexa- through octa- internal standards are calculated using $^{13}C_{12}$-1,2,3,7,8,9-HxCDD. Recoveries of the surrogate standards are calculated using the corresponding homolog from the internal standard. When no peak is detected, the noise level, as measured by the intensity of the noise in a clear zone of the chromatogram, is used to calculate the detection limit. Tables 7, 8, and 9 summarize the quantification relationships for the unlabeled analytes, internal standards and surrogate standards, respectively.

6. CALIBRATION

Same as Method 5 with the following additions.

6.1 GC/MS System.

6.1.1 Initial Calibration. Calibrate the GC/MS system using the set of five standards shown in Table 3. The relative standard deviation for the mean response factor from each of the unlabeled analytes (Table 3) and of the internal and surrogate standards shall be less than or equal to the values in Table 6. The signal to noise ratio for the GC signal present in every selected ion current profile shall be greater than or equal to 10. The ion abundance ratios shall be within the control limits in Table 5.

6.1.2 Daily Performance Check.

6.1.2.1 Calibration Check. Inject 2 μl of solution Number 3 from Table 3. Calculate the relative response factor (RRF) for each compound and compare each RRF to the corresponding mean RRF obtained during the initial calibration. The analyzer performance is acceptable if the measured RRF's for the labeled and unlabeled compounds for the daily run are within the limits of the mean values shown in Table 10. In addition, the ion-abundance ratios shall be within the allowable control limits shown in Table 6.

6.1.2.2 Column Separation Check. Inject 2 • l of a solution of a mixture of PCDD's and PCDF's that documents resolution between 2,3,7,8-TCDD and other TCDD isomers. Resolution is defined as a valley between peaks that is less than 25 percent of the lower of the two peaks. Identify and record the retention time windows for each homologous series. Perform a similar resolution check on the confirmation column to document the resolution between 2,3,7,8 TCDF and other TCDF isomers.

6.2 Lock Channels. Set mass spectrometer lock channels as specified in Table 5. Monitor the quality control check channels specified in Table 5 to verify instrument stability during the analysis.

7. QUALITY CONTROL

7.1 Sampling Train Collection Efficiency Check. Add 40 μl of the surrogate standards in Table 2 for samples split for analysis or 20 • l of the surrogate standards for sample <u>not</u> split for analysis to the adsorbent cartridge of each train before collecting the field samples.

7.2 Internal Standard Percent Recoveries. A group of nine carbon-labeled PCDDs and PCDFs representing the tetra- through octachlorinated homologues, is added to every sample prior to extraction. The role of the internal standards is to quantify the native PCDD's and PCDF's present in the sample as well as to determine the overall method efficiency. Recoveries of the internal standards shall be between 40 to 130 percent for the tetra- through hexachlorinated compounds while the range is 25 to 130 percent for the hepta- and octachlorinated homologues.

7.3 Surrogate Standard Recoveries. The five surrogate compounds in Table 3 are added to the resin in the adsorbent sampling cartridge before the sample is collected. The surrogate recoveries are measured relative to the internal standards and are a measure of the sampling train collection efficiency. They are not used to measure the native PCDD's and PCDF's. All surrogate standard recoveries shall be between 70 and 130 percent. Poor recoveries for all the surrogates may be an indication of breakthrough in the sampling train. If the recovery of all standards is below 70 percent, the sampling runs must be repeated. As an alternative, the sampling runs do not have to be repeated if the final results are divided by the fraction of surrogate recovery (on a homolog group basis). Poor recoveries of isolated surrogate compounds should not be grounds for rejecting an entire set of samples.

7.4 Toluene QA Rinse. Report the results of the toluene QA rinse separately from the total sample catch. Do not add it to the total sample.

7.5 Detection Limits. Calculate the detection limits using the equation in Section 9.8. If the detection limits meet the Target Detection Limits (TDLs) in Table 1, then they are considered acceptable. If the TDLs are not met, the impact of the detection limits shall be calculated using the procedures in Section 9.9. If the maximum potential value of the sum of the summed detection limits is less then 50 percent of the emission standard, the detection limits are acceptable. If the value is greater than 50 percent of the emission standard, then the analysis and/or sampling and analysis must be repeated until acceptable detection limits are obtained.

8. QUALITY ASSURANCE

8.1 Applicability. When the method is used to analyze samples to demonstrate compliance with a source emission regulation, an audit sample must be analyzed, subject to availability.

8.2 Audit Procedure. Analyze an audit sample with each set of compliance samples. The audit sample contains tetra through octa isomers of PCDD and PCDF. Concurrently analyze the audit sample and a set of compliance samples in the same manner to evaluate the technique of the analyst and the standards preparation. The same analyst, analytical reagents, and analytical system shall be used both for the compliance samples and the EPA audit sample.

8.3 Audit Sample Availability. Audit samples will be supplied only to enforcement agencies for compliance tests. Audit samples may be obtained by writing:

Source Test Audit Coordinator (MD-77B)
Quality Assurance Division
Atmospheric Research and Exposure Assessment Laboratory
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

or by calling the Source Test Audit Coordinator (STAC) at (919) 541-7834. The audit sample request must be made at least 30 days prior to the scheduled compliance sample analysis.

8.4 Audit Results. Calculate the audit sample concentration according to the calculation procedure provided in the audit instructions included with the audit sample. Fill in the audit sample concentration and the analyst's name on the audit response form included with the audit instructions.

Send one copy to the EPA Regional Office or the appropriate enforcement agency and a second copy to the STAC. The EPA Regional office or the appropriate enforcement agency will report the results of the audit to the laboratory being audited. Include this response with the results of the compliance samples in relevant reports to the EPA Regional Office or the appropriate enforcement agency.

9. CALCULATIONS

Same as Method 5, Section 6 with the following additions.

9.1 Nomenclature.

A_{ai} = Integrated ion current of the noise at the retention time of the analyte.
A_{cij} = Integrated ion current of the two ions characteristic of compound i in the jth calibration standard.
A^*_{cij} = Integrated ion current of the two ions characteristic of the internal standard i in the jth calibration standard.
A_{csi} = Integrated ion current of the two ions characteristic of surrogate compound i in the calibration standard.
A_i = Integrated ion current of the two ions characteristic of compound i in the sample.
A^*_i = Integrated ion current of the two ions characteristic of internal standard i in the sample.
A_{rs} = Integrated ion current of the two ions characteristic of the recovery standard.
A_{si} = Integrated ion current of the two ions characteristic of surrogate compound i in the sample.
C_i = Concentration of PCDD or PCDF i in the sample, pg/M^3.
C_T = Total concentration of PCDD's or PCDF's in the sample, pg/M^3.
DL = Detection limit, pg/sample.
DL_{hs} = Detection limit for each homologous series, pg/sample.
DL_{sum} = Sum of all isomers times the corresponding detection limit, ng/m^3.
H_{ai} = Summed heights of the noise at the retention time of the analyte in the two analyte channels.
m_{ci} = Mass of compound i in the calibration standard injected into the analyzer, pg.
m^*_{ci} = Mass of labeled compound i in the calibration standard injected into the analyzer, pg.
m^*_i = Mass of internal standard i added to the sample, pg.
m_{rs} = Mass of recovery standard in the calibration standard injected into the analyzer, pg.
m_s = Mass of surrogate compound in the sample to be analyzed, pg.
m_{si} = Mass of surrogate compound i in the calibration standard, pg.
RRF_i = Relative response factor for compound i.
RRF_{rs} = Recovery standard response factor.
RRF_s = Surrogate compound response factor.
$V_{m(std)}$= Metered volume of sample run, dscm.
1000 = pg per ng.

9.2 Average Relative Response Factor.

$$RRF_i = \frac{1}{n}\sum_{j=1}^{n}\frac{A_{cij}\ m^*_{ci}}{A^*_{cij}\ m_{ci}} \qquad \text{Eq. 23-1}$$

9.3 Concentration of the PCDD's and PCDF's.

$$C_i = \frac{m^*_i\ A_i}{A^*_i\ RRF_i\ V_{m_{std}}} \qquad \text{Eq. 23-2}$$

9.4 Recovery Standard Response Factor.

$$RRF_{rs} = \frac{A^*_{ci}\ m_{rs}}{A_{rs}\ m^*_{ci}} \qquad \text{Eq. 23-3}$$

9.5 Recovery of Internal Standards (R^*).

$$R^* = \frac{A^*_i\ m_{rs}}{A_{rs}\ RF_{rs}\ m^*_i}\times 100\% \qquad \text{Eq. 23-4}$$

9.6 Surrogate Compound Response Factor.

$$RRF_s = \frac{A^*_{ci}\ m_{si}}{A_{csi}\ m^*_{ci}} \qquad \text{Eq. 23-5}$$

9.7 Recovery of Surrogate Compounds (R_s).

$$R_s = \frac{A_{si}\ m_i^{*}}{A_i^{*}\ RRF_s\ m_s} \times 100\% \qquad \text{Eq. 23-6}$$

9.8 Detection Limit (DL). The detection limit can be calculated based on either the height of the noise or the area of the noise using one of the two equations.

Detection limit using height for the DB-225 column. Three and one half times the height has been empirically determined to give area.

$$DL = \frac{2.5\ (3.5\ x\ H_{ai})\ m_i^{*}}{A_{ci}^{*}\ RRF_i} \qquad \text{Eq. 23-7}$$

Detection limit using height for the DB-5 column. Five times the height has been empirically determined to give area.

$$DL = \frac{2.5\ (5\ x\ H_{ai})\ m_i^{*}}{A_{ci}^{*}\ RRF_i} \qquad \text{Eq. 23-8}$$

Detection limit using area of the noise.

$$DL = \frac{2.5\ A_{ai}\ m_i^{*}}{A_{ci}^{*}\ RRF_i} \qquad \text{Eq. 23-9}$$

9.9 Summed Detection Limits. Calculate the maximum potential value of the summed detection limits. If the isomer (group of unresolved isomers) was not detected, use the value calculated for the detection limit in Section 9.8 above. If the isomer (group of unresolved isomers) was detected, use the value (target detection limit) from Table 1.

$$DL_{sum} = (13\ DL_{TCDD} + 16\ DL_{TCDF} + 12\ DL_{PeCDD} + 14\ DL_{PeCDF} + 7\ DL_{HxCDD} + 12\ DL_{HxCDF} + 2\ DL_{HpCDD} + 4\ DL_{HpCDF} + DL_{OCDD} + DL_{OCDF})\ /\ 1000\ V_{m(std)} \qquad \text{Eq.23-10}$$

Note: The number of isomers used to calculate the summed detection limit represent the total number of isomers typically separated and not the actual number of isomers for each series.

9.10 Total Concentration of PCDD's and PCDF's in the Sample.

$$C_T = \sum_{i=1}^{n} C_i \qquad \text{Eq. 23-11}$$

Any PCDDs or PCDFs that are reported as nondetected (below the DL) shall be counted as zero for the purpose of calculating the total concentration of PCDDs and PCDFs in the sample.

10. BIBLIOGRAPHY

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Chromatography/High-Resolution Mass Spectrometry. In: Test Methods for Evaluating Solid Waste. Washington, DC. SW-846.

6. Personnel communications with R. L. Harless of U.S. EPA and Triangle Laboratory staff.

TABLE 23-1. TARGET DETECTION LIMITS (TDLs)

	TDL (pg/Sample Train)
TCDD/TCDF	50
PeCDD/PeCDF	250
HxCDD/HxCDF	250
HpCDD/HpCDF	250
OCDD/OCDF	500

TABLE 23-2. COMPOSITION OF THE SAMPLE FORTIFICATION AND RECOVERY STANDARDS SOLUTIONS*

Analyte	Concentration (pg/µl)
<u>Internal Standards</u>	
$^{13}C_{12}$-2,3,7,8-TCDD	100
$^{13}C_{12}$-1,2,3,7,8-PeCDD	100
$^{13}C_{12}$-1,2,3,6,7,8-HxCDD	100
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD	100
$^{13}C_{12}$-OCDD	100
$^{13}C_{12}$-2,3,7,8-TCDF	100
$^{13}C_{12}$-1,2,3,7,8-PeCDF	100
$^{13}C_{12}$-1,2,3,6,7,8-HxCDF	100
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF	100
<u>Surrogate Standards</u>	
$^{37}Cl_4$-2,3,7,8-TCDD	100
$^{13}C_{12}$-1,2,3,4,7,8-HxCDD	100
$^{13}C_{12}$-2,3,4,7,8-PeCDF	100
$^{13}C_{12}$-1,2,3,4,7,8-HxCDF	100
$^{13}C_{12}$-1,2,3,4,7,8,9-HpCDF	100
<u>Recovery Standards</u>	
$^{13}C_{12}$-1,2,3,4-TCDD	100
$^{13}C_{12}$-1,2,3,7,8,9-HxCDD	100

*Calibration levels are specific for samples at the MWC compliance standard level.

TABLE 23-3. COMPOSITION OF THE INITIAL CALIBRATION SOLUTIONS

Concentrations (pg/μL)

Compound Solution No.	1	2	3	4	5
<u>Unlabeled Analytes</u>					
2,3,7,8-TCDD	0.5	1	5	50	100
2,3,7,8-TCDF	0.5	1	5	50	100
1,2,3,7,8-PeCDD	2.5	5	25	250	500
1,2,3,7,8-PeCDF	2.5	5	25	250	500
2,3,4,7,8-PeCDF	2.5	5	25	250	500
1,2,3,4,7,8-HxCDD	2.5	5	25	250	500
1,2,3,6,7,8-HxCDD	2.5	5	25	250	500
1,2,3,7,8,9-HxCDD	2.5	5	25	250	500
1,2,3,4,7,8-HxCDF	2.5	5	25	250	500
1,2,3,6,7,8-HxCDF	2.5	5	25	250	500
1,2,3,7,8,9-HxCDF	2.5	5	25	250	500
2,3,4,6,7,8-HxCDD	2.5	5	25	250	500
1,2,3,4,6,7,8-HpCDD	2.5	5	25	250	500
1,2,3,4,6,7,8-HpCDF	2.5	5	25	250	500
1,2,3,4,7,8,9-HpCDF	2.5	5	25	250	500
OCDD	5.0	10	50	500	1000
OCDF	5.0	10	50	500	1000
<u>Internal Standards</u>					
$^{13}C_{12}$-2,3,7,8-TCDD	100	100	100	100	100
$^{13}C_{12}$-1,2,3,7,8-PeCDD	100	100	100	100	100
$^{13}C_{12}$-1,2,3,6,7,8-HxCDD	100	100	100	100	100
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD	100	100	100	100	100
$^{13}C_{12}$-OCDD	200	200	200	200	200
$^{13}C_{12}$-2,3,7,8-TCDF	100	100	100	100	100
$^{13}C_{12}$-1,2,3,7,8-PeCDF	100	100	100	100	100
$^{13}C_{12}$-1,2,3,6,7,8-HxCDF	100	100	100	100	100
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF	100	100	100	100	100

(Continued)

TABLE 23-3. (Continued)

Compound	Concentrations (pg/µL) Solution No. 1	2	3	4	5
Surrogate Standards					
$^{37}\text{Cl}_4$-2,3,7,8-TCDD	60	80	100	120	140
$^{13}\text{C}_{12}$-2,3,4,7,8-PeCDF	60	80	100	120	140
$^{13}\text{C}_{12}$-1,2,3,4,7,8-HxCDD	60	80	100	120	140
$^{13}\text{C}_{12}$-1,2,3,4,7,8-HxCDF	60	80	100	120	140
$^{13}\text{C}_{12}$-1,2,3,4,7,8,9-HpCDF	60	80	100	120	140
Recovery Standards					
$^{13}\text{C}_{12}$-1,2,3,4-TCDD	100	100	100	100	100
$^{13}\text{C}_{12}$-1,2,3,7,8,9-HxCDD	100	100	100	100	100

TABLE 23-4. RECOMMENDED GC OPERATING CONDITIONS

Column Type	DB-5	DB-225
Length (m)	60	30
i.d. (mm)	0.25	0.25
Film Thickness (• m)	0.25	0.25
Carrier Gas	Helium	Helium
Carrier Gas Flow (mL/min)	1-2	1-2
Injection Mode	<-- splitless -->	
Valve Time (min)	2.5	2.5
Initial Temperature (**N** C)	150	130
Initial Time (min)	0.5	2.5
Rate 1 (deg. C/min)	60	50
Temperature 2 (deg. C)	170	170
Rate 2 (deg. C/min)	3	4
Final Temperature (deg. C)	300	250

TABLE 23-5. ELEMENTAL COMPOSITIONS AND EXACT MASSES OF THE IONS MONITORED BY HIGH RESOLUTION MASS SPECTROMETRY FOR PCDD's AND PCDF's

Descriptor Number	Accurate Mass	Ion Type	Elemental Composition	Analyte
2	292.9825	LOCK	C_7F_{11}	PFK
	303.9016	M	$C_{12}H_4{}^{35}Cl_4O$	TCDF
	305.8987	M+2	$C_{12}H_4{}^{35}Cl^{37}O$	TCDF
	315.9419	M	$^{13}C_{12}H_4{}^{35}Cl_4O$	TCDF (S)
	317.9389	M+2	$^{13}C_{12}H_4{}^{35}Cl_3{}^{37}ClO$	TCDF (S)
	319.8965	M	$C_{12}H_4{}^{35}ClO_2$	TCDD
	321.8936	M+2	$C_{12}H_4{}^{35}Cl_3{}^{37}ClO_2$	TCDD
	327.8847	M	$C_{12}H_4{}^{37}Cl_4O_2$	TCDD (S)
	330.9792	QC	C_7F_{13}	PFK
	331.9368	M	$^{13}C_{12}H_4{}^{35}Cl_4O_2$	TCDD (S)
	333.9339	M+2	$^{13}C_{12}H_4{}^{35}Cl^{37}ClO_2$	TCDD (S)
	339.8597	M+2	$C_{12}H_3{}^{35}Cl_4{}^{37}ClO$	PECDF
	341.8567	M+4	$C_{12}H_3{}^{35}Cl_3{}^{37}Cl_2O$	PeCDF
	351.9000	M+2	$^{13}C_{12}H_3{}^{35}Cl_4{}^{37}ClO$	PeCDF (S)
	353.8970	M+4	$^{13}C_{12}H_3{}^{35}Cl_3{}^{37}Cl_2O$	PeCDF (S)
	355.8546	M+2	$C_{12}H_3{}^{35}Cl_3 37ClO_2$	PeCDD
	357.8516	M+4	$C_{12}H_3{}^{35}Cl_3{}^{37}Cl_2O_2$	PeCDD
	367.8949	M+2	$^{13}C_{12}H_3{}^{35}Cl_4{}^{37}ClO_2$	PeCDD (S)
	369.8919	M+4	$^{13}C_{12}H_3{}^{35}Cl_3{}^{37}Cl_2O_2$	PeCDD (S)
	375.8364	M+2	$C_{12}H_4{}^{35}Cl_5{}^{37}ClO$	HxCDPE
	409.7974	M+2	$C_{12}H_3{}^{35}Cl_6{}^{37}ClO$	HpCPDE

(Continued)

TABLE 23-5. (Continued)

Descriptor number	Accurate mass	Ion type	Elemental compositio	Analyte
3	373.8208	M+2	$C_{12}H_2 35Cl_5{}^{37}ClO$	HxCDF
	375.8178	M+4	$C_{12}H_2{}^{35}Cl_4{}^{37}Cl_2O$	HxCDF
	383.8639	M	${}^{13}C_{12}H_2{}^{35}Cl_6O$	HxCDF (S)
	385.8610	M+2	${}^{13}C_{12}H_2{}^{35}Cl_5{}^{37}ClO$	HxCDF (S)
	389.8157	M+2	$C_{12}H_2{}^{35}Cl_5{}^{37}ClO_2$	HxCDD
	391.8127	M+4	$C_{12}H_2{}^{35}Cl_4{}^{37}Cl_2O_2$	HxCDD
	392.9760	LOCK	C_9F_{15}	PFK
	401.8559	M+2	${}^{13}C_{12}H_2{}^{35}Cl_5{}^{37}ClO_2$	HxCDD (S)
	403.8529	M+4	${}^{13}C_{12}H_2{}^{35}Cl_4{}^{37}Cl_2O$	HxCDD (S)
	445.7555	M+4	$C_{12}H_2{}^{35}Cl_6{}^{37}Cl_2O$	OCDPE
	430.9729	QC	C_9F_{17}	PFK

(Continued)

TABLE 23-5. (Continued)

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Descriptor number	Accurate mass	Ion type	Elemental composition	Analyte
4	407.7818	M+2	$C_{12}H^{35}Cl_6{}^{37}ClO$	HpCDF
	409.7789	M+4	$C_{12}H^{35}Cl_5{}^{37}Cl_2O$	HpCDF
	417.8253	M	$^{13}C_{12}H^{35}Cl_7O$	HpCDF (S)
	389.8157	M+2	$C_{12}H_2{}^{35}Cl_5{}^{37}ClO_2$	HxCDD
	391.8127	M+4	$C_{12}H_2{}^{35}Cl_4{}^{37}Cl_2O_2$	HxCDD
	392.9760	LOCK	C_9F_{15}	PFK
	401.8559	M+2	$^{13}C_{12}H_2{}^{35}Cl_5{}^{37}ClO_2$	HxCDD (S)
	403.8529	M+4	$^{13}C_{12}H_2{}^{35}Cl_4{}^{37}Cl_2O$	HxCDD (S)
	445.7555	M+4	$C_{12}H_2{}^{35}Cl_6{}^{37}Cl_2O$	OCDPE
	430.9729	QC	C_9F_{17}	PFK
	407.7818	M+2	$C_{12}H^{35}Cl_6{}^{37}ClO$	HpCDF
	409.7789	M+4	$C_{12}H^{35}Cl_5{}^{37}Cl_2O$	HpCDF
	417.8253	M	$^{13}C_{12}H^{35}Cl_7O$	HpCDF (S)
	419.8220	M+2	$^{13}C_{12}H^{35}Cl_6{}^{37}ClO$	HpCDF (S)
	423.7766	M+2	$C_{12}H^{35}Cl_6{}^{37}ClO_2$	HpCDD
	425.7737	M+4	$C_{12}H^{35}Cl_5{}^{37}Cl_2O_2$	HpCDD
	435.8169	M+2	$^{13}C_{12}H^{35}Cl_6{}^{37}ClO_2$	HpCDD (S)
	437.8140	M+4	$^{13}C_{12}H^{35}Cl_5{}^{37}Cl_2O_2$	HpCDD (S)
	479.7165	M+4	$C_{12}H^{35}Cl_7{}^{37}Cl_2O$	NCPDE
	430.9729	LOCK	C_9F_{17}	PFK
	441.7428	M+2	$C_{12}{}^{35}Cl_7{}^{37}ClO$	OCDF
	443.7399	M+4	$C_{12}{}^{35}Cl_6{}^{37}Cl_2O$	OCDF
	457.7377	M+2	$C_{12}{}^{35}Cl_7{}^{37}ClO_2$	OCDD
	459.7348	M+4	$C_{12}{}^{35}Cl_6{}^{37}Cl_2O_2$	OCDD
	469.7779	M+2	$^{13}C_{12}{}^{35}Cl_7{}^{37}ClO_2$	OCDD (S)
	471.7750	M+4	$^{13}C_{12}{}^{35}Cl_6{}^{37}Cl_2O_2$	OCDD (S)
	513.6775	M+4	$C_{12}{}^{35}Cl_8{}^{37}Cl_2O_2$	DCDPE
	442.9728	QC	$C_{10}F_{17}$	PFK

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The following nuclidic masses were used:
H = 1.007825 O = 15.994914 C = 12.000000 ^{35}Cl = 34.968853
^{13}C = 13.003355 ^{37}Cl = 36.965903 F = 18.9984 S = Labeled Standard
QC = Ion selected for monitoring instrument stability during the GC/MS analysis.

TABLE 23-6. ACCEPTABLE RANGES FOR ION-ABUNDANCE RATIOS OF PCDD's AND PCDF's

Number of Chlorine Atoms	Ion Type	Theoretical Ratio	Control Limits	
			Lower	Upper
4	M/M+2	0.77	0.65	0.89
5	M+2/M+4	1.55	1.32	1.78
6	M+2/M+4	1.24	1.05	1.43
6[a]	M/M+2	0.51	0.43	0.59
7[b]	M/M+2	0.44	0.37	0.51
7	M+2/M+4	1.04	0.88	1.20
8	M+2/M+4	0.89	0.76	1.02

[a] Used only for ^{13}C-HxCDF.

[b] Used only for ^{13}C-HpCDF.

TABLE 23-7. UNLABELED ANALYTES QUANTIFICATION RELATIONSHIPS

Analyte	Internal Standard Used During Quantification
2,3,7,8-TCDD	$^{13}C_{12}$-2,3,7,8-TCDD
Other TCDDs	$^{13}C_{12}$-2,3,7,8-TCDD
1,2,3,7,8-PeCDD	$^{13}C_{12}$-1,2,3,7,8-PeCDD
Other PeCDDs	$^{13}C_{12}$-1,2,3,7,8-PeCDD
1,2,3,4,7,8-HxCDD	$^{13}C_{12}$-1,2,3,6,7,8-HxCDD
1,2,3,6,7,8-HxCDD	$^{13}C_{12}$-1,2,3,6,7,8-HxCDD
1,2,3,7,8,9-HxCDD	$^{13}C_{12}$-1,2,3,6,7,8-HxCDD
Other HxCDDs	$^{13}C_{12}$-1,2,3,6,7,8-HxCDD
1,2,3,4,6;7,8-HpCDD	$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD
Other HpCDD	$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD
OCDD	$^{13}C_{12}$-OCDD
2,3,7,8-TCDF	$^{13}C_{12}$-2,3,7,8-TCDF
Other TCDFs	$^{13}C_{12}$-2,3,7,8-TCDF
1,2,3,7,8-PeCDF	$^{13}C_{12}$-1,2,3,7,8-PeCDF
2,3,4,7,8-PeCDF	$^{13}C_{12}$-1,2,3,7,8-PeCDF
Other PeCDFs	$^{13}C_{12}$-1,2,3,7,8-PeCDF
1,2,3,4,7,8-HxCDF	$^{13}C_{12}$-1,2,3,6,7,8-HxCDF
1,2,3,6,7,8-HxCDF	$^{13}C_{12}$-1,2,3,6,7,8-HxCDF
1,2,3,7,8,9-HxCDF	$^{13}C_{12}$-1,2,3,6,7,8-HxCDF
2,3,4,6,7,8-HxCDF	$^{13}C_{12}$-1,2,3,6,7,8-HxCDF
Other HxCDFs	$^{13}C_{12}$-1,2,3,6,7,8-HxCDF
1,2,3,4,6,7,8-HpCDF	$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF
1,2,3,4,7,8,9-HpCDF	$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF
Other HpCDFs	$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF
OCDF	$^{13}C_{12}$-OCDD

TABLE 23-8. INTERNAL STANDARDS QUANTIFICATION RELATIONSHIPS

Internal Standard	Standard Used During Percent Recovery Determination
$^{13}\text{C}_{12}$-2,3,7,8-TCDD	$^{13}\text{C}_{12}$-1,2,3,4-TCDD
$^{13}\text{C}_{12}$-1,2,3,7,8-PeCDD	$^{13}\text{C}_{12}$-1,2,3,4-TCDD
$^{13}\text{C}_{12}$-1,2,3,6,7,8-HxCDD	$^{13}\text{C}_{12}$-1,2,3,7,8,9-HxCDD
$^{13}\text{C}_{12}$-1,2,3,4,6,7,8-HpCDD	$^{13}\text{C}_{12}$-1,2,3,7,8,9-HxCDD
$^{13}\text{C}_{12}$-OCDD	$^{13}\text{C}_{12}$-1,2,3,7,8,9-HxCDD
$^{13}\text{C}_{12}$-2,3,7,8-TCDF	$^{13}\text{C}_{12}$-1,2,3,4-TCDD
$^{13}\text{C}_{12}$-1,2,3,7,8-PeCDF	$^{13}\text{C}_{12}$-1,2,3,4-TCDD
$^{13}\text{C}_{12}$-1,2,3,6,7,8-HxCDF	$^{13}\text{C}_{12}$-1,2,3,7,8,9-HxCDD
$^{13}\text{C}_{12}$-1,2,3,4,6,7,8-HpCDF	$^{13}\text{C}_{12}$-1,2,3,7,8,9-HxCDD

TABLE 23-9. SURROGATE STANDARDS QUANTIFICATION RELATIONSHIPS

Surrogate Standard	Standard Used During Percent Recovery Determination
$^{37}\text{Cl}_4$-2,3,7,8-TCDD	$^{13}\text{C}_{12}$-2,3,7,8-TCDD
$^{13}\text{C}_{12}$-2,3,4,7,8-PeCDF	$^{13}\text{C}_{12}$-1,2,3,7,8-PeCDF
$^{13}\text{C}_{12}$-1,2,3,4,7,8-HxCDD	$^{13}\text{C}_{12}$-1,2,3,6,7,8-HxCDD
$^{13}\text{C}_{12}$-1,2,3,4,7,8-HxCDF	$^{13}\text{C}_{12}$-1,2,3,6,7,8-HxCDF
$^{13}\text{C}_{12}$-1,2,3,4,7,8,9-HpCDF	$^{13}\text{C}_{12}$-1,2,3,4,6,7,8-HpCDF

TABLE 23-10. MINIMUM REQUIREMENTS FOR INITIAL AND DAILY CALIBRATION RESPONSE FACTORS

	Relative Response Factors	
Compound	Initial Calibration RSD	Daily Calibration % Difference
<u>Unlabeled Analytes</u>		
2,3,7,8-TCDD	25	25
2,3,7,8-TCDF	25	25
1,2,3,7,8-PeCDD	25	25
1,2,3,7,8-PeCDF	25	25
2,3,4,7,8-PeCDF	25	25
1,2,4,5,7,8-HxCDD	25	25
1,2,3,6,7,8-HxCDD	25	25
1,2,3,7,8,9-HxCDD	25	25
1,2,3,4,7,8-HxCDF	25	25
1,2,3,6,7,8-HxCDF	25	25
1,2,3,7,8,9-HxCDF	25	25
2,3,4,6,7,8-HxCDF	25	25
1,2,3,4,6,7,8-HpCDD	25	25
1,2,3,4,6,7,8-HpCDF	25	25
OCDD	25	25
OCDF	30	30
<u>Internal Standards</u>		
$^{13}C_{12}$-2,3,7,8-TCDD	25	25
$^{13}C_{12}$-1,2,3,7,8-PeCDD	30	30
$^{13}C_{12}$-1,2,3,6,7,8-HxCDD	25	25
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD	30	30
$^{13}C_{12}$-OCDD	30	30
$^{13}C_{12}$-2,3,7,8-TCDF	30	30
$^{13}C_{12}$-1,2,3,7,8-PeCDF	30	30
$^{13}C_{12}$-1,2,3,6,7,8-HxCDF	30	30
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF	30	30

TABLE 23-10. (Continued)

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	Relative Response Factors	
	Initial Calibration	Daily Calibration
Compound	RSD	% Difference
Surrogate Standards		
$^{37}Cl_4$-2,3,7,8-TCDD	25	25
$^{13}C_{12}$-2,3,4,7,8-PeCDF	25	25
$^{13}C_{12}$-1,2,3,4,7,8-HxCDD	25	25
$^{13}C_{12}$-1,2,3,4,7,8-HxCDF	25	25
$^{13}C_{12}$-1,2,3,4,7,8,9-HpCDF	25	25

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METHOD 26A - DETERMINATION OF HYDROGEN HALIDE AND HALOGEN EMISSIONS FROM STATIONARY SOURCES ISOKINETIC METHOD

NOTE: This method does not include all of the specifications (*e.g.* equipment and supplies) and procedures (*e.g.* sampling and analytical) essential to its performance. Some material is incorporated by reference from other methods in this part. Therefore, to obtain reliable results, persons using this method should have a thorough knowledge of at least the following additional test methods: Method 2, Method 5, and Method 26.

1.0 Scope and Application.

1.1 Analytes.

Analytes	CAS No.
Hydrogen Chloride (HCl)	7647-01-0
Hydrogen Bromide (HBr)	10035-10-6
Hydrogen Fluoride (HF)	7664-39-3
Chlorine (Cl_2)	7882-50-5
Bromine (Br_2)	7726-95-6

1.2 This method is applicable for determining emissions of hydrogen halides (HX) [HCl, HBr, and HF] and halogens (X_2) [Cl_2 and Br_2] from stationary sources when specified by the applicable subpart. This method collects the emission sample isokinetically and is therefore particularly suited for sampling at sources, such as those controlled by wet scrubbers, emitting acid particulate matter (e.g., hydrogen halides dissolved in water droplets).

1.3 Data Quality Objectives. Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods.

2.0 Summary of Method.

2.1 Principle. Gaseous and particulate pollutants are withdrawn isokinetically from the source and collected in an optional cyclone, on a filter, and in absorbing solutions. The cyclone collects any liquid droplets and is not necessary if the source emissions do not contain them; however, it is preferable to include the cyclone in the sampling train to protect the filter from any liquid present. The filter collects particulate matter including halide salts but is not routinely recovered or analyzed. Acidic and alkaline absorbing solutions collect the gaseous hydrogen halides and halogens, respectively. Following sampling of emissions containing liquid droplets, any halides/halogens dissolved in the liquid in the cyclone and on the filter are vaporized to gas and collected in the impingers by pulling conditioned ambient air through the sampling train. The hydrogen halides are solubilized in the acidic solution and form chloride (Cl^-), bromide (Br^-), and fluoride (F^-) ions. The halogens have a very low solubility in the acidic solution and pass through to the alkaline solution where they are hydrolyzed to form a proton (H^+), the halide ion, and the hypohalous acid (HClO or HBrO). Sodium thiosulfate is added to the alkaline solution to assure reaction with the hypohalous acid to form a second halide ion such that 2 halide ions are formed for each molecule of halogen gas. The halide ions in the separate solutions are measured by ion chromatography (IC). If desired, the particulate matter recovered from the filter and the probe is analyzed following the procedures in Method 5.

NOTE: If the tester intends to use this sampling arrangement to sample concurrently for particulate matter, the alternative Teflon probe liner, cyclone, and filter holder should not be used. The Teflon filter support must be used. The tester must also meet the probe and filter temperature requirements of both sampling trains.

3.0 Definitions. [Reserved]

4.0 Interferences.

4.1 Volatile materials, such as chlorine dioxide (ClO_2) and ammonium chloride (NH_4Cl), which produce halide ions upon dissolution during sampling are potential interferents. Interferents for the halide measurements are the halogen gases which disproportionate to a hydrogen halide and an hypohalous acid upon dissolution in water. The use of acidic rather than neutral or basic solutions for collection of the hydrogen halides greatly reduces the dissolution of any halogens passing through this solution.

4.2 The simultaneous presence of both HBr and Cl_2 may cause a positive bias in the HCl result with a corresponding negative bias in the Cl_2 result as well as affecting the HBr/Br_2 split.

4.3 High concentrations of nitrogen oxides (NO_x) may produce sufficient nitrate (NO_3^-) to interfere with measurements of very low Br^- levels.

4.4 There is anecdotal evidence that HF may be outgassed from new Teflon components. If HF is a target analyte then preconditioning of new Teflon components, by heating, should be considered.

5.0 Safety.

5.1 Disclaimer. This method may involve hazardous materials, operations, and equipment. This test method may not address all of the safety problems associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and determine the applicability of regulatory limitations before performing this test method.

5.2 Corrosive Reagents. The following reagents are hazardous. Personal protective equipment and safe procedures are useful in preventing chemical splashes. If contact occurs, immediately flush with copious amounts of water for at least 15 minutes. Remove clothing under shower and decontaminate. Treat residual chemical burns as thermal burns.

5.2.1 Sodium Hydroxide (NaOH). Causes severe damage to eyes and skin. Inhalation causes irritation to nose, throat, and lungs. Reacts exothermically with limited amounts of water.

5.2.2 Sulfuric Acid (H_2SO_4). Rapidly destructive to body tissue. Will cause third degree burns. Eye damage may result in blindness. Inhalation may be fatal from spasm of the larynx, usually within 30 minutes. May cause lung tissue damage with edema. 1 mg/m^3 for 8 hours will cause lung damage or, in higher concentrations, death. Provide ventilation to limit inhalation. Reacts violently with metals and organics.

6.0. Equipment and Supplies.

NOTE: Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency.

6.1 Sampling. The sampling train is shown in Figure 26A-1; the apparatus is similar to the Method 5 train where noted as follows:

6.1.1 Probe Nozzle. Borosilicate or quartz glass; constructed and calibrated according to Method 5, Sections 6.1.1.1 and 10.1, and coupled to the probe liner using a Teflon union; a stainless steel nut is recommended for this union. When the stack temperature exceeds 210°C (410°F), a one-piece glass nozzle/liner assembly must be used.

6.1.2 Probe Liner. Same as Method 5, Section 6.1.1.2, except metal liners shall not be used. Water-cooling of the stainless steel sheath is recommended at temperatures exceeding 500°C (932°F). Teflon may be used in limited applications where the minimum stack temperature exceeds

120°C (250°F) but never exceeds the temperature where Teflon is estimated to become unstable [approximately 210°C (410°F)].

6.1.3 Pitot Tube, Differential Pressure Gauge, Filter Heating System, Metering System, Barometer, Gas Density Determination Equipment. Same as Method 5, Sections 6.1.1.3, 6.1.1.4, 6.1.1.6, 6.1.1.9, 6.1.2, and 6.1.3.

6.1.4 Cyclone (Optional). Glass or Teflon. Use of the cyclone is required only when the sample gas stream is saturated with moisture; however, the cyclone is recommended to protect the filter from any liquid droplets present.

6.1.5 Filter Holder. Borosilicate or quartz glass, or Teflon filter holder, with a Teflon filter support and a sealing gasket. The sealing gasket shall be constructed of Teflon or equivalent materials. The holder design shall provide a positive seal against leakage at any point along the filter circumference. The holder shall be attached immediately to the outlet of the cyclone.

6.1.6 Impinger Train. The following system shall be used to determine the stack gas moisture content and to collect the hydrogen halides and halogens: five or six impingers connected in series with leak-free ground glass fittings or any similar leak-free noncontaminating fittings. The first impinger shown in Figure 26A-1 (knockout or condensate impinger) is optional and is recommended as a water knockout trap for use under high moisture conditions. If used, this impinger should be constructed as described below for the alkaline impingers, but with a shortened stem, and should contain 50 ml of 0.1 N H_2SO_4. The following two impingers (acid impingers which each contain 100 ml of 0.1 N H_2SO_4) shall be of the Greenburg-Smith design with the standard tip (Method 5, Section 6.1.1.8). The next two impingers (alkaline impingers which each contain 100 ml of 0.1 N NaOH) and the last impinger (containing silica gel) shall be of the modified Greenburg-Smith design (Method 5, Section 6.1.1.8). The condensate, acid, and alkaline impingers shall contain known quantities of the appropriate absorbing reagents. The last impinger shall contain a known weight of silica gel or equivalent desiccant. Teflon impingers are an acceptable alternative.

6.1.7 Heating System. Any heating system capable of maintaining a temperature around the probe and filter holder greater than 120 °C (248 °F) during sampling, or such other temperature as specified by an applicable subpart of the standards or approved by the Administrator for a particular application.

6.1.8 Ambient Air Conditioning Tube (Optional). Tube tightly packed with approximately 150 g of fresh 8 to 20 mesh sodium hydroxide-coated silica, or equivalent, (Ascarite II has been found suitable) to dry and remove acid gases from the ambient air used to remove moisture from the filter and cyclone, when the cyclone is used. The inlet and outlet ends of the tube should be packed with at least 1-cm thickness of glass wool or filter material suitable to prevent escape of fines. Fit one end with flexible tubing, etc. to allow connection to probe nozzle following the test run.

6.2 Sample Recovery.

6.2.1 Probe-Liner and Probe-Nozzle Brushes, Wash Bottles, Glass Sample Storage Containers, Petri Dishes, Graduated Cylinder and/or Balance, and Rubber Policeman. Same as Method 5, Sections 6.2.1, 6.2.2, 6.2.3, 6.2.4, 6.2.5, and 6.2.7.

6.2.2 Plastic Storage Containers. Screw-cap polypropylene or polyethylene containers to store silica gel. High-density polyethylene bottles with Teflon screw cap liners to store impinger reagents, 1-liter.

6.2.3 Funnels. Glass or high-density polyethylene, to aid in sample recovery.

6.3 Sample Preparation and Analysis.

6.3.1 Volumetric Flasks. Class A, various sizes.

6.3.2 Volumetric Pipettes. Class A, assortment. To dilute samples to calibration range of the ion chromatograph (IC).

6.3.3 Ion Chromatograph (IC). Suppressed or nonsuppressed, with a conductivity detector and electronic integrator operating in the peak area mode. Other detectors, a strip chart recorder, and peak heights may be used.

7.0 Reagents and Standards.

NOTE: Unless otherwise indicated, all reagents must conform to the specifications established by the Committee on Analytical Reagents of the American Chemical Society (ACS reagent grade). When such specifications are not available, the best available grade shall be used.

7.1 Sampling.

7.1.1 Filter. Teflon mat (e.g., Pallflex TX40HI45) filter. When the stack gas temperature exceeds 210°C (410°F) a quartz fiber filter may be used.

7.1.2 Water. Deionized, distilled water that conforms to American Society of Testing and Materials (ASTM) Specification D 1193-77 or 91, Type 3 (incorporated by reference - see § 60.17).

7.1.3 Acidic Absorbing Solution, 0.1 N Sulfuric Acid (H_2SO_4). To prepare 1 L, slowly add 2.80 ml of concentrated 17.9 M H_2SO_4 to about 900 ml of water while stirring, and adjust the final volume to 1 L using additional water. Shake well to mix the solution.

7.1.4 Silica Gel, Crushed Ice, and Stopcock Grease. Same as Method 5, Sections 7.1.2, 7.1.4, and 7.1.5, respectively.

7.1.5 Alkaline Absorbing Solution, 0.1 N Sodium Hydroxide (NaOH). To prepare 1 L, dissolve 4.00 g of solid NaOH in about 900 ml of water and adjust the final volume to 1 L using additional water. Shake well to mix the solution.

7.1.6 Sodium Thiosulfate, ($Na_2S_2O_33 \cdot 5\ H_2O$).

7.2 Sample Preparation and Analysis.

7.2.1 Water. Same as in Section 7.1.2.

7.2.2 Absorbing Solution Blanks. A separate blank solution of each absorbing reagent should be prepared for analysis with the field samples. Dilute 200 ml of each absorbing solution (250 ml of the acidic absorbing solution, if a condensate impinger is used) to the same final volume as the field samples using the blank sample of rinse water. If a particulate determination is conducted, collect a blank sample of acetone.

7.2.3 Halide Salt Stock Standard Solutions. Prepare concentrated stock solutions from reagent grade sodium chloride (NaCl), sodium bromide (NaBr), and sodium fluoride (NaF). Each must be dried at 110°C (230°F) for two or more hours and then cooled to room temperature in a desiccator immediately before weighing. Accurately weigh 1.6 to 1.7 g of the dried NaCl to within 0.1 mg, dissolve in water, and dilute to 1 liter. Calculate the exact Cl^- concentration using Equation 26A-1 in Section 12.2. In a similar manner, accurately weigh and solubilize 1.2 to 1.3 g of dried NaBr and 2.2 to 2.3 g of NaF to make 1-liter solutions. Use Equations 26A-2 and 26A-3 in Section 12.2, to calculate the Br^- and F^- concentrations. Alternately, solutions containing a nominal certified concentration of 1000 mg/L NaCl are commercially available as convenient stock solutions from which standards can be made by appropriate volumetric dilution. Refrigerate the stock standard solutions and store no longer than one month.

7.2.4 Chromatographic Eluent. Same as Method 26, Section 7.2.4.

7.2.5 Water. Same as Section 7.1.1.

7.2.6 Acetone. Same as Method 5, Section 7.2.

7.3 Quality Assurance Audit Samples. When making compliance determinations, and upon availability, audit samples may be obtained from the appropriate EPA regional Office or from the responsible enforcement authority.

NOTE: The responsible enforcement authority should be notified at least 30 days prior to the test date to allow sufficient time for sample delivery.

8.0 Sample Collection, Preservation, Storage, and Transport.

NOTE: Because of the complexity of this method, testers and analysts should be trained and experienced with the procedures to ensure reliable results.

8.1 Sampling.

8.1.1 Pretest Preparation. Follow the general procedure given in Method 5, Section 8.1, except the filter need only be desiccated and weighed if a particulate determination will be conducted.

8.1.2 Preliminary Determinations. Same as Method 5, Section 8.2.

8.1.3 Preparation of Sampling Train. Follow the general procedure given in Method 5, Section 8.1.3, except for the following variations: Add 50 ml of 0.1 N H_2SO_4 to the condensate impinger, if used. Place 100 ml of 0.1 N H_2SO_4 in each of the next two impingers. Place 100 ml of 0.1 N NaOH in each of the following two impingers. Finally, transfer approximately 200-300 g of preweighed silica gel from its container to the last impinger. Set up the train as in Figure 26A-1. When used, the optional cyclone is inserted between the probe liner and filter holder and located in the heated filter box.

8.1.4 Leak-Check Procedures. Follow the leak-check procedures given in Method 5, Sections 8.4.2 (Pretest Leak-Check), 8.4.3 (Leak-Checks During the Sample Run), and 8.4.4 (Post-Test Leak-Check).

8.1.5 Sampling Train Operation. Follow the general procedure given in Method 5, Section 8.5. It is important to maintain a temperature around the probe, filter (and cyclone, if used) of greater than 120°C (248 °F) since it is extremely difficult to purge acid gases off these components. (These components are not quantitatively recovered and hence any collection of acid gases on these components would result in potential undereporting these emissions. The applicable subparts may specify alternative higher temperatures.) For each run, record the data required on a data sheet such as the one shown in Method 5, Figure 5-3. If the condensate impinger becomes too full, it may be emptied, recharged with 50 ml of 0.1 N H_2SO_4, and replaced during the sample run. The condensate emptied must be saved and included in the measurement of the volume of moisture collected and included in the sample for analysis. The additional 50 ml of absorbing reagent must also be considered in calculating the moisture. Before the sampling train integrity is compromised by removing the impinger, conduct a leak-check as described in Method 5, Section 8.4.2.

8.1.6 Post-Test Moisture Removal (Optional). When the optional cyclone is included in the sampling train or when liquid is visible on the filter at the end of a sample run even in the absence of a cyclone, perform the following procedure. Upon completion of the test run, connect the ambient air conditioning tube at the probe inlet and operate the train with the filter heating system at least 120°C (248 °F) at a low flow rate (e.g., $\Delta H = 1$ in. H_2O) to vaporize any liquid and hydrogen halides in the cyclone or on the filter and pull them through the train into the impingers. After 30 minutes, turn off the flow, remove the conditioning tube, and examine the cyclone and filter for any visible liquid. If liquid is visible, repeat this step for 15 minutes and observe again. Keep repeating until the cyclone is dry.

NOTE: It is critical that this is repeated until the cyclone is completely dry.

8.2 Sample Recovery. Allow the probe to cool. When the probe can be handled safely, wipe off all the external surfaces of the tip of the probe nozzle and place a cap loosely over the tip to prevent gaining or losing particulate matter. Do not cap the probe tip tightly while the sampling train is cooling down because this will create a vacuum in the filter holder, drawing water from the impingers into the holder. Before moving the sampling train to the cleanup site, remove the probe from the sample train, wipe off any silicone grease, and cap the open outlet of the impinger train, being careful not to lose any condensate that might be present. Wipe off any silicone grease and cap the filter or cyclone inlet. Remove the umbilical cord from the last impinger and cap the impinger. If a flexible line is used between the first impinger and the filter holder, disconnect it at the filter holder and let any condensed water drain into the first impinger. Wipe off any silicone grease and cap the filter holder outlet and the impinger inlet. Ground glass stoppers, plastic caps, serum caps, Teflon tape, Parafilm, or aluminum foil may be used to close these openings. Transfer the probe and filter/impinger assembly to the cleanup area. This area should be clean and protected from the weather to minimize sample contamination or loss. Inspect the train prior to and during disassembly and note any abnormal conditions. Treat samples as follows:

8.2.1 Container No. 1 (Optional; Filter Catch for Particulate Determination). Same as Method 5, Section 8.7.6.1, Container No. 1.

8.2.2 Container No. 2 (Optional; Front-Half Rinse for Particulate Determination). Same as Method 5, Section 8.7.6.2, Container No. 2.

8.2.3 Container No. 3 (Knockout and Acid Impinger Catch for Moisture and Hydrogen Halide Determination). Disconnect the impingers. Measure the liquid in the acid and knockout impingers to ±1 ml by using a graduated cylinder or by weighing it to ±0.5 g by using a balance. Record the volume or weight of liquid present. This information is required to calculate the moisture content of the effluent gas. Quantitatively transfer this liquid to a leak-free sample storage container. Rinse these impingers and connecting glassware including the back portion of the filter holder (and flexible tubing, if used) with water and add these rinses to the storage container. Seal the container, shake to mix, and label. The fluid level should be marked so that if any sample is lost during transport, a correction proportional to the lost volume can be applied. Retain rinse water and acidic absorbing solution blanks to be analyzed with the samples.

8.2.4 Container No. 4 (Alkaline Impinger Catch for Halogen and Moisture Determination). Measure and record the liquid in the alkaline impingers as described in Section 8.2.3. Quantitatively transfer this liquid to a leak-free sample storage container. Rinse these two impingers and connecting glassware with water and add these rinses to the container. Add 25 mg of sodium thiosulfate per ppm halogen anticipated to be in the stack gas multiplied by the volume (dscm) of stack gas sampled (0.7 mg/ppm-dscf). Seal the container, shake to mix, and label; mark the fluid level. Retain alkaline absorbing solution blank to be analyzed with the samples.

NOTE: 25 mg per sodium thiosulfate per ppm halogen anticipated to be in the stack includes a safety factor of approximately 5 to assure complete reaction with the hypohalous acid to form a second Cl^- ion in the alkaline solution.

8.2.5 Container No. 5 (Silica Gel for Moisture Determination). Same as Method 5, Section 8.7.6.3, *Container No. 3*.

8.2.6 Container Nos. 6 through 9 (Reagent Blanks). Save portions of the absorbing reagents (0.1 N H_2SO_4 and 0.1 N NaOH) equivalent to the amount used in the sampling train; dilute to the approximate volume of the corresponding samples using rinse water directly from the wash bottle being used. Add the same ratio of sodium thiosulfate solution used in container No. 4 to the 0.1 N NaOH absorbing reagent blank. Also, save a portion of the rinse water alone and a portion of the acetone equivalent to the amount used to rinse the front half of the sampling train. Place each in a separate, prelabeled sample container.

8.2.7 Prior to shipment, recheck all sample containers to ensure that the caps are well-secured. Seal the lids of all containers around the circumference with Teflon tape. Ship all liquid samples upright and all particulate filters with the particulate catch facing upward.

9.0 Quality Control.

9.1 Miscellaneous Quality Control Measures.

Section	Quality Control Measure	Effect
8.1.4, 10.1	Sampling equipment leak-check and calibration	Ensure accurate measurement of stack gas flow rate, sample volume
11.5	Audit sample analysis	Evaluate analyst's technique and standards preparation

9.1 Volume Metering System Checks. Same as Method 5, Section 9.2.

10.0 Calibration and Standardization.

NOTE: Maintain a laboratory log of all calibrations.

10.1 Probe Nozzle, Pitot Tube Assembly, Dry Gas Metering System, Probe Heater, Temperature Sensors, Leak-Check of Metering System, and Barometer. Same as Method 5, Sections 10.1, 10.2, 10.3, 10.4, 10.5, 8.4.1, and 10.6, respectively.

10.2 Ion Chromatograph.

10.2.1 To prepare the calibration standards, dilute given amounts (1.0 ml or greater) of the stock standard solutions to convenient volumes, using 0.1 N H_2SO_4 or 0.1 N NaOH, as appropriate. Prepare at least four calibration standards for each absorbing reagent containing the three stock solutions such that they are within the linear range of the field samples.

10.2.2 Using one of the standards in each series, ensure adequate baseline separation for the peaks of interest.

10.2.3 Inject the appropriate series of calibration standards, starting with the lowest concentration standard first both before and after injection of the quality control check sample, reagent blanks, and field samples. This allows compensation for any instrument drift occurring during sample analysis. The values from duplicate injections of these calibration samples should agree within 5 percent of their mean for the analysis to be valid.

10.2.4 Determine the peak areas, or height, of the standards and plot individual values versus halide ion concentrations in μg/ml.

10.2.5 Draw a smooth curve through the points. Use linear regression to calculate a formula describing the resulting linear curve.

11.0 Analytical Procedures.

NOTE: the liquid levels in the sample containers and confirm on the analysis sheet whether or not leakage occurred during transport. If a noticeable leakage has occurred, either void the sample or use methods, subject to the approval of the Administrator, to correct the final results.

11.1 Sample Analysis.

11.1.1 The IC conditions will depend upon analytical column type and whether suppressed or non-suppressed IC is used. An example chromatogram from a non-suppressed system using a 150-mm Hamilton PRP-X100 anion column, a 2 ml/min flow rate of a 4 mM 4-hydroxy benzoate solution adjusted to a pH of 8.6 using 1 N NaOH, a 50 μl sample loop, and a conductivity detector set on 1.0 μS full scale is shown in Figure 26-2.

11.1.2 Before sample analysis, establish a stable baseline. Next, inject a sample of water, and determine if any Cl^-, Br^-, or F^- appears in the chromatogram. If any of these ions are present, repeat the load/injection procedure until they are no longer present. Analysis of the acid and alkaline absorbing solution samples requires separate standard calibration curves; prepare each according to Section 10.2. Ensure adequate baseline separation of the analyses.

11.1.3 Between injections of the appropriate series of calibration standards, inject in duplicate the reagent blanks, quality control sample, and the field samples. Measure the areas or heights of the Cl^-, Br^-, and F^- peaks. Use the mean response of the duplicate injections to determine the concentrations of the field samples and reagent blanks using the linear calibration curve. The values from duplicate injections should agree within 5 percent of their mean for the analysis to be valid. If the values of duplicate injections are not within 5 percent of the mean, the duplicator injections shall be repeated and all four values used to determine the average response. Dilute any sample and the blank with equal volumes of water if the concentration exceeds that of the highest standard.

11.2 Container Nos. 1 and 2 and Acetone Blank (Optional; Particulate Determination). Same as Method 5, Sections 11.2.1 and 11.2.2, respectively.

11.3 Container No. 5. Same as Method 5, Section 11.2.3 for silica gel.

11.4 Audit Sample Analysis.

11.4.1 When the method is used to analyze samples to demonstrate compliance with a source emission regulation, a set of two EPA audit samples must be analyzed, subject to availability.

11.4.2 Concurrently analyze the audit samples and the compliance samples in the same manner to evaluate the technique of the analyst and the standards preparation.

11.4.3 The same analyst, analytical reagents, and analytical system shall be used for the compliance samples and the EPA audit samples. If this condition is met, duplicate auditing of subsequent compliance analyses for the same enforcement agency within a 30-day period is waived. An audit sample set may not be used to validate different sets of compliance samples under the jurisdiction of separate enforcement agencies, unless prior arrangements have been made with both enforcement agencies.

11.5 Audit Sample Results.

11.5.1 Calculate the concentrations in mg/L of audit sample and submit results following the instructions provided with the audit samples.

11.5.2 Report the results of the audit samples and the compliance determination samples along with their identification numbers, and the analyst's name to the responsible enforcement authority. Include this information with reports of any subsequent compliance analyses for the same enforcement authority during the 30-day period.

11.5.3 The concentrations of the audit samples obtained by the analyst shall agree within 10 percent of the actual concentrations. If the 10 percent specification is not met, reanalyze the compliance and audit samples, and include initial and reanalysis values in the test report.

11.5.4 Failure to meet the 10 percent specification may require retests until the audit problems are resolved. However, if the audit results do not affect the compliance or noncompliance status of the affected facility, the

Administrator may waive the reanalysis requirement, further audits, or retests and accept the results of the compliance test. While steps are being taken to resolve audit analysis problems, the Administrator may also choose to use the data to determine the compliance or noncompliance status of the affected facility.

12.0. Data Analysis and Calculations.

NOTE: Retain at least one extra decimal figure beyond those contained in the available data in intermediate calculations, and round off only the final answer appropriately.

12.1 Nomenclature. Same as Method 5, Section 12.1. In addition:

B_{X^-} = Mass concentration of applicable absorbing solution blank, μg halide ion (Cl^-, Br^-, F^-)/ml, not to exceed 1 μg/ml which is 10 times the published analytical detection limit of 0.1 μg/ml. (It is also approximately 5 percent of the mass concentration anticipated to result from a one hour sample at 10 ppmv HCl.)

C = Concentration of hydrogen halide (HX) or halogen (X_2), dry basis, mg/dscm.

K = 10^{-3} mg/μg.

K_{HCl} = 1.028 (μg HCl/μg-mole)/(μg Cl^-/μg-mole).

K_{HBr} = 1.013 (μg HBr/μg-mole)/(μg Br^-/μg-mole).

K_{HF} = 1.053 (μg HF/μg-mole)/(μg F^-/μg-mole).

m_{HX} = Mass of HCl, HBr, or HF in sample, ug.

m_{X2} = Mass of Cl_2 or Br_2 in sample, ug.

S_{X^-} = Analysis of sample, ug halide ion (Cl^-, Br^-, F^-)/ml.

V_s = Volume of filtered and diluted sample, ml.

12.2 Calculate the exact Cl^-, Br^-, and F^- concentration in the halide salt stock standard solutions using the following equations.

μg Cl^-/ml = g of NaCl x 10^3 x 35.453/58.44 **Eq. 26A-1**

μg Br^-/ml = g of NaBr x 10^3 x 79.904/102.90 **Eq. 26A-2**

μg F^-/ml = g of NaF x 10^3 x 18.998/41.99 **Eq. 26A-3**

12.3 Average Dry Gas Meter Temperature and Average Orifice Pressure Drop. See data sheet (Figure 5-3 of Method 5).

12.4 Dry Gas Volume. Calculate $V_{m(std)}$ and adjust for leakage, if necessary, using the equation in Section 12.3 of Method 5.

12.5 Volume of Water Vapor and Moisture Content. Calculate the volume of water vapor $V_{w(std)}$ and moisture content B_{ws} from the data obtained in this method (Figure 5-3 of Method 5); use Equations 5-2 and 5-3 of Method 5.

12.6 Isokinetic Variation and Acceptable Results. Use Method 5, Section 12.11.

12.7 Acetone Blank Concentration, Acetone Wash Blank Residue Weight, Particulate Weight, and Particulate Concentration. For particulate determination.

12.8 Total μg HCl, HBr, or HF Per Sample.

$$m_{HX} = K_{HCl,\ Hbr,\ HF}\ V_s\ (S_{X^-} - B_{X^-}) \qquad \textbf{Eq. 26A-4}$$

12.9 Total μg Cl_2 or Br_2 Per Sample.

$$m_{X2} = V_s\ (S_{X^-} - B_{X^-}) \qquad \textbf{Eq. 26A-5}$$

12.10 Concentration of Hydrogen Halide or Halogen in Flue Gas.

$$C = K\ m_{HX,X2}/V_{m(std)} \qquad \textbf{Eq. 26A-6}$$

12.11 Stack Gas Velocity and Volumetric Flow Rate. Calculate the average stack gas velocity and volumetric flow rate, if needed, using data obtained in this method and the equations in Sections 12.3 and 12.4 of Method 2.

3.0 Method Performance.

13.1 Precision and Bias. The method has a possible measurable negative bias below 20 ppm HCl perhaps due to reaction with small amounts of moisture in the probe and filter. Similar bias for the other hydrogen halides is possible.

13.2 Sample Stability. The collected Cl^- samples can be stored for up to 4 weeks for analysis for HCl and Cl_2.

13.3 Detection Limit. A typical analytical detection limit for HCl is 0.2 μg/ml. Detection limits for the other analyses should be similar. Assuming 300 ml of liquid recovered for the acidified impingers and a similar amounts recovered from the basic impingers, and 1 dscm of stack gas sampled, the analytical detection limits in the stack gas would be about 0.04 ppm for HCl and Cl2, respectively.

14.0 Pollution Prevention. [Reserved]

15.0 Waste Management. [Reserved]

16.0 References.

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3. Cheney, J.L. and C.R. Fortune. Improvements in the Methodology for Measuring Hydrochloric Acid in Combustion Source Emissions. J. Environ. Sci. Health. A19(3): 337-350. 1984.

4. Stern, D.A., B.M. Myatt, J.F. Lachowski, and K.T. McGregor. Speciation of Halogen and Hydrogen Halide Compounds in Gaseous Emissions. In: Incineration and Treatment of Hazardous Waste: Proceedings of the 9th Annual Research Symposium, Cincinnati, Ohio, May 2-4, 1983. Publication No. 600/9-84-015. July 1984. Available from

National Technical Information Service, Springfield, VA 22161 as PB84-234525.

5. Holm, R.D. and S.A. Barksdale. Analysis of Anions in Combustion Products. In: Ion Chromatographic Analysis of Environmental Pollutants, E. Sawicki, J.D. Mulik, and E. Wittgenstein (eds.). Ann Arbor, Michigan, Ann Arbor Science Publishers. 1978. pp. 99-110.

17.0 Tables, Diagrams, Flowcharts, and Validation Data.

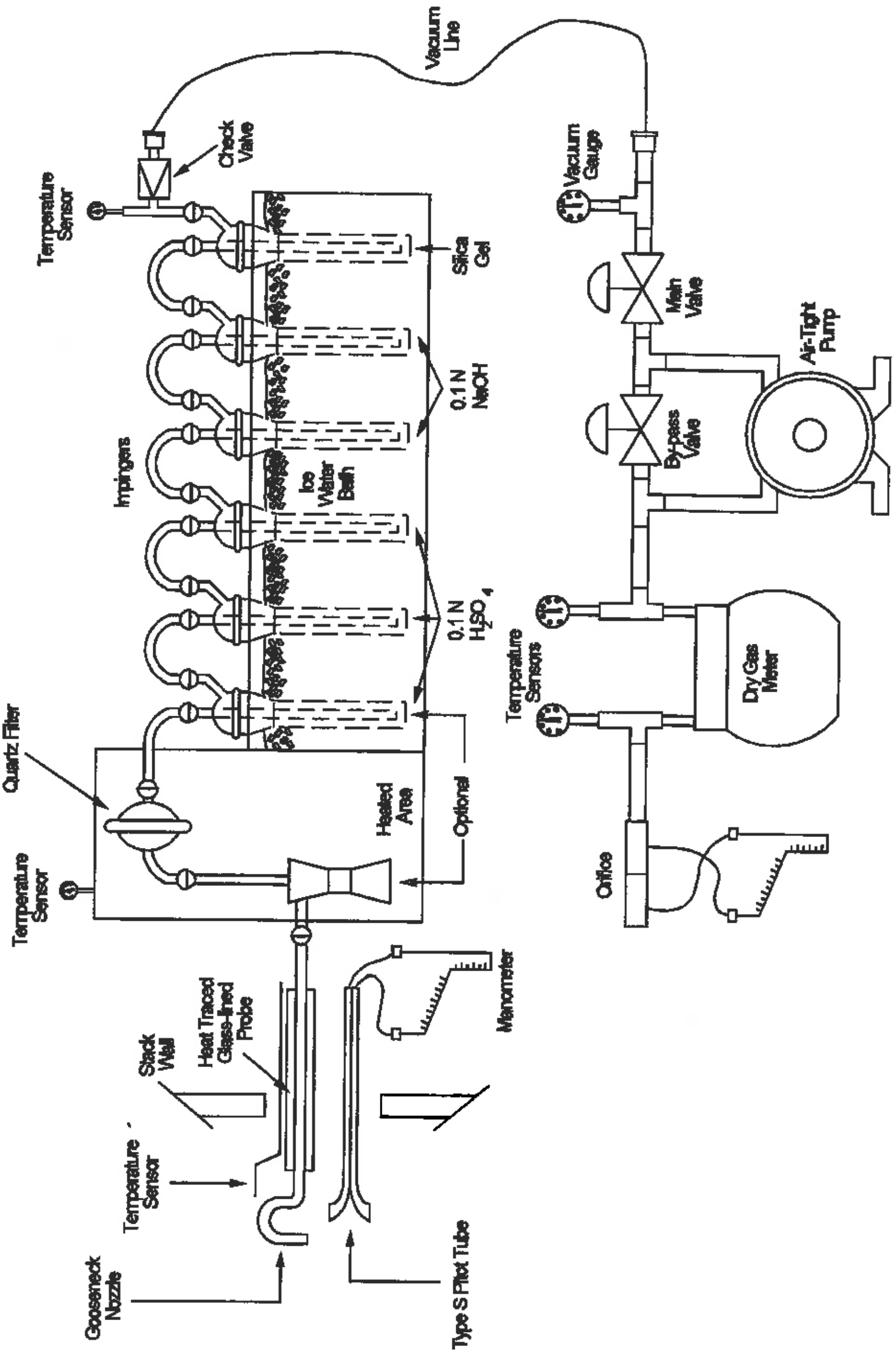
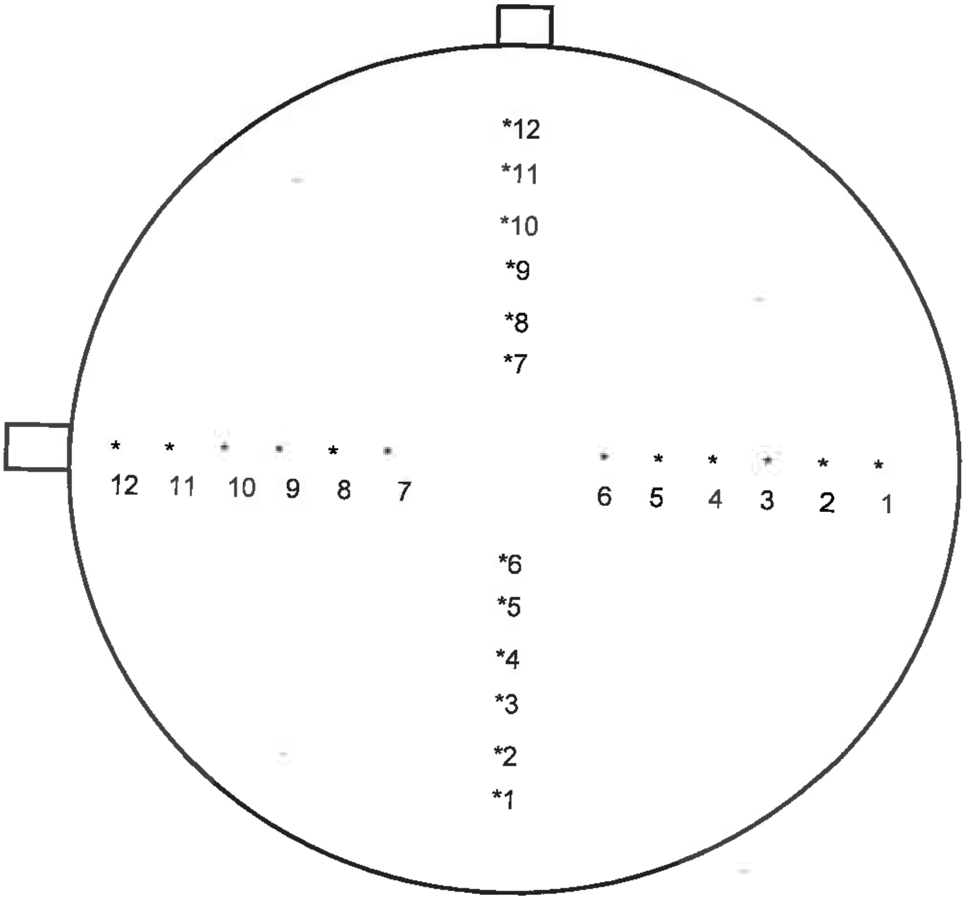


Figure 26A-1. Sampling Train



DRAWING NOT TO SCALE

POINTS	DISTANCE FROM INSIDE WALL
1)	46.991 "
2)	44.783 "
3)	42.335 "
4)	39.503 "
5)	35.999 "
6)	30.912 "
7)	17.088 "
8)	12.000 "
9)	8.496 "
10)	5.664 "
11)	3.216 "
12)	1.008 "

STACK AREA = 12.566 sq ft
STACK DIAMETER = 4.00 '

Recycling Solutions Technology, LLC
Davella, KY
Unit 1

GCI

APPENDIX

Sample Calculations

SAMPLE CALCULATIONS

Recycling Solutions Technologies
Davella, Kentucky
Unit 1
RUN 1

$$Ps = Pb + \left(\frac{Pf}{13.6}\right)$$

$$29.51 = 29.53 + \left(\frac{-.21}{13.6}\right)$$

Vm = (Final Dry Gas Meter reading – Initial Dry Gas Meter reading) x Y

37.087931 = (229.314 – 192.337) x 1.003

$$\text{Vm(std)} = Vm \times \frac{528}{Tm + 460} \times \left(\frac{Pb + \frac{DeltaH}{13.6}}{29.92}\right)$$

$$36.17 = 37.087931 \text{ x } \frac{528}{536} \times \left(\frac{29.53 + \frac{1.24}{13.6}}{29.92}\right)$$

Vwc = .04706 x Vl

Vwsg = .04715 x Wsg

Vwc(std) = Vwc + Vwsg

6.155448 = .04706 x 130.8 ml of condensate

.49979 = .04715 x 10.6 g. of silica gel

6.655238 Vwc(std) = 6.155448 + .49979

Bws = $\frac{Vwc(std)}{Vwc(std)+Vm(std)}$

.1554 = $\frac{6.655238}{6.655238+36.17}$

%M = Bws x 100

15.54% = .1554 x 100

$\%N_2$ dry = 100 – ($\%CO_2$ + $\%O_2$ + %CO)

80.32% = 100 – (7.77% + 11.91% + 0)

Md = (.44 x %CO2) + (.32 x %O2) + (.28 x (%N2+%CO))

29.7196 = (.44 x 7.77%) + (.32 x 11.91%) + (.28 x 80.32%)

Ms = Md (1-Bws) + (18.0 x Bws)

27.90 = 29.7196 x (1 - .1554) + (18.0 x .1554)

Vs = 85.49 x Cp x $\sqrt{\Delta P} \times \sqrt{\frac{Ts}{Ps \times Ms}}$

43.48 = 85.49 x .84 x .681 x $\sqrt{\frac{651}{29.51 \times 27.90}}$

ACFM = 60 x Vs x A

32,785 = 60 x 43.48 x 12.566

$$\text{DSCFM} = \frac{Tstd}{Pstd} \times ACFM \times \frac{Ps}{Ts} \times (1 - Bws)$$

$$22{,}154 = \frac{528}{29.92} \times 32{,}785 \times \frac{29.51}{651} \times (1 - .1554)$$

Wg = Weight gain in grams

Wg = 0.0008

Wp = .002205 x Wg

.000001764 = .002205 x 0.0008

$$Wd = \frac{Wp}{Vm(std)} \quad \text{(lb/dscf)}$$

$$4.88\text{E-}08 = \frac{.000001764}{36.17}$$

Wh = Wd x Qsd (lb/hr)

.06 = 4.88E-08 x 1,329,240

Ws = Wd x 7000 (gr/dscf)

3.41E-04 = 4.88E-08 x 7000

$$\text{DI} = \frac{f - factor \times 20.9 \times Wd}{(20.9 - \%O2)} \quad \text{(lb/mmBtu)}$$

N/A

$$\%\text{I} = \frac{1.667 \times Ts \times \left| .002669 \times Vlc + \frac{Vm \times Y}{Tm} \right| \left(Pbar + \frac{DeltaH}{13.6} \right)}{* \times Vs \times Ps \times An}$$

$$100.3\% = \frac{1.667 \times 651 \times \left| .002669 \times 141.4 + \frac{36.977 \times 1.003}{536} \right| \left(29.53 + \frac{1.24}{13.6} \right)}{60 \times 43.48 \times 29.51 \times .0003408843316}$$

NOMENCLATURE

A = cross-sectional area of stack, (ft^2)
acf = actual cubic feet
acfm = actual cubic feet per minute
A_n = cross-sectional area of nozzle, (ft^2)
B_{ws} = water vapor in the gas stream, proportion by volume
C_a = acetone blank residue concentration, mg/mg
C_p = pitot tube coefficient, dimensionless
$C_{p(s)}$ = type S pitot tube coefficient, dimensionless
$C_{p(std)}$ = standard pitot tube coefficient; use 0.99
C_s = concentration of particulate matter in stack gas, dry basis, corrected to standard conditions, (gr/dscf)
D_e = equivalent diameter
D_I = dust loading per heat input, (lb/mmBtu)
dscf = dry standard cubic feet
dscm = dry standard cubic meters
fps = feet per second
gms = grams
gm-mole = gram-mole
grs = grains
ΔH = orifice pressure drop in inches water, average
hr = hour
I = percent of isokinetic sampling
In. Hg = inches mercury
L = length.
L_1 = Individual leakage relate observed during the leak-check conducted prior to the first component change, (ft^3/min)
L_a = maximum acceptable leakage rate for either a pretest leak-check or for a leak-check following a component change; equal to 0.00057 m^3/min (0.020 cfm) or 4 percent of the average sampling rate, whichever is less
lbs = pounds
lb-mole = pound-mole
L_i = Individual leakage rate observed during the leak-check conducted prior to the "i^{th}" component change (i = 1, 2, 3..n), (cfm)
L_p = leakage rate observed during the post-test leak-check, (cfm)
%M = percent moisture by volume
m_a = mass of residue of acetone after evaporation, mg
M_d = molecular weight of stack gas, dry basis, (lb/lb-mole)
mmBtu = million Btu
m_n = total amount of particulate matter collected, mg
M_s = molecular weight of stack gas, wet basis, (lb/lb-mole)
M_w = molecular weight of water, (18.0 lb/lb-mole)
n = total number of traverse points
P_b = barometric pressure at the sampling site, (in Hg)
P_f = static pressure in flue in inches water, average
P_g = stack static pressure, (in. Hg)
P_s = absolute stack gas pressure, (in. Hg)
P_{std} = standard absolute pressure, (29.92 in. Hg)
Q_{sd} = dry volumetric stack gas flow rate corrected to standard conditions, (dscf/hr)
R = ideal gas constant, $\{21.85$ [(in Hg) (ft^3)] / [(°R) (lb-mole)]$\}$
$\sqrt{\Delta P}$ = square root of velocity head in inches water, average
scf = standard cubic feet
scm = standard cubic meters
T = sensitivity factor for differential pressure gauges

T_m = absolute average DGM temperature, (°R)
T_s = absolute average stack gas temperature, (°R)
T_{std} = standard absolute temperature, (528 °R)
V_a = volume of acetone blank, ml
V_{aw} = volume of acetone used in wash, ml
V_l = volume of condensate through the impingers, ml
V_{lc} = total volume of liquid collected in impingers and silica gel, ml
V_m = volume of gas sample as measured by dry gas meter, (dcf)
$V_{m(std)}$ = volume of gas sample measured by the dry gas meter, corrected to standard conditions, (dscf)
V_o = volume of flue gas at actual conditions in cubic feet per minute
$V_{w(std)}$ = volume of water vapor in the gas sample, corrected to standard conditions, (scf)
V_{wc} = volume of water condensed in impingers corrected to standard conditions
V_{wsg} = volume of water collected in silica gel corrected to standard conditions
V_s = average stack gas velocity, (ft/sec)
W = width
W_a = weight of residue in acetone wash, mg
W_d = weight of dust collected per unit volume, (lb/dscf)
W_g = weight of dust collected in grams
W_h = weight of dust collected per unit volume, (lb/hr), dry basis
W_p = weight of dust collected in pounds
W_s = weight of dust collected per unit volume, (gr/dscf)
W_{sg} = weight gain of impinger silica gel in grams
Y = dry gas meter calibration factor
$*_a$ = density of acetone, mg/ml
$*$ = total sampling time, min
$*_1$ = sampling time interval, from the beginning of a run until the first component change, min
*i = sampling time interval, between two successive component changes, beginning with the interval between the first and second changes, min
$*_p$ = sampling time interval, from the final (nth) component change until the end of the sampling run, min
13.6 = specific gravity of mercury
60 = sec/min
100 = conversion to percent

NO_x CALCULATION
(O$_2$ Based)

lb/dscf = 1.194×10^{-7} x PPM

lb/mmBtu = lb/dscf x f-factor x $\frac{20.9}{20.9 - \%O_2}$

lb/hour = lb/dscf x dscfm x 60 min./hr

NO_x CALCULATION AT 7% O_2

NO_x ppm at 7% O_2 = corrected ppm x $\frac{20.9 - 7}{20.9 - \%O_2}$

SO_2 CALCULATION
(${O_2}$ Based)

lb/dscf = 1.660×10^{-7} x PPM

lb/mmBtu = lb/dscf x f-factor x $\frac{20.9}{20.9 - \%O_2}$

lb/hour = lb/dscf x dscfm x 60 min./hr

SO_2 CALCULATION AT 7% O_2

CO ppm at 7% O_2 = corrected ppm x $\frac{20.9 - 7}{20.9 - \%O_2}$

CO CALCULATION
(O_2 Based)

lb/dscf = $.726 \times 10^{-7} \times$ ppm

lb/mmBtu = lb/dscf x f-factor x $\frac{20.9}{20.9 - \%O_2}$

lb/hour = lb/dscf x dscfm x 60 min./hr

CO CALCULATION AT 7% O_2

CO ppm at 7% O_2 = corrected ppm x $\frac{20.9 - 7}{20.9 - \%O_2}$

SAMPLING SYSTEM BIAS CORRECTION

EMISSION CALCULATION
(CFR 40, Part 60, Appendix A)

Eq. 6C-1

$$C_{gas} = (\overline{C} - C_o)\frac{C_{ma}}{C_m - C_o}$$

Where:

C_{gas} = Effluent gas concentration, dry basis, ppm.
$\overline{C}$ = Average gas concentration indicated by gas analyzer, dry basis, ppm.
C_o = Average of initial and final system calibration bias check responses for the zero gas, ppm.
C_m = Average of initial and final system calibration bias check responses for the upscale calibration gas, ppm.
C_{ma} = Actual concentration of the upscale calibration gas, ppm.

Test Data Sheets

Field Data Sheet

3A

Client: Recycling Solutions		Date: 9-25-08	~~Orsat~~ Analysis		
Project No: 08-293	Operator: B. Peyton		CO2%	O2	O2%
Sampling Location: Stack		Run No: 1			
Filter No.: T-404	Impinger Box No: 8C	Condensate: 130.8 ml or [✓ g]	7.77		11.91
Barometric Pressure: 29.53	Static Pressure: -0.21	Silica Gel: 10.6 g			
Nozzle Diameter: 0.2~~39~~.250	Nozzle Number: G-~~8~~-23	Pitot Number:			
Meter Corr. Factor: 1.003	Pitot Coefficient: ~~1.003~~ .84	Meter No. 16A	RM: 5126A		
Sample Pt. Time: 2.5	Meter Orifice: 3.26201	Date Calibrated: 8-22-08	Flue Area: 12.566 ft.2		
Assumed % Moisture: 6	Delta H@: 1.723				
Saturated Gas Stream: Y or [✓ N]	Leak Test Initial: 0.002 ft3@ 15 "Hg(1 min.)	Final: 0.001 ft3@ 5 "Hg(1 min.)			

Sample Point	Delta P	Sq. Rt Delta P	Delta H	Stack	Probe 223-273	Imp. Out <68	Oven 223-273	Meter In	Meter Out	Vac. Pr (in. HG)	Dry Gas Meter Reading (Cubic Feet)
Start Time: 11:35							Filter		Initial DGM Reading		192.337
							Outlet				
A 1	0.42	0.648	1.10	195	247	65	251	NA	73	2	193.821
2	0.48	0.693	1.26	192	246	62	246		74	2	195.420
3	0.47	0.686	1.24	186	250	56	247		74	2	196.871
4	0.45	0.671	1.20	183	251	53	248		75	2	198.504
5	0.45	0.671	1.20	181	252	53	248		75	2	199.907
6	0.45	0.671	1.20	181	257	52	250		75	2	201.351
7	0.37	0.608	0.98	186	258	51	251		75	2	202.781
8	0.35	0.592	0.92	191	256	55	252		75	2	204.130
9	0.33	0.574	0.88	184	257	61	250		75	2	205.450
10	0.32	0.566	0.84	194	258	52	246		75	2	206.685
11	0.35	0.592	0.92	196	256	51	247		75	2	207.843
12	0.35	0.592	0.92	196	254	51	246		75	2	209.417
B1	0.53	0.728	1.39	198	251	52	245	NA	77	2	211.027
2	0.65	0.806	1.73	194	250	52	243		78	2	212.283
3	0.58	0.762	1.54	192	250	51	244		78	2	214.608
4	0.64	0.800	1.70	192	251	51	245		78	2	216.239
5	0.68	0.825	1.82	189	256	52	246		78	2	217.950
6	0.65	0.806	1.73	192	257	52	247		78	2	219.350
7	0.52	0.721	1.38	194	254	53	246		78	2	221.306
8	0.48	0.693	1.27	197	252	54	245		78	2	222.960
9	0.48	0.693	1.27	196	251	54	247		78	2	224.861
10	0.41	0.640	1.09	194	256	54	246		78	2	226.202
11	0.42	0.648	1.11	195	252	52	246		78	2	227.741
12	0.40	0.632	1.06	192	252	52	247		78	2	229.314
Stop Time: 12:48											
avg's.		~~.680~~ .681	1.24	191					76		36.977

Pitot Tube Leak Test: Stable for 15 seconds at 3.0" H_2O Initial ✓ Final ✓

Grace Consulting, Inc.

Field Data Sheet

Client: Recycling Solutions		Date: 9-25-08		Orsat Analysis	
Project No: 08-293	Operator: Brandon Payton		CO₂%	O₂	O₂%
Sampling Location: Stack		Run No: 2			
Filter No.: T-403	Impinger Box No: 7C	Condensate: 116.5 ml or (g)	5.94		14.1
Barometric Pressure: 29.53	Static Pressure: -0.21	Silica Gel: 7.9 g			
Nozzle Diameter: ~~0.259~~ .250	Nozzle Number: GB-23	Pitot Number:			
Meter Corr. Factor: 1.003	Pitot Coefficient: 0.84	Meter No. 16A	RM: 5126A		
Sample Pt. Time: 2.5	Meter Orifice: 3.26201	Date Calibrated: 8-22-08	Flue Area: ft.2		
Assumed % Moisture: 16	Delta H@: 1.723				
Saturated Gas Stream: Y or N	Leak Test Initial: 0.000 ft3@ 17 "Hg(1 min.)		Final: 0.000 ft3@ 5 "Hg(1 min.)		

Sample Point	Delta P	Sq. Rt Delta P	Delta H	Stack	Probe 223-273	Imp. Out <68	Oven 223-273	Meter In	Meter Out	Vac. Pr (in. HG)	Dry Gas Meter Reading (Cubic Feet)
Start Time: 14:00							Filter Exit		Initial DGM Reading		229.465
B 1	0.64	0.800	2.10	193	252	60	237	NA	86	2	231.367
2	0.64	0.800	2.09	196	251	54	246		86	2	233.480
3	0.58	0.762	1.90	192	256	53	244		86	2	235.417
4	0.70	0.837	1.85	186	257	52	245		86	2	237.150
5	0.64	0.800	1.69	186	257	52	247		86	2	239.015
6	0.67	0.819	1.77	190	257	52	246		87	2	240.871
7	0.45	0.671	1.18	192	258	52	248		87	2	242.360
8	0.46	0.678	1.20	197	257	51	244		87	2	243.986
9	0.46	0.678	1.20	197	253	51	247		87	2	245.450
10	0.42	0.648	1.09	198	254	52	246		87	2	246.897
11	0.38	0.616	1.00	194	257	53	244		88	2	248.261
12	0.38	0.616	1.00	194	256	53	245		88	2	249.649
A 1	0.42	0.648	1.11	189	252	54	247	NA	88	2	251.070
2	0.36	0.600	0.96	191	251	53	251		89	2	252.473
3	0.57	0.755	1.52	189	262	52	248		89	2	254.208
4	0.63	0.794	1.69	185	251	52	250		89	2	255.921
5	0.68	0.825	1.83	183	250	51	248		90	2	257.773
6	0.64	0.800	1.73	182	249	52	251		90	2	259.830
7	0.51	0.714	1.37	187	251	52	257		90	2	261.183
8	0.35	0.592	0.92	197	252	51	256		91	2	262.721
9	0.36	0.600	0.94	204	260	52	260		91	2	263.971
10	0.34	0.583	0.89	204	261	50	250		91	2	265.184
11	0.43	0.656	1.13	205	258	48	249		91	2	266.821
12	0.40	0.632	1.05	205	257	50	250		91	2	268.371
Stop Time: 15:05											
avg's.		.705	1.38	193					88		38.906

Pitot Tube Leak Test: Stable for 15 seconds at 3.0" H_2O Initial OK Final OK

Grace Consulting, Inc.

Field Data Sheet

Client: Recycling Solutions
Date: 9-25-08
Project No: 08-293
Operator: Brandon Peyton
Sampling Location: Stack
Run No: 3
Filter No.: T-405
Impinger Box No: AA
Condensate: 174.2 ml or g
Barometric Pressure: 29.53
Static Pressure: -.21
Silica Gel: 16.4 g
Nozzle Diameter: 0.292
Nozzle Number: 66-34
Pitot Number:
Meter Corr. Factor: 1.003
Pitot Coefficient: 0.84
Meter No. 16A
Sample Pt. Time: 2.5
Meter Orifice: 3.26201
Date Calibrated: 8-2208
Assumed % Moisture: 16
Delta H@: 1.723
Saturated Gas Stream: Y or N
Leak Test Initial: 0.000 ft3@ 16 "Hg(1 min.)
Final: 0.000 ft3@ 7 "Hg(1 min.)

Orsat Analysis		
CO2%	O2	O2%
8.21		11.55
22		54

RM:
Flue Area: ft.2

Sample Point	Delta P	Sq. Rt Delta P	Delta H	Temperature (Degrees Fahrenheit) Stack	Probe 223-273	Imp. Out <68	Oven 223-273	Meter In	Meter Out	Vac. Pr (in. HG)	Dry Gas Meter Reading (Cubic Feet)
Start Time: 15:45										Initial DGM Reading	268.307
A1	0.53	0.728	2.56	188	256	60	250	NA	82	3	270.807
2	0.57	0.755	2.72	198	254	52	250		82	3	272.806
3	0.62	0.787	2.92	206	253	51	248		82	4	275.187
4	0.63	0.794	2.96	208	252	51	247		82	4	277.382
5	0.65	0.806	3.05	209	256	49	246		82	4	279.887
6	0.63	0.794	2.95	205	254	49	248		82	4	282.281
7	0.59	0.768	2.79	202	251	48	247		82	4	284.709
8	0.42	0.648	1.99	201	257	49	246		82	3	286.591
9	0.38	0.616	1.80	203	260	49	248		82	3	288.406
10	0.38	0.616	1.80	203	258	50	249		82	3	290.317
11	0.42	0.648	1.99	201	260	50	248		82	3	292.291
12	0.42	0.648	1.99	201	261	51	247		82	3	294.306
B1	0.58	0.762	2.75	202	261	50	246	NA	82	4	296.491
2	0.68	0.825	3.22	202	259	57	247		82	4	299.079
3	0.72	0.849	3.41	202	261	56	246		82	5	301.491
4	0.73	0.854	3.46	202	262	57	248		82	5	304.250
5	0.58	0.762	2.75	202	253	56	246		82	4	306.419
6	0.62	0.787	2.93	203	257	57	243		82	4	308.921
7	0.68	0.825	3.21	204	258	54	247		82	5	311.302
8	0.64	0.800	3.02	204	257	58	242		82	5	313.702
9	0.64	0.800	3.02	204	254	59	241		82	5	316.117
10	0.55	0.742	2.60	204	256	58	243		82	4	318.302
11	0.48	0.693	2.27	202	257	58	241		82	4	320.303
12	0.48	0.693	2.27	202	258	57	243		82	4	022.318
Stop Time: 16:48											
avg's.		0.750	2.695	202.4					82		54.011

Pitot Tube Leak Test: Stable for 15 seconds at 3.0" H_2O Initial ok Final ok

Grace Consulting, Inc.

Field Data Sheet

3A

Client: Recycling Solutions		Date: 9-26-08			
Project No: 08-293	Operator: Brandon Peyton				
Sampling Location: Stack		Run No: 1			
Filter No.: R-1	Impinger Box No: 9B	Condensate: 167 [✓ ml] or g			
Barometric Pressure: 29.27	Static Pressure: -0.28	Silica Gel: 14.4 g			
Nozzle Diameter: 0.292	Nozzle Number: 67-	Pitot Number:			
Meter Corr. Factor: 1.003	Pitot Coefficient: 0.84	Meter No. 16A	RM: 23		
Sample Pt. Time: 2.5	Meter Orifice: 3.26201	Date Calibrated: 8-22-08	Flue Area: ft.2		
Assumed % Moisture: 16	Delta H@: 1.723				
Saturated Gas Stream: Y or N	Leak Test Initial: 0.000 ft3@ 15 "Hg(1 min.)	Final: 0.003 ft3@ 12 "Hg(1 min.)			

~~Orsat~~ Analysis		
CO2%	O2	O2%

Sample Point	Delta P	Sq. Rt Delta P	Delta H	Stack	Temperature (Degrees Fahrenheit) Probe 223-273	Imp. Out <68	Oven 223-273	~~Meter In~~ condenser	Meter Out	Vac. Pr (in. HG)	Dry Gas Meter Reading (Cubic Feet)
Start Time: 9:45									Initial DGM Reading		330.398
B 1	0.52	0.721	2.38	188	249	56	260	40	65	5	332.562
2	0.56	0.748	2.56	189	248	52	261	41	65	5	334.681
3	0.46	0.678	2.11	188	256	48	258	41	65	5	336.690
4	0.57	0.755	2.66	191	254	49	284	41	65	5	338.871
5	0.68	0.825	3.12	192	256	47	256	41	67	5	341.350
6	0.62	0.787	2.86	191	253	47	254	40	68	5	343.761
7	0.48	0.693	2.21	193	249	48	252	41	68	4	345.760
8	0.43	0.656	1.98	191	250	47	256	40	68	4	347.761
9	0.46	0.678	2.12	193	248	47	287	41	68	4	349.881
10	0.42	0.648	1.93	194	249	47	257	41	69	4	351.624
11	0.46	0.678	2.12	200	247	47	258	41	69	4	353.697
12	0.46	0.678	2.12	200	248	48	256	41	69	4	355.802
A 1	0.67	0.819	3.07	200	242	49	251	44	70	5	358.150
2	0.72	0.849	3.31	201	247	50	251	43	71	5	360.761
3	0.67	0.819	3.08	200	248	51	256	43	71	5	363.071
4	0.68	0.825	3.11	203	250	50	256	43	71	5	365.491
5	0.63	0.794	2.90	201	248	50	254	44	72	5	367.907
6	0.58	0.762	2.67	201	247	50	260	44	72	5	370.250
7	0.42	0.648	1.94	198	249	49	261	44	73	4	372.102
8	0.36	0.600	1.66	200	249	49	258	44	73	3	373.780
9	0.37	0.608	1.71	199	248	48	256	44	73	3	375.621
10	0.35	0.592	1.62	199	247	48	257	44	73	3	377.502
11	0.34	0.583	1.58	198	248	50	257	44	73	3	379.020
12	0.34	0.583	1.58	198	250	50	256	44	73	3	380.291
Stop Time: 10:50											
avg's.		.710	2.35	196					70		50.393

Pitot Tube Leak Test: Stable for 15 seconds at 3.0" H_2O	Initial ok Final ok

Grace Consulting, Inc.

Field Data Sheet

Client: Recycling Solutions		Date: 9-26-08	
Project No: 08J-293	Operator: Brandon Peyton		
Sampling Location: Stack		Run No: 2	
Filter No.: R-2	Impinger Box No: 8C	Condensate: 138.1 ml or g	
Barometric Pressure: 29.27	Static Pressure: - 0.28	Silica Gel: 12.5 g	
Nozzle Diameter: 0.292	Nozzle Number:	Pitot Number:	
Meter Corr. Factor: 1.003	Pitot Coefficient: 0.84	Meter No. 16A	RM:
Sample Pt. Time: 2.5	Meter Orifice: 3.26201	Date Calibrated: 8-2208	Flue Area: ft.2
Assumed % Moisture: 16	Delta H@: 1.723		
Saturated Gas Stream: Y or N	Leak Test Initial: 0.001 ft3@ 16 "Hg(1 min.)	Final: 0.001 ft3@ 12 "Hg(1 min.)	

Orsat Analysis		
CO_2%	O_2	O_2%

Sample Point	Delta P	Sq. Rt Delta P	Delta H	Temperature (Degrees Fahrenheit) Stack	Probe 223-273	Imp. Out <68	Oven 223-273	Meter In	Meter Out	Vac. Pr (in. HG)	Dry Gas Meter Reading (Cubic Feet)	
Start Time: 12:15										Initial DGM Reading	362.945	Coil
A 1	0.45	0.671	2.15	193	252	62	248	NA	79	3	385.010	42
2	0.40	0.632	1.91	194	251	60	249		79	3	386.952	44
3	0.38	0.616	1.83	190	250	56	250		79	3	387.862	44
4	0.38	0.616	1.83	191	249	54	248		79	3	390.213	45
5	0.28	0.529	1.34	194	251	54	248		79	3	392.406	46
6	0.26	0.510	1.25	192	252	53	247		79	3	393.816	44
7	0.27	0.520	1.29	192	253	54	246		79	3	395.319	46
8	0.31	0.557	1.49	192	251	56	248		79	3	397.150	44
9	0.29	0.539	1.39	192	256	54	246		79	3	398.740	44
10	0.28	0.529	1.34	192	254	54	247		79	3	400.216	44
11	0.27	0.520	1.30	190	257	53	248		80	3	402.624	46
12	0.27	0.520	1.30	190	254	53	247		80	3	403.921	46
B 1	0.45	0.671	2.16	190	248	51	257	NA	79	3	405.816	47
2	0.42	0.648	2.01	190	250	52	256		78	3	407.761	47
3	0.48	0.693	2.30	190	246	46	252		78	3	409.603	47
4	0.48	0.693	2.30	190	251	47	251		78	3	411.603	47
5	0.48	0.693	2.30	190	246	46	256		78	3	413.600	46
6	0.47	0.686	2.25	190	248	47	254		78	3	415.762	46
7	0.38	0.616	1.82	190	249	48	253		78	3	417.534	44
8	0.42	0.648	2.01	188	250	47	252		78	3	419.363	44
9	0.36	0.600	1.73	189	248	49	254		78	3	421.306	44
10	0.34	0.583	1.63	189	247	50	251		78	3	423.201	47
11	0.32	0.566	1.54	189	251	51	252		78	3	424.736	46
12	0.34	0.583	1.63	190	250	50	248		78	3	426.895	45
Stop Time: 13:23												
avg's.		.602	1.754	191					79		43.95	

Pitot Tube Leak Test: Stable for 15 seconds at 3.0" H_2O | Initial OK | Final OK

Field Data Sheet

Client: Recycling Solutions		Date: 9-26-08	Orsat Analysis		
Project No: 08-293	Operator: Brandon Peyton		CO₂%	O₂	O₂%
Sampling Location: Stack		Run No: 3			
Filter No.: R-3	Impinger Box No: 10A	Condensate: 113.8 ml or g			
Barometric Pressure: 29.27	Static Pressure: -0.28	Silica Gel: 10.9 g			
Nozzle Diameter: 0.292	Nozzle Number:	Pitot Number:			
Meter Corr. Factor: 1.003	Pitot Coefficient: 0.84	Meter No. 16A	RM: 23		
Sample Pt. Time: 2.5	Meter Orifice: 3.26201	Date Calibrated: 8-22-08	Flue Area: ft.2		
Assumed % Moisture: 16	Delta H@: 1.723				
Saturated Gas Stream: Y or N	Leak Test Initial: 0.007 ft3@ 18 "Hg(1 min.)		Final: 0.002 ft3@ 8 "Hg(1 min.)		

Sample Point	Delta P	Sq. Rt Delta P	Delta H	Stack	Probe 223-273	Imp. Out <68	Oven 223-273	~~Meter~~ In	Meter Out	Vac. Pr (in. HG)	Dry Gas Meter Reading (Cubic Feet)
Start Time: 14:25									Initial DGM Reading		442.858
								Coil			
B 1	0.38	0.616	1.83	181	262	57	259	52	76	3	444.868
2	[illegible]	0.632	1.93	181	260	56	247	49	76	3	446.863
3	0.34	0.583	1.64	180	256	57	248	50	76	3	448.343
4	0.36	0.600	1.74	179	254	54	246	51	76	3	450.636
5	0.37	0.608	1.78	181	267	52	244	49	77	3	452.063
6	0.42	0.648	2.03	184	256	52	247	48	77	3	454.073
7	0.43	0.656	2.05	190	254	51	246	48	77	3	456.080
8	0.42	0.648	2.00	190	256	51	244	48	77	3	458.087
9	0.38	0.616	1.80	191	253	51	246	48	77	3	459.877
10	0.29	0.539	1.38	191	254	51	243	48	77	3	461.520
11	0.29	0.539	1.38	191	257	53	245	48	77	3	463.202
12	0.34	0.583	1.62	190	258	52	246	48	77	3	464.882
A 1	0.37	0.608	1.77	188	259	51	246	47	76	3	466.783
2	0.28	0.529	1.34	187	254	52	245	47	76	3	468.361
3	0.30	0.548	1.44	183	253	51	246	47	76	3	470.010
4	0.29	0.539	1.38	188	252	51	247	47	76	3	476.683
5	0.33	0.574	1.57	189	254	51	245	47	76	3	473.481
6	0.34	0.583	1.62	188	254	52	243	48	76	3	475.130
7	0.28	0.529	1.34	188	256	52	244	48	76	3	476.636
8	0.30	0.548	1.43	188	257	51	247	48	76	3	478.436
9	0.26	0.510	1.24	188	254	51	246	47	76	3	479.891
10	0.28	0.529	1.34	189	256	51	245	47	78	3	481.523
11	0.28	0.529	1.34	189	254	52	246	47	78	3	483.307
12	0.28	0.529	1.3	189	254	52	247	48	78	3	485.106
Stop Time: 15:30											
avg's.		.576	1.595	187					77		42.248

Pitot Tube Leak Test: Stable for 15 seconds at 3.0" H_2O Initial OK Final OK

Field Data Sheet

Client: Recycling Solutions		Date: 9-26-08	
Project No: 08-293	Operator: Brandon Peyton		
Sampling Location: Stack		Run No: 4	
Filter No.:	Impinger Box No: 8C	Condensate: 128.2 ml or g	
Barometric Pressure: 29.27	Static Pressure: -0.28	Silica Gel: 11.9 g	
Nozzle Diameter: 0.292	Nozzle Number:	Pitot Number:	
Meter Corr. Factor: 1.003	Pitot Coefficient: 0.84	Meter No. 16A	RM:
Sample Pt. Time: 2.5	Meter Orifice: 326201	Date Calibrated: 8-22-08	Flue Area: ft.2
Assumed % Moisture: 16	Delta H@: 1.723		
Saturated Gas Stream: Y or [✓ N]	Leak Test Initial: 0.001 ft3@16 "Hg(1 min.)	Final: 0.00 ft3@ 7 "Hg(1 min.)	

Orsat Analysis		
CO_2%	O_2	O_2%

Sample Point	Delta P	Sq. Rt Delta P	Delta H	Temperature (Degrees Fahrenheit): Stack	Probe 223-273	Imp. Out <68	Oven 223-273	~~Meter~~	Meter Out	Vac. Pr (in. HG)	Dry Gas Meter Reading (Cubic Feet)
Start Time: 16:35								Coil	Initial DGM Reading		497.648
A1	0.36	0.660	1.77	182	245	63	243	55	82	3	499.561
2	0.28	0.529	1.38	183	246	60	243	58	83	3	501.003
3	0.44	0.663	2.14	192	250	56	246	59	83	3	503.103
4	0.67	0.819	3.26	193	252	52	248	52	84	3	505.520
5	0.33	0.574	1.60	185	254	51	247	51	84	3	507.421
6	0.38	0.616	1.85	192	256	51	246	53	83	3	509.308
7	0.28	0.529	1.37	188	253	53	247	52	83	3	510.791
8	0.27	0.520	1.33	186	256	52	243	51	83	3	512.518
9	0.26	0.510	0.92	186	252	51	242	50	83	3	513.821
10	0.28	0.529	0.99	186	256	51	244	50	83	3	514.806
11	0.28	0.529	0.99	185	253	52	246	50	83	3	516.471
12	0.36	0.660	1.27	185	252	55	247	49	83	3	518.021
B1	0.44	0.663	1.56	186	245	58	255	48	83	3	519.836
2	0.38	0.616	1.34	187	248	55	256	49	84	3	521.186
3	0.63	0.794	2.21	189	247	57	257	52	84	3	523.418
4	0.51	0.714	1.79	184	248	56	254	52	84	3	525.318
5	0.33	0.574	1.17	184	246	56	253	52	84	3	526.836
6	0.32	0.566	1.12	182	247	54	254	53	84	3	528.436
7	0.29	0.539	1.03	182	248	55	256	52	84	3	529.763
8	0.28	0.529	1.00	180	246	56	256	53	84	3	531.058
9	0.26	0.510	0.92	182	247	56	254	53	83	3	532.671
10	0.28	0.529	1.00	180	248	56	254	54	83	3	533.816
11	0.28	0.529	1.00	180	251	57	252	53	83	3	535.124
12	0.28	0.529	1.00	180	252	57	251	53	83	3	536.643
Stop Time: 17:44											
avg's.		.600	1.417	185					83		38.995

Pitot Tube Leak Test: Stable for 15 seconds at 3.0" H_2O Initial OK Final OK

Grace Consulting, Inc.

Test Run 1 Begin. STRATA Version 2.0

Operator: h stiles

Plant Name: Recycling Solutions

Location: Stack

		O2 %	CO2 %
Start Averaging			
9/25/2008	11:36:06	13.34	6.37
9/25/2008	11:37:03	13.77	6.05
9/25/2008	11:38:03	14.03	5.84
9/25/2008	11:39:04	14.32	5.62
9/25/2008	11:40:04	14.28	5.66
9/25/2008	11:41:04	14.15	5.75
9/25/2008	11:42:04	13.65	6.14
9/25/2008	11:43:04	13.51	6.27
9/25/2008	11:44:04	12.97	6.75
9/25/2008	11:45:04	12.25	7.41
9/25/2008	11:46:04	11.98	7.65
9/25/2008	11:47:04	11.85	7.79
9/25/2008	11:48:04	11.65	8.01
9/25/2008	11:49:04	11.06	8.58
9/25/2008	11:50:04	10.29	9.23
9/25/2008	11:51:04	10.14	9.35
9/25/2008	11:52:04	10.12	9.39
9/25/2008	11:53:04	10.29	9.26
9/25/2008	11:54:04	10.38	9.20
9/25/2008	11:55:04	10.37	9.21
9/25/2008	11:56:04	10.25	9.31
9/25/2008	11:57:04	9.96	9.54
9/25/2008	11:58:04	9.60	9.83
9/25/2008	11:59:05	9.54	9.84
9/25/2008	12:00:05	9.80	9.57
9/25/2008	12:01:05	10.08	9.31
9/25/2008	12:02:05	10.84	8.67
9/25/2008	12:03:05	11.19	8.38
9/25/2008	12:04:05	11.21	8.38
9/25/2008	12:05:05	10.90	8.66
9/25/2008	12:06:05	10.45	9.04
9/25/2008	12:07:05	10.02	9.39
9/25/2008	12:08:05	9.95	9.43
9/25/2008	12:09:05	9.94	9.41
9/25/2008	12:10:05	9.99	9.36
9/25/2008	12:11:05	10.18	9.19
9/25/2008	12:12:05	10.72	8.72
9/25/2008	12:13:05	11.70	7.89
9/25/2008	12:14:05	13.05	6.75
9/25/2008	12:15:05	14.28	5.82

9/25/2008	12:16:05	14.93	5.31
9/25/2008	12:17:05	15.35	4.98
9/25/2008	12:18:06	15.35	5.03
9/25/2008	12:19:03	15.14	5.25
9/25/2008	12:20:03	14.89	5.48
9/25/2008	12:21:03	14.58	5.75
9/25/2008	12:22:04	14.21	6.04
9/25/2008	12:23:04	13.60	6.51
9/25/2008	12:24:04	13.24	6.75
9/25/2008	12:25:04	12.80	7.08
9/25/2008	12:26:04	12.58	7.25
9/25/2008	12:27:04	12.27	7.52
9/25/2008	12:28:04	12.09	7.66
9/25/2008	12:29:04	12.06	7.68
9/25/2008	12:30:04	12.11	7.66
9/25/2008	12:31:04	12.02	7.76
9/25/2008	12:32:04	11.88	7.90
9/25/2008	12:33:04	11.93	7.86
9/25/2008	12:34:04	12.06	7.74
9/25/2008	12:35:04	12.27	7.55
Test Run 1 End			
Average		**12.05**	**7.68**

Test Run 2 Begin. STRATA Version 2.0
Operator: h stiles
Plant Name: Recycling Solutions
Location: Stack

		O2	CO2
		%	%
Start Averaging			
9/25/2008	14:01:25	14.16	6.04
9/25/2008	14:02:25	14.07	6.12
9/25/2008	14:03:25	13.98	6.18
9/25/2008	14:04:25	13.64	6.43
9/25/2008	14:05:25	13.13	6.81
9/25/2008	14:06:25	12.61	7.23
9/25/2008	14:07:26	12.45	7.36
9/25/2008	14:08:26	12.56	7.20
9/25/2008	14:09:26	12.83	6.93
9/25/2008	14:10:26	13.74	6.19
9/25/2008	14:11:26	15.18	4.99
9/25/2008	14:12:26	16.45	3.92
9/25/2008	14:13:26	17.41	3.13
9/25/2008	14:14:26	18.09	2.58
9/25/2008	14:15:26	18.54	2.18
9/25/2008	14:16:26	18.83	1.91
9/25/2008	14:17:26	19.02	1.75
9/25/2008	14:18:26	18.46	2.29
9/25/2008	14:19:26	17.69	2.97
9/25/2008	14:20:26	17.06	3.50
9/25/2008	14:21:24	16.35	4.10
9/25/2008	14:22:24	15.71	4.62
9/25/2008	14:23:24	15.46	4.82
9/25/2008	14:24:24	15.16	5.08
9/25/2008	14:25:24	14.95	5.25
9/25/2008	14:26:24	14.59	5.52
9/25/2008	14:27:24	14.03	5.95
9/25/2008	14:28:24	13.36	6.45
9/25/2008	14:29:24	13.12	6.64
9/25/2008	14:30:25	12.42	7.32
9/25/2008	14:31:25	11.64	8.11
9/25/2008	14:32:25	11.24	8.50
9/25/2008	14:33:25	10.98	8.73
9/25/2008	14:34:25	10.56	9.07
9/25/2008	14:35:25	10.43	9.20
9/25/2008	14:36:25	10.37	9.28
9/25/2008	14:37:25	10.66	9.06
9/25/2008	14:38:25	10.55	9.15
9/25/2008	14:39:25	10.27	9.32
9/25/2008	14:40:25	10.20	9.30

	9/25/2008	14:41:25	10.12	9.27
	9/25/2008	14:42:25	9.90	9.37
	9/25/2008	14:43:25	9.84	9.40
	9/25/2008	14:44:25	9.77	9.40
	9/25/2008	14:45:25	9.84	9.30
	9/25/2008	14:46:25	10.68	8.62
	9/25/2008	14:47:25	11.85	7.64
	9/25/2008	14:48:25	12.68	6.93
	9/25/2008	14:49:25	13.92	5.98
	9/25/2008	14:50:26	15.37	4.76
	9/25/2008	14:51:26	16.63	3.71
	9/25/2008	14:52:26	17.55	2.98
	9/25/2008	14:53:26	18.24	2.42
	9/25/2008	14:54:26	18.43	2.27
	9/25/2008	14:55:26	17.79	2.86
	9/25/2008	14:56:26	17.30	3.28
	9/25/2008	14:57:26	16.92	3.61
	9/25/2008	14:58:26	16.61	3.88
	9/25/2008	14:59:26	16.31	4.12
	9/25/2008	15:00:26	16.09	4.28
Test Run 2 End				
Average			**14.13**	**5.92**

Test Run 3 Begin. STRATA Version 2.0
Operator: h stiles
Plant Name: Recycling Solutions
Location: Stack

Start Averaging

		O2	CO2
		%	%
9/25/2008	15:46:59	13.94	6.14
9/25/2008	15:47:59	13.04	6.83
9/25/2008	15:48:59	12.47	7.30
9/25/2008	15:49:59	12.02	7.70
9/25/2008	15:50:59	11.72	7.98
9/25/2008	15:51:59	11.51	8.17
9/25/2008	15:52:59	11.44	8.23
9/25/2008	15:53:59	11.35	8.30
9/25/2008	15:54:59	11.34	8.31
9/25/2008	15:55:59	11.56	8.12
9/25/2008	15:56:59	11.67	8.03
9/25/2008	15:57:59	11.87	7.87
9/25/2008	15:58:59	11.89	7.87
9/25/2008	15:59:59	11.75	8.00
9/25/2008	16:00:59	11.75	8.00
9/25/2008	16:01:59	11.68	8.06
9/25/2008	16:03:00	11.60	8.13
9/25/2008	16:04:00	11.42	8.27
9/25/2008	16:05:00	11.41	8.25
9/25/2008	16:06:00	11.39	8.25
9/25/2008	16:07:00	11.52	8.12
9/25/2008	16:08:00	11.70	7.95
9/25/2008	16:09:00	11.72	7.94
9/25/2008	16:10:00	11.73	7.92
9/25/2008	16:10:58	11.83	7.82
9/25/2008	16:11:58	11.89	7.75
9/25/2008	16:12:58	11.95	7.69
9/25/2008	16:13:58	11.99	7.66
9/25/2008	16:14:58	12.03	7.65
9/25/2008	16:15:58	11.91	7.78
9/25/2008	16:16:58	11.77	7.92
9/25/2008	16:17:58	11.46	8.23
9/25/2008	16:18:58	11.22	8.45
9/25/2008	16:19:58	11.11	8.53
9/25/2008	16:20:58	11.10	8.52
9/25/2008	16:21:58	11.27	8.39
9/25/2008	16:22:58	11.66	8.06
9/25/2008	16:23:58	11.87	7.90
9/25/2008	16:24:59	11.90	7.88
9/25/2008	16:25:59	12.01	7.79

	9/25/2008	16:26:59	12.16	7.65
	9/25/2008	16:27:59	12.19	7.65
	9/25/2008	16:28:59	11.96	7.87
	9/25/2008	16:29:59	11.74	8.08
	9/25/2008	16:30:59	11.51	8.27
	9/25/2008	16:31:59	11.27	8.47
	9/25/2008	16:32:59	11.06	8.63
	9/25/2008	16:33:59	10.87	8.78
	9/25/2008	16:34:59	10.66	8.97
	9/25/2008	16:35:59	10.65	8.98
	9/25/2008	16:36:59	10.65	8.97
	9/25/2008	16:37:59	10.70	8.92
	9/25/2008	16:38:59	10.91	8.74
	9/25/2008	16:39:59	11.14	8.53
	9/25/2008	16:40:59	11.22	8.46
	9/25/2008	16:41:59	11.16	8.50
	9/25/2008	16:42:59	10.97	8.65
	9/25/2008	16:43:59	10.75	8.82
	9/25/2008	16:45:00	10.46	9.02
	9/25/2008	16:46:00	10.22	9.17
Test Run 3	End			
Average			**11.54**	**8.15**

Test Run 1 Begin. STRATA Version 2.0
Operator: h stiles
Plant Name: Recycling Solutions
Location: Stack

		O2 %	CO2 %	CO ppm	SO2 ppm	NOx ppm
Start Averaging						
9/26/2008	9:46:04	11.05	8.67	7.23	1.27	74.71
9/26/2008	9:47:04	11.22	8.57	7.46	1.17	76.59
9/26/2008	9:48:04	11.38	8.45	7.46	1.27	78.27
9/26/2008	9:49:04	11.47	8.38	6.97	1.16	78.38
9/26/2008	9:50:04	11.35	8.49	6.50	1.17	78.87
9/26/2008	9:51:04	11.11	8.68	6.49	1.26	79.11
9/26/2008	9:52:04	10.87	8.87	6.20	1.21	78.20
9/26/2008	9:53:04	10.57	9.09	6.99	1.24	76.92
9/26/2008	9:54:04	10.33	9.27	33.20	1.18	75.11
9/26/2008	9:55:04	10.22	9.35	93.91	1.16	73.48
9/26/2008	9:56:05	10.14	9.41	163.61	1.13	72.30
9/26/2008	9:57:05	10.50	9.13	124.46	1.16	74.10
9/26/2008	9:58:05	11.19	8.55	77.46	1.16	83.56
9/26/2008	9:59:05	11.63	8.17	47.50	1.16	87.22
9/26/2008	10:00:05	11.69	8.11	31.72	1.15	86.95
9/26/2008	10:01:05	11.33	8.42	28.82	1.16	86.26
9/26/2008	10:02:05	10.90	8.78	63.66	1.12	84.71
9/26/2008	10:03:05	10.52	9.09	120.92	1.00	81.91
9/26/2008	10:04:05	10.61	9.01	201.84	1.10	79.83
9/26/2008	10:05:05	11.20	8.53	133.58	1.14	81.44
9/26/2008	10:06:05	11.94	7.90	79.00	1.13	84.96
9/26/2008	10:07:05	12.27	7.62	49.48	1.07	88.15
9/26/2008	10:08:03	12.17	7.73	32.21	1.10	89.25
9/26/2008	10:09:03	11.38	8.43	31.46	1.05	88.19
9/26/2008	10:10:03	10.60	9.05	192.72	1.10	81.40
9/26/2008	10:11:03	9.78	9.61	499.86	1.12	69.92
9/26/2008	10:12:03	10.40	9.09	499.85	1.10	69.51
9/26/2008	10:13:03	10.84	8.75	499.84	1.08	82.11
9/26/2008	10:14:03	11.28	8.39	499.83	1.06	89.17
9/26/2008	10:15:03	11.77	8.00	438.72	1.14	91.56
9/26/2008	10:16:03	11.94	7.87	261.88	1.10	94.00
9/26/2008	10:17:03	11.81	8.00	160.95	1.13	94.64
9/26/2008	10:18:03	11.49	8.27	89.64	1.10	91.52
9/26/2008	10:19:04	11.04	8.63	69.03	1.07	88.11
9/26/2008	10:20:04	10.35	9.15	436.16	1.09	79.88
9/26/2008	10:21:04	9.87	9.50	499.79	0.99	70.70
9/26/2008	10:22:04	10.09	9.32	499.79	1.06	68.89
9/26/2008	10:23:04	10.83	8.75	499.78	1.00	79.34
9/26/2008	10:24:04	11.37	8.30	499.77	0.90	85.24
9/26/2008	10:25:04	11.75	7.98	493.46	0.95	91.90

9/26/2008	10:26:04	12.00	7.78	347.92	0.96	92.84
9/26/2008	10:27:04	11.54	8.21	207.86	1.03	92.68
9/26/2008	10:28:04	11.06	8.64	128.51	0.86	88.51
9/26/2008	10:29:04	10.71	8.92	95.72	0.99	82.70
9/26/2008	10:30:04	10.58	8.99	67.26	0.99	77.92
9/26/2008	10:31:04	10.92	8.67	43.76	1.03	74.43
9/26/2008	10:32:04	11.45	8.23	30.78	0.91	69.21
9/26/2008	10:33:04	11.99	7.80	22.85	0.94	65.86
9/26/2008	10:34:04	12.34	7.56	17.52	0.90	64.60
9/26/2008	10:35:04	12.38	7.58	13.79	0.99	63.41
9/26/2008	10:36:04	12.54	7.50	11.58	0.89	62.43
9/26/2008	10:37:04	12.59	7.48	9.10	0.90	61.93
9/26/2008	10:38:04	12.59	7.47	7.67	0.93	62.66
9/26/2008	10:39:05	12.46	7.57	6.93	0.90	64.42
9/26/2008	10:40:05	12.28	7.69	6.31	0.93	66.01
9/26/2008	10:41:05	12.13	7.80	5.83	0.82	68.24
9/26/2008	10:42:05	12.03	7.88	5.51	0.92	69.89
9/26/2008	10:43:05	11.63	8.20	10.40	0.97	69.89
9/26/2008	10:44:05	11.35	8.41	28.21	0.85	68.66
9/26/2008	10:45:05	11.06	8.63	92.47	0.88	67.27
Test Run 1 End						
Average		**11.30**	**8.44**	**144.55**	**1.06**	**78.33**

Test Run 2 Begin. STRATA Version 2.0
Operator: h stiles
Plant Name: Recycling Solutions
Location: Stack

		O2	CO2	CO	SO2	NOx
		%	%	ppm	ppm	ppm
Start Averaging						
9/26/2008	12:16:02	12.68	7.09	2.48	1.18	52.02
9/26/2008	12:17:02	12.69	7.06	2.46	1.20	51.66
9/26/2008	12:18:02	12.72	7.02	2.16	1.21	51.30
9/26/2008	12:19:03	12.74	7.00	1.98	1.35	51.63
9/26/2008	12:20:03	12.63	7.11	1.98	1.15	52.40
9/26/2008	12:21:03	12.61	7.12	1.98	1.21	53.15
9/26/2008	12:22:03	12.63	7.11	1.98	1.10	53.45
9/26/2008	12:23:03	12.70	7.04	1.98	1.19	53.31
9/26/2008	12:24:03	12.78	6.96	1.98	1.19	52.72
9/26/2008	12:25:03	12.91	6.86	1.97	1.14	52.04
9/26/2008	12:26:03	12.96	6.83	1.97	1.18	51.89
9/26/2008	12:27:03	13.04	6.76	1.97	1.15	51.55
9/26/2008	12:28:03	13.08	6.72	1.97	1.08	51.06
9/26/2008	12:29:03	13.15	6.66	1.80	1.16	51.17
9/26/2008	12:30:03	13.20	6.63	1.65	1.02	51.20
9/26/2008	12:31:03	13.16	6.64	1.66	1.09	51.23
9/26/2008	12:32:03	13.21	6.59	1.64	0.93	51.24
9/26/2008	12:33:03	13.24	6.61	1.49	0.84	50.54
9/26/2008	12:34:03	13.27	6.64	1.49	0.76	50.32
9/26/2008	12:35:03	13.20	6.73	1.49	0.75	50.75
9/26/2008	12:36:03	13.12	6.82	1.49	0.70	51.42
9/26/2008	12:37:03	12.94	7.00	1.48	0.60	52.18
9/26/2008	12:38:03	12.76	7.18	1.49	0.67	53.77
9/26/2008	12:39:04	12.58	7.35	1.49	0.59	55.17
9/26/2008	12:40:01	12.45	7.48	1.49	0.54	56.83
9/26/2008	12:41:01	12.29	7.64	1.49	0.47	59.04
9/26/2008	12:42:02	12.11	7.81	1.49	0.61	61.71
9/26/2008	12:43:02	11.95	7.95	1.49	0.53	63.93
9/26/2008	12:44:02	11.85	8.03	1.48	0.53	65.78
9/26/2008	12:45:02	11.71	8.15	1.48	0.53	67.17
9/26/2008	12:46:02	11.47	8.36	1.34	0.68	68.46
9/26/2008	12:47:02	11.33	8.46	1.17	0.51	69.35
9/26/2008	12:48:02	11.13	8.62	1.00	0.58	69.73
9/26/2008	12:49:02	11.07	8.67	1.00	0.62	70.25
9/26/2008	12:50:02	11.08	8.66	1.00	0.56	70.19
9/26/2008	12:51:02	11.00	8.73	0.99	0.51	69.33
9/26/2008	12:52:02	10.88	8.81	0.99	0.52	68.34
9/26/2008	12:53:02	10.82	8.85	0.99	0.47	67.61
9/26/2008	12:54:02	10.94	8.75	0.99	0.52	67.41
9/26/2008	12:55:02	11.05	8.66	0.99	0.44	68.05

9/26/2008	12:56:02	11.29	8.48	0.99	0.50	68.63
9/26/2008	12:57:02	11.33	8.47	0.99	0.44	69.01
9/26/2008	12:58:02	11.30	8.49	0.99	0.47	68.93
9/26/2008	12:59:02	11.54	8.28	0.99	0.47	68.08
9/26/2008	13:00:02	11.92	7.95	0.99	0.42	66.52
9/26/2008	13:01:02	12.26	7.66	0.98	0.49	64.86
9/26/2008	13:02:03	12.59	7.36	0.98	0.46	63.02
9/26/2008	13:03:03	12.85	7.13	0.98	0.44	61.44
9/26/2008	13:04:03	12.98	7.01	0.98	0.45	61.07
9/26/2008	13:05:03	13.13	6.88	0.98	0.41	60.73
9/26/2008	13:06:03	13.08	6.91	0.97	0.42	60.64
9/26/2008	13:07:03	12.98	7.00	0.97	0.41	62.19
9/26/2008	13:08:03	12.82	7.16	0.97	0.43	64.41
9/26/2008	13:09:03	12.66	7.30	0.97	0.43	67.68
9/26/2008	13:10:03	12.34	7.56	0.96	0.41	69.84
9/26/2008	13:11:03	11.98	7.86	0.96	0.41	71.44
9/26/2008	13:12:03	11.66	8.12	0.96	0.40	71.76
9/26/2008	13:13:03	11.48	8.27	0.96	0.30	71.68
9/26/2008	13:14:03	11.47	8.28	0.95	0.41	72.51
9/26/2008	13:15:03	11.32	8.41	1.02	0.34	73.30
Test Run 2 End						
Average		**12.27**	**7.56**	**1.38**	**0.69**	**60.80**

Test Run 3 Begin. STRATA Version 2.0
Operator: h stiles
Plant Name: Recycling Solutions
Location: Stack

Start Averaging

		O2	CO2	CO	SO2	NOx
		%	%	ppm	ppm	ppm
9/26/2008	14:27:14	13.40	6.62	2.20	0.62	60.49
9/26/2008	14:28:15	13.12	6.84	1.98	0.52	63.57
9/26/2008	14:29:15	12.83	7.10	1.98	0.68	65.90
9/26/2008	14:30:15	12.49	7.41	1.98	0.68	68.00
9/26/2008	14:31:15	12.19	7.67	1.61	0.61	70.14
9/26/2008	14:32:15	11.86	7.96	1.50	0.60	71.49
9/26/2008	14:33:15	11.63	8.14	1.50	0.56	71.62
9/26/2008	14:34:15	11.44	8.28	1.50	0.65	71.34
9/26/2008	14:35:13	11.22	8.46	3.11	0.68	70.56
9/26/2008	14:36:13	10.90	8.70	19.83	0.73	69.33
9/26/2008	14:37:13	10.64	8.90	117.86	0.70	67.35
9/26/2008	14:38:13	10.26	9.19	252.32	0.66	65.17
9/26/2008	14:39:13	10.37	9.07	462.26	0.72	62.38
9/26/2008	14:40:13	11.64	7.97	326.07	0.73	71.12
9/26/2008	14:41:13	12.44	7.26	155.34	0.80	76.47
9/26/2008	14:42:13	12.73	6.98	79.51	0.77	76.69
9/26/2008	14:43:13	12.50	7.18	45.97	0.90	77.30
9/26/2008	14:44:13	12.08	7.53	29.59	0.85	77.19
9/26/2008	14:45:13	11.52	7.98	30.02	0.82	74.18
9/26/2008	14:46:13	11.27	8.15	26.31	0.89	69.48
9/26/2008	14:47:13	12.00	7.51	16.97	0.90	64.83
9/26/2008	14:48:13	12.25	7.25	10.97	1.00	59.08
9/26/2008	14:49:13	13.16	6.54	7.30	0.73	49.85
9/26/2008	14:50:14	13.83	6.15	4.84	0.60	44.44
9/26/2008	14:51:14	14.27	5.91	3.56	0.49	41.94
9/26/2008	14:52:14	14.38	5.89	2.74	0.45	41.83
9/26/2008	14:53:14	14.40	5.91	2.20	0.46	43.97
9/26/2008	14:54:14	14.42	5.92	1.97	0.54	47.22
9/26/2008	14:55:14	14.19	6.13	1.77	0.50	50.55
9/26/2008	14:56:14	13.88	6.37	1.50	0.56	54.44
9/26/2008	14:57:14	13.42	6.71	1.50	0.44	56.91
9/26/2008	14:58:14	13.02	7.03	1.50	0.47	59.06
9/26/2008	14:59:14	12.81	7.21	1.50	0.50	61.13
9/26/2008	15:00:14	12.62	7.38	1.18	0.44	62.17
9/26/2008	15:01:14	12.43	7.53	1.01	0.41	62.27
9/26/2008	15:02:14	12.24	7.69	1.01	0.48	62.29
9/26/2008	15:03:14	11.99	7.91	1.01	0.49	62.42
9/26/2008	15:04:14	11.52	8.32	1.01	0.49	62.72
9/26/2008	15:05:14	11.46	8.36	1.01	0.46	63.97
9/26/2008	15:06:14	11.50	8.33	1.01	0.46	64.45

9/26/2008	15:07:14	11.33	8.46	1.01	0.38	65.23
9/26/2008	15:08:14	11.27	8.47	1.01	0.50	63.67
9/26/2008	15:09:14	11.30	8.43	1.01	0.50	61.86
9/26/2008	15:10:14	11.50	8.22	1.01	0.53	60.54
9/26/2008	15:11:14	11.77	7.99	1.01	0.46	59.86
9/26/2008	15:12:15	12.10	7.70	1.01	0.50	60.29
9/26/2008	15:13:15	12.36	7.49	1.01	0.43	61.04
9/26/2008	15:14:15	12.51	7.37	1.01	0.50	61.15
9/26/2008	15:15:15	12.66	7.26	1.01	0.46	60.54
9/26/2008	15:16:15	12.83	7.14	1.01	0.46	59.53
9/26/2008	15:17:13	12.79	7.20	1.01	0.58	59.51
9/26/2008	15:18:13	12.65	7.35	1.01	0.54	59.98
9/26/2008	15:19:13	12.46	7.51	1.01	0.44	60.60
9/26/2008	15:20:13	12.34	7.60	1.01	0.48	61.18
9/26/2008	15:21:13	12.16	7.74	1.01	0.50	61.61
9/26/2008	15:22:13	11.95	7.91	1.02	0.48	61.96
9/26/2008	15:23:13	11.69	8.13	1.01	0.50	62.28
9/26/2008	15:24:13	11.50	8.30	1.01	0.49	61.91
9/26/2008	15:25:13	11.33	8.47	1.14	0.55	61.55
9/26/2008	15:26:13	11.27	8.53	1.50	0.41	61.53
Test Run 3 End						
Average		**12.27**	**7.58**	**27.51**	**0.58**	**62.35**

Test Run 4 Begin. STRATA Version 2.0
Operator: h stiles
Plant Name: Recycling Solutions
Location: Stack

Start Averaging

		O2	CO2	CO	SO2	NOx
		%	%	ppm	ppm	ppm
9/26/2008	16:36:43	13.60	6.50	0.54	0.51	58.05
9/26/2008	16:37:43	13.35	6.69	0.63	0.44	61.66
9/26/2008	16:38:43	13.09	6.91	0.73	0.63	64.23
9/26/2008	16:39:43	12.76	7.22	0.66	0.53	66.26
9/26/2008	16:40:43	12.42	7.55	0.54	0.53	67.58
9/26/2008	16:41:43	12.08	7.85	0.54	0.45	68.02
9/26/2008	16:42:43	11.76	8.15	1.15	0.59	67.83
9/26/2008	16:43:43	11.53	8.34	41.52	0.63	66.14
9/26/2008	16:44:43	11.03	8.73	241.54	0.49	60.33
9/26/2008	16:45:43	10.77	8.86	479.90	0.38	55.88
9/26/2008	16:46:43	12.35	7.45	321.34	0.58	53.47
9/26/2008	16:47:43	13.94	6.10	174.29	0.47	50.68
9/26/2008	16:48:43	15.41	4.84	89.63	0.51	40.99
9/26/2008	16:49:43	16.69	3.74	41.40	0.34	28.73
9/26/2008	16:50:44	17.42	3.16	24.58	0.42	23.76
9/26/2008	16:51:44	17.84	2.84	17.22	0.39	21.10
9/26/2008	16:52:44	17.98	2.75	11.83	0.43	20.14
9/26/2008	16:53:44	17.93	2.81	8.81	0.45	20.83
9/26/2008	16:54:44	17.69	3.03	6.72	0.45	22.19
9/26/2008	16:55:44	17.25	3.43	5.00	0.45	24.54
9/26/2008	16:56:44	16.72	3.90	3.97	0.41	26.21
9/26/2008	16:57:44	16.19	4.36	3.21	0.41	27.91
9/26/2008	16:58:44	15.62	4.88	2.52	0.37	32.01
9/26/2008	16:59:44	14.96	5.47	1.97	0.30	42.80
9/26/2008	17:00:42	14.57	5.79	1.62	0.48	45.34
9/26/2008	17:01:42	14.23	6.06	1.49	0.29	47.77
9/26/2008	17:02:42	13.84	6.35	1.49	0.39	52.29
9/26/2008	17:03:42	13.43	6.64	1.23	0.31	56.33
9/26/2008	17:04:42	13.16	6.83	1.01	0.33	60.34
9/26/2008	17:05:42	12.99	6.94	1.01	0.46	63.06
9/26/2008	17:06:42	12.84	7.08	1.00	0.41	64.94
9/26/2008	17:07:42	12.67	7.23	1.00	0.45	66.13
9/26/2008	17:08:42	12.50	7.40	1.00	0.47	67.35
9/26/2008	17:09:42	12.30	7.59	1.00	0.43	68.25
9/26/2008	17:10:42	12.01	7.85	1.39	0.44	68.68
9/26/2008	17:11:42	11.50	8.30	26.36	0.46	68.30
9/26/2008	17:12:42	10.92	8.76	268.49	0.47	65.16
9/26/2008	17:13:43	10.54	9.03	499.89	0.38	61.61
9/26/2008	17:14:43	11.60	8.13	469.23	0.35	64.82
9/26/2008	17:15:43	12.50	7.33	294.25	0.38	72.83

9/26/2008	17:16:43	12.96	6.91	166.20	0.46	72.65
9/26/2008	17:17:43	13.26	6.67	104.41	0.45	72.59
9/26/2008	17:18:43	13.23	6.66	73.48	0.32	71.37
9/26/2008	17:19:43	13.10	6.73	48.37	0.39	70.05
9/26/2008	17:20:43	13.63	6.31	30.13	0.41	67.00
9/26/2008	17:21:43	14.36	5.74	17.32	0.40	57.75
9/26/2008	17:22:43	14.92	5.26	12.06	0.46	48.35
9/26/2008	17:23:43	15.29	4.94	9.43	0.26	39.97
9/26/2008	17:24:43	15.60	4.67	7.42	0.46	35.70
9/26/2008	17:25:43	16.00	4.33	5.45	0.57	30.57
9/26/2008	17:26:43	16.39	4.03	4.18	0.38	25.59
9/26/2008	17:27:43	16.48	4.00	3.30	0.37	23.36
9/26/2008	17:28:43	16.35	4.15	2.65	0.36	24.23
9/26/2008	17:29:43	16.05	4.45	2.21	0.48	25.60
9/26/2008	17:30:43	15.42	5.06	1.96	0.49	26.09
9/26/2008	17:31:43	14.83	5.59	1.60	0.43	26.75
9/26/2008	17:32:43	14.21	6.10	1.49	0.36	28.35
9/26/2008	17:33:44	13.63	6.53	1.48	0.33	30.89
9/26/2008	17:34:44	13.35	6.69	1.48	0.28	33.18
9/26/2008	17:35:44	13.35	6.64	1.27	0.29	35.17
Test Run 4 End						
Average		**14.07**	**6.07**	**59.16**	**0.43**	**48.50**

Visual Determination of Opacity (page 1)

Company Recycling Solutions Ther.
Location Hawesville KY
Job # 08-283
Run # 1
Stack

Observer Dale Vineyard
Date 9-25-08
Start Time 11:33
End Time 1234

	0	15	30	45
0	0	0	0	0
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0
7	0	0	0	0
8	0	0	0	0
9	0	0	0	0
10	0	0	0	0
11	0	0	0	0
12	0	0	0	0
13	0	0	0	0
14	0	0	0	0
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
18	0	0	0	0
19	0	0	0	0
20	0	0	0	0
21	0	0	0	0
22	0	0	0	0
23	0	0	0	0
24	0	0	0	0
25	0	0	0	0
26	0	0	0	0
27	0	0	0	0
28	0	0	0	0
29	0	0	0	0

	0	15	30	45
30	0	0	0	0
31	0	0	0	0
32	0	0	0	0
33	0	0	0	0
34	0	0	0	0
35	0	0	0	0
36	0	0	0	0
37	0	0	0	0
38	0	0	0	0
39	0	0	0	0
40	0	0	0	0
41	0	0	0	0
42	0	0	0	0
43	0	0	0	0
44	0	0	0	0
45	0	0	0	0
46	0	0	0	0
47	0	0	0	0
48	0	0	0	0
49	0	0	0	0
50	0	0	0	0
51	0	0	0	0
52	0	0	0	0
53	0	0	0	0
54	0	0	0	0
55	0	0	0	0
56	0	0	0	0
57	0	0	0	0
58	0	0	0	0
59	0	0	0	0

% Opacity 0%

Comments:

Visual Determination of Opacity (page 2)

Company Recycling Solutions Inc.
Location Danville, KY
Job # 08-293
Test Date 9-25-08
Type of Facility Power Plant
Observer Dale Vineyard

R1

OBSERVER LOCATION -
Distance to discharge ~~80~~ 250'
Direction from discharge ~~200'~~ SE
Height of observation point 100' approx

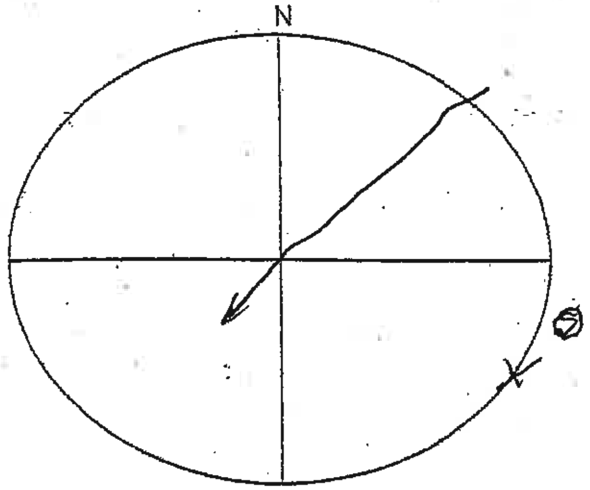
BACKGROUND DESCRIPTION - Sky

WEATHER CONDITIONS -
Wind Direction NE
Wind Speed 0 to 2
Ambient Temperature 65.2[illegible]

SKY CONDITIONS ([✓ Clear], overcast, % clouds, etc.)

PLUME DESCRIPTION -
Color NA
Distance Visible

Sun Direction Ⓢ



Visual Determination of Opacity (page 1)

Company Recycling Solutions Inc.
Location Dabella, KY
Job # 08-293
Run # 2
Stack

Observer Dale Vineyard
Date 9-25-08
Start Time 14:00
End Time 15:00

	0	15	30	45
0	0	0	0	0
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0
7	0	0	0	0
8	0	0	0	0
9	0	0	0	0
10	0	0	0	0
11	0	0	0	0
12	0	0	0	0
13	0	0	0	0
14	0	0	0	0
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
18	0	0	0	0
19	0	0	0	0
20	0	0	0	0
21	0	0	0	0
22	0	0	0	0
23	0	0	0	0
24	0	0	0	0
25	0	0	0	0
26	0	0	0	0
27	0	0	0	0
28	0	0	0	0
29	0	0	0	0

	0	15	30	45
30	0	0	0	0
31	0	0	0	0
32	0	0	0	0
33	0	0	0	0
34	0	0	0	0
35	0	0	0	0
36	0	0	0	0
37	0	0	0	0
38	0	0	0	0
39	0	0	0	0
40	0	0	0	0
41	0	0	0	0
42	5	5	5	5
43	5	5	5	5
44	5	5	5	5
45	5	5	5	5
46	5	5	5	0
47	0	0	0	0
48	0	0	0	0
49	0	0	0	0
50	0	0	0	0
51	0	0	0	0
52	0	0	0	0
53	0	0	0	0
54	0	0	0	0
55	0	0	0	0
56	0	0	0	0
57	0	0	0	0
58	0	0	0	0
59	0	0	0	0

% Opacity .40%

Comments:

Visual Determination of Opacity (page 2)

Company Recycling Solutions Inc.
Location Davella, [illegible] KY
Job # 08-293
Test Date 9-25-08
Type of Facility Power Plant
Observer Dale Vineyard DZ

OBSERVER LOCATION -
Distance to discharge 250' approx
Direction from discharge SE
Height of observation point 100' approx

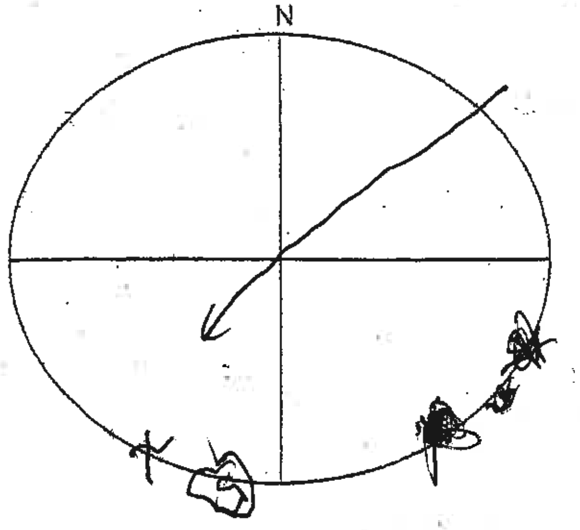
BACKGROUND DESCRIPTION - Sky

WEATHER CONDITIONS -
Wind Direction NE
Wind Speed 0+2
Ambient Temperature 82

SKY CONDITIONS ([✓ Clear], overcast, % clouds, etc.)

PLUME DESCRIPTION -
Color NA
Distance Visible

Sun Direction Ⓢ



Visual Determination of Opacity (page 1)

Company Recycling Solution Three
Location Bardwell, KY
Job # 08-293
Run # 3
Stack

Observer Dale Vineyard
Date 9-25-08
Start Time 1545
End Time 16 45

	0	15	30	45
0	0	0	0	0
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	0	0	0	0
7	0	0	0	0
8	0	0	0	0
9	0	0	0	0
10	0	0	0	0
11	0	0	0	0
12	0	0	0	0
13	0	0	0	0
14	0	0	0	0
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
18	0	0	0	0
19	0	0	0	0
20	0	0	0	0
21	0	0	0	0
22	0	0	0	0
23	0	0	0	0
24	0	0	0	0
25	0	0	0	0
26	0	0	0	0
27	0	0	0	0
28	0	0	0	0
29	0	0	0	0

	0	15	30	45
30	0	0	0	0
31	0	0	0	0
32	0	0	0	0
33	0	0	0	0
34	0	0	0	0
35	0	0	0	0
36	0	0	0	0
37	0	0	0	0
38	0	0	0	0
39	0	0	0	0
40	0	0	0	0
41	0	0	0	0
42	0	0	0	0
43	0	0	0	0
44	0	0	0	0
45	0	0	0	0
46	0	0	0	0
47	0	0	0	0
48	0	0	0	5
49	5	0	0	0
50	0	0	0	0
51	0	0	0	0
52	0	0	0	0
53	0	0	0	0
54	0	0	0	0
55	0	0	0	0
56	0	0	0	0
57	0	0	0	0
58	0	0	0	0
59	0	0	0	0

% Opacity .04%

Comments:

Visual Determination of Opacity (page 2)

Company	Recycling Solution Thru
Location	9-25 Roff Danville KY
Job #	9-293
Test Date	9-25-08
Type of Facility	Paver Plant
Observer	Dale Vineyard

R3

OBSERVER LOCATION -

Distance to discharge	100
Direction from discharge	SW
Height of observation point	100

BACKGROUND DESCRIPTION - Sky

WEATHER CONDITIONS -

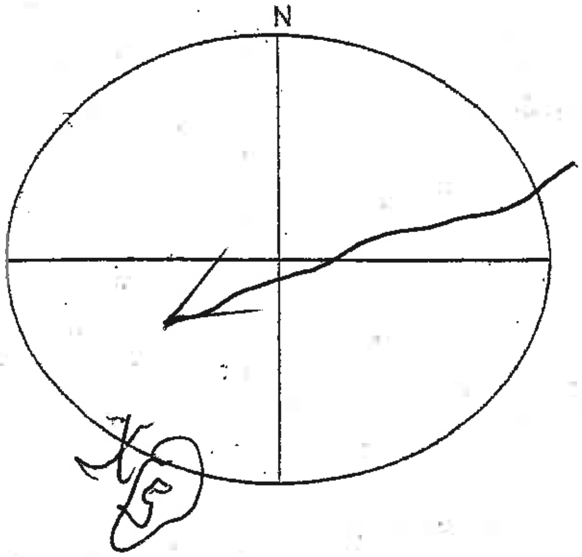
Wind Direction	NE
Wind Speed	0 to 3
Ambient Temperature	81

SKY CONDITIONS [✓ (Clear] overcast, % clouds, etc.)

PLUME DESCRIPTION -

Color	NA
Distance Visible	

Sun Direction ⓢ



GCI Calibration Data

Co2 Cal Sheet 1

Client	Recycling Solutions	Test Date	9/25/2008
	Davella, KY	Project #	08-293
Source Identification	Baghouse Exit	Operator	stiles

Calibration Data For Sampling Runs: 1- Gas Type: CO2 Span: 17.9	Cylinder Number	Cylinder Value % or PPM	Analyzer Response	Absolute Difference % or PPM	Difference % of Span	
Zero Gas		**0.00**	0.03	0.03	0.168	
Low-Range Gas						
Mid-Range Gas		**9.11**	9.30	0.19	1.061	
High-Range Gas		**17.90**	17.83	0.07	0.391	

Run #: 1 Gas Type: CO2 Span: 17.9	Analyzer Response	Initial Values System Response	Initial Values System Cal. Bias % of Span	Final Values System Response	Final Values System Cal. Bias % of Span	Drift % of Span
Zero Gas	0.03	0.05	0.11	0.05	0.11	0.00
Upscale Gas	9.3	8.92	-2.12	9.05	-1.40	0.73

Run #: 2 Gas Type: CO2 Span: 17.9	Analyzer Response	Initial Values System Response	Initial Values System Cal. Bias % of Span	Final Values System Response	Final Values System Cal. Bias % of Span	Drift % of Span
Zero Gas	0.03	0.05	0.11	0.06	0.17	0.06
Upscale Gas	9.3	9.05	-1.40	9.03	-1.51	-0.11

Run #: 3 Gas Type: CO2 Span: 17.9	Analyzer Response	Initial Values System Response	Initial Values System Cal. Bias % of Span	Final Values System Response	Final Values System Cal. Bias % of Span	Drift % of Span
Zero Gas	0.03	0.06	0.17	0.04	0.06	-0.11
Upscale Gas	9.3	9.03	-1.51	9.00	-1.68	-0.17

O2 Cal Sheet 1

Client	Recycling Solutions	Test Date	9/25/2008
	Davella, KY	Project #	08-293
Source Identification	Baghouse Exit	Operator	stiles

Calibration Data For Sampling Runs: 1- Gas Type: O2 Span: 22.5	Cylinder Number	Cylinder Value % or PPM	Analyzer Response	Absolute Difference % or PPM	Difference % of Span	
Zero Gas		**0.00**	0.02	0.02	0.089	
Low-Range Gas						
Mid-Range Gas		**10.90**	11.09	0.19	0.844	
High-Range Gas		**22.50**	22.45	0.05	0.222	

Run #: 1 Gas Type: O2 Span: 22.5	Analyzer Response	Initial Values System Response	Initial Values System Cal. Bias % of Span	Final Values System Response	Final Values System Cal. Bias % of Span	Drift % of Span
Zero Gas	0.02	0.59	2.53	0.29	1.20	-1.33
Upscale Gas	11.09	11.13	0.18	11.00	-0.40	-0.58

Run #: 2 Gas Type: O2 Span: 22.5	Analyzer Response	Initial Values System Response	Initial Values System Cal. Bias % of Span	Final Values System Response	Final Values System Cal. Bias % of Span	Drift % of Span
Zero Gas	0.02	0.29	1.20	0.31	1.29	0.09
Upscale Gas	11.09	11.00	-0.40	10.98	-0.49	-0.09

Run #: 3 Gas Type: O2 Span: 22.5	Analyzer Response	Initial Values System Response	Initial Values System Cal. Bias % of Span	Final Values System Response	Final Values System Cal. Bias % of Span	Drift % of Span
Zero Gas	0.02	0.31	1.29	0.25	1.02	-0.27
Upscale Gas	11.09	10.98	-0.49	10.82	-1.20	-0.71

Nox Cal Sheet 1

Client	Recycling Solutions	Test Date	9/26/2008
	Davella, KY	Project #	08-293
Source Identification	Baghouse Exit	Operator	stiles

Calibration Data For Sampling Runs: 1- Gas Type: NOx Span: 228	Cylinder Number	Cylinder Value % or PPM	Analyzer Response	Absolute Difference % or PPM	Difference % of Span	
Zero Gas		**0.00**	0.44	0.44	0.193	
NO_2 Gas	1648	**51.20**	50.98	0.22	99.57%	**PASS**
Mid-Range Gas	1923	**98.60**	98.60	0.00	0.000	
High-Range Gas	1569	**228.00**	228.40	0.40	0.175	

Run #: 1 Gas Type: NOx Span: 228	Analyzer Response	Initial Values		Final Values		Drift % of Span
		System Response	System Cal. Bias % of Span	System Response	System Cal. Bias % of Span	
Zero Gas	0.44	1.90	0.64	1.90	0.64	0.00
Upscale Gas	98.6	95.20	-1.49	93.80	-2.11	-0.61

Run #: 2 Gas Type: NOx Span: 228	Analyzer Response	Initial Values		Final Values		Drift % of Span
		System Response	System Cal. Bias % of Span	System Response	System Cal. Bias % of Span	
Zero Gas	0.44	1.90	0.64	1.80	0.60	-0.04
Upscale Gas	98.6	93.80	-2.11	94.10	-1.97	0.13

Run #: 3 Gas Type: NOx Span: 228	Analyzer Response	Initial Values		Final Values		Drift % of Span
		System Response	System Cal. Bias % of Span	System Response	System Cal. Bias % of Span	
Zero Gas	0.44	1.80	0.60	1.80	0.60	0.00
Upscale Gas	98.6	94.10	-1.97	95.20	-1.49	0.48

Run #: 4 Gas Type: NOx Span: 228	Analyzer Response	Initial Values		Final Values		Drift % of Span
		System Response	System Cal. Bias % of Span	System Response	System Cal. Bias % of Span	
Zero Gas	0.44	1.80	0.60	1.90	0.64	0.04
Upscale Gas	98.6	95.20	-1.49	94.15	-1.95	-0.46

So2 Cal Sheet 1

Client	Recycling Solutions	Test Date	9/26/2008
	Davella, KY	Project #	08-293
Source Identification	Baghouse Exit	Operator	stiles

Calibration Data For Sampling Runs: 1- Gas Type: SO2 Span: 230	Cylinder Number	Cylinder Value % or PPM	Analyzer Response	Absolute Difference % or PPM	Difference % of Span	
Zero Gas		**0.00**	0.26	0.26	0.113	
Low-Range Gas						
Mid-Range Gas	1811	**95.90**	95.50	0.40	0.174	
High-Range Gas	1758	**230.00**	226.00	4.00	1.739	

Run #: 1 Gas Type: SO2 Span: 230	Analyzer Response	Initial Values		Final Values		Drift % of Span
		System Response	System Cal. Bias % of Span	System Response	System Cal. Bias % of Span	
Zero Gas	0.26	1.20	0.41	0.79	0.23	-0.18
Upscale Gas	95.5	88.10	-3.22	86.70	-3.83	-0.61

Run #: 2 Gas Type: SO2 Span: 230	Analyzer Response	Initial Values		Final Values		Drift % of Span
		System Response	System Cal. Bias % of Span	System Response	System Cal. Bias % of Span	
Zero Gas	0.26	0.79	0.23	0.11	-0.07	-0.30
Upscale Gas	95.5	86.70	-3.83	85.50	-4.35	-0.52

Run #: 3 Gas Type: SO2 Span: 230	Analyzer Response	Initial Values		Final Values		Drift % of Span
		System Response	System Cal. Bias % of Span	System Response	System Cal. Bias % of Span	
Zero Gas	0.26	0.11	-0.07	0.50	0.10	0.17
Upscale Gas	95.5	85.50	-4.35	85.00	-4.57	-0.22

Run #: 4 Gas Type: SO2 Span: 230	Analyzer Response	Initial Values		Final Values		Drift % of Span
		System Response	System Cal. Bias % of Span	System Response	System Cal. Bias % of Span	
Zero Gas	0.26	0.50	0.10	0.27	0.00	-0.10
Upscale Gas	95.5	85.00	-4.57	84.80	-4.65	-0.09

Client	Recycling Solutions	Test Date	9/26/2008
	Davella, KY	Project #	08-293
Source Identification	Baghouse Exit	Operator	stiles

Calibration Data For Sampling Runs: 1- Gas Type: CO Span: 453.7	Cylinder Number	Cylinder Value % or PPM	Analyzer Response	Absolute Difference % or PPM	Difference % of Span	
Zero Gas		**0.00**	0.50	0.50	0.110	
Mid-Range Gas	1831	**209.00**	217.00	8.00	1.763	
High-Range Gas	1362	**453.70**	451.00	2.70	0.595	
Span Gas						

Run #: 1 Gas Type: CO Span: 453.7	Analyzer Response	Initial Values		Final Values		Drift % of Span
		System Response	System Cal. Bias % of Span	System Response	System Cal. Bias % of Span	
Zero Gas	0.5	1.10	0.13	-0.07	-0.13	-0.26
Upscale Gas	217	215.50	-0.33	215.70	-0.29	0.04

Run #: 2 Gas Type: CO Span: 453.7	Analyzer Response	Initial Values		Final Values		Drift % of Span
		System Response	System Cal. Bias % of Span	System Response	System Cal. Bias % of Span	
Zero Gas	0.5	-0.07	-0.13	-0.09	-0.13	0.00
Upscale Gas	217	215.70	-0.29	218.40	0.31	0.60

Run #: 3 Gas Type: CO Span: 453.7	Analyzer Response	Initial Values		Final Values		Drift % of Span
		System Response	System Cal. Bias % of Span	System Response	System Cal. Bias % of Span	
Zero Gas	0.5	-0.09	-0.13	-0.02	-0.11	0.02
Upscale Gas	217	218.40	0.31	217.40	0.09	-0.22

Run #: 4 Gas Type: CO Span: 453.7	Analyzer Response	Initial Values		Final Values		Drift % of Span
		System Response	System Cal. Bias % of Span	System Response	System Cal. Bias % of Span	
Zero Gas	0.5	-0.02	-0.11	-0.05	-0.12	-0.01
Upscale Gas	217	217.40	0.09	218.40	0.31	0.22

Co2 Cal Sheet 1

Client	Recycling Solutions	Test Date	9/26/2008
	Davella, KY	Project #	08-293
Source Identification	Baghouse Exit	Operator	stiles

Calibration Data For Sampling Runs: 1- Gas Type: CO2 Span: 17.9	Cylinder Number	Cylinder Value % or PPM	Analyzer Response	Absolute Difference % or PPM	Difference % of Span	
Zero Gas		**0.00**	0.05	0.05	0.279	
Low-Range Gas						
Mid-Range Gas	1680	**9.11**	9.25	0.14	0.782	
High-Range Gas	1695	**17.90**	17.81	0.09	0.503	

Run #: 1 Gas Type: CO2 Span: 17.9	Analyzer Response	Initial Values		Final Values		Drift % of Span
		System Response	System Cal. Bias % of Span	System Response	System Cal. Bias % of Span	
Zero Gas	0.05	0.12	0.39	0.08	0.17	-0.22
Upscale Gas	9.25	9.03	-1.23	9.04	-1.17	0.06

Run #: 2 Gas Type: CO2 Span: 17.9	Analyzer Response	Initial Values		Final Values		Drift % of Span
		System Response	System Cal. Bias % of Span	System Response	System Cal. Bias % of Span	
Zero Gas	0.05	0.08	0.17	0.07	0.11	-0.06
Upscale Gas	9.25	9.04	-1.17	9.05	-1.12	0.06

Run #: 3 Gas Type: CO2 Span: 17.9	Analyzer Response	Initial Values		Final Values		Drift % of Span
		System Response	System Cal. Bias % of Span	System Response	System Cal. Bias % of Span	
Zero Gas	0.05	0.07	0.11	0.08	0.17	0.06
Upscale Gas	9.25	9.05	-1.12	9.07	-1.01	0.11

Run #: 4 Gas Type: CO2 Span: 17.9	Analyzer Response	Initial Values		Final Values		Drift % of Span
		System Response	System Cal. Bias % of Span	System Response	System Cal. Bias % of Span	
Zero Gas	0.05	0.08	0.17	0.09	0.22	0.06
Upscale Gas	9.25	9.07	-1.01	9.04	-1.17	-0.17

O2 Cal Sheet 1

Client	Recycling Solutions Davella, KY	Test Date	9/26/2008
		Project #	08-293
Source Identification	Baghouse Exit	Operator	stiles

Calibration Data For Sampling Runs: 1- Gas Type: O2 Span: 22.5	Cylinder Number	Cylinder Value % or PPM	Analyzer Response	Absolute Difference % or PPM	Difference % of Span	
Zero Gas		**0.00**	0.04	0.04	0.178	
Low-Range Gas						
Mid-Range Gas	1680	**11.00**	11.03	0.03	0.133	
High-Range Gas	1695	**22.50**	22.46	0.04	0.178	

Run #: 1 Gas Type: O2 Span: 22.5	Analyzer Response	Initial Values		Final Values		Drift % of Span
		System Response	System Cal. Bias % of Span	System Response	System Cal. Bias % of Span	
Zero Gas	0.04	0.48	1.96	0.40	1.60	-0.36
Upscale Gas	11.03	11.07	0.18	11.03	0.00	-0.18

Run #: 2 Gas Type: O2 Span: 22.5	Analyzer Response	Initial Values		Final Values		Drift % of Span
		System Response	System Cal. Bias % of Span	System Response	System Cal. Bias % of Span	
Zero Gas	0.04	0.40	1.60	0.38	1.51	-0.09
Upscale Gas	11.03	11.03	0.00	11.04	0.04	0.04

Run #: 3 Gas Type: O2 Span: 22.5	Analyzer Response	Initial Values		Final Values		Drift % of Span
		System Response	System Cal. Bias % of Span	System Response	System Cal. Bias % of Span	
Zero Gas	0.04	0.38	1.51	0.34	1.33	-0.18
Upscale Gas	11.03	11.04	0.04	11.05	0.09	0.04

Run #: 4 Gas Type: O2 Span: 22.5	Analyzer Response	Initial Values		Final Values		Drift % of Span
		System Response	System Cal. Bias % of Span	System Response	System Cal. Bias % of Span	
Zero Gas	0.04	0.34	1.33	0.36	1.42	0.09
Upscale Gas	11.03	11.05	0.09	11.03	0.00	-0.09

Calibration Sheets/Gas Certification Sheets

Grace Consulting, Inc.
EPA Method 5
522 Series Meter Box Calibration
Calibration Orifice Method
English Meter Box Units, English K' Factor

Date:	8/22/2008
Model:	ES
Serial:	16A

Barometric Pressure:	29.5	(in Hg)
Theoretical Critical Vacuum:	13.92	(in Hg)

IMPORTANT For valid test results, the Actual Vacuum should be 1 to 2 in. Hg greater than the Theoretical Critical Vacuum shown above.
IMPORTANT The Critical Orifice Coefficient, K', must be entered in English units, (ft)^3*(deg R)^0.5/((in.Hg)*(min)).

DRY GAS METER READINGS							Critical Orifice Readings			AMBIENT TEMPERATURE		
dH (in H2O)	Time (min)	Volume Initial (cu ft)	Volume Final (cu ft)	Volume Total (cu ft)	Temp Initial (deg F)	Temp Final (deg F)	Orifice Serial #	K' Orifice Coefficient (see above)	Actual Vacuum (in Hg)	Initial (deg F)	Final (deg F)	Average (deg F)
0.61	22.7	823.100	833.537	10.437	74	76	48	0.3449	20	74	73	73.5
1.00	16.6	833.600	843.625	10.025	76	77	55	0.4595	19	73	74	73.5
1.80	13	843.700	853.770	10.070	77	78	63	0.5958	17	74	74	74
3.40	9.50	853.800	863.817	10.017	78	79	73	0.8215	14	74	74	74

CORRECTED VOLUME	
DRY GAS METER Vm(std) (cu ft)	ORIFICE Vcr(std) (cu ft)
10.167	9.999
9.748	9.742
9.793	9.888
9.762	9.963

DRY GAS METER CALIBRATION FACTOR Y	
Value	Variation
0.983	-0.020
0.999	-0.0039
1.010	0.0064
1.021	0.0173

Average 1.003

ORIFICE CALIBRATION FACTOR dH@	
Value (in H20)	Variation (in H20)
1.768	0.046
1.633	-0.089
1.750	0.028
1.739	0.016

Average 1.723

Orifice for Calc.
3.26201

Note: For Calibration Factor Y, the ratio of the reading of the calibration meter to the dry gas meter, acceptable tolerance of individual values from the average is +-0.02.

For Orifice Calibration Factor dH@, the orifice differential pressure in inches of H20 that equates to 0.75 cfm of air at 68 F and 29.92 inches of Hg, acceptable tolerance of individual values from the average is +-0.2.

SIGNED:

Date: 8-22-08

$$V_{m(std)} = 17.64\,(V_m)\frac{P_b + \frac{\Delta H}{13.6}}{t_m + 460}$$

$$V_{cr(std)} = K'\frac{P_b\theta}{\sqrt{t_{amb} + 460}}$$

$$Y = \frac{V_{cr(std)}}{V_{m(std)}}$$

$$\Delta H_@ = \Delta H\left(\frac{.75\theta}{V_{cr(std)}}\right)^2$$

Grace Consulting, Inc.
EPA Method 5
522 Series Meter Box Calibration
Calibration Orifice Method
English Meter Box Units, English K' Factor

Date:	10/21/2008
Model:	ES
Serial:	16A

Barometric Pressure:	29.45	(in Hg)
Theoretical Critical Vacuum:	13.89	(in Hg)

IMPORTANT For valid test results, the Actual Vacuum should be 1 to 2 in. Hg greater than the Theoretical Critical Vacuum shown above.
IMPORTANT The Critical Orifice Coefficient, K', must be entered in English units, (ft)^3*(deg R)^0.5/((in.Hg)*(min)).

DRY GAS METER READINGS							Critical Orifice Readings			AMBIENT TEMPERATURE		
dH (in H2O)	Time (min)	Volume Initial (cu ft)	Volume Final (cu ft)	Volume Total (cu ft)	Temp Initial (deg F)	Temp Final (deg F)	Orifice Serial #	K' Orifice Coefficient (see above)	Actual Vacuum (in Hg)	Initial (deg F)	Final (deg F)	Average (deg F)
0.57	22.8	810.500	820.575	10.075	56	57	48	0.3449	20	57	58	57.5
1.00	17.2	820.600	830.622	10.022	57	59	55	0.4595	19	58	59	58.5
1.70	13.3	830.700	840.715	10.015	59	60	63	0.5958	17	59	59	59
3.30	9.9	840.800	850.900	10.100	60	62	73	0.8215	14	59	60	60

CORRECTED VOLUME	
DRY GAS METER Vm(std) (cu ft)	ORIFICE Vcr(std) (cu ft)
10.148	10.180
10.076	10.222
10.057	10.244
10.154	10.508

DRY GAS METER CALIBRATION FACTOR Y	
Value	Variation
1.003	-0.015
1.014	-0.0033
1.019	0.0007
1.035	0.0171

Average 1.018

ORIFICE CALIBRATION FACTOR dH@	
Value (in H20)	Variation (in H20)
1.608	-0.007
1.593	-0.022
1.612	-0.003
1.648	0.032

Average 1.615

Orifice for Calc.
3.19731

Note: For Calibration Factor Y, the ratio of the reading of the calibration meter to the dry gas meter, acceptable tolerance of individual values from the average is +-0.02.

For Orifice Calibration Factor dH@, the orifice differential pressure in inches of H20 that equates to 0.75 cfm of air at 68 F and 29.92 inches of Hg, acceptable tolerance of individual values from the average is +-0.2.

SIGNED:

Date: 10-21-08

$$V_{m(std)} = 17.64\,(V_m)\frac{P_b + \frac{\Delta H}{13.6}}{t_m + 460}$$

$$V_{cr(std)} = K'\frac{P_b\theta}{\sqrt{t_{amb} + 460}}$$

$$Y = \frac{V_{cr(std)}}{V_{m(std)}}$$

$$\Delta H_{@} = \Delta H\left(\frac{.75\theta}{V_{cr(std)}}\right)^2$$

PITOT CALIBRATION

Pitot Tube Assembly		**Post Calibration**	
Pitot #	new	Visual Inspection	OK
Pitot Coefficient:	0.84	Recalibrated	N/A
		Adjusted Cp	N/A

Grace Consulting,Inc.
Nozzle Calibration Sheet
Glass Nozzles

Date: 8-14-07/ 8-18-07

		Measurement			
Box	Nozzle #	A	B	C	Average
1	G1-1C	0.124	0.125	0.126	**0.125**
1	G1-1B	0.154	0.153	0.154	**0.154**
1	G1-2A	0.213	0.214	0.213	**0.213**
1	G1-2D	0.255	0.255	0.226	**0.245**
1	G1-3A	0.311	0.312	0.313	**0.312**
1	G1-5A	0.498	0.499	0.498	**0.498**
2	G2-1	0.120	0.122	0.123	**0.122**
2	G2-21	0.190	0.191	0.191	**0.191**
2	G2-31	0.247	0.246	0.249	**0.247**
2	G2-3A	0.309	0.308	0.306	**0.308**
2	G2-41	0.369	0.366	0.367	**0.367**
2	G2-4	0.431	0.429	0.431	**0.430**
2	G2-6	0.741	0.742	0.746	**0.743**
3	G3-1	0.129	0.128	0.128	**0.128**
3	G3-2A	0.183	0.181	0.181	**0.182**
3	G3-3	0.183	0.184	0.183	**0.183**
3	G3-2C	0.255	0.255	0.256	**0.255**
3	G3-31	0.305	0.306	0.307	**0.306**
3	G3-34	0.361	0.360	0.360	**0.360**
3	G3-5B	0.391	0.393	0.392	**0.392**
3	G3-6	0.500	0.499	0.501	**0.500**
5	G5-1	0.151	0.151	0.151	**0.151**
5	G5-3	0.182	0.181	0.181	**0.181**
5	G5-2B	0.217	0.217	0.218	**0.217**
5	G5-4	0.252	0.251	0.253	**0.252**
5	G5-41	0.304	0.306	0.304	**0.305**
5	G5-5C	0.376	0.377	0.377	**0.377**
6	G6-1	0.128	0.128	0.130	**0.129**
6	G6-2	0.187	0.186	0.185	**0.186**
6	G6-3	0.224	0.225	0.224	**0.224**
6	G6-3A	0.291	0.292	0.292	**0.292**
6	G6-4	0.252	0.254	0.255	**0.254**
6	G6-5	0.282	0.282	0.282	**0.282**
6	G6-6	0.312	0.311	0.312	**0.312**
6	G6-7	0.377	0.377	0.378	**0.377**
7	G7-1	0.144	0.144	0.144	**0.144**
7	G7-2	0.185	0.186	0.185	**0.185**
7	G7-21	0.214	0.212	0.213	**0.213**
7	G7-23	0.250	0.250	0.250	**0.250**
7	G7-32	0.307	0.307	0.307	**0.307**
7	G7-33	0.300	0.300	0.299	**0.300**
7	G7-41	0.377	0.377	0.378	**0.377**
8	G8-1	0.181	0.181	0.183	**0.182**
8	G8-3A	0.248	0.248	0.248	**0.248**
9	G9-1	0.112	0.112	0.112	**0.112**
9	G9-2	0.191	0.192	0.192	**0.192**
9	G9-2B	0.225	0.226	0.225	**0.225**
9	G9-3	0.255	0.254	0.256	**0.255**
9	G9-4B	0.319	0.315	0.319	**0.318**
9	G9-5A	0.371	0.374	0.375	**0.373**
9	G9-6	0.228	0.227	0.227	**0.227**
9	G9-7	0.491	0.491	0.493	**0.492**

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6055 BRENT DR. TOLEDO, OH 43611
419-729-7732 FAX 419-729-2411

THE AMERICAN GAS GROUP

www.americangasgroup.com

ANALYTICAL REPORT

Certificate ID:	080607006	**Date:**	8/6/2007
Customer Name:	Grace Consulting, Inc.		
Customer Address:	510 Dickson St. Wellington OH 44090		
Purchase Order:	80300	**Work Order:**	065808-00
Lot Number:	1201SD06	**Product Name:**	2-Component Mixture, EPA Protocol
Size:	31A	**Pressure:**	2250 psig @ 85 Deg F
Content:	NA		
Serial #:	EB0002339		
Analysis Date:	12/28/2006		
Shelf Life:	24 months	**Expiration Date:**	12/28/2008

Component	Nominal	Actual	Accuracy	Method
Nitrogen Dioxide	45 ppm	51.2 ppm	+/- 0.3 ppm	Chemiluminescence
Nitric Oxide		1.50 ppm	+/- 0.01 ppm	Chemiluminescence
Nitrogen Oxides (NOx)		52.7 ppm	+/- 0.2 ppm	Chemiluminescence
Nitrogen	Balance	Balance		

REFERENCE STANDARD	Std Type	Std #	Cyl #	Concentration	Exp Date
	GMIS	1206SC05	EB0001291	46.79 ppm	3/16/2008
	GMIS	1206SC05	EB0001291	48.99 ppm	3/16/2008

INSTRUMENTATION	Instrument / ID	Component
	Rosemount 951A	NO
	Rosemount 951A	NOx

Note: * ANALYZED ACCORDING TO EPA TRACEABILITY PROTOCOL FOR ASSAY AND CERTIFICATION OF GASEOUS CALIBRATION STANDARDS - SEPTEMBER 1997:G1
* DO NOT USE STANDARD WHEN PRESSURE IS BELOW 150 PSIG

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ANALYTICAL REPORT

Certificate ID:	090308007	**Date:**	9/3/2008
Customer Name:	Grace Consulting, Inc.		
Customer Address:	510 Dickson St.		
	Wellington OH 44090		
Purchase Order:	08290800	**Work Order:**	080496-03
Lot Number:	0818HE08	**Product Name:**	2-Component Mixture, EPA Protocol
Size:	31A	**Pressure:**	2015 psig @ 70 Deg F
Content:	N/A		
Serial #:	CC286603		
Analysis Date:	8/28/2008		
Shelf Life:	24 months	**Expiration Date:**	8/28/2010

Component	Nominal	Actual	Accuracy	Method
Nitric Oxide	100 ppm	98.4 ppm	+/- 1% rel	Chemiluminescence
Nitrogen Oxides (NOx)	100 ppm	98.6 ppm	+/- 1% rel	Chemiluminescence
Nitrogen	Balance	Balance		

REFERENCE STANDARD	Std Type	Std #	Cyl #	Concentration	Exp Date
	GMIS	0411HI08	CC275890	248.7 ppm	6/19/2010
	GMIS	0411HI08	CC275890	249.0 ppm	6/19/2010

INSTRUMENTATION	Instrument / ID	Component
	Rosemount 951A	NO
	Rosemount 951A	NOx

Note: * ANALYZED ACCORDING TO EPA TRACEABILITY PROTOCOL FOR ASSAY AND CERTIFICATION OF GASEOUS CALIBRATION STANDARDS - SEPTEMBER 1997:G1
* DO NOT USE STANDARD WHEN PRESSURE IS BELOW 150 PSIG

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ANALYTICAL REPORT

Certificate ID:	050707003	**Date:**	5/7/2007
Customer Name:	Grace Consulting, Inc.		
Customer Address:	510 Dixon Wellington OH 44090		
Purchase Order:	42400	**Work Order:**	062057-01
Lot Number:	0424SB07	**Product Name:**	2-Component Mixture, EPA Protocol
Size:	31A	**Pressure:**	2200 psig @ 85 Deg F
Content:	NA		
Serial #:	EB0005127		
Analysis Date:	5/7/2007		
Shelf Life:	24 months	**Expiration Date:**	5/7/2009

Component	Nominal	Actual	Accuracy	Method
Nitrogen Oxides (NOx)	225 ppm	228 ppm	+/- 1% rel	Chemiluminescence
Nitrogen	Balance	Balance		

REFERENCE STANDARD

Std Type	Std #	Cyl #	Concentration	Exp Date
GMIS	1116SD05	EB0001294	989.8 ppm	3/17/2008

INSTRUMENTATION

Instrument / ID	Component
Rosemount 951A	NOx

Note: * ANALYZED ACCORDING TO EPA TRACEABILITY PROTOCOL FOR ASSAY AND CERTIFICATION OF GASEOUS CALIBRATION STANDARDS - SEPTEMBER 1997:G1
* DO NOT USE STANDARD WHEN PRESSURE IS BELOW 150 PSIG

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ANALYTICAL REPORT

Certificate ID:	040408025	**Date:**	4/4/2008
Customer Name:	Grace Consulting, Inc.		
Customer Address:	510 Dickson St. Wellington OH 44090		
Purchase Order:	3180800	**Work Order:**	073859-01
Lot Number:	0324SD08	**Product Name:**	2-Component Mixture, EPA Protocol
Size:	31A	**Pressure:**	2200 psig @ 78 Deg F
Content:	N/A		
Serial #:	EB0002695		
Analysis Date:	4/4/2008		
Shelf Life:	24 months	**Expiration Date:**	4/4/2010

Component	Nominal	Actual	Accuracy	Method
Sulfur Dioxide	100 ppm	95.9 ppm	+/- 1% rel	NDUV
Nitrogen	Balance	Balance		

REFERENCE STANDARD

Std Type	Std #	Cyl #	Concentration	Exp Date
GMIS	1002HG07	EB0005452	108.0000	10/2/2009

INSTRUMENTATION

Instrument / ID	Component
Ametek WR Series 900	SO2

Note: * ANALYZED ACCORDING TO EPA TRACEABILITY PROTOCOL FOR ASSAY AND CERTIFICATION OF GASEOUS CALIBRATION STANDARDS - SEPTEMBER 1997:G1
* DO NOT USE STANDARD WHEN PRESSURE IS BELOW 150 PSIG

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ANALYTICAL REPORT

Certificate ID:	022208026	**Date:**	2/22/2008
Customer Name:	Grace Consulting, Inc.		
Customer Address:	510 Dickson St. Wellington OH 44090		
Purchase Order:	2070801	**Work Order:**	072345-01
Lot Number:	0209SB08	**Product Name:**	2-Component Mixture, EPA Protocol
Size:	31A	**Pressure:**	2000 PSIG @ 70 DEGF
Content:	NA		
Serial #:	EB0004163		
Analysis Date:	2/21/2008		
Shelf Life:	24 MO	**Expiration Date:**	2/21/2010

Component	Nominal	Actual	Accuracy	Method
Sulfur Dioxide	230 PPM	230 PPM	+/- 1% REL	NDUV
Nitrogen	Balance	Balance		

REFERENCE STANDARD	Std Type	Std #	Cyl #	Concentration	Exp Date
	GMIS	1109SD05	EB0009133	425.4 ppm	2/14/2010

INSTRUMENTATION	Instrument / ID	Component
	Ametek WR Series 900	SO2

Note: * ANALYZED ACCORDING TO EPA TRACEABILITY PROTOCOL FOR ASSAY AND CERTIFICATION OF GASEOUS CALIBRATION STANDARDS - SEPTEMBER 1997:G1
* DO NOT USE STANDARD WHEN PRESSURE IS BELOW 150 PSIG

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ANALYTICAL REPORT

Certificate ID:	050108016	**Date:**	5/1/2008
Customer Name:	Grace Consulting, Inc.		
Customer Address:	510 Dickson St. Wellington OH 44090		
Purchase Order:	5010800	**Work Order:**	075644-01
Lot Number:	0414HG08	**Product Name:**	2-Component Mixture, EPA Protocol
Size:	31A	**Pressure:**	2015 psig @ 70 Deg F
Content:	N/A		
Serial #:	CC275815		
Analysis Date:	4/25/2008		
Shelf Life:	36 months	**Expiration Date:**	4/25/2011

Component	Nominal	Actual	Accuracy	Method
Carbon Monoxide	230 ppm	209 ppm	+/- 1% rel	NDIR
Nitrogen	Balance	Balance		

REFERENCE STANDARD	Std Type	Std #	Cyl #	Concentration	Exp Date
	GMIS	1011BK05	EB0000880	998 ppm	10/16/2009

INSTRUMENTATION	Instrument / ID	Component
	Horiba VA-3000	CO

Note: * ANALYZED ACCORDING TO EPA TRACEABILITY PROTOCOL FOR ASSAY AND CERTIFICATION OF GASEOUS CALIBRATION STANDARDS - SEPTEMBER 1997:G1
* DO NOT USE STANDARD WHEN PRESSURE IS BELOW 150 PSIG

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Airgas

Certificate of Analysis: EPA Protocol Gas Mixture

Airgas Great Lakes, Inc.
2009 Bellaire Ave.
Royal Oak, MI 48067
Ph: (248) 399-9150
Fax: (248) 584-2540
http://www.airgas.com

Cylinder Number:	CC147780	Reference Number:	32-112465146-1
Cylinder Pressure:	2000.6 PSIG	Expiration Date:	3/29/2009
Certification Date:	3/29/2006	Laboratory:	MIC - Royal Oak - MI

Certified Concentrations

Component	Concentration	Accuracy	Analytical Principle	Procedure
CARBON MONOXIDE	453.7 PPM	+/- 1%	Nondispersive Infrared (NDIR)	G1
NITROGEN	Balance			

Certification performed in accordance with "EPA Traceability Protocol (Sept. 1997)" using the assay procedures listed. Analytical Methodology does not require correction for analytical interferences.

Notes: CLEVELAND

Do not use cylinder below 150 psig.

Approval Signature ______________________

Reference Standard Information

Type	Balance Gas	Component	Cyl.Number	Concentration
NTRM 81681	NITROGEN	CARBON MONOXIDE	XC014020B	981 PPM

Analytical Results

1st Component CARBON MONOXIDE

1st Analysis Date: 03/22/2006

R 9.82	S 4.54	Z 0.00	Conc 453.5 PPM
S 4.54	Z 0.00	R 9.82	Conc 453.5 PPM
Z 0.00	R 9.82	S 4.54	Conc 453.5 PPM
			AVG: 453.5 PPM

2nd Analysis Date: 03/29/2006

R 9.82	S 4.54	Z 0.00	Conc 454 PPM
S 4.54	Z 0.00	R 9.82	Conc 454 PPM
Z 0.00	R 9.82	S 4.54	Conc 454 PPM
			AVG: 454 PPM

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ANALYTICAL REPORT

Certificate ID:	082107011	**Date:**	8/21/2007
Customer Name:	Grace Consulting, Inc.		
Customer Address:	510 Dickson St. Wellington OH 44090		
Purchase Order:	DALE VINEYARD 8/21/07	**Work Order:**	066333-00
Lot Number:	0507SE07	**Product Name:**	3-Component Mixture, EPA Protocol
Size:	31A	**Pressure:**	2200 psig @ 85 Deg F
Content:	NA		
Serial #:	EB0004369		
Analysis Date:	5/7/2007		
Shelf Life:	36 months	**Expiration Date:**	5/7/2010

Component	Nominal	Actual	Accuracy	Method
Carbon Dioxide	9%	9.11%	+/- 1% rel	NDIR
Oxygen	11%	11.0%	+/- 1% rel	Paramagnetic
Nitrogen	Balance	Balance		

REFERENCE STANDARD	Std Type	Std #	Cyl #	Concentration	Exp Date
	GMIS	1206BL05	EB0001508	15.16%	1/31/2008
	GMIS	1011SH05	EB0000776	7.53%	2/3/2008

INSTRUMENTATION	Instrument / ID	Component
	Rosemount 755R	O2
	GOWMAC-580 TCD	CO2

Note: * ANALYZED ACCORDING TO EPA TRACEABILITY PROTOCOL FOR ASSAY AND CERTIFICATION OF GASEOUS CALIBRATION STANDARDS - SEPTEMBER 1997:G1
* DO NOT USE STANDARD WHEN PRESSURE IS BELOW 150 PSIG

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ANALYTICAL REPORT

Certificate ID: 101007014 **Date:** 10/10/2007

Customer Name: Grace Consulting, Inc.

Customer Address: 510 Dickson St.

Wellington OH 44090

Purchase Order: 928000 **Work Order:** 067760-01

Lot Number: 1002HC07 **Product Name:** 3-Component Mixture, EPA Protocol

Size: 31A **Pressure:** 2200 psig @ 95 Deg F

Content: NA

Serial #: EB0002968

Analysis Date: 10/10/2007

Shelf Life: 36 months **Expiration Date:** 10/10/2010

Component	Nominal	Actual	Accuracy	Method
Carbon Dioxide	18%	17.9%	+/- 1% rel	GC-TCD
Oxygen	22.5%	22.5%	+/- 1% rel	Paramagnetic
Nitrogen	Balance	Balance		

REFERENCE STANDARD

Std Type	Std #	Cyl #	Concentration	Exp Date
GMIS	1011SH05	EB0000776	7.53%	2/3/2008
GMIS	1206BO05	EB0001025	25.17%	1/27/2008

INSTRUMENTATION

Instrument / ID	Component
GOWMAC-580 TCD	CO2
Rosemount 755R	O2

Note: * ANALYZED ACCORDING TO EPA TRACEABILITY PROTOCOL FOR ASSAY AND CERTIFICATION OF GASEOUS CALIBRATION STANDARDS - SEPTEMBER 1997:G1
* DO NOT USE STANDARD WHEN PRESSURE IS BELOW 150 PSIG

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ANALYTICAL REPORT

Certificate ID: 011607005 **Date:** 1/16/2007

Customer Name: Grace Consulting, Inc.

Customer Address: 510 Dixon

Wellington OH 44090

Purchase Order: INVENTORY **Work Order:** 055006-00

Lot Number: 1022BC06 **Product Name:** 3-Component Mixture, EPA Protocol

Size: 31A **Pressure:** 2000 psig @ 70 Deg F

Content: NA

Serial #: EB0004369

Analysis Date: 11/1/2006

Shelf Life: 36 months **Expiration Date:** 11/1/2009

Component	Nominal	Actual	Accuracy	Method
Carbon Dioxide	9%	8.91%	+/- 0.03%	NDIR
Oxygen	11%	10.9%	+/- 0.1%	Paramagnetic
Nitrogen	Balance	Balance		

REFERENCE STANDARD

Std Type	Std #	Cyl #	Concentration	Exp Date
GMIS	1011SH05	EB0000776	7.53%	2/3/2008
GMIS	1206BL05	EB0001508	15.16%	1/31/2008

INSTRUMENTATION

Instrument / ID	Component
Horiba VA-3000	CO2
Rosemount 755R	O2

Note: * ANALYZED ACCORDING TO EPA TRACEABILITY PROTOCOL FOR ASSAY AND CERTIFICATION OF GASEOUS CALIBRATION STANDARDS - SEPTEMBER 1997:G1
* DO NOT USE STANDARD WHEN PRESSURE IS BELOW 150 PSIG

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Specialty Gases of America, Inc

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Laboratory Reports

Laboratory Reports

CRYSTAL LABORATORIES

1201 Camden Ave, SW * Canton, Ohio 44706
Phone No: 330-454-4222

Laboratory No. **080929309** **Customer:** **Grace Consulting**
510 Dickson St.
Wellington, OH 44090

Date Received: **09/25/08**
Date Sampled: **09/25/08**
Project: **Recycling Solutions**
Identification: **Run 1 Container 1**
Sample Matrix: **Filter**

Analysis	Method	Results	Detection Limits	Date of Analysis
Particulate	PM 5	0.6 mg	0.1 mg	10/01/08

Approved By: ______________________

CRYSTAL LABORATORIES INC

1201 Camden Ave, SW * Canton, Ohio 44706
Phone No: 330-454-4222

Laboratory No. **080929310** **Customer:** **Grace Consulting**
510 Dickson St.
Wellington, OH 44090

Date Received: **09/25/08**
Date Sampled: **09/25/08**
Project: **Recycling Solutions**
Identification: **Run 1 Container 2**
Sample Matrix: **Liquid**

Analysis	Method	Results	Detection Limits	Date of Analysis
Particulate	PM 5	0.2 mg	0.1 mg	10/01/08

Approved By:

CRYSTAL LABORATORIES INC

1201 Camden Ave, SW * Canton, Ohio 44706
Phone No: 330-454-4222

Laboratory No. **080929313** **Customer:** **Grace Consulting**
510 Dickson St.
Wellington, OH 44090

Date Received: **09/25/08**
Date Sampled: **09/25/08**
Project: **Recycling Solutions**
Identification: **Run 2 Container 1**
Sample Matrix: **Filter**

Analysis	Method	Results	Detection Limits	Date of Analysis
Particulate	PM 5	1.3 mg	0.1 mg	10/01/08

Approved By:____________________

CRYSTAL LABORATORIES

1201 Camden Ave, SW * Canton, Ohio 44706
Phone No: 330-454-4222

Laboratory No. **080929314** **Customer:** **Grace Consulting**
510 Dickson St.
Wellington, OH 44090

Date Received: **09/25/08**
Date Sampled: **09/25/08**
Project: **Recycling Solutions**
Identification: **Run 2 Container 2**
Sample Matrix: **Liquid**

Analysis	Method	Results	Detection Limits	Date of Analysis
Particulate	PM 5	0.5 mg	0.1 mg	10/01/08

Approved By:______________________

CRYSTAL LABORATORIES INC

1201 Camden Ave, SW * Canton, Ohio 44706
Phone No: 330-454-4222

Laboratory No. **080929317** **Customer:** **Grace Consulting**
510 Dickson St.
Wellington, OH 44090

Date Received: **09/25/08**
Date Sampled: **09/25/08**
Project: **Recycling Solutions**
Identification: **Run 3 Container 1**
Sample Matrix: **Filter**

Analysis	**Method**	**Results**	**Detection Limits**	**Date of Analysis**
Particulate	PM5	1.2 mg	0.1 mg	10/01/08

Approved By:______________________

CRYSTAL LABORATORIES

1201 Camden Ave, SW * Canton, Ohio 44706
Phone No: 330-454-4222

Laboratory No. **080929318** **Customer:** **Grace Consulting**
510 Dickson St.
Wellington, OH 44090

Date Received: **09/25/08**
Date Sampled: **09/25/08**
Project: **Recycling Solutions**
Identification: **Run 3 Container 2**
Sample Matrix: **Liquid**

Analysis	Method	Results	Detection Limits	Date of Analysis
Particulate	PM5	0.2 mg	0.1 mg	10/01/08

Approved By: ______________________________

CRYSTAL LABORATORIES INC

1201 Camden Ave, SW * Canton, Ohio 44706
Phone No: 330-454-4222

Laboratory No. **080929325** **Customer:** **Grace Consulting**
510 Dickson St.
Wellington, OH 44090

Date Received: **09/25/08**
Date Sampled: **09/25/08**
Project: **Recycling Solutions**
Identification: **Acetone Blank**
Sample Matrix: **Liquid**

Analysis	Method	Results	Detection Limits	Date of Analysis
Particulate	PM 5	<0.1 mg	0.1 mg	10/01/08

Approved By: ______________________

CRYSTAL LABORATORIES

1201 Camden Ave, SW * Canton, Ohio 44706
Phone No: 330-454-4222

Laboratory No. **080929311** **Customer:** **Grace Consulting**
510 Dickson St.
Wellington, OH 44090

Date Received: **09/25/08**
Date Sampled: **09/25/08**
Project: **Recycling Solutions**

Identification: **Run 1 Container 3**
Sample Matrix: **Liquid**

Analysis	Method	Results	Detection Limits	Date of Analysis
HCL	EPA 26A	70 mg/l	0.1 mg/l	10/24/08

Approved By: ______________________

CRYSTAL LABORATORIES INC

1201 Camden Ave, SW * Canton, Ohio 44706
Phone No: 330-454-4222

Laboratory No. **080929315** **Customer:** **Grace Consulting**
510 Dickson St.
Wellington, OH 44090

Date Received: **09/25/08**
Date Sampled: **09/25/08**
Project: **Recycling Solutions**

Identification: **Run 2 Container 3**
Sample Matrix: **Liquid**

Analysis	Method	Results	Detection Limits	Date of Analysis
HCL	EPA 26A	67 mg/l	0.1 mg/l	10/24/08

Approved By: ______________________

CRYSTAL LABORATORIES INC

1201 Camden Ave, SW * Canton, Ohio 44706
Phone No: 330-454-4222

Laboratory No. **080929319** **Customer:** **Grace Consulting**
510 Dickson St.
Wellington, OH 44090

Date Received: **09/25/08**
Date Sampled: **09/25/08**
Project: **Recycling Solutions**

Identification: **Run 3 Container 3**
Sample Matrix: **Liquid**

Analysis	**Method**	**Results**	**Detection Limits**	**Date of Analysis**
HCL	EPA 26A	65 mg/l	0.1 mg/l	10/24/08

Approved By:

CRYSTAL LABORATORIES INC

1201 Camden Ave, SW * Canton, Ohio 44706
Phone No: 330-454-4222

Laboratory No. **080929312** **Customer:** **Grace Consulting**
510 Dickson St.
Wellington, OH 44090

Date Received: **09/25/08**
Date Sampled: **09/25/08**
Project: **Recycling Solutions**
Identification: **Run 1 Container 4**
Sample Matrix: **Liquid**

Analysis	**Method**	**Results**	**Detection Limits**	**Date of Analysis**
Chloride	RM 26A	49 mg/l	0.1 mg/l	10/02/08

Approved By:______________________________

CRYSTAL LABORATORIES INC

1201 Camden Ave, SW * Canton, Ohio 44706
Phone No: 330-454-4222

Laboratory No. **080929316** **Customer:** **Grace Consulting**
510 Dickson St.
Wellington, OH 44090

Date Received: **09/25/08**
Date Sampled: **09/25/08**
Project: **Recycling Solutions**
Identification: **Run 2 Container 4**
Sample Matrix: **Liquid**

Analysis	**Method**	**Results**	**Detection Limits**	**Date of Analysis**
Chloride	RM 26A	44 mg/l	0.1 mg/l	10/02/08

Approved By:

CRYSTAL LABORATORIES INC

1201 Camden Ave, SW * Canton, Ohio 44706
Phone No: 330-454-4222

Laboratory No. **080929320** **Customer:** **Grace Consulting**
510 Dickson St.
Wellington, OH 44090

Date Received: **09/25/08**
Date Sampled: **09/25/08**
Project: **Recycling Solutions**
Identification: **Run 3 Container 4**
Sample Matrix: **Liquid**

Analysis	Method	Results	Detection Limits	Date of Analysis
Chloride	RM 26A	43 mg/l	0.1 mg/l	10/02/08

Approved By:

CRYSTAL LABORATORIES

1201 Camden Ave, SW * Canton, Ohio 44706
Phone No: 330-454-4222

Laboratory No. **080929321** **Customer:** **Grace Consulting**
510 Dickson St.
Wellington, OH 44090

Date Received: **09/25/08**
Date Sampled: **09/25/08**
Project: **Recycling Solutions**

Identification: **Container 6**
Sample Matrix: **Liquid**

Analysis	**Method**	**Results**	**Detection Limits**	**Date of Analysis**
HCL	EPA 26A	<0.1 mg/l	0.1 mg/l	10/24/08

Approved By:

CRYSTAL LABORATORIES INC

1201 Camden Ave, SW * Canton, Ohio 44706
Phone No: 330-454-4222

Laboratory No.	**080929322**	**Customer:**	**Grace Consulting** **510 Dickson St.** **Wellington, OH 44090**
Date Received:	**09/25/08**		
Date Sampled:	**09/25/08**		
Project:	**Recycling Solutions**		
Identification:	**Container 7**		
Sample Matrix:	**Liquid**		

Analysis	Method	Results	Detection Limits	Date of Analysis
Chloride	RM 26A	<0.1 mg/l	0.1 mg/l	10/02/08

Approved By: ______________________

CRYSTAL LABORATORIES INC

1201 Camden Ave, SW * Canton, Ohio 44706
Phone No: 330-454-4222

Laboratory No. **080929323** **Customer:** **Grace Consulting**
510 Dickson St.
Wellington, OH 44090

Date Received: **09/25/08**
Date Sampled: **09/25/08**
Project: **Recycling Solutions**
Identification: **Container 8**
Sample Matrix: **Liquid**

Analysis	**Method**	**Results**	**Detection Limits**	**Date of Analysis**
Chloride	RM 26A	<0.1 mg/l	0.1 mg/l	10/02/08

Approved By:

CRYSTAL LABORATORIES INC

1201 Camden Ave, SW * Canton, Ohio 44706
Phone No: 330-454-4222

Laboratory No. **080929324** **Customer:** **Grace Consulting**
510 Dickson St.
Wellington, OH 44090

Date Received: **09/25/08**
Date Sampled: **09/25/08**
Project: **Recycling Solutions**
Identification: **Container 9**
Sample Matrix: **Liquid**

Analysis	**Method**	**Results**	**Detection Limits**	**Date of Analysis**
Chloride	RM 26A	<0.1 mg/l	0.1 mg/l	10/02/08

Approved By:______________________

GRACE CONSULTING, INC.
EMISSIONS TESTING SERVICES

P.O. Box 58
510 Dickson St.
Wellington, OH 44090

Phone: 440-647-6672
Fax: 440-647-6673

Chain of Custody

Customer Name	Grace Consulting, Inc.	Report Attention	Stacy Sword
Report Address		Project Name	Recycling Solutions 08-293
Billing Address		Purchase Order #	
City / State / Zip		Indicate state where samples were collected:	KY
Phone		Compliance ¹ Non-Compliance ¹	

Sample Identification	date collected	time collected	Sample Description		Analysis Required	
Run 1 container 1	9/25/2008		sample filter	--	gravimetric - RM5	080929309
Run 1 container 2	9/25/2008		front half acetone wash	mL	gravimetric - RM5	310
Run 1 container 3	9/25/2008		acid impinger catch	358 mL	RM 26A	311
Run 1 container 4	9/25/2008		alkaline impinger catch	256 mL	RM 26A	312
Run 2 container 1	9/25/2008		sample filter	--	gravimetric - RM5	313
Run 2 container 2	9/25/2008		front half acetone wash	mL	gravimetric - RM5	314
Run 2 container 3	9/25/2008		acid impinger catch	330 mL	RM 26A	315
Run 2 container 4	9/25/2008		alkaline impinger catch	246 mL	RM 26A	316
Run 3 container 1	9/25/2008		sample filter	--	gravimetric - RM5	317
Run 3 container 2	9/25/2008		front half acetone wash	mL	gravimetric - RM5	318
Run 3 container 3	9/25/2008		acid impinger catch	453 mL	RM 26A	319
Run 3 container 4	9/25/2008		alkaline impinger catch	314 mL	RM 26A	320
container 6	9/25/2008		.1N H2SO4 Blank	101 mL	RM 26A	321
container 7	9/25/2008		.1N NaOH Blank	99 mL	RM 26A	322
container 8	9/25/2008		H2O Blank	200 mL	RM 26A	323
container 9	9/25/2008		Acetone Blank	100 mL	RM 26A	324
Acetone Blank	9/25/2008		Acetone Blank Method 5	mL	gravimetric - RM5	325

Turnaround Time Requested: Normal Rush

Date Results are needed: ____________

Rush results requested by: Fax Mail

Fax # ____________

Notes:

Relinquished By:	Date	Time	Received By:	Date	Time
hes	9/25/2008		Bethany Edwards	09/29	09:15
Bethany Edwards	09/29		B. B	9/29	12:59

P9775 - TEQ

Project ID: Recycling Solutions

Sample Summary
Part 1

ANALYTICAL PERSPECTIVES

Method 23

Analyte	0_6252_MB001 pg	Run 1 pg	Run 2 pg	Run 3 pg	Run 4 pg
2,3,7,8-TCDD	(1.74)	268	202	171	118
1,2,3,7,8-PeCDD	(1.64)	558	373	356	225
1,2,3,4,7,8-HxCDD	(1.72)	335	191	216	134
1,2,3,6,7,8-HxCDD	(1.81)	534	314	347	204
1,2,3,7,8,9-HxCDD	(1.94)	351	191	223	128
1,2,3,4,6,7,8-HpCDD	(<5)	1700	803	1120	653
OCDD	(4.44)	1170	514	786	497
2,3,7,8-TCDF	(1.53)	1570	1220	1030	691
1,2,3,7,8-PeCDF	(3.42)	1890	1330	1260	849
2,3,4,7,8-PeCDF	(<5)	3470	2270	2270	1480
1,2,3,4,7,8-HxCDF	(<5)	2340	1380	1530	943
1,2,3,6,7,8-HxCDF	(<5)	2500	1470	1650	1010
2,3,4,6,7,8-HxCDF	(<5)	2610	1450	1710	1050
1,2,3,7,8,9-HxCDF	(1.05)	635	333	394	247
1,2,3,4,6,7,8-HpCDF	(<5)	5110	2520	3340	2050
1,2,3,4,7,8,9-HpCDF	(2.26)	471	206	296	187
OCDF	(5.11)	984	376	628	426
ITEF TEQ (ND=0; EMPC=0)	0.00	3,540	2,280	2,310	1,480
ITEF TEQ (ND=0; EMPC=EMPC)	0.00	3,540	2,280	2,310	1,480
ITEF TEQ (ND=DL/2; EMPC=0)	3.83	3,540	2,280	2,310	1,480
ITEF TEQ (ND=DL/2; EMPC=EMPC)	3.83	3,540	2,280	2,310	1,480
ITEF TEQ (ND=DL; EMPC=EMPC)	7.67	3,540	2,280	2,310	1,480
Checkcode	0232	0550	0884	3220	1483

( ) = DL
[ ] = EMPC

Reviewer
Date

P9775 - Totals

Project ID: Recycling Solutions

Sample Summary
Part 2

ANALYTICAL PERSPECTIVES

Method 23

Analyte	0_6252_MB001 pg	Run 1 pg	Run 2 pg	Run 3 pg	Run 4 pg
Totals					
TCDDs	0	13600	11000	8600	6320
PeCDDs	0	11300	7770	7360	4810
HxCDDs	3.94	8490	4950	5310	3210
HpCDDs	0	3690	1790	2460	1420
OCDD	0	1170	514	786	497
TCDFs	3.9	80000	66200	54400	37800
PeCDFs	17	49600	36100	33300	21800
HxCDFs	11.3	25600	15200	16800	10300
HpCDFs	2.84	7650	3760	5000	3090
OCDF	0	984	376	628	426
Total PCDD/Fs (ND=0; EMPC=0)	**39.0**	**202,000**	**148,000**	**135,000**	**89,800**
Total PCDD/Fs (ND=0; EMPC=EMPC)	**66.0**	**202,000**	**148,000**	**135,000**	**89,800**
Total PCDD/Fs (2378-X ND=DL; EMPC=EMPC)	**92.7**	**202,000**	**148,000**	**135,000**	**89,800**
Total 2378s (ND=0; EMPC=0)	**0.00**	**26,500**	**15,100**	**17,300**	**10,900**
Total 2378s (ND=0.5; EMPC=0)	**28.3**	**26,500**	**15,100**	**17,300**	**10,900**
Total 2378s (ND=1; EMPC=0)	**56.7**	**26,500**	**15,100**	**17,300**	**10,900**
Total 2378s (ND=0; EMPC=1)	**0.00**	**26,500**	**15,100**	**17,300**	**10,900**
Total 2378s (ND=0.5; EMPC=1)	**28.3**	**26,500**	**15,100**	**17,300**	**10,900**
Total 2378s (ND=1; EMPC=1)	**56.7**	**26,500**	**15,100**	**17,300**	**10,900**
Checkcode	0232	0550	0884	3220	1483

Total 2378s = Sum of 17 2378-substituted PCDD/PCDF congeners (SARA 313)

( ) = DL
[ ] = EMPC

Reviewer
Date 23 Oct 08

P9775 - Others

Project ID: Recycling Solutions

Sample Summary
Part 3

ANALYTICAL PERSPECTIVES

Method 23

Analyte	0_6252_MB001 pg	Run 1 pg	Run 2 pg	Run 3 pg	Run 4 pg
Other PCDD/Fs (ND=0, EMPC=0)					
Other TCDD	0	13300	10800	8430	6200
Other PeCDD	0	10800	7400	7000	4590
Other HxCDD	3.94	7270	4250	4530	2740
Other HpCDD	0	1990	983	1350	763
Other TCDF	3.9	78500	65000	53400	37100
Other PeCDF	14	44200	32500	29800	19500
Other HxCDF	11.3	17500	10600	11600	7080
Other HpCDF	0	2080	1030	1370	859
Other PCDD/Fs (ND=0, EMPC=EMPC)					
Other TCDD	0	13300	10800	8430	6200
Other PeCDD	3.19	10800	7400	7000	4590
Other HxCDD	3.94	7270	4250	4530	2740
Other HpCDD	2.62	1990	983	1350	763
Other TCDF	6.02	78500	65000	53400	37100
Other PeCDF	25.3	44200	32500	29800	19500
Other HxCDF	11.3	17500	10600	11600	7080
Other HpCDF	0	2080	1030	1370	859
Checkcode	0232	0550	0884	3220	1483

( ) = DL
[ ] = EMPC

Reviewer
Date 23Oct02