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RTP ENVIRONMENTAL ASSOCIATES INC.
AIR • WATER • SOLID WASTE CONSULTANTS
239 U.S. Highway 22 East • Green Brook, New Jersey 08812
(201)968-9600

April 28, 1987

Mr. Hamilton S. Oven, Jr., P.E.
Florida Dept. of Environmental Regulation
2600 Blair Stone Road
Tallahassee, Fl 32301

Dear Mr. Oven:

Enclosed are some materials in support of our recent permit modification request for the Hillsborough County resource recovery facility. Specifically, test data is enclosed for the Ogden-Martin Tulsa facility, a copy of the application to modify the Tulsa permit for the same parameters (NO_x and H_2SO_4), and a determination written by the Oregon Department of Environmental Quality concerning the modifications to the NO_x condition in the permit for that facility.

Please have FDER staff review these materials in preparation for receiving our formal request for modification. At this time, it is hoped to have this request sent to you during the week of April 27th.

Thank you for your assistance on this project. Should you have any questions concerning the materials, please feel free to contact either myself at the above number or David Dee at (904) 224-1585. Look forward to seeing you again soon.

Sincerely,

RTP ENVIRONMENTAL ASSOCIATES, INC.

Donald F. Elias
Principal

DFE/trp

Enclosure

cc: Clair Fancy
David Dee
Tom Smith
R. Hauser/D. Strobridge
Project File - HCRR

OGDEN PROJECTS, INC.

ENVIRONMENTAL ENGINEERING DEPARTMENT

ENVIRONMENTAL TEST REPORT

PREPARED FOR Ogden Martin Systems of Tulsa, Inc.
2122 South Yukon Avenue
Tulsa, Oklahoma 74104

REGARDING Walter B. Hall Resource Recovery Facility
Units 1 and 2

REGULATORY AGENCIES U.S. EPA Permit PSD-OK-556M-2
Semi-Annual Testing for SO_2 Emissions

PURPOSE Compliance with Permit Conditions

TEST DATES January 15, 1987

ASSOCIATED REPORTS 101, 102

REPORT NUMBER 122

PREPARED BY Ronald A Zurlinden
Ronald A. Zurlinden, Environmental Scientist

Henry P. Von Dem Fange, Manager of Environmental Testing

Jeffrey L Hahn
Jeffrey L. Hahn, P.E., Vice President, Environmental Engineering

Testing Firm:
Ogden Projects, Inc.
1900 Powell Street, Suite 400
Emeryville, California 94608
Richard Seelinger,
Executive Vice President
Engineering

REGISTERED PROFESSIONAL ENGINEER
JEFFREY L. HAHN
No. 3289
Exp. 3-31-90
CHEMICAL
STATE OF CALIFORNIA

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I. Introduction

On January 15, 1987, Ogden Projects, Inc. performed emission tests at the Walter B. Hall Resource Recovery Facility, a Waste-to-Energy Facility owned and operated by Ogden Martin Systems of Tulsa, Inc.

Two MSW-fired boilers (units 1 and 2), each with a 375 tons per day (TPD) capacity, were tested for sulfur dioxide emissions from the common stack. This testing was performed for the semi-annual demonstration of compliance with permit PSD-OK-556M-2, technically administered for the U.S. EPA Region VI, by the State of Oklahoma, Department of Health.

The test program consisted of triplicate test runs for the following parameters:

Parameter	Method
Volumetric Flue Gas Flow	U.S. EPA Methods 2,3,4
Sulfur Dioxide	U.S. EPA Method 6

The testing was performed by Messrs. Ronald Zurlinden and Matthew Turner of OPI, Emeryville, CA. Mr. Robert E. Cullen, P.E., representing Oklahoma State Department of Health, was an observer during the test program. The analysis for SO_2 was performed by OPI at its Emeryville, CA laboratory.

The results from the compliance test program are summarized in Section II. For comparison, the permitted level of sulfur dioxide emissions is also presented in Section II. As shown, the sulfur dioxide emission levels are approximately 55% of the permitted level and are similar to the results obtained for SO_2 emissions in the initial source test, as reported in OPI Report Numbers 101 and 102.

The boiler capacities are calculated in terms of percent of design steam flow rate. As shown in Section III, all testing was performed with boiler capacities at, or near, the design capacity.

II. Summary of Sulfur Dioxide Source Test Results and Permit Emission Rates

Run	Common Stack Test Results		Permit Emission Rates	
	lb/hr	TPY[1]	lb/hr	TPY[1]
1	68.6	300	---	---
2	56.2	246	---	---
3	41.0	180	---	---
Average	55.3	242	100.9	441.9

[1] at 100% availability

III. Stoker/Boiler Operational Data

Time	Boiler 1		Boiler 2		Boiler 1 and 2	
	Steam Rate lbs/hr(*10^3)	Capacity[1] %	Steam Rate lbs/hr(*10^3)	Capacity[1] %	Steam Rate lbs/hr(*10^3)	Capacity[2] %
1000	---	---	82	93		
1100	82	93	---	---		
1200	---	---	85	96		
1300	85	96	---	---		
1400	---	---	82	93		
1500	83	94	---	---		
1600	---	---	85	96		
Average 1000-1500	83	94	84	95	167	94

[1] 88,500 lbs/hr steam is equal to 100% design heat input capacity.
[2] 177 lbs/hr steam is equal to 100% design heat input capacity.

IV. Appendix

FACILITY; Tulsa
DATE: 1-15-87
UNIT: units 1&2

FIELD DATA @ 68° F

SITE: Common Stack

RUN #:	1	2	4
TIME:	1025	1255	1516
Vm (dry gas sampled)	30.22	33.92	36.94
Y (meter calib. factor)	0.926	0.926	0.926
P bar (Barometric pressure)	29.81	29.81	29.81
P static (stack pressure, " H2O)	-0.4	-0.4	-0.4
Delta H (differential meter press, " H2O)	1	1	1
Tm (meter temperature, R`)	511	518	507
Vol H2O mls	122	118.2	140.4
Vm(std),dscf	28.88	31.98	35.58
Bws-H2O vapor	0.166	0.148	0.157
MF-moisture factor	0.834	0.852	0.843
% CO2	9.5	9.4	9.6
% O2	10.2	10.4	10.2
% N2	80.3	80.2	80.2
Md-MW stk gas,dry	29.93	29.92	29.94
Ms-MW stk gas,wet	27.95	28.15	28.07
Cp-pitot tube	0.84	0.84	0.84
Avg sq rt ^p	0.48	0.469	0.469
T stack, R'	802	808	810
Stack area,ft2	70.88	70.88	70.88
Vs-fps	33.76	32.99	33.08
Qstd-dscfm	78500	77700	77000
Sample time	63	60	60

SULFUR DIOXIDE RESULTS

RUN 1 RESULTS

N BaCL	Vs/Va	dilution	Vt	ppm,dry	ppm,dry @ 12% CO2	ppm,dry @ 7% O2	lbs/hr
0.202	50	1	0.60	87.7	103.2	106.9	68.6

RUN 2 RESULTS

N BaCL	Vs/Va	dilution	Vt	ppm,dry	ppm,dry @ 12% CO2	ppm,dry @ 7% O2	lbs/hr
0.202	50	1	0.55	72.6	83.8	87.8	56.2

RUN 4 RESULTS

N BaCL	Vs/Va	dilution	Vt	ppm,dry	ppm,dry @ 12% CO2	ppm,dry @ 7% O2	lbs/hr
0.202	50	1	0.45	53.4	62.8	65.7	41.0

ADDITIONAL DATA:

RUN #	TIME START	END	%O2	%CO2	%H2O	VmSTD	DSCFM
1	1025	1148	9.5	10.2	16.6	28.88	78500
2	1255	1355	9.4	10.4	14.8	31.98	77700
4	1516	1616	9.6	10.2	15.7	35.58	77000

2,3,4,6

U.S. EPA METHODS 8 FIELD DATA SUMMARY

Project ____________

Plant Tulsa

Sample location Common Stack

Date 1-15-87

Run M8 / 1-15 / CS / Run 1)

EPA Impinger 1 Final 269.6	Initial 171.5	Net volume 98.1
H2O2 Impinger 2 Final 329.3	Initial 308.4	Net volume 20.9
H2O2 Impinger 3 Final 50.0	Initial 50.0	Net volume 0.0
Silica gel Final 695.2	Initial 692.2	Net volume 3.0

V_{lc}	- Volume of water collected in train, ml.	122.0
V_m	- Sample gas volume, meter conditions, dcf.	(30.22 unc) 27.98 Corr
Y	- Meter calibration factor.	0.926
P_{bar}	- Barometric pressure, in Hg.	29.72
P_g	- Stack static pressure, in Hg.	29.81
ΔH	- Average orifice pressure diff., in H_2O	1.0
T_m	- Absolute meter temperature, °R.	51
$V_{m(std)}$	- Standard sample gas volume, dscf.	
B_{ws}	- Water vapor in gas stream	
MF	- Moisture factor.	
CO_2	- Dry, volume %.	9.5
O_2	- Dry, volume %.	10.2
N_2	- Dry, volume %.	
CH_4	- Dry, volume %.	
M_d	- Molecular weight of stack gas, dry.	
M_s	- Molecular weight of stack gas, wet.	
C_p	- Pitot tube coefficient.	0.84
Δp	- Average of the square roots of each p.	0.23
T_s	- Absolute stack temperature, °R.	342
A	- Area of stack, ft2.	37.72 (9'6" dia)
Q_{std}	- Volumetric flowrate, dscfm.	
An	- Nozzle area, ft2.	—
Θ	- Sampling time, min.	63
%I	- Isokinetic variation.	—

67.4
16.7
+ 20.0 ml

Run 1

2,3,4,6

Method Field Test Data Form

Plant	Tulsa	Probe length	6'	Sheet	1 of 3
Location	Common Stack	Probe liner material	SS	Nozzle identification number	—
Operator	MTT / RAZ	Probe heater setting	5	Nozzle diameter	—
Date	1-15-87	Ambient temperature	30-35°F	Final leak rate	0.015
Run number	M6/1-15/CS/Run 1	Barometric pressure	29.81	Vacuum during leak check	5
Sample box number	#1	Assumed moisture	15%	Remarks:	
Meter box number	#1	Static pressure	-0.40		
Meter ΔH@	0.8	C factor	—		
Meter calibration Y	0.926	Reference ΔP	—		
Pitot tube CP	0.84	Maximum ΔH	—		

U.S. EPA Method 2, Traverse point number	U.S. EPA Met 4,6 Sampling time (Θ), min	Clock time 24 h	Vacuum, mm Hg (in. Hg)	Stack temperature (T_s), °C (°F)	Velocity head (ΔP_s), mm H_2O (in. H_2O)	Pressure differential across orifice meter, mm H_2O (in. H_2O)	Gas sample volume, m^3 (ft^3)	Gas sample temperature at dry gas meter		Temperature of gas leaving condenser or last impinger, °C (°F)
								Inlet, °C (°F)	Outlet, °C (°F)	
6 5	1025	0	2	342	0.22	1.0	149.70		42	42
5	1028	3	2	346	0.24	1.0			48	40
4	1031	6	2	348	0.24	1.0			55	40
3	1034	9	2	341	0.22	1.0			62	40
2	1037	12	2	341	0.24	1.0			61	40
1	1040	15	2	341	0.24	1.0			57	40
	1043	18	2	341			152.90			
Total or Avg	1025-1043	18	2			1.0	3.20			

U.S. EPA Met. 2,3,4,6

8

Plant Tulsa
Location Common Stack
Operator MTT/RAL
Date 1-15-87
Run No. M6/1-15/CS/Run 1
Sample box no. #1
Meter box no. #1
Meter ΔH@ 0.8
C factor —
Pitot tube coefficient, Cp 0.826

Schematic of stack cross section

Static pressure mm Hg (in. Hg) -0.40
Ambient temperature 30
Barometric pressure 29.81
Assumed moisture, % 15
Probe length, m (ft) 6
Nozzle identification no. —
Average calibrated nozzle diameter, cm (in.) —
Probe heater setting 5
Leak rate, m³/min, (cfm) 0.015
Probe liner material SS
Filter no. 1

U.S. EPA Method 2,[illegible] Traverse Number	U.S. EPA Met 4,6 Sampling Time (Θ), min	Vacuum mm Hg (in. Hg)	Stack Temperature (T_s), °C (°F)	Velocity Head (ΔP_s), mm (H_2O) (in. H_2O)	Pressure Differential Across Orifice Meter, mm H_2O, (in. H_2O)	Gas Sample Volume, m^3 (ft^3)	Gas Sample Temperature at Dry Gas Meter: Inlet, °C (°F)	Gas Sample Temperature at Dry Gas Meter: Outlet, °C (°F)	Temperature of Gas Leaving Condenser or Last Impinger, °C (°F)
6 SW	1047	2	342	0.24	1.0	153.1		54	40
5	1050	2	341	0.23	1.0			58	40
4	1053	2	341	0.24	1.0			56	40
3	1056	2	341	0.24	1.0			54	40
2	1058	2	342	0.24	1.0			52	40
1	1100	2	341	0.23	1.0	160.4		52	40
Total						7.30	Avg.	Avg	
Average							Avg		

Figure 8.2. Field data.

U.S. EPA Met 2,3,4,6

Plant Tulsa
Location Common Stack
Operator MTI / RAZ
Date 1-15-87
Run No. M6/1-15/CS/Run1
Sample box no. #1
Meter box no. #1
Meter ΔH@ 0.8
C factor –
Pitot tube coefficient, Cp 0.926

Schematic of stack cross section

Static pressure mm Hg (in. Hg) -0.40
Ambient temperature 30
Barometric pressure 29.61
Assumed moisture, % 15
Probe length, m (ft) 6
Nozzle identification no. –
Average calibrated nozzle diameter, cm (in.) –
Probe heater setting 5
Leak rate, m³/min, (cfm) 0.015
Probe liner material SS
Filter no. 1

U.S. EPA Method 2 Traverse Number	U.S. EPA Method 4,6 Sampling Time (Θ), min	Vacuum mm Hg (in. Hg)	Stack Temperature (T_s), °C (°F)	Velocity Head (ΔP_s), mm (H_2O) (in. H_2O)	Pressure Differential Across Orifice Meter, mm H_2O, (in. H_2O)	Gas Sample Volume, m^3 (ft^3)	Gas Sample Temperature at Dry Gas Meter Inlet, °C (°F)	Gas Sample Temperature at Dry Gas Meter Outlet, °C (°F)	Temperature of Gas Leaving Condenser or Last Impinger, °C (°F)
6 NE	1105	2	341	0.24	1.0	160.5		53	40
5	1107	2	342	0.24	1.0			52	40
4	1109	2	341	0.23	1.0			51	40
3	1112	2	341	0.23	1.0			50	40
2	1118	2	341	0.24	1.0			49	40
1	1120	2	342	0.24	1.0	162.8		53	40
Total						2.30	Avg.	Avg	
Average							Avg		

Figure 8.2. Field data.

U.S. EPA Met. 2,3,4,6

Plant Tulsa
Location Common Stack
Operator MTT/RAL
Date 1-15-87
Run No. M6/1-15/CS/Run1
Sample box no. 1
Meter box no. 1
Meter ΔH@ 0.8
C factor —
Pitot tube coefficient, Cp 0.976

Schematic of stack cross section

Static pressure mm Hg (in. Hg) -0.40
Ambient temperature 30
Barometric pressure 29.81
Assumed moisture, % 15
Probe length, m (ft) 6
Nozzle identification no. —
Average calibrated nozzle diameter, cm (in.) —
Probe heater setting 5
Leak rate, m^3/min, (cfm) 0.015
Probe liner material SS
Filter no. 1

U.S. EPA Method 2 Traverse Number	U.S. EPA Met 4,6 Sampling Time (Θ), min	Vacuum mm Hg (in. Hg)	Stack Temperature (T_s), °C (°F)	Velocity Head (ΔP_s), mm (H_2O) (in. H_2O)	Pressure Differential Across Orifice Meter, mm H_2O, (in. H_2O)	Gas Sample Volume, m^3 (ft^3)	Gas Sample Temperature at Dry Gas Meter		Temperature of Gas Leaving Condenser or Last Impinger, °C (°F)
							Inlet, °C (°F)	Outlet, °C (°F)	
6 NE	1130	4	344	0.24	1.0	163.00		45	40
5	1135	5	342	0.22	1.0			44	40
4	1138	4	342	0.24	1.0			44	40
3	1140	4	341	0.24	1.0			43	40
2	1142	4	342	0.24	1.0			42	40
1	1148	4	341	0.22	1.0	180.42		41	40
Total						17.42	Avg.	Avg	
Average		4	342	0.23	1.0		Avg	51	40

Total 30.22

Figure 8.2. Field data.

2,3,4,6

U.S. EPA METHODS [illegible] FIELD DATA SUMMARY

Project Tulsa

Plant Tulsa P+E

Sample location Common Stack

Date 1-15-87

Run 2 M8/1-15/CS/Run 2

Impinger 1 Final	638.2	Initial	550.5	Net volume	87.7
Impinger 2 Final	590.2	Initial	535.0	Net volume	15.2
Impinger 3 Final	50.0	Initial	50.0	Net volume	0.0
Silica gel Final	700.5	Initial	685.2	Net volume	15.3

V_{lc}	-	Volume of water collected in train, ml.	118.2
V_m	-	Sample gas volume, meter conditions, dcf.	33.92 unc (31.41 cor)
Y	-	Meter calibration factor.	0.926
P_{bar}	-	Barometric pressure, in Hg.	29.81
P_g	-	Stack static pressure, in Hg.	-0.40
ΔH	-	Average orifice pressure diff., in H_2O	1.0
T_m	-	Absolute meter temperature, °R.	58
$V_{m(std)}$	-	Standard sample gas volume, dscf.	
B_{ws}	-	Water vapor in gas stream	
MF	-	Moisture factor.	
CO_2	-	Dry, volume %.	9.4
O_2	-	Dry, volume %.	10.4
N_2	-	Dry, volume %.	
CH_4	-	Dry, volume %.	
M_d	-	Molecular weight of stack gas, dry.	
M_s	-	Molecular weight of stack gas, wet.	
C_p	-	Pitot tube coefficient.	0.84
Δp	-	Average of the square roots of each p.	0.22
T_s	-	Absolute stack temperature, °R.	348
A	-	Area of stack, ft^2.	37.72 (9'6" dia)
Q_{std}	-	Volumetric flowrate, dscfm.	
An	-	Nozzle area, ft^2.	-
Θ	-	Sampling time, min.	60
%I	-	Isokinetic variation.	-

Plant Tulsa
Location Common Stack
Operator MTT/RAC
Date 1·15·87
Run No. M6/1-15/CS/Run 2
Sample box no. 1
Meter box no. 1
Meter ΔH@ 0.8
C factor —
Pitot tube coefficient, Cp 0.926

Schematic of stack cross section

Static pressure mm Hg (in. Hg) -0.40
Ambient temperature 30
Barometric pressure 29.81
Assumed moisture, % 15
Probe length, m (ft) 6
Nozzle identification no. -
Average calibrated nozzle diameter, cm (in.) —
Probe heater setting 5
Leak rate, m³/min, (cfm) 0.015 at 10" H₂O
Probe liner material SS
Filter no. 2

U.S. EPA Method 2 Traverse Number	U.S. EPA Mtd 4,6 Sampling Time (Θ), min	Vacuum mm Hg (in. Hg)	Stack Temperature (T_s), °C (°F)	Velocity Head (ΔP_s), mm (H_2O (in. H_2O)	Pressure Differential Across Orifice Meter, mm H_2O, (in. H_2O)	Gas Sample Volume, m³ (ft³)	Gas Sample Temperature at Dry Gas Meter Inlet, °C (°F)	Gas Sample Temperature at Dry Gas Meter Outlet, °C (°F)	Temperature of Gas Leaving Condenser or Last Impinger, °C (°F)
6	1255	8	342	0.24	1.0	186.28		52	40
5	1300	9	342	0.24	1.0			54	40
4	1308	9	343	0.24	1.0			60	40
3	1311	8	344	0.23	1.0			60	40
2	1312	8	345	0.22	1.0			61	40
1	1315	8	344	0.22	1.0	220.20		62	40
			END OF METHOD 6 at			1355			
Total						33.92	Avg.	Avg	
Average							Avg	58	40

Figure 8.2. Field data.

U.S. EPA Met 2,3,4,6

Plant	Tulsa
Location	Common Stack
Operator	MTT / RAL
Date	1-15-87
Run No.	M6/1-15/CS/Run 2
Sample box no.	1
Meter box no.	1
Meter ΔH@	0.8
C factor	–
Pitot tube coefficient, Cp	0.926

Schematic of stack cross section

Static pressure mm Hg (in. Hg)	-0.40
Ambient temperature	30
Barometric pressure	29.81
Assumed moisture, %	15
Probe length, m (ft)	6
Nozzle identification no.	–
Average calibrated nozzle diameter, cm (in.)	
Probe heater setting	5
Leak rate, m³/min, (cfm)	0.015 @ 10"
Probe liner material	SS
Filter no.	2

VELOCITY TRAVERSE

U.S. EPA Method 2 Traverse Number	U.S. EPA Met 4,6 Sampling Time (Θ), min	Vacuum mm Hg (in. Hg)	Stack Temperature (T_s), °C (°F)	Velocity Head (ΔP_s), mm $(H_2O$ (in. $H_2O)$	Pressure Differential Across Orifice Meter, mm H_2O, (in. $H_2O)$	Gas Sample Volume, m^3 (ft^3)	Gas Sample Temperature at Dry Gas Meter Inlet, °C (°F)	 Outlet, °C (°F)	Temperature of Gas Leaving Condenser or Last Impinger, °C (°F)
6	1320	–	351	0.26		–			
5	1321	–	351	0.25		–			
4	1322	–	351	0.24		–			
3	1323	–	350	0.22		–			
2	1324	–	349	0.20		–			
1	1325	–	350	0.19		–			
6	1330	–	350	0.22		–			
5	1331	–	350	0.22		–			
Total							Avg.	Avg	
Average							Avg		

Figure 8.2. Field data.

U.S. EPA Met. 1,3,4

Plant Tulsa

Location Common Stack

Operator MTT/EAZ

Date 1-15-87

Run No. M6/1-15/CS/Run 2

Sample box no. 1

Meter box no. 1

Meter ΔH@ 1.8

C factor –

Pitot tube coefficient, Cp 0.926

Schematic of stack cross section

Static pressure mm Hg (in. Hg) -0.40

Ambient temperature 30

Barometric pressure 29.81

Assumed moisture, % 15

Probe length, m (ft) 6 –

Nozzle identification no. –

Average calibrated nozzle diameter, cm (in.) –

Probe heater setting 5

Leak rate, m³/min, (cfm) 0.015 @ 10"

Probe liner material SS

Filter no. 2

VELOCITY TRAVERSE

U.S. EPA Method 2 Traverse Number	U.S. EPA Met 4,6 Sampling Time (Θ), min	Vacuum mm Hg (in. Hg)	Stack Temperature (T_s), °C (°F)	Velocity Head (ΔP_s), mm (H_2O) (in. H_2O)	Pressure Differential Across Orifice Meter, mm H_2O, (in. H_2O)	Gas Sample Volume, m³ (ft³)	Gas Sample Temperature at Dry Gas Meter Inlet, °C (°F)	Gas Sample Temperature at Dry Gas Meter Outlet, °C (°F)	Temperature of Gas Leaving Condenser or Last Impinger, °C (°F)
4			350	0.22		–			
3			351	0.22		–			
2			350	0.20		–			
1	1335		350	0.18		–			
6	1340		350	0.20		–			
5			350	0.22		–			
4			350	0.22		–			
3			351	0.18					
Total			–				Avg.	Avg	
Average							Avg		

Figure 8.2. Field data.

U.S. EPA Mtd 2,3,4,6

Plant Tulsa

Location Common Stack

Operator MTT / RAZ

Date 1-15-87

Run No. M6/1-15/CS/Run2

Sample box no. 1

Meter box no. 1

Meter ΔH@ 0.8

C factor –

Pitot tube coefficient, Cp 0.926

Schematic of stack cross section

Static pressure mm Hg (in. Hg) -0.40

Ambient temperature 30

Barometric pressure 29.81

Assumed moisture, % 15

Probe length, m (ft) 6

Nozzle identification no. –

Average calibrated nozzle diameter, cm (in.) –

Probe heater setting 5

Leak rate, m³/min, (cfm) 0.015@10"

Probe liner material SS

Filter no.

VELOCITY TRAVERSE

U.S. EPA Method 2 Traverse Number	U.S. EPA Met 4,6 Sampling Time (Θ), min	Vacuum mm Hg (in. Hg)	Stack Temperature (T_s), °C (°F)	Velocity Head (ΔP_s), mm (H_2O (in. H_2O)	Pressure Differential Across Orifice Meter, mm H_2O, (in. H_2O)	Gas Sample Volume, m³ (ft³)	Gas Sample Temperature at Dry Gas Meter		Temperature of Gas Leaving Condenser or Last Impinger, °C (°F)
							Inlet, °C (°F)	Outlet, °C (°F)	
2			350	0.20					
1	1345		350	0.20					
	1355		End of	TEST					
Total							Avg.	Avg	
Average			348	0.22			Avg		

Figure 8.2. Field data.

2,3,4,6

U.S. EPA METHODS FIELD DATA SUMMARY

Project 5-1009

Plant TU\SG

Sample location COMMON STACK

Date 1-15-87

Run M8\1-15\CS \RUN 4

Impinger 1 Final 691.0 Initial 577.0 Net volume 114.0

Impinger 2 Final 559.0 Initial 550.0 Net volume 9.0

Impinger 3 Final 50.0 Initial 50.0 Net volume 0.0

Silica gel Final 730.4 Initial 713.0 Net volume 17.4

V_{lc}	-	Volume of water collected in train, ml.	140.4
V_m	-	Sample gas volume, meter conditions, dcf.	(36.94 unc) 34.21 cor
Y	-	Meter calibration factor.	0.926
P_{bar}	-	Barometric pressure, in Hg.	29.81
P_g	-	Stack static pressure, in Hg.	-.40
ΔH	-	Average orifice pressure diff., in H_2O	1.12
T_m	-	Absolute meter temperature, °R.	47
$V_{m(std)}$	-	Standard sample gas volume, dscf.	
B_{ws}	-	Water vapor in gas stream	
MF	-	Moisture factor.	
CO_2	-	Dry, volume %.	9.6
O_2	-	Dry, volume %.	10.2
N_2	-	Dry, volume %.	
CH_4	-	Dry, volume %.	
M_d	-	Molecular weight of stack gas, dry.	
M_s	-	Molecular weight of stack gas, wet.	
C_p	-	Pitot tube coefficient.	0.84
Δp	-	Average of the square roots of each p.	0.22
T_s	-	Absolute stack temperature, °R.	350
A	-	Area of stack, ft2.	
Q_{std}	-	Volumetric flowrate, dscfm.	37.72 (9'6" Dia)
An	-	Nozzle area, ft2.	-
Θ	-	Sampling time, min.	60
%I	-	Isokinetic variation.	-

Run 4 U.S. EPA Met 4,6,2

Static pressure mm Hg (in. Hg) -0.40

Plant Tulsa
Location Common Stack
Operator MTT/RAL
Date 1-15-87
Run No. M6/1-15/CS/Run 4
Sample box no. 1
Meter box no. 1
Meter ΔH@ 6.8
C factor -
Pitot tube coefficient, Cp 0.926

Schematic of stack cross section

Ambient temperature 30
Barometric pressure 29.81
Assumed moisture, % 15
Probe length, m (ft) 6
Nozzle identification no. -
Average calibrated nozzle diameter, cm (in.) -
Probe heater setting 5
Leak rate, m³/min, (cfm) 0.005 at 10"
Probe liner material SS
Filter no. 4

VELOCITY TRAVERSE / MET 6

U.S. EPA Method 2 Traverse Number	U.S. EPA Met. 4,6 Sampling Time (Θ), min	Vacuum mm Hg (in. Hg)	Stack Temperature (T_s), °C (°F)	Velocity Head (ΔP_s), mm (H_2O (in. H_2O)	Pressure Differential Across Orifice Meter, mm H_2O, (in. H_2O)	Gas Sample Volume, m^3 (ft^3)	Gas Sample Temperature at Dry Gas Meter Inlet, °C (°F)	Gas Sample Temperature at Dry Gas Meter Outlet, °C (°F)	Temperature of Gas Leaving Condenser or Last Impinger, °C (°F)
6	1516	5	350	0.22	1.0	238.79		40	40
5	1519	6	350	0.23	1.0			42	40
4	1525	2	350	0.24	1.0			45	40
3	1535	6	351	0.23	1.0			50	40
2	1545	5	351	0.22	1.0			52	40
1	1616	5	352	0.22	1.0	275.73		55	40
6	1620		351	0.24					
5	1625		351	0.22					
Total						36.94	Avg.	Avg	
Average					1.0		Avg	47	40

Figure 8.2. Field data.

[redacted]

Plant Tulsa

Location Common Stack

Operator MTT / RAZ

Date 1-15 87

Run No. M6 / 1-15 / CS / Run 4

Sample box no. 1

Meter box no. 1

Meter ΔH@ 0.8

C factor –

Pitot tube coefficient, Cp 0.926

Static pressure mm Hg (in. Hg) -0.40

Ambient temperature 30

Barometric pressure 29.81

Assumed moisture, % 15

Probe length, m (ft) 6

Nozzle identification no. –

Average calibrated nozzle diameter, cm (in.) –

Probe heater setting 5

Leak rate, m³/min, (cfm) 0.005 at 10"

Probe liner material SS

Filter no. 4

Schematic of stack cross section

VELOCITY TRAVERSE

U.S. EPA Method 2 Traverse Number	U.S. EPA Met. 4,6 Sampling Time (Θ), min	Vacuum mm Hg (in. Hg)	Stack Temperature (T_s), °C (°F)	Velocity Head (ΔP_s), mm (H_2O) (in. H_2O)	Pressure Differential Across Orifice Meter, mm H_2O, (in. H_2O)	Gas Sample Volume, m^3 (ft^3)	Gas Sample Temperature at Dry Gas Meter Inlet, °C (°F)	Gas Sample Temperature at Dry Gas Meter Outlet, °C (°F)	Temperature of Gas Leaving Condenser or Last Impinger, °C (°F)
4	1630		350	0.24		–			
3	1631		350	0.22		–			
2	1632		350	0.22		–			
1	1634		350	0.20		–			
6	1640		351	0.24		–			
5	1641		350	0.22		-			
4	1642		350	0.22		–			
3	1644		350	0.18		–			
Total							Avg.	Avg	
Average							Avg		

Figure 8.2. Field data.

[redacted]

U.S. EPA Met 2,3,4,6

Plant Tulsa
Location Common Stack
Operator MET / RAZ
Date 1-15-87
Run No. M6 / 1-15 / CS / Run 4
Sample box no. 1
Meter box no. 1
Meter ΔH@ 0.8
C factor —
Pitot tube coefficient, Cp 0.926

Schematic of stack cross section

Static pressure mm Hg (in. Hg) -0.40
Ambient temperature 30
Barometric pressure 29.81
Assumed moisture, % 15
Probe length, m (ft) 6
Nozzle identification no. —
Average calibrated nozzle diameter, cm (in.) —
Probe heater setting 5
Leak rate, m³/min, (cfm) 0.005 at 10"
Probe liner material SS
Filter no. Y

VELOCITY TRAVERSE

U.S. EPA Method 2 Traverse Number	U.S. EPA Met 4,6 Sampling Time (Θ), min	Vacuum mm Hg (in. Hg)	Stack Temperature (T_s), °C (°F)	Velocity Head (ΔP_s), mm (H_2O) (in. H_2O)	Pressure Differential Across Orifice Meter, mm H_2O, (in. H_2O)	Gas Sample Volume, m³ (ft³)	Gas Sample Temperature at Dry Gas Meter		Temperature of Gas Leaving Condenser or Last Impinger, °C (°F)
							Inlet, °C (°F)	Outlet, °C (°F)	
2	1645		351	0.18		—			
1	1645		351	0.24		—			
6	1647		350	0.24		—			
5	1648		350	0.22		—			
4	1649		350	0.22		—			
3	1650		350	0.22		—			
2	1651		350	0.20					
1	1651		350	0.20					
Total							Avg.	Avg	
Average			350	0.22			Avg		

Figure 8.2. Field data.

ADDENDUM TO REVISE PREVENTION OF SIGNIFICANT DETERIORATION PERMIT
(PSD-OK-556M-2)
Tulsa, Oklahoma

Submitted to:

Mr. Grant Marburger
Director of Permits and Enforcement
Oklahoma State Department of Health
Air Quality Service
1000 N.E. 10th
Oklahoma City, Oklahoma 73152

March 11, 1987

Submitted by:

Ogden Martin Systems of Tulsa, Inc.
2122 South Yukon Avenue
Tulsa, Oklahoma 74107

TERA Environmental
1995 University Avenue
Berkeley, California 94704
415 · 845 · 5200
Telex: 338592

ADDENDUM TO REVISE PREVENTION OF SIGNIFICANT DETERIORATION PERMIT

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APPENDICES

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1.0 SUMMARY

Ogden Martin Systems of Tulsa, Inc. (OMST), a subsidiary of Ogden Projects, Inc., operates the Walter B. Hall Resource Recovery Facility located in Tulsa, Oklahoma. This facility currently operates two combustion/boiler units that each have a design output capacity of 88,500 lbs/hr steam. Based on a refuse heating value of 4,500 Btu/lb, each unit would have a feed rate of 375 tons/day of municipal solid waste and a heat input capacity of 140.6 million Btu/hr. The facility has been issued permits to construct and operate from the Oklahoma Air Quality Service (OAQS), PSD-OK-556M-2, and from the Tulsa City-County Health Department (TCCHD), T84-23. The post-construction performance stack testing of the air emissions discharged to the atmosphere was completed in October, 1986.

The results of the performance stack tests determined that three air pollutants exceed the emission estimates provided in the final pre-construction application document. Those air pollutants are oxides of nitrogen (NO_x), mercury (Hg), and sulfuric acid mist (H_2SO_4).

The purpose of this addendum is twofold, first to request adjustments to the permitted emission rates for NO_x, Hg, and H_2SO_4, and second to request the elimination of specific permit condition 3, which requires that semiannual stack testing be conducted to monitor sulfur dioxide (SO_2) emissions. OMST believes that this addendum provides sufficient data and information to justify the granting of each of these requests.

The results of the performance testing are compared in Table1-1 to the air emission estimates that were used in the final permit application (dated April 2, 1984), and the allowable emission rates approved in the Tulsa City-County Health Department Permit to Operate T83-75, issued October, 1986. Table 1-2 compares the ground-level impacts associated with actual emissions and TCCHD-permitted rates to the PSD regulations. The changes in ground-level impact compared to the 1984 addendum are the result of changed emission rates and use of a different air quality model with different meteorological data. Since the remodeling utilized a five-year meteorological record, the values listed in the table represent the highest second-high impact for all time periods except annual, where the highest value is reported. The changes are described in detail within this addendum. However, the location of maximum ground-level air quality impact has not changed from that presented in the April, 1984, addendum, even though the magnitude of the impact has increased slightly and now exceeds the PSD significance level for NO_x and SO_2. The areas subject to annual impacts which exceed 1.0 $\mu g/m^3$ are located in the elevated

TABLE 1-1

ESTIMATED VERSUS MEASURED AIR EMISSIONS

Pollutant	Air Emissions (TPY)(1)		
	Estimated(2)	Measured	TCCHD Permit(3)
Carbon Monoxide	182.2	27.0	182.2
Nitrogen Oxides	451.6	657.2	876.0
Sulfur Dioxide	441.9	260.0	441.9
Total Suspended Particulates	150.0	50.0	150.0
Volatile Organic Compounds	20.1	0.8	20.1
Lead	0.9	0.44	0.9
Beryllium	2.25×10^{-5}	3.2×10^{-6}	2.25×10^{-5}
Mercury	0.3	0.44	0.5
Fluorides	14.5	5.5	14.5
Sulfuric Acid Mist	5.5	42.5	78.8

(1) Assumes 100% availability, 365 day/year.
(2) From April 1984 addendum.
(3) From October 1986 permit.

TABLE 1-2

COMPARISON OF AIR QUALITY IMPACTS
(μg/m^3)

Pollutant		Units 1 & 2 Maximum Actual Emissions[1]	Units 1 & 2 TCCHD-Permitted Rate[2]	PSD Significance Levels	PSD *De Minimis* Levels	Allowable PSD Increment	Ambient Monitored Level (OAQS 1985 Report)	Total Air Quality	NAAQS	
									Primary	Secondary
TSP	Annual	0.19	0.45	1	-	37	61.4[3]	61.8	75	60
	24-hour	2.3	5.4	5	10	75	NR[4]	-	260	150
SO_2	Annual	0.94	1.4	1	-	40	65.1[5]	66.5	80	-
	24-hour	11.0	16.0	5	13	182	218	234	365	-
	3-hour	21.0	31.0	25	-	700	435.3	466	-	1,300
CO	8-hour	1.7	9.4	500	575	-	4140[6]	4149.4	10,000	10,000
	1-hour	2.5	13.0	2000	-	-	7400[6]	7413.3	40,000	40,000
NO_2	Annual	2.6	2.7	1	14	-	35.5	38.2	100	100
Lead	Quarterly	-[7]	-[7]	-	-	-	NR	-	1.5	1.5
	3-hour	3.9×10^{-2}	6.1×10^{-2}	-	-	-	NR	-	-	-

[1] Reported to two significant figures
[2] From October 1986 permit
[3] Annual Geometric Mean
[4] NR = Not Reported
[5] At Tulsa Monitoring Site #175
[6] At Tulsa Monitoring Site #191
[7] Quarterly impacts not estimated as 3-hour impacts below quarterly NAAQS
Note that all modeling values are reported to two significant figures only.

terraindue north, south, and south-southwest of the facility. A map identifying these areas is provided in Section 7.

Estimated increases in H_2SO_4 emissions now require that control of this pollutant meet the Best Available Control Technology (BACT) requirements. Within this addendum, the H_2SO_4 emissions are shown to be consistent with emissions from similar waste-to-energy facilities which utilize various control technologies, all of which have been demonstrated as providing BACT. Therefore, no additional controls are proposed for control of this pollutant. The BACT determination is discussed in detail in Section 5.

Using the emission rates approved by the TCCHD, the facility neither violates any PSD increments nor contributes significantly toward any violations of the National Ambient Air Quality Standards. The facility meets all applicable federal, state, and local air pollution regulations.

With regard to the second issue to be addressed in the addendum, the first semiannual testing of SO_2 emissions was completed on January 15, 1987. The results of this test are compared in Table 1-3 to the SO_2 performance tests completed in July, 1986. As demonstrated in the table, the values agree closely and do not exhibit wide variations which would justify the continued testing of this pollutant. Based on the monitored data, OMST requests the elimination of the semiannual testing permit condition.

TABLE 1-3

VARIATION IN SO_2 EMISSIONS

Test Date	SO_2 Emission Rate(1)	
	lbs/hr	tons/year
June 23 - July 2, 1986		
Average	64.3	280
Maximum	70.2	310
January 15, 1987		
Run 1	68.6	300
Run 2	56.2	246
Run 3	41.0	180
Average	55.3	242

(1) Assumes 100% annual availability

2.0 INTRODUCTION

Ogden Martin Systems of Tulsa, Inc., operates a waste to energy facility in Tulsa, Oklahoma. The facility incinerates municipal solid waste from Tulsa as provided in agreements with the Tulsa Authority for Recovery of Energy, generates steam for Sun Refining and Marketing Company, and produces electrical energy which is sold to the Public Service Company of Oklahoma for distribution through their grid. In addition to making use of a previously discarded resource and replacing non-renewable fuels such as coal, oil, or natural gas, the facility greatly reduces the volume of material taken to nearby landfills, thereby extending their lifetimes.

The facility is subject to the Prevention of Significant Deterioration (PSD) regulations as administered at the time of the previous April, 1984, pre-construction permit application addendum. The information presented in this addendum has been prepared to satisfy the Oklahoma and USEPA requirements for a complete PSD application.

This addendum has been organized to facilitate the review process. The analyses completed for this addendum are consistent with recommendations and requirements provided by representatives of EPA and the State of Oklahoma.

Based on the results of the stack tests conducted in June, July, and October, 1986, OMST requested modification of the permitted emission rates to correspond to the measured values. The TCCHD responded to the request and adjusted their permit number T83-75 to allow the emission rates listed in Table 1-1. The OAQS requested that OMST reestablish the compliance of the TCCHD-issued emission rates (which in some cases exceeded the actual emission rates) with applicable PSD regulations. This addendum to revise PSD-OK-556-M2 has been prepared as a complete, stand-alone document to present the results of the reanalysis, including documentation of emission rates, remodeling of ground-level impacts, assessment of compliance with PSD regulations, and quantification of potential air quality impacts.

2.1 Applicant Information

The facility is known as the Walter B. Hall Resource Recovery Facility. The following information identifies the applicant and has been signed by a responsible official of the applicant and operator of the facility.

The name and address of the facility operator is:

Ogden Martin Systems of Tulsa, Inc.
2122 South Yukon Avenue
Tulsa, Oklahoma 74104

The undersigned representative of Ogden Martin Systems of Tulsa, Inc., has reviewed this addendum and affirms that all information provided herein is accurate to the best of the company's knowledge.

No business confidentiality claim is made with respect to information contained within this PSD application addendum.

Jeffrey L. Hahn, P.E.
Vice President, Environmental Engineering

Date: 3/[illegible]/87

2.2 Facility Location

The location of the Walter B. Hall Resource Recovery Facility is shown in Figure 2-1. The location and area of the site have not changed from the April, 1984 addendum. Construction is currently underway for a third unit, which has received PSD and local pre-construction approval as currently administered by the TCCHD.

The facility is located within the Tulsa city limits. The area is industrialized, with an oil refinery to the north, another to the southeast, several galvanizing and heavy metal fabricating facilities to the south and east, and a pipeline terminal station to the west. The nearest residence is approximately 1/2 mile due east. The facility location and residence are separated by an eight-lane expressway, a four-lane major thoroughfare, and six sets of railroad tracks. No new significant land development has taken place since the date of the original application. Class I PSD areas are outlined in Figure 2-2. At this time, the only Class I area in Oklahoma is the Wichita Mountain National Wilderness Area, which is approximately 275 kilometers southwest

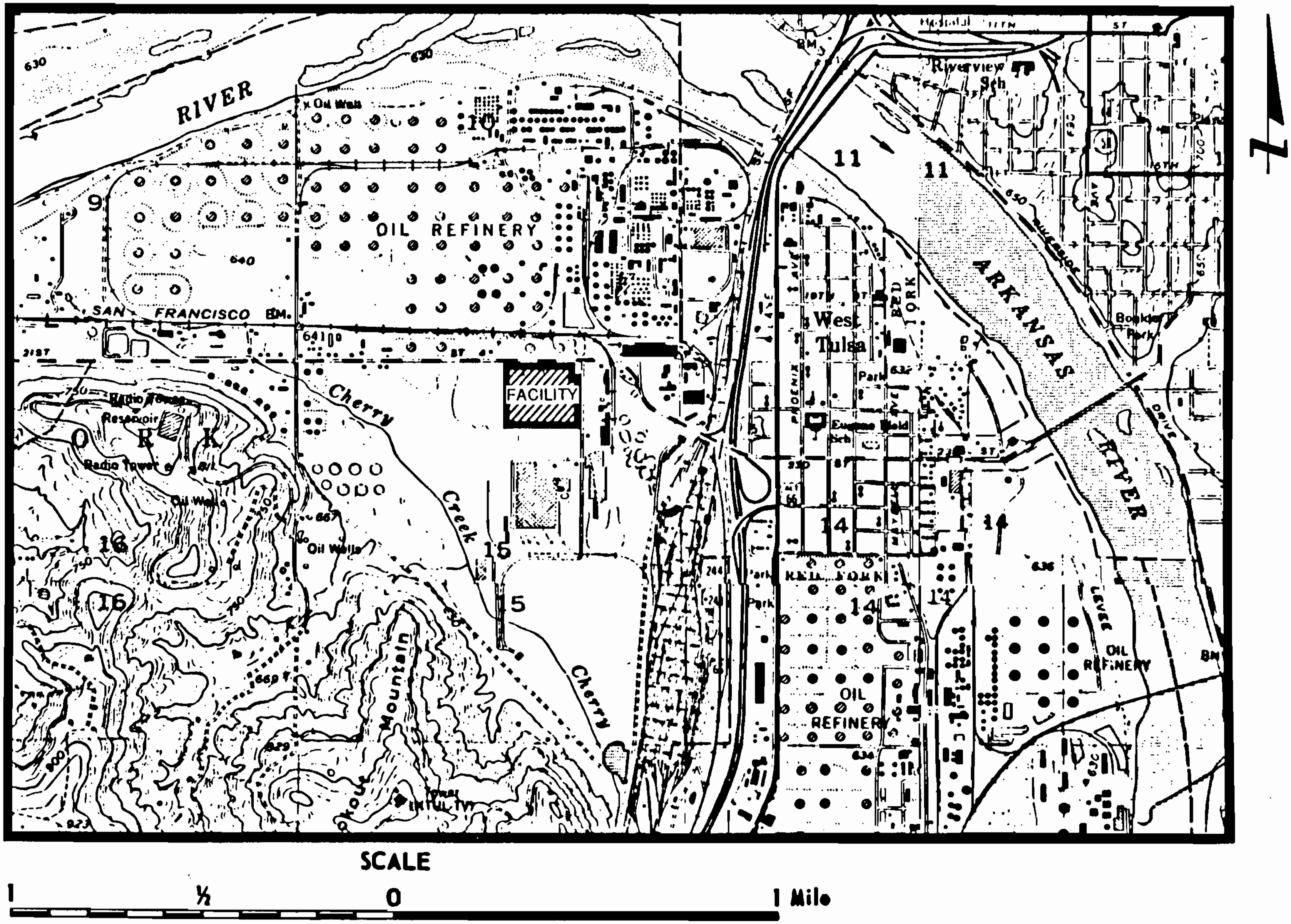


FIGURE 2-1

FACILITY LOCATION

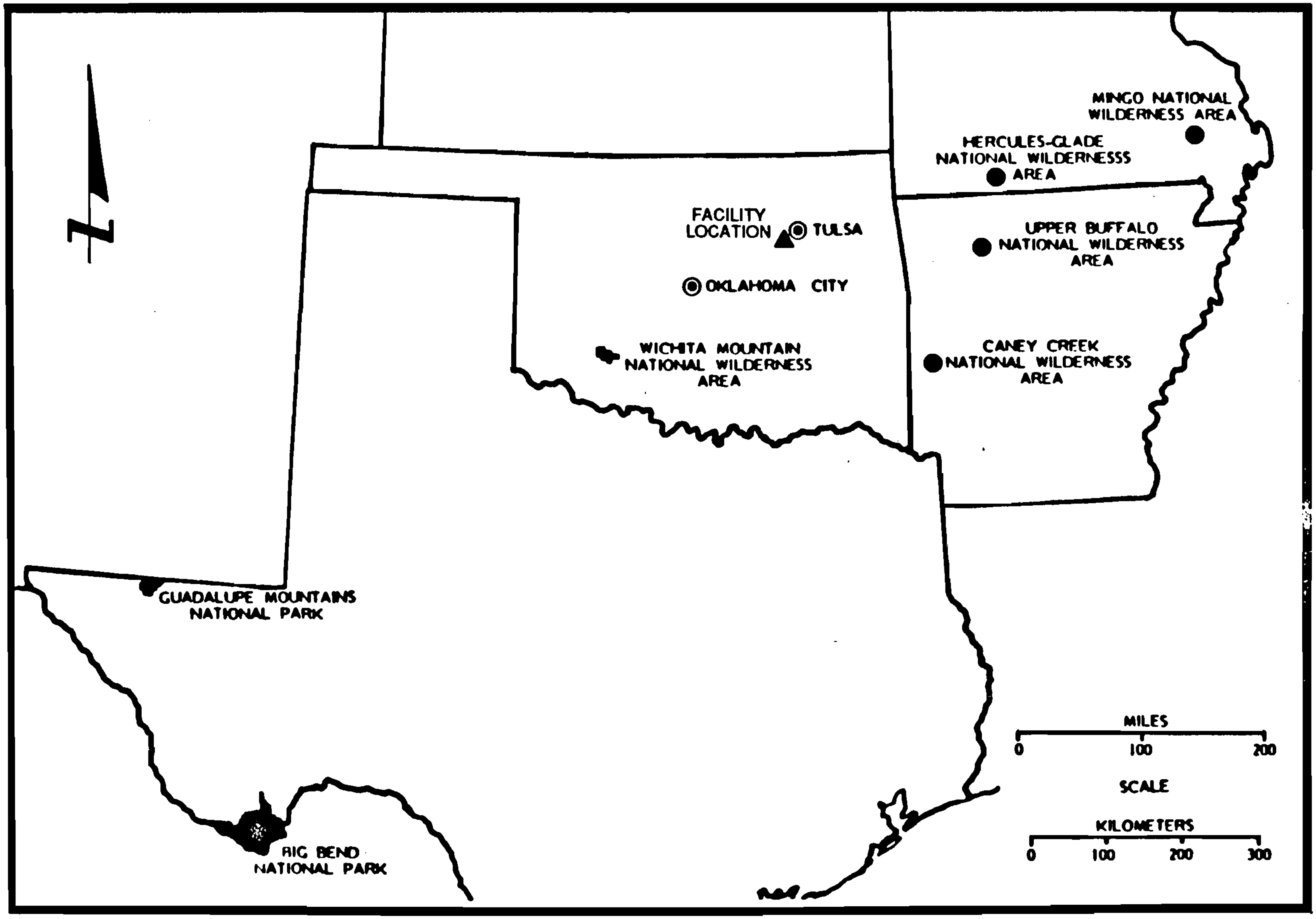


FIGURE 2-2

LOCATION OF NEAREST CLASS I PSD AREAS

of Tulsa. The closest PSD Class I area is the Upper Buffalo National Wilderness Area (in Arkansas), which is located approximately 260 kilometers east-southeast of the facility. The facility is located at the corner of four adjoining USGS quadrangle maps (scale 1:250,000). These maps have been fitted together to provide a development and topographic representation of the facility vicinity. A copy of this map is included in a map pocket and titled Figure 2-3, Facility Vicinity.

FIGURE 2-3

FACILITY VICINITY

(In Map Pocket)

3.0 FACILITY OPERATION

Groundbreaking for the facility began in May, 1984, with construction of Units 1 and 2 completed and the facility dedicated in March, 1986. Since the dedication, the facility has completed routine start-up and conducted the first set of performance tests in late June through early July. Additional tests were conducted in October, 1986, and January, 1987.

3.1 Process Description

Municipal solid waste (MSW) is delivered to the site by vehicles such as refuse packers and roll-off container trucks. These vehicles operate under arrangements with the Tulsa Authority for Recovery of Energy (TARE). The trucks discharge the MSW into a waste storage pit, which is an enclosed building. Non-processible items such as white goods (stoves, refrigerators, etc.), are sorted out and stacked for later disposal or sale. Odors and fugitive dusts are retained within the building as a result of negative air pressure, since air is drawn in from the building to supply combustion air requirements for the stoker/boiler incinerators.

Material from the waste storage pit is conveyed by means of an overhead crane to one of two feed chutes which feed the stoker/boilers, where it is incinerated. Exhaust gases from the boiler pass through a superheater/economizer section. Gases leaving the economizer are cleaned by an electrostatic precipitator. Each unit has a separate precipitator, with the discharge directed to a common stack.

Bottom ash from the stoker/boilers, and fly ash from the economizers, and the electrostatic precipitators is collected and stored in an ash handling building prior to disposal at an approved landfill.

A simplified flow diagram is presented as Figure 3-1, Figure 3-2 shows the plant cross-section, and Figure 3-3 provides a current site plan which identifies the locations of process equipment and the Unit 3 equipment and stack.

At 100 percent design capacity and 100 percent equipment availability, Units 1 and 2 of this facility are able to process 273,750 tons/year of MSW.

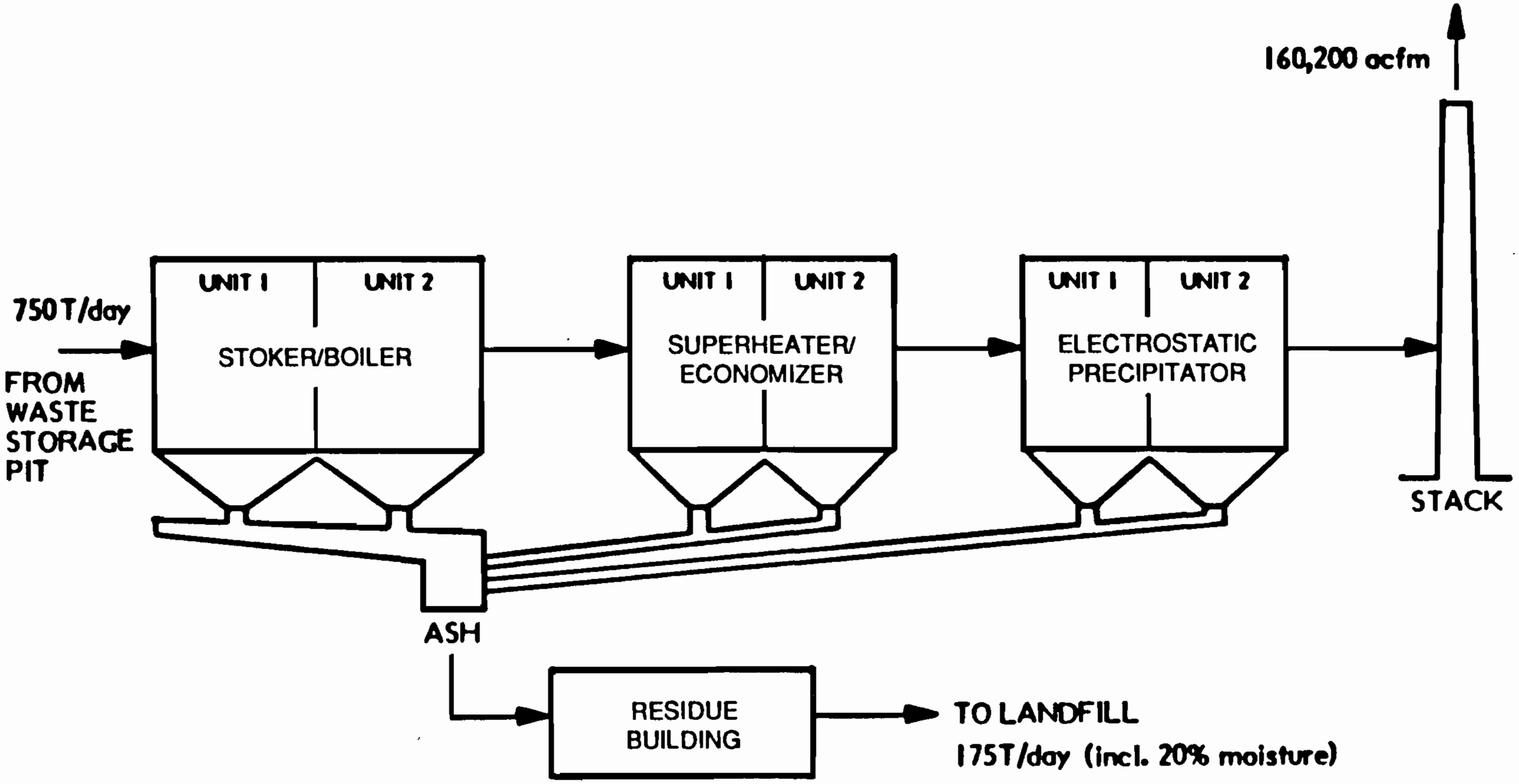


FIGURE 3-1

SIMPLIFIED FLOW DIAGRAM

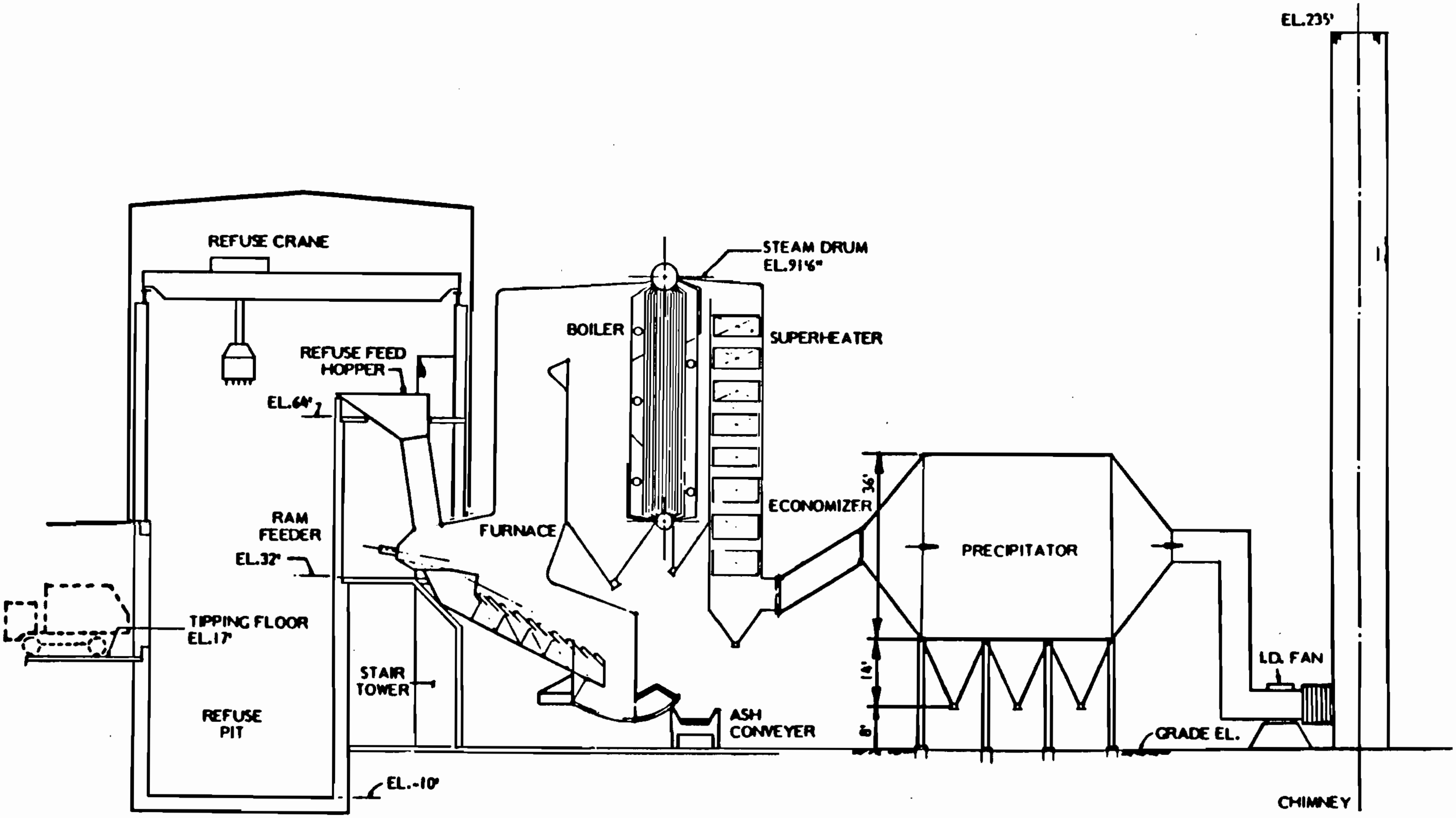
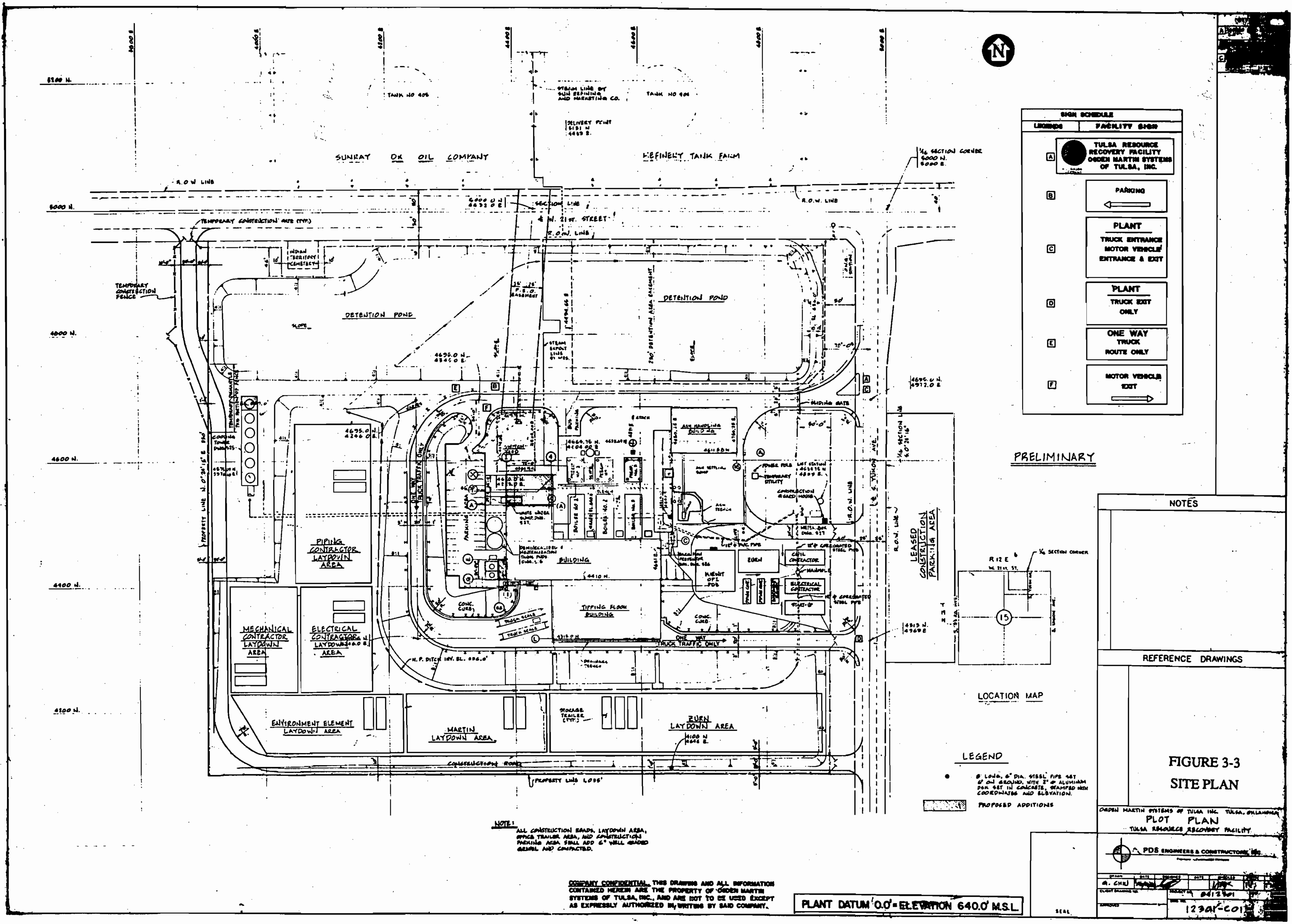


FIGURE 3-2
PLANT CROSS-SECTION

Best Available Copy



NOTE:
ALL CONSTRUCTION ROADS, LAYDOWN AREA, OFFICE TRAILER AREA, AND CONSTRUCTION PARKING AREA SHALL ADD 6" WELL GRADED GRAVEL AND COMPACTED.

COMPANY CONFIDENTIAL. THIS DRAWING AND ALL INFORMATION CONTAINED HEREIN ARE THE PROPERTY OF OGDEN MARTIN SYSTEMS OF TULSA, INC., AND ARE NOT TO BE USED EXCEPT AS EXPRESSLY AUTHORIZED IN WRITING BY SAID COMPANY.

PLANT DATUM 0.0' = ELEVATION 640.0' M.S.L.

FIGURE 3-3
SITE PLAN

3.2 Power/Steam Production

The facility currently operates two stoker/boiler units that each have a design output capacity of 88,500 lbs/hr steam. Based on a refuse heating value of 4,500 Btu/lb, each unit has a feed rate of 375 tons/day of municipal solid waste and a heat input capacity of 140.6 million Btu/hr. The facility has a contract with the Public Service Company of Oklahoma to provide as much as 16.5 megawatts of electricity annually. Currently the facility primarily sells steam up to approximately 160,000 lbs/hr to the Sun Refining and Marketing Company, which is located adjacent to the site.

4.0 EMISSIONS FROM THE PROJECT

Originally, air emissions were estimated based on engineering design, estimated MSW composition, and representative 1970's air emission data available on similar waste-to-energy facilities, including Martin facilities built in the 1970's. This section provides a summary of the estimated emissions and a comparison of the actual emissions, as determined during the performance testing, to the emission rates approved by the TCCHD.

4.1 Estimated Emissions

The estimated emissions presented in the April, 1984, addendum were reported as pounds of pollutant/ton of waste. The emission rate could also have been expressed as pounds of pollutant/million Btu as determined by the boiler operation. The annual emission estimates were based on 100 percent equipment availability for an entire 365-day year. Table 4-1 provides a listing by pollutant of emission factor and total annual emission rate.

4.2 Actual Emissions

The actual emissions and gas flow characteristics have been determined by performance testing of the emitted stack gases. This performance testing was conducted during June and July, 1986, by representatives of Ogden Projects, Inc. (OPI), with the exception of the continuous emission monitoring compliance testing of NO_x, CO, and VOC, which was conducted by Petro Chem Environmental Services. The laboratory analyses of TSP, H_2SO_4, SO_2, and HCl were performed by OPI, and the analyses of Pb, Be, and Hg were conducted by Brown and Caldwell Analytical Laboratories. Additionally, non-PSD pollutants such as PCDDs and PCDFs were included in the testing with the isomer-specific analyses performed by Triangle Laboratories.

After review of the June and July data with representatives of the TCCHD, OPI agreed to re-test the common stack for NO_x emissions in October, 1986. Subsequent to the last performance test, the OAQS-required semiannual SO_2 test was conducted in January, 1987. All test results have been submitted to the OAQS, TCCHD, and EPA Region VI. Copies of each of the test reports are included in a separately bound appendix to this permit modification request. Table 4-2 provides a summary listing of the test results. As indicated above, the actual gas flow characteristics such as total volumetric flow, velocity, and temperature were also documented by the testing. The data for the gas flow characteristic calculations are presented in Appendix B.

TABLE 4-1

ESTIMATED EMISSION FACTORS AND RATES(1)

	Two Units in Operation			
Pollutant	gm/sec	lb/hr	lb/mBtu(2)	t/yr
TSP	4.3	34.2	0.12	150.0
SO_2	12.71	100.9	0.36	441.9
NO_x	13.0	103.1	0.37	451.6
VOC	0.58	4.6	1.6×10^{-2}	20.1
CO	5.24	41.6	0.15	182.2
Pb	0.025	0.2	7.1×10^{-4}	0.9
Hg	7.8×10^{-3}	0.0625	2.2×10^{-4}	0.3
Be	6.46×10^{-7}	5.13×10^{-6}	1.8×10^{-8}	2.25×10^{-5}
HF	0.42	3.3	1.2×10^{-2}	14.5
H_2SO_4	0.16	1.25	4.4×10^{-3}	5.5

(1) from April 1984 Application.

(2) million Btu produced by burning waste.

TABLE 4-2

RESULTS OF PERFORMANCE TESTS

Pollutant	Test Date (1986)	Maximum Emission Rate	
		lbs/hr	g/sec
TSP	6/25	14.3	1.8
SO_2	6/23 - 7/2	70.2	8.85
NO_x	6/24, 6/27$^{(1)}$	191.7	24.15
VOC	6/24, 6/27	< 0.2	0.025
CO	6/24, 6/27	7.7	0.97
Pb	7/1	0.13	0.016
Hg	6/30	0.12	0.015
Be	7/1	$< 8.0 \times 10^{-7}$	$< 1.0 \times 10^{-7}$
Total F	6/23 - 7/2	1.95	0.246
H_2SO_4	6/23 - 7/2	14.8	1.86

(1) Stack retest for NO_x on 10/8/86 shows significantly lower emissions (an average of 142.6 lbs/hr for three runs).

Stack Parameters:

Temperature (T) = 453.0°K
Gas Flow Velocity (V) = 21.1 m/sec
Stack Height (H) = 71.63 m
Stack Diameter (D) = 2.13 m
Average Air Volume ($\overline{Q}$) = 160,200.0 acfm

4.3 TCCHD-Permitted Emission Rate

Based on the results of the performance tests, the TCCHD issued the facility a local permit to operate. For those pollutants for which the actual emissions were less than the original estimate, the originally estimated value was adopted as the enforceable permit limitation. For the three pollutants (NO_x, Hg, and H_2SO_4) for which actual emissions exceeded the estimated rate, a new permitted value was assigned. The new values allowed for some variability in emission rates based on an understanding that the quality (heating value and chemical composition) of the fuel source is not constant, and that the higher emission rates would not have a significant impact on ambient air quality.

Table 4-3 provides a summary listing comparing the maximum annual emissions to the TCCHD-permitted emission rates. The values are listed in grams/sec, pounds/hour, pounds/million Btu produced, and tons/year.

TABLE 4-3

MAXIMUM ANNUAL VERSUS PERMITTED EMISSION RATES

Pollutant	Maximum Emissions				TCCHD-Permitted Emissions(1)			
	gm/sec	lb/hr	lb/mBtu	t/yr	gm/sec	lb/hr	lb/mBtu	t/yr
TSP	1.80	14.3	5.1×10^{-2}	63	4.3	34.2	0.12	150.0
SO_2	8.85	70.2	0.25	310	12.71	100.9	0.36	441.9
NO_X	24.15	191.7	0.68	840	25.2	200.0	0.71	876
VOC	0.025	< 0.2	7.1×10^{-4}	0.88	0.58	4.6	1.6×10^{-2}	20.1
CO	0.97	7.7	2.7×10^{-2}	34	5.24	41.6	0.15	182.2
Pb	0.016	0.13	4.6×10^{-4}	0.57	2.5×10^{-2}	0.2	7.1×10^{-4}	0.9
Hg	0.015	0.12	4.3×10^{-4}	0.53	1.5×10^{-2}	0.12	4.3×10^{-4}	0.5
Be	$< 1.0 \times 10^{-7}$	$< 8.0 \times 10^{-7}$	$< 2.8 \times 10^{-9}$	$< 3.5 \times 10^{-6}$	6.46×10^{-7}	5.13×10^{-6}	1.8×10^{-8}	2.25×10^{-5}
Total F	0.246	1.95	6.9×10^{-3}	8.5	0.42	3.3	1.2×10^{-2}	14.5
H_2SO_4	1.86	14.8	5.3×10^{-2}	65	2.27	18.0	6.4×10^{-2}	78.8
HCl	22.18	176.0	0.63	770	24.4	194.0	0.69	849.7

(1) From October 1986 permit.

5.0 BEST AVAILABLE CONTROL TECHNOLOGY (BACT)

Efficient and stable stoker/boiler operation in conjunction with the use of individual electrostatic precipitators (ESPs) was accepted by all permitting agencies as the Best Available Control Technology (BACT) for this facility. The purpose of this section is to demonstrate that this strategy for control of air pollution still represents BACT for this facility under the new requested emission rates.

5.1 Applicable Regulations

Prevention of Significant Deterioration (PSD) regulations stipulate that BACT must be applied when facility emissions for any pollutant exceed PSD significance levels. The April, 1984, emission estimates and the TCCHD-permitted emission rates are compared to the PSD significance levels in Table 5-1. A BACT determination is necessary for carbon monoxide (CO), nitrogen oxides (NO_x), sulfur dioxide (SO_2), total suspended particulates (TSP), lead (Pb), mercury (Hg), fluorides (HF), and sulfuric acid mist (H_2SO_4), since the requested emission rate for these pollutants is greater than the associated PSD significance levels.

5.2 Current BACT Determination

Efficient and stable stoker/boiler operation in conjunction with the use of ESPs was demonstrated as BACT for each pollutant except H_2SO_4, which, due to the measured emission rate, is now subject to BACT. The proposed BACT for H_2SO_4 is presented in the following subsections along with justification for continuation of existing operations and controls as BACT.

No change in emission rate is requested for carbon monoxide, sulfur dioxide, total suspended particulates, lead, or fluorides. The BACT analysis presented in the April, 1984, addendum as approved by OAQS and EPA remains valid for the control of these air pollutants. However, based on the performance tests and as interpreted by the TCCHD, increases in emissions without adjustments to BACT are requested for nitrogen oxides, mercury, and sulfuric acid mist.

5.2.1 Oxides Of Nitrogen

The April, 1984, application addendum established that efficient and stable stoker/boiler operation would provide control of NO_x emissions. Such efficient and stable operation has been

TABLE 5-1

EPA CRITERIA FOR SIGNIFICANT EMISSION RATES AND TCCHD-PERMITTED EMISSION RATES FROM THE FACILITY

Pollutant	Significant Emission Rate (TPY)	Estimated Project Emission Rate(1) (TPY)	TCCHD-Permitted Emission Rate(2) (TPY)	Subject to BACT
Carbon Monoxide	100.0	182.2	182.2	yes
Nitrogen Oxides	40.0	451.6	876.0	yes
Sulfur Dioxide	40.0	441.9	441.9	yes
Total Suspended Particulates	25.0	150.0	150.0	yes
Volatile Organic Compounds (Ozone)	40.0	20.1	20.1	no
Lead	0.6	0.9	0.9	yes
Asbestos	0.007	--(3)	--	no
Beryllium	0.0004	2.25×10^{-5}	2.25×10^{-5}	no
Mercury	0.1	0.3	0.5	yes
Vinyl Chloride	1.0	--	--	no
Fluorides	3.0	14.5	14.5	yes
Sulfuric Acid Mist	7.0	5.5	78.8	yes(4)
Total Reduced Sulfur (Including H_2S)	10.0	--	--	no

(1) From April 1984 application addendum.

(2) From October 1986 permit.

(3) Blanks indicate emission rates below minimum detection levels.

(4) The permitted emission rate of sulfuric acid mist is now subject to BACT.

demonstrated during the start-up and performance testing of the units. The highest nitrogen levels were measured during the June and July performance testing and were attributable to the summertime peaking of vegetative matter (lawn trimmings) in the waste stream. The anticipated variability of the nitrogen content of the fuels (which has a direct effect on the NO_x emissions) was demonstrated by the significantly lower results obtained during the October 1986 re-test. Any adjustments to the operation to reduce NO_x emissions would have significant detrimental effects on the life of the process equipment. In addition, production of non-PSD regulated pollutants such as dioxins would also be increased; these are pollutants whose generation or control is not completely understood, except that lower dioxin emission rates are associated with low CO emission. CO emission rates would also rise if the stoker/boiler operating parameters were changed.

No additional pollution equipment or change in stoker/boiler operation are proposed as BACT for control of this seasonal NO_x peak.

5.2.2 Mercury

At the time of the April, 1984, application addendum, mercury emissions were estimated based on an average mercury content of 1 ppm by weight, or 0.002 pounds/ton of municipal solid waste. Subsequent air emissions data from other recent performance tests conducted worldwide has shown that mercury emissions (when normalized to pound of emission per ton of waste) are virtually independent of the type of pollution control equipment used. Table 5-2 lists the results of tests from other facilities. The average mercury emission rate is shown to be 0.00298 lbs/ton with a standard deviation of 0.00180. With an emission rate of 0.0036 lbs/ton, mercury emissions from the Tulsa project agree closely with the worldwide average.

Since the type of pollution control equipment has negligible effect on Hg emissions, no change in BACT is proposed for control of this pollutant.

5.2.3 Sulfuric Acid Mist

Emissions of sulfuric acid mist were estimated based on tests completed on the Martin facility in Harrisburg, PA. Additional data obtained from source tests of the KURE facility in Japan have established a more direct relationship between sulfur dioxide emissions and sulfuric acid mist emissions when ESPs are the pollution control equipment. The KURE data show that sulfuric acid mist emissions are approximately 13 percent of the sulfur dioxide emissions. The

TABLE 5-2

SUMMARY OF MERCURY EMISSIONS DATA(1)

Plant I.D. (Year)	Test I.D.	Emissions lb/ton	Pollution Control(2)
Japan (1983)	2 Samples	0.00093	DS/FF
Sheridan Avenue (1984)	1	0.00391	ESP
	2	0.00270	
	3	0.00449	
Kure (1980)		0.00045	ESP
Swaru (1979)	2	0.0028	ESP
	3	0.0040	
	4	0.0036	
	5	0.0022	
	6	0.0026	
	7	0.0023	
Sysav-Malmo (1983)	Average(2)	0.00235	
Gallatin (1983)	2/7/83	0.00119	FF
	2/8/83	0.00268	
	2/9/83	0.00127	
Charlottetown (1985)	PT2	0.0040	NC
	PT3	0.0038	
	PT4	0.0090	
Marion County (1986)	1	0.0023	DS/FF
	2	0.0030	
Overall Average		0.00298	
Standard Deviation		0.00180	
Tulsa (1986)	Average(4)	0.0036	ESP

NOTES:
(1) All plant and emissions data (except Marion County and Tulsa) from Ogden Projects, Inc., Response to Data Request 140(b), IRRF, CEC, 1985
(2) DS = Dry Scrubber; FF = Fabric Filter; ESP = Electrostatic Precipitator; NC = No Control
(3) Average of 20 samples
(4) Average value from three samples

ratio of these two pollutants for the Tulsa facility is 16 percent. The original estimate using the Harrisburg data predicted a 1 percent ratio. The equilibrium relationship between SO_2 and H_2SO_4 in the flue gas is shown in Table 5-3.

The error in estimating sulfuric acid mist emissions is due in part to lack of data for comparable facilities at the time of the application. However, as shown in Section 7, the resultant impact on air quality from the higher emission rate is negligible when compared to criteria established by the OAQS for toxic/hazardous emissions. Based on this negligible impact, the continued use of ESPs and existing operating conditions are requested as BACT for control of sulfuric acid mist.

5.3 Good Engineering Practice (GEP)

After review of environmental and economic factors, a stack height of 235 feet (71.6 meters) was selected and approved for this project as meeting GEP guidelines set by the EPA. This optimum stack height for the project was determined by considering physical building dimensions, changes to air quality impacts, aesthetics, and safety.

TABLE 5-3

SUMMARY OF H_2SO_4 EMISSIONS

Plant	Pollutant	Emission Rate, (lb/ton)	
		Estimated	Measured
Tulsa	SO_2	3.23	1.90
	H_2SO_4	0.04	0.31
	Ratio: H_2SO_4/SO_2	0.012	0.16
Kure	SO_2	--	1.38
	H_2SO_4	--	0.18
	Ratio: H_2SO_4/SO_2	--	0.13

6.0 AIR QUALITY AND CLIMATOLOGICAL DATA

The State of Oklahoma has been divided into eight Air Quality Control Regions (AQCR) as shown in Figure 6-1. The Walter B. Hall Resource Recovery Facility is located within the Northeastern Oklahoma Interstate AQCR, Region 186.

6.1 Existing Ambient Air Quality Data

A summary of air quality data measured at Tulsa is presented in this section, including data for total suspended particulates, sulfur dioxide, nitrogen dioxide, ozone, carbon monoxide, and lead. The data presented are from the nearest sites operated by the Tulsa City-County Health Department. Figure 6-2 shows the monitoring sites operated within Tulsa County and indicates the TSP non-attainment area in the vicinity of the project site. All of Tulsa County is non-attainment for ozone (O_3).

6.1.1 Total Suspended Particulates

The Pollution Control Air Monitoring Section of the Tulsa City-County Health Department operated particulate monitors at eight sites in Tulsa County in 1985, the most recent year for which data are available. The 1985 Annual Air Quality Report produced by the Oklahoma State Department of Health reports TSP data in terms of annual geometric mean and a distribution range summary for all observations. The latest data available, from the three years 1983 through 1985, show average TSP values decreasing slightly over time at the downtown Tulsa monitoring site. All TSP values within the vicinity of the project attain the National Ambient Air Quality standards. Annual geometric means for the TCCHD monitors in the vicinity of the site are listed in Table 6-1 for 1983 to 1985. An area to the west of the facility is designated as a non-attainment area for TSP, as shown in Figure 6-1. This area is located outside of the facility impact area.

6.1.2 Sulfur Dioxide

The Air Monitoring Section of the TCCHD reports that SO_2 levels have never been a problem in Tulsa County. Table 6-2 shows monitoring data for sulfur dioxide at Sites 135 and 175 for 1983, 1984, and 1985. The table shows values increasing during this time period; however, all values

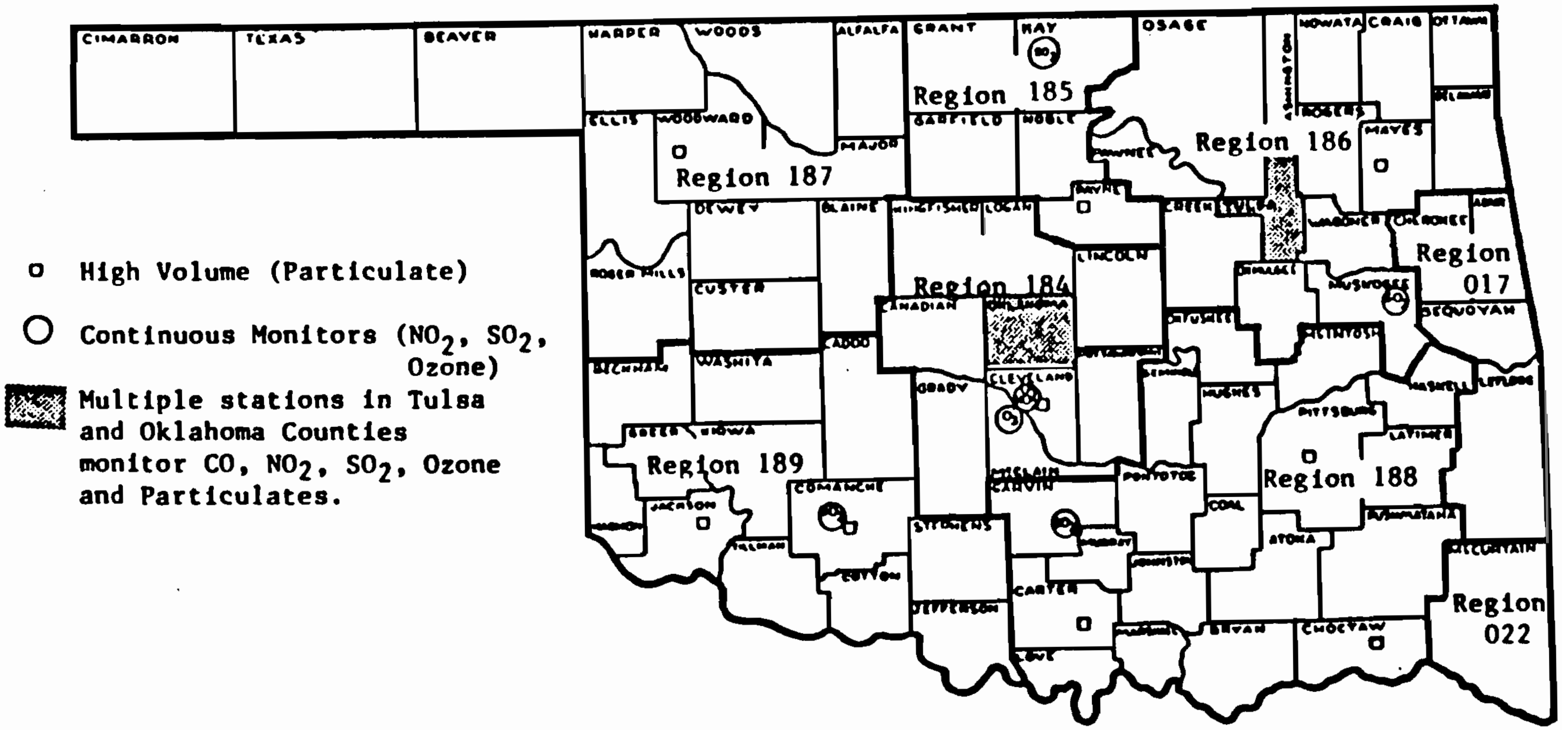


FIGURE 6-1

1985 OKLAHOMA AIR SAMPLING NETWORK

Source: OAQS Air Quality Report, 1985

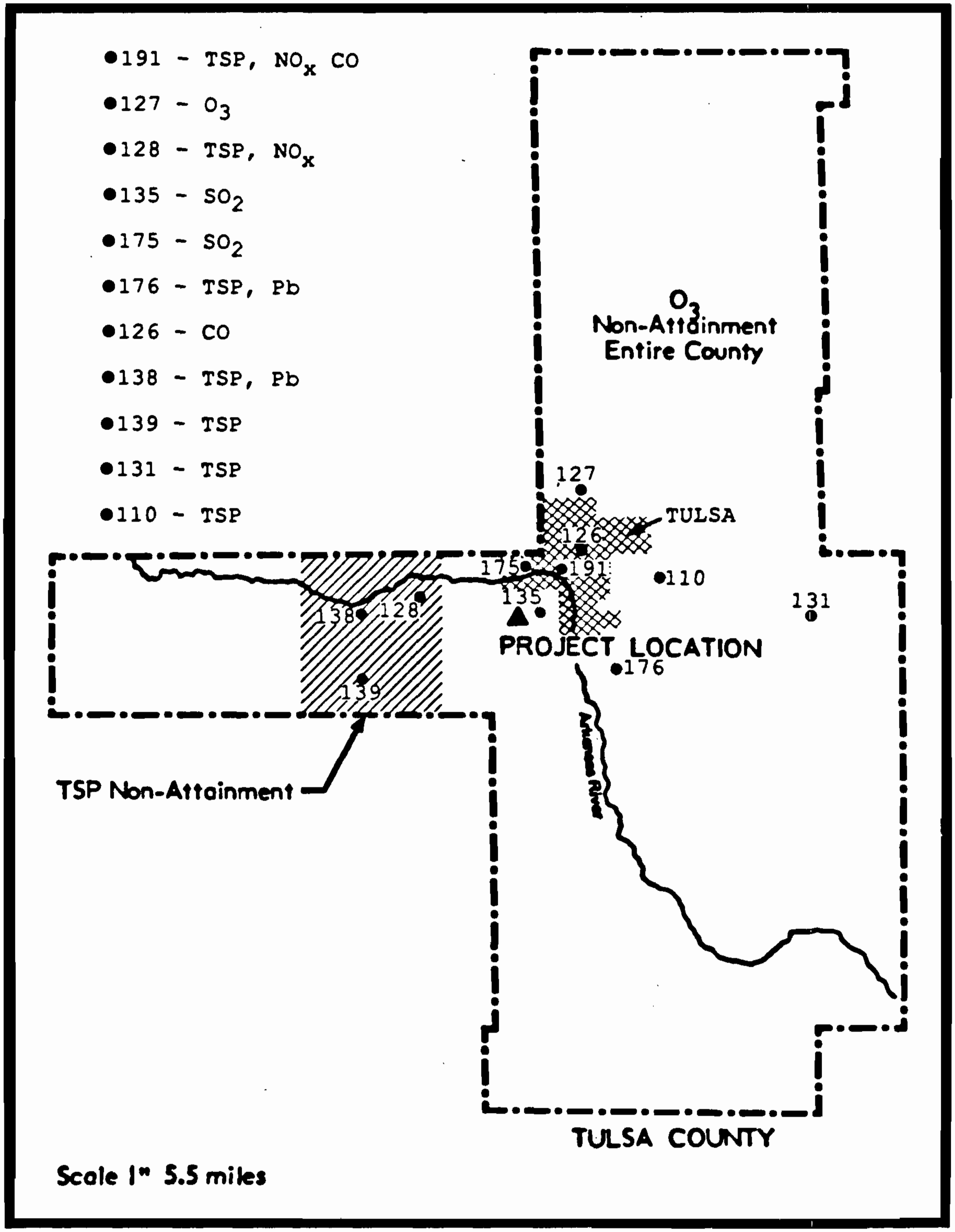


FIGURE 6-2

NON-ATTAINMENT AREAS AND
AIR QUALITY MONITORING SITES

Source: OAQS, Air Quality Report, 1985

TABLE 6-1

TOTAL SUSPENDED PARTICULATE DATA

Site Location	Site Number	Year	Distribution In Ranges ($\mu g/m^3$) 0-64	65-130	131-195	196-260	Number of Observations	Geometric Mean	Maximum Value	High Reached >Once
TULSA	110	85	33	27	0	0	60	61.7	129	85
	110	84	31	30	0	0	61	61.7	130	109
	110	83	33	24	0	0	57	60.0	127	113
SAND SPRINGS	128	85	24	34	1	0	59	68.3	157	84
	128	84	24	38	0	0	62	67.3	112	109
	128	83	24	26	1	0	61	70.4	143	115
TULSA	131	85	28	29	1	0	58	63.1	147	83
	131	84	26	32	0	0	58	65.1	101	99
	131	83	34	25	4	0	63	65.3	157	150
SAND SPRINGS	138	85	16	38	7	0	61	81.2	184	115
	138	84	12	50	0	0	62	71.8	118	112
	138	83	20	43	0	1	64	72.0	218	126
TULSA	139	85	30	29	1	0	60	63.6	147	70
	139	84	18	40	0	0	58	68.0	117	113
	139	83	27	33	2	0	62	64.7	166	138
TULSA	176	85	30	28	0	0	58	60.4	103	74
	176	84	37	24	0	0	61	61.5	100	98
	176	83	35	25	0	0	60	60.0	101	100
TULSA	191	85	30	27	0	0	57	61.4	111	75
	191	84	35	23	0	0	58	60.1	102	81
	191	83	83	14	3	0	17	55.1	72	69

TABLE 6-2

AMBIENT POLLUTANT CONCENTRATIONS NEAR THE FACILITY SITE

		Reported Value (µg/m^3)		
Pollutant	Averaging Time	1983	1984	1985
Sulfur Dioxide	Highest Hourly	324.0	515.0	841.0
Site 135	Highest 3-Hour	181.0	279.7	491.3
	Highest 24-Hour	70.6	110.3	138.9
	Annual Average	14.8	NR	17.3
Sulfur Dioxide	Highest Hourly	323.0	349.0	496.0
Site 175	Highest 3-Hour	228.3	281.0	435.3
	Highest 24-Hour	121.6	152.0	217.8
	Annual Average	24.5	NR	65.1
Nitrogen Dioxide				
Sites 112 & 191	Annual Average	40.5	33.4	35.5
Site 127	Annual Average	31.6	29.0	26.6
Ozone - Site 127	Highest Hourly	263.0	301.0	248.0
Carbon Monoxide	Highest Hourly	10.1	8.0	7.4
Sites 112 & 191	Highest 8-Hour	8.3	6.2	4.8
Lead	First Quarter	0.20	0.29	0.21
Site 176	Second Quarter	0.12	0.21	0.16
	Third Quarter	0.20	0.35	0.10
	Fourth Quarter	0.23	0.30	0.15

NR = Not Reported.

Source: Tulsa City-County Health Department, 1986.

still indicate attainment of the NAAQ standards. Previous data for 1981 also indicated attainment of SO_2 standards.

6.1.3 Nitrogen Dioxide

The highest one-hour reading for NO_2 in downtown Tulsa in 1984 was 244 μ/m^3. One-hour values were not reported for 1985. During 1985, the annual average was 35.5 $\mu g/m^3$, well below the NAAQ standard of 100 $\mu g/m^3$. Annual summary data for recent years are presented in Table 6-2.

6.1.4 Ozone

Exceedances of the ozone standard are common and the entire County of Tulsa is designated as a non-attainment area for ozone. In 1985, the high one-hour value reported at Site 127 was 248 $\mu g/m^3$, which is above the 235 $\mu g/m^3$ standard. Data from other years also show exceedances of the standard, as seen in Table 6-2.

6.1.5 Carbon Monoxide

In 1985, the highest 8-hour average for CO was measured at Site 126 at 5.7 mg/m^3. The major contributor to CO levels in downtown Tulsa is automobiles. Thus, values in other parts of the county would be expected to be significantly lower. In the vicinity of the project, the highest 8-hour average was measured at 4.8 mg/m^3.

6.1.6 Lead

Table 6-2 shows ambient lead concentrations on a quarterly basis for 1983, 1984, and 1985. The highest quarterly lead average for 1985 was 0.21, considerably below the applicable standard of 1.5 $\mu g/m^3$.

6.2 Local Climate And Meteorological Conditions

6.2.1 Climate

Tulsa is located along the Arkansas River in the northeastern region of Oklahoma. It is approximately 900 miles south of the Canadian border and 500 miles north of the Gulf of Mexico. The surrounding country is gently rolling, with no nearby mountains that affect weather conditions. Elevations range around 700 feet above mean sea level.

Normally the climate is controlled by the continental circulation characteristic of the region. The continental effect produces pronounced daily and seasonal temperature changes and considerable variation in seasonal and annual precipitation. Periodically some influence is exerted by moist, warm air currents from the Gulf of Mexico. Summers are long and usually hot. Winters are comparatively mild.

The annual average temperature for Tulsa is 60.2^{O}F. In a typical year, 72 days will have maximum temperatures exceeding 90^{O}F. An average of 85 days will have temperatures of 32^{O}F or lower, but only one to three days will have temperatures of zero or lower.

Spring and summer rainfall comes mainly from showers or thunderstorms, while fall rains are steady. A typical year has 90 days with 0.01 inch or more of precipitation. Quarterly distribution of precipitation is normally as follows: 15 percent in January - March, 38 percent in April - June, 29 percent in July - September, and 18 percent in October - December. The months with the lowest precipitation are November, December, January, and February; the month with the most rainfall is May. Snowfall averages less than 10 inches per year and seldom remains on the ground very long. Violent windstorms and tornadoes affect the Tulsa area, more in the spring and early summer than throughout the remainder of the year. Heavy fogs are infrequent.

6.2.2 Dispersion Meteorology

The nearest long-term record of wind speed and direction data was obtained for Tulsa International Airport, which is approximately nine miles northeast of the project site. While there are sources of data located closer to the project, these sources do not routinely record all of the parameters necessary for dispersion modeling. The frequency, speed, and direction of Tulsa winds are shown in Figure 6-3. Winds are commonly from the south or south-southeast. Surface

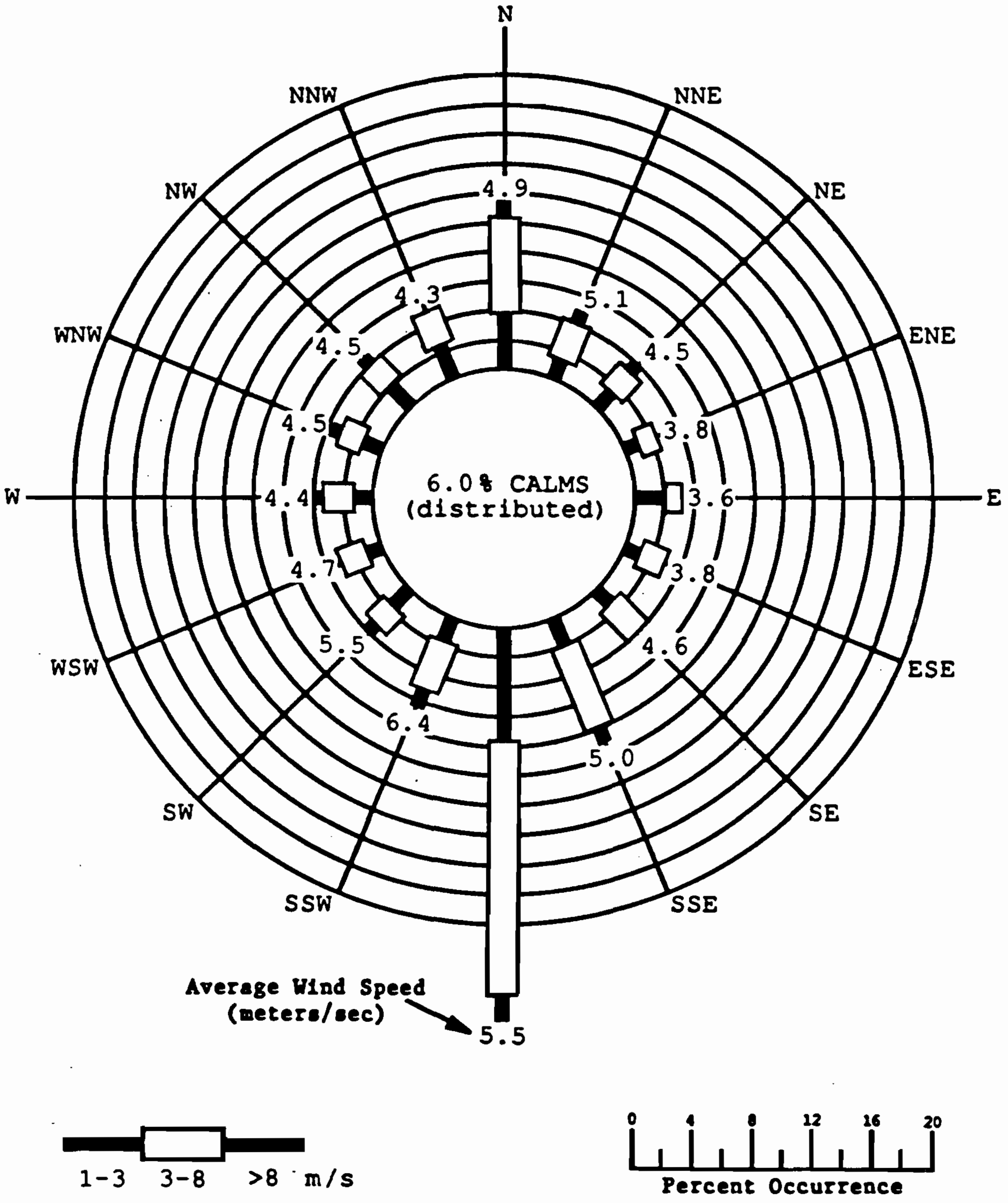


FIGURE 6-3

WIND ROSE FOR
TULSA, OKLAHOMA 1973 - 1977

data from Tulsa International Airport were utilized in all previous dispersion modeling analyses for annual impact estimates.

For the reassessment of the air quality impacts based on permitted emissions (from TCCHD after completion of actual emissions tests), and actual stack gas exit conditions, the OAQS required the use of surface data from Ponca City, Oklahoma, and upper-level mixing heights from Norman (1974) and Oklahoma City (1975 - 1978). Ponca City, elevation 1,003 feet msl, is located in May County on the northern border of central Oklahoma, approximately 70 miles northwest of Tulsa. Oklahoma City and Norman are located in central Oklahoma, approximately 100 miles southwest of Tulsa. Norman is located approximately 10 miles south of Oklahoma City.

The continuous five-year record of hourly observations (1974-1978) allowed the use of the Industrial Source Complex (ISC) model for calculation of air quality impacts for short- and long-term periods. The frequency, speed, and direction of Ponca City winds are shown for each year of record in Figures 6-4 through 6-8. The wind rose data for Tulsa and Ponca City exhibit common trends for persistent north and south wind flow and average wind speeds.

6.2.3 Air Stagnation Potential

Large-scale air pollution episodes tend to be associated with high pressure systems and light winds lingering over an area for several days or longer. Most high pressure systems that occur in the Tulsa region's climate are migratory and do not stagnate. Thus, in general, the region is not subjected to serious air pollution episodes.

Meteorological conditions which are typically conducive to high air pollution potential on a large scale are light winds, surface temperature inversions, and stable layers aloft. The surface inversion is usually a short-term effect because surface heating on most days produces a well-mixed boundary layer by mid-afternoon. The surface-based inversion generally increases the close-in air quality impact by restricting the vertical mixing of pollutants to a region close to the ground. If warming caused by subsiding air occurs, a stable layer aloft (subsidence inversion) may also result. This condition limits the mixing depth, which is the depth over which relatively vigorous vertical mixing takes place, and can also increase the air quality impact of a source. The seasonal and annual mean mixing heights and wind speeds for Oklahoma City, which is the nearest city analyzed, are presented in Table 6-3.

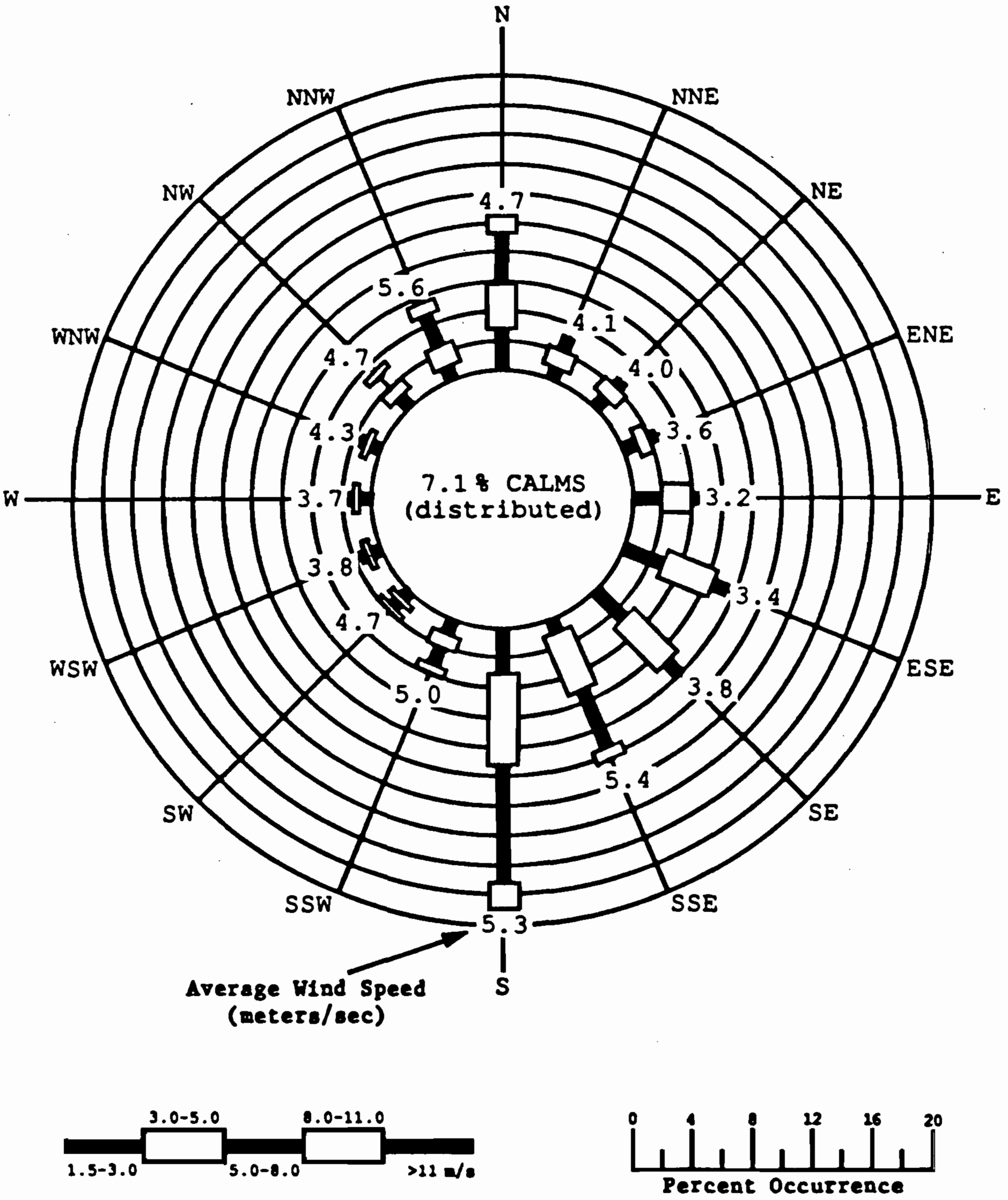


FIGURE 6-4

WIND ROSE FOR
PONCA CITY, OKLAHOMA 1974

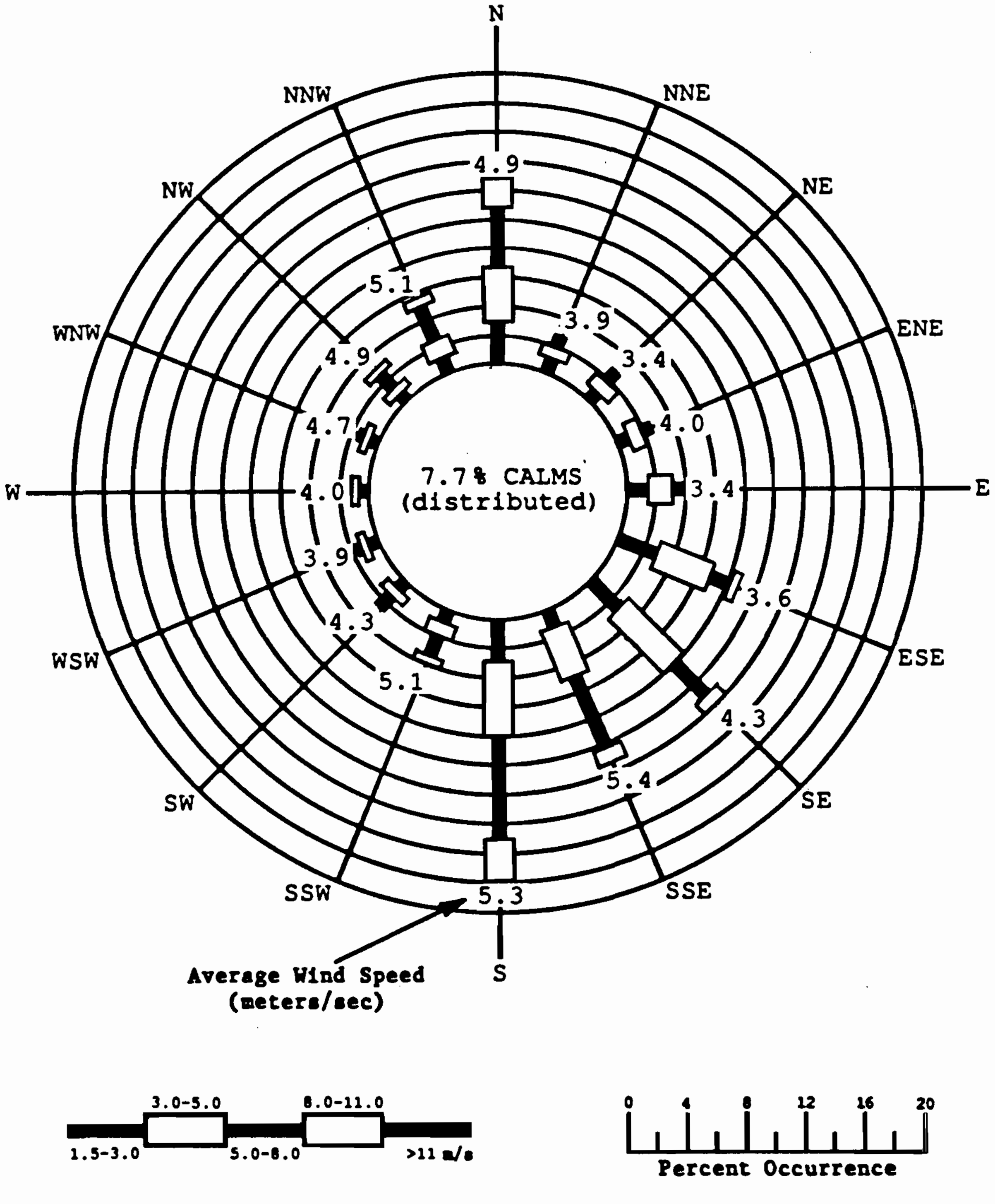


FIGURE 6-5

WIND ROSE FOR
PONCA CITY, OKLAHOMA 1975

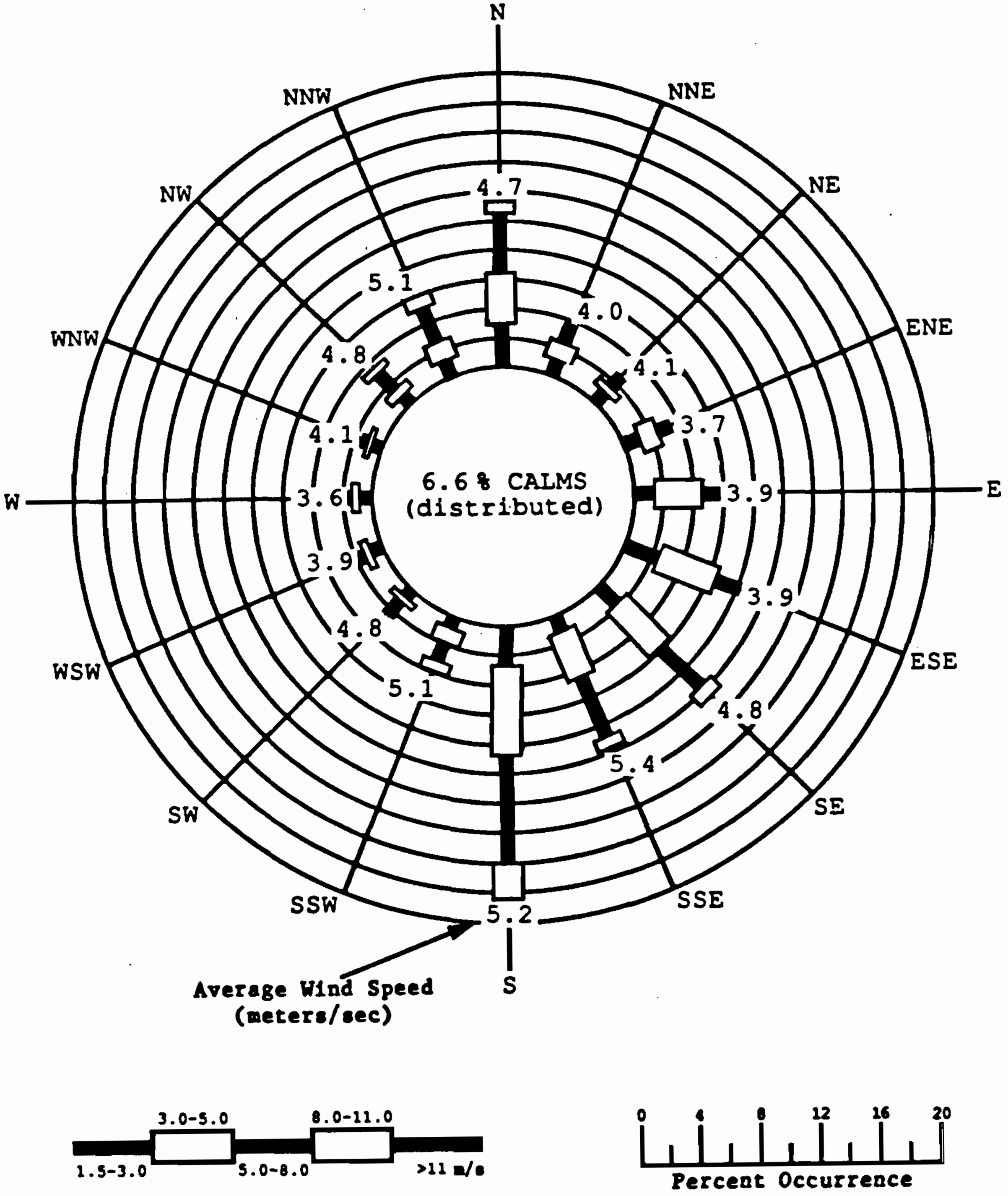


FIGURE 6-6

WIND ROSE FOR
PONCA CITY, OKLAHOMA 1976

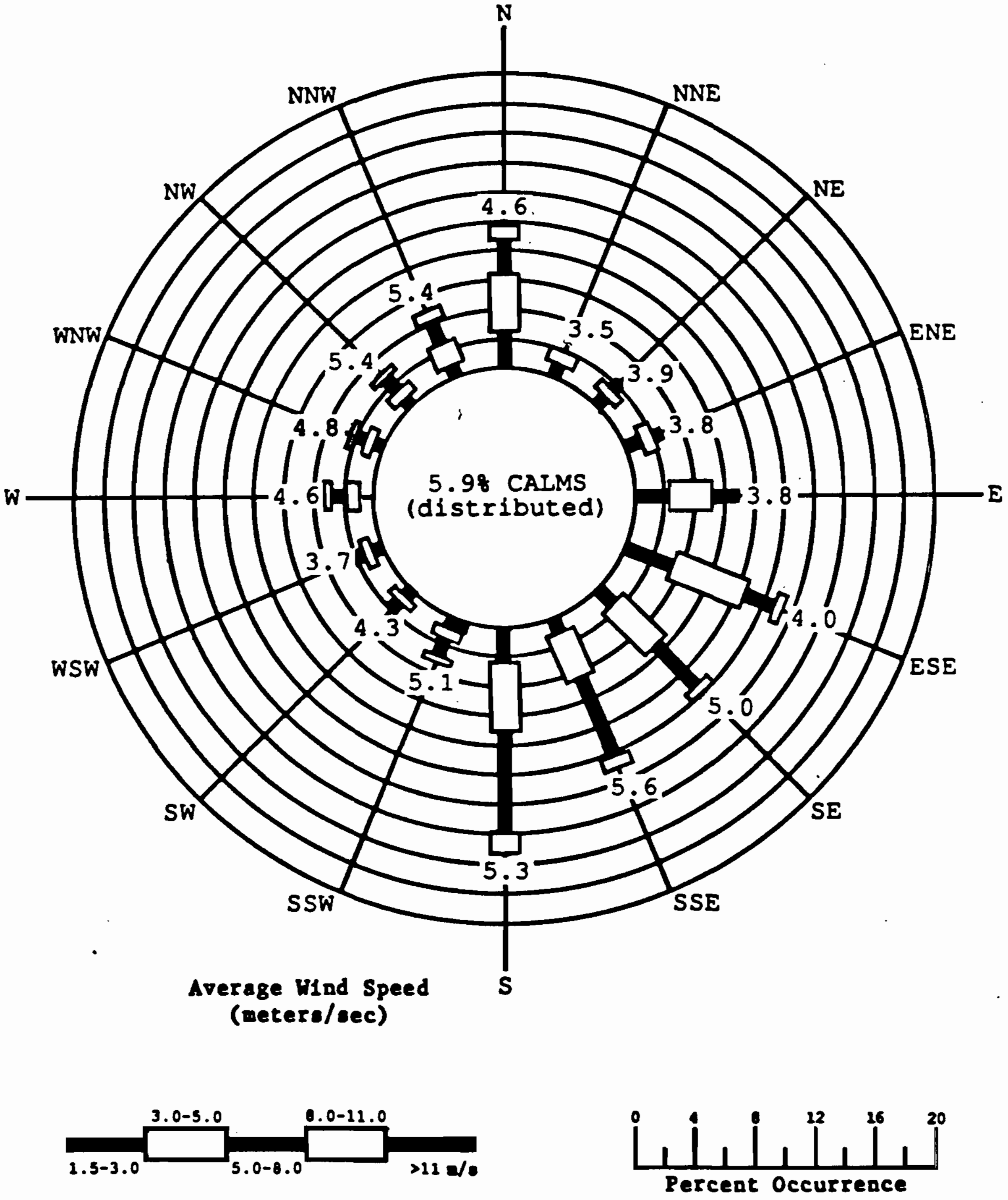


FIGURE 6-7

WIND ROSE FOR
PONCA CITY, OKLAHOMA 1977

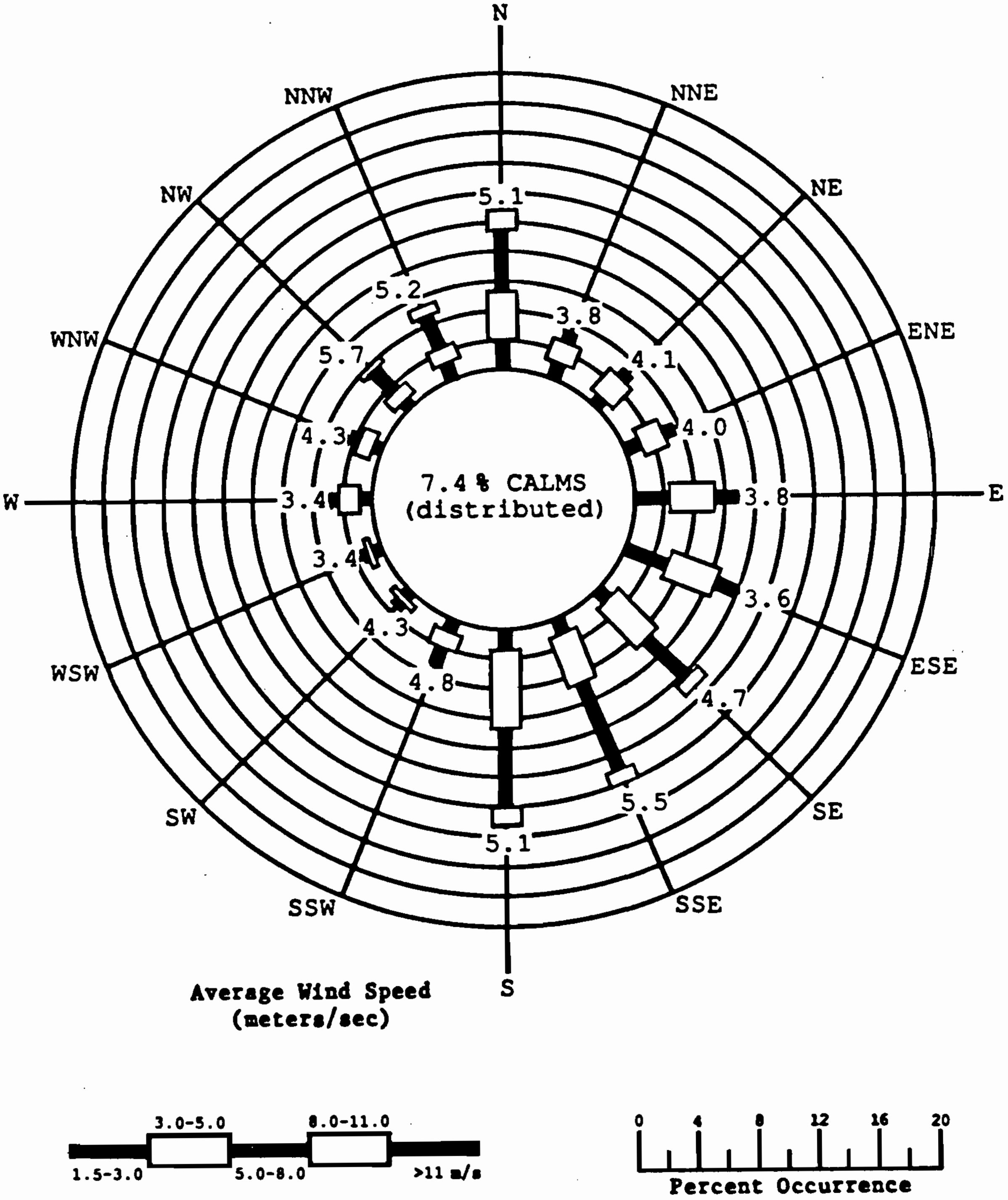


FIGURE 6-8

WIND ROSE FOR
PONCA CITY, OKLAHOMA 1978

TABLE 6-3

MEAN SEASONAL AND ANNUAL MORNING AND AFTERNOON MIXING HEIGHTS AND WIND SPEEDS FOR OKLAHOMA CITY, OKLAHOMA
(1960 through 1964)

Season	Time	Mixing Height (meters)	Wind Speed (meters/sec)
Winter	Morning	342	7.5
	Afternoon	859	8.4
Spring	Morning	457	9.2
	Afternoon	1,506	10.0
Summer	Morning	367	7.2
	Afternoon	1,862	7.3
Autumn	Morning	343	7.2
	Afternoon	1,302	7.9
Annual	Morning	377	7.8
	Afternoon	1,382	8.4

Source: Holzworth 1972.

TABLE 6-4

METEOROLOGICAL EPISODES OF SLOWEST DILUTION FOR OKLAHOMA CITY, OKLAHOMA

Episode Duration	Time	Date Mo/Da/Yr	H (m)	U (m/sec)	H x U (m^2/sec)	Limits		
						H_L	U_L	No.
1 Day:	Morning	01/07/60	166.0	3.5	581.0	250.0	4.0	1
	Afternoon	08	57.0	3.3	188.1			
	Morning	08	102.0	3.9	397.8			
	Average				388.9			
2 Days:	Morning	01/07/60	142.0	3.0	426.0	250.0	6.0	1
	Afternoon	07	166.0	3.5	581.0			
	Morning	08	57.0	3.3	188.1			
	Afternoon	08	102.0	3.9	397.8			
	Morning	09	135.0	5.6	756.0			
	Average				469.8			
3 Days:	Morning	12/12/63	389.0	3.3	1,283.7	750.0	8.0	1
	Afternoon	12	565.0	3.0	1,695.0			
	Morning	13	434.0	5.7	2,473.8			
	Afternoon	13	418.0	7.3	3,051.4			
	Morning	14	379.0	4.3	1,629.7			
	Afternoon	14	654.0	5.8	3,793.2			
	Morning	15	104.0	4.8	499.2			
	Average				2,060.8			
4 Days:	Morning	09/29/64	422.0	4.7	1,983.4	1,000.0	8.0	3
	Afternoon	29	699.0	3.5	2,446.5			
	Morning	30	142.0	2.8	406.0			
	Afternoon	30	668.0	4.3	2,872.4			
	Morning	10/01/64	178.0	6.5	1,157.0			
	Afternoon	01	907.0	8.0	7,256.0			
	Morning	02	550.0	4.0	2,200.0			
	Afternoon	02	809.0	7.0	5,663.0			
	Morning	03	54.0	3.4	183.6			
	Average				2,685.3			

TABLE 6-4

METEOROLOGICAL EPISODES OF SLOWEST DILUTION FOR OKLAHOMA CITY, OKLAHOMA (CONTINUED)

Episode Duration	Time	Date Mo/Da/Yr	H (m)	U (m/sec)	H x U (m^2/sec)	Limits H_L	U_L	No.
5 Days:	Morning	09/28/64	399.0	4.7	1,875.3	1,500.0	8.0	1
	Afternoon	28	1,031.0	3.8	3,917.8			
	Morning	29	422.0	4.7	1,983.4			
	Afternoon	29	699.0	3.5	2,446.5			
	Morning	30	142.0	2.8	406.0			
	Afternoon	30	668.0	4.3	2,872.4			
	Morning	10/01/64	178.0	6.5	1,157.0			
	Afternoon	01	907.0	8.0	7,256.0			
	Morning	02	550.0	4.0	2,200.0			
	Afternoon	02	809.0	7.0	5,663.0			
	Morning	03	54.0	3.4	183.6			
	Average				2,723.7			

H = Mixing height

U = Wind speed averaged through H. In calculations of HxU, values of U = 0.0 m/sec are treated as 0.1 m/sec.

Limits = Limiting values of H and U used to define episodes.

No. = Total number of episodes within these limits.

Source: Holzworth, 1974.

Holzworth (1974) analyzed the meteorological episodes of slowest dilution for all the 62 of the upper air stations in the United States. The results of his analysis for Oklahoma City are presented in Table 6-4. These tables include mixing heights, wind speeds, and dilution factors for various episodes. Holzworth's analysis shows that of the 62 cities analyzed, Oklahoma City ranks between first and fourth for episodes of slowest dilution lasting from three to five days. For episodes lasting one day, Oklahoma City is ranked fifteenth. For episodes lasting two days, Oklahoma City is ranked twenty-third. On an overall basis considering episodes from one to five days in length, Oklahoma City ranked second of the sixty-two stations analyzed. Lower rank (i.e., 3, 2, 1) implies greater dilution and therefore better air quality. Hence, based on Holzworth's findings, the synoptic conditions in the project area tend to be conducive to good air quality.

7.0 AIR QUALITY IMPACT ANALYSIS

The facility's impact on air quality is presented in this section. Applicable regulations and the facility's impacts as compared to these regulations are discussed. Impacts are estimated based on the Industrial Source Complex (ISC) modeling, using actual facility parameters as determined by performance testing and meteorological data as required by the OAQS. The results of this air quality impact analysis indicate that cumulative levels associated with the facility's maximum predicted concentrations do not violate any federal, state, or local ambient air quality standards, nor do they exceed PSD increment limits at any location.

7.1 Applicable Standards

Three sets of air quality standards are applicable to the project: National Ambient Air Quality Standards, PSD increment standards, and Tulsa City-County regulations.

7.1.1 National Ambient Air Quality Standards

The project must comply with National Ambient Air Quality Standards as administered by the Oklahoma Air Quality Service under authorization from the USEPA Region VI. The State of Oklahoma standards are thus identical to the national standards. These regulations set ambient air concentrations in micrograms per cubic meter for a number of pollutants; these maximum concentrations are shown in Table 7-1. Project impact as compared to these standards is discussed in Section 7.3.

7.1.2 PSD Increments

Based on the emission levels shown in Section 4, the facility is subject to PSD review due to emissions of greater than 100 tons per year of NO_x, SO_2, and TSP, and its classification as a major stationary source as stipulated in Regulation 1.4.4. Therefore, the PSD increments resulting from the facility must fall below the maximum allowable increment as defined in Regulation 1.2 of the Oklahoma Clean Air Act, Table 1.2(2). These values are shown in Table 7-2 for Class I, II, and III areas. The project is located in a Class II area; the closest Class I area is the Upper Buffalo National Wilderness Area in Arkansas, approximately 260 km east-southeast of the project site.

TABLE 7-1

APPLICABLE AMBIENT AIR QUALITY STANDARDS
(micrograms per cubic meter)

Pollutant	Averaging Time	National and Oklahoma Standard	Tulsa County Standard
Total suspended particulate	Annual (geometric mean)	75	75
	24-hour	150/260(1)	150/260
Sulfur dioxide	Annual	80	80
	24-hour	365	365
	3-hour	1,300	1,300
Nitrogen dioxide	Annual	100	100
Ozone	1-hour	235	235
Carbon monoxide	8-hour	10,000	10,000
	1-hour	40,000	40,000
Lead	3-Month (calendar)	1.5	1.5

(1) Secondary standard/primary standard.

Source: Oklahoma Clean Air Act, Regulation 1.2.

TABLE 7-2

ALLOWABLE PSD INCREMENTS
(micrograms per cubic meter)

	Class I	Class II	Class III
Sulfur Dixode			
Annual	2	20	40
24-hour(1)	5	91	182
3-hour(1)	25	512	700
Total Suspended Particulate Matter			
Annual	5	19	37
24-hour(1)	10	37	75

(1) Not to be exceeded more than once a year.

Note: The facility is located in a Class II area.

Source: Oklahoma Clean Air Act, Regulation 1.2.

7.1.3 Tulsa City and County Regulations

The Air Quality Control Section of the Tulsa City-County Health Department has regulations applicable to this facility. Section 214 of the Clean Air Rules and Regulations requires compliance with ambient air quality standards. These standards are shown in Table 7-1 and are identical to the Oklahoma State standards. Additionally, Section 217 sets limitations on ambient concentrations of sulfur compounds resulting from facility emissions, as shown in Table 7-3. These limitations apply at any location beyond the property boundary of the source.

Regulation 3.4 of the Oklahoma Clean Air Act sets sulfur dioxide ambient air limitations that are identical to those presented in Table 7-3.

Several other Tulsa City-County regulations pertaining to particulates and fugitive emissions are discussed in Section 9; these rules are not applicable to ambient air quality and thus are not addressed here.

7.2 Modeling

Ground-level concentrations for all pollutants of interest have been estimated using the most recent (Version 6, 1986) EPA-approved ISC code. Several sets of ISC runs were carried out, using the parameters determined during stack testing, to estimate the impacts of the project. The following section describes the run sequences, receptor locations, selection of the appropriate modeling years, and considerations relating to individual runs.

The ISC model is capable of modeling impacts for a specified receptor grid and/or for individual receptors. Terrain elevation is possible with the constraint that no receptors may be located at an elevation that exceeds the height, of the stack(s) being modeled; if the receptor height exceeds the stack height, the model automatically assigns a height 0.005 meters below the stack height to the receptor.

The discrete receptor set chosen for the modeling runs is the same as the receptor grid modeled during earlier VALLEY modeling of project impacts. This receptor grid was selected to coincide with anticipated points of highest impact due to the terrain surrounding the project. A total of 112 receptor points were modeled.

TABLE 7-3

TULSA CITY - COUNTY AMBIENT AIR LIMITATIONS FOR SULFUR COMPOUNDS

Compound	Time Period	Limitation ($\mu g/m^3$)
SO_2	3 minutes	1,350
	1 hour	1,200
	3 hours	650
	24 hours	130
H_2SO_4(1)	24 hours(2)	10
H_2S	24 hours(2)	70

(1) Or SO_3 calculated as H_2SO_4.

(2) No time period indicated, 24 hours assumed.

Source: Tulsa City - County Health Department,
Clean Air Rules and Regulations, Section 217B.

In order to establish the stack parameters required as input to the ISC model, stack test data for the common stack (for boilers 1 and 2) were evaluated to determine average temperature and gas flow. Exit stack gas velocity was calculated from the flow rate using the stack diameter. Emission rate values for each pollutant were taken directly from the stack testing data. Appendix C includes a complete description of the modeling parameters used, and Table 4-1 listed the emission rates for each pollutant.

With these data, initial screening runs of the ISC Short Term (ISCST) model were made for each year of the five-year meteorological record provided by the Oklahoma Air Quality Service to determine the year of worst-case second-highest impacts. The reporting of second-highest impacts is consistent with guidance provided by representatives of EPA and OAQS. This methodology is approved when a full five-year meteorological record is used.

Table 7-4 contains the results of these screening runs, giving the highest second-high NO_x concentrations for three- and 24-hour averaging periods for each meteorological year as calculated by the ISCST model. Note that these runs were made without the use of the buoyancy-induced dispersion option, which was used in final model runs.

From these data, the year 1976 was chosen for use in subsequent ISCST runs. The calculated short-term impacts are, however, fairly consistent from year to year; the standard deviations do not exceed 15% of the mean. Thus, the choice of one meteorological year over another is expected to have minor effect on the results of the analysis.

Similarly, screening runs for each year of the five-year meteorological record were made with the ISC Long Term (ISCLT) model to select the worst-case meteorological year for use in subsequent runs. These results are also shown in Table 7-4. From these data, 1975 was chosen for use in final model runs.

Having selected the appropriate meteorological data set for use with both the ISCST model and the ISCLT model, final model runs were made to estimate the short- and long-term impacts of the project. For the final model runs, careful examination of the USGS quadrangle sheets for the receptor areas identified discrepancies in the original receptor heights modeled for six of the 112 receptors. These receptor heights were corrected during the final runs, with the maximum adjustment being approximately 40 feet. Additionally, as per guidance from the OAQS, the final ISCST runs were made using the buoyancy-induced dispersion option.

TABLE 7-4

SCREENING ISC COMPARISON OF IMPACTS FOR 5 YEARS OF DATA

Year	Predicted NO_x Impact, µg/m^3(1)		
	ISCST Highest 3-hour 2nd High	ISCST Highest 24-hour 2nd High	ISCLT Highest Annual
1974	50	17	1.8
1975(2)	51	21	2.3
1976(3)	53	25	1.9
1977	52	20	1.5
1978	45	21	2.0
Standard Deviation From the Mean	3.1 (6%)	2.9 (14%)	0.29 (15%)

(1) Modeling results are rounded to two significant figures.

(2) 1975 chosen as maximum impact year for ISCLT modeling.

(3) 1976 chosen as maximum impact for year for ISCST modeling.

The relationship of the location of the maximum impact receptors to adjoining terrain was also evaluated. The site vicinity map provided as Figure 2-3 is a reproduction from available USGS topographic maps of the area. The modeling analysis considered alternate receptor locations around the maximum receptor, and confirmed that the chosen receptors do represent the location of maximum ground-level concentration. Ridge lines and terrain to the south and southwest of the projects are located at equal radial distances from the facility.

All model runs were made at a representative emission rate, and the calculated impacts were ratioed to determine the impact for each pollutant. Example calculations are shown in Appendix C. Predicted SO_2 impacts should be considered to be conservative, since atmospheric decay was not considered.

It should be noted that impacts for one boiler in operation are slightly higher than 1/2 the value reported for two boilers, due to decreases in flow rate and because the emission rates chosen represent the maximums reported for one boiler in operation which was not necessarily 1/2 the emission rate for the two boilers.

7.3 Summary Of Impacts

Table 7-5 shows the ISC-predicted air quality impacts due to the facility alone as compared to ambient air quality standards. The Oklahoma, federal, and Tulsa City-County standards are identical.

Project impacts are also compared to allowable PSD increment levels and Oklahoma monitoring-level exemptions. The monitoring-level exemptions, as given in the Oklahoma Clean Air Act, Regulation 1.4.4(d), establish the impact level for a project below which it is not required to supply continuous air quality monitoring data to establish background pollutant levels. The predicted maximum ground-level concentrations (using the TCCHD-permitted emission rates) indicate that the PSD baseline area will be triggered for SO_2 and NO_x. This is based on annual impacts that exceed 1 $\mu g/m^3$ for both pollutants. With this triggering of the PSD areas, the impacts from the project also consume "PSD increment." The triggered PSD baseline area is confined to the elevated terrain north, south, and southwest of the project site. The affected area and modeling receptor locations are identified on Figure 7-1. The maximum impacts from the project are within the allowable PSD increment.

TABLE 7-5

MODELING RESULTS - PROJECT CONTRIBUTION
(all values in micrograms per cubic meter)

Pollutant	Averaging Time	Ambient Air Quality Standards	PSD Class II Increment	Oklahoma Monitoring-Level Exemption	Predicted Level(1)(2)
TSP	24-hour	150/260(3)	37	10	5.4
	Annual	75	19	--	0.45
SO_2	3-hour	1,300	512	--	31
	24-hour	365	91	13	16
	Annual	80	20	--	1.4
NO_2	Annual	100	--	14	2.7
CO	1-hour	10,000	--	--	16
	8-hour	10,000	--	575	11
Ozone (VOC)	1-hour	235(4)	--	--	1.8
Lead	24-hour	1.5	--	0.1	0.031
Mercury	24-hour	--	--	0.25	0.019
Beryllium	24-hour	--	--	0.0005	$8.1x10^{-7}$
Fluorides	24-hour	--	--	0.25	0.53

(1) Based on TCCHD-permitted emission rates.

(2) Values rounded to two significant figures.

(3) Secondary/primary standard.

(4) Standard is 160 μ/m^3 as VOC.

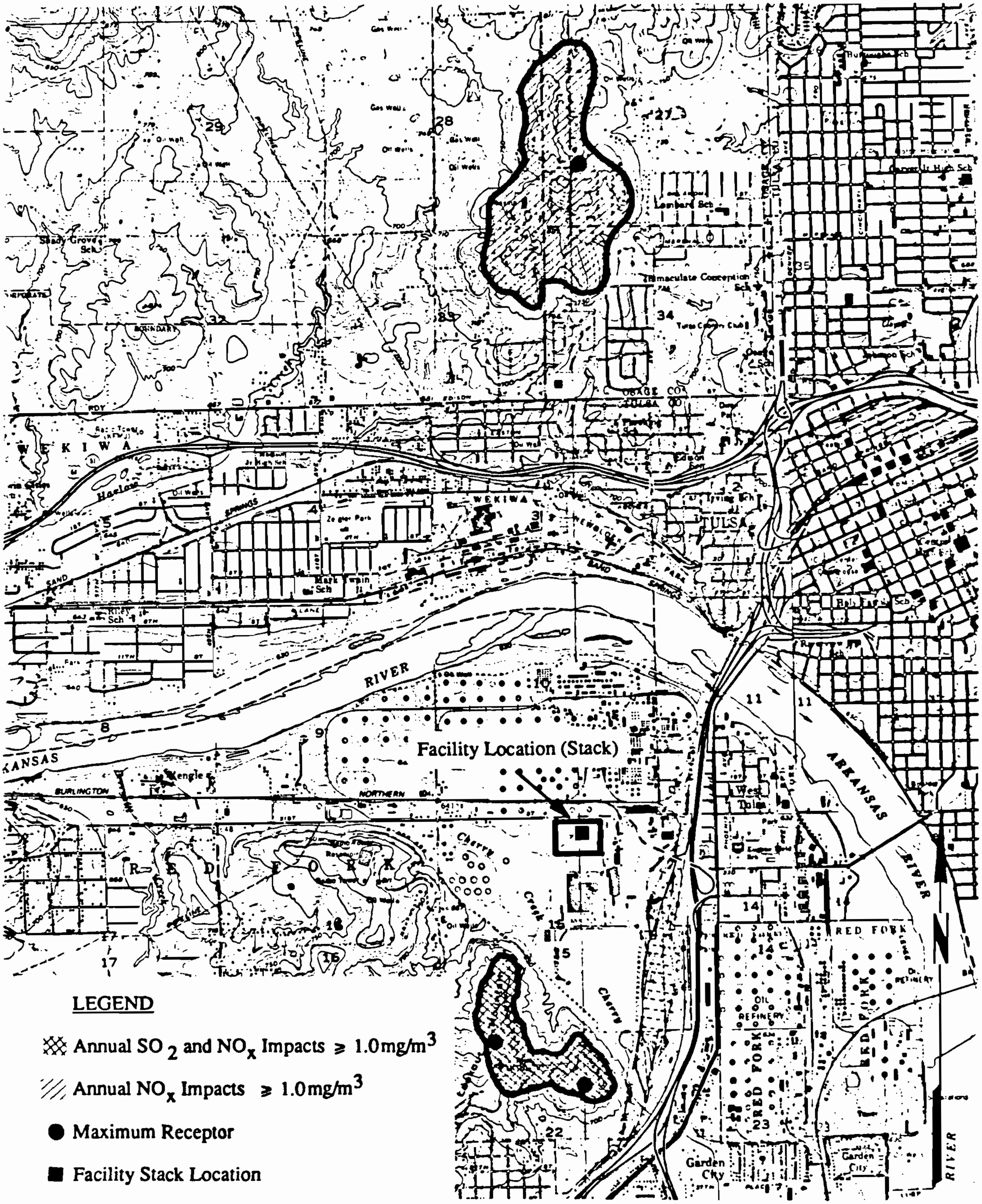


FIGURE 7-1

LOCATION OF MAXIMUM IMPACTS

When the TCCHD-permitted emission rates are used, the maximum predicted 24-hour SO_2 concentrations exceed the monitoring exemption levels. (The maximum 24-hour impact under actual emission rates does not exceed the monitoring exemption level.) Currently, the TCCHD operates two SO_2 monitors in Tulsa which have historically shown no ambient SO_2 problems. Considering the presence of these two monitors, the Applicant requests an exemption from the monitoring requirements for the facility.

The impact levels from project contributions alone do not violate any ambient air quality standard. Additionally, the PSD increments are not exceeded for SO_2.

Table 7-6 shows the modeling results as compared to the Tulsa City-County ambient air limitations for sulfur compounds resulting from operation of the project. These results indicate that the project does not cause a violation of these standards. In addition to the Tulsa City-County limitations, Oklahoma State is developing toxic air emission regulations which may be used to confirm the insignificance of the H_2SO_4 impacts. The Oklahoma State regulations are based on adjustments to threshold limit values (TLVs) that have been adopted for workplace exposure limits. The proposed regulations establish a twenty four-hour Maximum Acceptable Ambient Concentration (MAAC) for three toxic categories: A = high toxicity, B = medium, and C = low toxicity. The MAAC is calculated by dividing the TLV by 100, 50, or 10 for categories A, B, or C, respectively.

For H_2SO_4 the TLV value is 1,000 $\mu g/m^3$. For this pollutant, the computed MAAC would be 10 $\mu g/m^3$, 20 $\mu g/m^3$, or 100 $\mu g/m^3$ depending on the assignment by Oklahoma State to H_2SO_4 of high, medium, or low toxicity. The maximum twenty four-hour impact estimated for H_2SO_4 (using the TCCHD-permitted emission rate) would be 2.8 $\mu g/m^3$. Based on these results, the H_2SO_4 impacts are insignificant.

TABLE 7-6

MODELING RESULTS COMPARED TO TULSA SULFUR COMPOUND LIMITATIONS

Compound	Averaging Time Period	Limitation	Maximum Concentration(1) (μg/m^3)
SO_2	3 minutes	1,350	Not Calculated
	1 hour	1,200	40
	3 hours	650	31
	24 hours	130	16
H_2SO_4(2)	24 hours(3)	10	2.8
H_2S	24 hours(3)	70	(4)

(1) Values are rounded to two significant figures.

(2) Or SO_3 calculated as H_2SO_2

(3) No time period indicated; 24 hours assumed.

(4) No emissions of H_2S are expected from the project.

Source: Tulsa City-County Health Department,
Clean Air Rules and Regulations, Section 217B.

8.0 ADDITIONAL IMPACT ANALYSIS

This section addresses impacts upon soils and vegetation, upon visibility due to growth associated with the project, and upon Class I areas.

8.1 Soils And Vegetation

Ground-level concentrations for all pollutants and averaging times (except TSP) fall below the secondary ambient air quality standards which have been established to protect vegetation. The secondary standard for annual TSP concentration is exceeded by less than 3 percent. However, the facility's contribution to the total concentration is less than 1 percent. Even at the point of maximum impact, concentrations resulting from TCCHD-permitted emissions are well below the ambient standard. The facility thus has no adverse effects on vegetation or soils.

8.2 Visibility Assessment

A Level I screening analysis has been conducted to determine the impact that the project has on the nearest Class I area, Upper Buffalo National Wilderness Area, located approximately 260 kilometers from the project site. All techniques were taken from the <u>Workbook for Estimating Visibility Impairment</u> (EPA-450/4-80-031). Appendix D1 details the complete calculation; results indicate no visibility impairment of the Class I area.

8.3 Other Industrial/Commercial Growth

No significant industrial or commercial secondary growth has come about as a result of the project. Approximately seven new jobs have been created by the project expansion. These jobs have been filled by the available local work force.

8.4 Impacts Upon Class I Areas

Due to the large distance between the project site and the nearest Class I area and the fact that impact from the project is limited to an area within a few kilometers of the site, there are no adverse impacts on any Class I areas as a result of the project. Section 8.2 has demonstrated that there are no adverse visibility effects on Class I areas due to the project.

9.0 COMPLIANCE WITH OTHER REGULATIONS

This section demonstrates the facility's compliance with rules and regulations which have not been previously addressed in this application. The status of other required air pollution permits is addressed, along with the compliance status of other major sources.

9.1 Applicable Rules and Regulations

9.1.1 New Source Performance Standards

The New Source Performance Standards for incinerators, as administered by the State of Oklahoma, set three requirements for operation of the proposed project. These are:

- Source must meet an emission limit of 0.08 grains/dscf corrected to 12 percent CO_2.
- Records of daily charging rates and hours of operation must be maintained.
- Source must be stack-tested to ensure that the emission limitations are being met.

The particulate emission limitation is being met, since, as demonstrated by the performance tests, the project is operating at less than the original design criteria of 0.06 gr/dscf. The other requirement for recordkeeping is being met.

9.1.2 National Emission Standards For Hazardous Air Pollutants (NESHAP)

The project burns only municipal and some commercial refuse. NESHAP requirements are outlined in 40 CFR Part 61. Subpart C and Subpart E establish standards for emission of beryllium and mercury, respectively. However, the NESHAP emission limitations for mercury are not applicable to the project, since the facility does not incinerate or dry wastewater treatment plant sewage sludge. The NESHAP emission limitation for the incineration of sludge is 7.05 pounds of mercury per 24-hour period. The emission rate of mercury from the project is permitted at 2.88 pounds per 24-hour period, thus demonstrating compliance if the NESHAP limitation were applicable.

Emissions from incineration facilities that accept beryllium containing wastes are subject to the NESHAP limitations. The standard limits emissions to the atmosphere to 10 grams of beryllium over a 24-hour period. The emission rate of beryllium from the project is permitted at 0.06 grams per 24-hour period (with actual emissions less than detection limits), thus demonstrating compliance with the NESHAP limitation, if the limitation were applicable to MSW facilities.

9.1.3 Oklahoma State Regulations

Regulation 2.3 of the Oklahoma Clean Air Act limits emissions from combustion units as follows:

- Visible emissions must not exceed one on the Ringelmann chart.
- The allowable particulate emission rate is determined as a function of refuse feed rate.

The visible emission limitation is being met. Appendix D2 details the calculation of allowable particulate emissions. The allowable rate is 52.55 pounds per hour of particulates, and the facility will generate a maximum of 34.2 pounds per hour.

Regulation 3.4 sets ambient concentration limitations for sulfur dioxide: these have been discussed in the modeling results (Section 7.2). These limitations are being met. Additionally, Regulation 3.4 sets emission limits for hydrogen sulfide and total reduced sulfur. The facility does not emit either of these pollutants; thus these regulations do not apply.

9.1.4 Tulsa City and County Regulations

The particulate allowable emission limit set by the City-County regulations is the same as the State limit. In addition, Rule 210(C)(2) sets a grain loading limit of 0.2 grains/dscf, corrected to 12 percent CO_2, for combustion units. As discussed in Section 4.2, the outlet grain loading design criteria of 0.06 gr/dscf for the ESP is being met, and this level meets the required limitation.

The City-County regulation for visibility is the same as the Oklahoma State regulation. The sulfur dioxide ambient air quality limitations are set forth in Rule 217(B). Additionally, Rule 217(C) set an SO_2 emission limitation of 1.3 grams per cubic meter. The calculation shown in Appendix D3 shows that this limitation is met by the facility.

Regulation 215(B) addresses the control of fugitive dust. Fugitive dust from the facility is controlled such that no violation of this rule occurs. Vehicles travel only on paved surfaces at the facility site, and the waste storage pit for receiving municipal solid waste is enclosed and operates under negative air pressure.

9.2 Compliance With Permit Conditions

If the requested changes in permitted emission rates are approved, the facility will be in compliance with all permit conditions as presented in permit PSD-OK-556M-2, including special condition 3, which stipulates that semiannual performance tests be completed for demonstration of compliance with the SO_2 permit emission level. The bases for the requested changes in permitted emission rates are outlined within this addendum.

The special condition 3 emission tests were performed on January 1, 1987, by Ogden Projects, Inc. Table 9-1 summarizes the results of these tests, which show that the project is operating well within compliance for the SO_2 permit levels. SO_2 emissions are approximately half of the permitted levels. For this reason, Ogden Martin Systems of Tulsa requests that special condition 3 be rescinded from the PSD permit.

9.3 Other Major Source Compliance

Ogden Projects, Inc., is currently permitted to construct one other boiler unit for the processing and reduction of municipal solid waste at the same site as this facility. This unit is currently under construction. Ogden owns no other facilities in the State of Oklahoma.

TABLE 9-1

SUMMARY OF SULFUR DIOXIDE SOURCE TEST RESULTS AND PERMIT EMISSION RATES

	Common Stack Test Results		Permit Emission Rates	
Run	lb/hr	TPY(1)	lb/hr	TPY(1)
1	68.6	300	--	--
2	56.2	246	--	--
3	41.0	180	--	--
Average	55.3	242	100.9	441.9

(1) At 100% availability.

APPENDIX A

CROSS-REFERENCE BETWEEN INFORMATION REQUIREMENTS AND INFORMATION LOCATIONS IN THE APPLICATION

Under the PSD regulations, certain information is necessary in order to satisfy the PSD application requirements. The following list describes the information required and where it can be found in this report:

	Item	Location in Report
1.	Applicant name, address; telephone number; person to contact; date of application	Section 2.1
2.	Project name, location, type of operation, and other source information	Sections 2.1, 2.2, and 7.0
3.	Estimated starting dates of construction and operation	Section 2.0
4.	Project description and site information, including drawings and nature of surrounding topography	Sections 2.2 and 3.0
5.	Emissions from the project and applicability of PSD regulations	Sections 4.0 and 7.1
6.	Fuel types and contents	Sections 3.0
7.	Emission control equipment descriptions and efficiencies	Sections 4.0 and 5.0
8.	Class 1 area list	Section 2.2
9.	Information on NSPS compliance	Section 9.1
10	Information on NESHAP compliance	Section 9.1
11.	BACT information	Section 5.0

	Item	Location in Report
12.	Pre-application air monitoring data	Section 6.1
13.	Existing air quality determination	Section 6.1
14.	Source impact analysis information as per required modeling	Sections 7.3 and 9.0
15.	Analysis of secondary emissions; associated growth impacts	Section 8.3
16.	Effects on Class 1 areas	Section 8.1
17.	Effects on visibility	Sections 8.2 and Appendix D1
18.	Effects on soils and vegetation	Section 8.1

APPENDIX B

ACTUAL GAS FLOW CHARACTERISTICS

CALCULATIONS

Actual boiler operation flow and temperature calculations. Based on Ogden Projects, Inc., Environmental Test Report.

Common stack runs were made 6/1/86, 7/1/86, and 6/26/86, giving run data as follows:

	ACFM	T°F
6/30/86		
RUN 1	162283	342
RUN 2	169385	363
RUN 3	169811	362
7/1/86		
RUN 1	172698	359
RUN 2	164222	353
RUN 3	165026	358
6/26/86		
RUN 1	146249	362
RUN 2	149116	352
RUN 3	142979	351

From This Data

Mean T°F = 356
T°K = 453

Mean Flow $\overline{X}$ = 160197 ACFM
σ = 11129 ACFM (6.9%)

VELOCITY CALCULATIONS:

Two Boilers:

Stack ID = 7 ft. = 2.13 m = 3.575 m^2 AREA
Q = 160197 ft^3/min x .0283 min^3/ft^3 x min/60 sec = 75.6 m^3/sec
VELOCITY = Q/A = 75.6 m^3/sec/3.575 = 21.1 m/sec

One Boiler:

Assume Q = 1/2 $Q_{\text{Two Boilers}}$ = 37.8 m^3/sec
VELOCITY = 37.8 m^3/sec/3.575 = 10.57 m/sec

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Run 1
Hg
Common Stack

U.S. EPA METHOD 101A FIELD DATA SUMMARY

Project Tulsa Start-up 51001

Plant Tulsa

Sample location Common Stack

Date 6/30/86

Run 1

Filter # 01
Oven box A

IMP.						
B1	Impinger 1 Final	744.4	Initial	563.4	Net volume	181.0
B2	Impinger 2 Final	596.6	Initial	541.0	Net volume	55.6
B4	Impinger 3 Final	485.5	Initial	474.0	Net volume	11.5
B3	Silica gel Final	885.1	Initial	858.5	Net volume	26.6

V_{lc}	- Volume of water collected in train, ml.	274.7
V_m	- Sample gas volume, meter conditions, dcf.	71.67
Y	- Meter calibration factor.	0.970
P_{bar}	- Barometric pressure, in Hg.	29.85
P_g	- Stack static pressure, in Hg.	-2.5
ΔH	- Average orifice pressure diff., in H_2O	1.62
T_m	- Absolute meter temperature, o~~R~~.F	97
$V_{m(std)}$	- Standard sample gas volume, dscf.	68.01
B_{ws}	- Water vapor in gas stream	16.0
MF	- Moisture factor.	
CO_2	- Dry, volume %.	~~10.1~~ 10.0
O_2	- Dry, volume %.	~~9.8~~ 10.2
N_2	- Dry, volume %.	~~80.1~~ 79.8
CH_4	- Dry, volume %.	
M_d	- Molecular weight of stack gas, dry.	
M_s	- Molecular weight of stack gas, wet.	28.09
C_p	- Pitot tube coefficient.	0.84
Δp	- Average of the square roots of each p.	~~0.29~~ 0.29418
T_s	- Absolute stack temperature, o~~R~~.F	342
A	- Area of stack, ft2.	~~89.38~~ 70.26
Q_{std}	- Volumetric flowrate, dscfm.	~~112,838~~ 89,251
An	- Nozzle area, ft2.	9.5 mm
Θ	- Sampling time, min.	72
%I	- Isokinetic variation.	98.5

ACFM 162,283 @ 342°F + 29.74
SCFM 106,215
DSCFM 89,251 @ 16.0 % H_2O
Nm^3/sec 39.25
Nm^3 collected 1.794

6/30
Run 2
Hg
Common Stack

U.S. EPA METHOD 101A FIELD DATA SUMMARY

Project Tulsa Startup 51001

Plant Tulsa

Filter # 8

Sample location Common Stack

Date 6/30/86

Run 2

C1	Impinger 1 Final	769.7	Initial	578.4	Net volume	191.3
C2	Impinger 2 Final	642.2	Initial	588.2	Net volume	54.0
C3	Impinger 3 Final	461.0	Initial	449.2	Net volume	11.8
C4	Silica gel Final	830.4	Initial	806.1	Net volume	24.3

V_{lc}	-	Volume of water collected in train, ml.	281.4
V_m	-	Sample gas volume, meter conditions, dcf.	68.89
Y	-	Meter calibration factor.	0.926/0.970
P_{bar}	-	Barometric pressure, in Hg.	29.85
P_g	-	Stack static pressure, in Hg.	-2.5
ΔH	-	Average orifice pressure diff., in H_2O	1.71
T_m	-	Absolute meter temperature, °~~R~~.F	95
$V_{m(std)}$	-	Standard sample gas volume, dscf.	65.62
B_{ws}	-	Water vapor in gas stream	16.8
MF	-	Moisture factor.	
CO_2	-	Dry, volume %.	~~[illegible]~~ 10.0
O_2	-	Dry, volume %.	~~[illegible]~~ 10.2
N_2	-	Dry, volume %.	~~80.1~~ 79.8
CH_4	-	Dry, volume %.	
M_d	-	Molecular weight of stack gas, dry.	
M_s	-	Molecular weight of stack gas, wet.	27.99
C_p	-	Pitot tube coefficient.	0.84
Δp	-	Average of the square roots of each p.	~~0.31~~ 0.31120
T_s	-	Absolute stack temperature, °~~R~~.F	363
A	-	Area of stack, ft2.	~~89.36~~ 70.26
Q_{std}	-	Volumetric flowrate, dscfm.	~~113,194~~
An	-	Nozzle area, ft2.	9.5(mm)
Θ	-	Sampling time, min.	72
%I	-	Isokinetic variation.	94.3

ACFM 169,385 @ 363 °F & 29.74

SCFM 108,034

DSCFM 89,890 @ 11.8 % H2O

Nm³/sec 39.53

Nm³ 1.73[illegible]

BEST AVAILABLE COPY

6/30
Run 3
Hg
Common Stack

U.S. EPA METHOD 101A FIELD DATA SUMMARY

Filter #04

Project Tulsa Start up S1001
Plant Tulsa
Sample location Common Stack
Date 6/30/86
Run 3

Impinger 1 Final 783.4 Initial 578.8 Net volume 204.6
Impinger 2 Final 648.4 Initial 584.2 Net volume 64.2
Impinger 3 Final 463.6 Initial 449.1 Net volume 14.5
Silica gel Final 831.6 Initial ~~[illegible]~~ 803.7 Net volume 27.9

V_{lc}	- Volume of water collected in train, ml.	311.2
V_m	- Sample gas volume, meter conditions, dcf.	39.55
Y	- Meter calibration factor.	0.97
P_{bar}	- Barometric pressure, in Hg.	29.85
P_g	- Stack static pressure, in Hg.	-2.5
ΔH	- Average orifice pressure diff., in H_2O	1.72
T_m	- Absolute meter temperature, o~~R~~.F	103
$V_{m(std)}$	- Standard sample gas volume, dscf.	34.71
B_{ws}	- Water vapor in gas stream	16.4
MF	- Moisture factor.	
CO_2	- Dry, volume %.	~~9.6~~ 9.8
O_2	- Dry, volume %.	~~10.2~~ 10.1
N_2	- Dry, volume %.	80.1
CH_4	- Dry, volume %.	
M_d	- Molecular weight of stack gas, dry.	
M_s	- Molecular weight of stack gas, wet.	27.98
C_p	- Pitot tube coefficient.	0.84
Δp	- Average of the square roots of each p.	~~0.37~~ 0.31333
T_s	- Absolute stack temperature, o~~R~~.F	362
A	- Area of stack, ft2.	~~89.36~~ 30.26
Q_{std}	- Volumetric flowrate, dscfm.	~~9.5 mm~~ ~~44,878~~
An	- Nozzle area, ft2.	9.5 mm
Θ	- Sampling time, min.	72
%I	- Isokinetic variation.	106.3

ACFM	169,811 @ 362°F + 29.74
SCFM	108,437
DSCFM	90,635 @ 16.4 % H_2O
Nm³/sec	39.86

BEST AVAILABLE COPY

Run 1
7-1
Common Stack
M 104

12/104

U.S. EPA METHOD 104 FIELD DATA SUMMARY

Project Tulsa Start up 51001

Filter #02

Plant Tulsa

Sample location Common Stack

Date 7-1-86

Run 1

D3 Impinger 1 Final 822.7 Initial 582.8 Net volume 239.9

E2 Impinger 2 Final 833.3 Initial 563.7 Net volume 296.6

E3 Impinger 3 Final 788.5 Initial 453.7 Net volume 334.8

E4 Silica gel Final 790.4 Initial 747.2 Net volume 43.2

1 silica gel — B3 Silica gel Final 896.8 Initial 845.9 50.9

V_{1c}	- Volume of water collected in train, ml.	965.4
V_m	- Sample gas volume, meter conditions, dcf. 245.05	237.70
Y	- Meter calibration factor.	0.970
P_{bar}	- Barometric pressure, in Hg.	29.92
P_g	- Stack static pressure, in Hg.	-1.5
ΔH	- Average orifice pressure diff., in H_2O	1.68
T_m	- Absolute meter temperature, °R/F	90
$V_{m(std)}$	- Standard sample gas volume, dscf.	229.05
B_{ws}	- Water vapor in gas stream	16.6
MF	- Moisture factor.	
CO_2	- Dry, volume %.	~~9.5~~ 9.8
O_2	- Dry, volume %.	~~10.2~~ 10.1
N_2	- Dry, volume %.	~~80.3~~ 80.1
CH_4	- Dry, volume %.	
M_d	- Molecular weight of stack gas, dry.	
M_s	- Molecular weight of stack gas, wet.	~~29.95~~ 29.99
C_p	- Pitot tube coefficient.	0.84
Δp	- Average of the square roots of each p.	~~0.33~~ 0.3258
T_s	- Absolute stack temperature, °R,F	359
A	- Area of stack, ft2.	~~89.36~~ 70.26
Q_{std}	- Volumetric flowrate, dscfm.	~~116,755~~ 91,802
An	- Nozzle area, ft2.	9.5 (mm)
Θ	- Sampling time, min.	240
%I	- Isokinetic variation.	95.7

ACFM 172698 @ 359 & 29.81

SCFM 110 946

DSCFM [illegible] @ 16.6 % H_2O

Nm^3/sec 40.71

Nm^3 [illegible]

Run 2
M-104
Common Stack
7-1

U.S. EPA METHOD 17/104 FIELD DATA SUMMARY

Project Tulsa Start up 51001

Filter #07

Plant Tulsa

Sample location Common Stack

Date 7-1-86

Run 2

A1 Impinger 1 Final 933.3 Initial 582.2 Net volume 351.1

A2 Impinger 2 Final 886.2 Initial 588.2 Net volume 298.0

A3 Impinger 3 Final 686.5 Initial 446.8 Net volume 239.7

A4 Silica gel Final 948.3 Initial 855.1 Net volume 93.2

2nd silica gel – C4 Silica gel Final 838.0 Initial 813.8 24.2

V_{lc}	- Volume of water collected in train, ml.	1006.2
V_m	- Sample gas volume, meter conditions, dcf. 255.23	236.34
Y	- Meter calibration factor.	0.926
P_{bar}	- Barometric pressure, in Hg.	29.92
P_g	- Stack static pressure, in Hg.	-1.5
ΔH	- Average orifice pressure diff., in H_2O	1.62
T_m	- Absolute meter temperature, °~~R~~F	92
$V_{m(std)}$	- Standard sample gas volume, dscf.	226.97
B_{ws}	- Water vapor in gas stream	17.3
MF	- Moisture factor.	
CO_2	- Dry, volume %.	~~9.5~~ 9.9
O_2	- Dry, volume %.	~~10.2~~ 10.1
N_2	- Dry, volume %.	~~80.3~~ 80.0
CH_4	- Dry, volume %.	
M_d	- Molecular weight of stack gas, dry.	
M_s	- Molecular weight of stack gas, wet.	27.86
C_p	- Pitot tube coefficient.	0.84
Δp	- Average of the square roots of each p.	~~0.300~~ 0.2960
T_s	- Absolute stack temperature, °~~R~~.F	353
A	- Area of stack, ft2.	~~89.36~~ 70.26
Q_{std}	- Volumetric flowrate, dscfm.	~~110,815 87,210~~
An	- Nozzle area, ft2.	9.5 mm
Θ	- Sampling time, min.	240
%I	- Isokinetic variation.	99.8

ACFM 164,222 @ 353 29.81
SCFM 106,279
DSCFM 87,895 @ 17.3 % H_2O
Nm³/sec 5.990
Nm³ collected ~~38.36~~ 38.66

Run 3
7-1
M104
Common Stack

U.S. EPA METHOD $^{\checkmark}$104 FIELD DATA SUMMARY

Project Tulsa Start up 51001

Plant Tulsa

Filter #06

Sample location Common Stack

Date 7/1/86

Run 3

Impinger 1 Final 860.0 Initial ~~850.3~~ 505.7 Net volume 354.3 Soml H₂O

Impinger 2 Final 860.7 Initial 562.5 Net volume 298.2

E-3 Impinger 3 Final 608.1 Initial 454.7 Net volume 153.4

E-4 Silica gel Final 910.4 Initial 850.3 Net volume 60.1

C-4 840.6 755.8 84.8

V_{lc}	-	Volume of water collected in train, ml.	950.8
V_m	-	Sample gas volume, meter conditions, dcf.	235.78
Y	-	Meter calibration factor.	0.970 / 0.926
P_{bar}	-	Barometric pressure, in Hg.	29.92
P_g	-	Stack static pressure, in Hg.	-1.5
ΔH	-	Average orifice pressure diff., in H_2O	1.64
T_m	-	Absolute meter temperature, o~~R~~.F	98
$V_{m(std)}$	-	Standard sample gas volume, dscf.	223.97
B_{ws}	-	Water vapor in gas stream	16.7
MF	-	Moisture factor.	
CO_2	-	Dry, volume %.	~~[illegible]~~ 9.9
O_2	-	Dry, volume %.	~~[illegible]~~ 10.3
N_2	-	Dry, volume %.	~~80.3~~ 79.8
CH_4	-	Dry, volume %.	
M_d	-	Molecular weight of stack gas, dry.	
M_s	-	Molecular weight of stack gas, wet.	27.94
C_p	-	Pitot tube coefficient.	0.84
Δp	-	Average of the square roots of each p.	~~0.30~~ 0.29793
T_s	-	Absolute stack temperature, o~~R~~.F	358
A	-	Area of stack, ft2.	~~89.36~~ 70.26
Q_{std}	-	Volumetric flowrate, dscfm.	~~111,589~~ 87,340
An	-	Nozzle area, ft2.	9.5(mm)
Θ	-	Sampling time, min.	240
%I	-	Isokinetic variation.	97.9

ACFM 165 026 @ 359°F + 29.81

SCFM 106 147

DS[illegible] 88 436 @ 16.7 % H_2O

Nm³/sec 38.90

N[illegible] collected 5.910

MM-5
6/25
Comm. St

MODIFIED U.S. mod EPA METHOD 5 FIELD DATA SUMMARY

Project Tulsa Start up 51001
Plant Tulsa
Sample location Common Stack
Date 6/25/86
Run 1 (one)

Filter # 15
Res Cart. # X-3
Spiked ?

C1 Impinger 1 Final 979.2 Initial ~~430.6~~ 362.9 Net volume 616.3
C2 Impinger 2 Final 855.5 Initial 568.1 Net volume 285.4
C3 Impinger 3 Final 482.9 Initial 447.6 Net volume 35.3
C4 Silica gel Final 800.0 Initial 751.7 Net volume 48.3

V_{lc}	- Volume of water collected in train, ml.	985.3
V_m	- Sample gas volume, meter conditions, dcf.	230.29 (223.38 Act
Y	- Meter calibration factor.	0.97
P_{bar}	- Barometric pressure, in Hg.	30.00
P_g	- Stack static pressure, in Hg.	~~[illegible]~~ -1.0
ΔH	- Average orifice pressure diff., in H_2O	1.28
T_m	- Absolute meter temperature, °~~R~~ F	108
$V_{m(std)}$	- Standard sample gas volume, dscf.	209.43
B_{ws}	- Water vapor in gas stream	18.2
MF	- Moisture factor.	
CO_2	- Dry, volume %.	~~[illegible]~~ 10.6
O_2	- Dry, volume %.	~~[illegible]~~ 8.5
N_2	- Dry, volume %.	~~[illegible]~~ 81.9
CH_4	- Dry, volume %.	
M_d	- Molecular weight of stack gas, dry.	
M_s	- Molecular weight of stack gas, wet.	~~[illegible]~~ 27.90
C_p	- Pitot tube coefficient.	0.84
$\sqrt{\Delta p}$	- Average of the square roots of each p.	~~0.23~~ 0.23268
T_s	- Absolute stack temperature, °~~R~~.F	362
A	- Area of stack, ft2.	~~69.56~~ 70.26
Q_{std}	- Volumetric flowrate, dscfm.	~~[illegible]~~
An	- Nozzle area, ~~ft2~~. mm	9.5
θ	- Sampling time, min.	~~[illegible]~~ 240
%I	- Isokinetic variation.	105.7

ACFM 146 249 @ 362°F & 29.89" Hg
SCFM 93,863
DSCFM 77195

Run 2
Dioxin
6/26

MODIFIED U.S. EPA METHOD 5 FIELD DATA SUMMARY

Project Tulsa Startup S1001
Plant Tulsa
Sample location Common Stack
Date 6/26/86
Run 2

Filter # 14
Cart # Blank

E2	Impinger 1 Final	968.5	Initial	368.1	Net volume	600.4
E3	Impinger 2 Final	726.1	Initial	553.7	Net volume	172.4
D3	Impinger 3 Final	651.9	Initial	452.3	Net volume	199.6
E-4	Silica gel Final	860.0	Initial	802.2	Net volume	57.8

V_{lc}	- Volume of water collected in train, ml.	1030.2	
V_m	- Sample gas volume, meter conditions, dcf.	235.92	(228.84
Y	- Meter calibration factor.	0.970	
P_{bar}	- Barometric pressure, in Hg.	30.00	
P_g	- Stack static pressure, in Hg.	-1.0	
ΔH	- Average orifice pressure diff., in H_2O	1.38	
T_m	- Absolute meter temperature, °~~R~~. F	111	
$V_{m(std)}$	- Standard sample gas volume, dscf.	213.56	
B_{ws}	- Water vapor in gas stream	18.5	
MF	- Moisture factor.		
CO_2	- Dry, volume %.	~~[illegible]~~ 10.3	
O_2	- Dry, volume %.	~~[illegible]~~ 8.9	
N_2	- Dry, volume %.	~~[illegible]~~ 80.8	
CH_4	- Dry, volume %.		
M_d	- Molecular weight of stack gas, dry.		
M_s	- Molecular weight of stack gas, wet.	~~[illegible]~~ 27.83	
C_p	- Pitot tube coefficient.	0.84	
Δp	- Average of the square roots of each p.	~~0.25~~ 0.24512	
T_s	- Absolute stack temperature, °~~R~~. F	352	
A	- Area of stack, ft2.	~~84.36~~ 70.26	
Q_{std}	- Volumetric flowrate, dscfm.	~~100,184~~ ~~[illegible]~~	
An	- Nozzle area, ~~ft2~~. mm	9.5	
θ	- Sampling time, min.	240	
%I	- Isokinetic variation.	104.0	

ACFM 149116 @ 352°F & 29.99" Hg
SCFM 97,205
DSCFM 79,629 @ 18.1 % H2O

Run 3
Dioxin
6/26

MM5

MODIFIED U.S. EPA METHOD 5 FIELD DATA SUMMARY

Mod.

Project Tulsa Start up 51001
Plant Tulsa

Capt # X2

Sample location Common

Filter # 11

Date 6/26/86

Run 3

Imp #

C1 Impinger 1 Final 99~~6.6~~3.8 Initial 371.3 Net volume 622.5

C2 Impinger 2 Final 845.5 Initial 569.6 Net volume 275.9

C3 Impinger 3 Final 455.7 Initial 448.0 Net volume 7.7

C4 Silica gel Final 848.6 Initial 805.5 Net volume 43.1

V_{lc}	- Volume of water collected in train, ml.	949.2
V_m	- Sample gas volume, meter conditions, dcf.	~~275.06~~ (208.41
Y	- Meter calibration factor.	0.926
P_{bar}	- Barometric pressure, in Hg.	30.00
P_g	- Stack static pressure, in Hg.	-1.0
ΔH	- Average orifice pressure diff., in H_2O	1.27
T_m	- Absolute meter temperature, °~~R~~.F	109
$V_{m(std)}$	- Standard sample gas volume, dscf.	195.15
B_{ws}	- Water vapor in gas stream	18.7
MF	- Moisture factor.	
CO_2	- Dry, volume %.	~~9.2~~ 10.3
O_2	- Dry, volume %.	~~10.5~~ 8.9
N_2	- Dry, volume %.	~~80.3~~ 80.8
CH_4	- Dry, volume %.	
M_d	- Molecular weight of stack gas, dry.	
M_s	- Molecular weight of stack gas, wet.	~~[illegible]~~ 27.76
C_p	- Pitot tube coefficient.	0.84
Δp	- Average of the square roots of each p.	~~0.22~~ 0.22506
T_s	- Absolute stack temperature, °R.	351
A	- Area of stack, ft².	~~89.36~~ 70.26
Q_{std}	- Volumetric flowrate, dscfm.	~~8~~ 95,542
An	- Nozzle area, ~~ft²~~. mm	9.5
●	- Sampling time, min.	240
%I	- Isokinetic variation.	99.6

ACFM 142,979 @ 351°F & 29.99
SCFM 93,319
DSCFM 75,900 @ 18.7% H_2O

APPENDIX C

MODELING PARAMETERS AND CALCULATIONS

ISC LONG-TERM MODELING PARAMETERS

A) Source Parameters

The summary below indicates the source parameters used during ISCLT modeling of stack 1, for boilers 1 and 2, and stack 2, for boiler 3.

Parameter	Stack 1	Stack 2
Temperature, K	453	500
Exit velocity, m/sec	21.1	21.4
Stack height, m	71.63	71.63
Stack diameter, m	2.13	1.50
Pollutant emission rate:	generally modeled as 10 g/sec, with the results then ratioed to reflect actual emission rates of each pollutant.	
Stack coordinates, (x,y)	(0,0)	(20.73, 4.57)

B) Modeling Parameters

The ISCLT model has several choices of modeling parameters which affect the calculated concentrations. Those used were:

No building wake effects were calculated

Stack tip downwash was not considered

Final plume rise was used to calculate impact at all receptors

The rural mode was used

C) Meteorological Parameters

Unlike the ISC Short Term model, which reads hourly meteorological data covering almost all applicable parameters, the ISCLT model accepts these parameters as user input, and reads from the input meteorological file a simpler joint frequency distribution of wind speed and stability class. The other required input parameters are:

Average ambient temperature by stability class. The EPA guidance manual suggests that the average seasonal maximum T be assigned to stability classes A, B, and C, the average seasonal minimum be assigned to classes E and F, and the average T be assigned to stability class D. The temperature values used (degrees K) were 294.2 (A, B and C), 288.3 (D), and 282.4 (E and F). (NOAA, 1977).

Mixing heights by stability and wind speed. EPA guidance recommends that, lacking better data, the mixing height for each stability class be the same for all wind speeds in that class. Secondly, for the rural modeling mode, it is recommended that the mean afternoon mixing height be assigned to stability classes B, C, and D, and that 1.5 times that height be assigned to class A. In the rural mode, the program automatically assigns a value of 10,000 meters to classes E and F. Therefore, the values used (Holzworth, 1972) were 2073 m (A) and 1382 m (B, C, and D).

Potential temperature gradient. Default values of zero for stability classes A, B, C, and D, 0.02 degrees K per meter for class E, and 0.035 degrees K per meter for class F were used.

Wind speed. Default values were used.

Wind direction. Default values were used.

Wind speed power law exponent. Default values were used.

ISC SHORT-TERM MODELING PARAMETERS

A) Source Parameters

The source parameters used were the same as those for the long-term modeling.

B) Modeling Parameters

The modeling parameters used were the same as those for the long-term modeling with the following additions:

Calm wind processing was employed.

Program did not assume SO_2 was being modeled (no atmospheric decay).

Buoyancy-induced dispersion was used for final results runs.

C) Meteorological Parameters

Default values were used for wind profile exponents and vertical potential temperature gradients. All other meteorological data was read from the input file.

APPENDIX D

MODELING RESULTS

D1 - Visibility Assessment

D2 - TSP Emissions Versus Regulated Levels

D3 - SO_2 Emissions Versus Regulated Levels

D4 - Example Model Output

APPENDIX D1

Visibility Assessment

A Level 1 (screening) analysis is detailed below to determine the impact the facility will have on the nearest Class I Area. All techniques were taken from the *Workbook for Estimating Visibility Impairment* (EPA-450/4-80-031).

Five inputs are required:

QTSP = Particulate emission rate, metric tons/day = 0.374 (150.0 t/y)

QSO_2 = Sulfur dioxide emission rate, metric tons/day = 1.10 (441.9 t/y)

QNO_2 = Nitrogen dioxide emission rate, metric tons/day = 2.18 (876 t/y)

d = Distance from facility to Class I Area, km = 260

r_{vo} = Regional background visual range, km = 40
(From Figure 13, above reference)

First - Calculate plume dispersion parameter p

$$p = \frac{2.0 \times 10^8}{(\sigma_z)(d)} \qquad \sigma_z = 100\text{m (Figure 12, above reference)}$$

$$p = \frac{2.0 \times 10^8}{(100)(260)} \qquad p = 7.69 \times 10^3$$

Second - Calculate Optical Thickness τ

$$\tau TSP = (10 \times 10^{-7})(p)(QTSP)$$

$$= (10 \times 10^{-7})(7.69 \times 10^3)(0.374)$$

$$\tau TSP = 2.88 \times 10^{-3}$$

$$\tau NO_2 = (1.7 \text{ x } 10^{-7})(p)(QNO_2)$$

$$= (1.7 \text{ x } 10^{-7})(7.69 \text{ x } 10^{3})(2.18)$$

$$\tau NO_2 = 2.85 \text{ x } 10^{-3}$$

$$\tau \text{aerosol} = (1.06 \text{ x } 10^{-5})(r_{vo})(QTSP + 1.31\ QSO_2)$$

$$= (1.06 \text{ x } 10^{-5})(40)\left[0.374+(1.31)(1.10)\right]$$

$$\tau \text{aerosol} = 7.70 \text{ x } 10^{-4}$$

Third - Calculate the contrast parameters C_1, C_2, and C_3

C_1 is plume contrast against the sky
C_2 is plume contrast against the terrain
C_3 is a change in sky/terrain contrast caused by primary and secondary aerosol.

$$C_1 = \frac{\tau NO_2}{\tau TSP + \tau NO_2}\left[1 - e^{(-\tau TSP - \tau NO_2)}\right]\left[e^{(-0.78)(d/r_{vo})}\right]$$

$$= \left[\frac{2.85 \text{ x } 10^{-3}}{2.88 \text{ x } 10^{-3} + 2.85 \text{ x } 10^{-3}}\right]\left[1 - e^{(-2.88 \text{ x } 10^{-3} - 2.85 \text{ x } 10^{-3})}\right]\left[e^{(-0.78)(260/40)}\right]$$

$$= (4.97 \text{ x } 10^{-1})\ (5.71 \text{ x } 10^{-3})\ (6.28 \text{ x } 10^{-3})$$

$$= 1.78 \text{ x } 10^{-5}$$

$$C_2 = \left\{1-\left[\left[\left(\frac{1}{C_1 + 1}\right)e^{(-\tau TSP - \tau NO_2)}\right]\right]\right\}\left[e^{(-1.56\ d/r_{vo})}\right]$$

$$= \left[1-\left(\frac{1}{1.78 \text{ x } 10^{-5} + 1}\right)\ e^{(-2.88 \text{ x } 10^{-3} - 2.85 \text{ x } 10^{-3})}\right]\left[e^{[(-1.56)(260/40)]}\right]$$

$$= (5.73 \text{ x } 10^{-3})\ (3.95 \text{ x } 10^{-5})$$

$$= 2.26 \text{ x } 10^{-7}$$

$$C_3 = 0.368\left[1\text{-}e^{-\tau aerosol}\right]$$

$$= 0.368\left[1\text{-}e^{-7.7 \times 10^{-4}}\right]$$

$$= 2.83 \times 10^{-4}$$

If each of the values C_1, C_2, and C_3 are less than 0.1, the site passes the screening test and no visibility impairment is expected.

$C_1 = 1.78 \times 10^{-5}$

$C_2 = 2.26 \times 10^{-7}$

$C_3 = 2.83 \times 10^{-4}$

Thus, no visibility impairment is expected at Upper Buffalo National Wilderness Area due to the facility.

APPENDIX D2

TSP Emissions Versus Regulated Levels

Section 210(b), General Provisions of the Tulsa City-County Regulations and Regulation 2.3(d) of the Oklahoma Clean Air Act limit particulate emissions according to the following:

$$Y = 0.01221X^{0.7577}$$

Where X = Refuse charged, lb/hr

Y = Allowable emission, lb/hr TSP

For the facility,

X = 750 T/day = 62,500 lbs/hr

Therefore Y = 52.55 lbs/hr TSP allowable

Stack testing has shown TSP emissions from the facility to be below the permitted level of 34.2 lbs/hr. This limitation is therefore not violated by the facility.

Section 210(C)(2)(b) of the Tulsa City-County Regulations further sets a TSP outlet grain loading limitation of 0.2 gr/dscf. Facility emissions are a maximum of .06 gr/dscf, as guaranteed by the manufacturer. Therefore, this regulation is not violated by the facility.

APPENDIX D3

SO_2 Emissions Versus Regulated Levels

Regulation 217(c) of the Tulsa City-County Regulations sets an emission limit for SO_2 for new installations.

Limit:	1.3 g/m^3 SO_2.	(500 ppm)

It also specifies an emission limit for H_2SO_4.

Limit:	50 mg/m^3	(12.3 ppm)

Permit levels set the maximum lbs/hr of these pollutants to be:

SO_2:	100.9 lbs/hr	= 12.71 g/sec
H_2SO_4:	18.0 lbs/hr	= 2.27 g/sec

Total volumetric flow out stack = 75.60 m^3/sec

Thus, output from the stack is:

SO_2: 12.71 g/sec x sec/75.6 m^3 = 0.168 g/m^3

H_2SO_4: 2.27 g/sec x sec/75.6 m^3 = 3.00×10^{-2} g/m^3

or 30.0 mg/m^3

From this calculation, facility emissions fall below the Tulsa City-County limitations.

APPENDIX D4

Example Model Output

```
                 *** TULSA REMODEL PONCA76 MET DATA ACTUAL OP. NOX 3 BOILERS BID  ***

CALCULATE (CONCENTRATION=1,DEPOSITION=2)                                  ISW(1) =   1
RECEPTOR GRID SYSTEM (RECTANGULAR=1 OR 3, POLAR=2 OR 4)                   ISW(2) =   2
DISCRETE RECEPTOR SYSTEM (RECTANGULAR=1,POLAR=2)                          ISW(3) =   2
TERRAIN ELEVATIONS ARE READ (YES=1,NO=0)                                  ISW(4) =   1
CALCULATIONS ARE WRITTEN TO TAPE (YES=1,NO=0)                             ISW(5) =   0
LIST ALL INPUT DATA (NO=0,YES=1,MET DATA ALSO=2)                          ISW(6) =   1

COMPUTE AVERAGE CONCENTRATION (OR TOTAL DEPOSITION)
WITH THE FOLLOWING TIME PERIODS:
  HOURLY (YES=1,NO=0)                                                     ISW(7) =   0
  2-HOUR (YES=1,NO=0)                                                     ISW(8) =   0
  3-HOUR (YES=1,NO=0)                                                     ISW(9) =   1
  4-HOUR (YES=1,NO=0)                                                    ISW(10) =   0
  6-HOUR (YES=1,NO=0)                                                    ISW(11) =   0
  8-HOUR (YES=1,NO=0)                                                    ISW(12) =   0
  12-HOUR (YES=1,NO=0)                                                   ISW(13) =   0
  24-HOUR (YES=1,NO=0)                                                   ISW(14) =   1
PRINT 'N'-DAY TABLE(S) (YES=1,NO=0)                                      ISW(15) =   1

PRINT THE FOLLOWING TYPES OF TABLES WHOSE TIME PERIODS ARE
SPECIFIED BY ISW(7) THROUGH ISW(14):
  DAILY TABLES (YES=1,NO=0)                                              ISW(16) =   0
  HIGHEST & SECOND HIGHEST TABLES (YES=1,NO=0)                           ISW(17) =   1
  MAXIMUM 50 TABLES (YES=1,NO=0)                                         ISW(18) =   1
METEOROLOGICAL DATA INPUT METHOD (PRE-PROCESSED=1,CARD=2)                ISW(19) =   1
RURAL-URBAN OPTION (RU.=0,UR. MODE 1=1,UR. MODE 2=2,UR. MODE 3=3)        ISW(20) =   0
WIND PROFILE EXPONENT VALUES (DEFAULTS=1,USER ENTERS=2,3)                ISW(21) =   1
VERTICAL POT. TEMP. GRADIENT VALUES (DEFAULTS=1,USER ENTERS=2,3)         ISW(22) =   1
SCALE EMISSION RATES FOR ALL SOURCES (NO=0,YES>0)                        ISW(23) =   0
PROGRAM CALCULATES FINAL PLUME RISE ONLY (YES=1,NO=2)                    ISW(24) =   1
PROGRAM ADJUSTS ALL STACK HEIGHTS FOR DOWNWASH (YES=2,NO=1)              ISW(25) =   1
PROGRAM USES BUOYANCY INDUCED DISPERSION (YES=1,NO=2)                    ISW(26) =   1
CONCENTRATIONS DURING CALM PERIODS SET = 0 (YES=1,NO=2)                  ISW(27) =   1
REG. DEFAULT OPTION CHOSEN (YES=1,NO=2)                                  ISW(28) =   2
TYPE OF POLLUTANT TO BE MODELLED (1=SO2,2=OTHER)                         ISW(29) =   2
DEBUG OPTION CHOSEN (1=YES,2=NO)                                         ISW(30) =   2
USE RUNNING AVERAGES (0=NO,1=YES)                                        ISW(40) =   0

NUMBER OF INPUT SOURCES                                                   NSOURC =   2
NUMBER OF SOURCE GROUPS (=0,ALL SOURCES)                                  NGROUP =   3
TIME PERIOD INTERVAL TO BE PRINTED (=0,ALL INTERVALS)                      IPERD =   0
NUMBER OF X (RANGE) GRID VALUES                                           NXPNTS =   0
NUMBER OF Y (THETA) GRID VALUES                                           NYPNTS =   0
NUMBER OF DISCRETE RECEPTORS                                              NXWYPT =  17
SOURCE EMISSION RATE UNITS CONVERSION FACTOR                                  TK=.10000E+07
HEIGHT ABOVE GROUND AT WHICH WIND SPEED WAS MEASURED                          ZR =  10.00  METERS
LOGICAL UNIT NUMBER OF METEOROLOGICAL DATA                                  IMET =   9
DECAY COEFFICIENT FOR PHYSICAL OR CHEMICAL DEPLETION                       DECAY = .000000E+00
SURFACE STATION NO.                                                          ISS = 13969
YEAR OF SURFACE DATA                                                         ISY = 76
UPPER AIR STATION NO.                                                        IUS = 13967
YEAR OF UPPER AIR DATA                                                       IUY = 76
ALLOCATED DATA STORAGE                                                     LIMIT = 55500 WORDS
REQUIRED DATA STORAGE FOR THIS PROBLEM RUN                                 MIMIT =  2282 WORDS
```

1976 FINAL
ISCST RUN

MODELED AT 24.15 g/sec

```
                                                                                                    HIGH
                                                                                                     3-HR
                                                                                                    SGROUP#  1
                    *** TULSA REMODEL PONCA76 MET DATA ACTUAL OP. NOX 3 BOILERS BID ***

                  * HIGHEST  3-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)     *
                                        * FROM SOURCES:       1,
                                     * FOR THE DISCRETE RECEPTOR POINTS *
           - RNG -      - DIR -      CON.      (DAY,PER.)                - RNG -      - DIR -      CON.      (DAY,PER.)
  - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

            974.4        360.0     12.78066   (151,  4)                  1827.0        360.0     19.70330   (168,  5)
           2801.4        360.0     17.02925   (168,  5)                  3897.6        360.0     16.74605   ( 62,  1)
           4872.0        360.0     22.88736   (205,  2)                  5846.4        360.0     28.76223   (205,  2)
           6942.6        360.0     13.07365   ( 15,  1)                   974.4        180.0      7.38269   (138,  4)
           1827.0        180.0     65.34355   (345,  4)                  2801.4        180.0     14.22348   (279,  5)
           3897.6        180.0     12.62860   ( 44,  5)                  4872.0        180.0     11.23954   ( 44,  5)
           5846.4        180.0     10.33958   (345,  4)                  6942.6        180.0     10.15418   (308,  2)
            657.7        202.5      3.32630   (135,  5)                  1741.7        202.5     45.23807   (315,  1)
           2898.8        202.5     15.03930   (281,  4)
```

```
                                                                                                   2ND HIGH
                                                                                                    3-HR
                        *** TULSA REMODEL PONCA76 MET DATA ACTUAL OP.  NOX 3 BOILERS BID  ***      SGROUP#   1 ✓

                    * SECOND HIGHEST  3-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)      *
                                              * FROM SOURCES:          1,
                                            * FOR THE DISCRETE RECEPTOR POINTS *
           - RNG -      - DIR -      CON.      (DAY,PER.)              - RNG -      - DIR -      CON.      (DAY,PER.)
  - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

            974.4        360.0     12.72267   (132,  5)                 1827.0       360.0     16.68435   (195,  4)
           2801.4        360.0     13.86670   (162,  5)                 3897.6       360.0     14.26926   ( 40,  4)
           4872.0        360.0     22.78865   ( 15,  1)                 5846.4       360.0     22.66150   ( 15,  1)
           6942.6        360.0     12.28829   ( 62,  1)                  974.4       180.0      6.91179   (135,  4)
           1827.0        180.0     58.41932   (332,  5)                 2801.4       180.0     14.04729   ( 44,  5)
           3897.6        180.0     11.92278   (345,  4)                 4872.0       180.0     10.96008   (345,  4)
           5846.4        180.0     10.26208   ( 44,  5)                 6942.6       180.0      9.58778   (312,  2)
            657.7        202.5      3.22220   (124,  4)                 1741.7       202.5     41.90681   (281,  4)
           2898.8        202.5     11.68594   ( 35,  4)
```

```
                                                                                                   3-HR
                    *** TULSA REMODEL PONCA76 MET DATA ACTUAL OP. NOX 3 BOILERS BID ***          SGROUP#  1

              * 50 MAXIMUM  3-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)      *

                                    * FROM SOURCES:        1,

                                        X      Y(METERS)                                              X      Y(METERS)
                                        OR        OR                                                  OR        OR
                                      RANGE   DIRECTION                                             RANGE   DIRECTION
   RANK       CON.      PER.  DAY   (METERS)  (DEGREES)        RANK       CON.      PER.  DAY   (METERS)  (DEGREES)
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

     1       65.34355    4   345    1827.0     180.0            26       41.90681    4   281    1741.7     202.5
     2       58.41932    5   332    1827.0     180.0            27       41.79609    4   298    1827.0     180.0
     3       55.07568    5    44    1827.0     180.0            28       41.73547    1   346    1827.0     180.0
     4       54.54786    3    19    1827.0     180.0            29       40.98917    6   123    1827.0     180.0
     5       53.71890    6    25    1827.0     180.0            30       40.60586    2   264    1827.0     180.0
     6       53.71719    2   253    1827.0     180.0            31       40.57419    1    63    1827.0     180.0
     7       51.58708    2   308    1827.0     180.0            32       40.00037    2   215    1827.0     180.0
     8       51.52000    1   242    1827.0     180.0            33       39.44455    5   123    1827.0     180.0
     9       50.61985    2    94    1827.0     180.0            34       38.75191    3   363    1827.0     180.0
    10       49.32855    7   127    1827.0     180.0            35       38.09428    1   312    1827.0     180.0
    11       49.31750    4    19    1827.0     180.0            36       37.78405    7    68    1827.0     180.0
    12       47.16529    7   298    1827.0     180.0            37       37.32570    4   365    1827.0     180.0
    13       47.11095    7    36    1827.0     180.0            38       37.27051    3   253    1827.0     180.0
    14       46.59749    8    60    1827.0     180.0            39       37.02565    4   176    1827.0     180.0
    15       46.09703    5   279    1827.0     180.0            40       37.00718    1   299    1827.0     180.0
    16       45.23807    1   315    1741.7     202.5            41       36.94945    4   283    1827.0     180.0
    17       44.91679    2   279    1827.0     180.0            42       36.74487    5   307    1827.0     180.0
    18       44.83607    3    94    1827.0     180.0            43       36.68146    2   312    1827.0     180.0
    19       44.22655    2    63    1827.0     180.0            44       36.64452    7   325    1827.0     180.0
    20       43.34884    6   127    1827.0     180.0            45       36.45174    7    67    1827.0     180.0
    21       42.84167    2    95    1827.0     180.0            46       36.43757    5   338    1827.0     180.0
    22       42.47398    4    36    1827.0     180.0            47       36.42400    8    65    1827.0     180.0
    23       42.11701    4    25    1827.0     180.0            48       36.01052    5   271    1827.0     180.0
    24       41.98307    6   298    1827.0     180.0            49       35.64169    8   345    1827.0     180.0
    25       41.95414    3   298    1827.0     180.0            50       35.44775    1   298    1827.0     180.0
```

```
                                                                                                   HIGH
                                                                                                   24-HR
             *** TULSA REMODEL PONCA76 MET DATA ACTUAL OP.  NOX 3 BOILERS BID  ***                 SGROUP#  1

            * HIGHEST 24-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)      *
                              * FROM SOURCES:         1,
                         * FOR THE DISCRETE RECEPTOR POINTS *

   - RNG -     - DIR -     CON.      (DAY,PER.)            - RNG -     - DIR -     CON.      (DAY,PER.)
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

    974.4      360.0     2.80325C (149,  1)               1827.0      360.0     4.11324   (195,  1)
   2801.4      360.0     4.79406C (224,  1)               3897.6      360.0     6.38923   (192,  1)
   4872.0      360.0     8.97426  (192,  1)               5846.4      360.0     7.86676   (192,  1)
   6942.6      360.0     5.18594  (192,  1)                974.4      180.0     1.82388C  (135,  1)
   1827.0      180.0    30.80801C (279,  1)               2801.4      180.0     6.41268C  (279,  1)
   3897.6      180.0     6.07058C (279,  1)               4872.0      180.0     5.59913C  (279,  1)
   5846.4      180.0     5.35765C (279,  1)               6942.6      180.0     5.01657C  (279,  1)
    657.7      202.5      .78972C (135,  1)               1741.7      202.5    12.71833   ( 35,  1)
   2898.8      202.5     4.33759  ( 35,  1)
```

```
                                                                                                 2ND HIGH
                                                                                                 24-HR
          *** TULSA REMODEL PONCA76 MET DATA ACTUAL OP. NOX 3 BOILERS BID  ***                   SGROUP*  1   ✓

        * SECOND HIGHEST 24-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)      *
                               * FROM SOURCES:      1,
                             * FOR THE DISCRETE RECEPTOR POINTS *

   - RNG -     - DIR -      CON.     (DAY,PER.)          - RNG -     - DIR -      CON.     (DAY,PER.)
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

    974.4       360.0     2.44190C (132,  1)            1827.0       360.0     3.90666C (149,  1)
   2801.4       360.0     4.06231  (192,  1)            3897.6       360.0     6.23043C (224,  1)
   4872.0       360.0     7.48224  ( 40,  1)            5846.4       360.0     7.58296  ( 23,  1)
   6942.6       360.0     4.24132C (224,  1)             974.4       180.0     1.26705C (153,  1)
   1827.0       180.0    30.18172  ( 25,  1)            2801.4       180.0     4.93673  (298,  1)
   3897.6       180.0     5.17101  (298,  1)            4872.0       180.0     4.95523  ( 25,  1)
   5846.4       180.0     4.92199  ( 25,  1)            6942.6       180.0     4.74660  ( 25,  1)
    657.7       202.5      .40279  (124,  1)            1741.7       202.5     9.53212  (290,  1)
   2898.8       202 5     3.05257C ( 95,  1)
```

```
                                                                                                   MAX 50
                                                                                                   24-HR
         *** TULSA REMODEL PONCA76 MET DATA ACTUAL OP. NOX 3 BOILERS BID  ***                      SGROUPS   1

      * 50 MAXIMUM 24-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)      *

                                  * FROM SOURCES:        1,

                                            X       Y(METERS)                                               X       Y(METERS)
                                           OR          OR                                                  OR          OR
                                          RANGE    DIRECTION                                              RANGE    DIRECTION
    RANK        CON.        PER.  DAY    (METERS)  (DEGREES)         RANK        CON.        PER.  DAY   (METERS)  (DEGREES)
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

      1       30.80801C      1    279     1827.0      180.0           26       11.31979C      1     30     1827.0      180.0
      2       30.18172       1     25     1827.0      180.0           27       11.29807       1    281     1827.0      180.0
      3       29.74603       1    298     1827.0      180.0           28       10.51717C      1    308     1827.0      180.0
      4       26.49536       1     94     1827.0      180.0           29       10.45393C      1    338     1827.0      180.0
      5       22.88670       1    253     1827.0      180.0           30       10.36584       1     68     1827.0      180.0
      6       22.53090       1    345     1827.0      180.0           31       10.24969       1     44     1827.0      180.0
      7       19.75443       1     36     1827.0      180.0           32       10.21093       1    289     1827.0      180.0
      8       19.63779       1     63     1827.0      180.0           33        9.53212       1    290     1741.7      202.5
      9       16.91215       1    123     1827.0      180.0           34        9.50611C      1    346     1827.0      180.0
     10       16.03810       1    264     1827.0      180.0           35        9.48183       1    331     1827.0      180.0
     11       15.77865C      1    312     1827.0      180.0           36        9.28915C      1    135     1827.0      180.0
     12       15.14563       1    127     1827.0      180.0           37        9.00840       1    219     1827.0      180.0
     13       14.79052       1      7     1827.0      180.0           38        8.97426       1    192     4872.0      360.0
     14       14.10233C      1     19     1827.0      180.0           39        8.91979       1     65     1827.0      180.0
     15       13.85887       1    365     1827.0      180.0           40        8.44893C      1    153     1827.0      180.0
     16       13.75661       1    332     1827.0      180.0           41        8.32687       1     60     1827.0      180.0
     17       12.91360       1    307     1827.0      180.0           42        8.32333C      1    336     1827.0      180.0
     18       12.71833       1     35     1741.7      202.5           43        8.30782C      1    102     1741.7      202.5
     19       12.69749C      1    341     1827.0      180.0           44        8.24701C      1     95     1827.0      180.0
     20       12.56779       1    170     1827.0      180.0           45        8.24510       1    281     1741.7      202.5
     21       12.55898C      1    271     1827.0      180.0           46        8.22458C      1    145     1827.0      180.0
     22       12.28402       1    325     1827.0      180.0           47        8.11576       1    186     1827.0      180.0
     23       12.14237       1    317     1827.0      180.0           48        7.86676       1    192     5846.4      360.0
     24       11.72063       1    316     1827.0      180.0           49        7.58296       1     23     5846.4      360.0
     25       11.32744C      1    283     1827.0      180.0           50        7.50854C      1    176     1827.0      180.0
```

```
                  *** TULSA REMODEL PONCA75 MET DATA ACTUAL OPERATION ST.  1 + 2    ***

CALCULATE (CONCENTRATION=1,DEPOSITION=2)                                     ISW(1) =   1
RECEPTOR GRID SYSTEM (RECTANGULAR=1 OR 3, POLAR=2 OR 4)                      ISW(2) =   2
DISCRETE RECEPTOR SYSTEM (RECTANGULAR=1,POLAR=2)                             ISW(3) =   2
TERRAIN ELEVATIONS ARE READ (YES=1,NO=0)                                     ISW(4) =   1
CALCULATIONS ARE WRITTEN TO TAPE (YES=1,NO=0)                                ISW(5) =   0
LIST ALL INPUT DATA (NO=0,YES=1,MET DATA ALSO=2)                             ISW(6) =   1

COMPUTE AVERAGE CONCENTRATION (OR TOTAL DEPOSITION)
WITH THE FOLLOWING TIME PERIODS:
  HOURLY (YES=1,NO=0)                                                        ISW(7) =   0
  2-HOUR (YES=1,NO=0)                                                        ISW(8) =   0
  3-HOUR (YES=1,NO=0)                                                        ISW(9) =   1
  4-HOUR (YES=1,NO=0)                                                       ISW(10) =   0
  6-HOUR (YES=1,NO=0)                                                       ISW(11) =   0
  8-HOUR (YES=1,NO=0)                                                       ISW(12) =   0
  12-HOUR (YES=1,NO=0)                                                      ISW(13) =   0
  24-HOUR (YES=1,NO=0)                                                      ISW(14) =   1
PRINT 'N'-DAY TABLE(S) (YES=1,NO=0)                                         ISW(15) =   1

PRINT THE FOLLOWING TYPES OF TABLES WHOSE TIME PERIODS ARE
SPECIFIED BY ISW(7) THROUGH ISW(14):
  DAILY TABLES (YES=1,NO=0)                                                 ISW(16) =   0
  HIGHEST & SECOND HIGHEST TABLES (YES=1,NO=0)                              ISW(17) =   1
  MAXIMUM 50 TABLES (YES=1,NO=0)                                            ISW(18) =   1
METEOROLOGICAL DATA INPUT METHOD (PRE-PROCESSED=1,CARD=2)                   ISW(19) =   1
RURAL-URBAN OPTION (RU.=0,UR. MODE 1=1,UR. MODE 2=2,UR. MODE 3=3)           ISW(20) =   0
WIND PROFILE EXPONENT VALUES (DEFAULTS=1,USER ENTERS=2,3)                   ISW(21) =   1
VERTICAL POT. TEMP. GRADIENT VALUES (DEFAULTS=1,USER ENTERS=2,3)            ISW(22) =   1
SCALE EMISSION RATES FOR ALL SOURCES (NO=0,YES>0)                           ISW(23) =   0
PROGRAM CALCULATES FINAL PLUME RISE ONLY (YES=1,NO=2)                       ISW(24) =   1
PROGRAM ADJUSTS ALL STACK HEIGHTS FOR DOWNWASH (YES=2,NO=1)                 ISW(25) =   1
PROGRAM USES BUOYANCY INDUCED DISPERSION (YES=1,NO=2)                       ISW(26) =   2
CONCENTRATIONS DURING CALM PERIODS SET = 0 (YES=1,NO=2)                     ISW(27) =   1
REG. DEFAULT OPTION CHOSEN (YES=1,NO=2)                                     ISW(28) =   2
TYPE OF POLLUTANT TO BE MODELLED (1=SO2,2=OTHER)                            ISW(29) =   2
DEBUG OPTION CHOSEN (1=YES,2=NO)                                            ISW(30) =   2
USE RUNNING AVERAGES (0=NO,1=YES)                                           ISW(40) =   0

NUMBER OF INPUT SOURCES                                                      NSOURC =   1
NUMBER OF SOURCE GROUPS (=0,ALL SOURCES)                                     NGROUP =   0
TIME PERIOD INTERVAL TO BE PRINTED (=0,ALL INTERVALS)                         IPERD =   0
NUMBER OF X (RANGE) GRID VALUES                                              NXPNTS =   0
NUMBER OF Y (THETA) GRID VALUES                                              NYPNTS =   0
NUMBER OF DISCRETE RECEPTORS                                                 NXWYPT = 112
SOURCE EMISSION RATE UNITS CONVERSION FACTOR                                     TK=.10000E+07
HEIGHT ABOVE GROUND AT WHICH WIND SPEED WAS MEASURED                             ZR =  10.00  METERS
LOGICAL UNIT NUMBER OF METEOROLOGICAL DATA                                     IMET =   9
DECAY COEFFICIENT FOR PHYSICAL OR CHEMICAL DEPLETION                          DECAY = .000000E+00
SURFACE STATION NO.                                                             ISS = 13969
YEAR OF SURFACE DATA                                                            ISY = 75
UPPER AIR STATION NO.                                                           IUS = 13967
YEAR OF UPPER AIR DATA                                                          IUY = 75
ALLOCATED DATA STORAGE                                                        LIMIT = 55500 WORDS
REQUIRED DATA STORAGE FOR THIS PROBLEM RUN                                    MIMIT =  2409 WORDS
```

PONCA CITY 1975 MET
SCREENING SHORT TERM
RUN. MODELED AT 10G/SEC

```
          *** TULSA REMODEL PONCA75 MET DATA ACTUAL OPERATION ST. 1 + 2    ***

                              * ELEVATION HEIGHTS IN METERS *
                            * FOR THE DISCRETE RECEPTOR POINTS *

 - RNG -     - DIR -     HGT.            - RNG -     - DIR -     HGT.            - RNG -     - DIR -     HGT.
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

   974.4      360.0    195.07240          1827.0      360.0    193.54840          2801.4      360.0    205.74040
  3897.6      360.0    228.60040          4872.0      360.0    252.98450          5846.4      360.0    260.60450
  6942.6      360.0    252 98450           925.7       22.5    195.07240          1741.7       22.5    192.02440
  2998.7       22.5    208.78840          3982.9       22.5    231.64850          4908.5       22.5    222.50440
  5675.9       22.5    205.74040          6601.6       22.5    202.69240           864.8       45.0    195.07240
  2070.6       45.0    207.26440          2923.2       45.0    214.88440          3958.6       45.0    219.45640
  4823.3       45.0    220.98040          5688.1       45.0    222.50440          6540.6       45.0    213.36040
  1035.3       67.5    193.54840          2082.8       67.5    192.02440          3057.2       67.5    213.36040
  3714.9       67.5    216.40840          4750.2       67.5    217.93240          5675.9       67.5    225.55240
  6881.7       67.5    225.55240           974.4       90.0    193.54840          1948.8       90.0    192.02440
  2923.3       90.0    205.74040          3897.6       90.0    214.88440          4872.0       90.0    213.36040
  5846.4       90.0    222.50440          6820.8       90.0    239.26850          1035.3      112.5    193.54840
  2131.5      112.5    193.54840          3057.2      112.5    190.50040          3714.9      112.5    196.59640
  4750.2      112.5    213.36040          5675.9      112.5    216.40840          6881.7      112.5    220.98040
   864.8      135.0    193.54840          2070.6      135.0    192.02440          2923.2      135.0    192.02440
  3958.6      135.0    190.50040          4823.3      135.0    192.02440          5688.1      135.0    193.54840
  6540.6      135.0    195.07240           925.7      157.5    195.07240          1741.7      157.5    193.54840
  2998.8      157.5    193.54840          3982.9      157.5    192.02440          4859.8      157.5    201.16840
  5675.9      157.5    224.02840          6601.6      157.5    187.45240           974.4      180.0    193.54840
  1827.0      180.0    262.12850          2801.4      180.0    204.21640          3897.6      180.0    202.69240
  4872 0      180.0    202.69240          5846.4      180.0    207.26440          6942.6      180.0    213.36040
   657.7      202.5    195.07240          1741.7      202.5    266.70050          2898.8      202.5    228.60040
  3982.9      202.5    213.36040          4859.8      202.5    217.93240          5675.9      202.5    222.50440
  6601.6      202.5    234.69650          1205.8      225.0    195.07240          2070.6      225.0    207.26440
  2923.2      225.0    259.08050          3958.6      225.0    228.60040          4823.3      225.0    214.88440
  5680.1      225.0    231.64850          6540.6      225.0    242.31650          1035.3      247.5    196.59640
  2131.5      247.5    230.12450          3057.2      247.5    225.55240          3714.9      247.5    201.16840
  4750.2      247.5    214.88440          5675.9      247.5    237.74450          6881.7      247.5    216.40840
   974.4      270.0    199.64440          1948.9      270.0    222.50440          2923.2      270.0    210.31240
  3897.6      270.0    220.98040          4872.0      270.0    256.03250          5846.4      270.0    190.50040
  6820.8      270.0    196.59640          1035.3      292.5    195.07240          2082.8      292.5    193.54840
  3057.2      292.5    192.02440          3714.9      292.5    195.07240          4750.2      292.5    195.07240
  5675.9      292.5    213.36040          6881.7      292.5    240.79250          1205.8      315.0    193.54840
  2070.6      315.0    190.50040          2923.2      315.0    195.07240          3958.6      315.0    207.26440
  4823.3      315.0    213.36040          5688.1      315.0    225.55240          6540.6      315.0    262.12850
   657.7      337.5    193.54840          1741.7      337.5    192.02440          2898.8      337.5    201.16840
  3982.9      337.5    211.83640          4859.8      337.5    201.16840          5675.9      337.5    214.88440
  6601.6      337.5    228.60040
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                                                                                                  3-HR
                                                                                               SGROUP#  1
                    *** TULSA REMODEL PONCA75 MET DATA ACTUAL OPERATION ST. 1 + 2    ***

                   * HIGHEST  3-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)     *
                                          * FROM ALL SOURCES *
                                    * FOR THE DISCRETE RECEPTOR POINTS *

        - RNG -      - DIR -      CON.      (DAY,PER.)              - RNG -      - DIR -      CON.      (DAY,PER.)
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

         974.4        360.0     4.97970C  (208,  4)                 1827.0        360.0     6.34129   (230,  4)
        2801.4        360.0     6.00485   (230,  4)                 3897.6        360.0     7.61333   (348,  1)
        4872.0        360.0    11.16315   ( 23,  2)                 5846.4        360.0    12.53837   (217,  8)
        6942.6        360.0     9.27074   ( 23,  2)                  925.7         22.5     4.28747C  (166,  4)
        1741.7         22.5     5.57527   ( 78,  4)                 2998.7         22.5     4.75700   (224,  3)
        3982.9         22.5     7.68702   ( 20,  5)                 4908.5         22.5     5.96871   ( 20,  5)
        5675.9         22.5     4.38347   ( 20,  5)                 6601.6         22.5     3.89344   ( 20,  5)
         864.8         45.0     6.54688C  (166,  4)                 2070.6         45.0     6.86146   (187,  5)
        2923.2         45.0     6.07202   ( 43,  5)                 3958.6         45.0     5.35107   ( 43,  5)
        4823.3         45.0     4.57227   ( 43,  5)                 5688.1         45.0     3.93664   ( 43,  5)
        6540.6         45.0     3.45315   ( 43,  5)                 1035.3         67.5     4.40828   (202,  4)
        2082.8         67.5     5.05742   (273,  4)                 3057.2         67.5     4.62874   (333,  7)
        3714.9         67.5     4.65052   (333,  7)                 4750.2         67.5     4.16627   ( 80,  6)
        5675.9         67.5     4.14391   ( 58,  6)                 6881.7         67.5     3.59930   ( 58,  6)
         974.4         90.0     4.58141   (127,  4)                 1948.8         90.0     5.16665   (109,  6)
        2923.3         90.0     5.21415   (109,  6)                 3897.6         90.0     5.12560   ( 82,  5)
        4872.0         90.0     4.22463   ( 82,  5)                 5846.4         90.0     3.88027   ( 82,  5)
        6820.8         90.0     5.03993   ( 25,  1)                 1035.3        112.5     3.41958   (151,  5)
        2131.5        112.5     5.03503   (314,  4)                 3057.2        112.5     4.96500   (314,  4)
        3714.9        112.5     4.42359   (314,  4)                 4750.2        112.5     3.83470   ( 89,  4)
        5675.9        112.5     3.54303   ( 89,  4)                 6881.7        112.5     3.41786   (162,  1)
         864.8        135.0     5.69677   (123,  5)                 2070.6        135.0     5.86756   (109,  4)
        2923.2        135.0     4.57332   (109,  4)                 3958.6        135.0     3.16184   (  6,  4)
        4823.3        135.0     3.35063   (  6,  4)                 5688.1        135.0     3.31358   (  6,  4)
        6540.6        135.0     3.17159   (  6,  4)                  925.7        157.5     5.50412   (123,  5)
        1741.7        157.5     4.83487   (349,  4)                 2998.8        157.5     5.92256   (349,  4)
        3982.9        157.5     5.00025   (349,  4)                 4859.8        157.5     4.44352   ( 49,  4)
        5675.9        157.5     4.95366   ( 37,  2)                 6601.6        157.5     3.53774   ( 49,  4)
         974.4        180.0     6.70393   (119,  5)                 1827.0        180.0    22.61731   (363,  2)
        2801.4        180.0     5.51445   (191,  3)                 3897.6        180.0     4.50010   (363,  2)
        4872.0        180.0     4.44710   (152,  6)                 5846.4        180.0     4.69925   (152,  6)
        6942.6        180.0     4.68994   (152,  6)                  657.7        202.5     4.90093   (216,  5)
        1741.7        202.5    17.50252   (133,  6)                 2898.8        202.5     5.77877   (133,  6)
        3982.9        202.5     3.96271   (133,  6)                 4859.8        202.5     3.92750   (133,  6)
        5675.9        202.5     3.74315   (133,  6)                 6601.6        202.5     3.67347   (133,  6)
        1205.8        225.0     5.05231   (151,  4)                 2070.6        225.0     5.37100   ( 67,  5)
        2923.2        225.0    12.92426   ( 62,  2)                 3958.6        225.0     6.46871   ( 62,  2)
        4823.3        225.0     4.97270   ( 62,  2)                 5680.1        225.0     6.15598   ( 62,  2)
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                                                                                                   3-HR
                 *** TULSA REMODEL PONCA75 MET DATA ACTUAL OPERATION ST. 1 + 2    ***            SGROUP#  1

               * HIGHEST  3-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)     *
                                     * FROM ALL SOURCES *
                              * FOR THE DISCRETE RECEPTOR POINTS *
      - RNO -      - DIR -      CON.      (DAY,PER.)             - RNO -      - DIR -      CON.      (DAY,PER.)
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

      6540. 6      225. 0      6. 30606   ( 62,  2)              1035. 3      247. 5      4. 43121   (206,  4)
      2131. 5      247. 5      5. 91765   (206,  4)              3057. 2      247. 5      3. 93304   (271,  7)
      3714. 9      247. 5      2. 52618   (206,  4)              4750. 2      247. 5      2. 94924   (271,  7)
      5675. 9      247. 5      3. 52638   (271,  7)              6881. 7      247. 5      2. 38200   (271,  7)
       974. 4      270. 0      3. 44808   (136,  5)              1948. 9      270. 0      6. 30365   (136,  6)
      2923. 2      270. 0      4. 51848   (329,  4)              3897. 6      270. 0      6. 26152   (329,  4)
      4872. 0      270. 0      8. 98299   (329,  4)              5846. 4      270. 0      3. 43593   (329,  4)
      6820. 8      270. 0      3. 52694   (329,  4)              1035. 3      292. 5      6. 98396   (206,  5)
      2082. 8      292  5      6. 46314   (182,  6)              3057. 2      292. 5      5. 37156   (190,  6)
      3714. 9      292. 5      5. 17301   (190,  6)              4750. 2      292. 5      4. 24518   (190,  6)
      5675. 9      292. 5      3. 98074   (  8,  1)              6881. 7      292. 5      4. 69174   (  8,  1)
      1205. 8      315. 0      7. 75889   (208,  5)              2070. 6      315. 0      5. 88238   (234,  5)
      2923. 2      315. 0      4. 51493   (209,  5)              3958. 6      315. 0      4. 58826   (221,  3)
      4823. 3      315. 0      4. 75987   (221,  3)              5688. 1      315. 0      5. 05485   (221,  3)
      6540. 6      315. 0     10. 65388   (284,  1)               657. 7      337. 5      4. 32315   (212,  4)
      1741. 7      337. 5      6. 26992   (209,  4)              2898. 8      337. 5      5. 07413   (209,  4)
      3982. 9      337. 5      5. 64484   (332,  8)              4859. 8      337. 5      4. 34759   (332,  8)
      5675. 9      337. 5      4. 68939   (332,  8)              6601. 6      337. 5      4. 60734   (332,  8)
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                                                                                                  2ND HIGH
                                                                                                   3-HR
                              *** TULSA REMODEL PONCA75 MET DATA ACTUAL OPERATION ST. 1 + 2    ***    SGROUP#  1

                         * SECOND HIGHEST  3-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)     *
                                                 * FROM ALL SOURCES *
                                           * FOR THE DISCRETE RECEPTOR POINTS *

                 - RNG -      - DIR -      CON.      (DAY,PER.)                 - RNG -      - DIR -      CON.      (DAY,PER.)
      - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

                  974.4        360.0     4.96945   (168,  5)                   1827.0        360.0     5.87780   (221,  4)
                 2801.4        360.0     5.02417   (348,  1)                   3897.6        360.0     7.37125   (107,  2)
                 4872.0        360.0    10.16088   (126,  8)                   5846.4        360.0    12.22159   (126,  8)
                 6942.6        360.0     9.07078   (126,  8)                    925.7         22.5     4.01144   (137,  4)
                 1741.7         22.5     5.20398   (218,  4)                   2998.7         22.5     4.69079   ( 20,  5)
                 3982.9         22.5     6.76358   ( 23,  5)                   4908.5         22.5     5.13817   ( 23,  5)
                 5675.9         22.5     3.74043   ( 23,  5)                   6601.6         22.5     3.26441   ( 23,  5)
                  864.8         45.0     5.05398   (187,  5)                   2070.6         45.0     6.59194   (185,  5)
                 2923.2         45.0     5.13983   (186,  3)                   3958.6         45.0     4.19774   (352,  5)
                 4823.3         45.0     4.04190   (352,  5)                   5688.1         45.0     3.75367   (352,  5)
                 6540.6         45.0     3.07010   (352,  5)                   1035.3         67.5     3.27204   (273,  4)
                 2082.8         67.5     3.51880   (202,  4)                   3057.2         67.5     3.95851   (353,  4)
                 3714.9         67.5     4.34939   ( 80,  6)                   4750.2         67.5     4.07901   (333,  7)
                 5675.9         67.5     4.11937   ( 80,  6)                   6881.7         67.5     3.49420   ( 80,  6)
                  974.4         90.0     2.12112   (201,  4)                   1948.8         90.0     3.04211   (187,  4)
                 2923.3         90.0     4.86364   ( 82,  5)                   3897.6         90.0     3.93514   (109,  6)
                 4872.0         90.0     3.00417   ( 83,  3)                   5846.4         90.0     3.71420   ( 25,  1)
                 6820.8         90.0     3.62414   ( 82,  5)                   1035.3        112.5     3.40289   (131,  4)
                 2131.5        112.5     4.26121   (311,  5)                   3057.2        112.5     4.01572   (311,  5)
                 3714.9        112.5     3.60895   (311,  5)                   4750.2        112.5     3.60704   (314,  4)
                 5675.9        112.5     3.29104   (162,  1)                   6881.7        112.5     3.12924   ( 89,  4)
                  864.8        135.0     4.01563   (123,  4)                   2070.6        135.0     4.39732   ( 99,  4)
                 2923.2        135.0     3.69969   (317,  4)                   3958.6        135.0     3.12398   (109,  4)
                 4823.3        135.0     2.69913   (317,  4)                   5688.1        135.0     2.49028   (226,  6)
                 6540.6        135.0     2.49376   (226,  6)                    925.7        157.5     2.25221   (152,  4)
                 1741.7        157.5     4.70230   ( 49,  4)                   2998.8        157.5     5.77985   (151,  3)
                 3982.9        157.5     4.94484   (151,  3)                   4859.8        157.5     4.26983   (349,  4)
                 5675.9        157.5     4.60215   (264,  6)                   6601.6        157.5     3.22904   (349,  4)
                  974.4        180.0     6.19716   (193,  4)                   1827.0        180.0    21.21880   (273,  6)
                 2801.4        180.0     5.31856   (265,  4)                   3897.6        180.0     4.39589C  ( 22,  5)
                 4872.0        180.0     4.23637C  ( 22,  5)                   5846.4        180.0     4.15782   ( 31,  2)
                 6942.6        180.0     4.40814   (191,  6)                    657.7        202.5     2.90525   (152,  4)
                 1741.7        202.5    15.61097   (301,  8)                   2898.8        202.5     5.27483   (130,  4)
                 3982.9        202.5     3.25923   (301,  8)                   4859.8        202.5     3.33060   ( 57,  3)
                 5675.9        202.5     3.26809   ( 57,  3)                   6601.6        202.5     3.66781   ( 32,  6)
                 1205.8        225.0     4.26995   (215,  6)                   2070.6        225.0     4.89071   (215,  6)
                 2923.2        225.0     8.12389   (267,  7)                   3958.6        225.0     3.16135   (213,  4)
                 4823.3        225.0     2.63371   ( 61,  4)                   5680.1        225.0     3.43218   ( 61,  7)
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                                                                                                  3-HR
                                                                                                  SGROUP#  1 ✓
                      *** TULSA REMODEL PONCA75 MET DATA ACTUAL OPERATION ST. 1 + 2    ***

                * SECOND HIGHEST  3-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)      *
                                            * FROM ALL SOURCES *
                                     * FOR THE DISCRETE RECEPTOR POINTS *

           - RNG -       - DIR -       CON.      (DAY,PER.)               - RNG -       - DIR -       CON.      (DAY,PER.)
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

           6540.6        225.0       4.45791     (267,  7)                 1035.3        247.5       2.76158C  (158,  5)
           2131.5        247.5       4.76267     (188,  5)                 3057.2        247.5       3.92331   (129,  6)
           3714.9        247.5       2.39361     (129,  6)                 4750.2        247.5       2.77551   (129,  6)
           5675.9        247.5       3.42564     (255,  7)                 6881.7        247.5       2.38135   (255,  7)
            974.4        270.0       3.38896     (157,  4)                 1948.9        270.0       5.08992   (206,  6)
           2923.2        270.0       4.15953     (136,  6)                 3897.6        270.0       3.83063   ( 85,  1)
           4872.0        270.0       8.80036     (121,  8)                 5846.4        270.0       2.02018   (  7,  8)
           6820.8        270.0       2.40770     (  7,  8)                 1035.3        292.5       5.85391   (181,  4)
           2082.8        292.5       6.12103     (180,  5)                 3057.2        292.5       5.17496   (182,  6)
           3714.9        292.5       4.23849     (182,  6)                 4750.2        292.5       3.37582   ( 16,  6)
           5675.9        292.5       3.63841     (190,  6)                 6881.7        292.5       4.60117   (343,  7)
           1205.8        315.0       5.45189     (234,  5)                 2070.6        315.0       5.68100   (209,  5)
           2923.2        315.0       4.35926     (234,  5)                 3958.6        315.0       4.24244   (115,  6)
           4823.3        315.0       4.39175     (115,  6)                 5688.1        315.0       4.54296   (115,  6)
           6540.6        315.0       8.98095     (298,  8)                  657.7        337.5       1.70882   (178,  5)
           1741.7        337.5       5.73945     (178,  5)                 2898.8        337.5       4.46117   (332,  8)
           3982.9        337.5       5.53257     (338,  2)                 4859.8        337.5       4.27420   (338,  2)
           5675.9        337.5       4.63494     (338,  2)                 6601.6        337.5       4.57259   (338,  2)
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                                                                                                   MAX 50
                                                                                                    3-HR
          *** TULSA REMODEL PONCA75 MET DATA ACTUAL OPERATION ST. 1 + 2    ***                     SGROUP#   1

       * 50 MAXIMUM  3-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)     *

                                    * FROM ALL SOURCES *

                                          X      Y(METERS)                                                X      Y(METERS)
                                          OR        OR                                                    OR        OR
                                        RANGE   DIRECTION                                               RANGE   DIRECTION
   RANK         CON.       PER.  DAY  (METERS)  (DEGREES)          RANK         CON.       PER.  DAY  (METERS)  (DEGREES)
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

     1        22.61731      2   363    1827.0      180.0             26        14.04058      6   348    1827.0      180.0
     2        21.21880      6   273    1827.0      180.0             27        13.84262      5   193    1827.0      180.0
     3        19.12220      5    72    1827.0      180.0             28        13.57810      7    46    1827.0      180.0
     4        18.91802      8    35    1827.0      180.0             29        13.51062      5   290    1827.0      180.0
     5        18.90852      7    52    1827.0      180.0             30        13.20505      2   101    1827.0      180.0
     6        17.85637      1   255    1827.0      180.0             31        13.17403      1   340    1827.0      180.0
     7        17.50252      6   133    1741.7      202.5             32        12.97566      5   273    1827.0      180.0
     8        17.29617      5    71    1827.0      180.0             33        12.97335      3    57    1741.7      202.5
     9        16.33696      2   351    1827.0      180.0             34        12.95501      4   214    1741.7      202.5
    10        16.32580      1   363    1827.0      180.0             35        12.92426      2    62    2923.2      225.0
    11        16.30051      6   152    1827.0      180.0             36        12.84666      4   130    1741.7      202.5
    12        15.61097      8   301    1741.7      202.5             37        12.67443      8   254    1827.0      180.0
    13        15.32094      8   362    1827.0      180.0             38        12.63536      6   261    1827.0      180.0
    14        15.27356      7   273    1827.0      180.0             39        12.63288      6    71    1827.0      180.0
    15        14.84158      4   120    1827.0      180.0             40        12.60050      6    72    1827.0      180.0
    16        14.81746      7   362    1827.0      180.0             41        12.55001      2    31    1827.0      180.0
    17        14.75453      5    46    1827.0      180.0             42        12.53971      3    84    1827.0      180.0
    18        14.74985      6   301    1827.0      180.0             43        12.53837      8   217    5846.4      360.0
    19        14.43449      7   350    1741.7      202.5             44        12.31727      1   101    1827.0      180.0
    20        14.40940      4    71    1827.0      180.0             45        12.26269      3   191    1827.0      180.0
    21        14.28156      3   363    1827.0      180.0             46        12.22756      1    40    1827.0      180.0
    22        14.27496      3    54    1827.0      180.0             47        12.22159      8   126    5846.4      360.0
    23        14.25409      4   263    1827.0      180.0             48        12.21928      4   193    1827.0      180.0
    24        14.18741      1    31    1827.0      180.0             49        12.17429      7    35    1827.0      180.0
    25        14.13890      5   359    1827.0      180.0             50        12.08821      4   265    1827.0      180.0
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                       *** TULSA REMODEL PONCA75 MET DATA ACTUAL OPERATION ST.  1 + 2     ***

                      * HIGHEST 24-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)      *
                                             * FROM ALL SOURCES *
                                      * FOR THE DISCRETE RECEPTOR POINTS *

         - RNG -      - DIR -      CON.      (DAY,PER.)           - RNG -      - DIR -      CON.      (DAY,PER.)
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

          974.4        360.0      1.22182   (243,  1)             1827.0        360.0      1.47541   (197,  1)
         2801.4        360.0      2.22789   (236,  1)             3897.6        360.0      2.94152   (113,  1)
         4872.0        360.0      3.04108   (113,  1)             5846.4        360.0      3.20811C  (217,  1)
         6942.6        360.0      2.32075C  (217,  1)              925.7         22.5       .78718C  (137,  1)
         1741.7         22.5      1.15467C  (137,  1)             2998.7         22.5      1.18978   (241,  1)
         3982.9         22.5      1.74272   ( 23,  1)             4908.5         22.5      1.32120   ( 23,  1)
         5675.9         22.5       .96029   ( 23,  1)             6601.6         22.5       .83686   ( 23,  1)
          864.8         45.0       .95003C  (166,  1)             2070.6         45.0      1.65351C  (185,  1)
         2923.2         45.0      1.20708C  (185,  1)             3958.6         45.0       .89185C  ( 43,  1)
         4823.3         45.0       .79386   (139,  1)             5688.1         45.0       .73128   (139,  1)
         6540.6         45.0       .59430   (139,  1)             1035.3         67.5       .77758C  (118,  1)
         2082.8         67.5      1.08210C  (118,  1)             3057.2         67.5      1.10993   (333,  1)
         3714.9         67.5      1.13576   (333,  1)             4750.2         67.5      1.01335   (333,  1)
         5675.9         67.5       .95351   (333,  1)             6881.7         67.5       .78261   (333,  1)
          974.4         90.0       .60384C  (127,  1)             1948.8         90.0       .65043   (109,  1)
         2923.3         90.0      1.44936   ( 82,  1)             3897.6         90.0      1.56077   ( 82,  1)
         4872.0         90.0      1.29081   ( 82,  1)             5846.4         90.0      1.19076   ( 82,  1)
         6820.8         90.0      1.15018C  ( 25,  1)             1035.3        112.5       .44603C  (151,  1)
         2131.5        112.5       .98560C  (311,  1)             3057.2        112.5      1.00402C  (311,  1)
         3714.9        112.5       .92262C  (311,  1)             4750.2        112.5       .75950C  (311,  1)
         5675.9        112.5       .71210   (162,  1)             6881.7        112.5       .70953   (162,  1)
          864.8        135.0      1.32999C  (123,  1)             2070.6        135.0      1.09273   (109,  1)
         2923.2        135.0       .98878C  (317,  1)             3958.6        135.0       .89538C  (  6,  1)
         4823.3        135.0       .97373C  (  6,  1)             5688.1        135.0       .98782C  (  6,  1)
         6540.6        135.0       .96857C  (  6,  1)              925.7        157.5      1.00456C  (123,  1)
         1741.7        157.5       .90604   (349,  1)             2998.8        157.5      1.41737C  ( 37,  1)
         3982.9        157.5      1.47550C  ( 37,  1)             4859.8        157.5      1.65100C  ( 37,  1)
         5675.9        157.5      1.99676C  (264,  1)             6601.6        157.5      1.36389C  ( 49,  1)
          974.4        180.0      1.05064C  (193,  1)             1827.0        180.0      9.41972   (351,  1)
         2801.4        180.0      1.76930C  (265,  1)             3897.6        180.0      1.94257   ( 46,  1)
         4872.0        180.0      1.97834   ( 46,  1)             5846.4        180.0      2.00840   ( 46,  1)
         6942.6        180.0      1.94315   ( 46,  1)              657.7        202.5       .79135C  (216,  1)
         1741.7        202.5      4.14013   ( 72,  1)             2898.8        202.5      1.24897   ( 72,  1)
         3982.9        202.5      1.04098   ( 32,  1)             4859.8        202.5      1.26437   ( 32,  1)
         5675.9        202.5      1.37984   ( 32,  1)             6601.6        202.5      1.55891   ( 32,  1)
         1205.8        225.0      1.20337C  (216,  1)             2070.6        225.0      1.24768   (215,  1)
         2923.2        225.0      3.20058   ( 61,  1)             3958.6        225.0      1.75289   ( 61,  1)
         4823.3        225.0      1.41477   ( 61,  1)             5680.1        225.0      1.68432   ( 61,  1)
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                                                                                                   HIGH
                                                                                                   24-HR
                       *** TULSA REMODEL PONCA75 MET DATA ACTUAL OPERATION ST.  1 + 2    ***     SGROUP#  1

                      * HIGHEST 24-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)     *
                                                  * FROM ALL SOURCES *
                                          * FOR THE DISCRETE RECEPTOR POINTS *
              - RNO -       - DIR -      CON.      (DAY,PER.)              - RNO -       - DIR -      CON.      (DAY,PER.)
  - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

              6540.6        225.0      1.72946   ( 61,  1)                 1035.3        247.5       .55806   (206,  1)
              2131.5        247.5      1.44114C  (271,  1)                 3057.2        247.5      1.48351C  (271,  1)
              3714.9        247.5       .84669C  (271,  1)                 4750.2        247.5      1.11361C  (271,  1)
              5675.9        247.5      1.51380C  (271,  1)                 6881.7        247.5       .94826C  (271,  1)
               974.4        270.0       .83862C  (136,  1)                 1948.9        270.0      1.41571   (329,  1)
              2923.2        270.0      1.37317   (329,  1)                 3897.6        270.0      1.81218   (329,  1)
              4872.0        270.0      2.49935   (329,  1)                 5846.4        270.0       .96784   (329,  1)
              6820.8        270.0       .97808   (329,  1)                 1035.3        292.5      1.02930   (180,  1)
              2082.8        292.5      2.09951C  (183,  1)                 3057.2        292.5      1.85422C  (183,  1)
              3714.9        292.5      1.60887C  (183,  1)                 4750.2        292.5      1.24009C  (183,  1)
              5675.9        292.5      1.56887   (365,  1)                 6881.7        292.5      1.98379   (365,  1)
              1205.8        315.0      1.40302   (221,  1)                 2070.6        315.0      1.26498   (221,  1)
              2923.2        315.0      1.10491   (230,  1)                 3958.6        315.0      1.49895   (103,  1)
              4823.3        315.0      1.63178   (103,  1)                 5688.1        315.0      1.76714   (103,  1)
              6540.6        315.0      2.61350C  ( 43,  1)                  657.7        337.5       .54099   (212,  1)
              1741.7        337.5      1.71088   (178,  1)                 2898.8        337.5      1.66133   (332,  1)
              3982.9        337.5      2.17704   (332,  1)                 4859.8        337.5      1.68047   (332,  1)
              5675.9        337.5      1.83560   (332,  1)                 6601.6        337.5      1.81837   (332,  1)
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                                                                                          24-HR
                                                                                          SGROUP#  1

                  *** TULSA REMODEL PONCA75 MET DATA ACTUAL OPERATION ST. 1 + 2    ***

          * SECOND HIGHEST 24-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)      *
                                      * FROM ALL SOURCES *
                                * FOR THE DISCRETE RECEPTOR POINTS *

        - RNO -      - DIR -      CON.      (DAY,PER.)         - RNO -      - DIR -      CON.      (DAY,PER.)
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

         974.4        360.0      1.06778C  (168,  1)           1827.0       360.0      1.38218C  (293,  1)
        2801.4        360.0      2.06161   (113,  1)           3897.6       360.0      2.82624   (236,  1)
        4872.0        360.0      3.02710   (107,  1)           5846.4       360.0      2.86985   (126,  1)
        6942.6        360.0      2.16793   (126,  1)            925.7        22.5       .71581C  (166,  1)
        1741.7         22.5      1.03553C  (204,  1)           2998.7        22.5      1.13484   ( 23,  1)
        3982.9         22.5      1.63500   (241,  1)           4908.5        22.5      1.20967   (241,  1)
        5675.9         22.5       .87416   (241,  1)           6601.6        22.5       .74684   (241,  1)
         864.8         45.0       .64955   (187,  1)           2070.6        45.0      1.43934C  (218,  1)
        2923.2         45.0      1.20265C  (218,  1)           3958.6        45.0       .84545C  (218,  1)
        4823.3         45.0       .76205C  ( 43,  1)           5688.1        45.0       .65611C  ( 43,  1)
        6540.6         45.0       .57552C  ( 43,  1)           1035.3        67.5       .58705C  (202,  1)
        2082.8         67.5       .70129   (273,  1)           3057.2        67.5       .83214C  (118,  1)
        3714.9         67.5       .65150C  (118,  1)           4750.2        67.5       .60655C  ( 89,  1)
        5675.9         67.5       .64706C  ( 89,  1)           6881.7        67.5       .58094C  ( 60,  1)
         974.4         90.0       .30302C  (201,  1)           1948.8        90.0       .64462   ( 82,  1)
        2923.3         90.0       .65478   (109,  1)           3897.6        90.0       .79361C  ( 25,  1)
        4872.0         90.0       .80121C  ( 25,  1)           5846.4        90.0       .94360C  ( 25,  1)
        6820.8         90.0      1.11797   ( 82,  1)           1035.3       112.5       .43141   (131,  1)
        2131.5        112.5       .75525C  (314,  1)           3057.2       112.5       .74475C  (314,  1)
        3714.9        112.5       .66354C  (314,  1)           4750.2       112.5       .69304   (330,  1)
        5675.9        112.5       .66385   (330,  1)           6881.7       112.5       .60343   (330,  1)
         864.8        135.0       .47580   (131,  1)           2070.6       135.0      1.02937C  (317,  1)
        2923.2        135.0       .80018   (109,  1)           3958.6       135.0       .83021C  (317,  1)
        4823.3        135.0       .73021C  (317,  1)           5688.1       135.0       ,67021   (316,  1)
        6540.6        135.0       .64059   (316,  1)            925.7       157.5       .41075C  (160,  1)
        1741.7        157.5       .82423   (131,  1)           2998.8       157.5      1.35788   (349,. 1)
        3982 9        157.5      1.32194C  ( 49,  1)           4859.8       157.5      1.49403C  ( 49,  1)
        5675.9        157.5      1.95811C  ( 37,  1)           6601.6       157.5      1.15843C  ( 37,  1)
         974.4        180.0       .96015   (119,  1)           1827.0       180.0      8.87044C  (363,  1)
        2801.4        180.0      1.69169C  (363,  1)           3897.6       180.0      1.78470   (351,  1)
        4872.0        180.0      1.75678   (351,  1)           5846.4       180.0      1.77388   (351,  1)
        6942.6        180.0      1.86122   ( 45,  1)            657.7       202.5       .45940C  (152,  1)
        1741.7        202.5      3.22766   (301,  1)           2898.8       202.5      1.21013   ( 32,  1)
        3982.9        202.5       .88831   ( 72,  1)           4859.8       202.5       .95623   ( 72,  1)
        5675.9        202.5       .97034   ( 72,  1)           6601.6       202.5      1.04448   ( 72,  1)
        1205.8        225.0      1.18102   (215,  1)           2070.6       225.0       .94688   ( 67,  1)
        2923.2        225.0      2 70148   (282,  1)           3958.6       225.0      1.31780C  ( 62,  1)
        4823.3        225.0      1.04015C  ( 62,  1)           5680.1       225.0      1.37838C  ( 62,  1)
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                                                                                              2ND HIGH
                                                                                              24-HR
                    *** TULSA REMODEL PONCA75 MET DATA ACTUAL OPERATION ST. 1 + 2    ***      SGROUP#  1

                 * SECOND HIGHEST 24-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)      *
                                          * FROM ALL SOURCES *
                                     * FOR THE DISCRETE RECEPTOR POINTS *

           - RNG -      - DIR -      CON.      (DAY,PER.)                   - RNG -      - DIR -      CON.      (DAY,PER.)
     - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

           6540.6       225.0      1.49948C ( 62,  1)                       1035.3       247.5       .43251C (189,  1)
           2131.5       247.5       .99379  (213,  1)                       3057.2       247.5       .88306  (129,  1)
           3714.9       247.5       .55241  (129,  1)                       4750.2       247.5       .66453  (133,  1)
           5675.9       247.5       .95394  (282,  1)                       6881.7       247.5       .55345  (282,  1)
            974.4       270.0       .74398  (206,  1)                       1948.9       270.0      1.28006C (136,  1)
           2923.2       270.0       .86204C (136,  1)                       3897.6       270.0       .81951  (133,  1)
           4872.0       270.0      1.90854C (  7,  1)                       5846.4       270.0       .53259C (  7,  1)
           6820.8       270.0       .65115C (  7,  1)                       1035.3       292.5      1.01453C (184,  1)
           2082.8       292.5      1.85386  (182,  1)                       3057.2       292.5      1.36609  (182,  1)
           3714.9       292.5      1.13986  (182,  1)                       4750.2       292.5      1.15257  (365,  1)
           5675.9       292.5      1.14132C (183,  1)                       6881.7       292.5      1.55221  (182,  1)
           1205.8       315.0      1.30115C (194,  1)                       2070.6       315.0      1.21950C (194,  1)
           2923.2       315.0      1.09147  (221,  1)                       3958.6       315.0      1.21289  (221,  1)
           4823.3       315.0      1.35026C ( 26,  1)                       5688.1       315.0      1.61966C ( 26,  1)
           6540.6       315.0      2.39495C ( 26,  1)                        657.7       337.5       .28846  (178,  1)
           1741.7       337.5      1.19916C (153,  1)                       2898.8       337.5      1.46947  (170,  1)
           3982.9       337.5      1.94123  (170,  1)                       4859.8       337.5      1.50125  (170,  1)
           5675.9       337.5      1.64690  (170,  1)                       6601.6       337.5      1.63764  (170,  1)
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                                                                                                   24-HR
            *** TULSA REMODEL PONCA75 MET DATA ACTUAL OPERATION ST. 1 + 2    ***                  SGROUP#  1

        * 50 MAXIMUM 24-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)      *

                                       * FROM ALL SOURCES *

                                      X       Y(METERS)                                              X       Y(METERS)
                                     OR          OR                                                 OR          OR
                                    RANGE    DIRECTION                                             RANGE    DIRECTION
   RANK        CON.      PER.  DAY  (METERS)  (DEGREES)        RANK        CON.      PER.  DAY    (METERS)  (DEGREES)
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

     1       9.41972      1   351    1827.0      180.0           26       3.64046C     1    22    1827.0      180.0
     2       8.87044C     1   363    1827.0      180.0           27       3.44560      1    45    1827.0      180.0
     3       8.76441      1    46    1827.0      180.0           28       3.22766      1   301    1741.7      202.5
     4       7.60434      1    71    1827.0      180.0           29       3.20811C     1   217    5846.4      360.0
     5       7.02225      1   273    1827.0      180.0           30       3.20058      1    61    2923.2      225.0
     6       6.45913      1    52    1827.0      180.0           31       3.09716C     1   350    1741.7      202.5
     7       6.31217C     1   288    1827.0      180.0           32       3.08974      1   119    1827.0      180.0
     8       6.28076C     1   362    1827.0      180.0           33       3.08922      1   146    1827.0      180.0
     9       5.79818      1   101    1827.0      180.0           34       3.06399      1    66    1827.0      180.0
    10       5.69909      1   267    1827.0      180.0           35       3.04108      1   113    4872.0      360.0
    11       5.46048      1    72    1827.0      180.0           36       3.02710      1   107    4872.0      360.0
    12       5.39684C     1   193    1827.0      180.0           37       3.02219      1    40    1827.0      180.0
    13       5.18225      1    31    1827.0      180.0           38       2.98721      1    84    1827.0      180.0
    14       5.17191      1   301    1827.0      180.0           39       2.97200      1   215    1827.0      180.0
    15       4.93739      1   348    1827.0      180.0           40       2.96966C     1   266    1827.0      180.0
    16       4.90479C     1   265    1827.0      180.0           41       2.95908C     1   214    1741.7      202.5
    17       4.80183      1   290    1827.0      180.0           42       2.94152      1   113    3897.6      360.0
    18       4.67340      1   340    1827.0      180.0           43       2.93894      1    32    1741.7      202.5
    19       4.54508C     1   191    1827.0      180.0           44       2.92975C     1   274    1827.0      180.0
    20       4.49131      1   261    1827.0      180.0           45       2.86985      1   126    5846.4      360.0
    21       4.43976      1    53    1827.0      180.0           46       2.86222      1   135    1741.7      202.5
    22       4.14013      1    72    1741.7      202.5           47       2.85635      1   236    4872.0      360.0
    23       4.04152      1   254    1827.0      180.0           48       2.82624      1   236    3897.6      360.0
    24       3.92810      1    35    1827.0      180.0           49       2.81829      1   199    4872.0      360.0
    25       3.84682C     1   359    1827.0      180.0           50       2.80114      1   120    1827.0      180.0
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                    *** TULSA REMODEL PONCA76 MET DATA ACTUAL OPERATION ST. 1 + 2    ***

CALCULATE (CONCENTRATION=1,DEPOSITION=2)                                      ISW(1) =   1
RECEPTOR GRID SYSTEM (RECTANGULAR=1 OR 3, POLAR=2 OR 4)                       ISW(2) =   2
DISCRETE RECEPTOR SYSTEM (RECTANGULAR=1,POLAR=2)                              ISW(3) =   2
TERRAIN ELEVATIONS ARE READ (YES=1,NO=0)                                      ISW(4) =   1
CALCULATIONS ARE WRITTEN TO TAPE (YES=1,NO=0)                                 ISW(5) =   0
LIST ALL INPUT DATA (NO=0,YES=1,MET DATA ALSO=2)                               ISW(6) =   1

COMPUTE AVERAGE CONCENTRATION (OR TOTAL DEPOSITION)
WITH THE FOLLOWING TIME PERIODS:
  HOURLY (YES=1,NO=0)                                                         ISW(7) =   0
  2-HOUR (YES=1,NO=0)                                                         ISW(8) =   0
  3-HOUR (YES=1,NO=0)                                                         ISW(9) =   1
  4-HOUR (YES=1,NO=0)                                                        ISW(10) =   0
  6-HOUR (YES=1,NO=0)                                                        ISW(11) =   0
  8-HOUR (YES=1,NO=0)                                                        ISW(12) =   0
  12-HOUR (YES=1,NO=0)                                                       ISW(13) =   0
  24-HOUR (YES=1,NO=0)                                                       ISW(14) =   1
PRINT 'N'-DAY TABLE(S) (YES=1,NO=0)                                          ISW(15) =   1

PRINT THE FOLLOWING TYPES OF TABLES WHOSE TIME PERIODS ARE
SPECIFIED BY ISW(7) THROUGH ISW(14):
  DAILY TABLES (YES=1,NO=0)                                                  ISW(16) =   0
  HIGHEST & SECOND HIGHEST TABLES (YES=1,NO=0)                               ISW(17) =   1
  MAXIMUM 50 TABLES (YES=1,NO=0)                                             ISW(18) =   1
METEOROLOGICAL DATA INPUT METHOD (PRE-PROCESSED=1,CARD=2)                    ISW(19) =   1
RURAL-URBAN OPTION (RU.=0,UR. MODE 1=1,UR. MODE 2=2,UR. MODE 3=3)            ISW(20) =   0
WIND PROFILE EXPONENT VALUES (DEFAULTS=1,USER ENTERS=2,3)                    ISW(21) =   1
VERTICAL POT. TEMP. GRADIENT VALUES (DEFAULTS=1,USER ENTERS=2,3)             ISW(22) =   1
SCALE EMISSION RATES FOR ALL SOURCES (NO=0,YES>0)                            ISW(23) =   0
PROGRAM CALCULATES FINAL PLUME RISE ONLY (YES=1,NO=2)                        ISW(24) =   1
PROGRAM ADJUSTS ALL STACK HEIGHTS FOR DOWNWASH (YES=2,NO=1)                  ISW(25) =   1
PROGRAM USES BUOYANCY INDUCED DISPERSION (YES=1,NO=2)                        ISW(26) =   2
CONCENTRATIONS DURING CALM PERIODS SET = 0 (YES=1,NO=2)                      ISW(27) =   1
REG. DEFAULT OPTION CHOSEN (YES=1,NO=2)                                      ISW(28) =   2
TYPE OF POLLUTANT TO BE MODELLED (1=SO2,2=OTHER)                             ISW(29) =   2
DEBUG OPTION CHOSEN (1=YES,2=NO)                                             ISW(30) =   2
USE RUNNING AVERAGES (0=NO,1=YES)                                            ISW(40) =   0

NUMBER OF INPUT SOURCES                                                      NSOURC =   1
NUMBER OF SOURCE GROUPS (=0,ALL SOURCES)                                     NGROUP =   0
TIME PERIOD INTERVAL TO BE PRINTED (=0,ALL INTERVALS)                         IPERD =   0
NUMBER OF X (RANGE) GRID VALUES                                              NXPNTS =   0
NUMBER OF Y (THETA) GRID VALUES                                              NYPNTS =   0
NUMBER OF DISCRETE RECEPTORS                                                 NXWYPT = 112
SOURCE EMISSION RATE UNITS CONVERSION FACTOR                                     TK=.10000E+07
HEIGHT ABOVE GROUND AT WHICH WIND SPEED WAS MEASURED                             ZR =  10.00  METERS
LOGICAL UNIT NUMBER OF METEOROLOGICAL DATA                                     IMET =   9
DECAY COEFFICIENT FOR PHYSICAL OR CHEMICAL DEPLETION                          DECAY = .000000E+00
SURFACE STATION NO.                                                             ISS = 13969
YEAR OF SURFACE DATA                                                            ISY = 76
UPPER AIR STATION NO.                                                           IUS = 13967
YEAR OF UPPER AIR DATA                                                          IUY = 76
ALLOCATED DATA STORAGE                                                        LIMIT = 55500 WORDS
REQUIRED DATA STORAGE FOR THIS PROBLEM RUN                                    MIMIT =  2409 WORDS
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PONCA CITY 1976 MET
SCREENING SHORT TERM
RUN. MODELED AT
10 G/SEC

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                  *** TULSA REMODEL PONCA76 MET DATA ACTUAL OPERATION ST. 1 + 2     ***

                                    * ELEVATION HEIGHTS IN METERS *
                                  * FOR THE DISCRETE RECEPTOR POINTS *

  - RNO -      - DIR -      HGT.             - RNO -      - DIR -      HGT.             - RNO -      - DIR -      HGT.
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

    974.4        360.0      195.07240          1827.0        360.0      193.54840          2801.4        360.0      205.74040
   3897.6        360.0      228.60040          4872.0        360.0      252.98450          5846.4        360.0      260.60450
   6942.6        360.0      252.98450           925.7         22.5      195.07240          1741.7         22.5      192.02440
   2998.7         22.5      208.78840          3982.9         22.5      231.64850          4908.5         22.5      222.50440
   5675.9         22.5      205.74040          6601.6         22.5      202.69240           864.8         45.0      195.07240
   2070.6         45.0      207.26440          2923.2         45.0      214.88440          3958.6         45.0      219.45640
   4823.3         45.0      220.98040          5688.1         45.0      222.50440          6540.6         45.0      213.36040
   1035.3         67.5      193.54840          2082.8         67.5      192.02440          3057.2         67.5      213.36040
   3714.9         67.5      216.40840          4750.2         67.5      217.93240          5675.9         67.5      225.55240
   6881.7         67.5      225.55240           974.4         90.0      193.54840          1948.8         90.0      192.02440
   2923.3         90.0      205.74040          3897.6         90.0      214.88440          4872.0         90.0      213.36040
   5846.4         90.0      222.50440          6820.8         90.0      239.26850          1035.3        112.5      193.54840
   2131.5        112.5      193.54840          3057.2        112.5      190.50040          3714.9        112.5      196.59640
   4750.2        112.5      213.36040          5675.9        112.5      216.40840          6881.7        112.5      220.98040
    864.8        135.0      193.54840          2070.6        135.0      192.02440          2923.2        135.0      192.02440
   3958.6        135.0      190.50040          4823.3        135.0      192.02440          5688.1        135.0      193.54840
   6540.6        135.0      195.07240           925.7        157.5      195.07240          1741.7        157.5      193.54840
   2998.8        157.5      193.54840          3982.9        157.5      192.02440          4859.8        157.5      201.16840
   5675.9        157.5      224.02840          6601.6        157.5      187.45240           974.4        180.0      193.54840
   1827.0        180.0      262.12850          2801.4        180.0      204.21640          3897.6        180.0      202.69240
   4872.0        180.0      202.69240          5846.4        180.0      207.26440          6942.6        180.0      213.36040
    657.7        202.5      195.07240          1741.7        202.5      266.70050          2898.8        202.5      228.60040
   3982.9        202.5      213.36040          4859.8        202.5      217.93240          5675.9        202.5      222.50440
   6601.6        202.5      234.69650          1205.8        225.0      195.07240          2070.6        225.0      207.26440
   2923.2        225.0      257.08050          3958.6        225.0      228.60040          4823.3        225.0      214.88440
   5680.1        225.0      231.64850          6540.6        225.0      242.31650          1035.3        247.5      196.59640
   2131.5        247.5      230.12450          3057.2        247.5      225.55240          3714.9        247.5      201.16840
   4750.2        247.5      214.88440          5675.9        247.5      237.74450          6881.7        247.5      216.40840
    974.4        270.0      199.64440          1948.9        270.0      222.50440          2923.2        270.0      210.31240
   3897.6        270.0      220.98040          4872.0        270.0      256.03250          5846.4        270.0      190.50040
   6820.8        270.0      196.59640          1035.3        292.5      195.07240          2082.8        292.5      193.54840
   3057.2        292.5      192.02440          3714.9        292.5      195.07240          4750.2        292.5      195.07240
   5675.9        292.5      213.36040          6881.7        292.5      240.79250          1205.8        315.0      193.54840
   2070.6        315.0      190.50040          2923.2        315.0      195.07240          3958.6        315.0      207.26440
   4823.3        315.0      213.36040          5688.1        315.0      225.55240          6540.6        315.0      262.12850
    657.7        337.5      193.54840          1741.7        337.5      192.02440          2898.8        337.5      201.16840
   3982.9        337.5      211.83640          4859.8        337.5      201.16840          5675.9        337.5      214.88440
   6601.6        337.5      228.60040
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                                                                                                         3-HR
               *** TULSA REMODEL PONCA76 MET DATA ACTUAL OPERATION ST. 1 + 2    ***                      SGROUP#  1

              * HIGHEST  3-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)      *
                                         * FROM ALL SOURCES *
                                   * FOR THE DISCRETE RECEPTOR POINTS *

    - RNG -     - DIR -     CON.     (DAY,PER.)                - RNG -     - DIR -     CON.     (DAY,PER.)
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

     974.4       360.0      5.01239  (151,  4)                  1827.0       360.0     7.94738  (168,  5)
    2801.4       360.0      7.21053  (168,  5)                  3897.6       360.0     7.76384  ( 62,  1)
    4872.0       360.0      8.72060  ( 62,  1)                  5846.4       360.0    11.34697  (205,  2)
    6942.6       360.0      8.03627  (205,  2)                   925.7        22.5     4.42211  (212,  5)
    1741.7        22.5      5.94346  (249,  4)                  2998.7        22.5     4.96242  (140,  5)
    3982.9        22.5      7.34520  (330,  4)                  4908.5        22.5     5.61388  (330,  4)
    5675.9        22.5      4.10307  (330,  4)                  6601.6        22.5     3.59690  (330,  4)
     864.8        45.0      3.65139  (225,  5)                  2070.6        45.0     6.24726  (189,  3)
    2923.2        45.0      5.49283  (189,  3)                  3958.6        45.0     4.85322  ( 60,  5)
    4823.3        45.0      4.39498  ( 60,  5)                  5688.1        45.0     3.91357  ( 60,  5)
    6540.6        45.0      3.15429  ( 60,  5)                  1035.3        67.5     4.20793  (236,  4)
    2082.8        67.5      4.63692  (273,  4)                  3057.2        67.5     4.10633  (294,  4)
    3714.9        67.5      4.36567  (351,  5)                  4750.2        67.5     4.12635  (351,  5)
    5675.9        67.5      4.03733  (351,  5)                  6881.7        67.5     3.48201  (136,  5)
     974.4        90.0      4.53748  ( 96,  5)                  1948.8        90.0     5.64441  (282,  5)
    2923.3        90.0      5.28006  (144,  6)                  3897.6        90.0     4.15896  (352,  4)
    4872.0        90.0      3.48677  (352,  4)                  5846.4        90.0     3.54796  (112,  1)
    6820.8        90.0      5.50735  (112,  1)                  1035.3       112.5     3.02936C (154,  4)
    2131.5       112.5      4.84035  (144,  5)                  3057.2       112.5     4.44191  (144,  5)
    3714.9       112.5      3.89004  (144,  5)                  4750.2       112.5     3.30949  ( 80,  6)
    5675.9       112.5      3.00072  ( 80,  6)                  6881.7       112.5     2.60038  ( 80,  6)
     864.8       135.0      4.54009  (153,  4)                  2070.6       135.0     5.05432  ( 76,  4)
    2923.2       135.0      4.48661  ( 76,  4)                  3958.6       135.0     3.29814  ( 76,  4)
    4823.3       135.0      3.35063  (  6,  4)                  5688.1       135.0     3.31358  (  6,  4)
    6540.6       135.0      3.47525  (308,  6)                   925.7       157.5     5.91813  (171,  4)
    1741.7       157.5      4.93985  (135,  6)                  2998.8       157.5     4.93733  (272,  4)
    3982.9       157.5      4.05470  (272,  4)                  4859.8       157.5     4.18531  ( 33,  4)
    5675.9       157.5      5.65562  (136,  7)                  6601.6       157.5     3.29077  ( 33,  4)
     974.4       180.0      2.59197  (135,  4)                  1827.0       180.0    24.43622  (345,  4)
    2801.4       180.0      5.80979  (279,  5)                  3897.6       180.0     5.14492  ( 44,  5)
    4872.0       180.0      4.61800  ( 44,  5)                  5846.4       180.0     4.27369  (345,  4)
    6942.6       180.0      3.92868  (345,  4)                   657.7       202.5      .91219  (124,  4)
    1741.7       202.5     17.81912  (281,  4)                  2898.8       202.5     5.88509  (281,  4)
    3982.9       202.5      4.13432  (281,  4)                  4859.8       202.5     4.18809  (281,  4)
    5675.9       202.5      4.03366  (281,  4)                  6601.6       202.5     4.91124  (315,  1)
    1205.8       225.0      5.87059  (267,  5)                  2070.6       225.0     6.66490  (214,  5)
    2923.2       225.0     10.73646  (185,  7)                  3958.6       225.0     4.66876  (102,  7)
    4823.3       225.0      3.54234  (281,  6)                  5680.1       225.0     4.70756  (185,  7)
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                                                                                          3-HR
              *** TULSA REMODEL PONCA76 MET DATA ACTUAL OPERATION ST. 1 + 2    ***        SGROUP#  1

             * HIGHEST  3-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)     *
                                     * FROM ALL SOURCES *
                               * FOR THE DISCRETE RECEPTOR POINTS *
       - RNO -      - DIR -      CON.       (DAY,PER.)            - RNO -      - DIR -      CON.       (DAY,PER.)
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

       6540.6       225.0      5.84435   (185,  7)             1035.3       247.5      8.24614   (210,  4)
       2131.5       247.5      9.57789   (156,  6)             3057.2       247.5      7.14825   (156,  6)
       3714.9       247.5      4.86985   (156,  6)             4750.2       247.5      4.08142   (156,  6)
       5675.9       247.5      4.72432   (315,  6)             6881.7       247.5      3.27206   (315,  6)
        974.4       270.0      9.23080   (232,  5)             1948.9       270.0      7.96514   (232,  5)
       2923.2       270.0      6.03239   (258,  6)             3897.6       270.0      5.42158   (258,  6)
       4872.0       270.0      7.62357   (158,  1)             5846.4       270.0      3.30028   (324,  4)
       6820.8       270.0      3.34246   (324,  4)             1035.3       292.5      5.83996   (182,  5)
       2082.8       292.5      5.69805   (182,  5)             3057.2       292.5      4.75067   (188,  6)
       3714.9       292.5      4.08283   (188,  6)             4750.2       292.5      3.37582   ( 16,  6)
       5675.9       292.5      3.98074   (  8,  1)             6881.7       292.5      5.46921   (276,  8)
       1205.8       315.0      4.57785   (226,  5)             2070.6       315.0      5.14515   (183,  5)
       2923.2       315.0      5.42710   (343,  5)             3958.6       315.0      5.74617   (142,  6)
       4823.3       315.0      5.78925   (142,  6)             5688.1       315.0      5.86147   (142,  6)
       6540.6       315.0      8.99563   ( 82,  8)              657.7       337.5      3.26722   (151,  4)
       1741.7       337.5      4.46219   (165,  4)             2898.8       337.5      4.23282   (327,  5)
       3982.9       337.5      5.06687   (223,  7)             4859.8       337.5      3.92765   (165,  1)
       5675.9       337.5      4.42540   (165,  1)             6601.6       337.5      4.49120   (165,  1)
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                   *** TULSA REMODEL PONCA76 MET DATA ACTUAL OPERATION ST. 1 + 2    ***                      SGROUP#  1✓

             * SECOND HIGHEST  3-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)     *
                                          * FROM ALL SOURCES *
                                 * FOR THE DISCRETE RECEPTOR POINTS *

    - RNO -      - DIR -      CON.     (DAY,PER.)                    - RNO -      - DIR -      CON.     (DAY,PER.)
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

     974.4        360.0      4.71722   (132,  5)                     1827.0        360.0      6.79948   (195,  4)
    2801.4        360.0      5.87689   (162,  5)                     3897.6        360.0      6.58535   ( 40,  4)
    4872.0        360.0      8.43809   (203,  1)                     5846.4        360.0      8.97676   ( 23,  2)
    6942.6        360.0      6.30395   ( 23,  2)                      925.7         22.5      4.04606   (188,  4)
    1741.7         22.5      5.55044   (212,  5)                     2998.7         22.5      4.91076   (204,  4)
    3982.9         22.5      5.77969   (330,  5)                     4908.5         22.5      4.30881   (364,  5)
    5675.9         22.5      3.20382   (364,  5)                     6601.6         22.5      2.83546   (364,  5)
     864.8         45.0      3.53726   (132,  4)                     2070.6         45.0      5.24703   ( 69,  5)
    2923.2         45.0      4.71329   ( 60,  5)                     3958.6         45.0      4.44103   ( 27,  5)
    4823.3         45.0      4.02793   ( 27,  5)                     5688.1         45.0      3.58918   ( 27,  5)
    6540.6         45.0      2.89096   ( 27,  5)                     1035.3         67.5      3.47645   (273,  4)
    2082.8         67.5      4.62774   (236,  4)                     3057.2         67.5      3.98893   (351,  5)
    3714.9         67.5      3.86974   (294,  4)                     4750.2         67.5      3.52289   (136,  5)
    5675.9         67.5      3.85230   (136,  5)                     6881.7         67.5      3.38022   (351,  5)
     974.4         90.0      2.12766C  (213,  4)                     1948.8         90.0      5.38298   (144,  6)
    2923.3         90.0      5.15806   (282,  5)                     3897.6         90.0      3.94424   (144,  6)
    4872.0         90.0      3.27320   (144,  4)                     5846.4         90.0      3.34286C  ( 64,  4)
    6820.8         90.0      4.30948   (198,  1)                     1035.3        112.5      2.78508   (181,  4)
    2131.5        112.5      4.74256   (122,  5)                     3057.2        112.5      3.38421   (122,  5)
    3714.9        112.5      2.71125   (122,  5)                     4750.2        112.5      3.02343   (144,  5)
    5675.9        112.5      2.32201   (144,  5)                     6881.7        112.5      2.28454   (328,  6)
     864.8        135.0      2.60536   (167,  5)                     2070.6        135.0      4.49551   (305,  5)
    2923.2        135.0      3.48557   ( 69,  4)                     3958.6        135.0      3.16184   (  6,  4)
    4823.3        135.0      2.93541   (308,  6)                     5688.1        135.0      3.27966   (308,  6)
    6540.6        135.0      3.17159   (  6,  4)                      925.7        157.5      3.51173   (171,  5)
    1741.7        157.5      3.41665   (272,  4)                     2998.8        157.5      4.23560   (135,  6)
    3982.9        157.5      3.88267   ( 33,  4)                     4859.8        157.5      3.93454   (136,  7)
    5675.9        157.5      4.61520   ( 33,  4)                     6601.6        157.5      3.22558   (136,  7)
     974.4        180.0      2.59110   (138,  4)                     1827.0        180.0     21.96083   (332,  5)
    2801.4        180.0      5.76313   (289,  5)                     3897.6        180.0      4.84742   (345,  4)
    4872.0        180.0      4.50378   (345,  4)                     5846.4        180.0      4.23765   ( 44,  5)
    6942.6        180.0      3.81722   ( 44,  5)                      657.7        202.5       .79851   (135,  5)
    1741.7        202.5     13.98827   ( 35,  4)                     2898.8        202.5      4.57868   ( 35,  4)
    3982.9        202.5      3.18890   ( 35,  4)                     4859.8        202.5      3.20899   ( 35,  4)
    5675.9        202.5      3.07579   ( 35,  4)                     6601.6        202.5      3.99513   (281,  4)
    1205.8        225.0      5.07262   (152,  4)                     2070.6        225.0      5.72036   (267,  5)
    2923.2        225.0      9.58024   (102,  7)                     3958.6        225.0      4.61165   (281,  6)
    4823.3        225.0      3.40969   ( 42,  1)                     5680.1        225.0      4.36354   (281,  6)
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                                                                                                  2ND HIGH
                                                                                                   3-HR
                                                                                                  SGROUP#   1
                   *** TULSA REMODEL PONCA76 MET DATA ACTUAL OPERATION ST. 1 + 2    ***

               * SECOND HIGHEST  3-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)      *
                                         * FROM ALL SOURCES *
                                      * FOR THE DISCRETE RECEPTOR POINTS *

          - RNO -       - DIR -      CON.       (DAY,PER.)              - RNO -       - DIR -      CON.       (DAY,PER.)
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

          6540.6        225.0      4.47662    (281,  6)                 1035.3        247.5      3.47299    (129,  4)
          2131.5        247.5      6.77596    (242,  4)                 3057.2        247.5      4.82558    (119,  4)
          3714.9        247.5      3.00048    (237,  6)                 4750.2        247.5      3.61179    (237,  6)
          5675.9        247.5      4.53375    (237,  6)                 6881.7        247.5      3.19480    (237,  6)
           974.4        270.0      7.94805    (220,  4)                 1948.9        270.0      6.95855    (220,  4)
          2923.2        270.0      4.21097    (268,  5)                 3897.6        270.0      4.20343    (214,  3)
          4872.0        270.0      6.52141    (299,  7)                 5846.4        270.0      3.19262    (258,  6)
          6820.8        270.0      2.88816    (258,  6)                 1035.3        292.5      5.65771    (207,  5)
          2082.8        292.5      5.12746    (188,  6)                 3057.2        292.5      4.21876    ( 16,  6)
          3714.9        292.5      3.90503    ( 16,  6)                 4750.2        292.5      3.04558    (  4,  4)
          5675.9        292.5      3.79311    (230,  6)                 6881.7        292.5      4.69174    (  8,  1)
          1205.8        315.0      4.14555    (228,  5)                 2070.6        315.0      4.84147    (190,  5)
          2923.2        315.0      4.16925    (183,  5)                 3958.6        315.0      4.86143    (343,  5)
          4823.3        315.0      4.54750    (108,  6)                 5688.1        315.0      5.15368    (108,  6)
          6540.6        315.0      8.71103    (139,  8)                  657.7        337.5      1.18182    (168,  4)
          1741.7        337.5      4.22331    (226,  4)                 2898.8        337.5      4.10370    (223,  7)
          3982.9        337.5      4.98352    (165,  1)                 4859.8        337.5      3.86527    (223,  7)
          5675.9        337.5      4.12372    (223,  7)                 6601.6        337.5      4.09164    (297,  1)
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                                    [illegible] ACTUAL OPERATION ST. 1 + 2    ***                                              SGROUP#  1

                      * 50 MAXIMUM  3-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)      *

                                                   * FROM ALL SOURCES *

                                                   X        Y(METERS)                                                   X        Y(METERS)
                                                   OR          OR                                                       OR          OR
                                                 RANGE     DIRECTION                                                  RANGE     DIRECTION
   RANK          CON.          PER.  DAY       (METERS)    (DEGREES)       RANK          CON.          PER.  DAY       (METERS)    (DEGREES)
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

     1         24.43622         4   345        1827.0        180.0          26         13.98827         4    35        1741.7        202.5
     2         21.96083         5   332        1827.0        180.0          27         13.85945         5   338        1827.0        180.0
     3         20.62573         5    44        1827.0        180.0          28         13.78371         5   307        1827.0        180.0
     4         19.37015         2   253        1827.0        180.0          29         13.67156         7    68        1827.0        180.0
     5         19.32980         6    25        1827.0        180.0          30         13.32029         5   271        1827.0        180.0
     6         17.91578         5   279        1827.0        180.0          31         13.25418         5   123        1827.0        180.0
     7         17.81912         4   281        1741.7        202.5          32         13.14879         1   346        1827.0        180.0
     8         16.85718         7    36        1827.0        180.0          33         13.12300         1    63        1827.0        180.0
     9         16.44216         2   279        1827.0        180.0          34         13.02714         2   215        1827.0        180.0
    10         16.33782         6   127        1827.0        180.0          35         12.87200         3   253        1827.0        180.0
    11         16.20591         2    63        1827.0        180.0          36         12.73930         5    25        1827.0        180.0
    12         15.76329         3    94        1827.0        180.0          37         12.62791         4   219        1827.0        180.0
    13         15.50772         7   298        1827.0        180.0          38         12.50228         6   341        1827.0        180.0
    14         15.30600         3   298        1827.0        180.0          39         11.97170         1   299        1827.0        180.0
    15         15.22359         4    25        1827.0        180.0          40         11.91047         7   331        1827.0        180.0
    16         14.77189         2   264        1827.0        180.0          41         11.52646         4   316        1827.0        180.0
    17         14.77061         3   363        1827.0        180.0          42         11.50488         8   345        1827.0        180.0
    18         14.74958         4   298        1827.0        180.0          43         11.43647         2    25        1827.0        180.0
    19         14.71510         6   298        1827.0        180.0          44         11.42326         3    63        1827.0        180.0
    20         14.54074         6   123        1827.0        180.0          45         11.37123         5   317        1827.0        180.0
    21         14.52259         4   283        1827.0        180.0          46         11.34697         2   205        5846.4        360.0
    22         14.34383         4    36        1827.0        180.0          47         11.23932         6   332        1827.0        180.0
    23         14.15536         4   176        1827.0        180.0          48         11.15447         6   253        1827.0        180.0
    24         14.12966         2    94        1827.0        180.0          49         11.11880         4   279        1827.0        180.0
    25         14.10042         4   365        1827.0        180.0          50         11.06265         7   365        1827.0        180.0
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                                                                                                  HIGH
                                                                                                  24-HR
                 *** TULSA REMODEL PONCA76 MET DATA ACTUAL OPERATION ST. 1 + 2     ***            SGROUP*  1

                 * HIGHEST 24-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)     *
                                     * FROM ALL SOURCES *
                             * FOR THE DISCRETE RECEPTOR POINTS *
            - RNO -      - DIR -      CON.      (DAY,PER.)            - RNO -      - DIR -      CON.      (DAY,PER.)
  - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

             974.4        360.0       .92895C  (149,  1)              1827.0        360.0      1.64905   (195,  1)
            2801.4        360.0      1.98109C  (224,  1)              3897.6        360.0      2.92320   (192,  1)
            4872.0        360.0      3.67930   (192,  1)              5846.4        360.0      3.30807   (192,  1)
            6942.6        360.0      2.52321   (192,  1)               925.7         22.5      1.03636C  (188,  1)
            1741.7         22.5      1.09977   (189,  1)              2998.7         22.5      1.49411   (330,  1)
            3982.9         22.5      2.04882   (330,  1)              4908.5         22.5      1.52489   (330,  1)
            5675.9         22.5      1.10768   (330,  1)              6601.6         22.5       .95017   (330,  1)
             864.8         45.0       .61811C  (132,  1)              2070.6         45.0      1.38185C  ( 29,  1)
            2923.2         45.0      1.65607C  ( 29,  1)              3958.6         45.0      1.52175C  ( 29,  1)
            4823.3         45.0      1.33157C  ( 29,  1)              5688.1         45.0      1.16835C  ( 29,  1)
            6540.6         45.0       .92622C  ( 29,  1)              1035.3         67.5       .82326C  (273,  1)
            2082.8         67.5      1.23935C  (273,  1)              3057.2         67.5      1.48233C  (294,  1)
            3714.9         67.5      1.38227C  (294,  1)              4750.2         67.5      1.15390C  (294,  1)
            5675.9         67.5      1.09822C  (351,  1)              6881.7         67.5       .99115C  (351,  1)
             974.4         90.0       .71659C  ( 96,  1)              1948.8         90.0      1.09768C  (282,  1)
            2923.3         90.0      1.14760C  (282,  1)              3897.6         90.0      1.05736   (144,  1)
            4872.0         90.0       .94863   (112,  1)              5846.4         90.0      1.19071   (112,  1)
            6820.8         90.0      1.59430   (112,  1)              1035.3        112.5       .68516C  (167,  1)
            2131.5        112.5       .81425C  ( 66,  1)              3057.2        112.5       .63555   (122,  1)
            3714.9        112.5       .56335   (122,  1)              4750.2        112.5       .60865C  (134,  1)
            5675.9        112.5       .57329C  (134,  1)              6881.7        112.5       .53379C  (134,  1)
             864.8        135.0       .61911C  (153,  1)              2070.6        135.0       .87983   ( 76,  1)
            2923.2        135.0       .80881   ( 76,  1)              3958.6        135.0      1.02499   (293,  1)
            4823.3        135.0      1.14139   (293,  1)              5688.1        135.0      1.17079   (293,  1)
            6540.6        135.0      1.15134   (293,  1)               925.7        157.5      1.22206   (171,  1)
            1741.7        157.5      1.00784   (171,  1)              2998.8        157.5       .91600C  (135,  1)
            3982.9        157.5       .87727   ( 72,  1)              4859.8        157.5      1.00614   (332,  1)
            5675.9        157.5      1.32297   ( 10,  1)              6601.6        157.5       .88257   ( 10,  1)
             974.4        180.0       .63204C  (135,  1)              1827.0        180.0     10.34760C  (279,  1)
            2801.4        180.0      2.40649C  (279,  1)              3897.6        180.0      2.37729C  (279,  1)
            4872.0        180.0      2.23980C  (279,  1)              5846.4        180.0      2.17454C  (279,  1)
            6942.6        180.0      2.05671C  (279,  1)               657.7        202.5       .13860C  (135,  1)
            1741.7        202.5      5.18269   ( 35,  1)              2898.8        202.5      1.65092   ( 35,  1)
            3982.9        202.5      1.14031   ( 35,  1)              4859.8        202.5      1.15253   ( 35,  1)
            5675.9        202.5      1.10780   ( 35,  1)              6601.6        202.5      1.09784   ( 35,  1)
            1205.8        225.0      1.19312C  (152,  1)              2070.6        225.0      1.17221C  (152,  1)
            2923.2        225.0      3.43963   (301,  1)              3958.6        225.0      1.64917   (301,  1)
            4823.3        225.0      1.19374   (301,  1)              5680.1        225.0      1.32638   (301,  1)
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                                                                                                  24-HR
                    *** TULSA REMODEL PONCA76 MET DATA ACTUAL OPERATION ST. 1 + 2    ***         SGROUP*  1

              * 50 MAXIMUM 24-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)     *

                                       * FROM ALL SOURCES *

                                      X       Y(METERS)                                          X       Y(METERS)
                                      OR         OR                                              OR         OR
                                    RANGE    DIRECTION                                         RANGE    DIRECTION
  RANK      CON.        PER.  DAY  (METERS)  (DEGREES)       RANK      CON.        PER.  DAY  (METERS)  (DEGREES)
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

    1     10.34760C      1    279   1827.0     180.0          26     3.49633C      1    312   1827.0     180.0
    2     10.18901       1    298   1827.0     180.0          27     3.43963       1    301   2923.2     225.0
    3     10.13866       1     25   1827.0     180.0          28     3.35542       1    281   1741.7     202.5
    4      8.04146       1    253   1827.0     180.0          29     3.30807       1    192   5846.4     360.0
    5      7.83031       1    345   1827.0     180.0          30     3.30028C      1    102   1741.7     202.5
    6      7.50099       1     94   1827.0     180.0          31     3.28670C      1    338   1827.0     180.0
    7      6.91989       1     63   1827.0     180.0          32     3.25939       1    325   1827.0     180.0
    8      6.35310       1     36   1827.0     180.0          33     3.25691       1    219   1827.0     180.0
    9      5.58306       1    123   1827.0     180.0          34     3.17393       1    289   1827.0     180.0
   10      5.56650       1    264   1827.0     180.0          35     3.15553       1    290   1741.7     202.5
   11      5.18269       1     35   1741.7     202.5          36     3.08256C      1    224   4872.0     360.0
   12      5.10704       1    332   1827.0     180.0          37     2.98135       1     23   5846.4     360.0
   13      4.96405       1    365   1827.0     180.0          38     2.97791       1    205   5846.4     360.0
   14      4.57915C      1    341   1827.0     180.0          39     2.93002C      1    176   1827.0     180.0
   15      4.24885       1    127   1827.0     180.0          40     2.92320       1    192   3897.6     360.0
   16      4.21372       1    317   1827.0     180.0          41     2.91919       1     40   5846.4     360.0
   17      3.94581C      1    283   1827.0     180.0          42     2.91799       1     40   4872.0     360.0
   18      3.82572C      1    271   1827.0     180.0          43     2.90241C      1     95   1741.7     202.5
   19      3.81708       1     44   1827.0     180.0          44     2.90130       1     55   4872.0     360.0
   20      3.72321       1    307   1827.0     180.0          45     2.85284C      1    224   3897.6     360.0
   21      3.67930       1    192   4872.0     360.0          46     2.82253       1    363   1827.0     180.0
   22      3.57882       1    316   1827.0     180.0          47     2.71691       1    194   4872 0     360.0
   23      3.53048       1     68   1827.0     180.0          48     2.63533       1    281   1827.0     180.0
   24      3.52949       1    331   1827.0     180.0          49     2.63405       1    365   1741.7     202.5
   25      3.51233       1    170   1827.0     180.0          50     2.59890C      1    224   5846.4     360.0
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                                                                                                   2ND HIGH
                                                                                                   24-HR
                  *** TULSA REMODEL PONCA76 MET DATA ACTUAL OPERATION ST. 1 + 2     ***              SGROUP#  1

              * SECOND HIGHEST 24-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)      *
                                         * FROM ALL SOURCES *
                                  * FOR THE DISCRETE RECEPTOR POINTS *

        - RNO -      - DIR -      CON.     (DAY,PER.)               - RNO -      - DIR -      CON.     (DAY,PER.)
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

         974.4        360.0      .88487C  (132,  1)                 1827.0        360.0     1.58813C  (149,  1)
        2801.4        360.0     1.74041   (107,  1)                 3897.6        360.0     2.85284C  (224,  1)
        4872.0        360.0     3.08256C  (224,  1)                 5846.4        360.0     2.98135   ( 23,  1)
        6942.6        360.0     2.18850   (205,  1)                  925.7         22.5      .75439C  (213,  1)
        1741.7         22.5     1.07601C  (254,  1)                 2998.7         22.5     1.13932   (189,  1)
        3982.9         22.5     1.49905C  (313,  1)                 4908.5         22.5     1.13756C  (313,  1)
        5675.9         22.5      .80451C  (313,  1)                 6601.6         22.5      .71279C  (313,  1)
         864.8         45.0      .45642   (225,  1)                 2070.6         45.0     1.37741C  (132,  1)
        2923.2         45.0     1.10791   ( 41,  1)                 3958.6         45.0     1.10802   ( 41,  1)
        4823.3         45.0      .98754   ( 41,  1)                 5688.1         45.0      .86794   ( 41,  1)
        6540.6         45.0      .69079   ( 41,  1)                 1035.3         67.5      .52599   (236,  1)
        2082.8         67.5     1.02197C  (294,  1)                 3057.2         67.5      .94685   ( 89,  1)
        3714.9         67.5     1.02101C  (351,  1)                 4750.2         67.5     1.02233C  (351,  1)
        5675.9         67.5     1.03322C  (294,  1)                 6881.7         67.5      .83098C  (294,  1)
         974.4         90.0      .35244C  (132,  1)                 1948.8         90.0      .90678   (144,  1)
        2923.3         90.0     1.10885   (144,  1)                 3897.6         90.0      .92419   (112,  1)
        4872.0         90.0      .89727   (144,  1)                 5846.4         90.0      .89099   (144,  1)
        6820.8         90.0      .99203   (144,  1)                 1035.3        112.5      .45440C  (154,  1)
        2131.5        112.5      .80618   (122,  1)                 3057.2        112.5      .61106C  ( 66,  1)
        3714.9        112.5      .52538C  (134,  1)                 4750.2        112.5      .52224   ( 31,  1)
        5675.9        112.5      .52287   ( 31,  1)                 6881.7        112.5      .51008   ( 31,  1)
         864.8        135.0      .47312C  (167,  1)                 2070.6        135.0      .82430C  (265,  1)
        2923.2        135.0      .79285   (293,  1)                 3958.6        135.0      .89538C  (  6,  1)
        4823.3        135.0      .97373C  (  6,  1)                 5688.1        135.0      .98782C  (  6,  1)
        6540.6        135.0      .96857C  (  6,  1)                  925.7        157.5      .35314C  (138,  1)
        1741.7        157.5      .99921C  (135,  1)                 2998.8        157.5      .89530   ( 72,  1)
        3982.9        157.5      .84752   (332,  1)                 4859.8        157.5      .94748   ( 10,  1)
        5675.9        157.5     1.25681   (332,  1)                 6601.6        157.5      .73204   (332,  1)
         974.4        180.0      .38107   (219,  1)                 1827.0        180.0    10.18901   (298,  1)
        2801.4        180.0     1.82225   (298,  1)                 3897.6        180.0     2.03521   (298,  1)
        4872.0        180.0     1.99207   (298,  1)                 5846.4        180.0     1.99062   ( 25,  1)
        6942.6        180.0     1.93969   ( 25,  1)                  657.7        202.5      .11402   (124,  1)
        1741.7        202.5     3.35542   (281,  1)                 2898.8        202.5     1.13709C  ( 95,  1)
        3982.9        202.5      .81550C  ( 95,  1)                 4859.8        202.5      .84426   (281,  1)
        5675.9        202.5      .82450   (281,  1)                 6601.6        202.5      .88703C  (347,  1)
        1205.8        225.0      .91983   (267,  1)                 2070.6        225.0     1.12797   (267,  1)
        2923.2        225.0     2.45037   (120,  1)                 3958.6        225.0     1.25032   (120,  1)
        4823.3        225.0      .98997   (120,  1)                 5680.1        225.0     1.31731   (120,  1)
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                                                                                         GROUP#  1 ✓
                 *** TULSA REMODEL PONCA76 MET DATA ACTUAL OPERATION ST. 1 + 2    ***

                 * HIGHEST 24-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)     *
                                         * FROM ALL SOURCES *
                                   * FOR THE DISCRETE RECEPTOR POINTS *

     - RNO -      - DIR -      CON.     (DAY,PER.)                  - RNO -      - DIR -      CON.     (DAY,PER.)
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

     6540.6        225.0      1.42097   (120,  1)                   1035.3        247.5      1.08135C (210,  1)
     2131.5        247.5      2.18523   (156,  1)                   3057.2        247.5      1.55789   (156,  1)
     3714.9        247.5      1.07092   (156,  1)                   4750.2        247.5      1.10780   (155,  1)
     5675.9        247.5      1.51536   (155,  1)                   6881.7        247.5       .96537   (155,  1)
      974.4        270.0      1.40809   (156,  1)                   1948.9        270.0      1.82322   (220,  1)
     2923.2        270.0      1.22762   (147,  1)                   3897.6        270.0      1.29716   (147,  1)
     4872.0        270.0      2.42245   (155,  1)                   5846.4        270.0       .68011   (147,  1)
     6820.8        270.0       .65652   (155,  1)                   1035.3        292.5      1.45671   (182,  1)
     2082.8        292.5      1.50422   (182,  1)                   3057.2        292.5      1.03419   (182,  1)
     3714.9        292.5       .99186C  (172,  1)                   4750.2        292.5       .99665C (172,  1)
     5675.9        292.5      1.30578C  (172,  1)                   6881.7        292.5      1.67758C (172,  1)
     1205.8        315.0      1.24177   (226,  1)                   2070.6        315.0      1.29899   (226,  1)
     2923.2        315.0      1.35499   (174,  1)                   3958.6        315.0      1.69218   (256,  1)
     4823.3        315.0      1.71039   (256,  1)                   5688.1        315.0      1.77181   (104,  1)
     6540.6        315.0      2.20062   (104,  1)                    657.7        337.5       .48444C (151,  1)
     1741.7        337.5      1.17853   (200,  1)                   2898.8        337.5      1.66461   (165,  1)
     3982.9        337.5      1.95100   (175,  1)                   4859.8        337.5      1.53448   (175,  1)
     5675.9        337.5      1.71984   (175,  1)                   6601.6        337.5      1.74063   (175,  1)
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                                                                                                   24-HR
                         *** TULSA REMODEL PONCA76 MET DATA ACTUAL OPERATION ST. 1 + 2    ***       SGROUP#  1

                 * SECOND HIGHEST 24-HOUR AVERAGE CONCENTRATION (MICROGRAMS/CUBIC METER)      *
                                             * FROM ALL SOURCES *
                                     * FOR THE DISCRETE RECEPTOR POINTS *
        - RNG -      - DIR -      CON.      (DAY,PER.)             - RNG -      - DIR -      CON.      (DAY,PER.)
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

        6540.6       225.0       1.27177   (301,  1)               1035.3       247.5        .82780   (129,  1)
        2131.5       247.5       1.75391   (155,  1)               3057.2       247.5       1.52309   (155,  1)
        3714.9       247.5        .94362   (155,  1)               4750.2       247.5        .85747   (156,  1)
        5675.9       247.5       1.15718C  (237,  1)               6881.7       247.5        .73649C  (237,  1)
         974.4       270.0       1.35023   (232,  1)               1948.9       270.0       1.63979   (232,  1)
        2923.2       270.0       1.21386   (220,  1)               3897.6       270.0       1.25473   (214,  1)
        4872.0       270.0       1.90854C  (  7,  1)               5846.4       270.0        .65975   (214,  1)
        6820.8       270.0        .65115C  (  7,  1)               1035.3       292.5       1.20621C  (207,  1)
        2082.8       292.5       1.18792   (228,  1)               3057.2       292.5        .94831C  (237,  1)
        3714.9       292.5        .84733   (228,  1)               4750.2       292.5        .77345   (221,  1)
        5675.9       292.5       1.07835   (243,  1)               6881.7       292.5       1.64044   (243,  1)
        1205.8       315.0        .95487C  (177,  1)               2070.6       315.0       1.13451   (238,  1)
        2923.2       315.0       1.17946   (256,  1)               3958.6       315.0       1.62918   ( 88,  1)
        4823.3       315.0       1.63996   ( 88,  1)               5688.1       315.0       1.73674   (256,  1)
        6540.6       315.0       2.17142C  (246,  1)                657.7       337.5        .19701C  (168,  1)
        1741.7       337.5       1.11773   (160,  1)               2898.8       337.5       1.52926   (208,  1)
        3982.9       337.5       1.83547   (165,  1)               4859.8       337.5       1.39453   (165,  1)
        5675.9       337.5       1.47941   (165,  1)               6601.6       337.5       1.46941   (165,  1)
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                                        POINTS =     0
NUMBER OF SPECIAL POINTS =  112
NUMBER OF SEASONS =    1
NUMBER OF WIND SPEED CLASSES =    6
NUMBER OF STABILITY CLASSES =    6
NUMBER OF WIND DIRECTION CLASSES =  16
FILE NUMBER OF DATA FILE USED FOR REPORTS =    1
THE PROGRAM IS RUN IN RURAL MODE
CONCENTRATION (DEPOSITION) UNITS CONVERSION FACTOR =0.10000000E 07
ACCELERATION OF GRAVITY (METERS/SEC**2) =   9.800
HEIGHT OF MEASUREMENT OF WIND SPEED (METERS) =  10.000
ENTRAINMENT PARAMETER FOR UNSTABLE CONDITIONS = 0.600
ENTRAINMENT PARAMETER FOR STABLE CONDITIONS = 0.600
CORRECTION ANGLE FOR GRID SYSTEM VERSUS DIRECTION DATA NORTH (DEGREES) =    0.000
DECAY COEFFICIENT =0.00000000E 00
PROGRAM OPTION SWITCHES = 1, 2, 2, 1, 0, 3, 2, 2, 3, 2, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0,
ALL SOURCES ARE USED TO FORM SOURCE COMBINATION  1
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SCREENING LONG TERM RUN
1973-1977 TULSA MET DATA
MODELING AT NG/RCC

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                                          - DISCRETE RECEPTOR TERRAIN ELEVATIONS (METERS) -

    X         Y         ELEVATION         X         Y         ELEVATION         X         Y         ELEVATION
  RANGE    AZIMUTH                      RANGE    AZIMUTH                      RANGE    AZIMUTH
           BEARING                               BEARING                               BEARING
 (METERS) (DEGREES)                    (METERS) (DEGREES)                    (METERS) (DEGREES)
          ---------------------------------------------------------------------------------------------------------
    974.4       0.0    195.072388        1827.0       0.0    193.548370        2801.4       0.0    205.740417
   3897.6       0.0    228.600464        4872.0       0.0    252.984497        5846.4       0.0    260.604492
   6942.6       0.0    252.984497         925.7      22.5    195.072388        1741.7      22.5    192.024384
   2998.7      22.5    208.788422        3982.9      22.5    231.648468        4908.5      22.5    222.504456
   5675.9      22.5    205.740417        6601.6      22.5    202.692413         864.8      45.0    195.072388
   2070.6      45.0    207.264404        2923.2      45.0    214.884430        3958.6      45.0    219.456451
   4823.3      45.0    220.980438        5688.1      45.0    222.504456        6540.6      45.0    213.360413
   1035.3      67.5    193.548370        2082.8      67.5    192.024384        3057.2      67.5    213.360413
   3714.9      67.5    216.408417        4750.2      67.5    217.932434        5675.9      67.5    225.552460
   6881.7      67.5    225.552460         974.4      90.0    193.548370        1948.8      90.0    192.024384
   2923.3      90.0    205.740417        3897.6      90.0    214.884430        4872.0      90.0    213.360413
   5846.4      90.0    222.504456        6820.8      90.0    239.268494        1035.3     112.5    193.548370
   2131.5     112.5    193.548370        3057.2     112.5    190.500366        3714.9     112.5    196.596405
   4750.2     112.5    213.360413        5675.9     112.5    216.408417        6881.7     112.5    220.980438
    864.8     135.0    193.548370        2070.6     135.0    192.024384        2923.2     135.0    192.024384
   3958.6     135.0    190.500366        4823.3     135.0    192.024384        5688.1     135.0    193.548370
   6540.6     135.0    195.072388         925.7     157.5    195.072388        1741.7     157.5    193.548370
   2998.8     157.5    193.548370        3982.9     157.5    192.024384        4859.8     157.5    201.168396
   5675.9     157.5    224.028442        6601.6     157.5    187.452362         974.4     180.0    193.548370
   1827.0     180.0    262.128540        2801.4     180.0    204.216400        3897.6     180.0    202.692413
   4872.0     180.0    202.692413        5846.4     180.0    207.264404        6942.6     180.0    213.360413
    657.7     202.5    195.072388        1741.7     202.5    266.700500        2898.8     202.5    228.600464
   3982.9     202.5    213.360413        4859.8     202.5    217.932434        5675.9     202.5    222.504456
   6601.6     202.5    234.696472        1205.8     225.0    195.072388        2070.6     225.0    207.264404
   2923.2     225.0    259.080505        3958.6     225.0    228.600464        4823.3     225.0    214.884430
   5680.1     225.0    231.648468        6540.6     225.0    242.316498        1035.3     247.5    196.596405
   2131.5     247.5    230.124451        3057.2     247.5    225.552460        3714.9     247.5    201.168396
   4750.2     247.5    214.884430        5675.9     247.5    237.744476        6881.7     247.5    216.408417
    974.4     270.0    199.644409        1948.9     270.0    222.504456        2923.2     270.0    210.312408
   3897.6     270.0    220.980438        4872.0     270.0    256.032471        5846.4     270.0    190.500366
   6820.8     270.0    196.596405        1035.3     292.5    195.072388        2082.8     292.5    193.548370
   3057.2     292.5    192.024384        3714.9     292.5    195.072388        4750.2     292.5    195.072388
   5675.9     292.5    213.360413        6881.7     292.5    240.792480        1205.8     315.0    193.548370
   2070.6     315.0    190.500366        2923.2     315.0    195.072388        3958.6     315.0    207.264404
   4823.3     315.0    213.360413        5688.1     315.0    225.552460        6540.6     315.0    262.128540
    657.7     337.5    193.548370        1741.7     337.5    192.024384        2898.8     337.5    201.168396
   3982.9     337.5    211.836426        4859.8     337.5    201.168396        5675.9     337.5    214.884430
   6601.6     337.5    228.600464
```

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**** ISCLT ************* TULSA REMODEL: TULSA73-77 STAR DECK, ACTUAL OPERATION 2 BOILERS                      ******** PAGE
                                                 - SOURCE INPUT DATA -

C T SOURCE SOURCE      X          Y       EMISSION  BASE /
A A NUMBER  TYPE  COORDINATE COORDINATE   HEIGHT  ELEV- /                  - SOURCE DETAILS DEPENDING ON TYPE -
R P                  (M)        (M)        (M)    ATION /
D E                                                (M)  /
  ------- ---- ------------------------------------------------------------------------------------------------------------
*       1  STACK        0.00         0.00  71.63  195.10 GAS EXIT TEMP (DEG K)= 453.00, GAS EXIT VEL. (M/SEC)= 21.10,
                                                         STACK DIAMETER (M)= 2.130, HEIGHT OF ASSO. BLDG. (M)=  0.00, W
                                                         ASSO. BLDG. (M)=    0.00, WAKE EFFECTS FLAG = 0
                                                               - SOURCE STRENGTHS ( GRAMS PER SEC
                                                                    SEASON 1      SEASON 2      SEASON 3      SEASON 4
                                                                   1.00000E 01
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*** ISCLT ************* TULSA REMODEL:  TULSA73-77 STAR DECK, ACTUAL OPERATION 2 BOILERS                              ********

     **   ANNUAL GROUND LEVEL CONCENTRATION ( MICROGRAMS PER CUBIC METER                ) FROM ALL SOURCES COMBINED

                                                                 - DISCRETE RECEPTORS -
      X            Y          CONCENTRATION          X            Y          CONCENTRATION          X            Y          CONCENTRATION
   RANGE       AZIMUTH                            RANGE       AZIMUTH                            RANGE       AZIMUTH
               BEARING                                        BEARING                                        BEARING
  (METERS)    (DEGREES)                          (METERS)    (DEGREES)                          (METERS)    (DEGREES)
               ------------------------------------------------------------------------------------------------------------------
     974.4          0.0          0.103696          1827.0          0.0          0.266926          2801.4          0.0          0.434896
    3897.6          0.0          0.650415          4872.0          0.0          0.872214          5846.4          0.0          0.859959
    6942.6          0.0          0.649565           925.7         22.5          0.034279          1741.7         22.5          0.092365
    2998.7         22.5          0.145816          3982.9         22.5          0.183273          4908.5         22.5          0.136050
    5675.9         22.5          0.098092          6601.6         22.5          0.083984           864.8         45.0          0.027240
    2070.6         45.0          0.083680          2923.2         45.0          0.089574          3958.6         45.0          0.081144
    4823.3         45.0          0.071560          5688.1         45.0          0.063596          6540.6         45.0          0.050810
    1035.3         67.5          0.020276          2082.8         67.5          0.036799          3057.2         67.5          0.046972
    3714.9         67.5          0.044358          4750.2         67.5          0.038303          5675.9         67.5          0.036646
    6881.7         67.5          0.031289           974.4         90.0          0.025629          1948.8         90.0          0.042960
    2923.3         90.0          0.049039          3897.6         90.0          0.049828          4872.0         90.0          0.042942
    5846.4         90.0          0.043647          6820.8         90.0          0.051868          1035.3        112.5          0.018606
    2131.5        112.5          0.034008          3057.2        112.5          0.035733          3714.9        112.5          0.035280
    4750.2        112.5          0.041509          5675.9        112.5          0.039432          6881.7        112.5          0.037697
     864.8        135.0          0.012257          2070.6        135.0          0.039887          2923.2        135.0          0.045428
    3958.6        135.0          0.045088          4823.3        135.0          0.042918          5688.1        135.0          0.040360
    6540.6        135.0          0.037858           925.7        157.5          0.019791          1741.7        157.5          0.040097
    2998.8        157.5          0.051858          3982.9        157.5          0.051806          4859.8        157.5          0.054622
    5675.9        157.5          0.073239          6601.6        157.5          0.044325           974.4        180.0          0.034806
    1827.0        180.0          0.744197          2801.4        180.0          0.165677          3897.6        180.0          0.163302
    4872.0        180.0          0.154174          5846.4        180.0          0.152202          6942.6        180.0          0.148478
     657.7        202.5          0.006538          1741.7        202.5          0.370512          2898.8        202.5          0.125740
    3982.9        202.5          0.085532          4859.8        202.5          0.083324          5675.9        202.5          0.079960
    6601.6        202.5          0.081974          1205.8        225.0          0.031969          2070.6        225.0          0.053076
    2923.2        225.0          0.137010          3958.6        225.0          0.068223          4823.3        225.0          0.049921
    5680.1        225.0          0.055072          6540.6        225.0          0.055456          1035.3        247.5          0.024391
    2131.5        247.5          0.058980          3057.2        247.5          0.050863          3714.9        247.5          0.032577
    4750.2        247.5          0.036214          5675.9        247.5          0.046590          6881.7        247.5          0.030333
     974.4        270.0          0.027023          1948.9        270.0          0.066459          2923.2        270.0          0.052397
    3897.6        270.0          0.055732          4872.0        270.0          0.094386          5846.4        270.0          0.032380
    6820.8        270.0          0.030488          1035.3        292.5          0.025123          2082.8        292.5          0.035384
    3057.2        292.5          0.034311          3714.9        292.5          0.032482          4750.2        292.5          0.029701
    5675.9        292.5          0.035082          6881.7        292.5          0.047771          1205.8        315.0          0.033546
    2070.6        315.0          0.046781          2923.2        315.0          0.051417          3958.6        315.0          0.062870
    4823.3        315.0          0.064838          5688.1        315.0          0.071190          6540.6        315.0          0.109865
     657.7        337.5          0.008267          1741.7        337.5          0.075872          2898.8        337.5          0.114998
    3982.9        337.5          0.140671          4859.8        337.5          0.109726          5675.9        337.5          0.126923
    6601.6        337.5          0.140063
```

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****  ************* TULSA REMODEL: TULSA73-77 STAR DECK, ACTUAL OPERATION 2 BOILERS              ******** PAGE
**   ANNUAL GROUND LEVEL CONCENTRATION ( MICROGRAMS PER CUBIC METER              ) FROM ALL SOURCES COMBINED (CONT.

                                 - PROGRAM DETERMINED MAXIMUM 10 VALUES -
                                      X            Y          CONCENTRATION
                                  COORDINATE   COORDINATE
                                    RANGE       AZIMUTH
                                                BEARING
                                   (METERS)    (DEGREES)
                                  ------------------------------------------
                                    4872.00        0.00         0.872214
                                    5846.40        0.00         0.859959
                                    1827.00      180.00         0.744197
                                    3897.60        0.00         0.650415
                                    6942.60        0.00         0.649565
                                    2801.40        0.00         0.434896
                                    1741.70      202.50         0.370512
                                    1827.00        0.00         0.266926
                                    3982.90       22.50         0.183273
                                    2801.40      180.00         0.165677
```

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**** ISCLT ************* TULSA REMODEL: PONCA75.STR. ACTUAL OP. 3 BOILERS ADJUSTED RH                          ******** PAGE
                                                - SOURCE INPUT DATA -

C T SOURCE SOURCE      X           Y        EMISSION  BASE /
A A NUMBER  TYPE  COORDINATE  COORDINATE  HEIGHT   ELEV- /                  - SOURCE DETAILS DEPENDING ON TYPE -
R P                  (M)         (M)        (M)    ATION /
D E                                                  (M) /
- -- -------------------------------------------------------------------------------------------------------------------
1       1   STACK      0.00         0.00  71.63  195.10 GAS EXIT TEMP (DEG K)= 453.00, GAS EXIT VEL. (M/SEC)= 21.10,
                                                        STACK DIAMETER (M)= 2.130, HEIGHT OF ASSO. BLDG. (M)=  0.00, W
                                                        ASSO. BLDG. (M)=    0.00, WAKE EFFECTS FLAG = 0
                                                              - SOURCE STRENGTHS ( GRAMS PER SEC
                                                                   SEASON 1      SEASON 2      SEASON 3      SEASON 4
                                                                  2.41500E 01
```

FINAL ISC LONG TERM RUN!
PONCA CITY 1975 MET DATA
MODELED AT 10 G/SEC

```
 **   ANNUAL GROUND LEVEL CONCENTRATION ( MICROGRAMS PER CUBIC METER              ) DUE TO SOURCE       1
                                                     - DISCRETE RECEPTORS -
    X          Y        CONCENTRATION             X          Y         CONCENTRATION               X          Y         CONCENTRATION
 RANGE      AZIMUTH                            RANGE      AZIMUTH                               RANGE      AZIMUTH
            BEARING                                       BEARING                                          BEARING
(METERS)  (DEGREES)                           (METERS)  (DEGREES)                              (METERS)  (DEGREES)
          ---------------------------------------------------------------------------------------------------------------------------------
   974.4        0.0        0.257007             1827.0        0.0        0.550687                2801.4        0.0        0.748304
  3897.6        0.0        0.936399             4872.0        0.0        1.277217                5846.4        0.0        1.173380
  6942.6        0.0        0.723065              974.4      180.0        0.104088                1827.0      180.0        2.554113
  2801.4      180.0        0.485205             3897.6      180.0        0.468443                4872.0      180.0        0.436149
  5846.4      180.0        0.425164             6942.6      180.0        0.409847                 657.7      202.5        0.016982
  1741.7      202.5        0.479125             2898.8      202.5        0.179959                3982.9      202.5        0.123633
  4859.8      202.5        0.122532             5675.9      202.5        0.120450                6601.6      202.5        0.130792
                                             - PROGRAM DETERMINED MAXIMUM 10 VALUES -
                                                   X             Y           CONCENTRATION
                                              COORDINATE    COORDINATE
                                                RANGE         AZIMUTH
                                                              BEARING
                                               (METERS)      (DEGREES)
                                              ----------------------------------------
                                                1827.00        180.00          2.554113
                                                4872.00          0.00          1.277217
                                                5846.40          0.00          1.173380
                                                3897.60          0.00          0.936399
                                                2801.40          0.00          0.748304
                                                6942.60          0.00          0.723065
                                                1827.00          0.00          0.550687
                                                2801.40        180.00          0.485205
                                                1741.70        202.50          0.479125
                                                3897.60        180.00          0.468443
```

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**** ISCLT ************* TULSA REMODEL: PONCA76 STAR DECK, ACTUAL OPERATION 3 BOILERS                                ******** PAGE
                                                 - SOURCE INPUT DATA -

C T SOURCE SOURCE      X            Y        EMISSION  BASE /
A A NUMBER  TYPE   COORDINATE   COORDINATE    HEIGHT   ELEV- /                         - SOURCE DETAILS DEPENDING ON TYPE -
R P                    (M)          (M)         (M)    ATION /
D E                                                     (M)  /
    ----------------------------------------------------------------------------------------------------------------------------
1       1   STACK        0.00         0.00    71.63   195.10 GAS EXIT TEMP (DEG K)= 453.00, GAS EXIT VEL. (M/SEC)= 21.10,
                                                             STACK DIAMETER (M)= 2.130, HEIGHT OF ASSO. BLDG. (M)=  0.00, W
                                                             ASSO. BLDG. (M)=   0.00, WAKE EFFECTS FLAG = 0
                                                                  - SOURCE STRENGTHS ( GRAMS PER SEC
                                                                        SEASON 1      SEASON 2      SEASON 3      SEASON 4
                                                                      2.41500E 01
```

FINAL LONG TERM RUN
PONCA CITY 1976 DATA
MODELED AT 100/SB C

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 **** ISCLT ************* TULSA REMODEL: PONCA76 STAR DECK, ACTUAL OPERATION 3 BOILERS                         ********* PAGE

        **   ANNUAL GROUND LEVEL CONCENTRATION ( MICROGRAMS PER CUBIC METER              ) DUE TO SOURCE      1

                                                         - DISCRETE RECEPTORS -
     X          Y        CONCENTRATION             X          Y        CONCENTRATION              X          Y        CONCENTRATION
  RANGE      AZIMUTH                            RANGE      AZIMUTH                             RANGE      AZIMUTH
             BEARING                                       BEARING                                        BEARING
 (METERS)  (DEGREES)                           (METERS)  (DEGREES)                            (METERS)  (DEGREES)
           -------------------------------------------   -----------------------------------------------------------------------
    974.4        0.0       0.239521               1827.0        0.0       0.506335              2801.4        0.0       0.690253
   3897.6        0.0       0.887710               4872.0        0.0       1.265697              5846.4        0.0       1.180430
   6942.6        0.0       0.718959                974.4      180.0       0.058679              1827.0      180.0       2.177585
   2801.4      180.0       0.386324               3897.6      180.0       0.378034              4872.0      180.0       0.356053
   5846.4      180.0       0.353146               6942.6      180.0       0.348324               657.7      202.5       0.007384
   1741.7      202.5       0.479777               2898.8      202.5       0.173699              3982.9      202.5       0.119946
   4859.8      202.5       0.122211               5675.9      202.5       0.122274              6601.6      202.5       0.135646

                                               - PROGRAM DETERMINED MAXIMUM 10 VALUES -
                                                     X              Y         CONCENTRATION
                                                COORDINATE     COORDINATE
                                                  RANGE          AZIMUTH
                                                                 BEARING
                                                 (METERS)       (DEGREES)
                                                ---------------------------------------------
                                                   1827.00         180.00          2.177585
                                                   4872.00           0.00          1.265697
                                                   5846.40           0.00          1.180430
                                                   3897.60           0.00          0.887710
                                                   6942.60           0.00          0.718959
                                                   2801.40           0.00          0.690253
                                                   1827.00           0.00          0.506335
                                                   1741.70         202.50          0.479777
                                                   2801.40         180.00          0.386324
                                                   3897.60         180.00          0.378034
```

NEIL GOLDSCHMIDT
GOVERNOR

Department of Environmental Quality

811 S.W. SIXTH AVENUE, PORTLAND, OREGON 97204 PHONE (503) 229-5696

RECEIVED
FEB 25 1987
D. L. JURAN

RECEIVED
APR 07 1987
OGDEN PROJECTS, INC., CALIFORNIA

February 13, 1987

Ogden Martin Systems of Marion, Inc.
40 Lane Road
P. O. Box CN 2615
Fairfield, NJ 07007

Re: ACDP #24-5398

The Department has completed its review of the source test report for the testing done between September 22, 1986 and October 8, 1986. The test report is accepted for compliance determination pursuant to Air Contaminant Discharge Permit 24-5398.

Our review of the report verifies exceedance of the permit limits for NO_x. The Department is processing your request for a permit modification to increase the NO_x limits and throughput limits. Pending action on the request for modification, the facility may be operated at the reported NO_x emission rate.

Test results for all other pollutants have been determined to demonstrate compliance with permit requirements. In order to maintain compliance, the Department must be advised in writing of any modifications to the pollution control system.

You will be advised of our progress on the permit modification. If you have any questions, please contact me at (503) 229-6414.

Sincerely,

Wendy L. Sims, P. E.
Senior Environmental Engineer
Air Quality Division

WLS:ahe

cc: Jeff Hahn, Ogden Projects, Inc.
Willamette Valley Region, DEQ

Department of Environmental Quality
Air Quality Control Division

AIR CONTAMINANT DISCHARGE PERMIT APPLICATION REVIEW REPORT

Ogden Martin Systems of Marion, Inc.
c/o Ogden Projects, Inc.
40 Lane Road
P. O. Box CN 2615
Fairfield NJ 07007

1. BACKGROUND

In December 1986, the Department issued permits for the construction and operation of a municipal solid waste-to-electricity facility at Brooks, Oregon. The Air Contaminant Discharge Permit (ACDP) established operating and emission conditions for the facility, based on a determination of Best Available Control Technology (BACT), ambient impact modeling, and other criteria. The facility, operated by Ogden Martin Systems of Marion, Inc. (Ogden Martin), became operational in 1986. In accordance with the ACDP, source tests for the regulated air pollutants were conducted in September-October 1986. In November 1986, Ogden Martin requested a permit modification to increase the NO_x emission limits and increase the annual limit on the quantity of refuse burned.

Prior to considering the modification request, the source test report was reviewed by the Department to ensure that it was acceptable for compliance determination. The report was found to be acceptable in February 1987. The facility was determined to be in compliance with furnace temperature and residence time requirements and with the emission limits for all regulated pollutants except NO_x.

Based on the review summarized in this report, the Department proposes to approve with some adjustments the requests for NO_x and throughput increases. The Department also proposes to establish limits for HC1 which are lower than the maximum established in the original ACDP and to require additional testing of NO_x emissions.

2. NO_x EMISSION EVALUATION

This section addresses the acceptability of the actual NO_x emission rate as BACT for the time of permit issuance. The concentration of NO_x in the exhaust gas from the Ogden Martin facility is higher than was expected when the permit was issued, resulting in mass emission rates which exceed the permit limit for NO_x. Table I compares the NO_x emission rates allowed in the ACDP to the source test results for the facility.

TABLE I
NO_x EMISSIONS ANALYSIS

	ACDP	SOURCE TEST RESULTS	
	BASIS	AVERAGE	MAXIMUM(2)
Mass Emissions-lb/hr			
Boiler 1	47.0	60.1	69.0
Boiler 2	47.0	48.5	53.2
Total	94.0	108.5	122.2
Concentration-ppmdv at 12% CO_2			
Boiler 1	180(1)	306	349
Boiler 2	180(1)	283	302
Emission Factor			
lb NO_x/ton fuel	3.6	4.95(1)	5.6(1)
Mass Emissions-tons/year			
Total	290	396(3)	

NOTES:
1. Value derived from operating parameters.
2. Maximum hourly values.
3. Based on operation at current limit of 160,000 tons waste/year. Increasing throughput to 198,700 tons/year would result in 492 tons/year of NO_x at 4.95 lb/ton.

BACT is defined as "an emission limitation...based on the maximum degree of reduction of each air contaminant...which would be emitted from any proposed major source or major modification which, on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, is achievable for such source or modification through application of production processes or available methods, systems, and techniques, including fuel cleaning or treatment or innovative fuel combustion techniques for control of such air contaminant..." (OAR 340-20-22(4)). The ACDP NO_x limits for this facility were based on the use of good combustion chamber design as BACT, with no add-on control equipment required. In light of the source test results, BACT must be reevaluated to determine both the acceptability of the actual NO_x concentration for this facility and the appropriateness of combustion chamber design as the NO_x control mechanism.

A. NO_x EMISSIONS FROM MODERN ENERGY RECOVERY FACILITIES

NO_x in combustion exhaust is the result of two chemical processes: the conversion of nitrogen contained in the fuel and the oxidation of atmospheric N_2, or thermal NO_x. The amount of NO_x formed from fuel bound nitrogen is a function of the concentration of nitrogen in the fuel and combustion conditions. Thermal NO_x formation is strongly dependent on the peak temperatures of the gases, increasing rapidly as temperatures rise above 2000°F. Both of these processes are considered to be contributing to elevated NO_x levels at the Ogden Martin facility.

Thermal NO_x emissions can be expected to be greater than the levels predicted at the time of permit issuance. The ACDP limit was derived from municipal solid waste combustion facilities then in operation, which emitted approximately 180 PPM to 200 ppm of NO_x. This data base included both energy recovery facilities and incinerators. The facilities were neither designed nor operated to achieve the high degree of control of toxic organic compound emissions (such as the chlorinated dioxins) required for the Ogden Martin facility. In order to control these compounds, the ACDP requires that the temperature of the combustion gases average of at least 1800°F for a minimum of 2 seconds during combustion of waste. Higher temperatures are experienced for shorter time periods. In contrast, older facilities, such as those used as the basis for the emission limits in the ACDP, operated at average temperatures closer to 1600°F.

The increase in NO_x at higher operating temperatures is reflected in Table II, which gives emissions for other facilities of modern design. These facilities, almost all of which have become operational since the ACDP for Ogden Martin's facility was issued, have combustion processes designed to achieve gas temperatures which will minimize the formation of toxic organic compounds. The NO_x emissions from the Ogden Martin facility are comparable to the emission rates from the other modern facilities.

TABLE II
NO_x EMISSION TEST RESULTS
MODERN MASS BURN ENERGY RECOVERY FACILITIES
ppmdv @ 12% CO_2

FACILITY	SYSTEM	AVERAGE EMISSIONS *
Brooks, OR	Martin	294
Tulsa, OK	Martin	343
Stockholn-Hogdalen, Sweden	Martin	310
Wurzburg, W. Germany	Martin	236
Pinellas, FL	Signal	251
Westchester, NY	Signal	236
Baltimore, MD	Signal	166
North Andover, MA	Signal	288

* Emissions values are based on differing sampling methods and averaging times. Comparison to the Brooks Facility is approximate.

The other factor which may have contributed to the observed NO_x level is high fuel nitrogen content. This could cause an additional increase in NO_x over the levels caused by higher operating temperatures. High fuel nitrogen content can result from the presence of "green" waste, such as yard debris. For instance, grass has an average nitrogen content of 1.35%. This is much higher than the nitrogen in other waste components such as plastics and paper, which average 0.05% nitrogen (Gershman, Brickner and Bratton, Inc., 8/12/86).

The source testing occurred in September and October, near the end of the growing season. As can be expected at this time of the year, the loading crane operators observed large quantities of "green" waste in the waste burned during the testing. During winter months or months when this waste component is reduced, a decrease in NO_x emissions could be expected. The amount of additional NO_x caused at the Ogden Martin facility by waste nitrogen flucuations can only be determined by testing the emissions at different times during the year.

Based on these considerations, the Department considers the rate of NO_x formation to be reasonable for this facility.

B. NO_x CONTROL TECHNOLOGY

The second aspect of this NO_x review, as mentioned above, addresses the appropriateness of the NO_x control technology at the actual emission rate. NO_x emissions from combustion sources can be reduced by several methods. "Air Pollution Control at Resource Recovery Facilities" (California Air Resources Board, CARB, May 24, 1984) describes the various methods. The CARB report can be considered to reflect the state of development of the control methods at the time of the original BACT determination in December 1983. The flue gas controls discussed in the report are selective catalytic reduction (SCR), flue gas denitrification (FGD), and selective non-catalytic reduction (SNCR). The first two methods had not been successfully applied to refuse burning facilities. SNCR was being considered only on refuse-fired facilities in the Los Angeles, CA area, where violations of the Ambient Air Quality Standards precipitate more stringent requirements for NO_x sources than apply in Marion County. In addition to not being demonstrated on refuse-burning facilities in the U.S., SNCR can result in ammonia and ammonia compound emissions.

NO_x emissions can also be reduced by combustion modifications. The Ogden Martin facility design incorporates staged combustion control with low excess air in the primary zone. Another technique, flue gas recirculation is also effective. However, the CARB report noted that the effectiveness, which is not additive to staged combustion/low excess air, is only 10-15%. Further, the technique had not been applied at American facilities.

Consequently, flue gas controls and flue gas recirculation are not proposed for the Ogden Martin facility.

One additional technique which could lower NO_x emissions from the Ogden Martin facility is source separation, or the removal of nitrogen-rich waste material from the waste stream. For example, a yard debris recycling program could reduce NO_x emissions by diverting that portion of the waste stream from the facility. A recycling program instituted by Marion County would be in accord with the state priorities for waste management, which place a higher priority on recycling than on energy recovery.

The Department proposes to accept the actual NO_x emission rate and control technology as BACT based on the factors reviewed in this section.

3. REQUESTED PERMIT MODIFICATIONS

Ogden Martin requested an increase in the allowable throughput from 160,000 tons per year to 200,750 tons per year and an increase in the NO_x emission limits from 94.0 pounds per hour to 122.2 pounds per hour and from 290 tons per year to 535 tons per year. The throughput request is considered first.

The existing facility design replaced the originally proposed design, for which Trans Energy-Oregon, Inc. was issued permits. Based on Trans Energy-Oregon's proposed daily capacity of 624 tons per day and anticipated downtime, the facility capacity was expected to be 160,000 tons per year (70% availability). The Ogden Martin facility has a lower daily rating, at 550 tons per day, but less expected downtime. As a result, the actual facility capacity is higher than allowed for by the ACDP on an annual basis.

The requested capacity increase was based on operation of the facility 100% of the year. The Department finds this to be unrealistic and considers usage of the facility without downtime for routine maintenance to be unacceptable. Accordingly, further analysis of the modification is based on 99% availability, or 198,700 tons per year of municipal solid waste.

Ogden Martin has requested the increased throughput without any increases in the permit emission limits for each pollutant except NO_x. Table III shows the projected facility emissions versus the permit limits. With the exception of NO_x, all pollutants would be within the established limits at the requested annual throughput. The effect of the improvement in combustion control over the older facilities analyzed prior to permit issuance is reflected in decreased CO and VOC emissions as well as increased NO_x emissions for the Ogden Martin facility. Except for NO_x, ambient pollutant levels would not be increased by the requested tonnage increase.

TABLE III
EMISSIONS COMPARISON

	ACDP Maximum Emission Limits		ACTUAL EMISSIONS		PROJECTED ANNUAL EMISSIONS	
			Average	Maximum	@160,000 tpy	@198,700 tp
Pollutant	lbs/hr	tons/yr	lbs/hr	lbs/hr	tons/yr	tons/yr
Nitrogen Oxides	94.0	290	108.5	122.2	396	492
Sulfur Dioxide	73.0	220	20.9	30.7	73	91
Carbon Monoxide	55.0	170	4.1	4.6	14	18
Total Suspended Particulate	20.0	61	4.5	5.9	16	20
Lead	0.52	1.6	.006	0.04	0.02	0.03
Beryllium	2.9×10^{-6}	8.8×10^{-6}	$<4.4\times10^{-7}$	5.4×10^{-7}	$<1.5\times10^{-6}$	<1.9x10
TCDD	1.7×10^{-6}	5.1×10^{-6}	3.84×10^{-8}	4.54×10^{-8}	1.3×10^{-7}	1.7x10
Volatile Organic Compounds	3.1	9.6	0.3	0.4	1.0	1.3
Fluorides	1.6	4.8	0.092	0.14	0.32	0.40
Mercury	0.17	0.51	0.06	0.068	0.21	0.26
Hydrogen Chloride	<23	<69	3.3	3.6	12	14

Since the Plant Site Emission Limits would be exceeded only for NO_x, the acceptability of the throughput increase is dependent on the review of the NO_x emissions. As discussed above, the actual NO_x concentration is acceptable as BACT for the facility. The other criterion for acceptability is the ambient impact of the increase.

The impact of the increased NO_x emissions would be minimal. Table IV gives the maximum annual impacts calculated using the conservative assumption that both boilers would be operated year round without downtime. These figures indicate that the requested increase would not cause or contribute to an exceedance of an Ambient Air Quality Standard. Therefore, the impact of the increase is acceptable.

TABLE IV
AMBIENT NO_x IMPACT ANALYSIS
ANNUAL IMPACT-ug/M^3

	Existing ACDP Limits	Proposed ACDP Emissions Limits
Annual Emissions-tons/year	290	492
Significant Impact Level (for nonattainment areas)	1.0	1.0
Predicted Maximum Impact	0.71	0.82
Background Concentration (Portland Station-4 yr. Av.)	32.8	32.8
Total Concentration	33.5	33.6
Ambient Air Quality Standard	100	100

180 $\frac{492}{290} =$

Based on the evaluation of BACT and the impact of the proposed throughput and NO_x emissions increases, the Department proposes to modify the ACDP to allow a maximum annual throughput of 198,700 tons per year of municipal solid waste and NO_x emissions of 122.2 pounds per hour and 492 tons per year, maximum. Of the proposed 202 tons per year increase, 96 tons per year is attributed to increased throughput. This increase over the existing ACDP limits would not violate any state or federal regulations.

OGDEN PROJECTS, INC.

ENVIRONMENTAL ENGINEERING DEPARTMENT

ENVIRONMENTAL TEST REPORT

PREPARED FOR Ogden Martin Systems of Tulsa, Inc.
2122 South Yukon Avenue
Tulsa, Oklahoma 74104

REGARDING Walter B. Hall Resource Recovery Facility
Units 1 and 2

REGULATORY AGENCIES Tulsa City-County Health Department Permit No. T84-23, and
U.S. EPA Permit PSD-OK-556M-1

PURPOSE Compliance with Permit Conditions

TEST DATES June 23 - July 2, 1986 and October 8, 1986

REPORT NUMBER 101

PREPARED BY Ronald A Zurlinden
Ronald A. Zurlinden, Environmental Scientist

Henry P Von Dem Fange, Manager of Environmental Testing

Jeffrey L Hahn
Jeffrey L Hahn, P.E., Vice President, Environmental Engineering

September 9, 1986
Revised October 15, 1986

Testing Firm:
Ogden Projects, Inc.
1900 Powell Street, Suite 400
Emeryville, California 94608
Richard Seelinger,
Executive Vice President
Engineering

REGISTERED PROFESSIONAL ENGINEER
JEFFREY L. HAHN
No. 3289
Exp. 3-31-90
CHEMICAL
STATE OF CALIFORNIA

AN OGDEN COMPANY

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AN OGDEN COMPANY

TULSA CITY-COUNTY HEALTH DEPARTMENT

4616 East 15th • 918 744-1000
Tulsa, Oklahoma 74112

October 28, 1986

Mr. Richard W. Seelinger
Ogden Martin Systems, Inc.
140 East Ridgewood Avenue
Paramus, N.J. 07652

RE: Permit to Operate T84-23
Walter B. Hall Resource Recovery Facility

Dear Mr. Seelinger:

Attached is the Permit to Operate for units number 1 and 2. Please note that we have included the total dioxin and furan emissions in Section 1 of the Special Conditions. This is not because we are necessarily concerned about these emission levels. On the contrary, we are pleased with the low levels measured. To insure that the plant operates efficiently and continues to have low dioxin and furan emissions, we have requested, and you have agreed, that a continuous carbon monoxide monitor be installed.

Oxides of Nitrogen, Mercury and Sulfuric Acid emission rates were increased in this permit to the levels slightly above those shown in the compliance tests performed in June, July and October. Although the hydrochloric acid emissions were high, we find they are in line with emissions from similar plants across the country.

We are pleased with the test results and believe, with proper maintenance, that the plant will continue to meet limits set in the permit for years to come. I also want to take this opportunity to compliment you on your excellent staff. They are knowledgeable, environmentally concerned and a pleasure to work with.

Sincerely,

Roger D. Randolph

Roger D. Randolph, P.E.
Supervisor, Air Quality Control

RDR:kcc

XC: Jerry Whitt
Jeffrey Hahn
John Drake

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PERMIT TO OPERATE

AIR QUALITY CONTROL SECTION
POLLUTION CONTROL DIVISION
TULSA CITY-COUNTY HEALTH DEPT.

4616 EAST 15th STREET
TULSA, OK 74112

Date *October 30*, 19*86* Permit No. *T84-23*

The *Ogden Martin Systems of Tulsa, Incorporated*, having complied with the requirements of the law, is hereby granted permission to:

operate Units Number 1 and 2 at the Walter B. Hall Resource Recovery Facility, a Solid Waste to Energy Facility, at 375 tons per day RDF at 21st and Yukon, Tulsa County, Tulsa, Oklahoma.

TOTAL ALLOWABLE EMISSIONS: SEE ATTACHED SHEET.

OGDEN MARTIN SYSTEMS OF TULSA, INCORPORATED, MUST COMPLY WITH THE FOLLOWING RULES, REGULATIONS AND/OR ORDINANCES: City of Tulsa Clean Air Ordinances, Sections 210 and 214; Oklahoma Clean Air Act, Regulations 1.4, 2.3 and 2.4 and NSPS, Subpart A and E.

subject to the Standard Provisions appearing on the back of this permit and the following or attached special conditions:

SEE ATTACHED SHEETS

This permit issued under authority, delegated to the Tulsa City-County Health Department by the Oklahoma State Department of Health, the Administrator of the Environmental Protection Agency and Section 214 of the City-County Air Pollution Regulations.

Roger D. Randolph Supervisor, Air Quality Control

Cleveland Chief, Pollution Control Division

STANDARD PROVISIONS

1. If any statement or presentation in the application is found to be incorrect, this permit may be revoked and the permittee thereupon waives all rights thereunder. However, the application may be amended and a supplemental written permit issued by the department.

2. Any modification of operating procedures from those used during the final testing of equipment which effects emissions of air contaminants, without notification of the Air Quality Control Section, shall be grounds for revocation.

3. Any agent of the Tulsa City-County Health Department shall have the right and authority to inspect, at reasonable times, the source(s) for which this permit is issued.

4. This permit shall not be construed to affect the title of the premises upon which the equipment is located, nor does it release the permittee from any liability for damage to persons or property caused by or resulting from the maintenance or operation of the equipment for which this permit is issued. This permit does not release the permittee from compliance with other applicable rules, regulations and statutes of Oklahoma or with applicable local laws, rules, regulations or ordinances.

5. This permit is subject to periodic review, change, or additional fees necessary to fulfill the intent and purposes of the Oklahoma Clean Air Act and City and County rules and regulations.

6. In complying with the provisions of Regulation 1.5 Oklahoma Clean Air Act or the City-County Air Pollution regulations, the person in charge of the facility shall:

    a. Immediately notify the Director whenever an air pollution emergency exists.

    b. Immediately notify Air Quality Control in event of a malfunction of any emission source, air pollution control equipment or related facility which may cause the emission of air contaminants in violation of these ordinances or permit limitations.

    c. Submit written reports of the above events to or request variances in accordance with the above cited regulations from the Air Quality Control Section.

7. This permit incorporates, by reference, correspondence and information submitted by the applicant and incorporates the requirements established in the permit to construct.

8. THIS PERMIT IS NOT TRANSFERABLE TO ANOTHER PERSON OR RELOCATION.

Special Conditions Page 1 of 3
Ogden Martin Systems of Tulsa, Inc.
Walter B. Hall Resource Recovery Facility
Permit To Operate T84-23

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1) Maximum allowable emissions based on 750 tons per day total boiler feed for two units are listed below:

MAXIMUM ALLOWABLE EMISSION RATES

Pollutant	Unit #1	Unit #2	Emission Rates/Both Units		Estimated Actual Emission Rates Both Units
	lbs/hr	lbs/hr	lbs/hr	TPY	TPY
TSP	17.1	17.1	34.2	150.0	50.0
SO2	50.45	50.45	100.9	441.9	260.0
NOx	100.0	100.0	200.0	876.0	657.2
VOC	2.3	2.3	4.6	20.1	0.80
CO	20.8	20.8	41.6	182.2	27.0
Pb	0.1	0.1	0.2	0.9	0.44
Hg	0.06	0.06	0.12	0.5	0.44
Be	2.565×10^{-6}	2.565×10^{-6}	5.13×10^{-6}	2.25×10^{-5}	3.2×10^{-6}
Hf	1.65	1.65	3.3	14.5	5.5
H2SO4	9.0	9.0	18.0	78.8	42.0
HCL	97.0	97.0	194.0	849.7	640.0

Total tetrachloredibenzodioxin (TCDD) is not to exceed 1.172×10^{-5} pounds per hour and total polychlorinated dibenzo-p-dioxins (PCDD) and polychlorinated dibenzo-p-furans (PCDF) are not to exceed 1.67×10^{-4} pounds per hour. Total estimated annual emissions (both units) of PCDD's and PCDF's are 3.54×10^{-5} per year.

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2) Emissions will not exceed:

   a) Ten percent (10%) average opacity (per clock hour) (BACT). Opacity of emissions shall not exceed 10%/clock hour as read by a certified visible emissions evaluator (a continuous opacity monitor may be used to monitor operating parameters).

   b) 0.06 gr/dscf (corrected to 12% CO) of particulate emissions (BACT).

   c) 31.08 lbs/hr per unit particulate emissions at rated capacity, State and City Rules (see condition #6).

3) No sewage sludge will be burned in this facility.

4) A bi-ennial stack test on one unit of Tulsa City/County Health Department's choosing will be required until such time as Tulsa City/County Health Department is satisfied that emission composition and rates are as represented and that there are no major changes or fluctuations in the test results.

5) In order to reduce odor emissions, Section 6.1.9 of the <u>Solid Waste Management Rules and Regulations Including Sludge Management Rules and Regulations</u> (Oklahoma State Department of Health Bulletin Number 0524) shall be met.

6) When performing the Method Five (5) Source Test to determine compliance, the particulates captured in the back half of the train, must be weighed and reported. The back half of the train is defined as those particles, both solids and liquids, captured in the impingers (desicated to dryness). When determining compliance with Oklahoma and City of Tulsa Regulations, the back half of the train must be included in the total particulate catch for compliance determinations. When determining compliance with BACT and the United States Environmental Protection Agency Regulations, the back half of the train is reported, but not counted.

7) A continuous carbon monoxide monitor, as approved by the Director, shall be installed in the combined stack.

8) Violations, measured by continuous emission monitors, of any applicable regulation or permit condition, must be reported to the Tulsa City/County Health Department Air Quality Program personnel as soon as practical, but no later than the following working day. High reading of carbon monoxide will be reported based on established operating history.

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Special Conditions Page 3 of 3
Ogden Martin Systems of Tulsa, Inc.
Walter B. Hall Resource Recovery Facility
Permit to Operate T84-23

9) An annual report shall be supplied to the Tulsa City/County Health Department for the period, January 1 - December 31, no later than February 15 of the following year, containing the following information:

   a) Percent of the time the instrument(s) was (were) operational;

   b) number of violations, if any; and the ten (10) highest one hour values, for each instrument(s);

   c) any repairs made on the instrument(s);

   d) date(s) instrument(s) was (were) calibrated. This is not to include daily zero and spans and

   e) details of quality assurance checks performed on the instrument(s).

10) Requirements for all continuous monitors installed:

   a) Calibration of the monitor shall be accomplished initally and at least yearly thereafter using standards traceable to an NBS standard or other primary standard approved by the Director.

   b) The Tulsa City/County Health Department must be notified 30 (thirty) days in advance of calibrations and must be given an opportunity to observe and approve the procedure.

APPROVED

TULSA CITY-COUNTY HEALTH DEPARTMENT

BY Roger D. [illegible]

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I. INTRODUCTION

Introduction

On June 23, 1986 through July 2, 1986, Ogden Projects, Inc. performed a series of emission tests at the Walter B. Hall Resource Recovery Facility, a Waste-to-Energy Facility owned and operated by Ogden Martin Systems of Tulsa, Incorporated.

Two MSW-fired boilers (Units 1 and 2), each with a 375 tons per day (TPD) capacity, were tested for various gaseous and solid air pollutant emissions from the common stack and the Electrostatic Precipitator outlet of each boiler. This testing was for determination of compliance with Tulsa City-County Health Department (TCCHD) Authority to Construct permit No. T84-23 and with the U.S. EPA Region VI permit PSD-OK-556M-1.

The test program as per the source test plan submitted to the TCCHD and the U.S. EPA on June 11, 1986, is outlined as follows:

Parameter	Method	Location
TSP	U.S. EPA Method 5	Boilers 1 and 2
Trace Chlorinated Organics	U.S. EPA Modified Method 5	Common Stack
Oxides of Nitrogen	U.S. EPA Method 7E	Boilers 1 and 2
H_2SO_4, SO_2, HF, HCl	U.S. EPA Method 8/13A	Boilers 1 and 2
Opacity	U.S. EPA Method 9	Common Stack
CO	U.S. EPA Method 10	Boilers 1 and 2
Pb, Be	U.S. EPA Method 12/104	Common Stack
VOC	California Air Resources Board Method 100	Boilers 1 and 2
Hg	U.S. EPA Method 101A	Common Stack
CO_2	NDIR Analyzer	Boilers 1 and 2
O_2	Paramagnetic Analyzer	Boilers 1 and 2

Variations to the source test plan are outlined in section VI.

The testing was supervised by Mr. Henry Von Dem Fange and performed by Messrs. Ronald Zurlinden, Matthew Turner and John Scholz, all of Ogden Projects, Inc. (OPI). The exception was the continuous emission monitoring compliance testing of NO_x, CO, and VOC, by Mr. Andy Winkler of Petro Chem Environmental Services of Bakersfield, California. The laboratory analyses of TSP, H_2SO_4, SO_2 and HCl were performed by OPI at its Emeryville laboratory and the analyses of Pb, Be and Hg were conducted by Brown and Caldwell Analytical Laboratories of Emeryville, California, a California certified hazardous waste laboratory. The isomer specific analyses of PCDDs and PCDFs were performed by Triangle Laboratories, Inc., of Research Triangle Park, North Carolina.

Mr. Ray Bishop and Mr. James Van Sandt representing TCCHD, and, Mr. Robert E. Cullen, P.E. and Mr. Grant Marburger representing the Oklahoma State Department of Health, were observers during the June-July, 1986 program.

After a review of the results of the September 9, 1986 Environmental Test Report by the TCCHD on September 26, 1986, it was agreed by OPI to re-test the common stack for NO_x emissions on October 8, 1986. This subsequent testing was supervised by Mr. Jeffrey L. Hahn of OPI and performed by Messrs. Tim Brennen and Mark Campbell of Petro Chem Environmental Services of Bakersfield, California. Mr. Roger Randolph, Mr. Ray Bishop and Mr. James Van Sandt representing TCCHD were observers during the October 8, 1986 test.

II. SUMMARY OF RESULTS

A. SCHEDULE OF TESTING

Date	Method	Run	Time
Boiler #1			
6-23-86	U.S. EPA Method 5	1	1000 - 1145
6-23-86	U.S. EPA Method 5	2	1354 - 1544
6-23-86	U.S. EPA Method 5	3	1745 - 1925
6-23-86	U.S. EPA Methods 8/13A	1 (2)	1439 - 1611
6-27-86	U.S. EPA Methods 8/13A	2 (5)	0945 - 1113
6-27-86	U.S. EPA Methods 8/13A	3 (6)	1242 - 1406
6-27-86	U.S. EPA Methods 7E, 10 and CARB Method 100	1,2,3,4,5	0920 - 1445
Boiler #2			
6-24-86	U.S. EPA Method 5	1 (2)	1339 - 1507
6-24-86	U.S. EPA Method 5	2 (3)	1642 - 1809
6-24-86	U.S. EPA Method 5	3 (4)	1925 - 2043
6-24-86	U.S. EPA Methods 8/13A	1 (2)	1341 - 1510
7-1-86	U.S. EPA Methods 8/13A	2 (6)	1845 - 2005
7-2-86	U.S. EPA Methods 8/13A	3 (7)	0858 - 1022
6-24-86	U.S. EPA Methods 7E, 10 and CARB Method 100	1,2,3,4,5	1200 - 1755
Common Stack			
6-25-86	U.S. EPA Modified Method 5	1	1250 - 1510
6-25-86	U.S. EPA Modified Method 5	Blank	1250 - 1510
6-26-86	U.S. EPA Modified Method 5	2	1050 - 1632
6-26-86	U.S. EPA Modified Method 5	3	1125 - 1555
6-30-86	U.S. EPA Method 101A	1	1040 - 1327
6-30-86	U.S. EPA Method 101A	2	1032 - 1334
6-30-86	U.S. EPA Method 101A	3	1550 - 1740
7-1-86	U.S. EPA Methods 12/104	1	0920 - 1440
7-1-86	U.S. EPA Methods 12/104	2	1020 - 1530
7-1-86	U.S. EPA Methods 12/104	3	1020 - 1305
6-23-86	U.S. EPA Method 9	1	1010 - 1110
6-24-86	U.S. EPA Method 9	2	1425 - 1525
7-1-86	U.S. EPA Method 9	3	1005 - 1035
7-2-86	U.S. EPA Method 9	4	0955 - 1055
10-8-86	U.S. EPA Method 7E	1,2,3	1350 - 1740

( ) indicates corresponding stack test run in appendix

II. B. Summary of Source Test Results

	Unit #1		Unit #2		Common Stack			
Pollutant	Average (lb/hr)	Maximum (lb/hr)	Average (lb/hr)	Maximum (lb/hr)	Average (lb/hr)	Maximum (lb/hr)	Estimated Actual Annual Emissions (TPY)	Maximum Annual Emissions (TPY)
TSP	7.06	7.43	5.40	6.89	12.5	14.3	50	63
SO_2	31.1	35.1	33.2	35.1	64.3	70.2	260	310
NO_x (high fuel N)	89.2	93.3	96.1	98.4	185.3	191.7	---	---
NO_x (medium to low fuel N)	---	---	---	---	142.6	148.7	---	---
NO_x	---	---	---	---	---	---	657	840
VOC	<0.1	<0.1	<0.1	<0.1	<0.2	<0.2	0.80	0.88
CO	3.1	3.7	3.7	4.0	6.8	7.7	27	34
Pb	--	--	--	--	0.11	0.13	0.44	0.57
Hg	--	--	--	--	0.11	0.12	0.44	0.53
Be	--	--	--	--	$<7.9\times10^{-7}$	$<8.0\times10^{-7}$	3.2×10^{-6}	3.5×10^{-6}
Total F	0.70	0.86	0.68	1.09	1.38	1.95	5.5	8.5
H_2SO_4	5.23	8.01	5.40	6.82	10.6	14.8	42	65
HCl	80.4	88.1	80.0	87.9	160	176	640	770
Opacity		Visible Emissions			0%			

C. Permit to Construct Emission Rates

POLLUTANT	Unit #1	Unit #2	Emission Rates Both Units		
	lb/hr	lb/hr	lb/hr	gr/dscf at 12% CO_2	TPY
TSP	17.1	17.1	34.2	0.06	150.0
SO_2	50.45	50.45	100.9		441.9
NO_x	51.55	51.55	103.1		451.6
VOC	2.3	2.3	4.6		20.1
CO	20.8	20.8	41.6		182.2
Pb	0.1	0.1	0.2		0.9
Hg	0.0313	0.0313	0.0625		0.3
Be	2.565×10^{-6}	2.565×10^{-6}	5.13×10^{-6}		2.25×10^{-5}
HF	1.65	1.65	3.3		14.5
H_2SO_4	0.625	0.625	1.25		5.5

Opacity | <u>Visible Emissions</u> | 10%

D. Average of PCDD and PCDF concentrations in the combustion flue gas.

COMPOUND	RUN 1	RUN 2	RUN 3	Average ng/Nm3 @ 12% CO2
2378 TCDD	0.094	0.099	0.111	0.101
TCDD	1.782	1.425	1.631	1.613
12378 PCDD	0.211	0.170	0.188	0.189
PCDD	3.009	2.694	3.261	2.988
123478 HxCDD	0.152	0.143	0.149	0.148
123678 HxCDD	0.371	0.370	0.387	0.376
123789 HxCDD	0.000	0.000	0.000	0.000
HxCDD	5.193	5.018	5.073	5.095
1234678 HpCDD	1.944	2.125	2.525	2.198
HpCDD	4.122	4.278	4.881	4.427
OCDD	4.103	4.569	5.756	4.810
TOTAL PCDD	18.210	17.983	20.602	18.932
2378 TCDF	3.341	2.675	2.699	2.905
TCDF	8.033	6.668	7.222	7.308
12378 PCDF	0.449	0.430	0.480	0.453
23478 PCDF	1.028	0.806	0.953	0.929
PCDF	3.354	3.068	3.584	3.335
123478 HxCDF	0.526	0.490	0.620	0.545
123678 HxCDF	0.195	0.196	0.262	0.218
234678 HxCDF	0.598	0.567	0.588	0.584
123789 HxCDF	0.104	0.112	0.054	0.090
HxCDF	1.754	1.733	1.975	1.821
1234678 HpCDF	1.383	1.315	1.690	1.463
1234789 HpCDF	0.160	0.161	0.183	0.168
HpCDF	2.210	2.154	2.686	2.350
OCDF	0.703	0.620	0.796	0.706
TOTAL PCDF	16.053	14.243	16.264	15.520
TOTAL PCDD & PCDF	34.263	32.226	36.866	34.452

2, 3, 7, 8 - TCDD toxic equivalent of PCDD and PCDF emissions from the Tulsa facility using 1985 U.S. EPA equivalence factors

COMPOUND	Multiplying factor	Tulsa Average	Toxic Equivalent
2378 TCDD	1.00000	0.101	0.101
Other TCDD	0.01000	1.512	0.015
12378 PCDD	0.50000	0.189	0.095
Other PCDD	0.00500	2.799	0.014
123478 HxCDD	0.04000	0.148	0.006
123678 HxCDD	0.04000	0.376	0.015
123789 HxCDD	0.04000	0.000	0.000
Other HxCDD	0.00040	4.571	0.002
1234678 HpCDD	0.00100	2.198	0.002
Other HpCDD	0.00001	2.229	.000
OCDD	0.00000	4.810	0.000
TOTAL PCDD			0.250
2378 TCDF	0.10000	2.905	0.291
Other TCDF	0.00100	4.403	0.004
12378 PCDF	0.10000	0.453	0.045
23478 PCDF	0.10000	0.929	0.093
Other PCDF	0.00100	1.953	0.002
123478 HxCDF	0.01000	0.545	0.005
123678 HxCDF	0.01000	0.218	0.002
234678 HxCDF	0.01000	0.584	0.006
123789 HxCDF	0.01000	0.090	0.001
Other HxCDF	0.00010	0.384	.000
1234678 HpCDF	0.00100	1.463	0.001
1234789 HpCDF	0.00100	0.168	.000
Other HpCDF	0.00100	0.719	0.001
OCDF	0.00000	0.706	0.000
TOTAL PCDF			0.452
Total Toxic Equivalent (2,3,7,8-TCDD Equivalents)			0.701

2, 3, 7, 8 - TCDD toxic equivalent of PCDD and PCDF emissions from the Tulsa facility using 1985 California DOHS equivalence factors (scenario 4)

COMPOUND	Multiplying factor	ng/NM3 @ Average	Toxic Equivalent
2378 TCDD	1.00	0.101	0.101
Other TCDD	0.00	1.512	0.000
12378 PCDD	1.00	0.189	0.189
Other PCDD	0.00	2.799	0.000
123478 HxCDD	0.03	0.148	0.004
123678 HxCDD	0.03	0.376	0.011
123789 HxCDD	0.03	0.000	0.000
Other HxCDD	0.00	4.571	0.000
1234678 HpCDD	0.03	2.198	0.066
Other HpCDD	0.00	2.229	0.000
OCDD	0.00	4.810	0.000
TOTAL PCDD			0.372
2378 TCDF	1.00	2.905	2.905
Other TCDF	0.00	4.403	0.000
12378 PCDF	1.00	0.453	0.453
23478 PCDF	1.00	0.929	0.929
Other PCDF	0.00	1.953	0.000
123478 HxCDF	0.03	0.545	0.016
123678 HxCDF	0.03	0.218	0.007
234678 HxCDF	0.03	0.584	0.018
123789 HxCDF	0.03	0.090	0.003
Other HxCDF	0.00	0.384	0.000
1234678 HpCDF	0.03	1.463	0.044
1234789 HpCDF	0.03	0.168	0.005
Other HpCDF	0.00	0.719	0.000
OCDF	0.00	0.706	0.000
TOTAL PCDF			4.379
Total Toxic Equivalent (2,3,7,8-TCDD Equivalents)			4.751

2, 3, 7, 8 - toxic equivalent of PCDD and PCDF emissions from the Tulsa facility using EADON equivalence factors

COMPOUND	Multiplying factor	Tulsa Average	Toxic Equivalent	Suggested Swedis Environmental Protection Board Guidelines for 2, 3, 7, 8 - TCD Toxic Equivalenc
2378 TCDD	1.00	0.101	0.101	
Other TCDD	0.00	1.512	0.000	
12378 PCDD	1.00	0.189	0.189	
Other PCDD	0.00	2.799	0.000	
123478 HxCDD	0.03	0.148	0.004	
123678 HxCDD	0.03	0.376	0.011	
123789 HxCDD	0.03	0.000	0.000	
Other HxCDD	0.00	4.571	0.000	
1234678 HpCDD	0.00	2.198	0.000	
Other HpCDD	0.00	2.229	0.000	
OCDD	0.00	4.810	0.000	
TOTAL PCDD			0.306	
2378 TCDF	0.33	2.905	0.959	
Other TCDF	0.00	4.403	0.000	
12378 PCDF	0.33	0.453	0.149	
23478 PCDF	0.33	0.929	0.307	
Other PCDF	0.00	1.953	0.000	
123478 HxCDF	0.01	0.545	0.005	
123678 HxCDF	0.01	0.218	0.002	
234678 HxCDF	0.01	0.584	0.006	
123789 HxCDF	0.01	0.090	0.001	
Other HxCDF	0.00	0.384	0.000	
1234678 HpCDF	0.00	1.463	0.000	
1234789 HpCDF	0.00	0.168	0.000	
Other HpCDF	0.00	0.719	0.000	
OCDF	0.00	0.706	0.000	
TOTAL PCDF			1.429	
Total Toxic Equivalent (2,3,7,8-TCDD Equivalents)			1.735	0.6 - 2.4

III. SOURCE TEST DATA SUMMARY

A. Stoker/Boiler 1 Emission Data

PARTICULATE RESULTS
Front and Back Half
Boiler 1, Run 1

SAMPLE	net mg	gr/dscf	gr/scf	gr/dscf @ 12% CO2	lbs/hr
Probe & Nozzle:	20.9	0.0061	0.0049	0.0071	1.89
Filter:	14.8	0.0043	0.0035	0.0051	1.34
Condensibles:	46.5	0.0135	0.0109	0.0159	4.20
Total:	82.2	0.0239	0.0193	0.0281	7.43

ADDITIONAL DATA:

TIME start	finish	%O2	%CO2	%H2O	Vm(std)	DSCFM
1000	1145	9.3	10.2	19.1	53.05	36245

PARTICULATE RESULTS
Front and Back Half
Boiler 1, Run 2

SAMPLE	net mg	gr/dscf	gr/scf	gr/dscf @ 12% CO2	lbs/hr
Probe & Nozzle:	21.5	0.0054	0.0044	0.0061	1.88
Filter:	11.0	0.0028	0.0022	0.0031	0.96
Condensibles:	41.4	0.0104	0.0084	0.0118	3.63
Total:	73.9	0.0186	0.0150	0.0211	6.47

ADDITIONAL DATA:

TIME start	finish	%O2	%CO2	%H2O	Vm(std)	DSCFM
1354	1544	8.5	10.6	19.3	61.16	40545

PARTICULATE RESULTS
Front and Back Half
Boiler 1, Run 3

SAMPLE	net mg	gr/dscf	gr/scf	gr/dscf @ 12% CO2	lbs/hr
Probe & Nozzle:	9.9	0.0026	0.0023	0.0031	0.94
Filter:	12.1	0.0032	0.0028	0.0038	1.15
Condensibles:	54.5	0.0143	0.0125	0.0172	5.19
Total:	76.5	0.0201	0.0175	0.0241	7.28

ADDITIONAL DATA:

TIME start	finish	%O2	%CO2	%H2O	Vm(std)	DSCFM
1745	1925	9.5	10.0	13.1	58.54	42168

PARTICULATE RESULTS
EPA Front Half
Boiler 1, Run 1

SAMPLE	net mg	gr/dscf	gr/scf	gr/dscf @ 12% CO2	lbs/hr
Probe & Nozzle:	20.9	0.0061	0.0049	0.0071	1.89
Filter:	14.8	0.0043	0.0035	0.0051	1.34
Total:	35.7	0.0104	0.0084	0.0122	3.23

ADDITIONAL DATA:

TIME start	finish	%O2	%CO2	%H2O	Vm(std)	DSCFM
1000	1145	9.3	10.2	19.1	53.05	36245

PARTICULATE RESULTS
EPA Front Half
Boiler 1, Run 2

SAMPLE	net mg	gr/dscf	gr/scf	gr/dscf @ 12% CO2	lbs/hr
Probe & Nozzle:	21.5	0.0054	0.0044	0.0061	1.88
Filter:	11.0	0.0028	0.0022	0.0031	0.96
Total:	32.5	0.0082	0.0066	0.0093	2.84

ADDITIONAL DATA:

TIME start	finish	%O2	%CO2	%H2O	Vm(std)	DSCFM
1354	1544	8.5	10.6	19.3	61.16	40545

PARTICULATE RESULTS
EPA Front Half
Boiler 1, Run 3

SAMPLE	net mg	gr/dscf	gr/scf	gr/dscf @ 12% CO2	lbs/hr
Probe & Nozzle:	9.9	0.0026	0.0023	0.0031	0.94
Filter:	12.1	0.0032	0.0028	0.0038	1.15
Total:	22.0	0.0058	0.0050	0.0069	2.09

ADDITIONAL DATA:

TIME start	finish	%O2	%CO2	%H2O	Vm(std)	DSCFM
1745	1925	9.5	10.0	13.1	58.54	42168

Back-half Condensible Analysis - Boiler #1

	mg, titrametric			mg, gravimetric	weight %	
RUN	H_2SO_4	HCl	Total	Total	H_2SO_4	HCl
1	64.6	1.5	66.1	46.5	138	3
2	48.1	1.5	49.6	41.4	116	4
3	44.6	1.2	45.8	54.5	97	2
Average	52.4	1.4	53.8	47.5	117	3

SO2 AND SULFATE RESULTS

Boiler 1, Run 1

SULFATE RESULTS:	Dilution	Vt	gr/dscf	gr/dscf @ 12% CO2	ppm (H2SO4)	lbs/hr
Probe & Nozzle:	50	0.90	0.0064	0.0074	3.5	2.15
Demister Filter:	5	3.45	0.0024	0.0028	1.4	0.83
IPA Impinger	50	2.10	0.0149	0.0172	8.2	5.03
		Total:	0.0237	0.0274	13.1	8.01

SULFUR DIOXIDE RESULTS:

N BaCL	Vs/Va	dilution	Vt	ppm,dry	ppm,dry @ 12% CO2	ppm,dry @ 7% O2	lbs/hr
0.0097	50	1	19.9	78.2	90.2	91.3	30.62

ADDITIONAL DATA:

TIME start	finish	%O2	%CO2	%H2O	Vm(std)	SDCFM
1439	1611	9.0	10.4	18.4	51.61	39314

SO_2 AND SULFATE RESULTS

Boiler 1, Run 2

SULFATE RESULTS:	Vol aliq	Vol samp Vt	gr/dscf	gr/dscf @ 12% CO_2	ppm (H_2SO_4)	lbs/hr
Probe & Nozzle:	20	0.95	0.0023	0.0029	1.3	0.83
Demister Filter:	5	1.25	0.0008	0.0010	0.4	0.27
IPA Impinger	50	1.60	0.0098	0.0123	5.4	3.48
		Total:	0.0129	0.0162	7.1	4.58

SULFUR DIOXIDE RESULTS:

N BaCL	Vs/Va	dilution	Vt	ppm,dry	ppm,dry @ 12% CO_2	ppm,dry @ 7% O_2	lbs/hr
0.0097	50	1	25.10	84.8	107.1	110.2	35.07

ADDITIONAL DATA:

TIME start	finish	%O_2	%CO_2	%H_2O	Vm(std)	SDCFM
945	1113	10.2	9.5	17.1	60.00	41505

SO2 AND SULFATE RESULTS

Boiler 1, Run 3

SULFATE RESULTS:	Vol aliq	Vt	gr/dscf	gr/dscf @ 12% CO2	ppm (H2SO4)	lbs/hr
Probe & Nozzle:	40	0.60	0.0028	0.0036	1.6	0.96
Demister Filter:	5	1.10	0.0006	0.0008	0.4	0.22
IPA Impinger	50	0.95	0.0056	0.0070	3.1	1.91
		Total:	0.0090	0.0114	5.0	3.09

SULFUR DIOXIDE RESULTS:

N BaCL	Vs/Va	dilution	Vt	ppm,dry	ppm,dry @ 12% CO2	ppm,dry @ 7% O2	lbs/hr
0.0097	50	1	21.30	69.3	87.5	90.0	27.50

ADDITIONAL DATA:

TIME start	finish	%O2	%CO2	%H2O	Vm(std)	SDCFM
1242	1406	10.2	9.5	15.9	62.35	39853

Fluoride Results

Boiler 1, Run 1

Sample	Vol. Sample	mg/L	ppm,dry	ppm,dry @ 12% CO_2	ppm,dry @ 7% O_2	lbs/hr
Front Half Rinse	250	0.62	0.13	0.15	0.15	0.02
Impinger	250	28	6.06	6.99	7.08	0.70
Total			6.19	7.14	7.23	0.72

Additional Data:

Time						
Start	Finish	$\%O_2$	$\%CO_2$	% H_2O	Vm(std)	DSCFM
1439	1618	9.0	10.4	18.4	51.61	39314

Fluoride Results

Boiler 1, Run 2

Sample	Vol. Sample	mg/L	ppm,dry	ppm,dry @ 12% CO_2	ppm,dry @ 7% O_2	lbs/hr
Front Half Rinse	100	0.77	0.06	0.08	0.08	0.01
Impinger	250	37	6.89	8.70	8.95	0.85
Total			6.95	8.78	9.03	0.86

Additional Data:

Time						
Start	Finish	%O_2	%CO_2	% H_2O	Vm(std)	DSCFM
0945	1113	10.2	9.5	17.1	60.00	41505

Fluoride Results

Boiler 1, Run 3

Sample	Vol. Sample	mg/L	ppm,dry	ppm,dry @ 12% CO_2	ppm,dry @ 7% O_2	lbs/hr
Front Half Rinse	200	0.19	0.03	0.04	0.04	0.00
Impinger	250	25	4.48	5.66	5.81	0.53
Total			4.51	5.70	5.85	0.53

Additional Data:

Time						
Start	Finish	%O_2	%CO_2	% H_2O	Vm(std)	DSCFM
1242	1406	10.2	9.5	15.9	62.35	39853

HCL Results

Boiler 1 Run 1

Sample	Vol. Aliq.	Vol. Sample	VT	ppm,dry	ppm,dry @ 12% CO_2	ppm,dry @ 7% O_2	lbs/hr
Front Half Rinse	5	250	1.35	14.91	17.2	17.4	3.33
IPA Impinger	5	250	26.50	292.64	337.6	341.8	65.30
Demister	10	25	0.50	0.27	0.32	0.32	6.16
H_2O_2 Impinger	5	250	0.90	9.93	11.47	11.61	2.22
		Total		317.75	366.59	371.13	77.01

Additional Data:

Time Start	Finish	%O_2	%CO_2	%H_2O	Vm(std)	DSCFM
1439	1618	9.0	10.4	18.4	51.61	39314

HCL Results

Boiler 1 Run 2

Sample	Vol. Aliq.	Vol. Sample	VT	ppm,dry	ppm,dry @ 12% CO_2	ppm,dry @ 7% O_2	lbs/hr
Front Half Rinse	5	100	0.40	1.52	1.92	1.97	0.36
IPA Impinger	5	250	37.70	358.11	452.35	465.21	84.36
Demister	10	25	0.45	0.22	0.25	0.26	0.01
H_2O_2 Impinger	5	250	1.50	14.24	18.00	18.51	3.36
		Total		374.09	472.52	485.95	88.09

Additional Data:

Time						
Start	Finish	%O_2	%CO_2	%H_2O	Vm(std)	DSCFM
0945	1113	10.2	9.5	17.1	60.00	41505

HCL Results

Boiler 1 Run 3

Sample	Vol. Aliq.	Vol. Sample	VT	ppm,dry	ppm,dry @ 12% CO_2	ppm,dry @ 7% O_2	lbs/hr
Front Half Rinse	5	200	0.20	1.46	1.85	1.90	0.33
IPA Impinger	5	250	32.70	298.91	377.57	388.30	67.61
Demister	10	25	1.60	0.73	0.92	0.95	0.17
H_2O_2 Impinger	5	250	3.85	35.19	44.45	45.72	7.96
				336.29	424.79	436.87	76.07

Additional Data:

Time						
Start	Finish	%O_2	%CO_2	%H_2O	Vm(std)	DSCFM
1242	1406	10.2	9.5	15.9	62.35	39853

B. Stoker/Boiler 2 Emission Data

PARTICULATE RESULTS
Front and Back Half
Boiler 2, Run 1

SAMPLE	net mg	gr/dscf	gr/scf	gr/dscf @ 12% CO2	lbs/hr
Probe & Nozzle:	6.7	0.0018	0.0015	0.0025	0.63
Filter:	8.1	0.0022	0.0018	0.0030	0.76
Condensibles:	24.6	0.0066	0.0053	0.0090	2.30
Total:	39.4	0.0106	0.0085	0.0145	3.69

ADDITIONAL DATA:

TIME start	finish	%O2	%CO2	%H2O	Vm(std)	DSCFM
1339	1507	10.4	8.8	19.6	57.16	40413

PARTICULATE RESULTS
Front and Back Half
Boiler 2, Run 2

SAMPLE	net mg	gr/dscf	gr/scf	gr/dscf @ 12% CO2	lbs/hr
Probe & Nozzle:	7.8	0.0021	0.0018	0.0027	0.75
Filter:	8.3	0.0022	0.0019	0.0029	0.80
Condensibles:	42.0	0.0113	0.0095	0.0147	4.06
Total:	58.1	0.0156	0.0131	0.0203	5.61

ADDITIONAL DATA:

TIME start	finish	%O2	%CO2	%H2O	Vm(std)	DSCFM
1642	1809	10.0	9.2	15.8	57.42	42055

PARTICULATE RESULTS
Front and Back Half
Boiler 2, Run 3

SAMPLE	net mg	gr/dscf	gr/scf	gr/dscf @ 12% CO2	lbs/hr
Probe & Nozzle:	3.8	0.0010	0.0008	0.0013	0.36
Filter:	6.9	0.0018	0.0014	0.0023	0.65
Condensibles:	62.4	0.0161	0.0131	0.0211	5.88
Total:	73.1	0.0189	0.0153	0.0247	6.89

ADDITIONAL DATA:

TIME start	finish	%O2	%CO2	%H2O	Vm(std)	DSCFM
1925	2043	10.0	9.2	18.9	59.53	42427

PARTICULATE RESULTS
EPA Front Half
Boiler 2, Run 1

SAMPLE	net mg	gr/dscf	gr/scf	gr/dscf @ 12% CO2	lbs/hr
Probe & Nozzle:	6.7	0.0018	0.0015	0.0025	0.63
Filter:	8.1	0.0022	0.0018	0.0030	0.76
Total:	14.8	0.0040	0.0032	0.0054	1.39

ADDITIONAL DATA:

TIME start	finish	%O2	%CO2	%H2O	Vm(std)	DSCFM
1339	1507	10.4	8.8	19.6	57.16	40413

PARTICULATE RESULTS
EPA Front Half
Boiler 2, Run 2

SAMPLE	net mg	gr/dscf	gr/scf	gr/dscf @ 12% CO2	lbs/hr
Probe & Nozzle:	7.8	0.0021	0.0018	0.0027	0.75
Filter:	8.3	0.0022	0.0019	0.0029	0.80
Total:	16.1	0.0043	0.0036	0.0056	1.55

ADDITIONAL DATA:

TIME start	finish	%O2	%CO2	%H2O	Vm(std)	DSCFM
1642	1809	10.0	9.2	15.8	57.42	42055

PARTICULATE RESULTS
EPA Front Half
Boiler 2, Run 3

SAMPLE	net mg	gr/dscf	gr/scf	gr/dscf @ 12% CO2	lbs/hr
Probe & Nozzle:	3.8	0.0010	0.0008	0.0013	0.36
Filter:	6.9	0.0018	0.0014	0.0023	0.65
Total:	10.7	0.0028	0.0022	0.0036	1.01

ADDITIONAL DATA:

TIME start	finish	%O2	%CO2	%H2O	Vm(std)	DSCFM
1925	2043	10.0	9.2	18.9	59.53	42427

Back Half Condensible Analysis - Boiler #2

	mg, titrametric			mg, gravimetric	weight %	
RUN	H_2SO_4	HCL	Total	Total	H_2SO_4	HCL
1	46.3	1.8	48.1	24.6	188	7
2	32.7	1.8	34.5	42.0	78	4
3	53.5	1.5	55.0	62.4	86	2
Average	44.2	1.7	45.9	43.0	117	4

SO2 AND SULFATE RESULTS

Boiler 2, Run 1

SULFATE RESULTS:	Dilution	Vt	gr/dscf	gr/dscf @ 12% CO2	ppm (H2SO4)	lbs/hr
Probe & Nozzle:	20	0.70	0.0020	0.0027	1.1	0.71
Demister Filter:	5	1.00	0.0007	0.0009	0.4	0.25
IPA Impinger	50	1.20	0.0085	0.0114	4.7	3.02
		Total:	0.0113	0.0150	6.2	3.98

SULFUR DIOXIDE RESULTS:

N BaCL	Vs/Va	dilution	Vt	ppm,dry	ppm,dry @ 12% CO2	ppm,dry @ 7% O2	lbs/hr
0.0097	50	1	21.65	85.3	113.8	110.8	35.05

ADDITIONAL DATA:

TIME start	finish	%O2	%CO2	%H2O	Vm(std)	SDCFM
1341	1510	10.2	9.0	18.4	51.44	41229

SO2 AND SULFATE RESULTS

Boiler 2, Run 2

(Not included in separate SO_2 and H_2SO_4 averages, see Section VI.C - Total SO_x value is valid.)

SULFATE RESULTS:	Vol aliq	Vol samp Vt	gr/dscf	gr/dscf @ 12% CO2	ppm (H2SO4)	lbs/hr
Probe & Nozzle:	20	0.55	0.0012	0.0015	0.7	0.48
Demister Filter:	5	0.60	0.0003	0.0004	0.2	0.13
IPA Impinger	50	10.75	0.0597	0.0746	33.0	23.38
		Total:	0.0612	0.0766	33.9	23.99

SULFUR DIOXIDE RESULTS:

N BaCL	Vs/Va	dilution	Vt	ppm,dry	ppm,dry @ 12% CO2	ppm,dry @ 7% O2	lbs/hr
0.0097	50	1	12.50	38.4	48.0	49.9	17.48

ADDITIONAL DATA:

TIME start	finish	%O2	%CO2	%H2O	Vm(std)	SDCFM
1845	1008	10.2	9.6	13.6	65.97	45660

SO2 AND SULFATE RESULTS

Boiler 2, Run 3

SULFATE RESULTS:	Vol aliq	Vt	gr/dscf	gr/dscf @ 12% CO2	ppm (H2SO4)	lbs/hr
Probe & Nozzle:	20	0.70	0.0015	0.0019	0.8	0.64
Demister Filter:	5	1.00	0.0005	0.0007	0.3	0.23
IPA Impinger	50	2.60	0.0141	0.0177	7.8	5.95
		Total:	0.0162	0.0202	9.0	6.82

SULFUR DIOXIDE RESULTS:

N BaCL	Vs/Va	dilution	Vt	ppm,dry	ppm,dry @ 12% CO2	ppm,dry @ 7% O2	lbs/hr
0.0097	50	1	21.35	64.2	80.3	84.2	31.42

ADDITIONAL DATA:

TIME start	finish	%O2	%CO2	%H2O	Vm(std)	SDCFM
858	1022	10.3	9.6	14.4	67.38	49087

Fluoride Results

Boiler 2, Run 1

Sample	Vol. Sample	mg/L	ppm,dry	ppm,dry @ 12% CO_2	ppm,dry @ 7% O_2	lbs/hr
Front Half Rinse	100	0.22	0.02	0.03	0.03	0.00
Impinger	250	16	3.48	4.64	4.52	0.42
Total			3.50	4.67	4.55	0.42

Additional Data:

Time Start	Finish	%O_2	%CO_2	% H_2O	Vm(std)	DSCFM
1341	1510	10.2	9.0	18.4	51.44	41229

Fluoride Results

Boiler 2, Run 2

Sample	Vol. Sample	mg/L	ppm,dry	ppm,dry @ 12% CO_2	ppm,dry @ 7% O_2	lbs/hr
Front Half Rinse	100	0.77	0.05	0.06	0.06	0.01
Impinger	350	16.00	3.79	4.74	4.92	0.51
Total			3.84	4.80	4.98	0.52

Additional Data:

Time						
Start	Finish	%O_2	%CO_2	% H_2O	Vm(std)	DSCFM
0845	1008	10.2	9.6	13.6	65.97	45660

Fluoride Results

Boiler 2, Run 3

Sample	Vol. Sample	mg/L	ppm,dry	ppm,dry @ 12% CO_2	ppm,dry @ 7% O_2	lbs/hr
Front Half Rinse	100	2.7	0.18	0.23	0.24	0.03
Impinger	250	44	7.30	9.12	9.57	1.06
Total		46.7	7.48	9.35	9.81	1.09

Additional Data:

Time Start	Finish	%O_2	%CO_2	% H_2O	Vm(std)	DSCFM
0858	1022	10.3	9.6	14.4	67.38	49087

HCL Results

Boiler 2 Run 1

Sample	Vol. Aliq.	Vol. Sample	VT	ppm,dry	ppm,dry @ 12% CO_2	ppm,dry @ 7% O_2	lbs/hr
Front Half Rinse	5	100	0.95	4.21	5.61	5.47	0.99
IPA Impinger	5	250	30.40	336.82	449.09	437.55	78.82
Demister	10	25	1.55	0.86	1.14	1.12	0.20
H_2O_2 Impinger	5	250	1.25	13.85	18.46	17.99	3.24
	Total			355.74	474.30	462.13	83.25

Additional Data:

Time						
Start	Finish	$\%O_2$	$\%CO_2$	$\%H_2O$	Vm(std)	DSCFM
1341	1510	10.2	9.0	18.4	51.44	41229

HCL Results

Boiler 2 Run 2

Sample	Vol. Aliq.	Vol. Sample	VT	ppm,dry	ppm,dry @ 12% CO_2	ppm,dry @ 7% O_2	lbs/hr
Front Half Rinse	5	100	0.60	2.07	2.59	2.69	0.54
IPA Impinger	5	350	23.50	284.23	355.29	369.24	73.66
Demister	10	25	0.85	0.37	0.46	0.48	0.10
H_2O_2 Impinger	5	250	6.05	52.27	65.33	67.90	13.55
	Total			338.94	423.67	440.31	87.85

Additional Data:

Time						
Start	Finish	$\%O_2$	$\%CO_2$	$\%H_2O$	Vm(std)	DSCFM
0845	1008	10.2	9.6	13.6	65.97	45660

HCL Results

Boiler 2 Run 3

Sample	Vol. Aliq.	Vol. Sample	VT	ppm,dry	ppm,dry @ 12% CO_2	ppm,dry @ 7% O_2	lbs/hr
Front Half Rinse	5.0	100	2.00	6.77	8.46	8.87	1.89
IPA Impinger	5.0	250	27.05	228.80	286.00	300.03	63.75
Demister	10	25	1.55	0.66	0.82	0.86	0.18
H_2O_2 Impinger	5.0	250	1.25	10.57	13.22	13.86	2.95
		Total		246.80	308.50	323.62	68.77

Additional Data:

Time						
Start	Finish	%O_2	%CO_2	%H_2O	Vm(std)	DSCFM
0858	1022	10.3	9.6	14.4	67.38	49087

C. Common Stack Emission Data

Pb Results

Common Stack, Run 1

SAMPLE	net mg	mg/Nm3	mg/m3 wet	mg/Nm3@ 12% CO2	lbs/hr
Filter:	1.9000	0.3144	0.2622	0.3849	0.102
Rinse and Condensibles:	0.2150	0.0356	0.0297	0.0436	0.011
Total:	2.1150	0.3499	0.2918	0.4285	0.113

ADDITIONAL DATA:

TIME start	finish	%O2	%CO2	%H2O	Nm3	Nm3/sec
920	1450	10.1	9.8	16.6	6.04	40.71

Pb Results

Common Stack, Run 2

SAMPLE	net mg	mg/Nm3	mg/m3 wet	mg/Nm3@ 12% CO2	lbs/hr
Filter:	2.2000	0.3673	0.3037	0.4452	0.113
Rinse and Condensibles:	0.2450	0.0409	0.0338	0.0496	0.013
Total:	2.4450	0.4082	0.3376	0.4948	0.125

ADDITIONAL DATA:

TIME start	finish	%O2	%CO2	%H2O	Nm3	Nm3/sec
1020	1540	10.1	9.9	17.3	5.99	38.66

Pb Results

Common Stack, Run 3

SAMPLE	net mg	mg/Nm3	mg/m3 wet	mg/Nm3@ 12% CO2	lbs/hr
Filter:	1.3000	0.2200	0.1832	0.2666	0.068
Rinse and Condensibles:	0.2750	0.0465	0.0388	0.0564	0.014
Total:	1.5750	0.2665	0.2220	0.3230	0.082

ADDITIONAL DATA:

TIME start	finish	%O2	%CO2	%H2O	Nm3	Nm3/sec
1610	2055	10.3	9.9	16.7	5.91	38.9

Mercury Emissions - Tulsa Resource Recovery Facility

Test No.	Fuel Rate (Tons/hr)	Emissions Boiler 1 and 2 lbs/hr	Emissions Boiler 1 and 2 lbs/ton	Flue Gas Temp. F°
1	29.9	0.106	0.00355	342
2	29.9	0.118	0.00395	363
3	31.8	0.103	0.00324	359
Average	30.5	0.109	0.00358	355

Mercury Results

Common Stack, Run 1

MERCURY RESULTS:	net mg	mg/Nm3	mg/m3 wet	mg/Nm3@ 12% CO2	lbs/hr
Filter:	0.0100	0.0056	0.0047	0.0067	0.0017
Rinse and Condensibles:	0.6010	0.3350	0.2814	0.4020	0.1044
Total:	0.6110	0.3406	0.2861	0.4087	0.106

ADDITIONAL DATA:

TIME						
start	finish	%O2	%CO2	%H2O	Nm3	Nm3/sec
1032	1344	10.2	10.0	16.0	1.79	39.25

Mercury Results

Common Stack, Run 2

MERCURY RESULTS:	net mg	mg/Nm3	mg/m3 wet	mg/Nm3@ 12% CO2	lbs/hr
Filter:	0.0024	0.0014	0.0012	0.0017	0.0004
Rinse and Condensibles:	0.6469	0.3737	0.3109	0.4484	0.1172
Total:	0.6493	0.3751	0.3121	0.4501	0.118

ADDITIONAL DATA:

TIME start	finish	%O2	%CO2	%H2O	Nm3	Nm3/sec
1040	1337	10.2	10.0	16.8	1.73	39.53

Mercury Results

Common Stack, Run 3

MERCURY RESULTS:	net mg	mg/Nm3	mg/m3 wet	mg/Nm3@ 12% CO2	lbs/hr
Filter:	0.0024	0.0012	0.0010	0.0015	0.0004
Rinse and Condensibles:	0.6363	0.3228	0.2699	0.3953	0.1021
Total:	0.6387	0.3241	0.2709	0.3968	0.103

ADDITIONAL DATA:

TIME start	finish	%O2	%CO2	%H2O	Nm3	Nm3/sec
1550	1750	10.1	9.8	16.4	1.97	39.86

Beryllium Emissions - Tulsa Resource Recovery Facility

Test No.	Mg/Nm^3	Mg^3@	lbs/hr
1	$< 2.48 \times 10^{-6}$	$< 3.04 \times 10^{-6}$	$< 8.02 \times 10^{-7}$
2	$< 2.50 \times 10^{-6}$	$< 3.04 \times 10^{-6}$	$< 7.68 \times 10^{-7}$
3	$< 2.54 \times 10^{-6}$	$< 3.08 \times 10^{-6}$	$< 7.84 \times 10^{-7}$
Average	$< 2.51 \times 10^{-6}$	$< 3.05 \times 10^{-6}$	$< 7.85 \times 10^{-7}$

Beryllium Results

Common Stack, Run 1

SAMPLE	net mg	mg/Nm3	mg/m3 wet	mg/Nm3@ 12% CO2	lbs/hr
Filter:	< 1.00E-05	1.65E-06	1.38E-06	2.03E-06	5.35E-07
Rinse and Condensibles:	< 5.00E-06	8.27E-07	6.90E-07	1.01E-06	2.67E-07
Total:	< 1.50E-05	2.48E-06	2.07E-06	3.04E-06	8.02E-07

ADDITIONAL DATA:

TIME						
start	finish	%O2	%CO2	%H2O	Nm3	Nm3/sec
920	1450	10.1	9.8	16.6	6.04	40.71

Beryllium Results

Common Stack, Run 2

SAMPLE	net mg	mg/Nm3	mg/m3 wet	mg/Nm3@ 12% CO2	lbs/hr
Filter:	< 1.00E-05	1.67E-06	1.38E-06	2.02E-06	5.12E-07
Rinse and Condensibles:	< 5.00E-06	8.35E-07	6.90E-07	1.01E-06	2.56E-07
Total:	< 1.50E-05	2.50E-06	2.07E-06	3.04E-06	7.68E-07

ADDITIONAL DATA:

TIME start	finish	%O2	%CO2	%H2O	Nm3	Nm3/sec
1020	1540	10.1	9.9	17.3	5.99	38.66

Beryllium Results

Common Stack, Run 3

SAMPLE	net mg	mg/Nm3	mg/m3 wet	mg/Nm3@ 12% CO2	lbs/hr
Filter:	< 1.00E-05	1.69E-06	1.41E-06	2.05E-06	5.22E-07
Rinse and Condensibles:	< 5.00E-06	8.46E-07	7.05E-07	1.03E-06	2.61E-07
Total:	< 1.50E-05	2.54E-06	2.11E-06	3.08E-06	7.84E-07

ADDITIONAL DATA:

TIME start	finish	%O2	%CO2	%H2O	Nm3	Nm3/sec
1610	2055	10.3	9.9	16.7	5.91	38.9

OPACITY RESULTS

DATE	TIME		Common Stack Visible Emissions
	From	To	%
6-23-86	1010	1110	0
6-24-86	1425	1525	0
7-1-86	1003	1036	0
7-2-86	0956	1055	0
	Average		0

D. Source Test Method Calculations

The testing methods and analytical calculations used for determination of pollutant emissions are as per source test plan. The calculations for determining HCl and HF emission levels are as follows:

HCL Calculations

$$\text{ppmdv} = \frac{\text{Vt} * \text{N} * 35450 * \text{Liters of sample} * \text{Aliquot factor} * 24.054 \frac{\text{liters @ } 68^{\circ}\text{F}}{\text{mole}} * 10^{6}}{\text{MW} * 1000 \frac{\text{mg}}{\text{g}} * 28.32 \frac{\text{liters}}{\text{ft}^{3}} * \text{VMSTD @ } 68^{\circ}\text{F}}$$

where MW = 36,453

$$\text{ppm dv @ } 12\%\ CO_2 = \frac{\text{ppm dv} * 12}{\%\ CO_2}$$

$$\text{ppm dv @ } 7\%\ O_2 = \text{ppm dv} * \frac{13.9}{20.9 - \%\ O_2}$$

$$\frac{\text{lbs}}{\text{hr}}\ \text{HCL} = \text{ppm dv} * \text{MW} * \text{DSCFM} * 1.557 \times 10^{-7}$$

Total Fluoride Calculations

$$\text{ppm dv} = \frac{\text{mg/L} * \text{L} * 24.054 \frac{\text{liters @ } 68^{\circ}}{\text{mole}} * 10^{6}\text{ppm}}{\text{MW} * 1000 \frac{\text{mg}}{\text{g}} * 28.32 \frac{\text{liters}}{\text{ft}^{3}} * \text{Vm std @ } 68^{\circ}\text{F}}$$

where MW = 19.0
L = Liters of sample

$$\text{ppm, dry @ } 12\%\ CO_2 = \text{ppm dv} * \frac{12}{\%CO_2}$$

$$\text{ppm, dry @ } 7\%\ O_2 = \text{ppm dv} * \frac{20.9 - 7\%}{20.9 - \%\ O_2}$$

$$\frac{\text{lbs}}{\text{hr}} = \text{ppm dv} * \text{MW} * \text{DSCFM} * 1.557 \times 10^{-7}$$

IV. CONTINUOUS EMISSION MONITORING DATA SUMMARY

A. Stoker/Boiler 1 Results - NO_x, CO, VOC
June 27, 1986

IV.A Stoker/Boiler 1 Results - NO_x, CO, VOC

	DATE	TIME	RUN	ppmdv	@ 68°F	lbs/hr	
NO_x							O_2
	6-27-86	0920-1020	1	314	41505[1]	93.3	8.6
	6-27-86	1025-1125	2	297	41505[1]	88.3	9.7
	6-27-86	1135-1235	3	297	40680[3]	86.5	9.0
	6-27-86	1240-1340	4	299	39853[2]	85.3	9.1
	6-27-86	1345-1445	5	324	39853[2]	92.5	9.1
	Average			306		89.2	
CO							
	6-27-86	0920-1020	1	13	41505[1]	2.4	
	6-27-86	1025-1235	2	20	41505[1]	3.6	
	6-27-86	1135-1235	3	21	40680[3]	3.7	
	6-27-86	1240-1340	4	16	39853[2]	2.8	
	6-27-86	1345-1445	5	16	39853[2]	2.8	
	Average			17		3.1	
VOC (as THC)							
	6-27-86	0920-1020	1	<1	41505[1]	<0.1	
	6-27-86	1025-1125	2	<1	41505[1]	<0.1	
	6-27-86	1135-1235	3	<1	40680[1]	<0.1	
	6-27-86	1240-1340	4	<1	39853[3]	<0.1	
	6-27-86	1345-1445	5	<1	39853[2]	<0.1	
	Average			<1		<0.1	

1/ DSCFM @ 68°F is calculated from the EPA Method 8, test run #5.

2/ DSCFM @ 68°F is calculated from the EPA Method 8, test run #6.

3/ Average of EPA Method 8, test runs #5 and 6.

B. Stoker/Boiler 2 Results - NO_x, CO, VOC
June 24, 1986

IV.B Stoker/Boiler 2 Results - NO$_x$, CO, VOC

	DATE	Time	Run	ppmdv	DSCFM @68°F	lbs/hr	O$_2$%
No$_x$							
	6-24-86	1200-1300	1	325	40413[1/]	94.1	87
	6-24-86	1315-1415	2	340	40413[1/]	98.4	8.6
	6-24-86	1435-1535	3	337	40413[1/]	97.5	8.9
	6-24-86	1545-1645	4	327	41229[2/]	96.6	8.4
	6-24-86	1655-1755	5	312	42055[3/]	94.0	8.6
	Average			328		96.1	
CO							
	6-24-86	1200-1300	1	22	40413[1/]	3.9	
	6-24-86	1315-1415	2	21	40413[1/]	3.7	
	6-24-86	1435-1535	3	18	40413[1/]	3.2	
	6-24-86	1545-1645	4	21	41229[2/]	3.8	
	6-24-86	1655-1755	5	22	42055[3/]	4.0	
				21		3.7	
VOC (as THC)							
	6-24-86	1200-1300	1	<1	40413[1/]	<0.1	
	6-24-86	1315-1415	2	<1	40413[1/]	<0.1	
	6-24-86	1435-1535	3	<1	40413[1/]	<0.1	
	6-24-86	1545-1645	4	<1	41239[1/]	<0.1	
	6-24-86	1655-1755	5	<1	42055[3/]	<0.1	
	Average			<1		<0.1	

[1/] DSCFM @ 68°F is calculated from EPA Method 5, Run #2.

[2/] DSCFM @ 68°F is calculated from EPA Method 8, Run #2.

[3/] DSCFM @ 68°F is calculated from EPA Method 5, Run #3.

C. Calibration and Correction Data for CEM Analyzers

COMPANY: OGDEN PROJECTS
DATE: 6/27/86
UNIT: ESP BOILER #1
REPORT #: 50-146

INSTRUMENT DATA

RUN #1

TIME INTERVAL BEGIN - END	NOx	CO	THC
09:20 AM - 09:30 AM	308	16	0
09:30 AM - 09:40 AM	305	18	0
09:40 AM - 09:50 AM	308	13	0
09:50 AM - 10:00 AM	317	13	0
10:00 AM - 10:10 AM	322	10	0
10:10 AM - 10:20 AM	322	10	0
Averages;	314	13	0

	NOx	CO	THC
ZERO DRIFT	0	0	-2
CALIB. DRIFT	0	0	-1
CAL GAS value	47.7	48.5	39.6
FULL SCALE RANGE	500	100	100

COMPANY: OGDEN PROJECTS
DATE: 6/27/86
UNIT: ESP BOILER #1
REPORT #: 50-146

INSTRUMENT DATA

RUN #1

TIME INTERVAL

BEGIN - END	O2;%	CO2;%
09:20 AM - 09:30 AM	8.5	10.2
09:30 AM - 09:40 AM	9.1	10.3
09:40 AM - 09:50 AM	8.7	10.3
09:50 AM - 10:00 AM	8.6	10.5
10:00 AM - 10:10 AM	8	10.4
10:10 AM - 10:20 AM	8.7	10.5
Averages;	8.6	10.4

	O2;%	CO2;%
ZERO DRIFT	-0.2	0
CALIB. DRIFT	0	0
CAL GAS value	20.9	9.87
FULL SCALE RANGE	25	20

COMPANY: OGDEN PROJECTS
DATE: 6/27/86
UNIT: ESP BOILER #1
REPORT #: 50-146

INSTRUMENT DATA

RUN #2

TIME INTERVAL BEGIN - END	NOx	CO	THC
10:25 AM - 10:35 AM	298	19	0
10:35 AM - 10:45 AM	312	17	0
10:45 AM - 10:55 AM	317	23	0
10:55 AM - 11:05 AM	293	20	0
11:05 AM - 11:15 AM	279	28	0
11:15 AM - 11:25 AM	284	12	0
Averages;	297	20	0

	NOx	CO	THC
ZERO DRIFT	0	0	-2
CALIB. DRIFT	0	0	-1
CAL GAS value	47.7	48.5	39.6
FULL SCALE RANGE	500	100	100

COMPANY: OGDEN PROJECTS
DATE: 6/27/86
UNIT: ESP BOILER #1
REPORT #: 50-146

INSTRUMENT DATA

RUN #2

TIME INTERVAL BEGIN	-	END	O2;%	CO2;%
09:20 AM	-	09:30 AM	10.1	10
09:30 AM	-	09:40 AM	9.8	10.2
09:40 AM	-	09:50 AM	9.6	9.9
09:50 AM	-	10:00 AM	9.8	9.7
10:00 AM	-	10:10 AM	9.6	10
10:10 AM	-	10:20 AM	9.3	9.9
Averages;			9.7	10

	O2;%	CO2;%
ZERO DRIFT	0	0
CALIB. DRIFT	0	0
CAL GAS value	20.9	9.87
FULL SCALE RANGE	25	20

COMPANY: OGDEN PROJECTS
DATE: 6/27/86
UNIT: ESP BOILER #1
REPORT #: 50-146

INSTRUMENT DATA

RUN #3

TIME INTERVAL BEGIN - END	NOx	CO	THC
11:35 AM - 11:45 AM	279	26	0
11:45 AM - 11:55 AM	267	30	0
11:55 AM - 12:05 PM	317	21	0
12:05 PM - 12:15 PM	308	17	0
12:15 PM - 12:25 PM	320	16	0
12:25 PM - 12:35 PM	293	14	0
Averages;	297	21	0

	NOx	CO	THC
ZERO DRIFT	0	0	-2
CALIB. DRIFT	0	0	-1
CAL GAS value	47.7	48.5	39.6
FULL SCALE RANGE	500	100	100

COMPANY: OGDEN PROJECTS
DATE: 6/27/86
UNIT: ESP BOILER #1
REPORT #: 50-146

INSTRUMENT DATA

RUN #3

TIME INTERVAL BEGIN - END	O2;%	CO2;%
11:35 AM - 11:45 AM	7.6	9.9
11:45 AM - 11:55 AM	9.6	10.2
11:55 AM - 12:05 PM	9.4	10
12:05 PM - 12:15 PM	9.3	10.2
12:15 PM - 12:25 PM	8.8	10.3
12:25 PM - 12:35 PM	9.1	10.5
Averages;	9.0	10.2

	O2;%	CO2;%
ZERO DRIFT	0	0
CALIB. DRIFT	-0.1	0
CAL GAS value	20.9	9.87
FULL SCALE RANGE	25	20

COMPANY: OGDEN PROJECTS
DATE: 6/27/86
UNIT: ESP BOILER #1
REPORT #: 50-146

INSTRUMENT DATA

RUN #4

TIME INTERVAL BEGIN - END	NOx	CO	THC
12:40 PM - 12:50 PM	293	23	0
12:50 PM - 01:00 PM	289	22	0
01:00 PM - 01:10 PM	305	11	0
01:10 PM - 01:20 PM	289	13	0
01:20 PM - 01:30 PM	308	14	0
01:30 PM - 01:40 PM	312	13	0
Averages;	299	16	0

	NOx	CO	THC
ZERO DRIFT	0	0	-2
CALIB. DRIFT	0	0	-1
CAL GAS value	47.7	48.5	39.6
FULL SCALE RANGE	500	100	100

COMPANY: OGDEN PROJECTS
DATE: 6/27/86
UNIT: ESP BOILER #1
REPORT #: 50-146

INSTRUMENT DATA

RUN #4

TIME INTERVAL BEGIN - END	O2;%	CO2;%
12:40 PM - 12:50 PM	9.4	10.3
12:50 PM - 01:00 PM	9.3	10.3
01:00 PM - 01:10 PM	8.4	10.5
01:10 PM - 01:20 PM	9.2	10.6
01:20 PM - 01:30 PM	9.2	10.3
01:30 PM - 01:40 PM	9.2	10.2
Averages;	9.1	10.4

	O2;%	CO2;%
ZERO DRIFT	0	0
CALIB. DRIFT	0	0
CAL GAS value	20.9	9.87
FULL SCALE RANGE	25	20

COMPANY: OGDEN PROJECTS
DATE: 6/27/86
UNIT: ESP BOILER #1
REPORT #: 50-146

INSTRUMENT DATA

RUN #5

TIME INTERVAL BEGIN - END	NOx	CO	THC
01:45 PM - 01:55 PM	327	19	0
01:55 PM - 02:05 PM	341	12	0
02:05 PM - 02:15 PM	360	11	0
02:15 PM - 02:25 PM	312	13	0
02:25 PM - 02:35 PM	317	22	0
02:35 PM - 02:45 PM	289	21	0
Averages;	324	16	0

	NOx	CO	THC
ZERO DRIFT	0	0	-2
CALIB. DRIFT	0	0	0
CAL GAS value	47.7	48.5	39.6
FULL SCALE RANGE	500	100	100

COMPANY: OGDEN PROJECTS
DATE: 6/27/86
UNIT: ESP BOILER #1
REPORT #: 50-146

INSTRUMENT DATA

RUN #5

TIME INTERVAL BEGIN	-	END	O2;%	CO2;%
01:45 PM	-	01:55 PM	8.9	10.2
01:55 PM	-	02:05 PM	8.7	10.6
02:05 PM	-	02:15 PM	8.8	10.5
02:15 PM	-	02:25 PM	9.2	10.3
02:25 PM	-	02:35 PM	9.3	10.2
02:35 PM	-	02:45 PM	9.9	9.9
Averages;			9.1	10.3

	O2;%	CO2;%
ZERO DRIFT	0	0
CALIB. DRIFT	-0.1	0
CAL GAS value	20.9	9.87
FULL SCALE RANGE	25	20

COMPANY: OGDEN PROJECTS
DATE: 6/24/86
UNIT: ESP BOILER #2
REPORT #: 50-146

INSTRUMENT DATA

RUN #1

TIME INTERVAL BEGIN - END	NOx	CO	THC
12:00 PM - 12:10 PM	321	22	0
12:10 PM - 12:20 PM	332	26	0
12:20 PM - 12:30 PM	354	21	0
12:30 PM - 12:40 PM	308	19	0
12:40 PM - 12:50 PM	325	21	0
12:50 PM - 01:00 PM	310	24	0
Averages;	325	22	0

	NOx	CO	THC
ZERO DRIFT	0	0	-2
CALIB. DRIFT	-1.5	0	0
CAL GAS value	47.7	48.5	39.6
FULL SCALE RANGE	500	100	100

COMPANY: OGDEN PROJECTS
DATE: 6/24/86
UNIT: ESP BOILER #2
REPORT #: 50-146

INSTRUMENT DATA

RUN #1

TIME INTERVAL BEGIN - END	O2;%	CO2;%
12:00 PM - 12:10 PM	8.7	10.6
12:10 PM - 12:20 PM	8.6	10.5
12:20 PM - 12:30 PM	8.3	10.6
12:30 PM - 12:40 PM	8.7	10.6
12:40 PM - 12:50 PM	9	10.6
12:50 PM - 01:00 PM	9	10.3
Averages;	8.7	10.5

	O2;%	CO2;%
ZERO DRIFT	0	0
CALIB. DRIFT	0	0
CAL GAS value	20.9	9.87
FULL SCALE RANGE	25	20

COMPANY: OGDEN PROJECTS
DATE: 6/24/86
UNIT: ESP BOILER #2
REPORT #: 50-146

INSTRUMENT DATA

RUN #2

TIME INTERVAL BEGIN - END	NOx	CO	THC
01:15 PM - 01:25 PM	337	25	0
01:25 PM - 01:35 PM	331	20	0
01:35 PM - 01:45 PM	352	23	0
01:45 PM - 01:55 PM	339	21	0
01:55 PM - 02:05 PM	337	20	0
02:05 PM - 02:15 PM	345	19	0
Averages;	340	21	0

	NOx	CO	THC
ZERO DRIFT	0	0	0
CALIB. DRIFT	0	0	0
CAL GAS value	47.7	48.5	39.6
FULL SCALE RANGE	500	100	100

COMPANY: OGDEN PROJECTS
DATE: 6/24/86
UNIT: ESP BOILER #2
REPORT #: 50-146

INSTRUMENT DATA

RUN #2

TIME INTERVAL BEGIN	-	END	O2;%	CO2;%
01:15 PM	-	01:25 PM	8.6	10.5
01:25 PM	-	01:35 PM	8.5	10.6
01:35 PM	-	01:45 PM	8.7	10.7
01:45 PM	-	01:55 PM	8.7	10.3
01:55 PM	-	02:05 PM	8.7	10.3
02:05 PM	-	02:15 PM	8.6	10.5
Averages;			8.6	10.5

	O2;%	CO2;%
ZERO DRIFT	0	0
CALIB. DRIFT	0	0
CAL GAS value	20.9	9.87
FULL SCALE RANGE	25	20

COMPANY: OGDEN PROJECTS
DATE: 6/24/86
UNIT: ESP BOILER #2
REPORT #: 50-146

INSTRUMENT DATA

RUN #3

TIME INTERVAL BEGIN - END	NOx	CO	THC
02:35 PM - 02:45 PM	331	17	0
02:45 PM - 02:55 PM	350	16	0
02:55 PM - 03:05 PM	352	19	0
03:05 PM - 03:15 PM	326	20	0
03:15 PM - 03:25 PM	342	15	0
03:25 PM - 03:35 PM	323	19	0
Averages;	337	18	0

	NOx	CO	THC
ZERO DRIFT	0	0	0
CALIB. DRIFT	0	0	0
CAL GAS value	47.7	48.5	39.6
FULL SCALE RANGE	500	100	100

COMPANY: OGDEN PROJECTS
DATE: 6/24/86
UNIT: ESP BOILER #2
REPORT #: 50-146

INSTRUMENT DATA

RUN #3

TIME INTERVAL BEGIN - END	O2;%	CO2;%
02:35 PM - 02:45 PM	9.5	10.3
02:45 PM - 02:55 PM	8.6	10.6
02:55 PM - 03:05 PM	9	10.4
03:05 PM - 03:15 PM	9.1	10.5
03:15 PM - 03:25 PM	8.2	10.5
03:25 PM - 03:35 PM	8.8	10.3
Averages;	8.9	10.4

	O2;%	CO2;%
ZERO DRIFT	0	0
CALIB. DRIFT	0	0
CAL GAS value	20.9	9.87
FULL SCALE RANGE	25	20

COMPANY: OGDEN PROJECTS
DATE: 6/24/86
UNIT: ESP BOILER #2
REPORT #: 50-146

INSTRUMENT DATA

RUN #4

TIME INTERVAL BEGIN - END	NOx	CO	THC
03:45 PM - 03:55 PM	347	23	0
03:55 PM - 04:05 PM	326	21	0
04:05 PM - 04:15 PM	350	19	0
04:15 PM - 04:25 PM	318	18	0
04:25 PM - 04:35 PM	315	18	0
04:35 PM - 04:45 PM	307	24	0
Averages;	327	21	0

	NOx	CO	THC
ZERO DRIFT	0	0	0
CALIB. DRIFT	0	0	0
CAL GAS value	47.7	48.5	39.6
FULL SCALE RANGE	500	100	100

COMPANY: OGDEN PROJECTS
DATE: 6/24/86
UNIT: ESP BOILER #2
REPORT #: 50-146

INSTRUMENT DATA

RUN #4

TIME INTERVAL BEGIN - END	O2;%	CO2;%
03:45 PM - 03:55 PM	8.5	10.6
03:55 PM - 04:05 PM	8.5	10.3
04:05 PM - 04:15 PM	8.2	10.6
04:15 PM - 04:25 PM	8.2	10.6
04:25 PM - 04:35 PM	8.2	10.6
04:35 PM - 04:45 PM	8.8	10.3
Averages;	8.4	10.5

	O2;%	CO2;%
ZERO DRIFT	0	0
CALIB. DRIFT	0	0
CAL GAS value	20.9	9.87
FULL SCALE RANGE	25	20

COMPANY: OGDEN PROJECTS
DATE: 6/24/86
UNIT: ESP BOILER #2
REPORT #: 50-146

INSTRUMENT DATA

RUN #5

TIME INTERVAL BEGIN - END	NOx	CO	THC
04:55 PM - 05:05 PM	305	23	0
05:05 PM - 05:15 PM	321	22	0
05:15 PM - 05:25 PM	310	21	0
05:25 PM - 05:35 PM	302	24	0
05:35 PM - 05:45 PM	305	22	0
05:45 PM - 05:55 PM	331	20	0
Averages;	312	22	0

	NOx	CO	THC
ZERO DRIFT	0	0	0
CALIB. DRIFT	0	0	0
CAL GAS value	47.7	48.5	39.6
FULL SCALE RANGE	500	100	100

COMPANY: OGDEN PROJECTS
DATE: 6/24/86
UNIT: ESP BOILER #2
REPORT #: 50-146

INSTRUMENT DATA

RUN #5

TIME INTERVAL BEGIN	-	END	O2;%	CO2;%
04:55 PM	-	05:05 PM	8.3	10.6
05:05 PM	-	05:15 PM	9	10.5
05:15 PM	-	05:25 PM	9.1	10.3
05:25 PM	-	05:35 PM	8.7	10.3
05:35 PM	-	05:45 PM	8.5	10.5
05:45 PM	-	05:55 PM	8	10.6
Averages;			8.6	10.5

	O2;%	CO2;%
ZERO DRIFT	0	0
CALIB. DRIFT	0	0
CAL GAS value	20.9	9.87
FULL SCALE RANGE	25	20

D. Common Stack Results - NO_x
October 8, 1986

D. Common Stack Results - NO_x on October 8, 1986

	Date	Time	Run	ppmdv	@68°F	lbs/hr	7% O_2	12% CO_2
NO_x								
387	10-8-86	1350-1450	1	240	86358[1]	148.7	294	25
[illegible]	10-8-86	1500-1600	2	227	86358[1]	140.3	297	25
419	10-8-86	1610-1740	3	225	86358[1]	138.9	291	28
[illegible]	Average			231		142.6	294	28

	Date	Time	Run	%
O_2				
	10-8-86	1350-1450	1	9.76
	10-8-86	1500-1600	2	10.26
	10-8-86	1610-1740	3	10.18
	Average			10.1

---

[1] DSCFM @68°F is calculated from the average of two U.S. EPA Methods 2-4 performed during test runs 1 and 3.

COMPANY:OGDEN PROJECTS
DATE: 10-8-86
UNIT: MAIN STACK OUTLET

RUN #1

NOx, O2 DATA

	TIME INTERVAL BEGIN	END	READING, % FULL SCALE O2;fs	NOx;fs	CONCENTRATION; %O2	ppm NOX
1	1350	1400	48.80	60.00	9.73	249
2	1400	1410	47.50	61.30	9.40	254
3	1410	1420	48.50	60.00	9.64	247
4	1420	1430	47.50	55.00	9.38	221
5	1430	1440	51.80	57.80	10.44	234
6	1440	1450	50.00	58.50	9.98	237
	1350	1450 Averages	49.02	58.77	9.76	240

	O2	NOX
INITIAL ZERO %fs	9.8	10
INITIAL SPAN %fs	93.5	66.4
FINAL ZERO %fs	9.8	10
FINAL SPAN %fs	94	67.8
% ZERO DRIFT:	0.00	0.00
% SPAN DRIFT:	0.53	2.11
CAL GAS ppm or %	20.9	281.4
RANGE ppm or %	25	500

```
COMPANY:OGDEN PROJECTS
DATE:   10-8-86
UNIT:   MAIN STACK OUTLET



                          RUN  #2
                          -------
                        NOx, 02 DATA
                      ----------------


TIME INTERVAL    READING, % FULL SCALE    |CONCENTRATION|
BEGIN   END         02|fs   NOx|fs        |  %02  ppm NOX
------------------------------------------|--------------
1   1500     1510   51.00   56.00            10.30      231
2   1510     1520   50.30   62.80            10.14      264
3   1520     1530   50.50   61.00            10.20      255
4   1530     1540   49.50   49.70             9.97      198
5   1540     1550   51.00   47.30            10.35      186
6   1550     1600   52.00   55.50            10.62      227
----------------------------------------------------------
    1500     1600   50.72   55.38            10.26      227
        Averages

                    02      NOX
                  ------  ------
INITIAL ZERO %fs     9.8      10
INITIAL SPAN %fs    93.5    66.1
FINAL ZERO   %fs     9.7      10
FINAL SPAN   %fs      93    66.5
% ZERO DRIFT:      -0.10    0.00
% SPAN DRIFT:      -0.53    0.61
CAL GAS ppm or %    20.9   281.4
RANGE ppm or %        25     500
----------------------------------------------------------------
```

COMPANY:OGDEN PROJECTS
DATE: 10-8-86
UNIT: MAIN STACK OUTLET

RUN #3

NOx, 02 DATA

	TIME INTERVAL BEGIN	END	READING, % FULL SCALE 02;fs	NOx;fs	CONCENTRATION %02	ppm NOX
1	1610	1625	51.00	57.00	10.28	234
2	1625	1640	49.00	56.00	9.76	229
3	1640	1655	51.50	56.00	10.36	230
4	1655	1710	51.60	53.00	10.36	215
5	1710	1725	51.50	52.50	10.31	213
6	1725	1740	50.30	55.30	9.99	227
	1610	1740 Averages	50.82	54.97	10.18	225

	02	NOX
INITIAL ZERO %fs	9.7	10
INITIAL SPAN %fs	93.5	66.5
FINAL ZERO %fs	9.8	10
FINAL SPAN %fs	94.5	66
% ZERO DRIFT:	0.10	0.00
% SPAN DRIFT:	1.07	-0.75
CAL GAS ppm or %	20.9	281
RANGE ppm or %	25	500

E. Calculation of Average and Maximum NO_x Emissions

E. Calculation of Average and Maximum NO_x Emissions

Date	Location	Run	NO_x ppmdv @7%O_2	Observed Fuel Nitrogen (i.e.,Grass)
6-24-86	Boiler 2	1	370	high
		2	384	high
		3	390	high
		4	364	high
		5	353	high
		Average	372	
6-27-86	Boiler 1	1	355	high
		2	369	high
		3	347	high
		4	352	high
		5	382	high
		Average	361	
10-8-86	Common Stack	1	300	variable (medium)
		2	296	variable (medium)
		3	291	variable (medium to low)
		Average	296	

Location	NO_x lbs/hr
Boiler 1 - high fuel Nitrogen	
Average	89.2
Maximum	93.3
Boiler 2 - high fuel Nitrogen	
Average	96.1
Maximum	98.4
Common Stack by Addition - high fuel Nitrogen	
Average	185.3
Maximum	191.7
Common Stack by Testing - medium to low fuel Nitrogen	
Average	142.6
Maximum	148.7

Annual Emissions TPY

Estimated Actual Emissions $\frac{(185.3+142.6)}{(2)}\ (.915)\ \frac{(365)(24)}{(2000)} = 657$

Maximum Annual Emission $\frac{(191.7)(24)(365)}{2000} = 840$

V. STOKER/BOILER OPERATIONAL DATA

V.A. Stoker/Boiler Operational Data

DATE	TIME	Boiler 1		Boiler 2		Boiler 1 and 2	
		Steam Rate lbs/hr(*1000)	Capacity 2/ %	Steam Rate lbs/hr(*1000)	Capacity 2/ %	Steam Rate lbs/hr(*1000)	Capacity 3/ %
6-23-86	0800-2100	87	98	1/	---		
6-24-86	0700-2100	89	101	85	96		
6-25-86	1100-1900	90	102	89	101		
6-26-86	1100-1700	90	102	90	102		
6-27-86	0800-1800	85	96	1/	---		
6-30-86	0800-1800					181.2	102
7-1-86	0800-1600					183.6	104
7-2-86	0800-1600					193.1	109

1/ No Air emissions tests were performed

2/ 88,500 lbs/hr steam is equal to 100% heat input Capacity

3/ 177,000 lbs/hr steam is equal to 100% heat input Capacity

V.B. Stoker/Boiler Operational Data

		Boiler 1		Boiler 2		Boiler 1 & 2	
		Steam Rate lbs/hr(*1000)	Capacity(1) %	Steam Rate lbs/hr(*1000)	Capacity(1) %	Steam Rate lbs/hr(*1000)	Capacity(2) %
10-8-86	1100	89	101	--	--		
	1200	--	--	90	102		
	1300	88	99	--	--		
	1400	--	--	90	102		
	1500	90	102	--	--		
	1600	--	--	93	105		
	1700	89	101	--	--		
	1800	--	--	90	102		
Average	1100-1800	89	101	90.8	103	179.8	102

1/ 88,500 lbs/hr steam is equal to 100% heat input Capacity

2/ 177,000 lbs/hr steam is equal to 100% heat input Capacity

VI. METHODOLOGY

A. References

VI. A. REFERENCES

CONTINUOUS EMISSION MONITORING SYSTEM (CEMS)

Reference: BAAQMD, Manual of Procedures; ST-13A, ST-19A, January 1982 State of California, Air Resources Board, Test Methods 1-100, June 1979.

Reference: EPA Code of Federal Regulations, Title 40, Part 60, Appendix A, Method 10, 1984.

MODIFIED METHOD 5

Reference: SW-846, "Proposed Sampling and Analytical Methodologies for Addition to Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, U.S. EPA.

Reference: EPA Code of Federal Regulations, Title 40, Part 60, Appendix A, Method 5, 1984.

METHOD 12

Reference: EPA, Code of Federal Regulations, Title 40, Part 60, Appendix A, Method 12, 1984.

METHOD 101A

Reference: EPA, Code of Federal Regulations, Title 40, Part 61, Appendix B, Method 101A, 1984.

METHOD 104

Reference: EPA, Code of Federal Regulations, Title 40, Part 61, Appendix B, Method 104, 1984.

METHOD 5

Reference: EPA, Code of Federal Regulations, Title 40, Part 61, Appendix A, Method 5, 1984.

METHOD 13B

Reference: EPA, Code of Federal Regulations, Title 40, Part 61, Appendix A, Method 13B, 1984.

B. Equipment

VI. B. EQUIPMENT

Method	Equipment Manufacturer
U.S. EPA Method 5/13A	Andersen Samplers, Inc.
U.S. EPA Modified Method 5	Andersen Samplers, Inc.
U.S. EPA Method 8	Andersen Samplers, Inc.
U.S. EPA Method 6C	Western Research
U.S. EPA Method 7E	Thermo Electron, Inc.
California Air Resources Board Method 100	Horiba Instruments, Inc.
U.S. EPA Method 10	Thermo Electron, Inc.
U.S. EPA Method 12/104	Andersen Samplers, Inc.
U.S. EPA Method 101A	Andersen Samplers, Inc.
Paramagnetic Analyzer	Taylor Sybron
NDIR Analyzer	Infrared Industries, Inc.
U.S. EPA Method 9	--
U.S. EPA Methods 1, 2, 3, 4	Andersen Samplers, Inc.

C. Variations From Source Test Plan

VI.C. Variations From Source Test Plan

HF, HCl

The proposed source test plan collected HF and HCl in an U.S. EPA Method 5/13A. The glass filter used in the U.S. EPA Method 5 could react with HF in the sample gas. To eliminate this potential, HF and HCl were collected in a U.S. EPA Method 8/13A without the use of a glass filter. The results are reported as total fluoride and total chloride.

Be

The proposed source test plan collected Be using the U.S. EPA Method 104 with the analysis performed on the filter, probe rinse and impinger liquid. The variation to this method involved combining the probe rinse and impinger liquid, and evaporating the water to effectively concentrate the Be twenty-fold. The sample was then analyzed as per U.S. EPA Method 104. A pre-analysis test run to determine the percent recovery of this concentration procedure was performed by Brown and Caldwell Laboratories. Results of 90 and 100 percent recovery of Be in the spiked samples were obtained from this procedure.

H_2SO_4

The proposed source test plan involved triplicate determination of H_2SO_4 and SO_2 using the U.S. EPA Method 8. The triplicate runs were performed on both boiler outlets and, upon analysis, the second U.S. EPA Method 8 on Boiler 2 was found to have hydrogen peroxide contamination in the IPA impinger. The relative levels of H_2SO_4 in each impinger were also indicative of a bad test, therefore, the second U.S. EPA Method 8 run on Boiler #2 is not included in the H_2SO_4 and SO_2 averages. The analysis of this test is included in Section III B for comparison.

Opacity

Opacity readings at the common stack were performed by Mr. James Van Sandt of the TCCHD.

VII. QUALITY ASSURANCE/QUALITY CONTROL

VII. Quality Assurance/Quality Control

In accordance with EPA-600/4-77-027b, dated August 1977, all OPI field data sheets for all test runs have been included in the Appendix. Along with these field data sheets, all OPI analytical data sheets and calibration data sheets are also included in the Appendix. In addition, the technical reports, including the quality assurance, quality control sections, from the testing sub-contractors and analytical laboratories have been reproduced in the Appendix.

The facility process data for the test periods have been included only in the Appendices submitted for the use of the regulatory officials.

VIII. CONCLUSIONS

VIII. Conclusions

The results from the Walter B. Hall Resource Recovery Facility Compliance test program are summarized in Section II. For comparison, the permitted levels of emissions, as per condition 1 in the Authority to Construct, are also presented in Section II.

The boiler capacities were calculated in terms of percent of design steam flow rate and all testing occurred with Boiler Capacities at, or near, capacity load as shown in Section V.

Seasonal increases of plant material (i.e., grass) in the fuel have resulted in elevated MSW fuel nitrogen content. Higher fuel nitrogen levels raised NO_x levels in the combustion gas and, compared with recent testing of similar facilities of the Martin GmbH stoker combustion system design, the average NO_x levels were higher at the Tulsa facility. Thus, the NO_x emissions, expressed both in pounds per hour and tons per year, reflect the added fuel nitrogen as shown by both the June and October, 1986 testing. Only when the MSW in the feed chute had typical amounts of grass did the NO_x emission levels return to the previously measured levels associated with the Martin GmbH stoker combustion system.

Total Suspended Particulate (TSP) was derived by analyzing both the front- and back-half (condensible) sections of the U.S. EPA Method 5 train. After dessication, the back-half impinger liquid was reconstituted to determine the proportion of non-sulfate particulate, sulfates and chlorides. As shown in Section III, the residue consisted primarily of sulfates. A direct comparison of sulfate results with the condensible particulate results in Section II indicates that from 80% to 100% of the condensible particulate is sulfate. Thus, only very minor amounts of either sub-micron particles or condensible hydrocarbons could be passing through the U.S. EPA Method 5 filter and reporting out as condensible particulate, especially since the THC readings were normally less than or equal to 1 ppm.

The emissions of PCDDs and PCDFs are the lowest reporting for a major, mass-fired, waterwall stoker/boiler in the United States and would meet the new, 1986 Swedish guidelines for existing stationary sources of dioxin.

The emission of Hg, although slightly higher than the permit limit, is close to the Hg emission factor based on worldwide testing of many MSW-fired boilers.

As for HCl emissions, the average level for this testing is below the worldwide average from the same database. In addition, the $SO_3 + H_2SO_4$ emissions, while higher than the permit limit, are typical of the $SO_2/SO_3+H_2SO_4$ ratios measured at other MSW-fired boilers.

OGDEN PROJECTS, INC.

ENVIRONMENTAL ENGINEERING DEPARTMENT

ENVIRONMENTAL TEST REPORT

Executive Summary

PREPARED FOR Ogden Martin Systems of Marion, Inc.
4850 Brooklake Road, NE
Brooks, Oregon 97305

REGARDING Marion County Solid Waste-To-Energy Facility
Boilers 1 and 2

REGULATORY AGENCIES Oregon Department of Environmental Quality (DEQ)
Air Contaminant Discharge Permit No. 24-5398

PURPOSE Compliance with Permit Conditions

TEST DATES September 22, 1986 - October 8, 1986

ASSOCIATED REPORTS 105, 107

REPORT NUMBER 108

PREPARED BY Ronald A. Zurlinden
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December 5, 1986

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VII. Methodology

I. INTRODUCTION

On September 22, 1986 through October 8, 1986, Ogden Projects, Inc. performed a series of emission tests at the Marion County Resource Recovery Facility, a Waste-to-Energy Facility owned and operated by Ogden Martin Systems of Marion, Incorporated.

Two municipal solid waste (MSW)-fired boilers of Martin GmbH Stoker Combustion System Design, each with a 275 tons-per-day (TPD) capacity, were tested for various gaseous and solid air pollutant emissions from the fabric filter (baghouse) outlet of each boiler. This testing was for determination of compliance with Oregon Department of Environmental Quality (ODEQ) Air Contaminant Discharge Permit No. 24-5398.

The test program, as per the source test plan submitted to the Oregon DEQ on August 22, 1986, is outlined as follows:

Parameter	Method	Location
Oxides of Nitrogen	U.S. EPA Method 7E	Boilers 1 and 2
Sulfur dioxide	U.S. EPA Method 6C	Boilers 1 and 2
Carbon Monoxide	U.S. EPA Method 10	Boilers 1 and 2
VOC	California Air Resources Board Method 100	Boilers 1 and 2
Particulate	Oregon Department of Environmental Quality Method 5	Boilers 1 and 2
Lead	U.S. EPA Method 12	Boiler 1
Beryllium	U.S. EPA Method 104	Boilers 1 and 2
Dioxin	U.S. EPA Modified Method 5	Boiler 1
Fluoride	U.S. EPA Method 13B	Boiler 1
Mercury	U.S. EPA Method 101A	Boilers 1 and 2
Hydrogen Chloride	U.S. EPA Method 5	Boilers 1 and 2
Total Chlorides	U.S. EPA Method 13B	Boiler 1
Opacity	U.S. EPA Method 9	Boilers 1 and 2

Variations to the source test plan are outlined in Section VII.C.

The testing was supervised by Mr. Henry Von Dem Fange and performed by Messrs. Ronald Zurlinden, Matthew Turner and John Scholz, all of Ogden Projects, Inc. (OPI). The laboratory analyses of particulate, sulfur dioxide, fluorides, hydrogen chloride and total chlorides were performed by OPI at its Emeryville, CA laboratory. The analyses of lead, beryllium and mercury were conducted by Brown and Caldwell Analytical Laboratories of Emeryville, CA, a California certified hazardous waste laboratory. The isomer specific analyses of PCDDs and PCDFs were performed by Triangle Laboratories, Inc. of Research Triangle Park, North Carolina.

Ms. Wendy Sims and Messrs. Fritz Skirvin and Don Peters, representing the Oregon DEQ were observers during the compliance source test program.

II. SUMMARY OF RESULTS

II.A. COMPLIANCE TESTING SCHEDULE

DATE	LOCATION	METHOD	RUN	TIME
09-22-86	Boiler 1	U.S. EPA Modified Method 5	1	1315-1750
09-23-86	Boiler 1	U.S. EPA Modified Method 5	2	1402-1834
09-24-86	Boiler 1	U.S. EPA Modified Method 5	3	1016-1443
09-26-86	Boiler 1	U.S. EPA Method 12	1	0715-1352
09-29-86	Boiler 1	U.S. EPA Method 12	2	1040-1047, 1403-2006
09-30-86	Boiler 1	U.S. EPA Method 12	3	0930-1615
10-01-86	Boiler 1	U.S. EPA Method 5	1(2)	1145-1300
10-01-86	Boiler 1	U.S. EPA Method 5	2(3)	1345-1535
10-01-86	Boiler 1	U.S. EPA Method 5	3(4)	1615-1730
10-01-86	Boiler 1	Operating Temperature and Residence Time	1,2,3,4,5	0717-1633
10-02-86	Boiler 2	U.S. EPA Method 5	1	0835-0945
10-02-86	Boiler 2	U.S. EPA Method 5	2	1030-1140
10-02-86	Boiler 2	U.S. EPA Method 5	3	1210-1330
10-02-86	Boiler 2	U.S. EPA Methods 7E, 10, 6C	1,2,3	1048-1440
10-02-86	Boiler 2	Operating Temperature and Residence Time	1,2,3,4,5	0900-1707
10-03-86	Boiler 1	U.S. EPA Method 104	1	0855-1155
10-03-86	Boiler 2	U.S. EPA Method 104	2	0855-1155
10-03-86	Boiler 1	U.S. EPA Method 7E, 10, 6C	1,2,3	1015-1338
10-07-86	Boiler 1	U.S. EPA Method 104	3	1129-1511
10-07-86	Boiler 1	U.S. EPA Method 13B	1	0835-0950
10-07-86	Boiler 1	U.S. EPA Method 13B	2	1050-1200
10-07-86	Boiler 1	U.S. EPA Method 13B	3	1320-1425
10-07-86	Boilap 1	CARB Method 100	1,2,3	1200-1541
10-07-86	Boiler 1	EPA Method 9	1,2,3	1205-1352
10-07-86	Boiler 2	EPA Method 9	1,2,3	1205-1352
10-08-86	Boiler 1	EPA Method 101A	1	0840-1110
10-08-86	Boiler 2	EPA Method 101A	2	0833-1108
10-08-86	Boiler 2	EPA Method 101A	3	1218-1432
10-08-86	Boiler 2	CARB Method 100	1,2,3	0910-1315

(   ) indicates corresponding stack test run in appendix.

II.B. SUMMARY OF SOURCE TEST RESULTS

Pollutant	Boiler #1		Boiler #2		Main Stack			
	Average lbs/hr	Maximum lbs/hr	Average lbs/hr	Maximum lbs/hr	Average lbs/hr	@91.5%(1) TPY	Maximum lbs/hr	@100%(1) TPY
NO_x	60.1	69.0	48.4	53.2	108.5	435	122.2	535
SO_2	10.3	12.8	10.6	17.9	20.9	83.8	30.7	134
CO	1.9	2.0	2.2	2.6	4.1	16	4.6	20
TSP	3.7	4.7	0.8	1.2	4.5	18	5.9	25.8
Pb normal	0.003	---	---	---	0.006	0.02	---	---
Pb bypass(2)	---	0.02	---	---	---	---	0.04	0.2
Be	$2.4x10^{-7}$	$2.7x10^{-7}$	$<2.0x10^{-7}$	---	$<4.4x10^{-7}$	$<1.8x10^{-6}$	$5.4x10^{-7}$	$2.4x10^{-6}$
TCDD	$1.9x10^{-8}$	$2.3x10^{-8}$	---	---	$3.8x10^{-8}$	$1.5x10^{-7}$	$4.5x10^{-8}$	$2.0x10^{-7}$
VOC	0.2	0.2	0.1	0.2	0.3	1.2	0.4	1.8
Fluorides	0.046	0.071	---	---	0.092	0.37	0.14	0.61
Hg	0.026	---	0.034	---	0.060	0.24	0.068	0.30
HCl	0.61	0.73	2.7	2.9	3.3	13	3.6	16
gr/dscf @ 12% CO_2	0.016	0.021	0.004	0.006				
Opacity		Visible Emissions		0%				

(1) facility availability

(2) during 5 minutes of one test, the baghouse was bypassed; the data are included at the request of the Oregon DEQ.

II.C. AIR CONTAMINANT DISCHARGE PERMIT EMISSION LIMITS

Pollutant	Flue from Boiler 1	Flue from Boiler 2	Emission Limits Main Stack (Both Flues)		
	lbs/hr	lbs/hr	lbs/hr	gr/dscf at 12% CO_2	TPY
NO_x	47.0	47.0	94.0		290
SO_2	36.5	36.5	73.0		220
CO	27.5	27.5	55.0		170
TSP	10.0	10.0	20.0	0.030	61
Pb	0.26	0.26	0.52		1.6
Be	1.45×10^{-6}	1.45×10^{-6}	2.9×10^{-6}		8.8×10^{-6}
TCDD	8.5×10^{-7}	8.5×10^{-7}	1.7×10^{-6}		5.1×10^{-6}
VOC	1.65	1.65	3.1		9.6
Fluorides	0.8	0.8	1.6		4.8
Hg	0.085	0.085	0.17		0.51
HCl	<11.5	<11.5	<23		<69
Opacity	Visible Emissions	10%			

II.D. DIOXIN EMISSIONS

1. Average of PCDD and PCDF concentrations and TCDD emission rate in the flue gas from Boiler 1.

COMPOUND	RUN 1 (1)	RUN 2	RUN 3 (2)	Boiler 1 Average ng/Nm3 @ 12% CO2	Boiler 1 lbs/hr
2378 TCDD	NR	0.022	0.139	0.081	
TCDD	NR	0.231	0.159	0.195	1.92×10^{-8}
12378 PCDD	NR	0.011	0.007	0.009	
PCDD	NR	0.085	0.021	0.053	
123478 HxCDD	NR	0.004	0.009	0.007	
123678 HxCDD	NR	0.005	0.010	0.008	
123789 HxCDD	NR	0.005	0.011	0.008	
HxCDD	NR	0.092	0.128	0.110	
1234678 HpCDD	NR	0.108	0.167	0.138	
HpCDD	NR	0.200	0.167	0.184	
OCDD	NR	0.841	0.366	0.589	
TOTAL PCDD	NR	1.449	0.811	1.130	
2378 TCDF	NR	0.234	0.102	0.168	
TCDF	NR	0.483	0.161	0.322	
12378 PCDF	NR	0.010	0.010	0.010	
23478 PCDF	NR	0.026	0.004	0.015	
PCDF	NR	0.053	0.034	0.044	
123478 HxCDF	NR	0.002	0.005	0.004	
123678 HxCDF	NR	0.003	0.005	0.004	
234678 HxCDF	NR	0.003	0.006	0.005	
123789 HxCDF	NR	0.003	0.006	0.005	
HxCDF	NR	0.003	0.023	0.013	
1234678 HpCDF	NR	0.004	0.010	0.007	
1234789 HpCDF	NR	0.006	0.013	0.010	
HpCDF	NR	0.005	0.011	0.008	
OCDF	NR	0.050	0.022	0.036	
TOTAL PCDF	NR	0.594	0.251	0.423	
TOTAL PCDD & PCDF		2.043	1.062	1.553	

(1) NR - not reported
(2) Adjusted for low % H2O - See Section VII.C.

II.D. DIOXIN EMISSIONS

2. By NYS DOH (EADON ET AL) and Swedish Scenario using EADON (ng/Nm3 @ 12% CO2)

COMPOUND	Multiplying factor	Marion County Average	Toxic Equivalent
2378 TCDD	1.00	0.081	0.081
Other TCDD	0.00	0.114	0.000
12378 PCDD	1.00	0.009	0.009
Other PCDD	0.00	0.044	0.000
123478 HxCDD	0.03	0.007	0.000
123678 HxCDD	0.03	0.008	0.000
123789 HxCDD	0.03	0.008	0.000
Other HxCDD	0.00	0.087	0.000
1234678 HpCDD	0.00	0.138	0.000
Other HpCDD	0.00	0.046	0.000
OCDD	0.00	0.589	0.000
TOTAL PCDD			0.091
2378 TCDF	0.33	0.168	0.055
Other TCDF	0.00	0.154	0.000
12378 PCDF	0.33	0.010	0.003
23478 PCDF	0.33	0.015	0.005
Other PCDF	0.00	0.019	0.000
123478 HxCDF	0.01	0.004	0.000
123678 HxCDF	0.01	0.004	0.000
234678 HxCDF	0.01	0.005	0.000
123789 HxCDF	0.01	0.005	0.000
Other HxCDF	0.00	0.000	0.000
1234678 HpCDF	0.00	0.007	0.000
1234789 HpCDF	0.00	0.010	0.000
Other HpCDF	0.00	0.000	0.000
OCDF	0.00	0.036	0.000
TOTAL PCDF			0.064
Total Toxic Equivalent (2,3,7,8-TCDD Equivalents)			0.155

II.D. DIOXIN EMISSIONS

3. By EPA Scenario (ng/Nm3 @ 12% CO2)

COMPOUND	Multiplying factor	Marion County Average	Toxic Equivalent
2378 TCDD	1.00000	0.081	0.081
Other TCDD	0.01000	0.114	0.001
12378 PCDD	0.50000	0.009	0.005
Other PCDD	0.00500	0.044	.000
123478 HxCDD	0.04000	0.007	0.000
123678 HxCDD	0.04000	0.008	0.000
123789 HxCDD	0.04000	0.008	0.000
Other HxCDD	0.00040	0.087	.000
1234678 HpCDD	0.00100	0.138	.000
Other HpCDD	0.00001	0.046	.000
OCDD	0.00000	0.589	0.000
TOTAL PCDD			0.088
2378 TCDF	0.10000	0.168	0.017
Other TCDF	0.00100	0.154	.000
12378 PCDF	0.10000	0.010	0.001
23478 PCDF	0.10000	0.015	0.002
Other PCDF	0.00100	0.019	.000
123478 HxCDF	0.01000	0.004	0.000
123678 HxCDF	0.01000	0.004	0.000
234678 HxCDF	0.01000	0.005	0.000
123789 HxCDF	0.01000	0.005	0.000
Other HxCDF	0.00010	0.000	.000
1234678 HpCDF	0.00100	0.007	0.000
1234789 HpCDF	0.00100	0.010	0.000
Other HpCDF	0.00100	0.000	0.000
OCDF	0.00000	0.036	0.000
TOTAL PCDF			0.020
Total Toxic Equivalent (2,3,7,8-TCDD Equivalents)			0.108

II.D. DIOXIN EMISSIONS

4. Average Toxic Equivalent Emissions by CA scenario IV (ng/Nm3 @ 12% CO2)

COMPOUND	Multiplying factor	Marion County Average	Toxic Equivalent
2378 TCDD	1.00	0.081	0.081
Other TCDD	0.00	0.114	0.000
12378 PCDD	1.00	0.009	0.009
Other PCDD	0.00	0.044	0.000
123478 HxCDD	0.03	0.007	0.000
123678 HxCDD	0.03	0.008	0.000
123789 HxCDD	0.03	0.008	0.000
Other HxCDD	0.00	0.087	0.000
1234678 HpCDD	0.03	0.138	0.004
Other HpCDD	0.00	0.146	0.000
OCDD	0.00	0.589	0.000
TOTAL PCDD			0.095
2378 TCDF	1.00	0.168	0.168
Other TCDF	0.00	0.154	0.000
12378 PCDF	1.00	0.010	0.010
23478 PCDF	1.00	0.015	0.015
Other PCDF	0.00	0.019	0.000
123478 HxCDF	0.03	0.004	0.000
123678 HxCDF	0.03	0.004	0.000
234678 HxCDF	0.03	0.005	0.000
123789 HxCDF	0.03	0.005	0.000
Other HxCDF	0.00	0.000	0.000
1234678 HpCDF	0.03	0.007	0.000
1234789 HpCDF	0.03	0.010	0.000
Other HpCDF	0.00	0.000	0.000
OCDF	0.00	0.036	0.000
TOTAL PCDF			0.194
Total Toxic Equivalent (2,3,7,8-TCDD Equivalents)			0.289

III. BOILER 1 AND 2 EMISSION DATA

III.A. BOILER 1 EMISSIONS

Pollutant	Run	gr/dscf @ 12% CO2	lbs/hr
TSP (including condensibles)	1	0.021	4.7
	2	0.013	3.1
	3	0.014	3.2
	Average	0.016	3.7
TSP (excluding condensibles)	1	0.012	2.7
	2	0.008	2.0
	3	0.013	3.1
	Average	0.011	2.6

Pollutant	Run	mg/Nm3 @ 12% CO2	lbs/hr
Lead	1	0.195[1]	0.020
	2	0.015	0.002
	3	0.035	0.004
	Average	0.025	0.003
Beryllium	1	2.4×10^{-6}	2.2×10^{-7}
	3	2.8×10^{-6}	2.7×10^{-7}
	Average	2.6×10^{-6}	2.4×10^{-7}
Mercury	1	0.24	0.026

Pollutant	Run	ppmdv @ 12% CO2	lbs/hr
HCl	1	4.36	0.61
	2	4.51	0.73
	3	2.95	0.47
	Average	3.94	0.61
Fluoride	1	0.55	0.043
	2	0.89	0.071
	3	0.29	0.023
	Average	0.58	0.046

---

[1] During Run 1, the Fabric Filter (Baghouse) was bypassed for approximately 5 minutes. Run 1 results are included in the emission data as per request from Ms. Wendy Sims, Oregon DEQ, but are not included in the average.

III.B. BOILER 2 EMISSION DATA

Pollutant	Run	gr/dscf @ 12% CO2	lbs/hr
TSP (including condensibles)	1	0.004	0.7
	2	0.003	0.6
	3	0.006	1.2
	Average	0.004	0.8
TSP (excluding condensibles)	1	0.002	0.3
	2	0.002	0.4
	3	0.005	1.0
	Average	0.003	0.6

Pollutant	Run	mg/Nm3 @ 12% CO2	lbs/hr
Beryllium	2	$< 2.4 \times 10^{-6}$	$< 2.0 \times 10^{-7}$
Mercury	2	0.32	0.034

Pollutant	Run	ppmdv @ 12% CO2	lbs/hr
HCl	1	17.7	2.29
	2	22.2	2.90
	3	20.0	2.80
	Average	20.0	2.66

IV. CONTINUOUS EMISSION MONITORING DATA SUMMARY

IV.A. BOILER 1 RESULTS - NOX, CO, SO2, VOC

	Date	Time	Run	ppmdv @ 12% CO2	DSCFM @ 68°F	lbs/hr
NOx	10-3-86	1015-1115	1	271	37921 1/	53.2
	10-3-86	1128-1228	2	299	37921 1/	58.1
	10-3-86	1238-1338	3	349	37921 1/	69.0
	Average			306		60.1
CO	10-3-86	1015-1115	1	16	37921 1/	2.0
	10-3-86	1128-1228	2	17	37921 1/	2.0
	10-3-86	1238-1338	3	14	37921 1/	1.7
	Average			16		1.9
SO2	10-3-86	1015-1115	1	27	37921 1/	7
	10-3-86	1129-1228	2	48	37921 1/	13
	10-3-86	1238-1338	3	40	37921 1/	11
	Average			38		10
VOC	10-7-86	1200-1300	1	2	41810 2/	0.2
(as	10-7-86	1320-1420	2	2	41810 2/	0.2
CH4)	10-7-86	1441-1541	3	2	41810 2/	0.2
	Average			2		0.2

1/ DSCFM @ 68 F is Calculated from the U.S. EPA Method 104, Run 1

2/ DSCFM @ 68 F is Calculated from the U.S. EPA Method 13B, Run 3

IV.B. BOILER 2 RESULTS - NOX, CO, SO2, VOC

	Date	Time	Run	ppmdv @ 12% CO2	DSCFM @ 68°F	lbs/hr
NOx	10-2-86	1048-1148	1	240	35233 1/	40.4
	10-2-86	1206-1306	2	302	35233 1/	51.5
	10-2-86	1340-1440	3	308	35233 1/	53.2
	Average			283		48.4
CO	10-2-86	1048-1148	1	18	35233 1/	1.8
	10-2-86	1206-1306	2	25	35233 1/	2.6
	10-2-86	1340-1440	3	19	35233 1/	2.0
	Average			21		2.1
SO2	10-2-86	1048-1148	1	19	35233 1/	5
	10-2-86	1206-1306	2	75	35233 1/	18
	10-2-86	1340-1440	3	42	35233 1/	11
	Average			45		11
VOC	10-8-86	0910-1010	1	3	40210 2/	0.2
(as	10-8-86	1030-1130	2	2	40210 2/	0.1
CH4)	10-8-86	1215-1315	3	1	40210 2/	0.1
	Average			2		0.1

1/ DSCFM @ 68 F is Calculated from the U.S. EPA Method 5, Runs 2 and 3
2/ DSCFM @ 68 F is Calculated from the U.S. EPA Method 101A, Run 2

V. FURNACE OPERATING TEMPERATURE AND RESIDENCE TIME

V. FURNACE OPERATING TEMPERATURE AND RESIDENCE TIME

To establish the furnace temperatures, temperature traverses were performed using an ASME-style, water cooled, suction type pyrometer at a boiler elevation of 66' 0", which is 35' 5" above the combustion grate.

The average measured temperatures at this elevation above the grate were about 1800°F. The residence times, calculated at these average measured temperatures, i.e., at ≥1800°F, based on the corrected (i.e., measured) stack flue gas flows, were 2.5 and 2.4 seconds, respectively, for Boilers 1 and 2.

When these corrected stack flue gas flows were compared with flows calculated from boiler combustion analyses, they were found to be consistently 10-15% too high. Therefore, the actual residence times are probably 10-15% longer than those reported above. This may be due, in part, to the volumetric flow rate sampling by U.S. EPA Methods 1-4 and the ducting arrangement associated with the Dry Venturis of both boilers.

V.A. Unit No. 1, Average Test Values:

The following data are the average values, calculated using the measurements taken on 10/01/86 on Unit No. 1:

Boiler Data:

Steam Flow	64,400 lb/hr
Steam Temperature	691°F
Feedwater Temperature	241°F
Refuse Quantity	21,610 lb/hr
Throughput	258 TPD
Fluegas Oxygen, Wet	7.89%
Dry	9.39%
FG Temperatures	
• Furnace Traverses	1792°F
• Furnace Roof (Avg. of 3 T/C's)	1557°F
• Economizer Outlet	407°F
• Quench Reactor Outlet	272°F
• Baghouse Outlet	260°F
• ID Fan Inlet	258°F

Stack Data (@ 68°F):

Fluegas Flow, Wet	47,900 SCFM
Dry	39,200 SCFM
FG Moisture Content	8,700 SCFM
FG Oxygen	11.7%
FG Moisture	11.3%

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TABLE V

Correcting the Unit No. 1 Stack Data to the Boiler Conditions:

$$\text{FG Mass Flow, Dry} = \frac{20.9 - 11.7}{20.9 - 9.39} \times 181{,}750 = 145{,}200 \text{ lb/hr}$$

$$\text{FG Mass Flow, Wet (Assumed)} = 105{,}200 + 16{,}400 = 161{,}600 \text{ lb/hr}$$

$$\text{QR Heat Load} = 161{,}600\ (0.268)\ (407-272) = 5.9\text{x}10^6 \text{ Btu/hr}$$

$$\text{QR Water Injection} = \frac{5.9\text{x}10^6}{1000}\ \frac{\text{Btu/hr}}{\text{Btu/lb}} = 5900 \text{ lb/hr}$$

$$\text{FG Moisture Flow} = 24{,}300 - 5{,}900 = 16{,}400 \text{ lb/hr}$$

$$\text{FG Mass Flow, Wet (calculated)} = 145{,}200 + 16{,}400 = 161{,}600 \text{ lb/hr}$$

$$\text{FG Sp. Volume} = 13.70 \text{ Ft}^3\text{/lb @ } 68°\text{F}$$

$$\text{FG Volumetric Flow} = 161{,}600 \times \frac{13.70}{60} \times \frac{460 + 1792}{460 + 68} = 157{,}400 \text{ CFM}$$

$$\text{Furnace Plan Area} = (14'\text{-}0") \times (13'\text{-}1") = 183.17 \text{ Ft}^2$$

$$\text{FG Velocity} = \frac{157{,}400}{60 \times 183.17} = 14.3 \text{ Fps}$$

The Residence Time calculated at the Combustion Gas Temperature of $\geq$ 1800°

$$\text{Residence Time} = \frac{35.42}{14.3} = 2.5 \text{ seconds}$$

V.B. Unit No. 2, Average Test Values:

The following data are the average values, calculated using the measurements taken on 10/02/86 on Unit No. 2:

Boiler Data:

Steam Flow	67,000 lb/hr
Steam Temperature	653°F
Feedwater Temperature	240°F
Refuse Quantity	19,649 lb/hr
Throughput	236 TPD
Fluegas Oxygen, Wet	8.07%
Dry	9.56%
FG Temperatures	
• Furnace Traverses	1802°F
• Furnace Roof (Avg. of 3 T/C's)	1603°F
• Economizer Outlet	383°F
• Quench Reactor Outlet	289°F
• Baghouse Outlet	273°F
• ID Fan Inlet	271°F

Stack Data (@ 68°F):

Fluegas Flow, Wet	41,300 SCFM
Dry	34,900 SCFM
FG Moisture Content	6,400 SCFM
FG Oxygen	11.3%
FG Moisture	15.6%
FG Carbon Dioxide	8.9%

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TABLE V

Correcting the Unit No. 2 Stack Data to the Boiler Conditions:

$$\text{FG Mass Flow, Dry} = \frac{20.9 - 11.3}{20.9 - 9.56} \times 180{,}300 = 152{,}600 \text{ lb/hr}$$

$$\text{FG Mass Flow, Wet (Assumed)} = 152{,}600 + 13{,}800 = 166{,}400 \text{ lb/hr}$$

$$\text{QR Heat Load} = 166{,}400\ (0.263)\ (383 - 289) = 4.1\text{x}10^6 \text{ Btu/hr}$$

$$\text{QR Water Injection} = \frac{4.1\text{x}10^6 \text{ Btu/hr}}{1000 \text{ Btu/lb}} = 4100 \text{ lb/hr}$$

$$\text{FG Moisture Flow} = 17{,}900 - 4{,}100 = 13{,}800 \text{ lb/hr}$$

$$\text{FG Mass Flow, Wet (calculated)} = 152{,}600 + 13{,}800 = 166{,}400 \text{ lb/hr}$$

$$\text{FG Sp. Volume} = 13.52 \text{ Ft}^2/\text{lb @ } 68°\text{F}$$

$$\text{FG Volumetric Flow} = 166{,}400 \times \frac{13.52}{60} \times \frac{460 + 1802}{460 + 68} = 160{,}600 \text{ CFM}$$

$$\text{Furnace Plan Area} = (10'\text{-}0^{6"}) \times (13'\text{-}1") = 183.17 \text{ Ft2}$$

$$\text{FG Velocity} = \frac{160{,}600}{60 \times 183.17} = 14.6 \text{ fps}$$

The Residence Time calculated at the Combustion Gas Temperature of ≥ 1800°F:

$$\text{Residence Time} = \frac{35.42}{14.6} = 2.4 \text{ Seconds}$$

VI. BOILER OPERATIONAL DATA DURING EMISSION TESTING

VI. A. SUMMARY OF STEAM RATE AS A PERCENTAGE OF DESIGN CAPACITY DURING EMISSION TESTING

DATE	TIME	Boiler 1		Boiler 2	
		Steam Rate lbs/hr (x 1000)	Capacity (1) %	Steam Rate lbs/hr (x 1000)	Capacity (1) %
09-22-86	1315-1750	64	97	(2)	-
09-23-86	1402-1834	64	97	(2)	-
09-24-86	1016-1443	66	100	(2)	-
09-26-86	0715-1352	66	100	(2)	-
09-29-86	1403-2008	65	98	(2)	-
09-30-86	0930-1615	66	100	(2)	-
10-01-86	1145-1730	62	94	(2)	-
10-02-86	0835-1707	(2)	-	66	100
10-03-86	0855-1338	67	102	64	97
10-07-86	0835-1541	65	98	(2)	-
10-08-86	0840-1432	66	100	67	102

(1) 66,000 lbs/hr steam is equal to 100% heat input capacity

(2) No air emissions tests were performed

VI.B. COMBUSTION AIR

DATE	METHOD	UNCALIBRATED COMBUSTION AIR FLOW (1000 lbs/hr)
09-22-86	U.S. EPA Modified Method 5	69
09-23-86	U.S. EPA Modified Method 5	65
09-24-86	U.S. EPA Modified Method 5	52
09-26-86	U.S. EPA Method 12	70
09-29-86	U.S. EPA Method 12	72
09-30-86	U.S. EPA Method 12	71
10-01-86	U.S. EPA Method 5	72
10-01-86	U.S. EPA Method 5	69
10-01-86	U.S. EPA Method 5	82
10-02-86	U.S. EPA Method 5	93
10-02-86	U.S. EPA Method 5	101
10-02-86	U.S. EPA Method 5	107
10-02-86	U.S. EPA Methods 7E, 10, 6C	103
10-03-86	U.S. EPA Method 104	77
10-03-86	U.S. EPA Method 104	104
10-03-86	U.S. EPA Method 7E, 10, 6C	77
10-07-86	U.S. EPA Method 104	87
10-07-86	U.S. EPA Method 13B	84
10-07-86	U.S. EPA Method 13B	88
10-07-86	U.S. EPA Method 13B	87
10-07-86	CARB Method 100	86
10-07-86	EPA Method 9	84
10-07-86	EPA Method 9	112
10-08-86	EPA Method 101A	107
10-08-86	EPA Method 101A	85
10-08-86	EPA Method 101A	104
10-08-86	CARB Method 100	103

VI. C. STEAM PRODUCTION

DATE	METHOD	STEAM FLOW (1000 lbs/hr)	STEAM TEMP. (°F)	STEAM PRESS. (psig)
09-22-86	U.S. EPA Modified Method 5	64	702	620
09-23-86	U.S. EPA Modified Method 5	64	702	601
09-24-86	U.S. EPA Modified Method 5	66	699	600
09-26-86	U.S. EPA Method 12	66	702	605
09-29-86	U.S. EPA Method 12	65	701	600
09-30-86	U.S. EPA Method 12	66	701	601
10-01-86	U.S. EPA Method 5	65	700	609
10-01-86	U.S. EPA Method 5	63	700	608
10-01-86	U.S. EPA Method 5	59	700	608
10-02-86	U.S. EPA Method 5	68	700	643
10-02-86	U.S. EPA Method 5	66	700	645
10-02-86	U.S. EPA Method 5	66	700	645
10-02-86	U.S. EPA Methods 7E, 10, 6C	66	700	644
10-03-86	U.S. EPA Method 104	67	702	605
10-03-86	U.S. EPA Method 104	64	700	645
10-03-86	U.S. EPA Method 7E, 10, 6C	67	702	605
10-07-86	U.S. EPA Method 104	64	700	605
10-07-86	U.S. EPA Method 13B	63	700	605
10-07-86	U.S. EPA Method 13B	66	700	605
10-07-86	U.S. EPA Method 13B	63	700	605
10-07-86	CARB Method 100	64	700	605
10-07-86	EPA Method 9	64	700	605
10-07-86	EPA Method 9	65	700	645
10-08-86	EPA Method 101A	66	700	605
10-08-86	EPA Method 101A	67	700	645
10-08-86	EPA Method 101A	66	700	645
10-08-86	CARB Method 100	67	700	645

VI D. FURNACE TEMPERATURE

DATE	METHOD	UNSHIELDED THERMOCOUPLE IN FIRST PASS OF FURNACE (°F)
09-22-86	U.S. EPA Modified Method 5	1567
09-23-86	U.S. EPA Modified Method 5	1563
09-24-86	U.S. EPA Modified Method 5	1609
09-26-86	U.S. EPA Method 12	1604
09-29-86	U.S. EPA Method 12	1585
09-30-86	U.S. EPA Method 12	1607
10-01-86	U.S. EPA Method 5	1569
10-01-86	U.S. EPA Method 5	1540
10-01-86	U.S. EPA Method 5	1468
10-02-86	U.S. EPA Method 5	1633
10-02-86	U.S. EPA Method 5	1601
10-02-86	U.S. EPA Method 5	1575
10-02-86	U.S. EPA Methods 7E, 10, 6C	1584
10-03-86	U.S. EPA Method 104	1588
10-03-86	U.S. EPA Method 104	1575
10-03-86	U.S. EPA Method 7E, 10, 6C	1603
10-07-86	U.S. EPA Method 104	1580
10-07-86	U.S. EPA Method 13B	1584
10-07-86	U.S. EPA Method 13B	1598
10-07-86	U.S. EPA Method 13B	1568
10-07-86	CARB Method 100	1579
10-07-86	EPA Method 9	1590
10-07-86	EPA Method 9	1567
10-08-86	EPA Method 101A	1616
10-08-86	EPA Method 101A	1583
10-08-86	EPA Method 101A	1595
10-08-86	CARB Method 100	1586

VI E. FLUE GAS TEMPERATURES

DATE	METHOD	ECON OUTLET TEMP (°F)	QR OUTLET TEMP (°F)	BH OUTLET TEMP (°F)	STACK TEMP (°F)
09-22-86	U.S. EPA Modified Method 5	403	286	258	250
09-23-86	U.S. EPA Modified Method 5	385	272	255	249
09-24-86	U.S. EPA Modified Method 5	379	272	260	249
09-26-86	U.S. EPA Method 12	387	271	260	250
09-29-86	U.S. EPA Method 12	397	272	260	252
09-30-86	U.S. EPA Method 12	397	272	260	251
10-01-86	U.S. EPA Method 5	410	271	260	253
10-01-86	U.S. EPA Method 5	409	271	260	254
10-01-86	U.S. EPA Method 5	419	272	260	255
10-02-86	U.S. EPA Method 5	377	276	262	250
10-02-86	U.S. EPA Method 5	378	289	271	262
10-02-86	U.S. EPA Method 5	387	291	274	267
10-02-86	U.S. EPA Methods 7E, 10, 6C	386	293	273	---
0-03-86	U.S. EPA Method 104	402	285	270	263
10-03-86	U.S. EPA Method 104	378	285	270	264
10-03-86	U.S. EPA Method 7E, 10, 6C	405	285	270	---
10-07-86	U.S. EPA Method 104	427	290	280	270
10-07-86	U.S. EPA Method 13B	410	289	280	266
10-07-86	U.S. EPA Method 13B	420	290	280	270
10-07-86	U.S. EPA Method 13B	426	289	280	272
10-07-86	CARB Method 100	427	290	280	---
10-07-86	EPA Method 9	425	290	280	---
10-07-86	EPA Method 9	429	291	280	---
10-08-86	EPA Method 101A	420	290	280	268
10-08-86	EPA Method 101A	406	289	280	266
10-08-86	EPA Method 101A	407	289	275	265
10-08-86	CARB Method 100	409	289	278	---

VI F. ACID GAS CONTROL
QUENCH REACTOR AND DRY VENTURI

DATE	METHOD	QR INLET PRESS (in WC)	QR OUTLET PRESS (in WC)	LIME FEED TO BOTH QRs (lbs/hr)	DRY VENTURI ΔP (in WC)
09-22-86	U.S. EPA Modified Method 5	-3.0	-5.5	452	1.3
09-23-86	U.S. EPA Modified Method 5	-3.0	-5.0	439	1.2
09-24-86	U.S. EPA Modified Method 5	-2.6	-4.9	404	1.0
09-26-86	U.S. EPA Method 12	-3.2	-5.1	426	1.0
09-29-86	U.S. EPA Method 12	3.0	5.3	428	1.2
09-30-86	U.S. EPA Method 12	-3.0	-5.2	471	1.1
10-01-86	U.S. EPA Method 5	-3.5	-5.8	368	1.3
10-01-86	U.S. EPA Method 5	-3.3	-5.7	420	1.3
10-01-86	U.S. EPA Method 5	-3.4	-6.3	304	1.4
10-02-86	U.S. EPA Method 5	-2.1	-4.7	360	0.9
10-02-86	U.S. EPA Method 5	-2.4	-5.1	334	1.0
10-02-86	U.S. EPA Method 5	-2.4	-5.1	353	1.0
10-02-86	U.S. EPA Methods 7E, 10, 6C	-2.6	-5.2	359	1.0
10-03-86	U.S. EPA Method 104	-3.6	-6.0	400	1.4
10-03-86	U.S. EPA Method 104	-2.3	-5.0	400	0.9
10-03-86	U.S. EPA Method 7E, 10, 6C	-3.4	-5.9	369	1.4
10-07-86	U.S. EPA Method 104	-3.8	-6.1	262	1.4
10-07-86	U.S. EPA Method 13B	-3.3	-5.7	224	1.2
10-07-86	U.S. EPA Method 13B	-3.7	-6.4	231	1.3
10-07-86	U.S. EPA Method 13B	-3.8	-6.2	240	1.3
10-07-86	CARB Method 100	-3.9	-6.1	280	1.3
10-07-86	EPA Method 9	-3.8	-6.1	269	1.3
10-07-86	EPA Method 9	-3.4	-5.4	280	1.1
10-08-86	EPA Method 101A	-4.0	-6.7	304	1.3
10-08-86	EPA Method 101A	-2.8	-5.3	302	1.2
10-08-86	EPA Method 101A	-2.9	-5.3	322	1.1
10-08-86	CARB Method 100	-3.0	-5.4	304	1.2

VI.B. BAGHOUSE

DATE	METHOD	BAGHOUSE ΔP (in WC)	INDIVIDUAL BAGHOUSE COMPARTMENT CLEANING CYCLE (MINUTES)
09-22-86	U.S. EPA Modified Method 5	5.4	60
09-23-86	U.S. EPA Modified Method 5	5.2	60
09-24-86	U.S. EPA Modified Method 5	4.4	75
09-26-86	U.S. EPA Method 12	5.0	60
09-29-86	U.S. EPA Method 12	5.8	60
09-30-86	U.S. EPA Method 12	6.1	60
10-01-86	U.S. EPA Method 5	6.2	60
10-01-86	U.S. EPA Method 5	6.1	60
10-01-86	U.S. EPA Method 5	7.0	60
10-02-86	U.S. EPA Method 5	4.8	60
10-02-86	U.S. EPA Method 5	4.8	60
10-02-86	U.S. EPA Method 5	5.5	60
10-02-86	U.S. EPA Methods 7E, 10, 6C	5.3	60
10-03-86	U.S. EPA Method 104	6.3	30
10-03-86	U.S. EPA Method 104	5.3	60
10-03-86	U.S. EPA Method 7E, 10, 6C	6.3	30
10-07-86	U.S. EPA Method 104	6.8	60
10-07-86	U.S. EPA Method 13B	6.1	60
10-07-86	U.S. EPA Method 13B	6.4	60
10-07-86	U.S. EPA Method 13B	6.5	60
10-07-86	CARB Method 100	6.8	60
10-07-86	EPA Method 9	6.5	60
10-07-86	EPA Method 9	6.4	60
10-08-86	EPA Method 101A	6.7	60
10-08-86	EPA Method 101A	5.7	60
10-08-86	EPA Method 101A	6.0	60
10-08-86	CARB Method 100	6.1	60

VI.H. OPACITY MONITOR READINGS

DATE	METHOD	STACK OPACITY %
09-22-86	U.S. EPA Modified Method 5	0
09-23-86	U.S. EPA Modified Method 5	0.2
09-24-86	U.S. EPA Modified Method 5	0
09-26-86	U.S. EPA Method 12	0.1
09-29-86	U.S. EPA Method 12	0
09-30-86	U.S. EPA Method 12	0
10-01-86	U.S. EPA Method 5	0.1
10-01-86	U.S. EPA Method 5	0
10-01-86	U.S. EPA Method 5	0.2
10-02-86	U.S. EPA Method 5	0
10-02-86	U.S. EPA Method 5	0
10-02-86	U.S. EPA Method 5	0
10-02-86	U.S. EPA Methods 7E, 10, 6C	0
10-03-86	U.S. EPA Method 104	0
10-03-86	U.S. EPA Method 104	0
10-03-86	U.S. EPA Method 7E, 10, 6C	0
10-07-86	U.S. EPA Method 104	0
10-07-86	U.S. EPA Method 13B	0
10-07-86	U.S. EPA Method 13B	0
10-07-86	U.S. EPA Method 13B	0
10-07-86	CARB Method 100	0
10-07-86	EPA Method 9	0
10-07-86	EPA Method 9	0
10-08-86	EPA Method 101A	0
10-08-86	EPA Method 101A	0
10-08-86	EPA Method 101A	0
10-08-86	CARB Method 100	0

VII. FUEL LOADING

DATE	METHOD	REFUSE FEED (tons)
09-22-86	U.S. EPA Modified Method 5	46.7
09-23-86	U.S. EPA Modified Method 5	49.8
09-24-86	U.S. EPA Modified Method 5	44.0
09-26-86	U.S. EPA Method 12	64.5
09-29-86	U.S. EPA Method 12	73.1
09-30-86	U.S. EPA Method 12	79.1
10-01-86	U.S. EPA Method 5	15.2
10-01-86	U.S. EPA Method 5	20.6
10-01-86	U.S. EPA Method 5	22.7
10-02-86	U.S. EPA Method 5	12.1
10-02-86	U.S. EPA Method 5	10.6
10-02-86	U.S. EPA Method 5	16.2
10-02-86	U.S. EPA Methods 7E, 10, 6C	39.6
10-03-86	U.S. EPA Method 104	38.1
10-03-86	U.S. EPA Method 104	32.4
10-03-86	U.S. EPA Method 7E, 10, 6C	39.5
10-07-86	U.S. EPA Method 104	42.0
10-07-86	U.S. EPA Method 13B	14.2
10-07-86	U.S. EPA Method 13B	15.9
10-07-86	U.S. EPA Method 13B	11.4
10-07-86	CARB Method 100	38.4
10-07-86	EPA Method 9	26.0
10-07-86	EPA Method 9	12.6
10-08-86	EPA Method 101A	29.3
10-08-86	EPA Method 101A	37.8
10-08-86	EPA Method 101A	24.9
10-08-86	CARB Method 100	44.3

VI. J. AUXILLIARY FUEL BURNERS

DATE	METHOD	ON/OFF
09-22-86	U.S. EPA Modified Method 5	Off
09-23-86	U.S. EPA Modified Method 5	Off
09-24-86	U.S. EPA Modified Method 5	Off
09-26-86	U.S. EPA Method 12	Off
09-29-86	U.S. EPA Method 12	Off
09-30-86	U.S. EPA Method 12	Off
10-01-86	U.S. EPA Method 5	Off
10-01-86	U.S. EPA Method 5	Off
10-01-86	U.S. EPA Method 5	Off
10-02-86	U.S. EPA Method 5	Off
10-02-86	U.S. EPA Method 5	Off
10-02-86	U.S. EPA Method 5	Off
10-02-86	U.S. EPA Methods 7E, 10, 6C	Off
10-03-86	U.S. EPA Method 104	Off
10-03-86	U.S. EPA Method 104	Off
10-03-86	U.S. EPA Method 7E, 10, 6C	Off
10-07-86	U.S. EPA Method 104	Off
10-07-86	U.S. EPA Method 13B	Off
10-07-86	U.S. EPA Method 13B	Off
10-07-86	U.S. EPA Method 13B	Off
10-07-86	CARB Method 100	Off
10-07-86	EPA Method 9	Off
10-07-86	EPA Method 9	Off
10-08-86	EPA Method 101A	Off
10-08-86	EPA Method 101A	Off
10-08-86	EPA Method 101A	Off
10-08-86	CARB Method 100	Off

VI.K. SOOT BLOWING

As part of the normal scheduled maintenance program of the Marion County facility, soot blowing is performed daily in the generating boiler bank between the hours of 0300-0400. Soot blowing in the superheater section is performed every other day during the hours of 0300-0400.

VII. METHODOLOGY

VII A. REFERENCES

CONTINUOUS EMISSION MONITORING SYSTEM (CEMS)

BAAQMD, Manual of Procedures, ST-13A, ST-19A, January 1982.

State of California, Air Resources Board, Test Method 100, June 1979.

U.S. EPA, Code of Federal Regulations, Title 40, Part 60, Appendix A, Method 10, 1984.

MODIFIED METHOD 5

U.S. EPA, Proposed Sampling and Analytical Methodologies for Addition to "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods," SW-846, 2nd edition, July 1982.

U.S. EPA, Code of Federal Regulations, Title 40, Part 60, Appendix A, Method 5, 1984.

MODIFIED METHOD 12

U.S. EPA, Code of Federal Regulations, Title 40, Part 60, Appendix A, Method 12, 1984 and as revised by U.S. EPA, Research Triangle Park, 1986.

METHOD 101A

U.S. EPA, Code of Federal Regulations, Title 40, Part 61, Appendix B, Method 101A, 1984.

METHOD 104

U.S. EPA, Code of Federal Regulations, Title 40, Part 61, Appendix B, Method 104, 1984.

METHOD 5

State of Oregon, Department of Environmental Quality, "Source Sampling Manual," Volume 1, Method Five, August 1981.

METHOD 13B

U.S. EPA, Code of Federal Regulations, Title 40, Part 61, Appendix A, Method 13B, 1984.

METHOD 9

U.S. EPA, Code of Federal Regulations, Title 40, Part 61, Appendix A, Method 9, 1984.

VII B. EQUIPMENT

METHOD	EQUIPMENT MANUFACTURER
U.S. EPA Method 5/13B	Andersen Samplers, Inc.
U.S. EPA Modified Method 5	Andersen Samplers, Inc.
U.S. EPA Method 6C	Western Research, Ltd.
U.S. EPA Method 7E	ThermoElectron, Inc.
California Air Resources Board . CARB Method 100	Horiba Instruments, Inc.
U.S. EPA Method 10	ThermoElectron, Inc.
U.S. EPA Modified Method 12	Andersen Samplers, Inc.
U.S. EPA Method 104	Andersen Samplers, Inc.
U.S. EPA Method 101A	Andersen Samplers, Inc.
Paramagnetic Analyzer (O2)	Horiba Instruments, Inc.
NDIR Analyzer (CO2)	Horiba Instruments, Inc.
U.S. EPA Method 9	CARB Certified Visible Emission Evaluator
U.S. EPA Methods 1, 2, 3, 4	Andersen Samplers, Inc.

VII.C. VARIATIONS FROM THE SOURCE TEST PLAN

Hydrogen Chloride

The proposed source test plan collected and analyzed chlorides in the U.S. EPA Method 13B sampling train. For determining hydrogen chloride, the test program analyzed for HCl in the back-half impinger solution of the U.S. EPA Method 5 sampling train. Triplicate determinations of hydrogen chloride were performed on both boilers and these data are presented in Section IV.G. For comparison, the U.S. EPA Method 13B was analyzed for chlorides and these data are presented in Section IV.E. The average emission rate of chlorides (calcium chloride and hydrogen chloride) as determined by U.S. EPA Method 13B, is within 12% of the average hydrogen chloride emission rate determined by U.S. EPA Method 5 when the $Ca(OH)_2$ feed rate was within 35%.

Mercury

The proposed source test plan involved triplicate determinations of Mercury using U.S. EPA Method 101A. Triplicate runs were performed on the flue gas of either boiler 1 or 2 and, upon analysis, the third U.S. EPA Method 101A test Run was determined to have a low percent water in the sampled flue gas. For this reason, the results of Run 3 are not included in the overall emission rate of mercury. However, the analysis of U.S. EPA Method 101A, Run 3, is included in Section IV.F.

Particulate

The proposed source test plan collected and analyzed for particulate using the U.S. EPA Method 5. The actual source test used the Oregon DEQ Method 5 as per a request from the Oregon DEQ.

Fluorides

The proposed source test plan listed Brown and Caldwell Analytical Laboratories for fluorides analysis of U.S. EPA Method 13B. The actual analysis of fluorides was performed by Ogden Projects, Inc. at its Emeryville, CA laboratory.

Dioxin

The proposed source test plan involved triplicate determinations of dioxin (TCDD) using U.S. EPA Modified Method 5.

The flue gas moisture, as calculated from U.S. EPA Modified Method 5 Run 3, was 10.7% H_2O. The EPA Method 5/HCl Run 3, performed alongside the above U.S. EPA Modified Method 5, Run 3, had a calculated percent moisture of 15.0%. Although the leak check test, as per U.S. EPA Modified Method 5, validated the test run, the dioxin analytical results obtained from Run 3 have been multiplied by a factor of 15.0/10.7 to estimate in-stack concentration of dioxin.

Dioxin results from U.S. EPA Modified Method 5 Run 1 are under review due to unusually low recovery of internal standards from the XAD-2 resin. For this reason, Runs 2 and 3 are used for the average for the presentation of results in Section II.B. In addition, since the front and back halves of the EPA Modified Method 5 runs were analyzed separately at the request of the EPA, the combination of the analytical results required the addition to include the GC/MS detection limits when reported as not detected. Thus, all dioxin values where one part of the sampling train reported not detected values are conservative with respect to the probable lower values.

VIII. CONCLUSIONS

VIII. CONCLUSIONS

The results from the Marion County Waste-to-Energy facility compliance source test program are summarized in Section II. For comparison, the maximum emission limits from the Air Contaminant Discharge Permit are also presented in Section II. A summary of the facility's operational data, as requested by the DEQ, is shown in Section VI, while the results of the testing for combustion gas temperature and furnace residence time are available in Section V. The Marion County Waste-to-Energy facility is designed to operate with 91.5% scheduled availability; however, the annual maximum emission limits, as shown in Section II in TPY, were derived based on a 70% on-line availability. OMS of Marion, Inc. will request Air Contaminant Discharge Permit modifications to reflect a more appropriate system availability based on operational data from other OMS, Inc. facilities and facilities utilizing Martin GmbH stoker combustion system technology worldwide.

The measured emission rates for all air pollutants, except nitrogen oxides (NOx), were below maximum permissible emission limits. In some cases, most noticeably, the combustion related air pollutants, the emission rates were over 1000% lower than the emission limits, e.g.,

1. CO, 4.1 vs. 55.0 lbs/hr or 1300% lower
2. VOCs, 0.3 vs. 3.1 lbs/hr or 1033% lower
3. TCDD, 3.84 x 10 vs. 1.7 x 10 lbs/hr or 4400% lower

These extremely low emissions resulted from the advanced design of the Martin GmbH stoker combustion system and its operation with Martin GmbH's automatic combustion controller. Thus, while most of the combustion related air pollutants were dramatically reduced, the emission rates for NOx were higher than the permit limits. It appears that the original Application for the Air Contaminant Discharge Permit, submitted in late 1982 and amended in 1983 by the original project developer, Trans Energy Systems, Inc., relied on outdated data taken from references in the 1968 to 1980 time period. The references cite data from incinerators no longer in operation or from those incinerators or waste-to-energy facilities designed in the late 1960s or 1970s, i.e., the Chicago Northwest and Harrisburg facilities. Thus, as recent public concern about the discharge of organic pollutants from waste-to-energy facilities encouraged more efficient furnace design and operation, the data base for air pollutant emissions did not keep pace. Adequate data on NOx, CO and hydrocarbon emissions were not available on modern Martin GmbH stoker combustion systems until after the Marion County facility was under construction. For example, the Chicago Northwest facility NOx emissions were cited at 179 ppm (actual) NOx, but the average emissions of NOx from the Battelle report, used as the data base, were only 88.7 ppm (actual). In addition, CO emissions were chosen at 150 ppm and hydrocarbons at 16 ppm. Therefore, in the original Application, emission factors for CO and hydrocarbons were 1.9 lbs/ton and 0.12 lbs/ton respectively, while the value for NOx was originally 1.6 lbs/ton; but in an amendment to the Application, the value was increased to 4.1 lbs/ton based on a revised U.S. EPA

AP-42 reference. NOx emission factors from modern Martin GmbH stoker combustion systems average near the compliance source test measured level of 4.7 lbs/ton as shown by NOx emission data from the Tulsa, Oklahoma and Wurzburg, FRG facilities. With regard to the emissions of NOx, OMS of Marion, Inc. will apply for a modification of the Air Contaminant Discharge Permit to reflect the NOx emission rates actually measured.

The air pollutants controlled by the first waste-to-energy facility using a dry scrubber/fabric filter (baghouse) in the United States were much lower than the maximum emission limits. Further optimization of this new air pollution control system used on a waste-to-energy facility will be carried out during 1987 by OMS of Marion, Inc. After a review of these data and the results presented herein, the DEQ would be able to set emission limits for HCl based on long-term operation.

Source Test Plan

Source Information

Type Unit:	Municipal Solid Waste-to-Energy Facility
Facility :	Hillsborough County Solid Waste Energy Recovery Project Owned and Operated by Ogden Martin Systems of Hillsborough, Inc. 210 N. Faulkenburg Rd. Tampa, Florida 33619
Air Quality Permit:	PSD-FL-104 U.S. Environmental Protection Agency Region IV Atlanta, Georgia
Water Quality and Noise Levels	Performance and Acceptance Tests of the Hillsborough County Design and Construction Agreement Section 6.4, Appendix E, Subsection C.
Person to Contact :	Mr. James Glen, Facility Manager (813) 685-1459 Mr. John Klett, Vice President Technical Operations (201) 882-9000

Testing Firm Information

Company:	To be selected from a list of independent testing firms supplied by the Hillsborough County Environmental Protection Commission.

Testing Information

Procedure:	Testing three (3) Municipal Solid Waste-fired boilers for various gaseous and solid air pollutant emissions at each stack. Testing facility noise levels and water quality.
Proposed Test Dates:	March 16, 1987 through March 20, 1987 and March 23, 1987 through March 27, 1987.
Test Schedule:	See Schedule of Activities

January 30, 1987
Report No. 121

General

Ogden Projects, Inc. (OPI) will retain an independent source testing company to perform air pollutant emission tests and facility noise level monitoring. OPI will gather water samples and collect data to determine quality and quantity of wastewater discharged to a sanitary sewer.

1) Air Pollutant Emissions Testing

Air pollutant emission tests will be performed on three (3) MSW-fired boilers for determination of compliance with U.S. EPA Permit PSD-FL-104. Determination of the following combustion-related emission levels will be performed first as triplicate test runs on each unit and are as follows: (see attachments for method descriptions).

Parameter	Method	Test Run (hrs)
Particulate	U.S. EPA and FDER Method 5	1
VOC	U.S. EPA Method 25	1
Visible Emissions	FDER Method 9	1
Nitrogen Oxides	U.S. EPA Method 7E	1
Carbon Monoxide	U.S. EPA Method 10	1

In accordance with permit condition 1.b.1, compliance tests for visible emissions will be conducted simultaneously with the compliance tests for particulate.

After the initial testing on all three units has demonstrated that they are comparable with regard to combustion related emissions, (i.e., all units are firing MSW from a well mixed MSW storage pit with similar levels of gaseous combustion-related pollutants and particulate in the abated flue gas), one set of triplicate runs on Unit #1 will be performed to determine the following fuel-related pollutant emission levels:

Parameter	Method	Test Run (hrs)
Sulfuric Acid/ Sulfur Dioxide	U.S. EPA Method 8	1
Lead	U.S. EPA Method 12	2
Fluorides	U.S. EPA Method 13B	1
Beryllium	U.S. EPA Method 104	2
Mercury	U.S. EPA Method 101A	2

Deviations

Deviations to, or combinations of, standard U.S. EPA and FDER source test methods listed above as test method protocols and/or analytical procedures are as follows:

a) Particulate:

Particulate will be sampled according to FDER Method 5. Particulate back-half concentration will be determined by evaporating an aliquot of the impinger solution at approximately 95°C. The resultant residue will be weighed, then reconstituted, and analyzed for the ammonium, sulfate, chloride and fluoide ions, which condense from acid gases in the flue gas. The weight of ammonium, sulfate, chloride and fluoride ions will be subtracted from the residue after evaporation, and the weight will be reported separately with the front-half particulate weight to represent both front-half and back-half particulate. The front-half or U.S. EPA Method 5 particulate levels will be compared to the PSD Permit Levels.

b) Visible Emissions:

No deviations are planned from the FDER Method 9 test procedure for visible emissions.

c) VOC

No deviations are planned from the U.S. EPA Method 25 test procedure for VOC.

d) SO_2/Sulfuric Acid Mist

U.S. EPA Method 8 will be used to sample for SO_2 and sulfuric acid mist concentrations. This method will capture sulfuric mist in the nozzle, probe, filter sections, first impinger and demister. SO_2 will be captured in the second and third impingers. According to EPA Method 8, the presence of ammonia in the flue gas is an interfering agent. Should the presence of ammonia result in sulfuric acid mist levels above the permit levels, an alternate method, subject to the approval of the U.S. EPA and Florida DER, will be used to sample for sulfuric acid mist.

e) Nitrogen Oxides and Carbon Monoxide

Continuous emission monitoring instruments recognized by U.S. EPA, i.e., as published in the Code of Federal Regulations, will be used to measure NO_x and CO concentrations in the outlet gas of each boiler.

f) Lead

No deviations are planned from U.S. EPA Method 12 test procedure.

g) Fluorides

No deviations are planned from U.S. EPA Method 13B test procedure.

h) Beryllium

No deviations are planned from U.S. EPA Method 104 test procedure .

i) Mercury

No deviations are planned from U.S. EPA Method 101A test procedure.

QUALITY ASSURANCE AND ANALYSIS

A quality assurance/quality control program will include the use of designated sampling and analytical equipment according to referenced methods and calibration gases traceable to the National Bureau of Standards (NBS).

Sample analysis will be performed using NBS traceable reagents according to referenced methods. The use of sample blanks, inert sample containers and chain of custody forms will be included.

Sampling Point Information

Diagram 1 indicates the configuration of each boiler flue with the respective distances to the nearest upstream and downsteam flow interferences.

Estimated typical flue gas conditions in each flue are as follows:

Temperature	430°F
Moisture Content	16% H_2O
Flue Diameter	5'6"
Flue Gas Velocity	60 ft/sec
Flue Gas Flow	49,581 SCFM @ 60°F

Process Monitoring

During the air pollutant emission testing, plant process data will be monitored and collected by OPI personnel to insure representative operation of the facility. MSW fuel throughput rate during the testing period will be at design rate, to be documented by calibrated scale and crane loading equipment. Steam flow rate during the testing period will be documented to insure representative heat input at design conditions. In addition, ESP field parameters for each boiler will be monitored throughout the testing period. Fuel rate, steam rate, and ESP operating parameters will be included in the final report.

2) Noise Level Testing

Noise levels will be tested for determination of compliance with Hillsborough County Design and Construction Agreement, Section 6.4, Appendix E, subsection C. Monitoring locations will be fifty (50) feet from the four sides of the project and the four (4) corners of the facility boundaries. The following test method will be performed at each monitoring site as indicated on diagram 2.

Parameter	Method	Test Run (min)	Regulation
noise levels	Sound Level Meter	10-30	Hillsborough County, Environmental Protection Commission, Chapter 1-10, Noise.

3) Water Quality

Water quality tests will be performed for determination of compliance with Hillsborough County Design and Construction Agreement, Section 6.4, Appendix E, subsection C and Hillsborough County Ordinance 85-28, Section 13. Water quality tests will consist of collecting triplicate grab samples at the point of discharge to the sewer system. This sampling will be conducted daily during the testing period by OPI personnel. The grab samples will be placed in the custody of the independent air/noise emissions testing firm for delivery to an independent analytical chemistry laboratory. The water quality testing will include a quantity measurement of the wastewater discharged to the Hillsborough County pump station adjacent to the Facility. The collection of process data will be performed by OPI personnel. The following tests will be performed:

Parameter	Analysis	Regulation
Heavy Metals	Atomic Absorption Spectroscopy	Hillsborough County Ordinance 85-28, Section 13
Volume Flow	Flow Meter	Hillsborough County Design and Construction Agreement, Section 6.4, Appendix E

Schedule of Activities

The following table outlines the proposed schedule for both air pollutant emission testing to demonstrate compliance with U.S. EPA Permit PSD-FL-104, and water quality and noise levels for compliance with Hillsborough County Design and Construction Agreement.

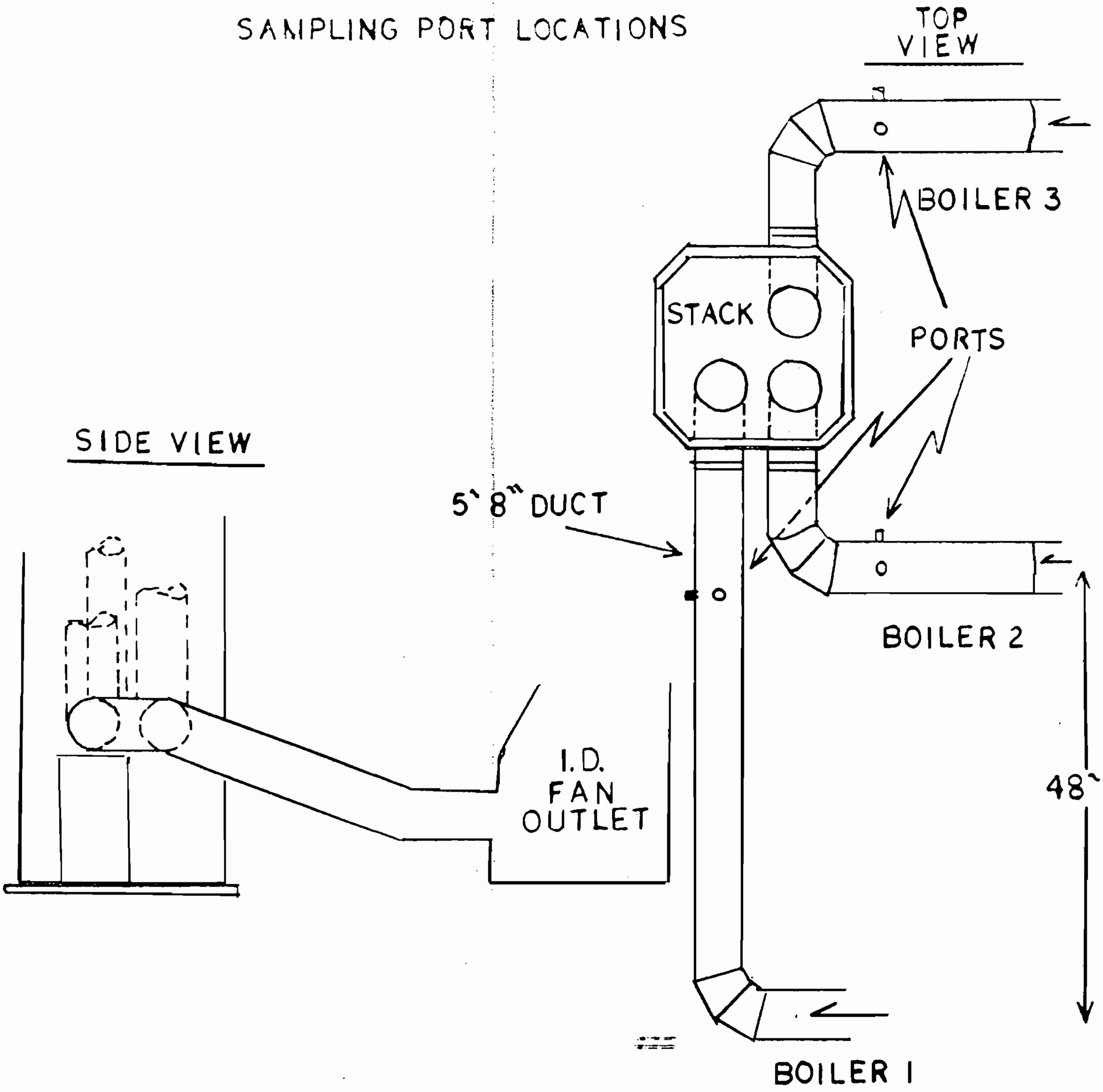
Schedule of Activities

Day	Date	Air Pollutant Emissions Testing (Triplicate)			Noise Level Testing	Water Quality Testing
		Boiler 1*	Boiler 2	Boiler 3		
1	3-16-87	Set up	Set up	Set up	Set up	Set up
2	3-17-87	U.S. EPA and FDER Method 5 U.S. EPA Methods 9, 7E, 10, 25	----	----	Locations A-H	Discharge Point
3	3-18-87	----	U.S. EPA and FDER Method 5 U.S. EPA Methods 9, 7E, 10, 25	----	----	Discharge Point
4	3-19-87	----	----	U.S. EPA and FDER Method 5 U.S. EPA Methods 9, 7E, 10, 25	----	Discharge Point
5	3-20-87	U.S. EPA Method 8	----	----	----	Discharge Point
6	3-23-87	U.S. EPA Method 12	----	----	----	Discharge Point
7	3-24-87	U.S. EPA Method 13B	----	----	----	Discharge Point
8	3-25-87	U.S. EPA Method 104	----	----	----	Discharge Point
9	3-26-87	U.S. EPA Method 101A	----	----	----	Discharge Point
10	3-27-87	Spare Day				

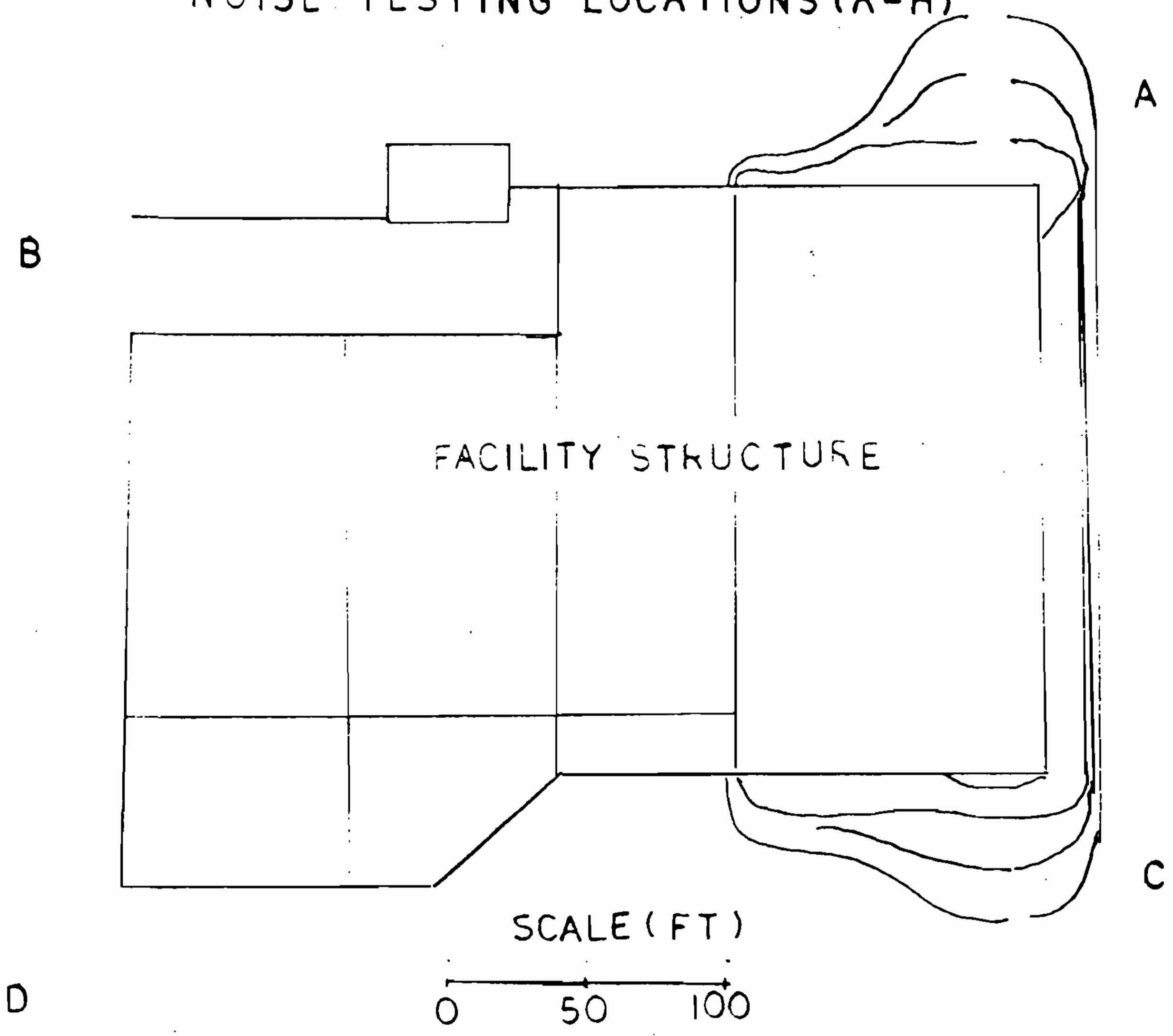
*Sampling port locations are the most favorable according to U.S. EPA Method 1.

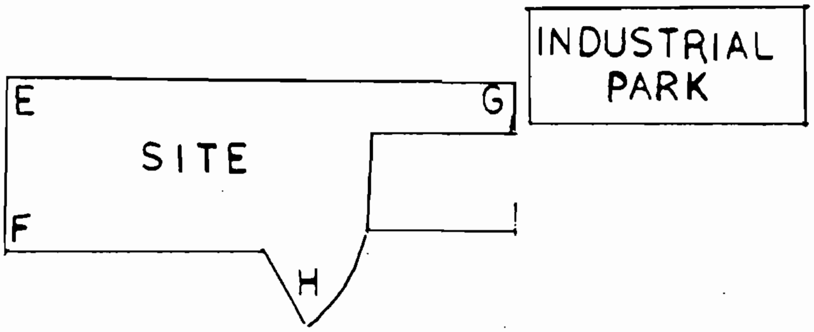
DIAGRAM 1

SAMPLING PORT LOCATIONS



NOISE TESTING LOCATIONS (A-H)





METHODOLOGY AND REGULATIONS

U.S. EPA - METHOD 5

tering system, and the procedure of Method 5, Section 5.7 to calibrate the barometer.

5. *Bibliography*

1. Air Pollution Engineering Manual (Second Edition). Danielson, J. A. (ed.). U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, N.C. Publication No. AP-40 1973.

2. Devorkin, Howard et al. Air Pollution Source Testing Manual. Air Pollution Control District, Los Angeles, Calif. November, 1963.

3. Methods for Determination of Velocity, Volume Dust and Mist Content of Gases. Western Precipitation Division of Joy Manufacturing Co., Los Angeles, Calif. Bulletin WP-50. 1968.

METHOD 5—DETERMINATION OF PARTICULATE EMISSIONS FROM STATIONARY SOURCES

1. *Principle and Applicability*

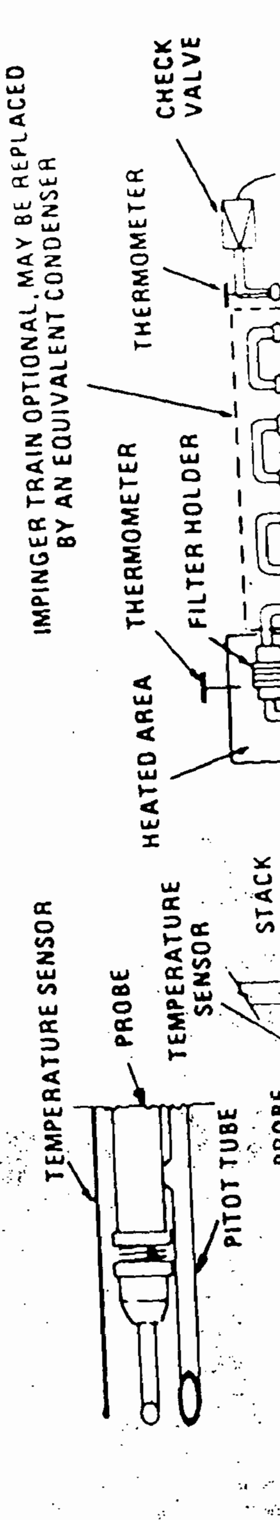
1.1 Principle. Particulate matter is withdrawn isokinetically from the source and collected on a glass fiber filter maintained at a temperature in the range of 120±14° C (248±25° F) or such other temperature as specified by an applicable subpart of the standards or approved by Administrator, U.S. Environmental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

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

2 *Apparatus*

2.1 Sampling Train. A schematic of the sampling train used in this method is shown in Figure 5-1. Complete construction details are given in APTD-0581 (Citation 2 in Bibliography); 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.

The operating and maintenance procedures for the sampling train are described in APTD-0576 (Citation 3 in Bibliography). 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. The sampling train consists of the following components:



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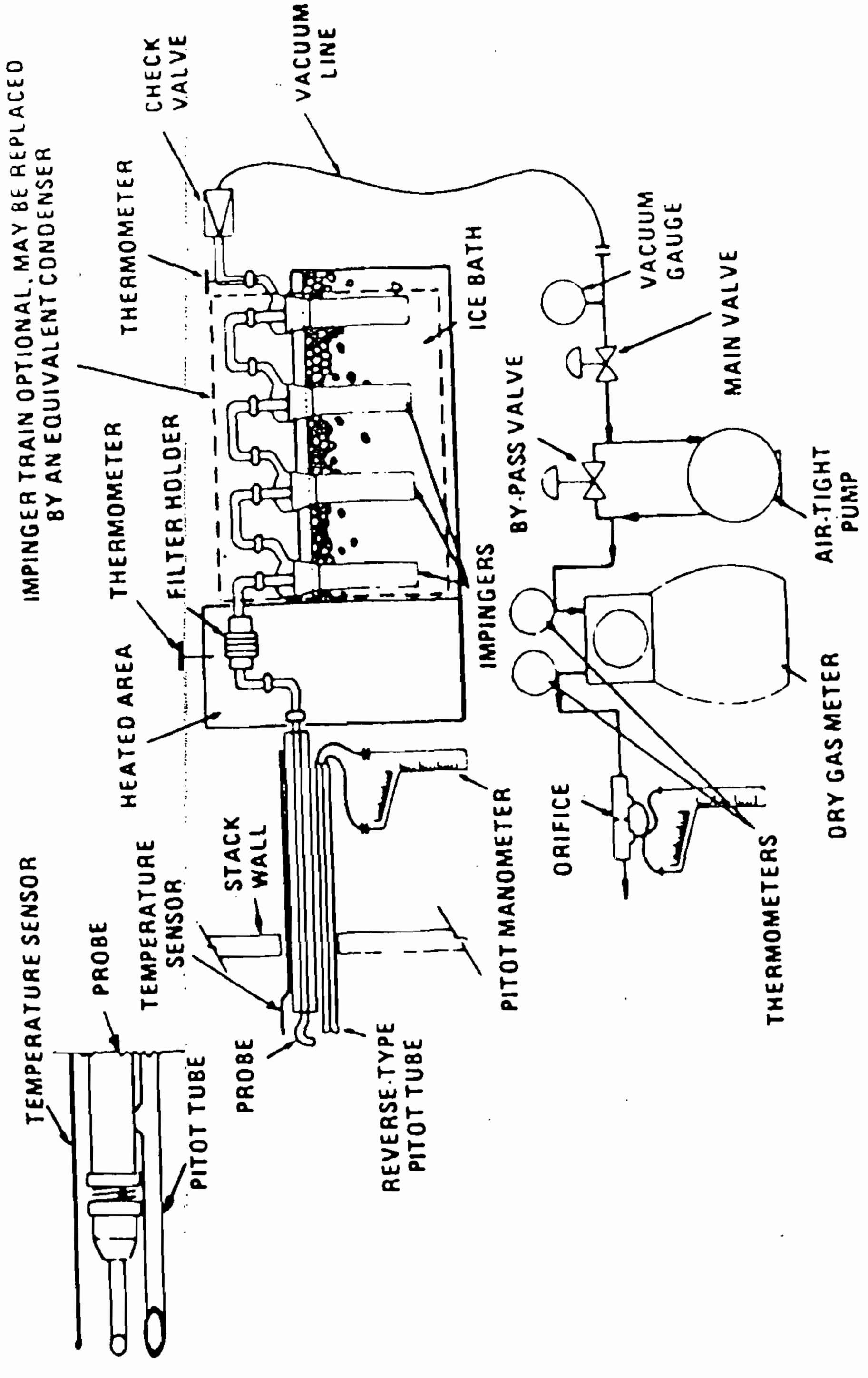

Figure 5-1. Particulate-sampling train.

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2.1.1 Probe Nozzle. Stainless steel (316) or glass with 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, e.g., 0.32 to 1.27 cm (⅛ to ½ in.)—or larger if higher volume sampling trains are used—inside diameter (ID) nozzles in increments of 0.16 cm (1/16 in.). Each nozzle shall be calibrated according to the procedures outlined in Section 5.

2.1.2 Probe Liner. Borosilicate or quartz glass tubing with a heating system capable of maintaining a gas temperature at the exit end during sampling 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 tester may opt to operate the equipment at a temperature lower than that specified.) 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 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 is 820° C (1,508° F), and for quartz it is 1,500° C (2,732° 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,[1] or other corrosion resistant metals) made of seamless tubing may be used, subject to the approval of the Administrator.

2.1.3 Pitot Tube. Type S, as described in Section 2.1 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 2-6b) during sampling. The Type S pitot tube assembly shall have a known coefficient, determined as outlined in Section 4 of Method 2.

2.1.4 Differentia Pressure Gauge. Inclined manometer or equivalent device (two), as described in Section 2.2 of Method 2. One manometer shall be used for velocity head (Δp) readings, and the other, for orifice differentia pressure readings.

2.1.5 Filter Holder. Borosilicate glass, with a glass frit filter support and a silicone rubber gasket. Other materials of construction (e.g., stainless steel, Teflon, Viton) may be used, subject to 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, it used).

2.1.6 Filter Heating System. Any heating system capable of maintaining a temperature around the filter holder during sampling 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. Alternatively, the tester may opt to operate the equipment at a temperature lower than that specified. A temperature gauge capable of measuring temperature to within 3° C (5.4° F) shall be installed so that the temperature around the filter holder can be regulated and monitored during sampling. Heating systems other than the one shown in APTD-0581 may be used.

2.1.7 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 non-contaminating fittings. The first, third, and fourth impingers shall be of the Greenburg-Smith design, modified by replacing the tip with 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 4.1.3), the third shall be empty, and the fourth shall contain a known weight of silica gel, or equivalent desiccant. A thermometer, capable of measuring temperture 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

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[1] Mention of trade names or specific product does not constitute endorsement by the Environmental Protection Agency.

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pable of maintaining a tempera-
nd the filter holder during sam-
120±14° C (248±25° F), or such
perature as specified by an appli-
art of the standards or approved
ministrator for a particular appli-
ernatively, the tester may opt to
ne equipment at a temperature
n that specified. A temperature
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ilar leak-free non-contaminating
he first, third, and fourth im-
all be of the Greenburg-Smith
dified by replacing the tip with
in.) ID glass tube extending to
m (½ in.) from the bottom of the
second impinger shall be of the
Smith design with the standard
cations (e.g., using flexible con-
tween the impingers, using mate-
than glass, or using flexible
es to connect the filter holder to
ser) may be used, subject to the
the Administrator. The first and
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and the fourth shall contain a
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thermometer, capable of meas-
rture to within 1° C (2° F) shall
the outlet of the fourth imping-
oring purposes.
ely, any system that cools the
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. Acceptable means are to measure the condensed water either gravimetrically or volumetrically and to measure 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 has 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 particulate matter 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.

2.1.8 Metering System. Vacuum gauge, leak-free pump, thermometers capable of measuring temperature to within 3° C (5.4° F), dry gas meter 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 enable checks of isokinetic rates.

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

2.1.9 Barometer. Mercury aneroid, or other barometer capable of measuring atmospheric pressure to within 2.5 mm Hg (0.1 in. Hg). In many cases the barometric reading may be obtained from a nearby national weather service station, in which 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 applied at a rate of minus 2.5 mm Hg (0.1 in. Hg) per 30 m (100 ft) elevation increase or vice versa for elevation decrease.

2.1.10 Gas Density Determination Equipment. Temperature sensor and pressure gauge, as described in Sections 2.3 and 2.4 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 2-7). As a second alternative, if a difference of not more than 1 percent in the average velocity measurement is to be introduced, the temperature gauge need not be attached to the probe or pitot tube. (This alternative is subject to the approval of the Administrator.)

2.2 Sample Recovery. The following items are needed.

2.2.1 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) 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.

2.2.2 Wash Bottles—Two. Glass wash bottles are recommended; polyethylene wash bottles may be used at the option of the tester. It is recommended that acetone not be stored in polyethylene bottles for longer than a month.

2.2.3 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.

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

2.2.5 Graduated Cylinder and/or Balance. To measure condensed water to within 1 ml or 1 g. Graduated cylinders shall have subdivisions no greater than 2 ml. Most laboratory balances are capable of weighing to the nearest 0.5 g or less. Any of these balances is suitable for use here and in Section 2.3.4.

2.2.6 Plastic Storage Containers. Airtight containers to store silica gel.

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

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

2.2 Analysis. For analysis, the following equipment is needed.

2.3.1 Glass Weighing Dishes.

2.3.2 Desiccator.

2.3.3 Analytical Balance. To measure to within 0.1 mg.

2.3.4 Balance. To measure to within 0.5 g.

2.3.5 Beakers. 250 ml.

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

2.3.7 Temperature Gauge. To measure the temperature of the laboratory environment.

3. *Reagents*

3.1 Sampling. The reagents used in sampling are as follows:

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 D2986-71 (Reapproved 1978) (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. Citation 10 in Section 7 Bibliography, may be used to select the appropriate filter.

3.1.2 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.

3.1.3 Water. When analysis of the material caught in the impingers is required, distilled water shall be used. Run blanks prior to field use to eliminate a high blank on test samples.

3.1.4 Crushed Ice.

3.1.5 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.

3.2 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.

3.3 Analysis. Two reagents are required for the analysis:

3.3.1 Acetone. Same as 3.2.

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

4. *Procedure*

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

4.1.1 Pretest Preparation. All the components shall be maintained and calibrated according to the procedure described in APTD-0576, unless otherwise specified herein.

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 need not be preweighed, but may be weighed directly in the impinger or sampling holder just prior to train assembly.

Check filters visually against light for irregularities and 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 plastic petri dishes) and keep the filters in these containers at all times except during sampling and weighing.

Desiccate the filters at 20±5.6° C (68±10° F) and ambient pressure for at least 24 hours and weigh 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 filter must not be exposed to the laboratory atmosphere for a period greater than 2 minutes and a relative humidity above 50 percent. 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.

4.1.2 Preliminary Determinations. 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 3.1) 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

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gas dry molecular weigh
Method 2, Section 3.6; if i
3 sampling is used for mo
termination, the integr
shall be taken simultan
the same total length of
ulate sample run.

Select a nozzle size bas
velocity heads, such that
to change the nozzle size
tain isokinetic sampling
run, do not change the n
that the proper different
is chosen for the range of
countered (see Section 2.2

Select a suitable probe
length such that all trave
sampled. For large stacks,
from opposite sides of th
the length of probes.

Select a total sampling t
or equal to the minimur
time specified in the test p
specific industry such that
time per point is not less
some greater time interva
the Administrator), and
volume taken (corrected t
tions) will exceed the re
total gas sample volume. T
on an approximate average

It is recommended that
minutes sampled at each p
or an integer plus one-half
to avoid timekeeping erro
time at each point shall be

In some cirumstances, e.
may be necessary to san
times at the traverse poin
smaller gas sample volume
the Administrator's appro
obtained.

4.1.3 Preparation of
During preparation and
sampling train, keep all op
tamination can occur co
prior to assembly or until
to begin.

Place 100 ml of water in
two impingers, leave th
empty, and transfer app
300 g of preweighed silica
tainer to the fourth imp
gel may be used, but care
ensure that it is not entr
out from the impinger
Place the container in a c
use in the sample recov
the weight of the silica
may be determined to th
recorded.

Using a tweezer or clea
cal gloves, place a label
weighed filter in the filt
that the filter is properl
gasket properly placed s
sample gas stream from

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Record the total weight of the
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ter or sampling holder just prior
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s and flaws or pinhole leaks.
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near the edge using numbering
nk. As an alternative, label the
ontainers (glass or plastic petri
l keep the filters in these contain-
imes except during sampling and

the filters at 20±5.6° C (68±10°
nbient pressure for at least 24
weigh at intervals of at least 6
a constant weight, i.e., 0.5 mg
m previous weighing; record re-
ne nearest 0.1 mg. During each
he filter must not be exposed to
tory atmosphere for a period
an 2 minutes and a relative hu-
ove 50 percent. Alternatively
erwise specified by the Adminis-
filters may be oven dried at 105°
for 2 to 3 hours, desiccated for 2
weighed. Procedures other than
ibed, which account for relative
ffects, may be used, subject to
al of the Administrator.
liminary Determinations. Select
g site and the minimum number
f points according to Method 1 or
d by the Administrator. Deter-
tack pressure, temperature, and
f velocity heads using Method 2;
mended that a leak-check of the
(see Method 2, Section 3.1) be
Determine the moisture content
oximation Method 4 or its alter-
the purpose of making isokinetic
ate settings. Determine the stack gas dry molecular weight, as described in Method 2, Section 3.6; 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.

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 differental pressure gauge is chosen for the range of velocity heads encountered (see Section 2.2 of Method 2).

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 length of probes.

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 min (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.

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. The sampling time at each point shall be the same.

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.

4.1.3 Preparation of Collection Train. 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.

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.

When glass liners are used, install the selected nozzle using a Viton A O-ring when stack temperatures are less than 260° C (500° F) and an asbestos 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 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.

Set up the train as 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 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.

Place crushed ice around the impingers.

4.1.4 Leak-Check Procedures.

4.1.4.1 Pretest Leak-Check. A pretest leak-check is recommended, but not required. If the tester opts to conduct the pretest leak-check, the following procedure shall be used.

After the sampling train has been assembled, turn on and set the filter and probe heating systems at 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 Hg (15 in. Hg) vacuum.

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

If an asbestos 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 (cycone, if applicable) and pulling a 380 mm Hg (15 in. Hg) vacuum (see Note immediately above). Then connect the probe to the train and leak-check at about 25 mm Hg (1 in. Hg) vacuum; alternatively, the probe may be leak-checked with the rest of the sampling train, in one step, at 380 mm Hg (15 in. Hg) vacuum. Leakage rates in excess of 4 percent of the average sampling rate or 0.00057 m^3/min (0.02 cfm), whichever is less, are unacceptable.

The following leak-check instructions for the sampling train described in APTD-0576 and APTD-0581 may be helpful. Start the pump with bypass valve fully open and coarse adjust valve, completely closed. Partially open the coarse adjust valve and slowly close the bypass valve until the desired vacuum is reached. Do not reverse direction of bypass value; 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 as shown below and start over.

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 silica gel from being entrained backward into the third impinger.

4.1.4.2 Leak-Checks During Sample Run. If, during the sampling run, a component (e.g., filter assembly or impinger) change becomes unecessary, 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 4.1.4.1 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 m³/min (0.02 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, the tester shall either record the leakage rate and plan to correct the sample volume as shown in Section 6.3 of this method, or shall void the sampling run.

Immediately after component changes, leak-checks are optional; if such leak-checks are done, the procedure outlined in Section 4.1.4.1 above shall be used.

4.1.4.3 Post-test Leak-Check. A leak-check is mandatory at the conclusion of each sampling run. The leakcheck shall be done in accordance with the procedures outlined in Section 4.1.4.1, 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 m³/min (0.02 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, the tester shall either record the leakage rate and correct the sample volume as shown in Section 6.3 of this method, or shall void the sampling run.

4.1.5 Particulate 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.

For each run, record the data required on a data sheet such as the one shown in Figure 5-2. Be sure to record the initial dry gas meter reading. Record the dry gas meter 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 required by Figure 5-2 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.

Clean the portholes prior to the test run to minimize the chance of sampling deposited material. To begin sampling, remove the nozzle cap, verify that the filter and probe heating systems are up to temperature, and 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 is 0.85 ± 0.02, and the stack gas equivalent density (dry molecular weight) 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 Citation 7 in Bibliography) are taken to compensate for the deviations.

FIGURE 5-2—PARTICULATE FIELD DATA

Plant ....
Location ....
Operator ....
Date ....
Run No ....
Sample box No ....
Meter box No ....
Meter ΔH@ ....
C factor ....
Pitot tube coefficient, Cp ....

Ambient temperature ....
Barometric pressure ....
Assumed moisture, % ....
Probe length, m. (ft.) ....
Nozzle identification No ....
Average calibrated nozzle diameter, cm (in) ....
Probe heater setting ....
Leak rate, m³/min, (cfm) ....
Probe liner material ....
Static pressure, mm Hg (in Hg) ....
Filter No ....

SCHEMATIC OF STACK CROSS SECTION

Gas sample temperature at

Temperature of

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er, a higher leakage rate is ob-
ıe tester shall either record the
ıte and correct the sample volume
ın Section 6 3 of this method, or
the sampling run.
ırticulate Train Operation.
ıe sampling run, maintain an iso-
mpling rate (within 10 percent of
ıetic unless otherwise specified by
ıinistrator) and a temperature
e filter of 120 ± 14° C (248 ± 25° F),
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2. Be sure to record the initial dry
reading. Record the dry gas meter
ıt the beginning and end of each
time increment, when changes in
ı are made, before and after each
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ır readings required by Figure 5-2
ınce at each sample point during
ı increment and additional read-
ı significant changes (20 percent
in velocity head readings) necessi-
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zero the manometer. Because the
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1. Position the nozzle at the first
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lomographs are available, which
rapid adjustment of the isokinetic
rate without excessive computa-
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the Type S pitot tube coefficient
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nomographs. If C_p and M_d are out-
ıbove stated ranges do not use the
ıhs unless appropriate steps (see
7 in Bibliography) are taken to
ıte for the deviations.

FIGURE 5-2—PARTICULATE FIELD DATA

Plant ....
Location ....
Operator ....
Date ....
Run No ....
Sample box No ....
Meter box No ....
Meter ΔH@ ....
C factor ....
Pitot tube coefficient, Cp ....

SCHEMATIC OF STACK CROSS SECTION

Ambient temperature ....
Barometric pressure ....
Assumed moisture, % ....
Probe length, m (ft.) ....
Nozzle identification No ....
Average calibrated nozzle diameter, cm (in.) ....
Probe heater setting ....
Leak rate, m³/min, (cfm) ....
Probe liner material ....
Static pressure, mm Hg (in. Hg) ....
Filter No ....

Traverse point number	Sampling time	Vacuum	Stack temperature	Velocity head	Pressure differential across orifice meter	Gas sample volume	Gas sample temperature at dry gas meter		Filter holder temperature	Temperature of gas leaving condenser or last impinger
	(θ) min.	mm Hg (in Hg)	(T_s) °C (° F)	(ΔP_s) mm (in) H_2O	mm H_2O (in. H_2O)	m³ (ft³)	Inlet °C (° F)	Outlet °C (° F)	°C (° F)	°C (° F)
Total							Avg.	Avg		
Average							Avg			

When the stack is under significant negative pressure (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.

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

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.

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.

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 a 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 4.1.4.2). The total particulate weight shall include the summation of all filter assembly catches.

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 that 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.

At the end of the sample run, turn off the coarse adjust valve, remove the probe and nozzle from the stack, turn off the pump, record the final dry gas meter reading, and conduct a post-test leak-check, as outlined in Section 4.1.4.3. Also, leak-check the pitot lines as described in Method 2, Section 3.1; the lines must pass this leak-check, in order to validate the velocity head data.

4.1.6 Calculation of Percent Isokinetic. Calculate percent isokinetic (see Calculations, Section 6) to determine whether the run was valid or another test run should be made. If there was difficulty in maintaining isokinetic rates due to source conditions, consult with the Administrator for possible variance on the isokinetic rates.

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. Allow the probe to cool.

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

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.

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.

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."

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

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 particulate cake is inside the fold. Carefully transfer to the petri dish any particulate matter and/or filter fibers which adhere to the filter holder gasket, by using a dry Nylon

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bristle brush and/or a s
Seal the container.
Container No. 2. Takin
dust on the outside of th
terior surfaces does not
quantitatively recover p
any condensate from
probe fitting, probe liner
the filter holder by was
nents with acetone and p
a glass container. Distil
used instead of acetone
the Administrator and s
specified by the Admin
cases, save a water blank
ministrator's directions o
the acetone rinses as foll
Carefully remove the
clean the inside surface b
tone from a wash bottle
a Nylon bristle brush. B
tone rinse shows no visi
which make a final rins
face with acetone.
Brush and rinse the
Swagelok fitting with a
way until no visible parti
Rinse the probe liner w
ing and rotating the pr
acetone into its upper en
surfaces will be wetted w
acetone drain from the
sample container. A fur
ethylene) may be used
ring liquid washes to th
the acetone rinse with a
the probe in an inclined
tone into the upper end
is being pushed with
through the probe; hold
underneath the lower en
catch any acetone and
which is brushed from
brush through the pr
more until no visible p
carried out with the ac
remains in the probe lin
tion. With stainless st
probes, run the brush th
prescribed manner at l
metal probes have sma
particulate matter can
the brush with acetone
collect these washings
tainer. After the brushi
tone rinse of the probe
It is recommended
used to clean the probe
losses. Between samplin
clean and protected fro
After ensuring that
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by rubbing the surfaces
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surface three times or
remove visible particu

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n the last impinger and cap the
a flexible line is used between
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and let any condensed water or
into the impingers or condens-
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the cleanup area. This area
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y from the wash bottle being
ace it in a glass sample container
tone blank."
e train prior to and during dis-
d note any abnormal conditions.
mples as follows:
No. 1. Carefully remove the
the filter holder and place it in
l petri dish container. Use a pair
and/or clean disposable surgical
ndle the filter. If it is necessary
ilter, do so such that the partic-
s inside the fold. Carefully trans-
etri dish any particulate matter
er fibers which adhere to the
r gasket, by using a dry Nylon

bristle brush and/or a sharp-edged blade. Seal the container.

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 particulate matter 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. 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 rinses as follows:

Carefully remove the probe nozzle and 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.

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

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 on 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 which is brushed from the probe. Run the brush through the probe three times or more until no visible particulate matter 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 as described above.

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

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 levcel to determine whether or not leakage occured during transport. Label the container to clearly identify its contents.

Container No. 3. Note the color of the indicating silica gel to determine if 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 4.3.

Impinger Water. Treat the impingers as follows: Make a notation of any color or film in the liquid catch. Measure the liquid which 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 (if one is available). 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 2.1.7).

If a different type of condenser is used, measure the amount of moisture condensed either volumetrically or gravimetrically.

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

4.3 Analysis. Record the data required on a sheet such as the one shown in Figure 5-3. Handle each sample container as follows:

FIGURE 5-3—ANALYTICAL DATA

Plant ————————————
Date ————————————
Run No. ————————————
Filter No. ————————————
Amount liquid lost during transport ————
Acetone blank volume, ml ————————
Acetone wash 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 increase by density of water (1 g/ml).

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

Container No. 1. Leave the contents in the shipping container or transfer the filter and any loose particulate 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 purposes of this Section, 4.3, 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 105° 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 tester may also opt to oven dry the sample at 105° C (220° F) for 2 to 3 hours, weigh the sample, and use this weight as a final weight.

Container No. 2. Note the level of liquid in the container and confirm on the analysis sheet whether or not 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.

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.

"Acetone Blank" Container. Measure acetone in this container either volumentrically 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: At the option of the tester, 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.

4.4 Quality Control Procedures. The following quality control procedures are suggested to check the volume metering system calibration values at the field test site prior to sample collection. These procedures are optional for the tester.

4.4.1 Meter Orifice Check. Using the calibration data obtained during the calibration procedure described in Section 5.3, determine the $\Delta H_@$ for the metering system orifice. The $\Delta H_@$ is the orifice pressure differential in 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:

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

Eq. 5-9

Where:

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

T_m = Absolute average dry gas meter temperature, °R.

P_{bar} = Barometric pressure, in. Hg.

Θ = Total sampling time, min.

Y = Dry gas meter calibration factor, dimensionless.

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

$0.0319 = (0.0567\ \text{in. Hg/°R}) \times (0.75\ \text{cfm})^2$

Before beginning the fi
three runs usually const
operate the metering s
volume meter, and orific
sure differential for 10 m

$Y_c = $

Where:

Y_c = Dry gas meter calib
dimensionless.

10 = 10 minutes of run tim

Compare the Y_c value
meter calibration facto
that:

$0.97Y < Y_c < 1.03Y$

If the Y_c value is not wit
volume metering system
gated before beginning th

4.4.2 Calibrated Critic
brated critical orifice, c
wet test meter or spiron
to be inserted at the inl
meter box, may be used
check, such procedure b
proval by the Administra

5. *Calibration*

Maintain a laboratory
tions.

5.1 Probe Nozzle. Pro
calibrated before their
field. Using a microm
inside diameter of the n
01.025 mm (0.001 in.). M
measurements using d
each time, and obtain
measurements. The diff
high and low numbers
mm (0.004 in.). Whe
nicked, dented, or corr
reshaped, sharpened,
before use. Each nozzle
ly and uniquely identifie

5.2 Pitot Tube. The T
sembly shall be calibrat
procedure outlined in S
2.

5.3 Metering System
use in the field, the me
be calibrated accordin
outlined in APTD-0576.
ly adjusting the dry gas
to correspond to the w
ings, calibration facto
mathematically correct
readings to the proper
brating the metering sy
that a leak-check be co
ing systems having dia
normal leak-check proc
leakages within the pu

t. Report the results to the near-

· No. 3. Weigh the spent silica
ı gel plus impinger) to the near-
ing a balance. This step may be
n the field.
Blank" Container. Measure ace-
container either volumentrical-
netrically. Transfer the acetone
250-ml beaker and evaporate to
ambient temperature and pres-
ate for 24 hours and weigh to a
ight. Report the results to the
ng.
:he option of the tester, the con-
ntainer No. 2 as well as the ace-
container may be evaporated at
es higher than ambient. If evap-
one at an elevated temperature,
ature must be below the boiling
· solvent; also, to prevent "bump-
aporation process must be close-
ed, and the contents of the
t be swirled occasionally to main-
ı temperature. Use extreme care,
is highly flammable and has a
int.
ty Control Procedures. The fol-
ity control procedures are sug-
eck the volume metering system
values at the field test site prior
ollection. These procedures are
the tester.
er Orifice Check. Using the cali-
ı obtained during the calibration
lescribed in Section 5.3, deter-
H@ for the metering system ori-
I@ is the orifice pressure differ-
its of in. H_2O that correlates to
air at 528°R and 29.92 in. Hg.
calculated as follows:

$$0.0319\ \Delta H\ \frac{T_m}{P_{bar}}\ \frac{\Theta^2}{Y^2V^2_m}$$

Eq. 5-9

e pressure differential across
ce meter, in. H_2O.
e average dry gas meter temper-
t.
etric pressure, in. Hg.
npling time, min.
meter calibration factor, dimen-

·of gas sample as measured by
neter, dcf.
567 in. Hg/°R) x (0.75 cfm)²

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 ΔH@ pressure differential for 10 minutes. Record the volume collected, the dry gas meter temperature, and the barometric pressure. Calculate a dry gas meter calibration check value, Y_c, as follows:

$$Y_c = \frac{10}{V_m}\left[\frac{0.0319\ T_m}{P_{bar}}\right]^{1/2} \qquad \text{Eq. 5-10}$$

Where:

Y_c = Dry gas meter calibration check value, dimensionless.

10 = 10 minutes of run time.

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.

4.4.2 Calibrated Critical Orifice. A calibrated 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 quality control check, such procedure being subject to approval by the Administrator.

5. *Calibration*

Maintain a laboratory log of all calibrations.

5.1 Probe Nozzle. Probe nozzles shall be calibrated before their initial use in the field. Using a micrometer, measure the inside diameter of the nozzle to the nearest 01.025 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.

5.2 Pitot Tube. The Type S pitot tube assembly shall be calibrated according to the procedure outlined in Section 4 of Method 2.

5.3 Metering System. Before its initial use in the field, the metering system shall be calibrated according to the procedure outlined in APTD-0576. Instead of physically adjusting the dry gas meter dial readings to correspond to the wet test meter readings, calibration factors may be used to mathematically correct the gas meter dial readings to the proper values. 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 0.0057 m³/min (0.02 cfm); at the end of the run, take the difference of the measured wet test meter and dry gas meter volumes; divide the difference by 10, to get the leak rate. The leak rate should not exceed 0.00057 m³/min (0.02 cfm).

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 calibration factor. If the calibration has changed by more than 5 percent, recalibrate the meter over the full range of orifice settings, as outlined in APTD-0576.

Alternative procedures, e.g., using the orifice meter coefficients, maybe used, subject to the approval of the Administrator.

NOTE: If the dry gas meter 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 test series shall be performed using whichever meter coefficient value (i.e., before or after) gives the lower value of total sample volume.

5.4 Probe Heater Calibration. The probe heating system shall be calibrated before its initial use in the field according to the procedure outlined in APTD-0576. Probes constructed according to APTD-0581 need not be calibrated if the calibration curves in APTD-0576 are used.

5.5 Temperature Gauges. Use the procedure in Section 4.3 of Method 2 to calibrate in-stack temperature gauges. Dial thermometers, such as are used for the dry gas meter and condenser outlet, shall be calibrated against mercury-in-glass thermometers.

5.6 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 follow-

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ing procedure is suggested (see Figure 5-4): Close the main valve on the meter box. Insert a one-hole rubber stopper with rubber tubing atached 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.

5.7 Barometer. Calibrate against a mercury barometer.

6. *Calculations*

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

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neter. Calibrate against a mer-
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cimal figure beyond that of the
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ation. Other forms of the equa-
used as long as they give equiv-

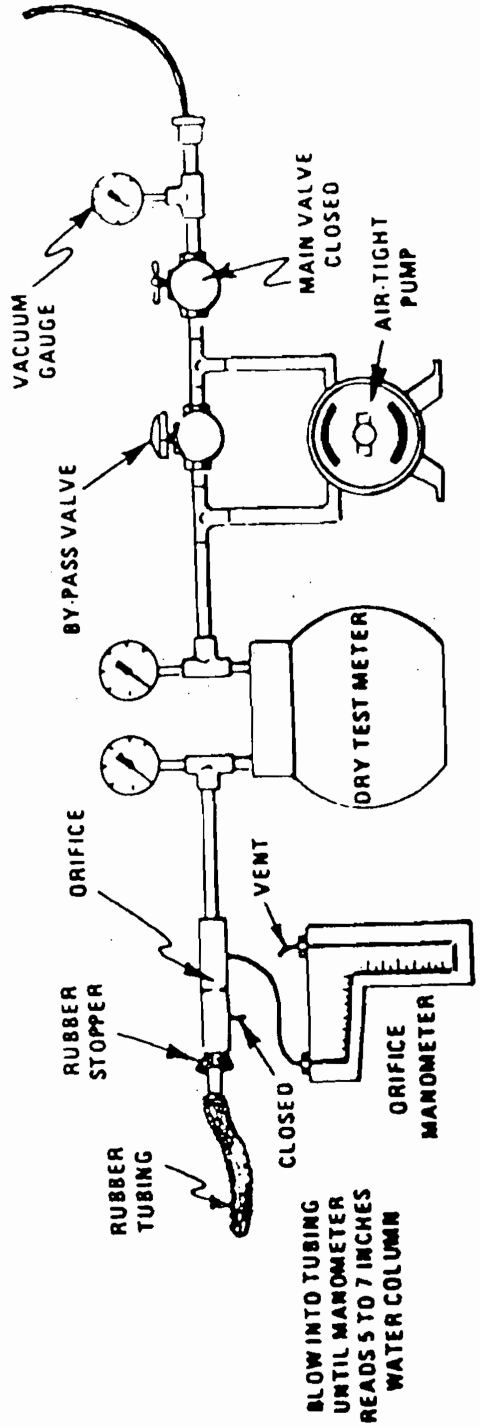


Figure 5-4. Leak check of meter box.

6.1 Nomenclature

A_n = Cross-sectional area of nozzle, m² (ft²).
B_{ws} = Water vapor in the gas stream, proportion by volume.
C_a = Acetone blank residue concentration, mg/g.
c_s = Concentration of particulate matter in stack gas, dry basis, corrected to standard conditions, g/dscm (g/dscf).
I = Percent of isokinetic sampling.
L_a = Maximum acceptable leakage rate for either a pretest leak check or for a leak check following a component change; equal to 0.0057 m³/min (0.02 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), m³/min (cfm).
L_p = Leakage rate observed during the post-test leak check, m³/min (cfm).
m_n = Total amount of particulate matter collected, mg.
M_w = Molecular weight of water, 18.0 g/g-mole (18.0lb/lb-mole).
m_a = Mass of residue of acteone after evaporation, mg.
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-m³/°K-g-mole (21.85 in. Hg-ft³/°R-lb-mole).
T_m = Absolute average dry gas meter temperature (see Figure 5-2), °K (°R).
T_s = Absolute average stack gas temperature (see Figure 5-2), °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 5-3), ml.
V_m = Volume of gas sample as measured by dry gas meter, dcm (dscf).
$V_{m(std)}$ = 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 2-9, 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 5-2), 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.

6.2 Average dry gas meter temperature and average orifice pressure drop. See data sheet (Figure 5-2).

6.3 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.

$$V_{m(std)} = V_m Y\left(\frac{T_{std}}{T_m}\right)\left[\frac{P_{bar}+\frac{\Delta H}{13.6}}{P_{std}}\right]$$

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

Equation 5-1

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 by the expression:

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

and substitute only for tho
(L_i or L_p) which exceed L_a
6.4 Volume of water vapo

$$V_{w(std)} = V_{lc}\left(\frac{\rho_w}{M_w}\right)\left(\frac{RT_{std}}{P_{std}}\right.$$

where:
K_2 = 0.001333 m³/ml for met
= 0.04707 ft³/ml for Engl
6.5 Moisture Content.

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

Equation 5-3
NOTE: In saturated or wa
gas streams, two calculati
ture content of the stack g
one from the impinger ana
3), and a second from th
saturated conditions. The
values of B_{ws} shall be consid
procedure for determining
tent based upon assumpt
conditions is given in the N
of Method 4. For the
method, the average stack
from Figure 5-2 may be u
determination, provided t
of the in-stack temperatur
(2° F).

6.6 Acetone Blank Conc

Equation 5-

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

6.7 Acetone Wash Blank.

$W_a = C_a V_{aw}\rho_a$ Equ

6.8 Total Particulate W
the total particulate catch
the weights obtained from
2 less the acetone blank (s

NOTE: Refer to Section
calculation of results invo
filter assemblies or two
trains.

6.9 Particulate Concent
C_s = (0.001 g/mg) (m_n/V
5-6

6.10 Conversion Factors:

of water, 0.9982 g/ml (0.002201

ıpling time, min.
g time interval, from the begin-
a run until the first component
min.
g time interval, between two suc-
component changes, beginning
: interval between the first and
hanges, min.
g time interval, from the final
ıponent change until the end of
ɔling run, min.
ic gravity of mercury.
ı.
ˈsion to percent.

.ge dry gas meter temperature
· orifice pressure drop. See data
ˈe 5-2).
Ɔas Volume. Correct the sample
ısured by the dry gas meter to
nditions (20° C, 760 mm Hg or
in. Hg) by using Equation 5-1.

$$Y\left(\frac{T_{std}}{T_m}\right)\left[\frac{P_{bar}+\frac{\Delta H}{13.6}}{P_{std}}\right]$$

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

Equation 5-1

K/mm Hg for metric units
t/in. Hg for English units

ation 5-1 can be used as written
ɛakage rate observed during any
latory leak checks (i.e., the post-
ıeck or leak checks conducted
ıponent changes) exceeds L_a. If
ɛeds L_a, Equation 5-1 must be
follows:
. No component changes made
ɔling run. In this case, replace
ion 5-1 with the expression:

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

II. One or more component
de during the sampling run. In
place V_m in Equation 5-1 by the

$$L_a)\theta_1$$

$$-\sum_{i=2}^{n}(L_i-L_a)\theta_i-(L_p\quad L_a)\theta_p\Big]$$

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

6.4 Volume of water vapor.

Equation 5-2

$$V_{w(std)} = V_{lc}\left(\frac{\rho_w}{M_w}\right)\left(\frac{RT_{std}}{P_{std}}\right)=K_2V_{lc}$$

where:
K_2 = 0.001333 m³/ml for metric units
= 0.04707 ft³/ml for English units.

6.5 Moisture Content.

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

Equation 5-3

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_w shall be considered correct. The procedure for determining the moisture content based upon assumption of saturated conditions is given in the Note of Section 1.2 of Method 4. For the purposes of this method, the average stack gas temperature from Figure 5-2 may be used to make this determination, provided that the accuracy of the in-stack temperature sensor is ±1° C (2° F).

6.6 Acetone Blank Concentration.

Equation 5-4

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

6.7 Acetone Wash Blank.

$W_a = C_a V_{aw} \rho_a$ Equation 5-5

6.8 Total Particulate Weight. Determine the total particulate catch from the sum of the weights obtained from containers 1 and 2 less the acetone blank (see Figure 5-3).

NOTE: Refer to Section 4.1.5 to assist in calculation of results involving two or more filter assemblies or two or more sampling trains.

6.9 Particulate Concentration.

$C_s = (0.001\ g/mg)\ (m_n/V_{m\ (std)})$ Equation 5-6

6.10 Conversion Factors:

From	To	Multiply by
scf	m³	0.02832
g/ft³	gr/ft³	15.43
g/ft³	lb/ft³	2.205×10^{-3}
g/ft³	g/m³	35.31

6.11 Isokinetic Varition.

6.11.1 Calculation From Raw Data.

$$I=\frac{100\ T_s[K_3V_{lc}+(P_m/T_m)(P_{bar}+\Delta H/13.6)]}{60\theta_n\ P_s\ A_n}$$

Equation 5-7

where:
K_3 = 0.003454 mm Hg-m³/ml-°K for metric units.
= 0.002669-in. Hg-ft³/ml-°R for English units.

6.11.2 Calculation From Intermediate Values.

$$I=\frac{T_sV_{m(std)}P_{std}100}{T_{std}v_s\theta A_nP_s60(1-B_{ws})}$$

$$=K_4\frac{T_sV_{m(std)}}{P_sv_sA_n\theta(1-B_{ws})}$$

Equation 5-8

where:
K_4 = 4.320 for metric units
= 0.09450 for English units.

6.12 Acceptable Results. If 90 percent I $<110<$ percent, the results are acceptable. If the results are low in comparison to the standard and I is beyond the acceptable range, or, if I is less than 90 percent, the Administrator may opt to accept the results. Use Citation 4 to make judgments. Otherwise, reject the results and repeat the test.

7. *Alternative Procedures*

7.1 Dry Gas Meter as a Calibration Standard. A dry gas meter may be used as a calibration standard for volume measurements in place of the wet test meter specified in Section 5.3, provided that it is calibrated initially and recalibrated periodically as follows:

7.1.1 Standard Dry Gas Meter Calibration.

7.1.1.1 The dry gas meter 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 ft³/rev). A spirometer (400 liters 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 ft³/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.

7.1.1.2 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 dry gas meter 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.

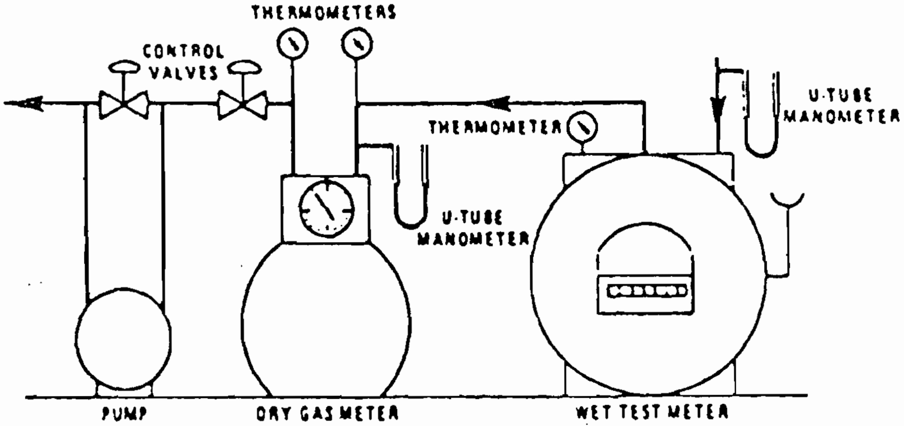
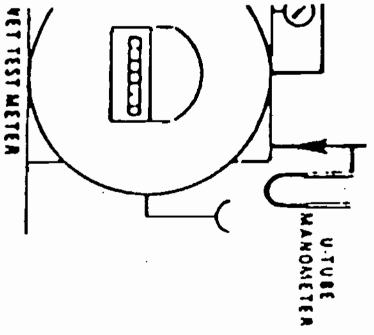


Figure 5.7. Equipment arrangement for dry-gas meter calibration.

7.1.1.3 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.

d In place of the wet test meter :m. Run the pump for at least 5 a flow rate of about 10 liters/min to condition the interior surface test meter. The pressure drop in- the manometer at the inlet side gas meter should be minimized than 100 mm H_2O (4 in. H_2O) at of 30 liters/min (1 cfm). This mplished by using large diame- onnections and straight pipe fit-



gas meter calibration.

w rates should be between 10 /min (0.35 and 1.2 cfm) or over operating range.

DATE: ____________

DRY GAS METER IDENTIFICATION: ____________

BAROMETRIC PRESSURE (P_b): ____________ in. Hg

APPROXIMATE FLOW RATE ($\bar{Q}$) cfm	SPIROMETER (WET METER) GAS VOLUME (V_s) ft^3	DRY GAS METER VOLUME (V_{dg}) ft^3	TEMPERATURES				DRY GAS METER PRESSURE (Δp) in. H_2O	TIME (Θ) min.	FLOW RATE (Q) cfm	METER COEFFICIENT (Y_{ds})	AVERAGE METER COEFFICIENT ($\bar{Y}_{ds}$)
			SPIROMETER (WET METER) (t_s) °F	DRY GAS METER							
				INLET (t_i) °F	OUTLET (t_o) °F	AVERAGE ($\bar{t}_d$) °F					
0.40											
0.60											
0.80											
1.00											
1.20											

$$Q = 17.65 \cdot \frac{V_s}{\Theta} \cdot \frac{P_b}{(t_s + 460)}$$

$$Y_{ds} = \frac{V_s}{V_{dg}} \cdot \frac{(t_d + 460)}{(t_s + 460)} \cdot \frac{P_b}{\left(P_b + \frac{\Delta p}{13.6}\right)}$$

Figure 5.8. Example data sheet for calibration of a standard dry gas meter for method 5 sampling equipment (English units)

7.1.1.4 Calculate flow rate, Q, for each run using the wet test meter gas volume, V_w, and the run time, θ. Calculate the dry gas meter coefficient, Y_{ds}, for each run. These calculations are as follows:

$$Q = K_1 \frac{P_{bar}}{t_w + t_{std}} \frac{V_w}{\theta}$$

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

Where:

K_1 = 0.3858 for international system of units (SI); 17.64 for English units.
V_w = Wet test meter volume, liters (ft³).
V_{ds} = Dry gas meter volume, liters (ft³).
t_{ds} = Average dry gas meter temperature, °C (°F).
t_{std} = 273° C for SI 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.

7.1.1.5 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 five average meter coefficients, $\overline{Y}_{ds}$.

7.1.1.6 Prepare a curve of meter coefficient, $\overline{Y}_{ds}$ versus flow rate, Q, for the dry gas meter. This curve shall be used as a reference when the meter is used to calibrate other dry gas meters and to determine whether recalibration is required.

7.1.2 Standard Dry Gas Meter Recalibration.

7.1.2.1 Recalibrate the standard dry gas meter 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 dry gas meter 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.

7.1.2.2 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 28 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.

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Procedure for Calibratin
Gas Volume Meters as C
ards. Source Evaluation S
3(1):17-30. February 1978.

METHOD 5A—DETERMINAT
EMISSIONS FROM THE A
AND ASPHALT ROOFING I

1. *Applicability and Pri*
1.1 *Applicability*. This
the determination of pa
from asphalt roofing ind
rators, blowing stills, an
specified in the regulatio
1.2 *Principle*. Particul
drawn isokinetically fro
collected on a glass filte
at a temperature of 42°
The particulate mass, w
material that condenses
tration temperature, is
metrically after remov
water.
2. *Apparatus*
2.1 *Sampling Train*.
configuration is the s
Figure 5-1 of Method 5.
consists of the following
2.1.1 *Probe Nozzle, P*
tial Pressure Gauge, Fil
er, Metering System, B
Density Determination
Method 5, Sections 2.1.
2.1.7 to 2.1.10, respective
2.1.2 *Probe Liner*. Sa
Section 2.1.2, with the
stack gas temperatures
(480°F)), water-cooled
quired to control the
ture to 42° ± 10°C (108 ±
2.1.3 *Precollector* C
glass following the
shown in Air Pollutio
ment-0581, "Constructi
etic Source-Sampling E
NOTE: The tester sh
when the stack gas mo
10 percent. The tester
collector cyclone unde
conditions.
2.1.4 *Filter Heating*
(or cooling) system cap
sample gas temperatu
the filter holder d
42° ± 10°C (108° ± 18°F).
gauge capable of meas
within 3°C (5.4°F) at
filter holder so that th
ature can be regula
during sampling. The
tems other than the
0581.

FDER METHODS 5 & 9

% EA is calculated by equation 3-1:

$$\% EA = \left[\frac{\%O_2 - 0.5\ \%CO}{0.264\ \%N_2 - (\%O_2 - 0.5\ \%CO)} \right] X\ 100 \qquad \text{Equation 3-1}$$

4. DER Method 4. This section is reserved.

5. Particulate Emissions.

a. DER Method 5. Determination of Particulate Emissions From Stationary Sources (By Liquid Impingement).

(i) Principle. A sample of the flue gas is withdrawn isokinetically from a source and particulate matter is collected by a series of impingers followed by a filter. The weight of particulate matter is determined gravimetrically after removal of uncombined water from the impinger solution, probe/glassware washing and filter.

(ii) Apparatus.

(A) Sampling Train. A schematic of the sampling train is shown in Figure 5-1. The sampling train consists of the following components:

i. The probe nozzle shall be stainless steel (316), glass, or quartz with a sharp, tapered leading edge. The angle of the taper shall be less than or equal to 30° and the taper shall be on the outside to preserve a constant internal diameter. The nozzle shall be of a button-hook or elbow design. If stainless steel is used, the nozzle shall be constructed from seamless tubing.

ii. The probe liner shall be borosilicate or quartz glass, Teflon, Incoloy 825 or stainless steel 316. Probe heating is not required. At the option of the tester a flexible hose between the probe and first impinger may be used. The hose shall be no more than two times the probe length or 25 feet long, whichever dimension is shorter. The flexible hose shall be made of Tygon, Teflon, or polyethylene or other nonreactive material with a smooth internal surface.

iii. The pitot tube shall be Type S, as described in EPA Method 2, Section 2.1. The pitot tube shall be attached to the probe 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 (Figure 5-2) during sampling. The Type S pitot tube shall have a known coefficient as provided in EPA Method 2, Section 4.

iv. Differential Pressure Gauge. Two inclined manometers or equivalent devices as described in EPA Method 2, Section 2.2 shall be used. One manometer shall be used for velocity (delta P) readings and the other for orifice differential readings (delta P).

v. Filter holders shall be borosilicate glass or stainless steel (316) with a glass or stainless steel (316) frit filter support and a silicone rubber, Teflon, or Viton gasket. The holder shall provide a positive seal against leakage from the outside or around the filter. The filter shall be connected to the exit of the dry trap and entrance to the silica gel impinger.

vi. Condenser. The following system shall be used to determine the stack gas moisture content: Four impingers connected as shown in Figure 5-1 with leak free, noncontaminating fittings. The filter is connected between the third and fourth impingers. The first, third and fourth impingers shall be of the Greenburg-Smith design, modified by replacing the tip with 1.3 cm (1/2 in.) I.D. glass tubing extending to 1.3 cm (1/2 in.) from the bottom of the flask. The second impinger shall be an unmodified Greenburg-Smith design. The first and second impingers shall contain measured quantities of water, the third shall be empty, and the fourth shall contain a measured quantity of silica gel. A thermometer capable of measuring the outlet temperature to within 1°C (2°F) shall be placed in the exit stream of the fourth impinger.

vii. The metering system shall consist of a vacuum gauge, leak-free pump, thermometers capable of measuring temperature to with 3°C (5.4°F), dry gas meter capable of measuring volume to within two percent, and related equipment, as shown in Figure 5-1. Isokinetic sampling rate is controlled with the use of the system.

viii. Barometer. A device capable of measuring atmospheric pressure to within 2.5 mm Hg (0.1 in. Hg) shall be used. Alternatively, barometric pressure may be obtained from the nearest national weather service station and a correction shall be applied to compensate for elevation differences between the barometric pressure measurement point and the sampling meter.

ix. Gas Density Determination Equipment. The tester shall use a temperature sensor and pressure gauge as described in EPA Method 2, Sections 2.3 and 2.4, and a gas analyzer as described in EPA Method 3. When stack temperature is measured, the temperature sensor must be attached in an interference-free arrangement with respect to the Type S pitot openings (Figure 5-3).

(B) Sample Recovery Equipment.

i. Probe liner and Probe-Nozzle Brushes. The tester shall use brushes made from inert materials such as nylon, or teflon with nylon, teflon or stainless steel handles and extensions. The brushes shall be properly shaped and sized to brush out the probe liner nozzle and filter holder.

ii. Wash Bottles. Two are required and shall be made of glass, polyethylene, or teflon. Acetone used for probe washing shall not have been stored in polyethylene bottles for longer than 30 days.

iii. Sample Storage Containers. Glass, teflon, high density polyethylene bottles of 500 to 1000 ml capacity shall be used.

iv. Storage Dishes. Filters shall be stored flat in glass, metal or polyethylene storage dishes.

v. Graduated Cylinder and/or Balance. Condensed water shall be measured to within 1 ml or 1 g using either a graduated cylinder with subdivisions no greater than 2 ml or a laboratory balance capable of readings to 0.5 g or less.

vi. Silica gel storage containers. Plastic or glass airtight containers shall be used.

(C) Analytical Apparatus shall consist of:

i. Inert weighing dishes.

ii. Desiccator stocked with anhydrous calcium sulfate indicating desiccant.

iii. Analytical balance with enclosed, desiccated weighing enclosure and capable of weighing to 0.1 mg.

iv. Balance to measure to 0.5 g.

v. Beakers, 250 ml, borosilicate glass.

vi. Inert vacuum filtration system.

vii. Pyrex glass filtering media for (vi) above with 98 percent retention efficiency at 0.2 micron particle size.

viii. Hygrometer to measure relative humidity of the laboratory environment.

ix. Temperature gauge to measure the temperature of the laboratory environment.

(iii) Reagents/Filter Media.

(A) Sampling. The reagents required are as follows:

i. Filters. Glass fiber filters, without organic binder, exhibiting at least 99.95 percent efficiency on 0.3 micron dioctyl pnthalate smoke particles.

ii. Silica Gel. Indicating type, 5 to 16 mesh. If previously used, dry at 175°C (350°F) for two hours. New silica gel may be used as received.

iii. Water. Analysis of the material caught in the impingers is required, and distilled or deionized water shall be used. Run blanks prior to field use to eliminate a high blank, above 0.001 percent residue.

iv. Crushed Ice.

v. Stopcock grease. Acetone insoluble, heatstable grease shall be used unless screw-on connectors with Teflon sleeves are used.

(B) Sample Recovery.

i. Acetone. Reagent grade (less than or equal to 0.001 percent residue) in glass storage bottles shall be used.

ii. Distilled or Deionized Water. Distilled or deionized water (less than or equal to 0.001 percent residue) shall be used.

(C) Analysis.

i. Acetone. Reagent grade (less than or equal to 0.001 percent residue) in glass bottles.

ii. Desiccant. Anhydrous calcium sulfate, indicating type.

(iv) Procedures.

(A) Sampling.

i. Pretest Preparation. All components shall be maintained and calibrated so as to allow isokinetic sampling of particulate emissions with documented evidence of all sampling and analytical calibrations for each submitted emission measurement.

A. Dry silica gel weight shall be determined and recorded to the nearest 0.5 g for each sampling run.

B. Check sampling filters visually and do not use any with irregularities, flaws or pinholes. Clearly number the glass fiber filters on the back side near the edge. The filters shall be oven dried at 105°C (220°F) for two hours, desiccated at ambient temperature for two hours, and then weighed to the nearest 0.1 mg. Optionally, desiccate the filter at ambient temperature and pressure for at least 24 hours. Weigh each filter at intervals of at least 6 hours until they attain a constant weight, i.e., less than 0.5 mg change from previous weighing. Do not expose filter being weighed to a relative humidity above 50% for longer than 1 minute. Record the results to the nearest 0.1 mg. Record the relative humidity and dry bulb temperature of the air in the laboratory at the time of weighing.

ii. Preliminary Determinations. Select the sampling site and traverse points according to EPA or DER Method 1. Determine the stack pressure, temperature, and preliminary velocity traverse using EPA or DER Method 2. Prior to test, determine the moisture content using EPA Method 4 or by knowledge of the process. Determine the stack gas dry molecular weight using EPA or DER Method 3. Select a sampling nozzle such that it can be used during the entire isokinetic run. Do not change nozzle size during the run. Select a sample time such that each traverse point is sampled for at least 2 minutes, and the sample volume (computed at dry standard conditions) is at least equal to the volume specified in Table 700-1, Applicable Test Procedures for Point Source Compliance Test. Reference 17-2.700(1)(d)3. for required sampling rate range.

iii. Preparation of Sampling Train.

A. During preparation and assembly of the sampling train, keep all openings sealed where contamination can occur, until just prior to assembly or until sampling is about to begin.

B. Place 100 ml of water in each of the first two impingers, leave the third empty, and transfer a known weight of between 200 to 300 g of silica gel to the fourth impinger. Silica gel shall not be entrained and carried out from the impinger during sampling.

C. Using a tweezer or clean disposable gloves, place an identified and weighed filter in the filter holder. The filter shall be properly centered and the gasket properly placed so as to prevent the sample gas from circumventing the filter. Check the filter for tears after assembly is completed. Replace if torn. Mark the probe to denote the proper distance into the stack or duct for each sampling point. Install the sampling nozzle using a leak-free connection.

D. Set up the train as shown in Figure 5-1 using a very light coat of silicone grease on any ground glass joints, greasing only the outer portion to avoid possibility of sample contamination by the silicone grease. Place ice around the impingers.

E. Post Test Leak Check. The sampling train shall be leak-checked by plugging the nozzle and pulling a 15 inch Hg vacuum. The coarse adjustment valve on the sampling train gas metering system must be open during this check. A lower vacuum may be used, provided that it was not exceeded during the test. Leakage rates in excess of 4 percent of the average sampling rate or 0.02 cfm, whichever is less, must be corrected for in the computed test results as shown in EPA Method 5 or void the sampling run.

If an asbestos string is used to seal the sampling nozzle, the tester may, as an option to E. above, perform the following leak-checks. Do not connect the nozzle to the probe during the leak check. Instead leak-check the train by plugging the inlet to the probe liner and by conducting the leak check as previously described in this subsection. Then connect the nozzle to the probe and conduct a second leak check in accordance with this subsection but at a vacuum of 1 in. Hg. Correct for any leakage rate in excess of 4 percent of the average sampling rate or 0.02 cfm.

iv. Sampling Train Operation. Sampling train shall be operated in accordance with the provisions of EPA Method 5, Section 4.1.

(B) Sample Recovery.

i. After the run is complete, remove the probe from the stack and allow it to cool until it can be safely handled. Carefully wipe off all external particulate material near the tip. Record the final sample volume. Remove all condensate from the probe and flexible hose.

ii. Remove the probe from the sampling train, wipe off excess silicone grease and cap the ends of the probe and the impinger inlet. Remove the umbilical cord from the last impinger and seal this impinger. Seal both ends of the flexible umbilical. Transfer the probe umbilical and impinger filter assembly to the cleanup area.

iii. Save a 100 ml portion of the acetone or water used for cleanup as a blank. Take 100 ml of the wash liquid directly from the wash bottle being used, transfer to a clean sample bottle, and label with the type of contents, the date, the tester's name and the unit tested.

iv. Inspect the sampling train prior to and during disassembly and record evidence of any components that are not in proper operating condition. Treat samples as follows:

A. Filter. Carefully remove each filter from the filter holders with tweezers or gloves and place it in an identified storage container. Transfer to the storage container or the probe wash container any particulate matter or filter fibers which adhere to the filter holder or the filter holder gasket. Use an inert bristle brush and/or a sharp blade to remove this material. Seal the container.

B. Sampling Train Washes. Washing will be done using water or acetone as specified in Table 700-1. The wash will be performed as follows for either wash liquid: The tester shall quantitatively recover particulate and any condensible matter from the interior surfaces of the probe nozzle, probe fitting(s), probe liner, flexible umbilical (if used) and front half of the filter holder by washing and brushing with acetone or water, whichever is specified in Table 700-1, Applicable Test Procedures for Point Source Compliance Tests, until no visible particles are present in the wash.

(I) The nozzle and its fitting shall be removed from the probe before washing. Brushing and rinsing of the nozzle and fitting shall continue until no visible particles are present in the wash, then a final rinse is done after removing the brush. The brush is to be rinsed after completing each wash.

(II) The probe liner shall be tilted up from horizontal and rotated while rinsing from the upper end so as to wet all interior surfaces with rinse liquid. A wet brushing of the liner shall follow rinsing. Hold the probe in an inclined position, squirt wash liquid into the upper end as the probe brush is being pushed with a twisting action through the probe. Run the brush through the probe three or more times for glass probes, six or more times for metal liners. No particulate matter shall be visible in the final rinse and none shall remain in the probe on visual inspection. Rinse again after final brushing, tilting the probe and rotating so as to wet all interior surfaces. Rinse the brush after the brushing procedure is complete. Quantitatively collect all wash liquid. Transfer all wash liquids into a clean labeled container. Rinse the transfer funnel into the sample container. Protect the brushes from contamination between sample runs.

(III) The flexible umbilical, when used, shall be securely fixed to a flat rigid surface in a straight line for washing. Umbilicals longer than 15 feet may be washed in two successive, overlapping sections; otherwise, washing procedures are identical to those used for probe liners.

(IV) The front half of the filter holder shall be washed after any silicone grease has been wiped from the joints. Rub inside surfaces with an inert bristle brush while washing with acetone or water as specified in Table 700-1. Wash each surface three or more times as necessary to remove visible particulate matter. Make a final rinse of the holder and brush used.

(V) Quantitatively transfer all washes into the clean sample container and seal so that no acetone or water will leak out when the bottle is transferred to the laboratory. Mark the height of the fluid level to determine whether or not leakage occurred during transport. Label the container clearly and indelibly to identify the contents including the sample site identification, date, test run number, and tester's name.

C. Silica gel. 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 the original container and seal. If a balance is available in the field, follow the procedure for silica analysis in EPA Method 5, Section 4.3.

D. Impinger Water. Treat the impingers as follows: Make a notation of any color or film in the liquid catch. Measure the liquid in the first three impingers to within plus or minus 1.0 g or 1 ml by using a balance or a graduated cylinder. Record the amount of liquid present. Transfer the impinger ~~liquid~~ contents into a clean storage container. Wash the impinger flasks, impinger inserts, interconnecting glassware and graduated cylinder. If an acetone probe wash has been used, wash the impinger components with acetone. If a water probe wash was used, wash the impinger components with water. Wash and brush with an inert bristle brush all of the first three impinger interior surfaces and the interior surfaces of the interconnecting glassware until no visible particulate remains. Rinse the brush often during use. Quantitatively collect all washes. Add acetone wash, if used, to the probe wash sample. Add water wash, if used, to the impinger water storage container. Seal the sample bottles so that no leakage will occur during transport to the laboratory. Label the sample clearly and include: contents, sample site identification, number of test run, date, and name of tester. Mark the fluid height level so that leakage will be detected.

E. Blank samples will be collected at the sample site at a rate of one blank of each type described herein for each set of three consecutive sample runs. Collection shall be made at some time after the sample recovery of the first run and before completion of sample recovery of the third run for each set of three consecutive runs at one sample location. Blank samples shall be collected at the same location at which all sample recovery operations are performed, using the same transfer techniques and equipment (including transfer or collection bottle and funnels). Blanks shall be drawn from the same wash bottles used for sample recovery washing and from the same stock of filters used for filter holder reloading. The following blanks and additional procedures are required;

(I) Filter blanks shall consist of unused, tared filters and shall be removed from their storage containers and transferred to clean storage dishes and sealed.

(II) Acetone or water blanks. 100 plus or minus 10 ml of wash are transferred from the wash bottle into a clean sample bottle. The bottle is sealed.

(III) Blank Storage. The above blank samples shall be labeled clearly to identify the contents, plant name, sample site identification, date and name of tester. Blank samples shall be stored so as to preserve their integrity from loss or contamination.

(v) Analysis.

(A) Sample Filter and Blank Filter. Leave the contents of the storage dish in the shipping container or transfer the filter and any loose particulate from the sample container to a tared weighing dish. The filters shall be placed in a desiccator containing anhydrous calcium sulfate for 24 hours and weighed at 6 hour intervals until the weight is constant. As an option, the filter may be oven dried at 105°C (221°F) for 2 to 3 hours, cooled in a desiccator containing anhydrous calcium sulfate, and weighed after 2 hour cooling. Do not expose filter being weighed to a relative humidity above 50% for longer than 1 minute. Record the relative humidity and dry bulb temperature of the laboratory air. For purposes of analysis, the term "constant weight" means a difference of no more than 0.5 mg or 1 percent of the total weight less tare weighings. At least 6 hours of desiccation time is required between weighings. Report the weight to the nearest 0.1 mg.

(B) Silica Gel. Determine the increase in weight of the silica gel.

(C) Impinger Water and Impinger Blank. These samples are analyzed for particulate by the following procedures.

Shake the sample bottles and check to assure that no liquid has been lost since testing. Record the quantity of sample lost.

i. Place the impinger water samples and blank samples into separate tared beakers and evaporate each to dryness over low heat (max. 95°C) at ambient pressure.

ii. Alternatively, if no suspended particulate is visible in the samples, an aliquot (100 ml. minimum) of the impinger water and wash may be evaporated to dryness at low heat (max. 95°C) and ambient pressure instead of the complete sample.

iii. Alternatively, if suspended particulate is visible, the sample may be filtered using a tared filter to determine insoluble particulate and an aliquot (100 ml. minimum) of the filtrate shall be analyzed for soluble particulate. This filter shall be analyzed using the same preparation and analytical methods as sample train filters except that the water wash filter shall be washed with at least 1000 ml of water prior to the initial taring process.

(D) Acetone Wash and Blank.

i. The analysis shall be made in accordance with EPA Method 5, Section 4.3, Container No. 2.

ii. Acetone Blank Analysis. The analysis shall be made in accordance with the EPA Method 5, Section 4.3, Container No. 1.

(vi) Calibration. Calibration of the sampling train shall be conducted in accordance with the schedule shown in Table 700-2.

(vii) Calculations. The calculations shall be made in accordance with EPA Method 5, Section 6, with the following exceptions:

(A) Total Particulate Weight. EPA Method 5, Section 6.8.

i. Water Wash Sampling. Determine the total particulate catch from the sum of the weights obtained from the filter analysis, the wash analysis, and the impinger water analysis, less the water and filter blank analysis.

ii. Acetone Wash Sampling. Determine the total particulate catch from the sum of the weights obtained from the filter analysis, the wash analysis and the impinger water analysis minus the acetone and impinger water blank analysis.

(B) Acceptable Sampling Rates. If the calculated isokinetic rate for each run is between 90 percent and 110 percent of isokinetic, inclusive, the rates are acceptable. If the measured emissions are low in comparison to the emission limiting standard (equal to or less than 80 percent of the standard) and if the isokinetic rate for a run is between 80 percent and 110 percent of isokinetic inclusive, the sampling rate is acceptable.

b. DER Method 5A. Determination of Total Particulate Emission Rate and Particle Size Distribution From Liquid Sulfur Tank Vents. (Reserved).

6. DER Method 6. Determination of Sulfur Dioxide Emissions from Stationary Sources. The provisions of EPA Method 6 (40 CFR 60, Appendix A) are adopted by reference except for the following:

Simultaneous Particulate Sampling, EPA Method 6, Section 2.1.

The tester shall not determine particulate and SO_2 simultaneously.

7. DER Method 7. This section is reserved.

8. DER Method 8. This section is reserved.

9. DER Method 9. Visual Determination of Opacity of Emissions from Stationary Sources. The provisions of EPA Method 9 (40 CFR 60, Appendix A) are adopted by reference with the following exceptions:

a. EPA Method 9, Section 2.4, Recording Observations. Opacity observations shall be made and recorded by a certified observer at sequential fifteen second intervals during the required period of observation.

b. EPA Method 9, Section 2.5, Data Reduction. For a set of observations to be acceptable, the observer shall have made and recorded or verified the recording of at least 90 percent of the possible individual observations during the required observation period.

For single valued opacity standards (i.e., 20 percent opacity), the test result shall be the highest valid six minute average for the set of observations taken.

For multiple-valued opacity standards (i.e., 20 percent opacity, except that an opacity of 40 percent is permissible for not more than 2 minutes per hour) opacity shall be computed as follows:

(i) For the basic part of the standard (i.e., 20 percent opacity) the opacity shall be determined as specified above for a single-valued opacity standard.

(ii) For the short-term average part of the standard, opacity shall be the highest valid short-term average (i.e., 2 minute, 3 minute average) for the set of observations taken.

In order to be valid, any required average (i.e., a six minute or two minute average) shall be based on all of the valid observations in the sequential sub-set of observations selected and the selected sub-set shall contain at least 90 percent of the observations possible for the required averaging time.

Calculate each required average by summing the opacity value of each of the valid observations in the appropriate sub-set and dividing this sum by the number of valid observations in the sub-set. Round this number to the nearest whole number and indicate the number of missing observations in the sub-set in parenthesis after the sub-set average value.

10. DER Method 10. This section is reserved.

11. DER Method 11. This section is reserved.

12. DER Method 12. This section is reserved.

13. DER Method 13. This section is reserved.

(b) EPA Test Procedures. The following EPA test procedures contained in 40 CFR 60, Appendix A, are adopted by reference (a copy of the above referenced document is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. and may be inspected and copied at the Department's Tallahassee Office).

1. EPA Method 1 - Sample and Velocity Traverses for Stationary Sources - 42 FR 41754 (08/18/77); amended 43 FR 11984 (03/23/78); amended 48 FR 45034 (09/30/83).

U.S. EPA METHOD 25

must be similar for all analyzers so that data can be correlated. The minimum data recording requirement for each analyzer is one measurement value per minute.

3.4 *Preparation.* Prepare and calibrate all equipment and analyzers according to the procedures in the respective methods. For the CO_2 analyzer, follow the procedures described in Method 10 for CO analysis substituting CO_2 calibration gas where the method calls for CO calibration gas. The span value for the CO_2 analyzer shall be 15 percent by volume. All calibration gases must be introduced at the connection between the probe and the sample line. If a manifold system is used for the exhaust analyzers, all the analyzers and sample pumps must be operating when the calibrations are done. Note: For the purposes of this test, methane should not be used as an organic calibration gas.

3.5 *Sampling.* At the beginning of the test period, record the initial parameters for the inlet volume meter according to the procedures in Method 2A and mark all of the recorder strip charts to indicate the start of the test. Continue recording inlet organic and exhaust CO_2, CO, and organic concentrations throughout the test. During periods of process interruption and halting of gas flow, stop the timer and mark the recorder strip charts so that data from this interruption are not included in the calculations. At the end of the test period, record the final parameters for the inlet volume meter and mark the end on all of the recorder strip charts.

3.6 *Post Test Calibrations.* At the conclusion of the sampling period, introduce the calibration gases as specified in the respective reference methods. If an analyzer output does not meet the specifications of the method, invalidate the test data for the period. Alternatively, calculate the volume results using initial calibration data and using final calibration data and report both resulting volumes. Then, for emissions calculations, use the volume measurement resulting in the greatest emission rate or concentration.

4. *Calculations.*

Carry out the calculations, retaining at least one extra decimal figure beyond that of the acquired data. Round off figures after the final calculation.

4.1 *Nomenclature*

CO_e = Mean carbon monoxide concentration in system exhaust, ppmv.
CO_{2e} = Mean carbon dioxide concentration in system exhaust, ppmv.
HC_e = Mean organic concentration in system exhaust as defined by the calibration gas, ppmv.
HC_i = Mean organic concentration in system inlet as defined by the calibration gas, ppmv.
K = Calibration gas factor = 2 for ethane calibration gas.
= 3 for propane calibration gas.
= 4 for butane calibration gas.
= Appropriate response factor for other calibration gas.
V_{es} = Exhaust gas volume, M^3.
V_{is} = Inlet gas volume, M^3.
Q_{es} = Exhaust gas volume flow rate, m^3/min.
Q_{is} = Inlet gas volume flow rate, m^3/min.

CO_2, ppmv. (CO_2 concentration in the ambient air may be measured during the test period using an NDIR and the mean value substituted into the equation.)

4.2 Concentrations. Determine mean concentration of inlet organics, outlet CO_2, outlet CO, and outlet organics according to the procedures in the respective methods and the analyzers' calibration curves, and for the time intervals specified in the applicable regulations. Concentrations should be determined on a parts per million by volume (ppmv) basis.

4.3 *Exhaust Gas Volume.* Calculate the exhaust gas volume as follows:

$$V_{es} = V_{is} \frac{K(HC_i)}{K(HC_e) + CO_{2e} - 300}$$

Eq. 2B-1

4.4 *Exhaust Gas Volume Flow Rate.* Calculate the exhaust gas volume flow rate as follows:

$$Q_{es} = \frac{V_{es}}{\theta}$$

Eq. 2B-2

5. *Bibliography.*

5.1 Measurement of Volatile Organic Compounds. U.S. Environmental Protection Agency. Office of Air Quality Planning and Standards. Research Triangle Park, N.C. 27711. Publication No. EPA-450/2-78-041. October 1978. p. 55.

* * * * *

Method 25A—Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer

1. *Applicability and Principle.*

1.1 *Applicability.* This method applies to the measurement of total gaseous organic concentration of vapors consisting primarily of alkanes, alkenes, and/or arenes (aromatic hydrocarbons). [redacted] (or other appropriate organic calibration gas) or in terms of carbon.

1.2 *Principle.* A gas sample is extracted from the source through a heated sample line, if necessary, and glass fiber filter to a flame ionization analyzer (FIA). Results are reported as volume concentration equivalents of the calibration gas or as carbon equivalents.

2. *Definitions.*

2.1 *Measurement System.* The total equipment required for the determination of the gas concentration. The system consists of the following major subsystems:

2.1.1 *Sample Interface.* That portion of the system that is used for one or more of the following: sample acquisition, sample transportation, sample conditioning or protection of the analyzer from the effects of the stack effluent.

2.1.2 *Organic Analyzer.* That portion of the system that senses organic concentration and generates an output proportional to the gas concentration.

2.2 *Span Value.* The upper limit of a gas concentration measurement range that is specified for affected source categories in the applicable part of the regulations. The span value is established in the applicable regulation and is usually 1.5 to 2.5 times the applicable emission limit. If no span value is provided, use a span value equivalent to 1.5 to 2.5 times the expected concentration. For convenience, the span value should correspond to 100 percent of the recorder scale.

2.3 *Calibration Gas.* A known concentration of a gas in an appropriate diluent gas.

2.4 *Zero Drift.* The difference in the measurement system response to a zero level calibration gas before and after a stated period of operation during which no unscheduled maintenance, repair, or adjustment took place.

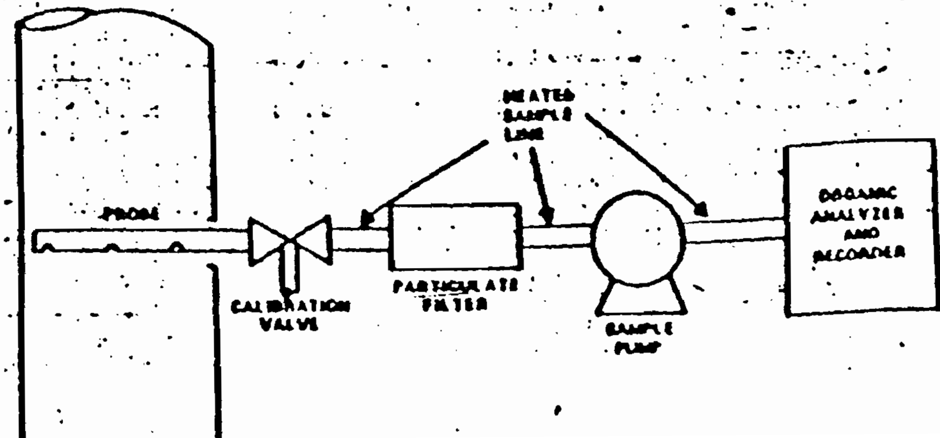
2.5 *Calibration Drift.* The difference in the measurement system response to a mid-level calibration gas before and after a stated period of operation during which no unscheduled maintenance, repair or adjustment took place.

2.6 *Response Time.* The time interval from a step change in pollutant concentration at the inlet to the emission measurement system to the time at which 95 percent of the corresponding final value is reached as displayed on the recorder.

2.7 *Calibration Error.* The difference between the gas concentration indicated by the measurement system and the known concentration of the calibration gas.

3. *Apparatus.*

A schematic of an acceptable measurement system is shown in Figure 25A-1. The essential components of the measurement system are described below.



3.1 Organic Concentration Analyzer. A flame ionization analyzer (FIA) capable of meeting or exceeding the specifications in this method.

3.2 Sample Probe. Stainless steel, or equivalent, three-hole rake type. Sample holes shall be 4 mm in diameter or smaller and located at 16.7, 50, and 83.3 percent of the equivalent stack diameter. Alternatively, a single opening probe may be used so that a gas sample is collected from the centrally located 10 percent area of the stack cross-section.

3.3 Sample Line. Stainless steel or Teflon* tubing to transport the sample gas to the analyzers. The sample line should be heated, if necessary, to prevent condensation in the line.

3.4 Calibration Valve Assembly. A three-way valve assembly to direct the zero and calibration gases to the analyzers is recommended. Other methods, such as quick-connect lines, to route calibration gas to the analyzers are applicable.

3.5 Particulate Filter. An in-stack or an out-of-stack glass fiber filter is recommended if exhaust gas particulate loading is significant. An out-of-stack filter should be heated to prevent any condensation.

3.6 Recorder. A strip-chart recorder, analog computer, or digital recorder for recording measurement data. The minimum data recording requirement is one measurement value per minute. Note: This method is often applied in highly explosive areas. Caution and care should be exercised in choice of equipment and installation.

4. Calibration and Other Gases.

Gases used for calibrations, fuel, and combustion air (if required) are contained in compressed gas cylinders. Preparation of calibration gases shall be done according to the procedure in Protocol No. 1, listed in Reference 9.2. Additionally, the manufacturer of the cylinder should provide a recommended shelf life for each calibration gas cylinder over which the concentration does not change more than ±2 percent from the certified value. For calibration gas values not generally available (i.e., organics between 1 and 10 percent by volume), alternative methods for preparing calibration gas mixtures, such as dilution systems, may be used with prior approval of the Administrator.

Calibration gases usually consist of propane in air or nitrogen and are determined in terms of the span value. Organic compounds other than propane can be used following the above guidelines and making the appropriate corrections for response factor.

4.1 Fuel. A 40 percent H_2/60 percent He or 40 percent H_2/60 percent N_2 gas mixture is recommended to avoid an oxygen synergism effect that reportedly occurs when oxygen concentration varies significantly from a mean value.

4.2 Zero Gas. High purity air with less than 0.1 parts per million by volume (ppmv) of organic material (propane or carbon equivalent) or less than 0.1 percent of the span value, whichever is greater.

4.3 Low-level Calibration Gas. An organic calibration gas with a concentration equivalent to 25 to 35 percent of the applicable span value.

4.4 Mid-level Calibration Gas. An organic calibration gas with a concentration equivalent to 45 to 55 percent of the applicable span value.

4.5 High-level Calibration Gas. An organic calibration gas with a concentration equivalent to 80 to 90 percent of the applicable span value.

5. Measurement System Performance Specifications.

5.1 Zero Drift. Less than ±3 percent of the span value.

5.2 Calibration Drift. Less than ±3 percent of span value.

5.3 Calibration Error. Less than ±5 percent of the calibration gas value.

6. Pretest Preparations.

6.1 Selection of Sampling Site. The location of the sampling site is generally specified by the applicable regulation or purpose of the test, i.e., exhaust stack, inlet line, etc. The sample port shall be located at least 1.5 meters or 2 equivalent diameters (whichever is less) upstream of the gas discharge to the atmosphere.

6.2 Location of Sample Probe. Install the sample probe so that the probe is centrally located in the stack, pipe, or duct and is sealed tightly at the stack port connection.

6.3 Measurement System Preparation. Prior to the emission test, assemble the measurement system following the manufacturer's written instructions in preparing the sample interface and the organic analyzer. Make the system operable.

FIA equipment can be calibrated for almost any range of total organics concentrations. For high concentrations of organics (>1.0 percent by volume as propane) modifications to most commonly available analyzers are necessary. One accepted method of equipment modification is to decrease the size of the sample to the analyzer through the use of a smaller diameter sample capillary. Direct and continuous measurement of organic concentration is a necessary consideration when determining any modification design.

6.4 Calibration Error Test. Immediately prior to the test series, (within 2 hours of the start of the test) introduce zero gas and high-level calibration gas at the calibration valve assembly. Adjust the analyzer output to the appropriate levels, if necessary. Calculate the predicted response for the low-level and mid-level gases based on a linear response line between the zero and high-level responses. Then introduce low-level and mid-level calibration gases successively to the measurement system. Record the analyzer responses for low-level and mid-level calibration gases and determine the differences between the measurement system responses and the predicted responses. These differences must be less than 5 percent of the respective calibration gas value. If not, the measurement system is not acceptable and must be replaced or repaired prior to testing. No adjustments to the measurement system before the drift check (Section 7.2). If adjustments are necessary before the completion of the test series, perform the drift checks prior to the required adjustments and repeat the calibration following the adjustments. If multiple electronic ranges are to be used, each additional range must be checked with a mid-level calibration gas to verify the multiplication factor.

6.5 Response Time Test. Introduce zero gas into the measurement system at the calibration valve assembly. When the system output has stabilized, switch quickly to the high-level calibration gas. Record the time from the concentration change to the measurement system response equivalent to 95 percent of the step change. Repeat the test three times and average the results.

7. Emission Measurement Test

7.1 Organic Measurement. Begin sampling at the start of the test period, recording time and any required process information as appropriate. In particular, note on the recording chart periods of process interruption or cyclic operation.

7.2 Drift Determination. Immediately following the completion of the test period and hourly during the test period, reintroduce the zero and mid-level calibration gases, one at a time, to the measurement system at the calibration valve assembly. (Make no adjustments to the measurement system until after both the zero and calibration drift checks are made.) Record the analyzer response. If the drift values exceed the specified limits, invalidate the test results preceding the check and repeat the test following corrections to the measurement system. Alternatively, recalibrate the test measurement system as in Section 6.4 and report the results using both sets of calibration data (i.e., data determined prior to the test period and data determined following the test period).

8. Organic Concentration Calculations.

Determine the average organic concentration in terms of ppmv as propane or other calibration gas. The average shall be determined by the integration of the output recording over the period specified in the applicable regulation.

If results are required in terms of ppmv as carbon, adjust measured concentrations using Equation 25A-1.

$$C_c = K\,C_{meas}$$

Eq. 25A-1

Where:

C_c = Organic concentration as carbon, ppmv.

C_{meas} = Organic concentration as measured, ppmv.

K = Carbon equivalent correction factor.

K = 2 for ethane.

K = 3 for propane.

K = 4 for butane.

K = Appropriate response factor for other organic calibration gases.

9. Bibliography.

9.1 Measurement of Volatile Organic Compounds—Guideline Series. U.S. Environmental Protection Agency. Research Triangle Park, N.C. Publication No. EPA-450/2-78-041. June 1978. p. 46-54.

9.2 Traceability Protocol for Establishing

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* Mention of trade names or specific products does not constitute endorsement by the

Calibration and Audits of Continuous Source Emission Monitors (Protocol No. 1). U.S. Environmental Protection Agency. Environmental Monitoring and Support Laboratory. Research Triangle Park, N.C. June 1978.

9.2 Gasoline Vapor Emission Laboratory Evaluation—Part 2. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, N.C. EMB Report No. 75–GAS–6. August 1975.

Method 25B—Determination of Total Gaseous Organic Concentration Using a Nondispersive Infrared Analyzer

1. *Applicability and Principle.*

1.1 *Applicability.* This method applies to the measurement of total gaseous organic concentration of vapors consisting primarily of alkanes. (Other organic materials may be measured using the general procedure in this method, the appropriate calibration gas, and an analyzer set to the appropriate absorption band.) The concentration is expressed in terms of propane (or other appropriate organic calibration gas) or in terms of carbon.

1.2 *Principle.* A gas sample is extracted from the source through a heated sample line, if necessary, and glass fiber filter to a nondispersive infrared analyzer (NDIR). Results are reported as volume concentration equivalents of the calibration gas or as carbon equivalents.

2. *Definitions.*

The terms and definitions are the same as for Method 25A.

3. *Apparatus.* The apparatus are the same as for Method 25A with the exception of the following:

3.1 *Organic Concentration Analyzer.* A nondispersive infrared analyzer designed to measure alkane organics and capable of meeting or exceeding the specifications in this method.

4. *Calibration Gases.*

The calibration gases are the same as are required for Method 25A, Section 4. No fuel gas is required for an NDIR.

5. *Measurement System Performance Specifications.*

5.1 *Zero Drift.* Less than ±3 percent of the span value.

5.2 *Calibration Drift.* Less than ±3 percent of the span value.

5.3 *Calibration Error.* Less than ±5 percent of the calibration gas value.

6. *Pretest Preparations.*

6.1 *Selection of Sampling Site.* Same as in Method 25A, Section 6.1.

6.2 *Location of Sampling Probe.* Same as in Method 25A, Section 6.2.

6.3 *Measurement System Preparation.* Prior to the emission test, assemble the measurement system following the manufacturer's written instructions in preparing the sample interface and the organic analyzer. Make the system operable.

6.4 *Calibration Error Test.* Same as in Method 25A, Section 6.4.

6.5 *Response Time Test Procedure.* Same as in Method 25A, Section 6.5.

7. *Emission Measurement Test Procedure.*

Proceed with the emission measurement immediately upon satisfactory completion of the calibration.

7.1 *Organic Measurement.* Same as in Method 25A, Section 7.1.

7.2 *Drift Determination.* Same as in Method 25A, Section 7.2.

8. *Organic Concentration Calculations.*

The calculations are the same as in Method 25A, Section 8.

9. *Bibliography.*

The bibliography is the same as in Method 25A, Section 9.

Method 27—Determination of Vapor Tightness of Gasoline Delivery Tank Using Pressure-Vacuum Test

1. *Applicability and Principle.*

1.1 *Applicability.* This method is applicable for the determination of vapor tightness of a gasoline delivery tank which is equipped with vapor collection equipment.

1.2 *Principle.* Pressure and vacuum are applied alternately to the compartments of a gasoline delivery tank and the change in pressure or vacuum is recorded after a specified period of time.

2. *Definitions and Nomenclature.*

2.1 *Gasoline.* Any petroleum distillate or petroleum distillate/alcohol blend having a Reid vapor pressure of 27.6 kilopascals or greater which is used as a fuel for internal combustion engines.

2.2 *Delivery tank.* Any container, including associated pipes and fittings, that is attached to or forms a part of any truck, trailer, or railcar used for the transport of gasoline.

2.3 *Compartment.* A liquid-tight division of a delivery tank.

2.4 *Delivery tank vapor collection equipment.* Any piping, hoses, and devices on the delivery tank used to collect and route gasoline vapors either from the tank to a bulk terminal vapor control system or from a bulk plant or service station into the tank.

2.5 *Time period of the pressure or vacuum test (t).* The time period of the test, as specified in the appropriate regulation, during which the change in pressure or vacuum is monitored, in minutes.

2.6 *Initial pressure (P_i).* The pressure applied to the delivery tank at the beginning of the static pressure test, as specified in the appropriate regulation, in mm H_2O.

2.7 *Initial vacuum (V_i).* The vacuum applied to the delivery tank at the beginning of the static vacuum test, as specified in the appropriate regulation, in mm H_2O.

2.8 *Allowable pressure change (Δp).* The allowable amount of decrease in pressure during the static pressure test, within the time period t, as specified in the appropriate regulation, in mm H_2O.

2.9 *Allowable vacuum change (Δv).* The allowable amount of decrease in vacuum during the static vacuum test, within the time period t, as specified in the appropriate regulation, in mm H_2O.

3. *Apparatus.*

3.1 *Pressure source.* Pump or compressed gas cylinder of air or inert gas sufficient to pressurize the delivery tank to 500 mm H_2O above atmospheric pressure.

3.2 *Regulator.* Low pressure regulator for controlling pressurization of the delivery tank.

3.3 *Vacuum source.* Vacuum pump capable of evacuating the delivery tank to 250 mm H_2O below atmospheric pressure.

3.4 *Pressure-vacuum supply hose.*

3.5 *Manometer.* Liquid manometer, or equivalent instrument, capable of measuring up to 500 mm H_2O gauge pressure with ±2.5 mm H_2O precision.

3.6 *Pressure-vacuum relief valves.* The test apparatus shall be equipped with an in-line pressure-vacuum relief valve set to activate at 675 mm H_2O above atmospheric pressure or 250 mm H_2O below atmospheric pressure, with a capacity equal to the pressurizing or evacuating pumps.

3.7 *Test cap for vapor recovery hose.* This cap shall have a tap for manometer connection and a fitting with shut-off valve for connection to the pressure-vacuum supply hose.

3.8 *Caps for liquid delivery hoses.*

4. *Pretest Preparations.*

4.1 *Summary.* Testing problems may occur due to the presence of volatile vapors and/or temperature fluctuations inside the delivery tank. Under these conditions, it is often difficult to obtain a stable initial pressure at the beginning of a test, and erroneous test results may occur. To help prevent this, it is recommended that, prior to testing, volatile vapors be removed from the tank and the temperature inside the tank be allowed to stabilize. Because it is not always possible to attain completely these pretest conditions, a provision to ensure reproducible results is included. The difference in results for two consecutive runs must meet the criterion in Sections 5.2.5 and 5.3.5.

4.2 *Emptying of tank.* The delivery tank shall be emptied of all liquid.

4.3 *Purging of vapor.* As much as possible, the delivery tank shall be purged of all volatile vapors by any safe, acceptable method. One method is to carry a load of non-volatile liquid fuel, such as diesel or heating oil, immediately prior to the test, thus flushing out all the volatile gasoline vapors. A second method is to remove the volatile vapors by blowing ambient air into each tank compartment for at least 20 minutes. This second method is usually not as effective and often causes stabilization problems, requiring a much longer time for stabilization during the testing.

4.4 *Temperature stabilization.* As much as possible, the test shall be conducted under isothermal conditions. The temperature of the delivery tank should be allowed to equilibrate in the test environment. During the test, the tank should be protected from extreme environmental and temperature variability, such as direct sunlight.

5. *Test Procedure.*

5.1 *Preparations.*

5.1.1 Open and close each dome cover.

5.1.2 *Connect static electrical ground connections to tank.* Attach the liquid delivery and vapor return hoses, remove the liquid delivery elbows, and plug the liquid delivery fittings.

(Note.—The purpose of testing the liquid delivery hoses is to detect tears or holes that would allow liquid leakage during a delivery. Liquid delivery hoses are not considered to be possible sources of vapor leakage, and thus, do not have to be attached for a vapor leakage test. Instead, a liquid delivery hose

U.S. EPA METHOD 7E

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 60

[AD-FRL-2714-3]

Standards of Performance for New Stationary Sources; Hearing

AGENCY: Environmental Protection Agency (EPA).

ACTION: Proposed rule and notice of public hearing.

SUMMARY: This action proposes revisions to Appendix A of 40 CFR Part 60 to add instrumental test methods for oxygen or carbon dioxide, sulfur dioxide, and nitrogen oxides. It also proposes to add these methods to the presently specified test methods in Subparts D and and Da of Part 60, where applicable. Use of these methods may result in savings in both time and costs.

A public hearing will be held, if requested, to provide interested persons an opportunity for oral presentation of data, views, or arguments concerning the proposed revisions.

DATES: *Comments.* Comments must be received on or before May 6, 1985.

Public Hearing. If anyone contacts EPA requesting to speak at a public hearing by March 11, 1985, a public hearing will be held on April 5, 1985 beginning at 10:00 a.m. Persons interested in attending the hearing should call Ms. Shelby Journigan at (919) 541-5578 to verify that a hearing will be held.

Request to Speak at Hearing. Persons wishing to present oral testimony must contact EPA by March 11, 1985.

ADDRESSES: *Comments.* Comments should be submitted (in duplicate if possible) to: Central Docket Section (LE-131), Attention Docket Number A-84-35, U.S. Environmental Protection Agency, 401 M Street SW, Washington, D.C. 20460.

Public Hearing. If anyone contacts EPA requesting a public hearing, it will be held at EPA's Office of Administration Auditorium, Research Triangle Park, North Carolina. Persons interested in attending the hearing or wishing to present oral testimony should notify Ms. Shelby Journigan, Standards Development Branch (MD-13), U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711, telephone number (919) 541-5578.

Docket. Docket No. A-84-35, containing materials relevant to this rulemaking, is available for public inspection and copying between 8:00 a.m. and 4:00 p.m., Monday through Friday, at EPA's Central Docket Section, West Tower Lobby, Gallery 1, Waterside Mall, 401 M Street, SW, Washington, D.C. 20460. A reasonable fee may be charged for copying.

FOR FURTHER INFORMATION CONTACT: Mr. K. William Grimley or Mr. Roger Shigehara, Emission Measurement Branch (MD-19), Emission Standards and Engineering Division, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711, telephone number (919) 541-2237.

SUPPLEMENTARY INFORMATION: Instrumental test methods for oxygen or carbon dioxide, sulfur dioxide, and nitrogen oxides have been employed by local agencies and private consultants to gather emission data at fossil-fuel-fired combustion processes. EPA has reviewed these methods and such supporting information that is available, and in this action is proposing to include these methods in Appendix A of 40 CFR Part 60. EPA is also proposing to add these methods to Subparts D and Da of Part 60.

Miscellaneous

Under Executive Order 12291, EPA must judge whether a regulation is "major" and therefore subject to the requirement of a regulatory impact analysis. This regulation is not major because it will not have an annual effect on the economy of $100 million or more; it will not result in a major increase in costs or prices; and there will be no significant adverse effects on competition, employment, investment, productivity, innovation, or on the ability of U.S.-based enterprises to compete with foreign-based enterprises in domestic or export markets.

This regulation was submitted to the Office of Management and Budget (OMB) for review as required by Executive Order 12291.

Pursuant to the provisions of 5 U.S.C. 605(b), I hereby certify that the attached rule willl not have a significant economic impact on small entities because there will not be any additional testing required, or any changes in the presently specified test methods.

This proposed rulemaking is issued under the authority of sections 111, 114, and 301(a) of the Clean Air Act, as amended (42 U.S.C. 7411, 7414, and 7601(a)).

List of Subjects in 40 CFR Part 60

Air pollution control, Aluminum, Ammonium sulfate plants, Cement industry Coal, Copper, Electric power plants, Glass and glass products, Grains, Intergovernmental relations, Iron, Lead, Metals, Motor vehicles, Nitric acid plants, Paper and paper products industry, Petroleum, Phosphate, Sewage disposal, Steel, Sulfuric acid plants, Volatile organic componds, Waste treatment and disposal, Zinc.

Dated: February 12, 1985.

Lee M. Thomas,

Administrator.

PART 60—[AMENDED]

It is proposed to amend 40 CFR Part 60 as follows:

1. In Appendix A, it is proposed to add Test Methods 3A, 6C, and 7E as follows:

* * * * *

Method 3A. Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)

1. *Applicability and Principle.*

1.1 Applicability. This method is applicable to the determination of oxygen (O_2) and carbon dioxide (CO_2) concentrations in emissions from stationary sources only when specified within the regulations.

1.2 Principle. A sample is continuously extracted from the effluent stream; a portion of the sample stream is conveyed to an instrumental analyzer(s) for determination of O_2 and CO_2 concentration(s). Performance specifications and test procedures are provided to ensure reliable data.

2. *Range and Sensitivity.*

Same as Method 6C, Sections 2.1 and 2.2.

3. *Definitions.*

3.1 Measurement System. The total equipment required for the determination of the O_2 or CO_2 concentration. The measurement system consists of the same major subsystems as defined in Method 6C, Sections 3.1.1, 3.1.2, and 3.1.3.

3.2 Span, Calibration Gas, Analyzer Calibration Error, Sampling System Bias, Zero Drift, Calibration Drift, Response Time, and Calibration Curve. Same as Method 6C, Sections 3.2 through 3.8, and 3.10.

3.3 Interference Response. The output response of the measurement system to a component in the sample gas, other than the gas component being measured.

4. *Measurement System Performance Specifications.*

Same as Method 6C, Sections 4.1 through 4.4.

5. *Apparatus and Reagents.*

5.1 Measurement System. Use any measurement system for O_2 or CO_2 that meets the specifications of this method. A schematic of an acceptable measurement system is shown in Figure 6C-1 of Method 6C. The essential components of the measurement system are described below.

5.1.1 Sample Probe. a leak-free probe of sufficient length to traverse the sample points.

5.1.2 Sample Line. Tubing to transport the sample from the probe to the moisture removal system.

5.1.3 Calibration Valve Assembly, Moisture Removal System, Particulate Filter, Sample Pump, Sample Flow Rate Control, Sample Gas Manifold, and Data Recorder. ame as Method 6C, Sections 5.1.2 through 1.8, and 5.1.10.

5.1.4 Gas Analyzer. An analyzer to termine continuously the O_2 or CO_2 ncentration in the sample gas stream. The nalyzer must meet the applicable performance specifications of Section 4. A means of controlling the analyzer flow rate and a device for determining proper sample flow rate (e.g., precision rotameter, pressure gauge downstream of all flow controls, etc.) must be provided at the analyzer.

5.2 Calibration Gases. The calibration gases for O_2 analyzers shall be O_2 in N_2. The calibration gases for CO_2 analyzers shall be CO_2 in N_2 or CO_2 in air. Use four calibration gases as specified in Method 6C, Sections 5.3.1 through 5.3.4. For O_2 monitors that cannot analyze zero gas, a calibration gas concentration equivalent to less than 10 percent of the span may be used in place of zero gas.

6. *Measurement System Performance Test Procedures.*

Perform the following procedures before measurement of emission (Section 7).

6.1 Calibration concentration Verification. Same as Method 6C, Section 6.1, except if calibration gas analysis is required, use Method 3 and change the acceptance criteria for agreement among Method 3 results to 5 percent (or 0.2 percent by volume, whichever is greater).

6.2 Interference Response. Conduct an interference response test of the analyzer r to its initial use in the field. Thereafter, eck the measurement system if changes made in the instrumentation that could r the interference response (e.g., changes e gas detector). Conduct the interference response in accordance with Section 5.4 of Method 20.

6.3 Measurement System Preparation, Analyzer Calibration Error, Response Time, and Sampling System Bias Check. Same as Method 6C, Sections 6.2 through 6.5.

7. *Emission Test Procedure.*

7.1 Selection of Sampling Site and Sampling Points. Select a measurement site and sampling using the same criteria that are applicable to tests performed using Method 3.

7.2 Sample Collection. Position the sampling probe at the first measurement point, and begin sampling at the same rate as used during the response time test. Maintain constant rate sampling (i.e., + 10 percent) during the entire run. The sampling time per run shall be the same as for tests conducted using Method 3 plus twice the average system response time. For each run, use only those measurements obtained after twice the response time of the measurement system has elapsed to determine the average effluent concentration.

7.3 Zero and Calibration Drift Test. Same as Method 6C, Section 7.4.

8. *Quality Control Procedures*

The following quality control procedures are recommended when the results of this ethod are used for an emission rate ction factor or excess air determination. tester should select one of the following ns for validating measurement results:

If both O_2 and CO_2 are measured Method 3A, the procedures described in Section 4.4 of Method 3 should be followed to validate the O_2 and CO_2 measurement results.

8.2 If only O_2 is measured using Method 3A, measurements of the sample stream CO_2 concentration should be obtained at the sample by-pass vent discharge using an Orsat or Fyrite analyzer, or equivalent. Duplicate samples should be obtained concurrent with at least one run. Average the duplicate Orsat or Fyrite analysis results for each run. Using the average CO_2 values for comparison with the O_2 measurements in accordance with the procedures described in Section 4.4 of Method 3.

8.3 If only CO_2 is measured using Method 3A. Concurrent measurements of the sample stream CO_2 concentration should be obtained using an Orsat or Fyrite analyzer as described in Section 8.2. For each run, differences greater than 0.5 percent between the Method 3A results and the average of the duplicate Fyrite analysis should be investigated.

9. *Emission Calculation.*

Same as Method 6C, Section 8, except that all concentrations must be expressed as percent by volume rather than ppm.

10. *Bibliography.*

Same as in Bibliography of Method 6C.

* * * * *

Method 6C. Determination of Sulfur Dioxide Emissions From Stationary Sources (Instrumental Analyzer Procedure)

1. *Applicability and Principle.*

1.1 Applicability. This method is applicable to the determination of sulfur dioxide (SO_2) concentrations in controlled and uncontrolled emissions from stationary sources only when specified within the regulations.

1.2 Principle. A sample is continuously extracted from the effluent stream; a portion of the sample stream is conveyed to an instrumental analyzer for for determination of SO_2 gas concentration. Performance specifications and test procedures are provided to ensure reliable data.

2. *Range and Sensitivity.*

2.1 Analytical Range. The analytical range is determined by the instrumental design. For this method, a portion of the analytical range is selected by choosing the span of the monitoring system. The span of the monitoring system shall be selected such that the mean gas concentration of each run is between 20 and 90 percent of the span. If at any time during a run the measured gas concentration exceeds the span, the run shall be considered invalid.

2.2 Sensitivity. The minimum detectable limit depends on the analytical range, span, and signal to noise ratio of the measurement system. For a well designed system, the minimum detectable limit should be less than 2 percent of the span. Measurement system components, including the data recorder, shall be selected such that the method can resolve a change in stack gas concentration of ±0.5 percent of the span.

3. *Definitions.*

3.1 Measurement System. The total equipment required for the determination of gas concentration. The measurement system consists of the following major subsystems:

3.1.1 Sample Interface. That portion of a system used for one or more of the following: sample acquisition, sample transport, sample conditioning, or protection of the analyzers from the effects of the stack effluent.

3.1.2 Gas Analyzer. That portion of the system that senses the gas to be measured and generates an output proportional to its concentration.

3.1.3 Data Recorder. A strip chart recorder, analog computer, or digital recorder for recording measurement data from the analyzer output.

3.2 Span. The upper limit of the gas concentration measurement range displayed on the data recorder.

3.3 Calibration Gas. A known concentration of a gas in an appropriate diluent gas.

3.4 Analyzer Calibration Error. The difference between the gas concentration exhibited by the gas analyzer and the known concentration of the calibration gas when the calibration gas is introduced directly to the analyzer.

3.5 Sampling System Bias. The difference between the gas concentrations exhibited by the measurement system when a known concentration gas is introduced at the outlet of the sampling probe and when the same gas is introduced directly to the analyzer.

3.6 Zero Drift. The difference in the measurement system output reading from the initial calibration response at the zero concentration level after a stated period of operation during which no unscheduled maintenance, repair, or adjustment took place.

3.7 Calibration Drift. The difference in the measurement system output reading from the initial calibration response at a mid-range calibration value after a stated period of operation during which no unscheduled maintenance, repair, or adjustment took place.

3.8 Response Time. The amount of time required for the measurement system to display 95 percent of a step change in gas concentration on the data recorder.

3.9 Interference Check. A method for detecting analytical interferences and excessive biases through direct comparison of gas concentrations provided by the measurement system and by a modified Method 6 procedure. For this check, the modified Method 6 samples are acquired at the sample by-pass discharge vent.

3.10 Calibration Curve. A graph or other systematic method of establishing the relationship between the analyzer response and the actual gas concentration introduced to the analyzer.

4. *Measurement System Performance Specifications.*

4.1 Analyzer Calibration Error. Less than ±2 percent of the span for the zero and low-, mid-, and high-range calibration gases.

4.2 Sampling System Bias. Less than ±5 percent of the span for the zero and mid-range calibration gases.

4.3 Zero Drift. Less than ±2 percent of the span over the period of each run.

4.4 Calibration Drift. Less than ±2 percent of the span over the period of each run.

4.6 Interference Check. Less than ±7 percent of the modified Method 6 result for each run.

5. *Apparatus and Reagents.*

5.1 Measurement System. Use any measurement system for SO_2 that meets the specifications of this method. A schematic of an acceptable measurement system is shown in Figure 6C-1. The essential components of the measurement system are described below:

5.1.1 Sample Probe. Glass, stainless steel, or equivalent, of sufficient length to traverse the sample points. The sampling probe shall be heated to prevent condensation.

5.1.2 Sample Line. Heated (sufficient to prevent condensation) stainless steel or Teflon tubing to transport the sample gas to the moisture removal system.

5.1.3 Calibration Valve Assembly. A three-way valve assembly, or equivalent, for blocking the sample gas flow and introducing calibration gases to the measurement system at the outlet of the sampling probe when in the calibration mode.

5.1.4 Moisture Removal System. A refrigerator-type condenser or other device (e.g., permeation dryer) designed to remove condensate continuously from the sample gas while maintaining minimal contact between the condensate and the sample gas. The moisture removal system is not necessary for analyzers that can measure gas concentrations on a wet basis; for these analyzers, (a) heat the sample line and all interface components up to the inlet of the analyzer sufficiently to prevent condensation, and (b) determine the moisture content and correct the measured gas concentrations to a dry basis using appropriate methods, subject to the approval of the Administrator.

5.1.5 Particulate Filter. An in-stack or heated, out-of-stack glass fiber filter or borosilicate glass wool plug. Additional filters at the inlet or outlet of the moisture removal system and inlet of the analyzer may be used to prevent accumulation of particulate material in the measurement system and extend the useful life of the components.

5.1.6 Sample Pump. A leak-free pump 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 nonreactive to the gas being sampled.

5.1.7 Sample Flow Rate Control. A sample flow rate control valve and rotameter, or equivalent, to maintain a constant sampling rate within 10 percent.

5.1.8 Sample Gas Manifold. A sample gas manifold to divert a portion of the sample gas stream to the analyzer and the remainder to the by-pass discharge vent. The sample gas manifold should also include provisions for introducing calibration gases directly to the analyzer. The manifold may be constructed of any material that is nonreactive to the gas being sampled.

5.1.9 Gas Analyzer. An analyzer to determine continuously the SO_2 concentration in the sample gas stream. The analyzer must meet the applicable performance specifications of Section 4. A means of controlling the analyzer flow rate and a device for determining proper sample flow rate (e.g., precision rotameter, pressure gauge downstream of all flow controls, etc.) must be provided at the analyzer.

5.1.10 Data Recorder. A strip chart recorder, analog computer, or digital recorder for recording measurement data.

5.2 Method 6 Apparatus and Reagents. The apparatus and reagents described in Method 6 and shown by the schematic of the sampling train in Figure 6C-2 are used to conduct the interference check.

5.3 SO_2 Calibration Gases. The calibration gases for the gas analyzer shall be SO_2 in N_2 or SO_2 in air. Use four calibration gases as specified below:

5.3.1 High-Range Gas. Concentration equivalent to 80 to 90 percent of the span.

5.3.2 Mid-Range Gas. Concentration equivalent to 50 to 60 percent of the span.

5.3.3 Low-Range Gas. Concentration equivalent to 20 to 30 percent of the span.

5.3.4 Zero Gas. Concentration of less than 0.25 percent of the span. Purified ambient air may be used for the zero gas by passing air through a charcoal filter or through one or more impingers containing a solution of 3 percent H_2O_2.

6. *Measurement System Performance Test Procedures*

Perform the following procedures before measurement of emissions (Section 7).

6.1 Calibration Gas Concentration Verification. There are two alternatives for establishing the concentrations of calibration gases.

6.1.1 Alternative Number 1. Use calibration gases that are analyzed following the Environmental Protection Agency Traceability Protocol Number 1 (see Citation 1 in Bibliography). Obtain a certification from the gas manufacturer that Protocol Number 1 was followed.

6.1.2 Alternative Number 2. Use calibration gases not prepared according to Protocol Number 1. If this alternative is chosen, obtain gas mixtures with a manufacturer's tolerance not to exceed ±2 percent of the tag value. Within 6 months before the emission test, analyze each of the calibration gases in triplicate using Method 6. Citation 2 in Bibliography describes procedures and techniques that may be used for this analysis. Record the results on a data sheet (example is shown in Figure 6C-3). For the low-, mid-, or high-range gases, each of the individual SO_2 analytical results must be within 5 percent (or 5 ppm, whichever is greater) of the triplicate set average; otherwise, discard the entire set and repeat the triplicate analyses. If the average of the triplicate analyses is within 5 percent of the calibration gas manufacturer's tag value, use the tag value; otherwise, conduct at least three additional analyses until the results of six individual runs (the three original plus three additional) agree within 5 percent (or 5 ppm, whichever is greater) of the average. Then use this average for the cylinder value.

6.2 Measurement System Preparation. Assemble the measurement system following the manufacturer's written instructions in preparing and preconditioning the gas analyzer and, as applicable, the other system components. Introduce any combination of calibration gases, and make all necessary adjustments to calibrate the analyzer and the data recorder. Adjust system components to achieve correct sampling rates.

6.3 Analyzer Calibration Error. Conduct the analyzer calibration error check by introducing calibration gases to the measurement system at any point upstream of the gas analyzer as follows:

6.3.1 After the measurement system has been prepared for use, introduce the zero and low-, mid-, and high-range gases to the analyzer. During this check, make no adjustments to the system except those necessary to achieve the correct calibration gas flow rate at the analyzer. Record the analyzer responses to each calibration gas on a form similar to Figure 6C-4.

Note.—A calibration curve established prior to the analyzer calibration error check may be used to convert the analyzer response to the equivalent gas concentration introduced to the analyzer. However, the same correction procedure must be used for all effluent and calibration measurements obtained during the test.

6.3.2 The analyzer calibration error check shall be considered invalid if the gas concentration displayed by the analyzer exceeds ±2 percent of the span for the zero or low-, mid-, or high-range calibration gases. If an invalid calibration is exhibited, take corrective action and repeat the analyzer calibration error check until acceptable performance is achieved.

6.4 Response Time. Determine response time by first positioning the sampling probe to obtain effluent samples at the measurement location, and adjusting the measurement system to achieve the proper sampling rate. Introduce zero gas into the system at the calibration valve until the analyzer response is stable; then switch to monitor the stack effluent until a stable reading can be obtained. A stable value is equivalent to a change of less than 1 percent of span for 30 seconds or less than 5 percent of the measured average concentration for 2 minutes. Record the upscale response time. Next, introduce high-range calibration gas into the system. Once the system has stabilized at the high-range concentration, switch to monitor the stack effluent, and wait until a stable value is reached. Record the downscale response time. Repeat the procedure three times. Record the response time data on a form similar to Figure 6C-5, average the three measurements of the upscale and downscale response times, and report the greater time as the "response time" for the measurement system.

6.5 Sampling System Bias Check. Perform the sampling system bias check by introducing calibration gases at the calibration valve installed at the outlet of the sampling probe as follows:

6.5.1 Introduce the mid-range calibration gas, and record the gas concentration displayed by the analyzer on a form similar to Figure 6C-6. Then introduce zero gas, and record the gas concentration displayed by the analyzer. During the sampling system bias check, operate the system at the normal sampling rate, and make no adjustments to the measurement system other than those necessary to achieve proper calibration gas flow rates at the analyzer. Introduce both the zero and mid range gases for a period not less than twice the response time.

6.5.2 The sampling system bias check shall be considered invalid if the difference between the gas concentrations displayed by the measurement system for the analyzer calibration error check and for the sampling system bias check exceeds ±3 percent of the span for either the zero or mid-range calibration gases. If an invalid calibration is exhibited, take corrective action, and repeat the sampling system bias check until acceptable performance is achieved. If adjustment to the analyzer is required, first repeat the analyzer calibration error check, then repeat the sampling system bias check.

7. *Emission Test Procedure.*

7.1 Selection of Sampling Site and Sampling Points. Select a measurement site and sampling points using the same criteria that are applicable to Method 6.

7.2 Interference Check Preparation. Conduct an interference check for at least three runs per test.

Assemble the modified Method 6 train (flow control valve, two midget impingers containing 3 percent H_2O_2, and dry gas meter) as shown in Figure 6C-2. Install the sampling train to obtain a sample at the measurement system sample by-pass discharge vent. Record the initial dry gas meter reading.

This check may be omitted, subject to the approval of the Administrator, provided that: (a) Information is submitted prior to the test demonstrating that measurement results for the gas analyzer used for the tests cannot be biased low because of the presence of interferents within the sample stream, and (b) no adjustment to the test data is made to account for interferents that may create a high bias in the measurement results.

7.3 Sample Collection. Position the sampling probe at the first measurement point, and begin sampling at the same rate as used during the response time test. Maintain constant rate sampling (i.e., ±10 percent) during the entire run. The sampling time per run shall be the same as for Method 6 plus twice the average system response time. For each run, use only those measurements obtained after twice the response time of the measurement system has elapsed to determine the average effluent concentration. Concurrent with the initiation of the sampling period, open the flow control valve on the modified Method 6 train, and adjust the flow to 1 liter per minute (±10 percent).

Note.—If a pump is not used in the modified Method 6 train, caution should be exercised in adjusting the flow rate since overpressurization of the impingers may cause leakage in the impinger train, resulting in positively biased results.

7.4 Zero and Calibration Drift Test. Immediately following each run, or if adjustments are necessary for the measurement system during the run, repeat the sampling system bias check procedure described in Section 6.5. (Make no adjustments to the measurement system until after the drift checks are completed.) Record the analyzer's responses on a form similar to Figure 6C-6.

7.4.1 If either the zero or mid-range calibration value exceeds the sampling system bias specification, then the run is considered invalid. Repeat both the analyzer calibration error check procedure (Section 6.3) and the sampling system bias check procedure (Section 6.5) before repeating the run.

7.4.2 If both the zero and mid-range calibration values are within the sampling system bias specification, then the average of the initial and final bias check values shall be used to calculate the gas concentration for the run. If the zero or mid-range drift value exceeds the drift limits, repeat both the analyzer calibration error/check procedure (Section 6.3) and the sampling bias check procedure (Section 6.5) before conducting additional runs.

7.5 Interference Check. After completing the run, record the final dry gas meter reading, meter temperature, and barometric pressure. Recover and analyze the contents of the midget impingers, and determine the SO_2 gas concentration using the procedures of Method 6. (It is not necessary to analyze EPA performance audit samples for Method 6.) Determine the average gas concentration exhibited by the analyzer for the run. If the gas concentrations provided by the analyzer and the modified Method 6 differ by more than 7 percent of the modified Method 6 result, the run shall be considered invalid.

8. *Emission Calculation.*

The average gas effluent concentration is determined from the average gas concentration displayed by the gas analyzer and is adjusted for the zero and mid-range sampling system bias checks as determined in accordance with Section 7.4. Calculate the effluent gas concentration using Equation 6C-1.

$$C_{gas} = (\bar{C} - C_o)\,\frac{C_m}{C_m - C_o} \qquad \text{Eq. 6C-1}$$

Where:

C_{gas} = Effluent gas concentration, ppm by volume (dry basis).

$\bar{C}$ = Average gas concentration indicated by gas analyzer, ppm (dry basis).

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 mid-range gas, ppm.

9. *Bibliography.*

1. Traceability Protocol for Establishing True Concentrations of Gases used for Calibrations and Audits of Continuous Source Emission Monitors: Protocol Number 1. U.S. Environmental Protection Agency, Quality Assurance Division, Research Triangle Park, N.C. June 1978.

2. Westlin, Peter R. and John W. Brown. Methods for Collecting and Analyzing Gas Cylinder Samples. U.S. Environmental Protection Agency, Emission Measurement Branch. Research Triangle Park, N.C. July 1978. Source Evaluation Society Newsletter 3(3):5–15, September 1978.

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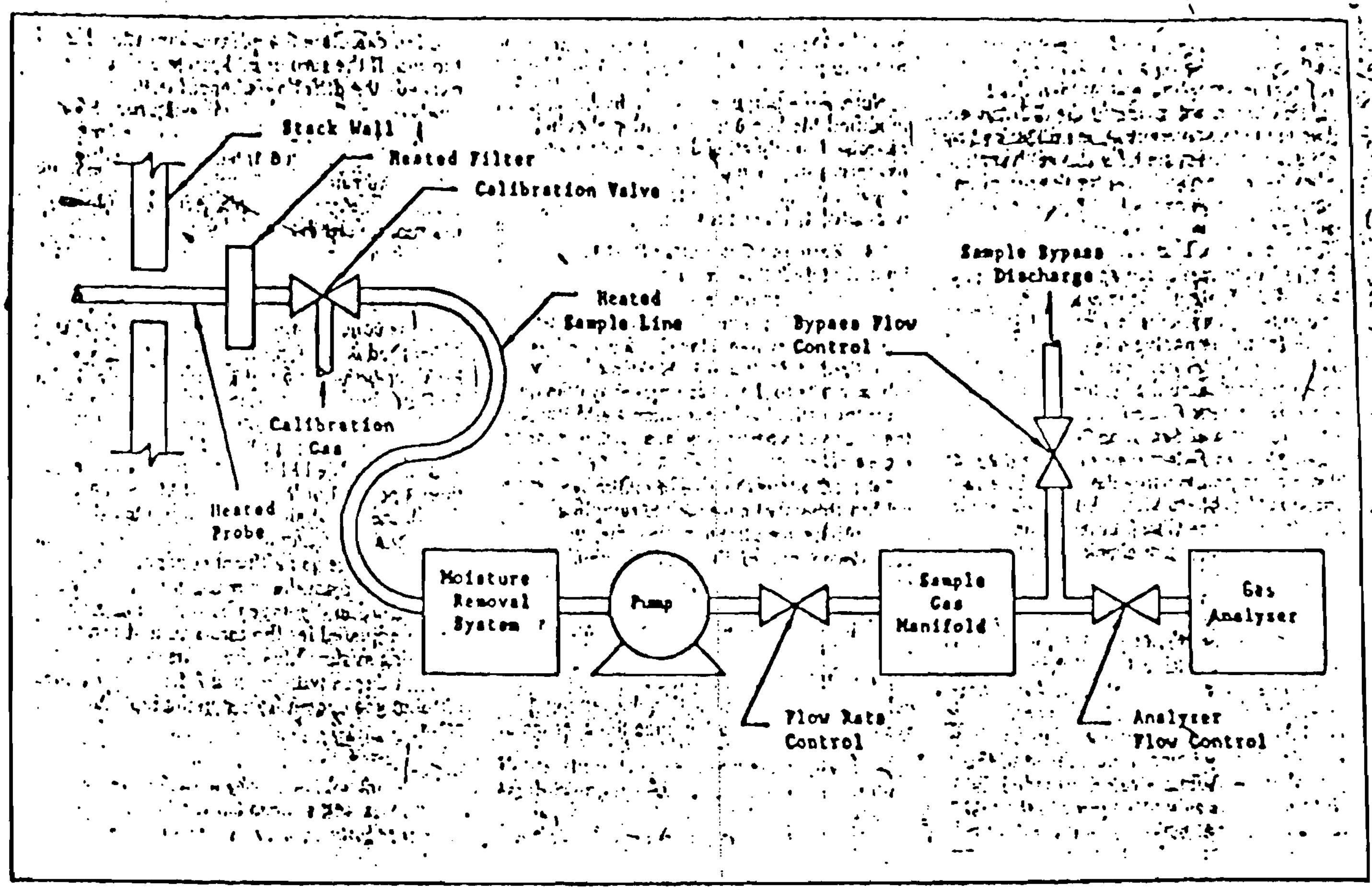

Figure 6C-1. Measurement system schematic.

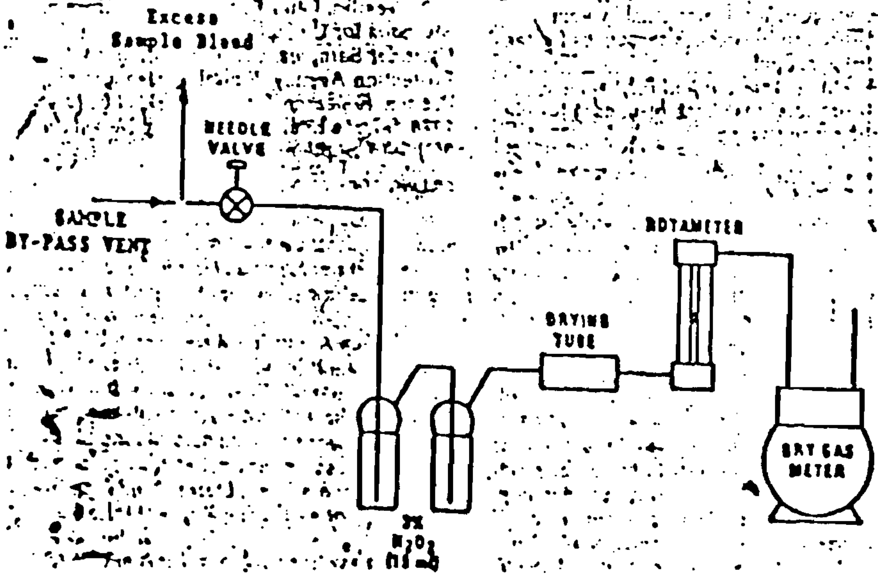

Figure 6C-2. Interference check sampling train.

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Date ____________________

Analytical method used ____________________

Sample run	Gas concentration (indicate units)		
	Low level[a]	Mid-level[b]	High level[c]
1			
2			
3			
Average			
Maximum % deviation			

[a] Average must be 20 to 30 percent of span.

[b] Average must be 50 to 60 percent of span.

[c] Average must be 80 to 90 percent of span.

Figure 6C-3. Analysis of calibration gases.

Source identification: ____________________

Test personnel: ____________________

Date: ____________________

Analyzer calibration data for sampling runs: ____________________

Span: ____________________

	Cylinder value	Analyzer calibration response	Absolute difference	Difference (% of span)
	(Indicate units)			
Zero gas				
Low range				
Mid-range				
High range				

Figure 6C-4. Analyzer calibration data.

Date of test ____________________

Analyzer type ____________________ SN ____________________

Span gas concentration ____________________ (indicate units)

Analyzer span setting ____________________ (indicate units)

Upscale
1 ____________________ seconds
2 ____________________ seconds
3 ____________________ seconds

Average upscale response ____________________ seconds

Downscale
1 ____________________ seconds
2 ____________________ seconds
3 ____________________ seconds

Average downscale response ____________________ seconds

System response time = slower average time = ____________________ seconds

Figure 6C-5. Response time.

Source identification: ____________________

Test personnel: ____________________

Date: ____________________ Run number: ____________________

Span: ____________________

		Initial Values		Final Values		
	Analyzer calibration response	System calibration response	System cal. bias (% of span)	System calibration response	System cal. bias (% of span)	Drift (% of span)
Zero gas						
Mid-range						

$$\text{System Calibration Bias} = \frac{\text{System Cal. Response} - \text{Analyzer Cal. Response}}{\text{Span}} \times 100$$

$$\text{Drift} = \frac{\text{Final System Cal. Response} - \text{Initial System Cal. Response}}{\text{Span}} \times 100$$

Figure 6C-6. System calibration bias and drift data.

Method 7E. Determination of Nitrogen Oxides Emissions From Stationary Sources

Instrumental Analyzer Procedure

1. Applicability and Principle.

1.1 Applicability. This method is applicable to the determination of nitrogen oxides (NO_x) concentrations in emissions from stationary sources only when specified within the regulations.

1.2 Principle. A sample is continously extracted from the effluent stream; a portion of the sample stream is conveyed to an instrumental chemiluminescent analyzer for determination of NO_x concentration. Performance specifications and test procedures are provided to ensure reliable data.

2. Range and Sensitivity

Same as Method 6C, Sections 2.1 and 2.2.

3. Definitions

3.1 Measurement System. The total equipment required for the determination of NO_x concentraton. The measurement system consists of the following major subsystems:

3.1.1 Sample Interface, Gas Analyzer, and Data Recorder. Same as Method 6C, Sections 3.1.1, 3.1.2, and 3.1.3.

3.1.2 NO_2 to NO Converter. A device that converts the nirtrogen dioxide (NO_2) in the sample gas to nitrogen oxide (NO).

3.2 Span, Calibration Gas, Analyzer Calibration Error, Sampling System Bias, Zero Drift, Calibration Drift, and Response Time. Same as Method 6C, Sections 3.2 through 3.8.

3.2 Interference Response. The output response of the measurement system to a component in the sample gas, other than the gas component being measured.

4. Measuremnt System Performance Specifications.

Same as Method 6C, Sections 4.1 through 4.4.

5. Apparatus and Reagents.

5.1 Measurement System. Use any measurement system for NO_x that meets the specifications of this method. A schematic of an acceptable measurement system is shown in Figure 6C-1 of Method 6C. The essential components of the measurement system are described below:

5.1.1 Sample Probe, Sample Line, Calibration Valve Assemply, Moisture Removal System, Particulate Filter, Sample Pump, Sample Flow Rate Control, Sample Gas Manifold, and Data Recorder. Same as Method 6C, Section 5.1.1 through 5.1.8, and 5.1.10.

5.1.2 NO_2 to NO Converter. That portion of the system that converts the nitrogen dioxide (NO_2) in the sample gas to nitrogen oxide (NO). A NO_2 to NO converter is not necessary if the NO$_2$ portion of the exhaust gas is less than 5 percent of the total NO$_x$ concentration.

5.1.3 NO$_x$ Analyzer. An analyzer based on the principles of chemiluminescence to determine continuously the NO$_x$ concentration in the sample gas stream. The analyzer must meet the applicable performance specifications of Section 4. A means of controlling the analyzer flow rate and a device for determining proper sample flow rate (e.g., precision rotameter, pressure gauge downstream of all flow controls, etc.) must be provided at the analyzer.

5.2 NO$_x$ Calibration Gases. The calibration gases for the NO$_x$ analyzer shall be NO in N$_2$. Use four calibration gases as specified in Method 6C, Sections 5.3.1 through 5.3.4. Ambient air may be used for the zero gas.

6. *Measurement System Performance Test Procedures.*

Perform the following procedures before measurement of emissions (Section 7).

6.1 Calibration Gas Concentration Verification. Same as Method 6C, Section 6.1, except if calibration gas analysis is required, use Method 7, and change all 5 percent performance values to 10 percent (OR 10 PPM, whichever is greater).

6.2 Interference Response. Conduct an interference response test of the analyzer prior to its intial use in the field. Thereafter, recheck the measurement system if changes are made in the instrumentation that could alter the interference response (e.g., chages in the gas detector). Conduct the interference response in accordance with Section 5.4 of Method 20.

6.3 Measurement System Preparation, Analyzer Calibration Error, Response Time, and Sample System Bias Check. Same as Method 6C, Sections 6.2 through 6.5.

6.4 NO$_2$ to NO Conversion Efficiency. If the NO$_2$ concentration within the sample stream is greater than 5 percent of the NO$_x$ concentration, conduct an NO$_2$ to NO conversion efficiency test in accordance with Section 5.6 of Method 20.

7. *Emission Test Procedure.*

7.1 Selection of Sampling Site and Sampling Points. Select a measurement site and sampling points using the same criteria that are applicable to tests performed using Method 7.

7.2 Sample Collection. Position the sampling probe at the first measurement point, and begin sampling at the same rate as used during the response time test. Maintain constant rate sampling (i.e., ±10 percent) during the entire run. The sampling time per run shall be the same as the total time required to perform a run using Method 7 plus twice the average system response time. For each run, use only those measurements obtained after twice the response time of the measurement system has elapsed to determine the average effluent concentration.

7.3 Zero and Calibration Drift Test. Same as Method 6C, Section 7.4.

8. *Emission Calculation.*

Same as Method 6C, section 8.

9. *Bibliography.*

Same as in Bibliography of Method 6C.

* * * * *

2. In subpart D, it is proposed to amend § 60.45 by revising paragraph (c)(1) as follows:

§ 60.45 Emission and fuel monitoring.

* * * * *

(c) * * *

(1) Methods 6 or 6C and 7, 7A, 7C, 7D, or 7E, as applicable, shall be used for conducting performance evaluations of sulfur dioxide and nitrogen oxides continuous monitoring systems.

* * * * *

3. In Subpart D, it is proposed to amend § 60.46 by revising paragraphs (a)(2), (a)(4), (a)(5), (f)(2), and (f)(3)(i) as follows:

§ 60.46 Test methods and procedures.

(a) * * *

(2) Method 3 or 3A for gas analysis to be used when applying Methods 5, 6 or 6C, and 7, 7A, 7C, 7D, or 7E.

(3) * * *

(4) Method 6 or 6C for concentration of SO$_2$. Method 6A may be used whenever Methods 6 or 6C and 3 or 3A data are used to determine the SO$_2$ emission rate in ng/J, and

(5) Method 7, 7A, 7C, 7D, or 7E for concentration of NO$_x$.

* * * * *

(f) * * *

(2) C = pillutant concentration, ng/dscm (1b/dscf) determined by Method 5, 6, 6C, 7, 7A, 7C, 7D, or 7E.

(3) Percent O$_2$ = Oxygen content by volume (expressed as percent), dry basis. Percent oxygen shall be determined by using the integrated or grab sampling and analysis procedures of Method 3 as applicable, or by using Method 3C. Oxygen samples shall be obtained as follows:

(i) For determination of sulfur dioxide by Method 6 or 6C and nitrogen oxides emissions by Method 7, 7A, 7C, 7D, or 7E, the oxygen sample shall be obtained simultaneously at the same point in the duct. For Method 7 or 7A, the oxygen sample shall be obtained using the grab sampling and analysis procedures of Method 3, or by using Method 3C.

* * * * *

4. In Subpart D, it is proposed to amend § 60.46 by revising the first sentence of paragraph (c) to read as follows:

§ 60.46 Test methods and procedures.

* * * * *

(c) For Methods 6 or 6C, and 7, 7A, 7C, 7D, or 7E, the sampling site shall be the same as that selected for Method 5.

* * * * *

5. In Subpart Da, it is proposed to amend § 60.47a by revising the first two sentences of paragraph (h)(1), the first sentence of paragraph (h)(4), and all of paragraph (h)(5)(i)(1) to read as follows:

§ 60.47a Emission monitoring.

* * * * *

(h) * * *

(1) Methods 3 or 3A, 6 or 6C, and 7, 7A, 7C, 7D, or 7E, as applicable, are used. Method 6B may be used whenever Methods 6 or 6C and 3 or 3A data are required to determine the SO$_2$ emission rate in ng/J.

* * * * *

(4) For Method 3, the oxygen or carbon dioxide sample is to be taken for each hour when continuous SO$_2$ and NO$_x$ data are taken or when Methods 6 or 6C and 7, 7A, 7C, 7D, or 7E are required.

* * * * *

(5) * * *

(i) * * *

(1) Method 6, 6C, 7, 7A, 7C, 7D, or 7E, as applicable, is used for conducting performance evaluations of sulfur dioxide and nitrogen oxides continuous monitoring systems.

* * * * *

6. In Subpart Da, it is proposed to amend § 60.48a by revising paragraph (a)(1) as follows:

§ 60.48a Compliance determination procedures and methods.

(a) * * *

(1) Method 3 or 3A is used for gas analysis when applying Method 5 or Method 17.

* * * * *

[FR Doc. 85-4878 Filed 2-27-85; 8:45 am]

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U.S. EPA METHOD 10

4.2 Performance Evaluation Tests. The owner of a lidar system shall subject such a lidar system to the performance verification tests described in Section 3, prior to first use of this method. The annual calibration shall be performed for three separate, complete runs and the results of each should be recorded. The requirements of Section 3.3.1 must be fulfilled for each of the three runs.

Once the conditions of the annual calibration are fulfilled the lidar shall be subjected to the routine verification for three separate complete runs. The requirements of Section 3.3.2 must be fulfilled for each of the three runs and the results should be recorded. The Administrator may request that the results of the performance evaluation be submitted for review.

5. *References.*

5.1 The Use of Lidar for Emissions Source Opacity Determination, U.S. Environmental Protection Agency, National Enforcement Investigations Center, Denver, CO, EPA-330/1-79-003-R, Arthur W. Dybdahl, current edition [NTIS No. PB81-246662].

5.2 Field Evaluation of Mobile Lidar for the Measurement of Smoke Plume Opacity, U.S. Environmental Protection Agency, National Enforcement Investigations Center, Denver, CO, EPA/NEIC-TS-128, February 1976.

5.3 Remote Measurement of Smoke Plume Transmittance Using Lidar, C. S. Cook, G. W. Bethke, W. D. Conner (EPA/RTP). Applied Optics 11, pg 1742, August 1972.

5.4 Lidar Studies of Stack Plumes in Rural and Urban Environments, EPA-650/4-73-002, October 1973.

5.5 American National Standard for the Safe Use of Lasers ANSI Z 136.1-176, 8 March 1976.

5.6 U.S. Army Technical Manual TB MED 279, Control of Hazards to Health from Laser Radiation, February 1969.

5.7 Laser Institute of America Laser Safety Manual, 4th Edition.

5.8 U.S. Department of Health, Education and Welfare, Regulations for the Administration and Enforcement of the Radiation Control for Health and Safety Act of 1968, January 1976.

5.9 Laser Safety Handbook, Alex Mallow, Leon Chabot, Van Nostrand Reinhold Co., 1978.

METHOD 10—DETERMINATION OF CARBON MONOXIDE EMISSIONS FROM STATIONARY SOURCES

1. *Principle and Applicability.*

1.1 *Principle.* An integrated or continuous gas sample is extracted from a sampling point and analyzed for carbon monoxide (CO) content using a Luft-type nondispersive infrared analyzer (NDIR) or equivalent.

1.2 *Applicability.* This method is applicable for the determination of carbon monoxide emissions from stationary sources only when specified by the test procedures for determining compliance with new source performance standards. The test procedure will indicate whether a continuous or an integrated sample is to be used.

2. *Range and sensitivity.*

2.1 Range. 0 to 1,000 ppm.

2.2 Sensitivity. Minimum detectable concentration is 20 ppm for a 0 to 1,000 ppm span.

3. *Interferences.*

Any substance having a strong absorption of infrared energy will interfere to some extent. For example, discrimination ratios for water (H_2O) and carbon dioxide (CO_2) are 3.5 percent H_2O per 7 ppm CO and 10 percent CO_2 per 10 ppm CO, respectively, for devices measuring in the 1,500 to 3,000 ppm range. For devices measuring in the 0 to 100 ppm range, interference ratios can be as high as 3.5 percent H_2O per 25 ppm CO and 10 percent CO_2 per 50 ppm CO. The use of silica gel and ascarite traps will alleviate the major interference problems. The measured gas volume must be corrected if these traps are used.

4. *Precision and accuracy.*

4.1 Precision. The precision of most NDIR analyzers is approximately ±2 percent of span.

4.2 Accuracy. The accuracy of most NDIR analyzers is approximately ±5 percent of span after calibration.

5. *Apparatus.*

5.1 Continuous sample (Figure 10-1).

5.1.1 Probe. Stainless steel or sheathed Pyrex[1] glass, equipped with a filter to remove particulate matter.

5.1.2 Air-cooled condenser or equivalent. To remove any excess moisture.

5.2 Integrated sample (Figure 10-2).

5.2.1 Probe. Stainless steel or sheathed Pyrex glass, equipped with a filter to remove particulate matter.

5.2.2 Air-cooled condenser or equivalent. To remove any excess moisture.

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

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

5.2.5 Rate meter. Rotameter, or equivalent, to measure a flow range from 0 to 1.0 liter per min. (0.035 cfm).

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[1] Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency.

5.2.6 Flexible bag. Tedlar, or equivalent, with a capacity of 60 to 90 liters (2 to 3 ft³). Leak-test the bag in the laboratory before using by evacuating bag with a pump followed by a dry gas meter. When evacuation is complete, there should be no flow through the meter.

5.2.7 Pitot tube. Type S, or equivalent, attached to the probe so that the sampling rate can be regulated proportional to the stack gas velocity when velocity is varying with the time or a sample traverse is conducted.

5.3 Analysis (Figure 10-3).

5.3.1 Carbon monoxide analyzer. Nondispersive infrared spectrometer, or equivalent. This instrument should be demonstrated, preferably by the manufacturer, to meet or exceed manufacturer's specifications and those described in this method.

5.3.2 Drying tube. To contain approximately 200 g of silica gel.

5.3.3 Calibration gas. Refer to paragraph 6.1.

5.3.4 Filter. As recommended by NDIR manufacturer.

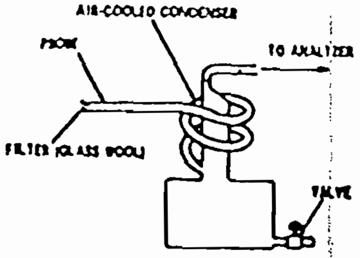

Figure 10-1. Continuous sampling train.

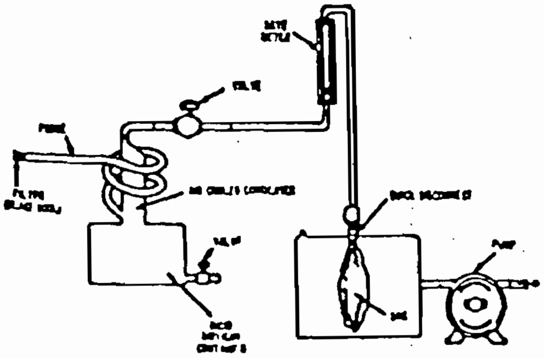

Figure 10-2. Integrated gas sampling train.

5.3.5 CO_2 removal tube. To contain approximately 500 g of ascarite.

5.3.6 Ice water bath. For ascarite and silica gel tubes.

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

5.3.8 Rate meter. Rotameter or equivalent to measure gas flow rate of 0 to 1.0 liter per min. (0.035 cfm) through NDIR.

5.3.9 Recorder (*optional*). *To provide permanent record of NDIR readings.*

6. *Reagents.*

6.1 Calibration gases. Known concentration of CO in nitrogen (N_2) for instrument span, prepurified grade of N_2 for zero, and two additional concentrations corresponding approximately to 60 percent and 30 percent span. The span concentration shall not exceed 1.5 times the applicable source performance standard. The calibration gases shall be certified by the manufacturer to be within ±2 percent of the specified concentration.

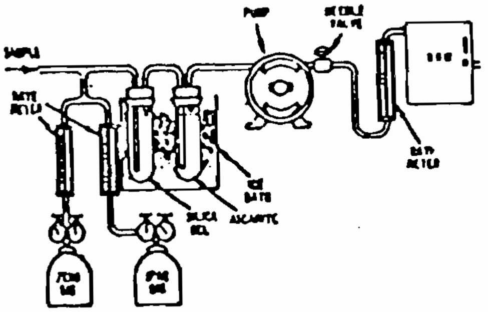

Figure 10-3. Analytical equipment.

6.2 Silica gel. Indicating type, 6 to 16 mesh, dried at 175° C (347° F) for 2 hours.

6.3 Ascarite. Commercially available.

7. *Procedure.*

7.1 Sampling.

7.1.1 Continuous sampling. Set up the equipment as shown in Figure 10-1 making sure all connections are leak free. Place the probe in the stack at a sampling point and purge the sampling line. Connect the analyzer and begin drawing sample into the analyzer. Allow 5 minutes for the system to stabilize, then record the analyzer reading as required by the test procedure. (See ¶ 7.2 and 8). CO_2 content of the gas may be determined by using the Method 3 integrated sample procedure (36 FR 24886), or by weighing the ascarite CO_2 removal tube and computing CO_2 concentration from the gas volume sampled and the weight gain of the tube.

7.1.2 Integrated sampling. Evacuate the flexible bag. Set up the equipment as shown in Figure 10-2 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. CO_2 content of the gas may be determined by using the Method 3 integrated sample procedures (36 FR 24886), or by weighing the ascarite CO_2 removal tube and computing CO_2 concentration from the gas volume sampled and the weight gain of the tube.

7.2 CO Analysis. Assemble the apparatus as shown in Figure 10-3, calibrate the instrument, and perform other required operations as described in paragraph 8. Purge analyzer with N_2 prior to introduction of each sample. Direct the sample stream through the instrument for the test period, recording the readings. Check the zero and span again after the test to assure that any drift or malfunction is detected. Record the sample data on Table 10-1.

8. *Calibration.*

Assemble the apparatus according to Figure 10-3. Generally an instrument requires a warm-up period before stability is obtained. Follow the manufacturer's instructions for specific procedure. Allow a minimum time of 1 hour for warm-up. During this time check the sample conditioning apparatus, i.e., filter, condenser, drying tube, and CO_2 removal tube, to ensure that each component is in good operating condition. Zero and calibrate the instrument according to the manufacturer's procedures using, respectively, nitrogen and the calibration gases.

TABLE 10-1—FIELD DATA

	Comments
Location	
Test	
Date	
Operator	
Clock time	Rotameter setting, liters per minute (cubic feet per minute)

9. *Calculation.*

Concentration of carbon monoxide. Calculate the concentration of carbon monoxide in the stack using equation 10-1.

$$C_{CO\ stack} = C_{CO\ NDIR}(1 - F_{CO_2})$$

where:

$C_{CO\ stack}$ = concentration of CO in stack, ppm by volume (dry basis).

$C_{CO\ NDIR}$ = concentration of CO measured by NDIR analyzer, ppm by volume (dry basis).

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

10. *Bibliography.*

10.1 McElroy, Frank. The Intertech NDIR-CO Analyzer, Presented at 11th Methods Conference on Air Pollution, University of California, Berkeley, Calif., April 1, 1970.

10.2 Jacobs, M. B., et al., Continuous Determination of Carbon Monoxide and Hydrocarbons in Air by a Modified Infrared Analyzer, J. Air Pollution Control Association, 9(2): 110-114, August 1959.

10.3 MSA LIRA Infrared Gas and Liquid Analyzer Instruction Book, Mine Safety Appliances Co., Technical Products Division, Pittsburgh, Pa.

10.4 Models 215A, 315A, and 415A Infrared Analyzers, Beckman Instruments, Inc., Beckman Instructions 1635-B, Fullerton, Calif., October 1967.

10.5 Continuous CO Monitoring System, Model A5611, Intertech Corp., Princeton, N.J.

10.6 UNOR Infrared Gas Analyzers, Bendix Corp., Ronceverte, West Virginia.

ADDENDA—A. PERFORMANCE SPECIFICATIONS FOR NDIR CARBON MONOXIDE ANALYZERS.

Range (minimum)	0-1000 ppm.
Output (minimum)	0-10mV.
Minimum detectable sensitivity.	20 ppm.
Rise time, 90 percent (maximum).	30 seconds.
Fall time, 90 percent (maximum).	30 seconds.
Zero drift (maximum)	10% in 8 hours.
Span drift (maximum)	10% in 8 hours.
Precision (minimum)	±2% of full scale.
Noise (maximum)	±1% of full scale.
Linearity (maximum deviation)	2% of full scale.
Interference rejection ratio	CO_2—1000 to 1, H_2O—500 to 1.

B. *Definitions of Performance Specifications.*

Range—The minimum and maximum measurement limits.

Output—Electrical signal which is proportional to the measurement; intended for connection to readout or data processing devices. Usually expressed as millivolts or milliamps full scale at a given impedance.

Full scale—The maximum measuring limit for a given range.

Minimum detectable sensitivity—The smallest amount of input concentration that can be detected as the concentration approaches zero.

Accuracy—The degree of agreement between a measured value and the true value; usually expressed as ± percent of full scale.

Time to 90 percent response—The time interval from a step change in the input concentration at the instrument inlet to a reading of 90 percent of the ultimate recorded concentration.

Rise Time (90 percent)—The interval between initial response time and time to 90 percent response after a step increase in the inlet concentration.

Fall Time (90 percent)—The interval between initial response time and time to 90 percent response after a step decrease in the inlet concentration.

Zero Drift—The change in instrument output over a stated time period, usually 24 hours, of unadjusted continuous operation when the input concentration is zero; usually expressed as percent full scale.

Span Drift—The change in instrument output over a stated time period, usually 24 hours, of unadjusted continuous operation when the input concentration is a stated upscale value; usually expressed as percent full scale.

Precision—The degree of agreement between repeated measurements of the same concentration, expressed as the average deviation of the single results from the mean.

Noise—Spontaneous deviations from a mean output not caused by input concentration changes.

Linearity—The maximum deviation between an actual instrument reading and the reading predicted by a straight line drawn between upper and lower calibration points.

METHOD 11—DETERMINATION OF HYDROGEN SULFIDE CONTENT OF FUEL GAS STREAMS IN PETROLEUM REFINERIES

1. *Principle and applicability.*

1.1 Principle. Hydrogen sulfide (H_2S) is collected from a source in a series of midget impingers and absorbed in pH 3.0 cadmium sulfate ($CdSO_4$) solution to form cadmium sulfide (CdS). The latter compound is then measured iodometrically. An impinger containing hydrogen peroxide is included to remove SO_2 as an interfering species. This method is a revision of the H_2S method originally published in the FEDERAL REGISTER, Volume 39, No. 47, dated Friday, March 8, 1974.

1.2 Applicability. This method is applicable for the determination of the hydrogen sulfide content of fuel gas streams at petroleum refineries.

2. *Range and sensitivity.*

The lower limit of detection is approximately 8 mg/m^3 (6 ppm). The maximum of the range is 740 mg/m^3 (520 ppm).

3. *Interferences.*

Any compound that reduces iodine or oxidizes iodide ion will interfere in this procedure, provided it is collected in the cadmium sulfate impingers. Sulfur dioxide in concentrations of up to 2,600 mg/m^3 is eliminated by the hydrogen peroxide solution. Thiols precipitate with hydrogen sulfide. In the absence of H_2S, only co-traces of thiols are collected. When methane- and ethane-thiols at a total level of 300 mg/m^3 are present in addition to H_2S, the results vary from 2 percent low at an H_2S concentration of 400 mg/m^3 to 14 percent high at an H_2S concentration of 100 mg/m^3. Carbon oxysulfide at a concentration of 20 percent does not interfere. Certain carbonyl-containing compounds react with iodine and produce recurring end points. However, acetaldehyde and acetone at concentrations of 1 and 3 percent, respectively, do not interfere.

Entrained hydrogen peroxide produces a negative interference equivalent to 100 percent of that of an equimolar quantity of hydrogen sulfide. Avoid the ejection of hydrogen peroxide into the cadmium sulfate impingers.

4. *Precision and accuracy.*

Collaborative testing has shown the within-laboratory coefficient of variation to be 2.2 percent and the overall coefficient of variation to be 5 percent. The method bias was shown to be −4.8 percent when only H_2S was present. In the presence of the interferences cited in section 3, the bias was positive at low H_2S concentration and negative at higher concentrations. At 230 mg H_2S/m^3, the level of the compliance standard, the bias was +2.7 percent. Thiols had no effect on the precision.

5. *Apparatus.*

5.1 Sampling apparatus.

5.1.1 Sampling line. Six to 7 mm (¼ in.) Teflon[1] tubing to connect the sampling train to the sampling valve.

5.1.2 Impingers. Five midget impingers, each with 30 ml capacity. The internal diameter of the impinger tip must be 1 mm ±0.05 mm. The impinger tip must be positioned 4 to 6 mm from the bottom of the impinger.

5.1.3 Glass or Teflon connecting tubing for the impingers.

5.1.4 Ice bath container. To maintain absorbing solution at a low temperature.

5.1.5 Drying tube. Tube packed with 6- to 16-mesh indicating-type silica gel, or equivalent, to dry the gas sample and protect the meter and pump. If the silica gel has been used previously, 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 approval of the Administrator.

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[1] Mention of trade names of specific products does not constitute endorsement by the Environmental Protection Agency.

U.S. EPA METHOD 12

as the calibration factor for subse-
it runs.

Post-test calibration check. After
d test series, conduct a calibration
in section 8.2.1.1. above, except for
wing variations: (a) The leak check
be conducted, (b) three or more
ns of the dry gas meter may be
d (c) only two independent runs
nade. If the calibration factor does
ite by more than 5 percent from
l calibration factor (determined in
2.1.1.), then the dry gas meter vol-
ained during the test series are ac-
If the calibration factor deviates
than 5 percent, recalibrate the dry
r as in section 8.2.1.1, and for the
ns, use the calibration factor (ini-
calibration) that yields the lower
e for each test run.

hermometers. Calibrate against
n-glass thermometers.

otameter. The rotameter need not
ated, but should be cleaned and
d according to the manufacturer's
n.

arometer. Calibrate against a mer-
meter.

ulations. Carry out calculations re-
t least one extra decimal figure
at of the acquired data. Round off
ly after the final calculation.

rmality of the Standard (∼0.1 N)
te Solution.

$$N_T = 2.039W/V_T$$

t of $K_2Cr_2O_7$ used, g.
e of $Na_2S_2O_3$ solution used, ml.
ality of standard thiosulfate solu-
-eq/liter.
nversion factor

mole $K_2Cr_2O_7$) (1,000 ml/liter)/=
$K_2Cr_2O_7$/mole) (10 aliquot factor)

mality of Standard Phenylarsine
ution (if applicable).

$$N_A = 0.2039 W/V_A$$

t of $K_2Cr_2O_7$ used, g.
e of C_6H_5AsO used, ml.
ality of standard phenylarsine
olution, g=eq/liter.
nversion factor

mole $K_2Cr_2O_7$) (1,000 ml/liter)/
g $K_2Cr_2O_7$/mole) (100 aliquot

mality of Standard Iodine Solu-

$$N_I = N_T V_T / V_I$$

N_I = Normality of standard iodine solution, g-eq/liter.
V_I = Volume of standard iodine solution used, ml.
N_T = Normality of standard (∼0.01 N) thiosulfate solution; assumed to be 0.1 N_S, g-eq/liter.
V_T = Volume of thiosulfate solution used, ml.

NOTE: If phenylarsine oxide is used intead of thiosulfate, replace N_T and V_T in Equation 9.3 with N_A and V_{AS}, respectively (see sections 8.1.1 and 8.1.3).

9.4 Dry Gas Volume. Correct the sample volume measured by the dry gas meter to standard conditions (20° C) and 760 mm Hg.

$$V_{m(std)} = V_m Y\ [(T_{std}/T_m)\ (P_{bar}/P_{std})]$$

where:

$V_{m(std)}$ = Volume at standard conditions of gas sample through the dry gas meter, standard liters.
V_m = Volume of gas sample through the dry gas meter (meter conditions), liters.
T_{std} = Absolute temperature at standard conditions, 293° K.
T_m = Average dry gas meter temperature, °K.
P_{bar} = Barometric pressure at the sampling site, mm Hg.
P_{std} = Absolute pressure at standard conditions, 760 mm Hg.
Y = Dry gas meter calibration factor.

9.5 Concentration of H_2S. Calculate the concentration of H_2S in the gas stream at standard conditions using the following equation:

$$C_{H_2S} = K[(V_{IT}N_I - V_{TT}N_T)\ \text{sample} - (V_{IT}N_I - V_{TT}N_T)\ \text{blank}]/V_{m(std)}$$

where (metric units):

C_{H_2S} = Concentration of H_2S at standard conditions, mg/dscm.
K = Conversion factor = 17.04×10^3

(34.07 g/mole H_2S) (1,000 liters/m^3) (1,000 mg/g)/=(1,000 ml/liter) (2H_2S eq/mole)

V_{IT} = Volume of standard iodine solution = 50.0 ml.
N_I = Normality of standard iodine solution, g-eq/liter.
V_{TT} = Volume of standard (∼0.01 N) sodium thiosulfate solution, ml.
N_T = Normality of standard sodium thiosulfate solution, g-eq/liter.
$V_{m(std)}$ = Dry gas volume at standard conditions, liters.

NOTE: If phenylarsine oxide is used instead of thiosulfate, replace N_T and V_{TT} in Equation 9.5 with N_A and V_{AT}, respectively (see Sections 7.3.1 and 8.1.3).

10. *Stability.* The absorbing solution is stable for at least 1 month. Sample recovery and analysis should begin within 1 hour of sampling to minimize oxidation of the acidified cadmium sulfide. Once iodine has been added to the sample, the remainder of the analysis procedure must be completed according to sections 7.2.2 through 7.3.2.

11. *Bibliography.*

11.1 Determination of Hydrogen Sulfide, Ammoniacal Cadmium Chloride Method. API Method 772-54. In: Manual on Disposal of Refinery Wastes, Vol. V: Sampling and Analysis of Waste Gases and Particulate Matter. American Petroleum Institute, Washington, D.C., 1954.

11.2 Tentative Method of Determination of Hydrogen Sulfide and Mercaptan Sulfur in Natural Gas, Natural Gas Processors Association, Tulsa, Okla., NGPA Publication No. 2265-65, 1965.

11.3 Knoll, J. E., and M. R. Midgett. Determination of Hydrogen Sulfide in Refinery Fuel Gases, Environmental Monitoring Series, Office of Research and Development, USEPA, Research Triangle Park, N.C. 27711, EPA 600/4-77-007.

11.4 Scheill, G. W., and M. C. Sharp. Standardization of Method 11 at a Petroleum Refinery, Midwest Research Institute Draft Report for USEPA, Office of Research and Development, Research Triangle Park, N.C. 27711, EPA Contract No. 68-02-1098, August 1976, EPA 600/4-77-088a (Volume 1) and EPA 600/4-77-088b (Volume 2).

METHOD 12—DETERMINATION OF INORGANIC LEAD EMISSIONS FROM STATIONARY SOURCES

1. *Applicability and Principle.*

1.1 Applicability. This method applies to the determination of inorganic lead (Pb) emissions from specified stationary sources only.

1.2 Principle. Particulate and gaseous Pb emissions are withdrawn isokinetically from the source and collected on a filter and in dilute nitric acid. The collected samples are digested in acid solution and analyzed by atomic absorption spectrometry using an air acetylene flame.

2. *Range, Sensitivity, Precision, and Interferences.*

2.1 Range. For a minimum analytical accuracy of ±10 percent, the lower limit of the range is 100 μg. The upper limit can be considerably extended by dilution.

2.2 Analytical Sensitivity. Typical sensitivities for a 1-percent change in absorption (0.0044 absorbance units) are 0.2 and 0.5 μg Pb/ml for the 217.0 and 283.3 nm lines, respectively.

2.3 Precision. The within-laboratory precision, as measured by the coefficient of variation ranges from 0.2 to 9.5 percent relative to a run-mean concentration. These values were based on tests conducted at a gray iron foundry, a lead storage battery manufacturing plant, a secondary lead smelter, and a lead recovery furnace of an alkyl lead manufacturing plant. The concentrations encountered during these tests ranged from 0.61 to 123.3 mg Pb/m³.

2.4 Interferences. Sample matrix effects may interfere with the analysis for Pb by flame atomic absorption. If this interference is suspected, the analyst may confirm the presence of these matrix effects and frequently eliminate the interference by using the Method of Standard Additions.

High concentrations of copper may interfere with the analysis of Pb at 217.0 nm. This interference can be avoided by analyzing the samples at 283.3 nm.

3. *Apparatus.*

3.1 Sampling Train. A schematic of the sampling train is shown in Figure 12-1; it is similar to the Method 5 train. The sampling train consists of the following components:

3.1.1 Probe Nozzle, Probe Liner, Pitot Tube, Differential Pressure Gauge, Filter Holder, Filter Heating System, Metering System, Barometer, and Gas Density Determination Equipment. Same as Method 5, Sections 2.1.1 to 2.1.6 and 2.1.8 to 2.1.10, respectively.

3.1.2 Impingers. Four impingers connected in series with leak-free ground glass fittings or any similar leak-free noncontaminating fittings. For the first, third, and fourth impingers, use 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. For the second impinger, use the Greenburg-Smith design with the standard tip. Place a thermometer, capable of measuring temperature to within 1°C (2°F) at the outlet of the fourth impinger for monitoring purposes.

be Nozzle, Probe Liner, Pitot
·rential Pressure Gauge, Filter
ter Heating System, Metering
·ometer, and Gas Density Deter·
quipment. Same as Method 5,
.1 to 2.1.6 and 2.1.8 to 2.1.10, re·

ingers. Four impingers connect·
with leak-free ground glass fit·
' similar leak-free noncontamin·
gs. For the first, third, and
ngers, use the Greenburg Smith
ified by replacing the tip with a
in.) ID glass tube extending to
1 (½ in.) from the bottom of the
the second impinger, use the
Smith design with the standard
thermometer, capable of meas·
rature to within 1°C (2°F) at the
ie fourth impinger for monitor·
s.

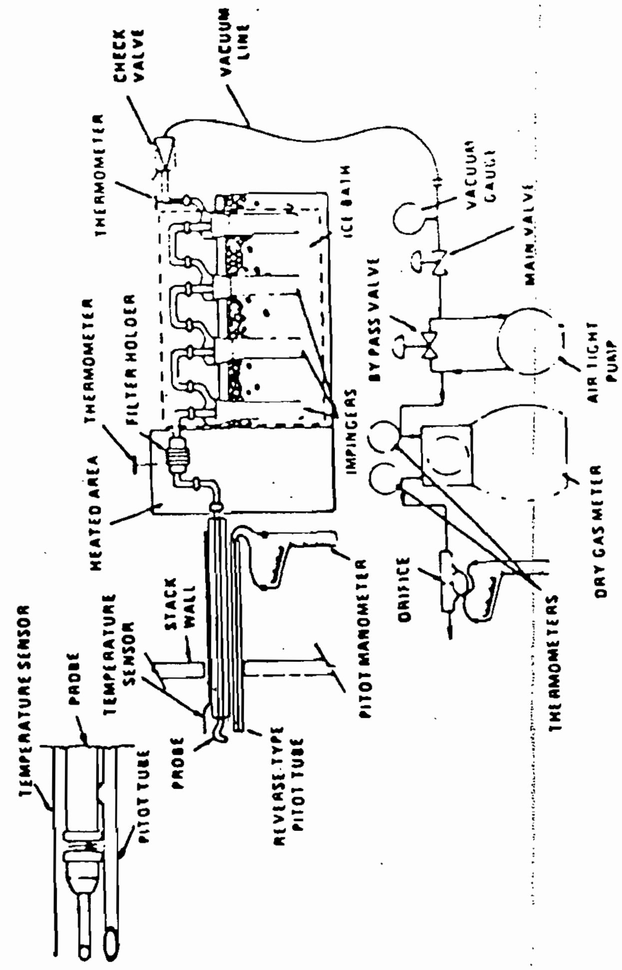

Figure 12-1. Inorganic lead sampling train

3.2 Sample Recovery. The following items are needed:

3.2.1 Probe-Liner and Probe-Nozzle Brushes, Petri Dishes, Plastic Storage Containers, and Funnel and Rubber Policeman. Same as Method 5, Sections 2.2.1, 2.2.4, 2.2.6, and 2.2.7, respectively.

3.2.2 Wash Bottles Glass (2).

3.2.3 Sample Storage Containers. Chemically resistant, borosilicate glass bottles, for 0.1 nitric acid (HNO_3) impinger and probe solutions and washes, 1000-ml. Use screw-cap liners that are either rubber-backed Teflon[*] or leak-free and resistant to chemical attack by 0.1 N HNO_3. (Narrow mouth glass bottles have been found to be less prone to leakage.)

3.2.4 Graduated Cylinder and/or Balance. To measure condensed water to within 2 ml or 1 g. Use a graduated cylinder that has a minimum capacity of 500 ml, and subdivisions no greater than 5 ml. (Most laboratory balances are capable of weighing to the nearest 0.5 g or less.)

3.2.5 Funnel. Glass, to aid in sample recovery.

3.3 Analysis. The following equipment is needed:

3.3.1 Atomic Absorption Spectrophotometer. With lead hollow cathode lamp and burner for air/acetylene flame.

3.3.2 Hot Plate.

3.3.3 Erlenmeyer Flasks. 125-ml, 24/40 \$.

3.3.4 Membrane Filters. Millipore SCWPO 4700 or equivalent.

3.3.5 Filtration Apparatus. Millipore vacuum filtration unit, or equivalent, for use with the above membrane filter.

3.3.6 Volumetric Flasks. 100-ml, 250-ml, and 1000-ml.

4. *Reagents.*

4.1 Sampling. The reagents used in sampling are as follows:

4.1.1 Filter. Gelman Spectro Grade, Reeve Angel 934 AH, MSA 1106 BH, all with lot assay for Pb, or other high-purity 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. Conduct the filter efficiency test using ASTM Standard Method D2986-71 (incorporated by reference—see § 60.17) or use test data from the supplier's quality control program.

4.1.2 Silica Gel, Crushed Ice, and Stopcock Grease. Same as Method 5, Section 3.1.2, 3.1.4, and 3.1.5, respectively.

4.1.3 Water. Deionized distilled, to conform to ASTM Specification D1193-77 (incorporated by reference—see § 60.17), Type 3. If high concentrations of organic matter are not expected to be present, the analyst may delete the potassium permanganate test for oxidizable organic matter.

4.1.4 Nitric Acid, 0.1 N. Dilute 6.5 ml of concentrated HNO_3 to 1 liter with deionized distilled water. (It may be desirable to run blanks before field use to eliminate a high blank on test samples.)

4.2 Pretest Preparation. 6 N HNO_3 is needed. Dilute 390 ml of concentrated HNO_3 to 1 liter with deionized distilled water.

4.3 Sample Recovery. 0.1 N HNO_3 (same as 4.1.4 above) is needed for sample recovery.

4.4 Analysis. The following reagents are needed for analysis (use ACS reagent grade chemicals or equivalent, unless otherwise specified):

4.4.1 Water. Same as 4.1.3 above.

4.4.2 Nitric Acid. Concentrated.

4.4.3 Nitric Acid, 50 percent (V/V). Dilute 500 ml of concentrated HNO_3 to 1 liter with deionized distilled water.

4.4.4 Stock Lead Standard Solution, 1000 μg Pb/ml. Dissolve 0.1598 g of lead nitrate [$Pb(NO_3)_2$] in about 60 ml of deionized distilled water, add 2 ml concentrated HNO_3, and dilute to 100 ml with deionized distilled water.

4.4.5 Working Lead Standards. Pipet 0.0, 1.0, 2.0, 3.0, 4.0, and 5.0 ml of the stock lead standard solution (4.4.4) into 250-ml volumetric flasks. Add 5 ml of concentrated HNO_3 to each flask and dilute to volume with deionized distilled water. These working standards contain 0.0, 4.0, 8.0, 12.0, 16.0, and 20.0 μg Pb/ml, respectively. Prepare, as needed, additional standards at other concentrations in a similar manner.

4.4.6 Air. Suitable quality for atomic absorption analysis.

4.4.7 Acetylene. Suitable quality for atomic absorption analysis.

4.4.8 Hydrogen Peroxide, 3 percent (V/V). Dilute 10 ml of 30 percent H_2O_2 to 100 ml with deionized distilled water.

5. *Procedure.*

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

5.1.1 Pretest Preparation. Follow the same general procedure given in Method 5, Section 4.1.1, except the filter need not be weighed.

5.1.2 Preliminary Determinations. Follow the same general procedure given in Method 5, Section 4.1.2.

5.1.3 Preparation of Collection Train. Follow the same general procedure given in Method 5, Section 4.1.3, except place 100 ml of 0.1 HNO_3 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

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[*] Mention of trade names or specific products does not constitute endorsement by the U.S. Environmental Protection Agency.

---

the fourth impinger. Set up
shown in Figure 12-1.
5.1.4 Leak-Check Procedur
general leak-check procedu
Method 5, Sections 4.1.4.1. (
Check), 4.1.4.2 (Leak-Checks
Sample Run), and 4.1.4.3 (Pc
Check).
5.1.5 Sampling Train Op
the same general procedure g
5. Section 4.1.5. For each ru
data required on a data shee
one shown in EPA Method 5. F
5.1.6 Calculation of Percer
Same as Method 5, Section 4.1.
5.2 *Sample Recovery.* Begin
up procedure as soon as the
moved from the stack at the en
pling period.
Allow the probe to cool. W
safely handled, wipe off all ext
late matter near the tip of the
and place a cap over it. Do no
probe tip tightly while the sam
cooling down as this would cre
in the filter holder, thus dr
from the impingers into the filt
Before moving the sampling
cleanup site, remove the pro
sapling train, wipe off the sil
and cap the open outlet of th
careful not to lose any conc
might be present. Wipe off
grease from the glassware inle
probe was fastened and ca
Remove the umbilical cord fron
pinger and cap the impinger.
may use ground-glass stoppers,
or serum caps to close these ope
Transfer the probe and filter-
sembly to a cleanup area, which
protected from the wind so that
of contaminating or losing the
minimized.
Inspect the train prior to an
assembly and note any abnorma
Treat the samples as follows:
5.2.1 *Container No. 1* (Filte
remove the filter from the filte
place it in its identified petri di
If it is necessary to fold the
such that the sample-exposed
the fold. Carefully transfer to t
any visible sample matter a
fibers that adhere to the f
gasket by using a dry Nylon
and/or a sharp-edged blade. S
tainer.
5.2.2 *Container No. 2* (Pro
care that dust on the outside of
other exterior surfaces does not
sample, quantitatively reco
matter or any condensate fro
nozzle, probe fitting, probe line
half of the filter holder by w
components with 0.1 N HNO_3
the wash into a glass sample

cted to be present, the analyst
the potassium permanganate
zable organic matter.

c Acid, 0.1 N. Dilute 6.5 ml of
HNO_3 to 1 liter with deionized
er. (It may be desirable to run
e field use to eliminate a high
samples.)

t Preparation. 6 N HNO_3 is
e 390 ml of concentrated HNO_3
deionized distilled water.

e Recovery. 0.1 N HNO_3 (same
e) is needed for sample recov-

ts. The following reagents are
nalysis (use ACS reagent grade
equivalent, unless otherwise

r. Same as 4.1.3 above.

c Acid. Concentrated.

c Acid, 50 percent (V/V). Dilute
ncentrated HNO_3 to 1 liter with
illed water.

Lead Standard Solution, 1000
issolve 0.1598 g of lead nitrate
about 60 ml of deionized dis-
add 2 ml concentrated HNO_3.
100 ml with deionized distilled

ing Lead Standards. Pipet 0.0,
.0, and 5.0 ml of the stock lead
ition (4.4.4) into 250-ml volu-
. Add 5 ml of concentrated
h flask and dilute to volume
d distilled water. These work-
contain 0.0, 4.0, 8.0, 12.0, 16.0,
b/ml, respectively. Prepare, as
ional standards at other con-
a similar manner.

uitable quality for atomic ab-
ysis.

lene. Suitable quality for
tion analysis.

ogen Peroxide, 3 percent (V/
ml of 30 percent H_2O_2 to 100
ized distilled water.

ng. The complexity of this
h that, in order to obtain reli-
testers should be trained and
ith the test procedures.

t Preparation. Follow the
procedure given in Method 5,
except the filter need not be

inary Determinations. Follow
ral procedure given in Method
2.

ration of Collection Train.
ne general procedure given in
tion 4.1.3, except place 100 ml
in each of the first two im-
the third impinger empty,
pproximately 200 to 300 g of
lica gel from its container to

the fourth impinger. Set up the train as shown in Figure 12-1.

5.1.4 Leak-Check Procedures. Follow the general leak-check procedures given in Method 5, Sections 4.1.4.1. (Pretest Leak-Check), 4.1.4.2 (Leak-Checks During the Sample Run), and 4.1.4.3 (Post-Test Leak-Check).

5.1.5 Sampling Train Operation. Follow the same general procedure given in Method 5, Section 4.1.5. For each run, record the data required on a data sheet such as the one shown in EPA Method 5, Figure 5-2.

5.1.6 Calculation of Percent Isokinetic. Same as Method 5, Section 4.1.6.

5.2 *Sample Recovery.* Begin proper cleanup procedure as soon as the probe is removed from the stack at the end of the sampling period.

Allow the probe to cool. When it can be safely handled, wipe off all external particulate matter near the tip of the probe nozzle and place a cap over it. Do not cap off the probe tip tightly while the sampling train is cooling down as this would create a vacuum in the filter holder, thus drawing liquid from the impingers into the filter.

Before moving the sampling train to the cleanup site, remove the probe from the sapling 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 glassware inlet where the probe was fastened and cap the inlet. Remove the umbilical cord from the last impinger and cap the impinger. The tester may use ground-glass stoppers, plastic caps, or serum caps to close these openings.

Transfer the probe and filter-impinger assembly to a cleanup area, which is clean and protected from the wind so that the chances of contaminating or losing the sample are minimized.

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

5.2.1 *Container No. 1* (Filter). Carefully remove the filter from the filter holder and place it in its identified petri dish container. If it is necessary to fold the filter, do so such that the sample-exposed side is inside the fold. Carefully transfer to the petri dish any visible sample matter and/or filter fibers that adhere to the filter holder gasket by using a dry Nylon bristle brush and/or a sharp-edged blade. Seal the container.

5.2.2 *Container No. 2* (Probe). Taking care that dust on the outside of the probe or other exterior surfaces does not get into the sample, quantitatively recover sample matter or any condensate from the probe nozzle, probe fitting, probe liner, and front half of the filter holder by washing these components with 0.1 N HNO_3 and placing the wash into a glass sample storage container. Measure and record (to the nearest 2-ml) the total amount of 0.1 N HNO_3 used for each rinse. Perform the 0.1 N HNO_3 rinses as follows:

Carefully remove the probe nozzle and rinse the inside surfaces with 0.1 N HNO_3 from a wash bottle while brushing with a stainless steel, Nylon-bristle brush. Brush until the 0.1 N HNO_3 rinse shows no visible particles, then make a final rinse of the inside surface.

Brush and rinse with 0.1 N HNO_3 the inside parts of the Swagelok fitting in a similar way until no visible particles remain.

Rinse the probe liner with 0.1 N HNO_3. While rotating the probe so that all inside surfaces will be rinsed with 0.1 N HNO_3, tilt the probe and squirt 0.1 N HNO_3 into its upper end. Let the 0.1 N HNO_3 drain from the lower end into the sample container. The tester may use a glass funnel to aid in transferring liquid washes to the container. Follow the rinse with a probe brush. Hold the probe in an inclined position, squirt 0.1 N HNO_3 into the upper end of the probe as the probe brush is being pushed with a twisting action through the probe; hold the sample container underneath the lower end of the probe and catch any 0.1 N HNO_3 and sample matter that is brushed from the probe. Run the brush through the probe three times or more until no visible sample matter is carried out with the 0.1 N HNO_3 and none remains on 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 sample matter can be entrapped. Rinse the brush with 0.1 N HNO_3 and quantitatively collect these washings in the sample container. After the brushing make a final rinse of the probe as described above.

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

After insuring that all joints are wiped clean of silicone grease, brush and rinse with 0.1 N HNO_3 the inside of the front half of the filter holder. Brush and rinse each suface three times or more, if needed, to remove visible sample matter. Make a final rinse of the brush and filter holder. After all 0.1 N HNO_3 washings and sample matter are collected in the sample container, tighten the lid on the sample container so that the fluid will not leak out when it is shipped to the laboratory. Mark the height of the fluid level to determine whether leakage occurs during transport. Label the container to clearly identify its contents.

5.2.3 *Container No. 3* (Silica Gel). Check the color of the indicating silica gel to determine if it has been completely spent and make a notation of its condition. Transfer the silica gel from the fourth impinger to the original container and seal. The tester may use a funnel to pour the silica gel and a rubber policeman to remove the silica gel from the impinger. It is not necessary to remove the small amount of particles that may adhere to the walls 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, the tester may follow procedure for Container No. 3 under Section 5.4 (Analysis).

5.2.4 *Container No. 4* (Impingers). Due to the large quantity of liquid involved, the tester may place the impinger solutions in several containers. Clean each of the first three impingers and connecting glassware in the following manner:

1. Wipe the impinger ball joints free of silicone grease and cap the joints.

2. Rotate and agitate each impinger, so that the impinger contents might serve as a rinse solution.

3. Transfer the contents of the impingers to a 500-ml graduated cylinder. Remove the outlet ball joint cap and drain the contents through this opening. Do not separate the impinger parts (inner and outer tubes) while transferring their contents to the cylinder. Measure the liquid volume to within ±2 ml. Alternatively, determine the weight of the liquid to within ±0.5 g. Record in the log the volume or weight of the liquid present, along with a notation of any color or film observed in the impinger catch. The liquid volume or weight is needed, along with the silica gel data, to calculate the stack gas moisture content (see Method 5, Figure 5-3).

4. Transfer the contents to Container No. 4.

5. Note: In steps 5 and 6 below, measure and record the total amount of 0.1 N HNO_3 used for rinsing. Pour approximately 30 ml of 0.1 N HNO_3 into each of the first three impingers and agitate the impingers. Drain the 0.1 N HNO_3 through the outlet arm of each impinger into Container No. 4. Repeat this operation a second time; inspect the impingers for any abnormal conditions.

6. Wipe the ball joints of the glassware connecting the impingers free of silicone grease and rinse each piece of glassware twice with 0.1 N HNO_3; transfer this rinse into Container No. 4. (*Do not rinse or brush the glass-fritted filter support.*) Mark the height of the fluid level to determine whether leakage occurs during transport. Label the container to clearly identify its contents.

5.2.5 Blanks. Save 200 ml of the 0.1 N HNO_3 used for sampling and cleanup as a blank. Take the solution directly from the bottle being used and place into a glass sample container labeled "0.1 N HNO_3 blank."

5.3 Sample Preparation.

5.3.1 *Container No. 1* (Filter). Cut the filter into strips and transfer the strips and all loose particulate matter into a 125-ml Erlenmeyer flask. Rinse the petri dish with 10 ml of 50 percent HNO_3 to insure a quantitative transfer and add to the flask. (Note: If the total volume required in Section 5.3.3 is expected to exceed 80 ml, use a 250-ml Erlenmeyer flask in place of the 125-ml flask.)

5.3.2 *Containers No. 2 and No. 4* (Probe and Impingers). (Check the liquid level in Containers No. 2 and/or No. 4 and confirm as to whether or not leakage occurred during transport; note observation on the analysis sheet. If a noticeable amount of leakage had occurred, either void the sample or take steps, subject to the approval of the Administrator, to adjust the final results.) Combine the contents of Containers No. 2 and No. 4 and take to dryness on a hot plate.

5.3.3 Sample Extraction for lead. Based on the approximate stack gas particulate concentration and the total volume of stack gas sampled, estimate the total weight of particulate sample collected. Then transfer the residue from Containers No. 2 and No. 4 to the 125-ml Erlenmeyer flask that contains the filter using rubber policeman and 10 ml of 50 percent HNO_3 for every 100 mg of sample collected in the train or a minimum of 30 ml of 50 percent HNO_3 whichever is larger.

Place the Erlenmeyer flask on a hot plate and heat with periodic stirring for 30 min at a temperature just below boiling. If the sample volume falls below 15 ml, add more 50 percent HNO_3. Add 10 ml of 3 percent H_2O_2 and continue heating for 10 min. Add 50 ml of hot (80°C) deionized distilled water and heat for 20 min. Remove the flask from the hot plate and allow to cool. Filter the sample through a Millipore membrane filter or equivalent and transfer the filtrate to a 250-ml volumetric flask. Dilute to volume with deionized distilled water.

5.3.4 Filter Blank. Determine a filter blank using two filters from each lot of filters used in the sampling train. Cut each filter into strips and place each filter in a separate 125-ml Erlenmeyer flask. Add 15 ml of 50 percent HNO_3 and treat as described in Section 5.3.3 using 10 ml of 3 percent H_2O_2 and 50 ml of hot, deionized distilled water. Filter and dilute to a total volume of 100 ml using deionized distilled water.

5.3.5 0.1 N HNO_3 Blank. Take the entire 200 ml of 0.1 N HNO_3 to dryness on a steam bath, add 15 ml of 50 percent HNO_3, and treat as described in Section 5.3.3 using 10 ml of 3 percent H_2O_2 and 50 ml of hot, deionized distilled water. Dilute to a total

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volume of 100 ml using deion
water.
5.4 Analysis.
5.4.1 Lead Determination.
spectrophotometer as describe
6.2 and determine the absorb
source sample, the filter bla
HNO_3 blank. Analyze each
times in this manner. Make a
lutions, as required, to bring
concentrations into the line
range of the spectrophotome
If the Pb concentration of
the low end of the calibrati
high accuracy is required, the
taken to dryness on a hot pla
due dissolved in the appropri
water to bring it into the opti
the calibration curve.
5.4.2 Mandatory Check fo
fects on the Lead Results. Th
Pb by atomic absorption is se
chemical compositon and to
properties (viscosity, pH) o
(matrix effects). Since the Pb
scribed here will be applied t
ent sources, many sample m
encountered. Thus, check (
least one sample from each so
Method of Additions to asce
chemical composition and p
ties of the sample did not c
analytical results.
Three acceptable "Method
procedures are described in
Procedure Section of the Per
poration Manual (see Citati
results of the Method of A
dure on the source sample
within 5 percent of the valu
the conventional atomic ab
sis, then the tester must re
ples from the source using
Additions procedure.
5.4.3 *Container No. 3* (S
tester may conduct this ste
Weigh the spent silica gel (o
impinger) to the nearest 0.
weight.
6. *Calibration.*
Maintain a laboratory lo
tions.
6.1 Sampling Train Ca
brate the sampling train
cording to the indicated sect
5: Probe Nozzle (Section 5
(Section 5.2); Metering Syste
Probe Heater (Section 5.4
Gauges (Section 5.5); Leak-C
tering System (Section 5.6);
(Section 5.7).
6.2 Spectrophotometer.
sorbance of the standard sol
instrument settings recom
spectrophotometer manuf
until good agreement (±3
tained between two conse

ıtainer labeled "0.1 N HNO_3

ıle Preparation.
.tainer No. 1 (Filter). Cut the
:rips and transfer the strips and
'ticulate matter into a 125-ml Er-
ısk Rinse the petri dish with 10
'cent HNO_3 to insure a quantita-
r and add to the flask. (Note If
lume required in Section 5.3.3 is
exceed 80 ml, use a 250-ml Er-
ısk in place of the 125-ml flask.)
tainers No. 2 and No. 4 (Probe
ers). (Check the liquid level in
No. 2 and/or No. 4 and confirm
:her or not leakage occurred
sport; note observation on the
eet. If a noticeable amount of
d occurred, either void the
ike steps, subject to the approv-
dministrator, to adjust the final
mbine the contents of Contain-
d No. 4 and take to dryness on a

ıple Extraction for lead. Based
·roximate stack gas particulate
on and the total volume of stack
l, estimate the total weight of
sample collected. Then transfer
from Containers No. 2 and No. 4
ml Erlenmeyer flask that con-
ter using rubber policeman and
percent HNO_3 for every 100 mg
ollected in the train or a mini-
nl of 50 percent HNO_3 whichev-

Erlenmeyer flask on a hot plate
th periodic stirring for 30 min at
ure just below boiling. If the
me falls below 15 ml, add more
HNO_3. Add 10 ml of 3 percent
ntinue heating for 10 min. Add
. (80°C) deionized distilled water
· 20 min. Remove the flask from
te and allow to cool. Filter the
ugh a Millipore membrane filter
ıt and transfer the filtrate to a
metric flask. Dilute to volume
ed distilled water.
er Blank. Determine a filter
two filters from each lot of fil-
ı the sampling train. Cut each
trips and place each filter in a
5-ml Erlenmeyer flask. Add 15
ercent HNO_3 and treat as de-
ection 5.3.3 using 10 ml of 3 per-
nd 50 ml of hot, deionized dis-
. Filter and dilute to a total
00 ml using deionized distilled

N HNO_3 Blank. Take the entire
l N HNO_3 to dryness on a steam
5 ml of 50 percent HNO_3, and
cribed in Section 5.3.3 using 10
rcent H_2O_2 and 50 ml of hot,
stilled water. Dilute to a total volume of 100 ml using deionized distilled water.

5.4 Analysis.

5.4.1 Lead Determination. Calibrate the spectrophotometer as described in Section 6.2 and determine the absorbance for each source sample, the filter blank, and 0.1 N HNO_3 blank. Analyze each sample three times in this manner. Make appropriate dilutions, as required, to bring all sample Pb concentrations into the linear absorbance range of the spectrophotometer.

If the Pb concentration of a sample is at the low end of the calibration curve and high accuracy is required, the sample can be taken to dryness on a hot plate and the residue dissolved in the appropriate volume of water to bring it into the optimum range of the calibration curve.

5.4.2 Mandatory Check for Matrix Effects on the Lead Results. The analysis for Pb by atomic absorption is sensitive to the chemical compositon and to the physical properties (viscosity, pH) of the sample (matrix effects). Since the Pb procedure described here will be applied to many different sources, many sample matrices will be encountered. Thus, check (mandatory) at least one sample from each source using the Method of Additions to ascertain that the chemical composition and physical properties of the sample did not cause erroneous analytical results.

Three acceptable "Method of Additions" procedures are described in the General Procedure Section of the Perkin Elmer Corporation Manual (see Citation 9.1). If the results of the Method of Additions procedure on the source sample do not agree within 5 percent of the value obtained by the conventional atomic absorption analysis, then the tester must reanalyze all samples from the source using the Method of Additions procedure.

5.4.3 *Container No. 3* (Silica Gel). The tester may conduct this step in the field. Weigh the spent silica gel (or silica gel plus impinger) to the nearest 0.5 g; record this weight.

6. *Calibration.*

Maintain a laboratory log of all calibrations.

6.1 Sampling Train Calibration. Calibrate the sampling train components according to the indicated sections of Method 5: Probe Nozzle (Section 5.1); Pitot Tube (Section 5.2); Metering System (Section 5.3); Probe Heater (Section 5.4); Temperature Gauges (Section 5.5); Leak-Check of the Metering System (Section 5.6); and Barometer (Section 5.7).

6.2 Spectrophotometer. Measure the absorbance of the standard solutions using the instrument settings recommended by the spectrophotometer manufacturer. Repeat until good agreement (±3 percent) is obtained between two consecutive readings. Plot the absorbance (y-axis) versus concentration in μg Pb/ml (x-axis). Draw or compute a straight line through the linear portion of the curve. Do not force the calibration curve through zero, but if the curve does not pass through the origin or at least lie closer to the origin than ±0.003 absorbance units, check for incorrectly prepared standards and for curvature in the calibration curve.

To determine stability of the calibration curve, run a blank and a standard after every five samples and recalibrate, as necessary.

7. *Calculations.*

7.1 Dry Gas Volume. Using the data from this test, calculate $V_{m(std)}$, the total volume of dry gas metered corrected to standard conditions (20°C and 760 mm Hg), by using Equation 5-1 of Method 5. If necessary, adjust $V_{m(std)}$ for leakages as outlined in Section 6.3 of Method 5. See the field data sheet for the average dry gas meter temperature and average orifice pressure drop.

7.2 Volume of Water Vapor and Moisture Content. Using data obtained in this test and Equations 5-2 and 5-3 of Method 5, calculate the volume of water vapor $V_{w(std)}$) and the moisture content B_{ws} of the stack gas.

7.3 Total Lead in Source Sample. For each source sample correct the average absorbance for the contribution of the filter blank and the 0.1 N HNO_3 blank. Use the calibration curve and this corrected absorbance to determine the μg Pb concentration in the sample aspirated into the spectrophotometer. Calculate the total Pb content C'_{Pb} (in μg) in the original source sample; correct for all the dilutions that were made to bring the Pb concentration of the sample into the linear range of the spectrophotometer.

7.4 Lead Concentration. Calculate the stack gas Pb concentration C_{Pb} in mg/dscm as follows:

$$C_{Pb} = K \frac{C'_{Pb}}{V_{m(std)}}$$

Where:
K = 0.001 mg/μg for metric units.
= 2.205 lb/μg for English units.

7.5 Isokinetic Variation and Acceptable Results. Same as Method 5, Sections 6.11 and 6.12, respectively. To calculate v_s the average stack gas velocity, use Equation 2-9 of Method 2 and the data from this field test.

8. *Alternative Test Methods for Inorganic Lead.*

8.1 Simultaneous Determination of Particulate and Lead Emissions. The tester may use Method 5 to simultaneously determine Pb provided that (1) he uses acetone to remove particulate from the probe and inside of the filter holder as specified by Method 5, (2) he uses 0.1 N HNO_3 in the impingers, (3) he uses a glass fiber filter with a low Pb background, and (4) he treats and analyzes the entire train contents, including the impingers, for Pb as described in Section 5 of this method.

8.2 Filter Location. The tester may use a filter between the third and fourth impinger provided that he includes the filter in the analysis for Pb.

8.3 In-stack Filter. The tester may use an in-stack filter provided that (1) he uses a glass-lined probe and at least two impingers, each containing 100 ml of 0.1 N HNO_3, after the in-stack filter and (2) he recovers and analyzes the probe and impinger contents for Pb. Recover sample from the nozzle with acetone if a particulate analysis is to be made.

9. Bibliography

9.1 Perkin Elmer Corporation. Analytical Methods for Atomic Absorption Spectrophotometry. Norwalk, Connecticut. September 1976.

9.2 American Society for Testing and Materials. Annual Book of ASTM Standards. Part 31; Water, Atmospheric Analysis. Philadelphia, Pa. 1974. p. 40-42.

9.3 Klein, R. and C. Hach. Standard Additions—Uses and Limitations in Spectrophotometric Analysis. *Amer. Lab.* 9:21-27. 1977.

9.4 Mitchell, W.J. and M.R. Midgett. Determining Inorganic and Alkyl Lead Emissions from Stationary Sources. U.S. Environmental Protection Agency. Emission Monitoring and Support Laboratory. Research Triangle Park, N.C. (Presented at National APCA Meeting. Houston. June 26, 1978).

9.5 Same as Method 5, Citations 2 to 5 and 7 of Section 7.

METHOD 13A—DETERMINATION OF TOTAL FLUORIDE EMISSIONS FROM STATIONARY SOURCES; SPADNS ZIRCONIUM LAKE METHOD

1. Applicability and Principle

1.1 Applicability. This method applies to the determination of fluoride (F) emissions from sources as specified in the regulations. It does not measure fluorocarbons, such as freons.

1.2 Principle. Gaseous and particulate F are withdrawn isokinetically from the source and collected in water and on a filter. The total F is then determined by the SPADNS Zirconium Lake colorimetric method.

2. Range and Sensitivity

The range of this method is 0 to 1.4 μg F/ml. Sensitivity has not been determined.

3. Interferences

Large quantities of chloride will interfere with the analysis, but this interference can be prevented by adding silver sulfate into the distillation flask (see Section 7.3.4). If chloride ion is present, it may be easier to use the Specific Ion Electrode Method (Method 13B). Grease on sample exposed surfaces may cause low F results due to adsorption.

4. Precision, Accuracy, and Stability

4.1 Precision. The following estimates are based on a collaborative test done at a primary aluminum smelter. In the test, six laboratories each sampled the stack simultaneously using two sampling trains for a total of 12 samples per sampling run. Fluoride concentrations encountered during the test ranged from 0.1 to 1.4 mg F/m³. The within-laboratory and between-laboratory standard deviations, which include sampling and analysis errors, were 0.044 mg F/m³ with 60 degrees of freedom and 0.064 mg F/m³ with five degrees of freedom, respectively.

4.2 Accuracy. The collaborative test did not find any bias in the analytical method.

4.3 Stability. After the sample and colorimetric reagent are mixed, the color formed is stable for approximately 2 hours. A 3°C temperature difference between the sample and standard solutions produces an error of approximately 0.005 mg F/liter. To avoid this error, the absorbances of the sample and standard solutions must be measured at the same temperature.

5. Apparatus

5.1 Sampling Train. A schematic of the sampling train is shown in Figure 13A-1; it is similar to the Method 5 train except the filter position is interchangeable. The sampling train consists of the following components:

5.1.1 Probe Nozzle, Pitot Tube, Differential Pressure Gauge, Filter Heating System, Metering System, Barometer, and Gas Density Determination Equipment. Same as Method 5, Sections 2.1.1, 2.1.3, 2.1.4, 2.1.6, 2.1.8, 2.1.9, and 2.1.10. When moisture condensation is a problem, the filter heating system is used.

5.1.2 Probe Liner. Borosilicate glass or 316 stainless steel. When the filter is located immediately after the probe, the tester may use a probe heating system to prevent filter plugging resulting from moisture condensation, but the tester shall not allow the temperature in the probe to exceed 120±14°C (248±25°F).

5.1.3 Filter Holder. With positive seal against leakage from the outside or around the filter. If the filter is located between the probe and first impinger, use borosilicate

glass or stainless steel with a 20-
less steel screen filter support an
rubber gasket; do not use a gla
sintered metal filter support. If
located between the third and
pingers, the tester may use boros
with a glass frit filter support ar
rubber gasket. The tester ma
other materials of construction
al from the Administrator.

5.1.4 Impingers. Four imp
nected as shown in Figure
ground-glass (or equivalent), v
fittings. For the first, third, anc
pingers, use the Greenburg-Sn
modified by replacing the tip w
inside-diameter (½ in.) glass tub
to 1.3 cm (½ in.) from the bo
flask. For the second impinger,
burg-Smith impinger with the s
The tester may use modification
ble connections between the
materials other than glass), su
approval of the Administrator.
mometer, capable of measuring
to within 1°C (2°F), at the o
fourth impinger for monitoring

5.2 Sample Recovery. The
items are needed:

5.2.1 Probe-Liner and
Brushes, Wash Bottles, Gradu
and/or Balance, Plastic Storag
Rubber Policeman, Funnel
Method 5, Sections 2.2.1 to 2.2.
2.2.8, respectively.

5.2.2 Sample Storage Cont
mouth, high-density-polyethy
for impinger water samples, 1-l

U.S. EPA METHOD 8

5.2 Standard Calibration Curve. Prepare a series of five standards by adding 1.0, 2.0, 4.0, 6.0, and 10.0 ml of working standard solution (25 µg/ml) to a series of five 50-ml volumetric flasks. (The standard masses will equal 25, 50, 100, 150, and 250 µg.) Dilute each flask to volume with water, and mix well. Analyze with the samples as described in Section 4.4 and subtract the blank from each value. Prepare or calculate a linear regression plot to the standard masses in µg (x-axis) versus their peak height responses in millimeters (y-axis). (Take peak height measurements with symmetrical peaks; in all other cases, calculate peak areas.) From this curve, or equation, determine the slope, and calculate its reciprocal to denote as the calibration factor, S. If any point deviates from the line by more than 7 percent of the concentration at that point, remake and reanalyze that standard. This deviation can be determined by multiplying S times the peak height response for each standard. The resultant concentrations must not differ by more than 7 percent from each known standard mass (i.e., 25, 50, 100, 150, and 250 µg).

5.3 Conductivity Detector. Calibrate according to manufacturer's specifications prior to initial use.

5.4 Barometer. Calibrate against a mercury barometer.

5.5 Temperature Gauge. Calibrate dial thermometers against mercury-in-glass thermometers.

5.6 Vacuum Gauge. Calibrate mechanical gauges, if used, against a mercury manometer such as that specified in Section 2.1.6 of Method 7.

5.7 Analytical Balance. Calibrate against standard weights.

6. *Calculations.*

Carry out the calculations, retaining at least one extra decimal figure beyond that of the acquired data. Round off figures after final calculations.

6.1 Sample Volume. Calculate the sample volume V_{sc} (in ml) on a dry basis, corrected to standard conditions, using Equation 7-2 of Method 7.

6.2 Sample Concentration of NO_x as NO_2. Calculate the sample concentration C (in mg/dscm) as follows:

$$C = \frac{HSF \times 10^4}{V_{sc}} \qquad \text{Eq. 7A-1}$$

Where:

F = Dilution factor (required only if sam
dilution was needed to reduce the c
centration into the range of calibrati
10^4 = 1:10 dilution times conversion fa
of

$$\frac{mg}{10^3\,\mu g} \times \frac{10^6\,ml}{m^3}$$

If desired, the concentration of NO_2
be calculated as ppm NO_2 at standard co
tions as follows:

$$ppm\ NO_2 = 0.5228\ C \qquad \text{Eq. 7}$$

Where:

0.5228 = ml/mg NO_2.

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METHOD 8—DETERMINATION OF SULFU[illegible] ACID MIST AND SULFUR DIOXIDE EMISSI[illegible] FROM STATIONARY SOURCES

1. *Principle and Applicability*

1.1 Principle. A gas sample is extrac
isokinetically from the stack. The sulfu
acid mist (including sulfur trioxide) and
sulfur dioxide are separated, and both f
tions are measured separately by
barium-thorin titration method.

1.2 Applicability. This method is appl
ble for the detemination of sulfuric
mist (including sulfur trioxide, and in
absence of other particulate matter)
[illegible]ur [illegible]e emissions from statior
sources. Collabora[illegible] tests [illegible] show[illegible]
[illegible] limits of

method are 0.05 milligrams/cubic meter (0.03×10^{-7} pounds/cubic foot) for sulfur trioxide and 1.2 mg/m³ ($0.74\ 10^{-7}$ lb/ft³) for sulfur dioxide. No upper limits have been established. Based on theoretical calculations for 200 milliters of 3 percent hydrogen peroxide solution, the upper concentration limit for sulfur dioxide in a 1.0 m³ (35.3 ft³) gas sample is about 12,500 mg/m³ (7.7×10^{-4} lb/ft³). The upper limit can be extended by increasing the quantity of peroxide solution in the impingers.

Possible interfering agents of this method are fluorides, free ammonia, and dimethyl aniline. If any of these interfering agents are present (this can be determined by knowledge of the process), alternative methods, subject to the approval of the Administrator, U. S. E. P.A., are required.

Filterable particulate matter may be determined along with SO_3 and SO_2 (subject to the approval of the Administrator) by inserting a heated glass fiber filter between the probe and isopronanol impinger (see Section 2.1 of method 6.) If this option is chosen, particulate analysis is gravimetric only; H_2SO_4 acid mist is not determined separately.

2. *Apparatus*

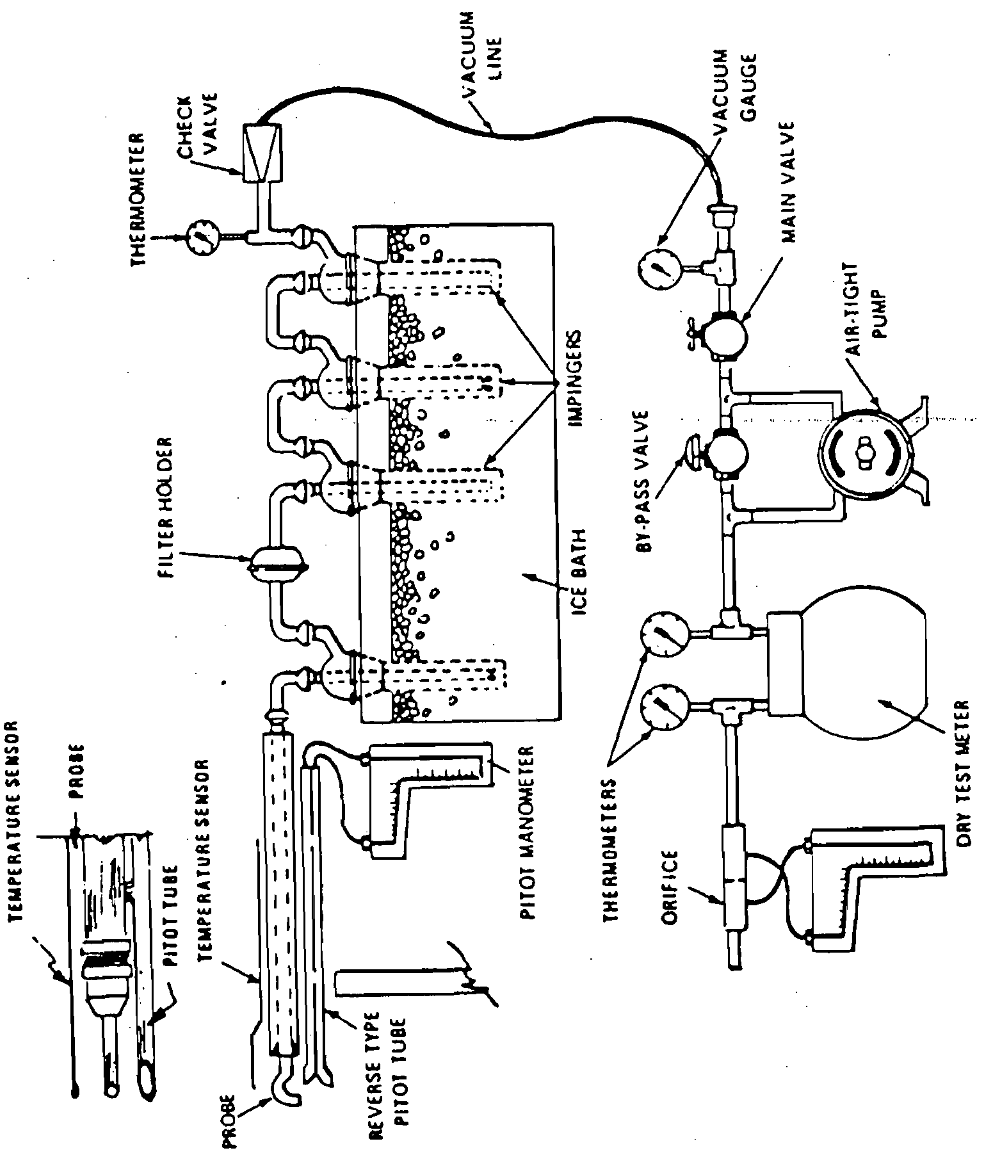
2.1 Sampling. A schematic of the sampling train used in this method is shown in Figure 8-1; it is similiar to the Method 5 train except that the filter position is different and the filter holder does not have to be heated. Commercial models of this train are avaiable. For those who desire to build their own, however, complete construction details are described in APTD-0581. Changes from the APTD-0581 document and allowable modifications to Figure 8-1 are discussed in the following subsections.

The operating and maintenance procedures for the sampling train are described in APTD-0576. Since correct usage is important in obtaining valid results, all users should read the APTD-0576 document and adopt the operating and maintenance procedures outlined in it, unless otherwise specified herein. Further details and guidelines on operation and maintenance are given in Method 5 and should be read and followed whenever they are applicable.

2.1.1 Probe Nozzle. Same as Method 5, Section 2.1.1.

2.1.2 Probe Liner. Borosilicate or quartz glass, with a heating system to prevent visible condensation during sampling. Do not use metal probe liners.

2.1.3 Pitot Tube. Same as Method 5, Section 2.1.3.



2.1.4 Differential Pressure Gauge. Same as Method 5, Section 2.1.4.

2.1.5 Filter Holder. Borosilicate glass, with a glass frit filter support and a silicone rubber gasket. Other gasket materials, e.g., 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 filter holder shall be placed between the first and second impingers. Note: Do not heat the filter holder.

2.1.6 Impingers—Four, as shown in Figure 8-1. The first and third shall be of the Greenburg-Smith design with standard tips. The second and fourth shall be of the Greenburg-Smith design, modified by replacing the insert with an approximately 13 millimeter (0.5 in.) ID glass tube, having an unconstricted tip located 13 mm (0.5 in.) from the bottom of the flask. Similar collection systems, which have been approved by the Administrator, may be used.

2.1.7 Metering System. Same as Method 5, Section 2.1.8.

2.1.8 Barometer. Same as Method 5, Section 2.1.9.

2.1.9 Gas Density Determination Equipment. Same as Method 5, Section 2.1.10.

2.1.10 Temperature Gauge. Thermometer, or equivalent, to measure the temperature of the gas leaving the impinger train to within 1° C (2° F).

2.2 Sample Recovery.

2.2.1 Wash Bottles. Polyethylene or glass, 500 ml. (two).

2.2.2 Graduated Cylinders. 250 ml, 1 liter. (Volumetric flasks may also be used.

2.2.3 Storage Bottles. Leak-free polyethlene bottles, 1000 ml size (two for each sampling run).

2.2.4 Trip Balance. 500-gram capacity, to measure to ±0.5 g (necessary only if a moisture content analysis is to be done).

2.3 Analysis.

2.3.1 Pipettes. Volumetric 25 ml, 100 ml.

2.3.2 Burette, 50 ml.

2.3.3 Erlenmeyer Flask. 250 ml. (one for each sample blank and standard).

2.3.4. Graduated Cylinder. 100 ml.

2.3.5 Trip Balance. 500 g capacity, to measure to ±0.5g.

2.3.6 Dropping Bottle. To add indicator solution, 125-ml size.

3. *Reagents*

Unless otherwise indicated, all reagents are to conform to the specifications established by the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Otherwise, use the best available grade.

3.1 Sampling.

3.1.1 Filters. Same as Method 5, Section 3.1.1.

3.1.2 Silica Gel. Same as Method 5, Section 3.1.2.

3.1.3 Water. Deionized, distilled to conform to ASTM specification D1193-77, Type 3 (Incorporated by reference—see § 60.17). At the option of the analyst, the $KMnO_4$ test for oxidizable organic matter may be omitted when high concentrations of organic matter are not expected to be present.

3.1.4 Isopropanol, 80 Percent. Mix 800 ml of isopropanol with 200 ml of deionized, distilled water.

NOTE: Experience has shown that only A.C.S. grade isopropanol is satisfactory. Tests have shown that isopropanol obtained from commerical sources occasionally has peroxide impurities that will cause erroneously high sulfuric acid mist measurement. Use the following test for detecting peroxides in each lot of isopropanol: Shake 10 ml of the isopropanol with 10 ml of freshly prepared 10 percent potassium iodide solution. Prepare a blank by similarly treating 10 ml of distilled water. After 1 minute, read the absorbance on a spectrophotometer at 352 nanometers. If the absorbance exceeds 0.1, the isopropanol shall not be used. Peroxides may be removed from isopropanol by redistilling, or by passage through a column of activated alumina. However, reagent-grade isopropanol with suitably low peroxide levels is readily available from commercial sources; therefore, rejection of contaminated lots may be more efficient than following the peroxide removal procedure.

3.1.5 Hydrogen Peroxide, 3 Percent. Dilute 100 ml of 30 percent hydrogen peroxide to 1 liter with deionized, distilled water. Prepare fresh daily.

3.1.6 Crushed Ice.

3.2 Sample Recovery.

3.2.1 Water. Same as 3.1.3.

3.2.2 Isopropanol, 80 Percent. Same as 3.1.4.

3.3 Analysis.

3.3.1 Water. Same as 3.1.3.

3.3.2 Isopropanol, 100 Percent.

3.3.3 Thorin Indicator. 1-(o-arsonophenylazo) 2-naphthol-3, 6-disulfonic acid, disodium salt, or equivalent. Dissolve 0.20 g in 100 ml of deionized, distilled water.

3.3.4 Barium Perchlorate (0.0100 Normal). Dissolve 1.95 g of barium perchlorate trihydrate ($Ba(ClO_4)_2 \cdot 3H_2O$) in 200 ml deionized, distilled water, and dilute to 1 liter with isopropanol; 1.22 g of barium chloride dihydrate ($BaCl_2 \cdot 2H_2O$) may be used instead of the barium perchlorate. Standardize with sulfuric acid as in Section 5.2. This solution must be protected against evaporation at all times.

3.3.5 Sulfuric Acid Standard (0.0100 N). Purchase or standardize to ±0.0002 N against 0.0100 N NaOH that has previously been standardized against primary standard potassium acid phthalate.

4. *Procedure*

4.1 Sampling.

4.1.1 Pretest Preparation. Follow the procedure outlined in Method 5, Section 4.1.1; filters should be inspected, but need not be desiccated, weighed, or identified. If the effluent gas can be considered dry, i.e., moisture free, the silica gel need not be weighed.

4.1.2 Preliminary Determinations. Follow the procedure outlined in Method 5, Section 4.1.2.

4.1.3 Preparation of Collection Train. Follow the procedure outlined in Method 5, Section 4.1.3 (except for the second paragraph and other obviously inapplicable parts) and use Figure 8-1 instead of Figure 5-1. Replace the second paragraph with: Place 100 ml of 80 percent isopropanol in the first impinger, 100 ml of 3 percent hydrogen peroxide in both the second and third impingers; retain a portion of each reagent for used as a blank solution. Place about 200g of silica gel in the fourth impinger.

NOTE: If moisture content is to be determined by impinger analysis, weigh each of the first three impingers (plus absorbing solution) to the nearest 0.5 g and record these weights. The weight of the silica gel (or silica gel plus container) must also be determined to the nearest 0.5 g and recorded.

4.1.4 Pretest Leak-Check Procedure. Follow the basic procedure outlined in Method 5, Section 4.1.4.1, noting that the probe heater shall be adjusted to the minimum temperature required to prevent condensation, and also that verbage such as, ". . . plugging the inlet to the filter holder . . .," shall be replaced by, ". . . plugging the inlet to the first impinger . . ." The pretest leak-check is optional.

4.1.5 Train Operation. Follow the basic procedures outlined in Method 5, Section 4.1.5, in conjunction with the following special instructions. Data shall be recorded on a sheet similar to the one in Figure 8-2. The sampling rate shall not exceed 0.030 m³/min (1.0 cfm) during the run. Periodically during the test, observe the connecting line between the probe and first impinger for signs of condensation. If it does occur, adjust the probe heater setting upward to the minimum temperature required to prevent condensation. If component changes become necessary during a run, a leak-check shall be done immediately before each change, according to the procedure outlined in Section 4.1.4.2 of Method 5 (with appropriate modifications, as mentioned in Section 4.1.4 of this method); record all leak rates. If the leakage rate(s) exceed the specified rate, the tester shall either void the run or shall plan to correct the sample volume as outlined in section 6.3 of Method 5. Immediately after component changes, leak-checks are optional. If these leak-checks are done, the procedure outlined in Section 4.1.4.1 of Method 5 (with appropriate modifications) shall be used.

Plant ....

Location ....

Operator ....

Date ....

Run No ....

Sample box No ....

Meter box No ....

Meter ΔH@ ....

C factor ....

Pitot tube coefficient, Cp ....

SCHEMATIC OF STACK CROSS SECTION

Static pressure, mm Hg (in. Hg) ....

Ambient temperature ....

Barometer pressure ....

Assumed moisture, % ....

Probe length, m (ft) ....

Nozzle identification No ....

Average calibrated nozzle diameter, cm (in.) ....

Probed heater setting ....

Leak rate, m³/min, (cfm) ....

Probe liner material ....

Filter No ....

Traverse point number	Sampling time (θ), min	Vacuum mm Hg (in Hg)	Stack temperature (T_s) °C (°F)	Velocity head (ΔP_s) mm H_2O (in H_2O)	Pressure differential across orifice meter mm H_2O (in H_2O)	Gas sample volume m³ (ft³)	Gas sample temperature at dry gas meter: Inlet °C (°F)	Gas sample temperature at dry gas meter: Outlet °C (°F)	Temperature of gas leaving condenser or last impinger °C (°F)
Total Average							Avg Avg	Avg	

After turning off the pump and recording the final readings at the conclusion of each run, remove the probe from the stack. Conduct a post-test (mandatory) leak-check as in Section 4.1.4.3 of Method 5 (with appropriate modification) and record the leak rate. If the post-test leakage rate exceeds the specified acceptable rate, the tester shall either correct the sample volume, as outlined in Section 6.3 of Method 5, or shall void the run.

Drain the ice bath and, with the probe disconnected, purge the remaining part of the train, by drawing clean ambient air through the system for 15 minutes at the average flow rate used for sampling.

NOTE: Clean ambient air can be provided by passing air through a charcoal filter. At the option of the tester, ambient air (without cleaning) may be used.

4.1.6 Calculation of Percent Isokinetic. Follow the procedure outlined in Method 5, Section 4.1.6.

4.2 Sample Recovery.

4.2.1 Container No. 1. If a moisture content analysis is to be done, weigh the first impinger plus contents to the nearest 0.5 g and record this weight.

Transfer the contents of the first impinger to a 250-ml graduated cylinder. Rinse the probe, first impinger, all connecting glassware before the filter, and the front half of the filter holder with 80 percent isopropanol. Add the rinse solution to the cylinder. Dilute to 250 ml with 80 percent isopropanol. Add the filter to the solution, mix, and transfer to the storage container. Protect the solution against evaporation. Mark the level of liquid on the container and identify the sample container.

4.2.2 Container No. 2. If a moisture content analysis is to be done, weigh the second and third impingers (plus contents) to the nearest 0.5 g and record these weights. Also, weigh the spent silica gel (or silica gel plus impinger) to the nearest 0.5 g.

Transfer the solutions from the second and third impingers to a 1000-ml graduated cylinder. Rinse all connecting glassware (including back half of filter holder) between the filter and silica gel impinger with deionized, distilled water, and add this rinse water to the cylinder. Dilute to a volume of 1000 ml with deionized, distilled water. Transfer the solution to a storage container. Mark the level of liquid on the container. Seal and identify the sample container.

4.3 Analysis.

Note the level of liquid in containers 1 and 2, and confirm whether or not any sample was lost during shipment; note this on the analytical data sheet. If a noticeable amount of leakage has occured, either void the sample or use methods, subject to the approval of the Administrator, to correct [illegible]nal r[illegible].

4.3.1 Container No. 1. Shake the container holding the isopropanol solution and the filter. If the filter breaks up, allow the fragments to settle for and few minutes before removing a sample. Pipette a 100-ml aliquot of this solution into a 250-ml Erlenmeyer flask, add 2 to 4 drops of thorin indicator, and titrate to a pink endpoint using 0.0100 N barium perchlorate. Repeat the titration with a second aliquot of sample and average the titration values. Replicate titrations must agree within 1 percent or 0.2 ml, whichever is greater.

4.3.2 Container No. 2. Thoroughly mix the solution in the container holding the contents of the second and third impingers. Pipette a 10-ml aliquot of sample into a 250-ml Erlenmeyer flask. Add 40 ml of isopropanol, 2 to 4 drops of thorin indicator, and titrate to a pink endpoint using 0.0100 N barium perchlorate. Repeat the titration with a second aliquot of sample and average the titration values. Replicate titrations must agree within 1 percent or 0.2 ml, whichever is greater.

4.3.3 Blanks. Prepare blanks by adding 2 to 4 drops of thorin indicator to 100 ml of 80 percent isopropanol. Titrate the blanks in the same manner as the samples.

5. *Calibration.*

5.1 Calibrate equipment using the procedures specified in the following sections of Method 5: Section 5.3 (metering system); Section 5.5 (termperature gauges); Section 5.7 (barometer). Note that the recommended leak-check of the metering system, described in Section 5.6 of Method 5, also applies to this method.

5.2 Standardize the barium perchlorate solution with 25 ml of standard sulfuric acid, to which 100 ml of 100 percent isopropanol has been added.

6. *Calculations*

NOTE: Carry out calculations retaining at least one extra decimal figure beyond that of the acquired data. Round off figures after final calculation.

6.1 Nomenclature.

A_n = Cross-sectional area of nozzle, m² (ft²).

B_{ws} = Water vapor in the gas stream, proportion by volume.

$C_{H_2SO_4}$ = Sulfuric acid (including SO_3) concentration, g/dscm (lb/dscf).

C_{SO_2} = Sulfur dioxide concentration, g/dscm (lb/dscf).

I = Percent of isokinetic sampling.

N = Normality of barium perchlorate titrant, g equivalents/liter.

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).

T_m = Average absolute dry gas meter temperature (see Figure 8-2), °K (°R).

T_s = Average absolute stack gas temperature (see Figure 8-2), °K (°R).

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

V_a = Volume of sample aliquot titrated, 100 ml for H_2SO_4 and 10 ml for SO_2.

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, dcm (dcf).

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

v_s = Average stack gas velocity, calculated by Method 2, Equation 2-9, using data obtained from method 8, m/sec (ft/sec).

V_{soln} = Total volume of solution in which the sufuric acid or sulfur dioxide sample is contained, 250 ml or 1,000 ml, respectively.

V_t = Volume of barium perchlorate titrant used for the sample, ml.

V_{tb} = Volume of barium perchlorate titrant used for the blank, ml.

Y = Dry gas meter calibration factor.

ΔH = Average pressure drop across orifice meter, mm (in.) H_2O.

θ = Total sampling time, min.

13.6 = Specific gravity of mercury.

60 = sec/min.

100 = Conversion to percent.

6.2 Average dry gas meter temperature and average orifice pressure drop. See data sheet (Figure 8-2).

6.3 Dry Gas Volume. Correct the sample volume measured by the dry gas meter to standard conditions (20° C and 760 mm Hg or 68° F and 29.92 in. Hg) by using Equation 8-1.

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

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

Equation 8-1

where:

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

= 17.64 °R/in., Hg for English units.

NOTE: If the leak rate observed during any mandatory leak-checks exceeds the specified acceptable rate, the tester shall either correct the value of V_m in Equation 8-1 (as described in Section 6.3 of Method shall invalidate the test run.

6.4 Volume of Water Vapor and M Content. Calculate the volume of vapor using Equation 5-2 of Method weight of water collected in the imp and silica gel can be directly conver milliliters (the specific gravity of wa g/ml). Calculate the moisture cont the stack gas, using Equation 5-3 of M 5. The "Note" in Section 6.5 of Met also applies to this method. Note that effluent gas stream can be considere the volume of water vapor and mo content need not be calculated.

6.5 Sulfuric acid mist (including concentration.

$$C_{H_2SO_4} = K_2 \frac{N(V_t - V_{tb}) \left(\frac{V_{soln}}{V_a}\right)}{V_{m(std)}}$$

Equation

where:

K_2 = 0.04904 g/milliequivalent for m units.

= 1.081 × 10⁻⁴ lb/meq for English units

6.6 Sulfur dioxide concentration.

$$C_{SO_2} = K_3 \frac{N(V_t - V_{tb}) \left(\frac{V_{soln}}{V_a}\right)}{V_{m(std)}}$$

Equation 8

where:

K_3 = 0.03203 g/meq for metric units.

= 7.061 × 10⁻⁵ lb/meq for English units.

6.7 Isokinetic Variation.

6.7.1 Calculation from raw data.

$$I = \frac{100 T_s [K_4 V_{lc} + (V_m/T_m) P_{bar} + \Delta H/13.6)]}{60 \theta v_s P_s A_n}$$

Equation 8-4

where:

K_4 = 0.003464 mm Hg-m³/ml-°K for me units.

= 0.002676 in. Hg-ft³/ml-°R for Eng units.

6.7.2 Calculation from intermediate va

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

$$=K_s \frac{T_s V_{m(std)}}{P_s v_s A_n \theta (1-B_{ws})}$$

Equation 8-5

where:

K_s=4.320 for metric units.

=0.09450 for English units

6.8 Acceptable Results. If 90 percent <I <110 percent, the results are acceptable. If the results are low in comparison to the standards and I is beyond the acceptable range, the Administrator may opt to accept the results. Use Citation 4 in the Bibliography of Method 5 to make judgments. Otherwise, reject the results and repeat the test.

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METHOD 9—VISUAL DETERMINATION OF THE OPACITY OF EMISSIONS FROM STATIONARY SOURCES

Many stationary sources discharge visible [illegible]ons 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 method includes procedures for the training and certification of observers, and procedures to be used in the field for determination of plume opacity. The appearance of a plume as viewed by an observer depends upon a number of variables, some of which may be controllable and some of which may not 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.

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 accurately assign 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. It follows from this, and is confirmed by field trials, that 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 cited for a violation of opacity standards due to observer error.

Studies have been undertaken to determine the magnitude of positive errors which can be 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

U.S. EPA METHOD 13 B

A_t = Aliquot of total sample added to still, ml.

B_{ws} = Water vapor in the gas stream, proportion by volume.

C_s = Concentration of F in stack gas, mg/m³, dry basis, corrected to standard conditions of 760 mm Hg (29.92 in. Hg) and 293°K (528°R).

F_t = Total F in sample, mg.

μg F = Concentration from the calibration curve, μg.

T_m = Absolute average dry gas meter temperature (see Figure 5-2 of Method 5), °K (°R).

T_s = Absolute average stack gas temperature (see Figure 5-2 of Method 5), °K (°R).

V_d = Volume of distillate as diluted, ml.

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

V_t = Total volume of F sample, after final dilution, ml.

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

9.2 Average Dry Gas Meter Temperature and Average Orifice Pressure Drop. See data sheet (Figure 5-2 of Method 5).

9.3 Dry Gas Volume. Calculate $V_{m(std)}$ and adjust for leakage, if necessary, using the equation in section 6.3 of Method 5.

9.4 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 13A-1); use Equations 5-2 and 5-3 of Method 5.

9.5 Concentration.

9.5.1 Total Fluoride in Sample. Calculate the amount of F in the sample using the following equation:

$$F_t = 10^{-3} \frac{V_t \, V_d}{A_t \, A_d} \ (\mu g\ F) \qquad \text{Eq. 13A-1}$$

9.5.2 Fluoride Concentration in Stack Gas. Determine the F concentration in the stack gas using the following equation:

$$C_s = K \frac{F_t}{V_{m(std)}} \qquad \text{Eq. 13A-2}$$

Where:

K = 35.31 ft³/m³ if $V_{m(std)}$ is expressed in English units.

= 1.00 m³/m³ if $V_{m(std)}$ is expressed in metric units.

9.6 Isokinetic Variation and Acceptable Results. Use Method 5, Sections 6.11 and 6.12.

10. *Bibliography*

1. Bellack, Ervin. Simplified Fluoride Distillation Method. Journal of the American Water Works Association. *50*:5306. 1958.

2. Mitchell, W. J., J. C. Suggs, and F. J. Bergman. Collaborative Study of EPA method 13A and Method 13B. Publication No. EPA-600/4-77-050. Environmental Protection Agency. Research Triangle Park, North Carolina. December 1977.

3. Mitchell, W. J. and M. R. Midgett. Adequacy of Sampling Trains and Analytical Procedures Used for Fluoride. Atm. Environ. *10*:865-872. 1976.

METHOD 13B—DETERMINATION OF TOTAL FLUORIDE EMISSIONS FROM STATIONARY SOURCES—SPECIFIC ION ELECTRODE METHOD

1. *Principle and Applicability*

1.1 Applicability. This method applies to the determination of fluoride (F) emissions from stationary sources as specified in the regulations. It does not measure fluorocarbons, such as freons.

1.2 Principle. Gaseous and particulate F are withdrawn isokinetically from the source and collected in water and on a filter. The total F is then determined by the specific ion electrode method.

2. *Range and sensitivity.*

The range of this method is 0.02 to 2,000 μg F/ml; however, measurements of less than 0.1 μg F/ml require extra care. Sensitivity has not been determined.

3. *Interferences.*

Grease on sample-exposed surfaces may cause low F results because of adsorption.

4. *Precision and Accuracy*

4.1 Precision. The following estimates are based on a collaborative test done at a primary aluminum smelter. In the test, six laboratories each sampled the stack simultaneously using two sampling trains for a total of 12 samples per sampling run. Fluoride concentrations encountered during the test ranged from 0.1 to 1.4 mg F/m³. The within-laboratory and between-laboratory standard deviations, which include sampling and analysis errors, are 0.037 mg F/m³ with 60 degrees of freedom and 0.056 mg F/m³ with five degrees of freedom, respectively.

4.2 Accuracy. The collaborative test did not find any bias in the analytical method.

5. *Apparatus*

5.1 Sampling Train and Sample Recovery. Same as Method 13A, Sections 5.1 and 5.2, respectively.

5.2 Analysis. The following items are needed:

5.2.1 Distillation Apparatus, Bunsen Burner, Electric Muffle Furnace, Crucibles, Beakers, Volumetric Flasks, Erlenmeyer Flasks or Plastic Bottles, Constant Temperature Bath, and Balance. Same as Method 13A, Sections 5.3.1 to 5.3.9, respectively, except include also 100-ml polyethylene beakers.

5.2.2 Fluoride Ion Activity Sensing Electrode.

5.2.3 Reference Electrode. Single junction, sleeve type.

5.2.4 Electrometer. A pH meter with millivolt-scale capable of ±0.1-mv resolution, or a specific ion meter made specifically for specific ion use.

5.2.5 Magnetic Stirrer and TFE [1] Fluorocarbon-Coated Stirring Bars.

6. *Reagents*

6.1 Sampling and Sample Recovery. Same as Method 13A, Sections 6.1 and 6.2, respectively.

6.2 Analysis. Use ACS reagent grade chemicals (or equivalent), unless otherwise specified. The reagents needed for analysis are as follows:

6.2.1 Calcium Oxide (CaO). Certified grade containing 0.005 percent F or less.

6.2.2 Phenolphthalein Indicator. Dissolve 0.1 g of phenolphthalein in a mixture of 50 ml of 90 percent ethanol and 50 ml deionized distilled water.

6.2.3 Sodium Hydroxide (NaOH). Pellets.

6.2.4 Sulfuric Acid (H_2SO_4), Concentrated.

6.2.5 Filters. Whatman No. 541, or equivalent.

6.2.6 Water. From same container as 6.1.2 of Method 13A.

6.2.7 Sodium Hydroxide, 5 M. Dissolve 20 g of NaOH in 100 ml of deionized distilled water.

6.2.8 Sulfuric Acid, 25 percent (V/V). Mix 1 part of concentrated H_2SO_4 with 3 parts of deionized distilled water.

6.2.9 Total Ionic Strength Adjustment Buffer (TISAB). Place approximately 500 ml of deionized distilled water in a 1-liter beaker. Add 57 ml of glacial acetic acid, 58 g of sodium chloride, and 4 g of cyclohexylene dinitrilo tetraacetic acid. Stir to dissolve. Place the beaker in a water bath to cool it. Slowly add 5 M NaOH to the solution, measuring the pH continuously with a calibrated pH/reference electrode pair, until the pH is 5.3. Cool to room temperature. Pour into a 1-liter volumetric flask, and dilute to volume with deionized distilled water. Commercially prepared TISAB may be substituted for the above.

6.2.10 Fluoride Standard Solution, 0.1 M. Oven dry some sodium fluoride (NaF) for a minimum of 2 hours at 110°C, and store in a desiccator. Then add 4.2 g of NaF to a 1-liter volumetric flask, and add enough deionized distilled water to dissolve. Dilute to volume with deionized distilled water.

7. *Procedure*

7.1 Sampling, Sample Recovery, and Sample Preparation and Distillation. Same as Method 13A, Sections 7.1, 7.2, and 7.3, respectively, except the notes concerning chloride and sulfate interferences are not applicable.

7.2 Analysis.

7.2.1 Containers No. 1 and No. 2. Distill suitable aliquots from Containers No. 1 and No. 2. Dilute the distillate in the volumetric flasks to exactly 250 ml with deionized distilled water and mix thoroughly. Pipet a 25-ml aliquot from each of the distillate and separate beakers. Add an equal volume of TISAB, and mix. The sample should be at the same temperature as the calibration standards when measurements are made. If ambient laboratory temperature fluctuates more than ±2°C from the temperature at which the calibration standards were measured, condition samples and standards in a constant-temperature bath before measurement. Stir the sample with a magnetic stirrer during measurement to minimize electrode response time. If the stirrer generates enough heat to change solution temperature, place a piece of temperature insulating material such as cork, between the stirrer and the beaker. Hold dilute samples (below 10^{-4} M fluoride ion content) in polyethylene beakers during measurement.

Insert the fluoride and reference electrodes into the solution. When a steady millivolt reading is obtained, record it. This may take several minutes. Determine concentration from the calibration curve. Between electrode measurements, rinse the electrode with deionized distilled water.

7.2.2 Container No. 3 (Silica Gel). Same as Method 13A, Section 7.4.2.

8. *Calibration*

Maintain a laboratory log of all calibrations.

8.1 Sampling Train. Same as Method 13A.

8.2 Fluoride Electrode. Prepare fluoride standardizing solutions by serial dilution of the 0.1 M fluoride standard solution. Pipet 10 ml of 0.1 M fluoride standard solution into a 100-ml volumetric flask, and make up to the mark with deionized distilled water for a 10^{-2} M standard solution. Use 10 ml of 10^{-2} M solution to make a 10^{-3} M solution in the same manner. Repeat the dilution procedure and make 10^{-4} and 10^{-5} solutions.

Pipet 50 ml of each standard into a separate beaker. Add 50 ml of TISAB to each

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[1] Mention of any trade name or specific product does not constitute endorsement by the U.S. Environmental Protection Agency.

beaker. Place the electrode in the most dilute standard solution. When a steady millivolt reading is obtained, plot the value on the linear axis of semilog graph paper versus concentration on the log axis. Plot the nominal value for concentration of the standard on the log axis, e.g., when 50 ml of 10^{-2} M standard is diluted with 50 ml of TISAB, the concentration is still designated "10^{-2} M."

Between measurements soak the fluoride sensing electrode in deionized distilled water for 30 seconds, and then remove and blot dry. Analyze the standards going from dilute to concentrated standards. A straight-line calibration curve will be obtained, with nominal concentrations of 10^{-4}, 10^{-3}, 10^{-2}, and 10^{-1} fluoride molarity on the log axis plotted versus electrode potential (in mv) on the linear scale. Some electrodes may be slightly nonlinear between 10^{-5} and 10^{-4} M. If this occurs, use additional standards between these two concentrations.

Calibrate the fluoride electrode daily, and check it hourly. Prepare fresh fluoride standardizing solutions daily (10^{-2} M or less). Store fluoride standardizing solutions in polyethylene or polypropylene containers.

NOTE: Certain specific ion meters have been designed specifically for fluoride electrode use and give a direct readout of fluoride ion concentration. These meters may be used in lieu of calibration curves for fluoride measurements over narrow concentration ranges. Calibrate the meter according to the manufacturer's instructions.)

9. *Calculations.*

Carry out calculations, retaining at least one extra decimal figure beyond that of the acquired data. Round off figures after final calculation.

9.1 Nomenclature. Same as Method 13A, Section 9.1. In addition:

M = F concentration from calibration curve, molarity.

9.2 Average Dry Gas Meter Temperature and Average Orifice Pressure Drop, Dry Gas Volume, Volume of Water Vapor and Moisture Content, Fluoride Concentration in Stack Gas, and Isokinetic Variation and Acceptable Results. Same as Method 13A, Section 9.2 to 9.4, 9.5.2, and 9.6, respectively.

9.3 Fluoride in Sample. Calculate the amount of F in the sample using the following:

$$F_t = K \frac{V_t}{A_t} V_d \; M \qquad \text{Eq. 13B-1}$$

Where:

K = 19 mg/ml.

10. *References.*

1. Same as Method 13A, Citations 1 and 2 of Section 10.

2. MacLeod, Kathryn E. and Howard L. Crist. Comparison of the SPADNS—Zirconium Lake and Specific Ion Electrode Methods of Fluoride Determination in Stack Emission Samples. Analytical Chemistry. *45*:1272-1273. 1973.

METHOD 14—DETERMINATION OF FLUORIDE EMISSIONS FROM POTROOM ROOF MONITORS FOR PRIMARY ALUMINUM PLANTS

1. *Applicability and Principle.*

1.1 Applicability. This method is applicable for the determination of fluoride emissions from stationary sources only when specified by the test procedures for determining compliance with new source performance standards.

1.2 Principle. Gaseous and particulate fluoride roof monitor emissions are drawn into a permanent sampling manifold through several large nozzles. The sample is transported from the sampling manifold to ground level through a duct. The gas in the duct is sampled using Method 13A or 13B—Determination of Total Fluoride Emissions from Stationary Sources. Effluent velocity and volumetric flow rate are determined with anemometers located in the roof monitor.

2. *Apparatus.*

2.1 Velocity measurement apparatus.

2.1.1 Anemometers. Propeller anemometers, or equivalent. Each anemometer shall meet the following specifications: (1) Its propeller shall be made of polystyrene, or similar material of uniform density. To insure uniformity of performance among propellers, it is desirable that all propellers be made from the same mold; (2) The propeller shall be properly balanced, to optimize performance; (3) When the anemometer is mounted horizontally, its threshold velocity shall not exceed 15 m/min (50 fpm); (4) The measurement range of the anemometer shall extend to at least 600 m/min (2,000 fpm); (5) The anemometer shall be able to withstand prolonged exposure to dusty and corrosive environments; one way of achieving this is to continuously purge the bearings of the anemometer with filtered air during operation; (6) All anemometer components shall be properly shielded or encased, such that the performance of the anemometer is uninfluenced by potroom magnetic field effects; (7) A known relationship shall exist between the electrical output signal from the anemometer generator and the propeller shaft rpm, at a minimum of three evenly spaced rpm settings

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pheric conditions), or equivalent, attached to the nozzle inlet of the complete sampling train.

5.2 Analysis. Perform the analysis standardization as suggested by the manufacturer of the instrument, or the procedures for the analytical method in use.

6. *Calculations.*

Calculate the Be emission rate R in g/day for each stack using Equation 103-2. For cyclic operations, use only the time per day each stack is in operation. The total Be emission rate from a source is the summation of results from all stacks.

Eq. 103-2

$$R = \frac{W_t v_s(avg)\ A_s\ (86{,}400 \times 10^{-6})}{V_{total}}$$

Where:

W_t = Total weight of Be collected, μg.
$v_s(avg)$ = Average stack gas velocity, m/sec (ft/sec).
$A_s(avg)$ = Stack area, m^2 (ft^2).
86,400 = Conversion factor, sec/day.
10^{-6} = Conversion factor, g/μg.
V_{total} = Total volume of gas sampled, m^3 (ft^3).

7. *Test Report.*

Prepare a test report that includes as a minimum: A detailed description of the sampling train used, results of the procedural check described in Section 5.1 with all data and calculations made, all pertinent data taken during the test, the basis for any estimates made, isokinetic sampling calculations, and emission results. Include a description of the test site, with a block diagram and brief description of the process, location of the sample points in the stack cross section, and stack dimensions and distances from any point of disturbance.

METHOD 104—REFERENCE METHOD FOR DETERMINATION OF BERYLLIUM EMISSIONS FROM STATIONARY SOURCES

1. *Applicability and Principle.*

1.1 Applicability. This method is applicable for the determination of beryllium (Be) emissions in ducts or stacks at stationary sources. Unless otherwise specified, this method is not intended to apply to gas streams other than those emitted directly to the atmosphere without further processing.

1.2 Principle. Be emissions are isokinetically sampled from the source, and the collected sample is digested in an acid solution and analyzed by atomic absorption spectrophotometry.

2. *Apparatus.*

2.1 Sampling Train. The sampling train is identical to the Method 5 train as shown in Figure 5-1 (mention of Method 5 refers to 40 CFR Part 60). The sampling train consists of the following components:

2.1.1 Probe Nozzle, Pitot Tube, Differential Pressure Gauge, Metering System, Barometer, and Gas Density Determination Equipment. Same as Method 5, Sections 2.1.1, 2.1.3, 2.1.4, 2.1.8, 2.1.9, and 2.1.10, respectively.

2.1.2 Probe Liner. Borosilicate or quartz glass tubing. The tester may use a heating system capable of maintaining a gas temperature of 120±14°C (248±25°F) at the probe exit during sampling to prevent water condensation. *Note:* Do not use metal probe liners.

2.1.3 Filter Holder. Borosilicate glass, with a glass frit filter support and a silicone rubber gasket. Other materials of construction (e.g., stainless steel, Teflon, Viton) may be used, subject to the approval of the Administrator. (*Note:* Mention of trade names of specific products does not constitute endorsement by the Environmental Protection Agency.) 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. A heating system capable of maintaining the filter at a minimum temperature in the range of the stack temperature may be used to prevent condensation from occurring.

2.1.4 Impingers. Four Greenburg-Smith impingers connected in series with leak-free ground glass fittings or any similar leak-free noncontaminating fittings. For the first, third, and fourth impingers, the tester may use impingers that are modified by replacing the tip with a 13-mm-ID (0.5-in.) glass tube extending to 13 mm (0.5 in.) from the bottom of the flask.

2.2 *Sample Recovery.* The following items are needed:

2.2.1 Probe Cleaning Rod. At least as long as probe.

2.2.2 Glass Sample Bottles. Leakless, with Teflon-lined caps, 500-ml.

2.2.3 Graduated Cylinder. 250-ml.

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

2.2.5 Funnel. Glass, to aid in sample recovery.

2.2.6 Plastic Jar. Approximately 300-ml.

2.3 Analysis. The following equipment is needed:

2.3.1 Atomic Absorption Spectrophotometer. Perkin-Elmer 303, or equivalent, with nitrous oxide/acetylene burner.

2.3.2 Hot Plate.

2.3.3 Perchloric Acid Fume Hood.

3. *Reagents.*

Use ACS reagent-grade chemicals or equivalent, unless otherwise specified.

3.1 Sampling and Rec
used in sampling and r
lows:
3.1.1 Filter. Millipore
It is suggested that a W
equivalent be placed i
the back side of the M
guard against breaking
To be equivalent, other
at least 99.95 percent
cent penetration) on
phthalate smoke partic
ciency tests shall be co
ance with ASTM Standa
71 (reapproved 1978) (in
ence—see § 61.18). Test
plier's quality control
cient for this purpose.
3.1.2 Water. Deionize
ASTM Specifications fo
Water—ASTM Test Met
corporated by referen
high concentrations of
not expected to be prese
eliminate the $KMnO_4$ te
ganic matter.
3.1.3 Silica Gel. Indic
mesh. If previously us
(350° F) for 2 hours. The
silica gel as received.
3.1.4 Acetone.
3.1.5 Wash Acid. 50
drochloric Acid (HCl).
Mix equal volumes of
and water, being caref
slowly to the water.
3.2 Sample Preparat
The reagents needed are
3.2.1 Water. Same as
3.2.2. Perchloric Acid
trated (70 percent).
3.2.3 Nitric Acid (HN
3.2.4 Beryllium Powd
98 percent.
3.2.5 Sulfuric Acid (
N. Dilute 33 ml of conc
liter with water.
3.2.6 Hydrochloric Ac
cent HCl (V/V).
3.2.7 Standard Beryl
Be/ml. Dissolve 10 mg
$12NH_2SO_4$ solution, and
with water. Dilute a 10-
with 25 percent HCl sol
centration of 1 μg/ml.
stock solution fresh
strength Be stock solu
pared from Be salts
$Be(NO_3)_2$ (98 percent mi
4. *Procedure.*
4.1 Sampling. Becaus
of this method testers s
experienced with the
assure reliable results.
testers should take prec
exposure. The amount
ed is generally small, t

Method 5 refers
ling train con-
nents:
Tube. Differen-
System. Ba-
Determination
od 5. Sections
and 2.1.10. re-

cate or quartz
use a heating
a gas temper-
) at the probe
ent water con-
metal probe

silicate glass.
and a silicone
als of construc-
on, Viton) may
val of the Ad-
of trade names
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shall provide a
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e holder shall
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n temperature
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on from occur-

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or any similar
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n (0.5 in.) from

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250-ml.
Policeman. To
container, not
ed in the field.
in sample re-

nately 300-ml.
equipment is

Spectrophoto-
equivalent, with
er.

Hood.

chemicals or
specified.

3.1 Sampling and Recovery. The reagents used in sampling and recovery are as follows:

3.1.1 Filter. Millipore AA, or equivalent. It is suggested that a Whatman 41 filter or equivalent be placed immediately against the back side of the Millipore filter as a guard against breaking the Millipore filter. To be equivalent, other filters shall exhibit at least 99.95 percent efficiency (0.05 percent penetration) on 0.3 micron dioctyl phthalate smoke particles. The filter efficiency tests shall be conducted in accordance with ASTM Standard Method D 2986-71 (reapproved 1978) (incorporated by reference—see § 61.18). Test data from the supplier's quality control program are sufficient for this purpose.

3.1.2 Water. Deionized distilled, meeting ASTM Specifications for Type 3 Reagent Water—ASTM Test Method D 1193-77 (incorporated by reference—see § 61.18). If high concentrations of organic matter are not expected to be present, the analyst may eliminate the $KMnO_4$ test for oxidizable organic matter.

3.1.3 Silica Gel. Indicating type, 6- to 16-mesh. If previously used, dry at 175° C (350° F) for 2 hours. The tester may use new silica gel as received.

3.1.4 Acetone.

3.1.5 Wash Acid, 50 Percent (V/V) Hydrochloric Acid (HCl).

Mix equal volumes of concentrated HCl and water, being careful to add the acid slowly to the water.

3.2 Sample Preparation and Analysis. The reagents needed are listed below:

3.2.1 Water. Same as Section 3.1.2.

3.2.2. Perchloric Acid ($HClO_4$). Concentrated (70 percent).

3.2.3 Nitric Acid (HNO_3). Concentrated.

3.2.4 Beryllium Powder. Minimum purity 98 percent.

3.2.5 Sulfuric Acid (H_2SO_4) Solution, 12 N. Dilute 33 ml of concentrated H_2SO_4 to 1 liter with water.

3.2.6 Hydrochloric Acid Solution, 25 percent HCl (V/V).

3.2.7 Standard Beryllium Solution, 1 μg Be/ml. Dissolve 10 mg of Be in 80 ml of $12N H_2SO_4$ solution, and dilute to 1000 ml with water. Dilute a 10-ml aliquot to 100 ml with 25 percent HCl solution to give a concentration of 1 μg/ml. Prepare this dilute stock solution fresh daily. Equivalent strength Be stock solutions may be prepared from Be salts such as $BeCl_2$ and $Be(NO_3)_2$ (98 percent minimum purity).

4. *Procedure.*

4.1 Sampling. Because of the complexity of this method testers should be trained and experienced with the test procedures to assure reliable results. As Be is hazardous, testers should take precautions to minimize exposure. The amount of Be that is collected is generally small, therefore, it is necessary to exercise particular care to pr
contamination or loss of sample.

4.1.1 Pretest Preparation. Follow
general procedure given in Method 5,
tion 4.1.1. Omit the directions of fi
except check them visually against ligh
irregularities and flaws such as pinhole

4.1.2 Preliminary Determinations. F
the general procedure given in Meth
Section 4.1.2, except as follows: Sel
nozzle size based on the range of ve
heads to assure that it is not necessa
change the nozzle size in order to mai
isokinetic sampling rates below 28 l
min (1.0 cfm).

Obtain samples over a period or perio
time that accurately determine the
mum emissions that occur in a 24
period. In the case of cyclic operations
form sufficient sample runs for the acc
determination of the emissions that
over the duration of the cycle. A mini
sample time of 2 hours per run is re
mended.

4.1.3 Prior to assembly, clean all
ware (probe, impingers, and connecto
first soaking in wash acid for 2 hours
lowed by rinsing with water. Place 100
water in each of the first two impinger
leave the third impinger empty. Save
tion of the water for a blank analysis.
approximately 200 g of preweighted
gel in the fourth impinger. The tester
use more silica gel, but should be care
ensure that it is not entrained and c
out from the impinger during sam
Place the silica gel container in a
place for later use in the sample rec
As an alternative, determine and recor
weight of the silica gel plus impinger
nearest 0.5 g.

Install the selected nozzel using a Vi
O-ring when stack temperatures are le
260°C (500°F). Use a fiberglass string
if temperatures are higher. See APTD
(Citation 9 in Section 10 of Method 10
details. Other connecting systems
either 316 stainless steel or Teflon fe
may be used.

If condensation in the probe or filte
problem, probe and filter heaters will
quired. Adjust the heaters to provide
perature at or above the stack temper
However, membrane filters such as th
lipore AA are limited to about 225°F.
stack gas is in excess of about 200°F, c
eration should be given to an alternat
cedure such as moving the filter
downstream of the first impinger to
that the filter does not exceed its ten
ture limit. Mark the probe with heat-
ant tape or by some other method to d
the proper distance into the stack o
for each sampling point. Assemble the
as shown in Figure 5-1 of Method 5.
(if necessary) a very light coat of si

grease on all ground glass joints. Grease only the outer portion (see APTD-0576) to avoid possibility of contamination by the silicone grease. *Note:* An empty impinger may be inserted between the third impinger and the silica gel to remove excess moisture from the sample stream.

After the sampling train has been assembled, turn on and set the probe, if applicable, at the desired operating temperature. Allow time for the temperatures to stabilize. Place crushed ice around the impingers.

4.1.4. Leak-Check Procedures. Follow the leak-check procedures outlined in Method 5, Sections 4.1.4.1 (Pretest Leak Check), 4.1.4.2 (Leak Checks During Sample Run), and 4.1.4.3 (Post-Test Leak Check).

4.1.5 Beryllium Train Operation. Follow the general procedure given in Method 5, Section 4.1.5. For each run, record the data required on a data sheet such as the one shown in Figure 5-2 of Method 5.

4.1.6 Calculation of Percent Isokinetic. Same as Method 5, Section 4.1.6.

4.2 Sample Recovery. Begin proper cleanup procedure as soon as the probe is removed from the stack at the end of the sampling period.

Allow the probe to cool. When it can be safely handled, wipe off any external particulate matter near the tip of the probe nozzle, and place a cap over it. Do not cap off the probe tip tightly while the sampling train is cooling. Capping would create a vacuum and draw liquid out from the impingers.

Before moving the sampling train to the cleanup site, remove the probe from the 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 impinger. Use either ground-glass stoppers, plastic caps, or serum caps to close these openings.

Transfer the probe and impinger assembly to a cleanup area that is clean, protected from the wind, and free of Be contamination.

Inspect the train before and during this assembly, and note any abnormal conditions. Treat the sample as follows:

Disconnect the probe from the impinger train. Remove the filter and any loose particulate matter from the filter holder, and place in a sample bottle. Place the contents (measured to ±1 ml) of the first three impingers into another sample bottle. Rinse the probe and all glassware between it and the back half of the third impinger with water and acetone, and add this to the latter sample bottle. Clean the probe with a brush or a long slender rod and cotton balls. Use acetone while cleaning. Add these to the sample bottle. Retain a sample of the water and acetone as a blank. The total amount of water and acetone used should be measured for accurate blank correction. Place the silica gel in the plastic jar. Seal and secure all sample containers for shipment. If an additional test is desired, the glassware can be carefully double rinsed with water and reassembled. However, if the glassware is out of use more than 2 days, repeat the initial acid wash procedure.

4.3 Analysis.

4.3.1 Apparatus Preparation. Before use, clean all glassware according to the procedure of Section 4.1.3. Adjust the instrument settings according to the instrument manual, using an absorption wavelength of 234.8 nm.

4.3.2 Sample Preparation. The digestion of Be samples is accomplished in part in concentrated $HClO_4$. *Caution:* The analyst must insure that the sample is heated to light brown fumes after the initial HNO_3 addition; otherwise, dangerous perchlorates may result from the subsequent $HClO_4$ digestion. $HClO_4$ should be used only under a hood.

4.3.2.1 Filter Preparation. Transfer the filter and any loose particulate matter from the sample container to a 150-ml beaker. Add 35 ml concentrated HNO_3. Heat on a hotplate until light brown fumes are evident to destroy all organic matter. Cool to room temperature, and add 5 ml concentrated H_2SO_4 and 5 ml concentrated $HClO_4$. Then proceed with step 4.3.2.4.

4.3.2.2 Water Preparation. Place a portion of the water and acetone sample into a 150-ml beaker, and put on a hotplate. Add portions of the remainder as evaporation proceeds and evaporate to dryness. Cool the residue, and add 35 ml concentrated HNO_3. Heat on a hotplate until light brown fumes are evident to destroy any organic matter. Cool to room temperature, and add 5 ml concentrated H_2SO_4 and 5 ml concentrated $HClO_4$. Then proceed with step 4.3.2.4.

4.3.2.3 Silica Gel Preparation Analyses. Weigh the spent silica gel, and report to the nearest gram.

4.3.2.4 Final Sample Preparation. Samples from 4.3.2.1 and 4.3.2.2 may be combined here for ease of analysis. Replace on a hotplate, and evaporate to dryness in a $HClO_4$ hood. Cool and dissolve the residue in 10.0 ml of 25 percent V/V HCl. Samples are now ready for the atomic absorption unit. It is necessary for the Be concentration of the sample to be within the calibration range of the unit. If necessary, perform further dilution of sample with 25 percent V/V HCl to bring the sample within the calibration range.

4.3.3 Beryllium Determination. Analyze the samples prepared in 4.3.2 at 234.8 nm using a nitrous oxide/acetylene flame. Aluminum, silicon and other elements can interfere with this method if present in large quantities. Standard methods are

available, however, that m
fectively eliminate these
Citation 2 in Section 8).

5. *Calibration.*

5.1 Sampling Train. C
pling train components
procedures outlined in
tions of Method 5:
Nozzle), Section 5.2 (Pit
(Metering System), S
Heater), Section 5.5 (Ten
Section 5.7 (Barometer)
check described in Sectio
applies to this method.

6. *Calculations.*

6.1 Dry Gas Volume. U
each sample run, calcu
sample volume at standa
(corrected for leakage, if
lined in Section 6.3 of Me

6.2 Volume of Water
and Moisture Content o
the data obtained from
calculate the volume of w
the sample, and the mois
the stack gas. Use Equat
Method 5.

6.3 Stack Gas Velocit
from each sample run a
Method 2, calculate the
velocity $v_{s(avg)}$.

6.4 Beryllium Emissio
the Be emission rate R
stack using Equation 104
ations, use only the time
is in operation. The tot
from a source will be th
sults from all stacks.

Eq. 104

$$R = K \frac{W_t v_{s(avg)}\ A_s(}{(V_{m(std)} + V}$$

Where:
W_t = Total weight of Be c
A_s = Stack cross-sectional
86,400 = Conversion facto
10^{-6} = Conversion factor.
T_s = Absolute average st
°K (°F).
P_s = Absolute stack gas p
Hg).
K = 0.3858 °K/mm Hg fo
= 17.64 °F/in. Hg for E

6.5 Isokinetic Variat
Results. Same as Meth
and 6.12, respectively.

7. *Determination of*
performance test consi
runs of the applicable t
purpose of determining
applicable national em
the average of the re
runs.

:curate blank correction.
'el in the plastic jar. Seal
mple containers for ship-
tional test is desired, the
: carefully double rinsed
assembled. However, if the
of use more than 2 days.
acid wash procedure.

s Preparation. Before use.
re according to the proce-
1.3. Adjust the instrument
ng to the instrument
absorption wavelength of

'reparation. The digestion
s accomplished in part in
IO₄. *Caution:* The analyst
: the sample is heated to
s after the initial HNO₃ ad-
:, dangerous perchlorates
the subsequent HClO₄ di-
hould be used only under a

Preparation. Transfer the
ose particulate matter from
ainer to a 150-ml beaker.
:ntrated HNO₃. Heat on a
ht brown fumes are evident
ganic matter. Cool to room
d add 5 ml concentrated
concentrated HClO₄. Then
) 4.3.2.4.

Preparation. Place a por-
' and acetone sample into a
nd put on a hotplate. Add
remainder as evaporation
porate to dryness. Cool the
35 ml concentrated HNO₃.
ate until light brown fumes
estroy any organic matter.
emperature, and add 5 ml
SO₄ and 5 ml concentrated
ceed with step 4.3.2.4.

Gel Preparation Analyses.
silica gel, and report to the

Sample Preparation. Sam-
1 and 4.3.2.2 may be com-
use of analysis. Replace on a
:vaporate to dryness in a
ol and dissolve the residue
percent V/V HCl. Samples
for the atomic absorption
sary for the Be concentra-
ole to be within the calibra-
: unit. If necessary, perform
of sample with 25 percent
ing the sample within the
e.

m Determination. Analyze
:pared in 4.3.2 at 234.8 nm
oxide/acetylene flame. Alu-
and other elements can
this method if present in
s. Standard methods are

available, however, that may be used to effectively eliminate these interferences (see Citation 2 in Section 8).

5. *Calibration.*

5.1 Sampling Train. Calibrate the sampling train components according to the procedures outlined in the following sections of Method 5: Section 5.1 (Probe Nozzle), Section 5.2 (Pitot Tube), Section 5.3 (Metering System), Section 5.4 (Probe Heater), Section 5.5 (Temperature Gauges), Section 5.7 (Barometer). Note that the leak check described in Section 5.6 of Method 5 applies to this method.

6. *Calculations.*

6.1 Dry Gas Volume. Using the data from each sample run, calculate the dry gas sample volume at standard conditions $V_{m(std)}$ (corrected for leakage, if necessary) as outlined in Section 6.3 of Method 5.

6.2 Volume of Water Vapor in Sample and Moisture Content of Stack Gas. Using the data obtained from each sample run, calculate the volume of water vapor $V_{w(std)}$ in the sample, and the moisture content B_{ws} of the stack gas. Use Equations 5-2 and 5-3 of Method 5.

6.3 Stack Gas Velocity. Using the data from each sample run and Equation 2-9 of Method 2, calculate the average stack gas velocity $v_{s(avg)}$.

6.4 Beryllium Emission Rate. Calculate the Be emission rate R in g/day for each stack using Equation 104-1. For cyclic operations, use only the time per day each stack is in operation. The total Be emission rate from a source will be the summation of results from all stacks.

Eq. 104-1

$$R = K\,\frac{W_t\, v_{s(avg)}\, A_s (86{,}400 \times 10^{-6})}{(V_{m(std)} + V_{w(std)})(T_s/P_s)}$$

Where:

W_t = Total weight of Be collected, µg.
A_s = Stack cross-sectional area, M^2 (ft^2).
86,400 = Conversion factor, sec/day.
10^{-6} = Conversion factor, g/µg.
T_s = Absolute average stack gas temperature, °K (°F).
P_s = Absolute stack gas pressure, mm Hg (in. Hg).
K = 0.3858 °K/mm Hg for metric units.
= 17.64 °F/in. Hg for English units.

6.5 Isokinetic Variation and Acceptable Results. Same as Method 5, Sections 6.11 and 6.12, respectively.

7. *Determination of Compliance.* Each performance test consists of three sample runs of the applicable test method. For the purpose of determining compliance with an applicable national emission standard, use the average of the results of all sample runs.

8. *Bibliography.*

In addition to Citations 1-3 and 5-15 of Section 10 of Method 101, the following citations may be helpful:

1. Amos, M.D., and J. B. Willis. Use of High-Temperature Pre-Mixed Flames in Atomic Absorption Spectroscopy. Spectrochim. Acta. 22:1325. 1966.

2. Fleet, B., K. V. Liberty, and T. S. West. A Study of Some Matrix Effects in the Determination of Beryllium by Atomic Absorption Spectroscopy in the Nitrous Oxide-Acetylene Flame. Talanta *17*:203. 1970.

METHOD 105—METHOD FOR DETERMINATION OF MERCURY IN WASTEWATER TREATMENT PLANT SEWAGE SLUDGES

1. *Principle and applicability.* 1.1 Principle—A weighed portion of the sewage sludge sample is digested in aqua regia for 2 minutes at 95° C, followed by oxidation with potassium permanganate. Mercury in the digested sample is then measured by the conventional spectrophotometer cold vapor technique. An alternative digestion involving the use of an autoclave is described in paragraph 4.5.2 of this method.

1.2 Applicability—This method is applicable for the determination of total organic and inorganic mercury content in sewage sludges, soils, sediments, and bottom-type materials. The normal range of this method is 0.2 to 5 µg/g. The range may be extended above or below the normal range by increasing or decreasing sample size and through instrument and recorder control.

2. *Apparatus.* 2.1 Analysis—The conventional cold vapor technique (5) is used to analyze the sample.

2.1.1 Atomic Absorption Spectrophotometer[1]—Any atomic absorption unit having an open sample presentation area in which to mount the absorption cell is suitable. Instrument settings recommended by the particular manufacturer should be followed.

2.1.2 Mercury Hollow Cathode Lamp—Westinghouse WL-22847, argon filled, or equivalent.

2.1.3 Recorder—Any multirange, variable-speed recorder that is compatible with the UV detection system is suitable.

2.1.4 Absorption Cell—Standard spectrophotometer cells 10 cm long, having quartz end windows may be used. Suitable cells may be constructed from plexiglass tubing, 2.5 cm O.D. x 11.4 cm (ca. 1" O.D. x 4½"). The ends are ground perpendicular to the longitudinal axis, and quartz windows (2.5

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[1] Instruments designed specifically for the measurement of mercury using the cold vapor technique are commercially available and may be substituted for the atomic absorption spectrophotometer.

U.S. EPA METHOD 101A

Figure 101-5. Schematic of aeration system.

METHOD 101A—DETERMINATION OF PARTICULATE AND GASEOUS MERCURY EMISSIONS FROM SEWAGE SLUDGE INCINERATORS

INTRODUCTION

This method is similar to Method 101. except acidic potassium permanganate solution is used instead of acidic iodine monochloride for collection.

1. *Applicability and Principle*—1.1 *Applicability*. This method applies to the determination of particulate and gaseous mercury (Hg) emissions from sewage sludge incinerators and other sources as specified in the regulations.

1.2 *Principle*. Particulate and gaseous Hg emissions are withdrawn isokinetically from the source and collected in acidic potassium permanganate ($KMnO_4$) solution. The Hg collected (in the mercuric form) is reduced to elemental Hg, which is then aerated from the solution into an optical cell and measured by atomic absorption spectrophotometry.

2. *Range and Sensitivity*—2.1 *Range*. After initial dilution, the range of this method is 20 to 800 ng Hg/ml. The upper limit can be extended by further dilution of the sample.

2.2 *Sensitivity*. The sensitivity of the method depends on the recorder/spectrophotometer combination selected.

3. *Interfering Agents*—3.1 *Sampling*. Excessive oxidizable organic matter in the stack gas prematurely depletes the $KMnO_4$ solution and thereby prevents further collection of Hg.

3.2 *Analysis*. Condensation of water vapor on the optical cell windows causes a positive interference.

4. *Precision*—Based on eight paired-train tests, the within-laboratory standard deviation was estimated to be 4.8 μg Hg/ml in the concentration range of 50 to 130 μg Hg/m^3.

5. *Apparatus*—5.1 *Sampling Train and Sample Recovery*. Same as Method 101. Sections 5.1 and 5.2, respectively, except for the following variations:

5.1.1 *Probe Liner*. Same as Method 101, Section 5.1.2, except that if a filter is used ahead of the impingers, the tester must use the probe heating system to minimize the condensation of gaseous Hg.

5.1.2 *Filter Holder (Optional)*. Borosilicate glass with a rigid stainless-steel wire-screen filter support (do not use glass frit supports) and a silicone rubber of Teflon gasket, designed to provide a positive seal against leakage from outside or around the filter. The filter holder must be equipped with a filter heating system capable of maintaining a temperature around the filter holder of 120 ± 15° C (248 ± 25° F) during sampling to minimize both water and gaseous Hg condensation. The tester may use a filter in cases where the stream contains large quantities of particulate matter.

5.2 *Analysis*. The apparatus needed for analysis is the same as Method 101. Sections 5.3 and 5.4, except as follows:

5.2.1 *Volumetric Pipets*. Class A; 1-, 2-, 3-, 4-, 5-, 10-, and 20-ml.

5.2.2 *Graduated Cylinder*. 25-ml.

5.2.3 *Steam Bath*.

6. *Reagents—Use ACS reagent-grade chemicals or equivalent, unless otherwise specified*.

6.1 *Sampling and Recovery*. The reagents used in sampling and recovery are as follows:

6.1.1 *Water*. Deionized distilled, meeting ASTM Specifications for Type 1 Reagent Water—ASTM Test Method D1193-77 (incorporated by reference—see § 61.18). If high concentrations of organic matter are not expected to be present, the analyst may eliminate the $KMnO_4$ test for oxidizable organic matter. Use this water in all dilutions and solution preparations.

6.1.2 *Nitric Acid (HNO_3), 50 Percent (V/V)*. Mix equal volumes of concentrated HNO_3 and deionized distilled water, being careful to slowly add the acid to the water.

6.1.3 *Silica Gel*. Indicating type, 6- to 16-mesh. If previously used, dry at 175° C (350° F) for 2 hr. The tester may use new silica gel as received.

6.1.4 *Filter (Optional)*. Glass fiber filter, without organic binder, exhibiting at least 99.95 percent efficiency on 0.3 μm dioctyl phthalate smoke particles. The tester may use the filter in cases where the gas stream contains large quantities of particulate matter, but he should analyze blank filters for Hg content.

6.1.5 *Sulfuric Acid (H_2SO_4), 10 Percent (V/V)*. Add and mix 100 ml of concentrated H_2SO_4 with 900 ml of deionized distilled water.

6.1.6 *Absorbing Solution, 4 Percent $KMnO_4$ (W/V)*. Prepare fresh daily. Dissolve 40 g of $KMnO_4$ in sufficient 10 percent H_2SO_4 to make 1 liter. Prepare and store in glass bottles to prevent degradation.

6.2 *Analysis*. The reagents needed for analysis are listed below:

6.2.1 *Tin (II) Solution*. Prepare fresh daily and keep sealed when not being used. Competely dissolve 20 g of tin (II) chloride [or 25 g of tin (II) sulfate] crystals (Baker Analyzed reagent grade or any other brand that will give a clear solution) in 25 ml of concentrated HCl. Dilute to 250 ml with deionized distilled water. Do not substitute HNO_3, H_2SO_4, or other strong acids for the HCl.

6.2.2 *Sodium Chloride—Hydroxylamine Solution*. Dissolve 12 g of sodium chloride and 12 g of hydroxylamine sulfate (or 12 g of hydroxylamine hydrochloride) in deionized distilled water and dilute to 100 ml.

6.2.3 *Hydrochloric Acid (HCl), 8 N.* Dilute 67 ml of concentrated HNO_3 to 100 ml with deionized distilled water (slowly add the HCl to the water).

6.2.4 *Nitric Acid, 15 Percent (V/V).* Dilute 15 ml of concentrated HNO_3 to 100 ml with deionized distilled water.

6.2.5 *Mercury Stock Solution, 1 mg Hg/ml.* Prepare and store all mercury standard solutions in borosilicate glass containers. Completely dissolve 0.1354 g of mercury (II) chloride in 75 ml of deionized distilled water. Add 100 ml of concentrated HNO_3, and adjust the volume to exactly 100 ml with deionized distilled water. Mix thoroughly. This solution is stable for at least 1 month.

6.2.6 *Intermediate Mercury Standard Solution, 10 μg Hg/ml.* Prepare fresh weekly. Pipet 5.0 ml of the mercury stock solution (Section 6.2.5) into a 500-ml volumetric flask and add 20 ml of 15 percent HNO_3 solution. Adjust the volume to exactly 500 ml with deionized distilled water. Thoroughly mix the solution.

6.2.7 *Working Mercury Standard Solution, 200 ng Hg/ml.* Prepare fresh daily. Pipet 5.0 ml from the "Intermediate Mercury Standard Solution" (Section 6.2.6) into a 250-ml volumetric flask. Add 5 ml of 4 percent $KMnO_4$ absorbing solution and 5 ml of 15 percent HNO_3. Adjust the volume to exactly 250 ml with deionized distilled water. Mix thoroughly.

6.2.8 *Potassium Permanganate, 5 Percent (W/V).* Dissolve 5 g of $KMnO_4$ in deionized distilled water and dilute to 100 ml.

6.2.9 *Filter.* Whatman No. 40 or equivalent.

7. *Procedure*—7.1 *Sampling.* The sampling procedure is the same as Method 101, except for changes due to the use of $KMnO_4$ instead of ICl absorbing solution and the possible use of a filter. These changes are as follows:

7.1.1 *Preliminary Determinations.* The preliminary determinations are the same as those given in Method 101, Section 7.1.2, except for the absorbing solution depletion sign. In this method, high oxidizable organic content may make it impossible to sample for the desired minimum time. This problem is indicated by the complete bleaching of the purple color of the $KMnO_4$ solution. In these cases, the tester may divide the sample run into two or more subruns to insure that the absorbing solution would not be depleted. In cases where an excess of water condensation is encountered, collect two runs to make one sample.

7.1.2 *Preparation of Sampling Train.* The preparation of the sampling train is the same as that given in Method 101, Section 7.1.3, except for the cleaning of the glassware (probe, filter holder (if used), impingers, and connectors] and the charging of the first three impingers. In this method, clean all the glass components by rinsing with 50 percent HNO_3, tap water, 8 N HCl, tap water, and finally deionized distilled water. Then place 50 ml of 4 percent $KMnO_4$ in the first impinger and 100 ml in each of the second and third impingers.

If a filter is used, use a pair of tweezers to place the filter in the filter holder. Be sure to center the filter and place the gasket in proper position to prevent the sample gas stream from by-passing the filter. Check the filter for tears after assembly is completed. Be sure also to set the filter heating system at the desired operating temperature after the sampling train has been assembled.

7.1.3 *Sampling Train Operation.* In addition to the procedure given in Method 101, Section 7.1.5, maintain a temperature around the filter (if applicable) of 120° ± 14° C (248° ± 25° F).

7.2 *Sample Recovery.* Begin proper cleanup procedure as soon as the probe is removed from the stack at the end of the sampling period. Allow the probe to cool. When it can be safely handled, wipe off any external particulate matter near the tip of the probe nozzle and place a cap over it. Do not cap off the probe tip tightly while the sampling train is cooling because the resultant vacuum would draw liquid out from the impingers.

Before moving the sample train to the cleanup site, remove the probe from the 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 impinger. Use either ground-glass stoppers, plastic caps, or serum caps to close these openings.

Transfer the probe, impinger assembly, and (if applicable) filter assembly to a cleanup area that is clean, protected from the wind, and free of Hg contamination. The ambient air in laboratories located in the immediate vicinity of Hg-using facilities is not normally free of Hg contamination.

Inspect the train before and during assembly, and note any abnormal conditions. Treat the sample as follows:

7.2.1 *Container No. 1* (Impinger, Probe, and Filter Holder). Use a graduated cylinder; measure the liquid in the first three impingers to within ±1 ml. Record the volume of liquid present (e.g., see Figure 5-3 of Method 5 in Part 60 of 40 CFR). This information is needed to calculate the moisture content of the effluent gas. (Use only graduated cylinder and glass storage bottles that have been precleaned as in Section 7.1.2.) Place the contents of the first three impingers into a 1000-ml glass sample bottle.

(NOTE: If a filter is u
from its holder, as ou
er No. 3" below.)

Taking care that
the probe or other
not get into the sa
cover the Hg (and a
probe nozzle, probe
front half of the filte
as follows: Rinse the
total of 250 to 400
$KMnO_4$ solution; add
1000-ml glass sample
sidual brown depos
using the minimum a
quired; and add th
sample container.

After all washings
the sample container.
container to prevent
ment to the laborator
the fluid level to dete
occurs during transpo
to clearly identify its

7.2.2. *Container N*
the color of the indica
mine whether it has
and make a notation
fer the silica gel fro
original container an
use as aids a funnel
and a rubber policem
gel from the impinge
remove the small am
may adhere to the
difficult to remove. S
is to be used for mo
not use any water or
fer the silica gel. If a
the field, weigh the s
gel plus impinger)
record this weight.

7.2.3 *Container No*
was used, carefully re
holder, place it in
bottle, and add 20
$KMnO_4$. If it is neces
be sure that the pa
the fold. Carefully
sample bottle any p
filter fibers that adh
gasket by using a d
and a sharp-edged bl
Label the container
contents. Mark the h
to determine whethe
transport.

7.2.4 *Container N*
filter was used, trea
the same filter lot u
same manner as Con

7.2.5 *Container N*
tion Blank). For a b
percent $KMnO_4$ ab
1000-ml sample bott

7.3 *Sample Prep*
level in each contai

er holder (if used), im-
ectors) and the charging
mpingers. In this method,
s components by rinsing
NO_3, tap water, 8 N HCl,
nally deionized distilled
ce 50 ml of 4 percent
st impinger and 100 ml in
l and third impingers.
l, use a pair of tweezers to
the filter holder. Be sure
r and place the gasket in
o prevent the sample gas
assing the filter. Check the
ter assembly is completed.
t the filter heating system
erating temperature after
n has been assembled.
Train Operation. In addi-
dure given in Method 101,
naintain a temperature
(if applicable) of 120°±14°

covery. Begin proper clean-
soon as the probe is re-
tack at the end of the sam-
w the probe to cool. When
andled, wipe off any exter-
natter near the tip of the
place a cap over it. Do not
tip tightly while the sam-
ling because the resultant
aw liquid out from the im-

the sample train to the
nove the probe from the
ne silicone grease, and cap
f the probe. Be careful not
ndensate that might be
f the silicone grease from
e either ground-glass stop-
s, or serum caps to close

probe, impinger assembly,
) filter assembly to a clean-
clean, protected from the
of Hg contamination. The
aboratories located in the
ty of Hg-using facilities is
e of Hg contamination.
in before and during assem-
any abnormal conditions.
as follows:
er No. 1 (Impinger, Probe,
er). Use a graduated cylin-
liquid in the first three im-
n ±1 ml. Record the volume
it (e.g., see Figure 5-3 of
t 60 of 40 CFR). This infor-
d to calculate the moisture
ffluent gas. (Use only grad-
nd glass storage bottles that
eaned as in Section 7.1.2.)
nts of the first three im-
00-ml glass sample bottle.

(NOTE: If a filter is used, remove the filter from its holder, as outlined under "Container No. 3" below.)

Taking care that dust on the outside of the probe or other exterior surfaces does not get into the sample, quantitatively recover the Hg (and any condensate) from the probe nozzle, probe fitting, probe liner and front half of the filter holder (if applicable) as follows: Rinse these components with a total of 250 to 400 ml of fresh 4 percent $KMnO_4$ solution; add all washings to the 1000-ml glass sample bottle; remove any residual brown deposits on the glassware using the minimum amount of 8 N HCl required; and add this HCl rinse to this sample container.

After all washings have been collected in the sample container, tighten the lid on the container to prevent leakage during shipment to the laboratory. Mark the height of the fluid level to determine whether leakage occurs during transport. Label the container to clearly identify its contents.

7.2.2. *Container No. 2* (Silica Gel). 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 its impinger to its original container and seal. The tester may use as aids a funnel to pour the silica gel and a rubber policeman to remove the silica gel from the impinger. It is not necessary to remove the small amount of 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, weigh the spent silica gel (or silica gel plus impinger) to the nearest 0.5 g; record this weight.

7.2.3 *Container No. 3* (Filter). If a filter was used, carefully remove it from the filter holder, place it in a 100-ml glass sample bottle, and add 20 to 40 ml of 4 percent $KMnO_4$. If it is necessary to fold the filter, be sure that the particulate cake is inside the fold. Carefully transfer to the 150-ml sample bottle any particulate matter and filter fibers that adhere to the filter holder gasket by using a dry Nylon bristle brush and a sharp-edged blade. Seal the container. Label the container to clearly identify its contents. Mark the height of the fluid level to determine whether leakage occurs during transport.

7.2.4 *Container No. 4* (Filter Blank). If a filter was used, treat an unused filter from the same filter lot used for sampling in the same manner as Container No. 3.

7.2.5 *Container No. 5* (Absorbing Solution Blank). For a blank, place 500 ml of 4 percent $KMnO_4$ absorbing solution in a 1000-ml sample bottle. Seal the container.

7.3 *Sample Preparation.* Check liquid level in each container to see if liquid was lost during transport. If a noticeable amount of leakage occurred, either void the sample or use methods subject to the approval of the Administrator to account for the losses. Then follow the procedures below.

7.3.1 *Containers No. 3 and No. 4* (Filter and Filter Blank). If a filter was used, place the contents, including the filter, of Containers No. 3 and No. 4 in separate 250-ml beakers and heat the beakers on a steam bath until most of the liquid has evaporated. Do not take to dryness. Add 20 ml of concentrated HNO_3 to the beakers, cover them with a glass, and heat on a hot plate at 70° C for 2 hours. Remove from the hot plate and filter the solution through Whatman No. 40 filter paper. Save the filtrate for Hg analysis. Discard the filter.

7.3.2 *Container No. 1* (Impingers, Probe, and Filter Holder). Filter the contents of Container No. 1 through Whatman 40 filter paper to remove the brown MnO_2 precipitate. Wash the filter with 50 ml of 4 percent $KMnO_4$ absorbing solution and add this wash to the filtrate. Discard the filter. Combine the filtrates from Containers No. 1 and No. 3 (if applicable), and dilute to a known volume with deionized distilled water. Mix thoroughly.

7.3.3 *Container No. 5* (Absorbing Solution Blank). Treat this container as described in Section 7.3.2. Combine this filtrate with the filtrate with Container No. 4 and dilute to a known volume with deionized distilled water. Mix thoroughly.

7.4 *Analysis.* Calibrate the spectrophotometer and recorder and prepare the calibration curve as described in Sections 8.1 to 8.4. Then repeat the procedure used to establish the calibration curve with appropriately sized aliquots (1 to 10 ml) of the samples (from Sections 7.3.2 and 7.3.3) until two consecutive peak heights agree within ±3 percent of their average value. If the 10-ml sample is below the detectable limit, use a larger aliquot (up to 20 ml), but decrease the volume of water added to the aeration cell accordingly to prevent the solution volume from exceeding the capacity of the aeration bottle. If the peak maximum of a 1.0-ml aliquot is off scale, further dilute the original sample to bring the Hg concentration into the calibration range of the spectrophotometer. If the Hg content of the absorbing solution and filter blank is below the working range of the analytical method, use zero for the blank.

Run a blank and standard at least after every five samples to check the spectrophotometer calibration; recalibrate as necessary.

It is also recommended that at least one sample from each stack test be checked by the Method of Standard Additions to confirm that matrix effects have not interfered in the analysis.

8. *Calibration and Standards*—The calibration and standards are the same as Method 101, Section 8, except for the following variations:

8.1 *Optical Cell Heating System Calibration*. Same as method 101, Section 8.2, except use a 25-ml graduated cylinder to add 25 ml of deionized distilled water to the bottle section of the aeration cell.

8.2 *Spectrophotometer and Recorder Calibration*. The mercury response may be measured by either peak height or peak area. (NOTE: the temperature of the solution affects the rate at which elemental Hg is released from a solution and, consequently, it affects the shape of the absorption curve (area) and the point of maximum absorbance (peak height). To obtain reproducible results, all solutions must be brought to room temperature before use.) Set the spectrophotometer wave length at 253.7 nm and make certain the optical cell is at the minimum temperature that will prevent water condensation.

Then set the recorder scale as follows: Using a 25-ml graduated cylinder, add 25 ml of deionized distilled water to the aeration cell bottle and pipet 5.0 ml of the working mercury standard solution into the aeration cell. (NOTE: Always add the Hg-containing solution to the aeration cell after the 25 ml of deionized distilled water.) Place a Teflon-coated stirring bar in the bottle. Add 5 ml of the 4 percent $KMnO_4$ absorbing solution followed by 5 ml of 15 percent HNO_3 and 5 ml of 5 percent $KMnO_4$ to the aeration bottle and mix well. Now, attach the bottle section to the bubbler section of the aeration cell and make certain that (1) the aeration cell exit arm stopcock (Figure 101-3 of Method 101) is closed (so that Hg will not prematurely enter the optical cell when the reducing agent is being added) and (2) there is no flow through the bubbler. Add 5 ml of sodium chloride hydroxylamine in 1-ml increments until the solution is colorless. Now add 5 ml of tin (II) solution to the aeration bottle through the side arm. Stir the solution for 15 seconds, turn on the recorder, open the aeration cell exit arm stopcock, and immediately initiate aeration with continued stirring. Determine the maximum absorbance of the standard and set this value to read 90 percent of the recorder full scale.

9. *Calculations*—9.1 *Dry Gas Volume, Volume of Water Vapor and Moisture Content, Stack Gas Velocity, Isokinetic Variation and Acceptable Results, and Determination of Compliance*. Same as Method 101, Sections 9.1, 9.2, 9.3, 9.6, and 9.7, respectively, except use data obtained from this test.

9.2 *Total Mercury*. For each source sample, correct the average maximum absorbance of the two consecutive samples whose peak heights agreed within ±3 percent of their average for the contribution of the field blank. Then calculate the total Hg content in µg in each sample. Correct for any dilutions made to bring the sample into the working range of the spectrophotometer.

9.3 *Mercury Emission Rate*. Calculate the Hg emission rate R in g/day for continuous operations using Equation 101A-1. For cyclic operations, use only the time per day each stack is in operation. The total Hg emission rate from a source will be the summation of results from all stacks.

$$R = K \frac{m_{Hg} v_s A_s (86.400 \times 10^{-6})}{(V_{m(std)} + V_{w(std)})(T_s/P_s)}$$

Eq. 101A-1

Where:

m_{Hg} = Total Hg content in each sample, µg.

v_s = Average stack gas velocity, m/sec (fps).

A_s = Stack cross-sectional area, m^2 (ft^2).

86.400 = Conversion factor, sec/day.

10^{-6} = Conversion factor, g/µg.

$V_{m(std)}$ = Dry gas sample volume at standard conditions, corrected for leakage (if any), m^3 (ft^3).

$V_{w(std)}$ = Volume of water vapor at standard conditions, m^3 (ft^3).

T_s = Absolute average stack gas temperature, °K (°R).

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

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

10. *Bibliography*. 1. Same as Method 101, Section 10.

2. Mitchell, W. J., M. R. Midgett, J. C. Suggs, and D. Albrinck.

Test Methods to Determine the Mercury Emissions from Sludge Incineration Plants. U.S. Environmental Protection Agency. Research Triangle Park, North Carolina. Publication No. EPA-600/4-79-058. September 1979.

METHOD 102—DETERMINATION OF PARTICULATE AND GASEOUS MERCURY EMISSIONS FROM CHLOR-ALKALI PLANTS—HYDROGEN STREAMS

1. *Introduction*—Although similar to Method 101, Method 102 requires changes to accommodate the sample being extracted from a hydrogen stream. Conduct the test according to Method 101, except as shown below:

2. *Mercury Train Operation*—2.1 *Probe Heating System*. Do not use, unless otherwise specified.

2.2 *Glass Fiber Filter.*
otherwise specified.
2.3 *Safety Procedures.*
conduct the source test
utmost safety, because
mixtures are explosive
train essentially is leak
operation can be conce
and outlet. If a leak
remove the meter box
ble explosive mixture. Th
precautions are recomme
2.3.1 *Operate only*
during the test. The oth
ment, e.g., heaters, fans,
ly are not essential to the
gen stream test.
2.3.2 *Seal the sample*
leakage of hydrogen from
2.3.3 *Vent sampled hy*
(10 feet) away from the
accomplished by attac
(0.50-in) Tygon tube to
the orifice meter. (No
tubing may cause the ori
tion to be erroneous.) T
that the exhaust line is n
2.4 *Setting of Isokineti*
2.4.1 If a nomograph
care in the calculation
weight of the stack gas a
the nomograph to mainta
tions during sampling
through 2.4.1.3 below).
2.4.1.1 *Calibrate the*
Use the techniques descri
(see Citation 9 in Section
Calibration of the orifice
ditions that simulate the
source is suggested. C
either be done with hydr
other gas having a
Number so that there is
the Reynolds Numbers
and during sampling.
2.4.1.2 The nomogra
APTD-0576 cannot be us
C factor because the nom
for use when the stack
weight is 20±4. Instead, t
lation should be made
proper C factor:

$$C = 0.00154 \Delta H_{@} C_p^2 T_m (P_s/P_m)$$

Where:

DY/YR 66 80

on of

DY/YR 56 80

ission control

DY/YR 66 80

/DY/YR 66 80

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of compliance

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ssion testing.
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or operator

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APPENDIX B—TEST METHODS

Method 101—Reference method for determination of particulate and gaseous mercury emissions from chlor-alkali plants--air streams
Method 101A—Determination of particulate and gaseous mercury emissions from sewage sludge incinerations
Method 102—Determination of particulate and gaseous mercury emissions from chlor-alkali plants—hydrogen streams
Method 103—Beryllium screening method
Method 104—Reference method for determination of beryllium emissions from stationary sources
Method 105—Method for determination of mercury in wastewater treatment plant sewage sludges
Method 106—Determination of vinyl chloride from stationary sources
Method 107—Determination of vinyl chloride content of inprocess wastewater samples, and vinyl chloride content of polyvinyl chloride resin, slurry, wet cake, and latex samples
Method 107A—Determination of vinyl chloride content of solvents, resin-solvent solution, polyvinyl chloride resin, resin slurry, wet resin, and latex samples

METHOD 101—DETERMINATION OF PARTICULATE AND GASEOUS MERCURY EMISSIONS FROM CHLOR-ALKALI PLANTS—AIR STREAMS

1. *Applicability and Principle*—1.1 *Applicability.* This method applies to the determination of particulate and gaseous mercury (Hg) emissions from chlor-alkali plants and other sources (as specified in the regulations), where the carrier-gas stream in the duct or stack is principally air.

1.2 *Principle.* Particulate and gaseous Hg emissions are withdrawn isokinetically from the source and collected in acidic iodine monochloride (ICl) solution. The Hg collected (in the mercuric form) is reduced to elemental Hg, which is then aerated from the solution into an optical cell and measured by atomic absorption spectrophotometry.

2. *Range and Sensitivity*—2.1 *Range.* After initial dilution, the range of this method is 0.5 to 120 μg Hg/ml. The upper limit can be extended by further dilution of the sample.

2.2 *Sensitivity.* The sensitivity of this method depends on the recorder/spectrophotometer combination selected.

3. *Interfering Agents*—3.1 *Sampling.* SO_2 reduces ICl and causes premature depletion of the ICl solution.

3.2 *Analysis.* ICl concentrations greate than 10^{-4} molar inhibit the reduction of th Hg (II) ion in the aeration cell. Condensa tion of water vapor on the optical cell win dows causes a positive interference.

4. *Precision and Accuracy*—The followin estimates are based on collaborative test wherein 13 laboratories performed duplica analyses on two Hg-containing samples fro a chlor-alkali plant and on one laborator prepared sample of known Hg concentr tion. The concentration ranged from 2 to μg Hg/ml.

4.1 *Precision.* The estimated within-lab ratory and between-laboratory standard d viations are 1.6 and 1.8 μg Hg/ml, respe tively.

4.2 *Accuracy.* The participating laborat ries that analyzed a 64.3-μg Hg/ml (in 0.1 ICl) standard obtained a mean of 63.7 Hg/ml.

5. *Apparatus*—5.1 *Sampling Train.* schematic of the sampling train is shown Figure 101-1; it is similar to the Method train (mention of Method 5 refers to Par 60 of 40 CFR). The sampling train consis of the following components:

5.1.1 *Probe Nozzle, Pitot Tube, Differe tial Pressure Gauge, Metering System, B rometer, and Gas Density Determinatio Equipment.* Same as Method 5, Sectio 2.1.1, 2.1.3, 2.1.4, 2.1.8, 2.1.9, and 2.1.10, r spectively.

5.1.2 *Probe Liner.* Borosilicate or quar glass tubing. The tester may use a heati system capable of maintaining a gas tempe ature of 120±14° C (248±25° F) at the pro exit during sampling to prevent water co densation.

NOTE: Do not use metal probe liners.

5.1.3 *Impingers.* Four Greenburg-Smi impingers connected in series with leak-fr ground glass fittings or any similar leak-fr noncontaminating fittings. For the fir third, and fourth impingers, the tester m use impingers that are modified by repla ing the tip with a 13-mm-ID (0.5-in.) gla tube extending to 13 mm (0.5 in.) from t bottom of the flask.

5.1.4 *Acid Trap.* Mine Safety Applianc air line filter, Catalog number 81857, wi acid absorbing cartridge and suitable co nections, or equivalent.

5.2 *Sample Recovery.* The followi items are needed:

5.2.1 *Glass Sample Bottles.* Leakless, wi Teflon-lined caps, 1000- and 100-ml.

5.2.2 *Graduated Cylinder.* 250-ml.

5.2.3 *Funnel and Rubber Policeman.* aid in transfer of silica gel to container; n necessary if silica gel is weighed in the fie

5.2.4 *Funnel.* Glass, to aid in sample recovery.

5.3 *Sample Preparation and Analysis.* The following equipment is needed:

5.3.1 *Atomic Absorption Spectrophotometer.* Perkin-Elmer 303, or equivalent, containing a hollow-cathode mercury lamp and the optical cell described in Section 5.3.2.

5.3.2 *Optical Cell.* Cylindrical shape with quartz end windows and having the dimensions shown in Figure 101-2. Wind the cell with approximately 2 meters of 24-gauge nichrome heating wire, and wrap with fiberglass insulation tape or equivalent; do not let the wires touch each other.

5.3.3 *Aeration Cell.* Constructed according to the specifications in Figure 101-3. Do not use a glass frit as a substitute for the blown glass bubbler tip shown in Figure 101-3.

5.3.4 *Recorder.* Matched to output of the spectrophotometer described in Section 5.3.1.

5.3.5 *Variable Transformer.* To vary the voltage on the optical cell from 0 to 40 volts.

5.3.6 *Hood.* For venting optical cell exhaust.

5.3.7 *Flowmetering Valve.*

5.3.8 *Flowmeter.* Rotameter or equivalent, capable of measuring a gas flow of 1.5 liters/min.

5.3.9 *Aeration Gas Cylinder.* Nitrogen or dry, Hg-free air, equipped with a single-stage regulator.

5.3.10 *Connecting Tubing.* Use glass tubing (ungreased ball- and socket-connections are recommended) for all tubing connections between the solution cell and the optical cell; do not use Tygon tubing, other types of flexible tubing, or metal tubing as substitutes. The tester may use Teflon, steel, or copper tubing between the nitrogen tank and flowmetering valve (5.3.7), and Tygon, gum, or rubber tubing between the flowmetering valve and the aeration cell.

5.3.11 *Flow Rate Calibration Equipment.* Bubble flowmeter or wet test meter for measuring a gas flow rate of 1.5±0.1 liters/min.

5.3.12 *Volumetric Flasks.* Class A with penny head standard taper stoppers; 100-, 250-, 500- and 1000-ml.

5.3.13 *Volumetric Pipets.* Class A; 1-, 2-, 3-, 4-, and 5-ml.

5.3.14 *Graduated Cylinder.* 50-ml.

5.3.15 *Magentic Stirrer.* General-purpose laboratory type.

5.3.16 *Magnetic Stirring Bar.* Teflon-coated.

5.3.17 *Balance.* Capable of weighing to ±0.5 g.

5.4 *Alternative Analytical Apparatus.* Alternative systems are allowable as long as they meet the following criteria:

5.4.1 A linear calibration curve is generated and two consecutive samples of the same aliquot size and concentration agree within 3 percent of their average.

5.4.2 A minimum of 95 percent of the spike is recovered when an aliquot of a source sample is spiked with a known concentration of mercury (II) compound.

5.4.3 The reducing agent should be added after the aeration cell is closed.

5.4.4 The aeration bottle bubbler should not contain a frit.

5.4.5 Any Tygon used should be as short as possible and conditioned prior to use until blanks and standards yield linear and reproducible results.

5.4.6 If manual stirring is done before aeration, it should be done with the aeration cell closed.

5.4.7 A drying tube should not be used unless it is conditioned as the Tygon above.

6. *Reagents*—Use ACS reagent-grade chemicals or equivalent, unless otherwise specified.

6.1 *Sampling and Recovery.* The reagents used in sampling and recovery are as follows:

6.1.1 *Water.* Deionized distilled, meeting ASTM Specifications for Type I Reagent Water—ASTM Test Method D1193-77 (incorporated by reference—see § 61.18). If high concentrations of organic matter are not expected to be present, the analyst may eliminate the $KMnO_4$ test for oxidizable organic matter. Use this water in all dilutions and solution preparations.

6.1.2 *Nitric Acid (HNO_3),* 50 Percent (V/V). Mix equal volumes of concentrated HNO_3 and deionized distilled water, being careful to slowly add the acid to the water.

6.1.3 *Silica Gel.* Indicating type, 6- to 16-mesh. If previously used, dry at 175° C (350° F) for 2 hours. The tester may use new silica gel as received.

6.1.4 *Potassium Iodide (KI) Solution, 25 Percent.* Dissolve 250 g of KI in deionized distilled water and dilute to 1 liter.

6.1.5 *Iodine Monochloride (ICl) Stock Solution, 1.0 M.* To 800 ml of 25 percent KI solution, add 800 ml of concentrated hydrochloric acid (HCl). Cool to room temperature. With vigorous stirring, slowly add 135 g of potassium iodate (KIO_3) and stir until all free iodine has dissolved. A clear orange-red solution occurs when all the KIO_3 has been added. Cool to room temperature and dilute to 1800 ml with deionized distilled water. Keep the solution in amber glass bottles to prevent degradation.

6.1.6 *Absorbing Solution, 0.1 M ICl.* Dilute 100 ml of the 1.0 M ICl stock solution to 1 liter with deionized distilled water. Keep the solution in amber glass bottles and in darkness to prevent degradation. This reagent is stable for at least 2 months.

6.2 *Sample Preparation and Analysis.* The reagents needed are listed below:

6.2.1 *Tin (II) Solution.*
daily and keep sealed when
Completely dissolve 20 g of
(or 25 g of tin (II) sulfate)
Analyzed reagent grade or a
that will give a clear solut
concentrated HCl. Dilute
deionized distilled water.
HNO_3, H_2SO_4, or other str
HCl.

6.2.2 *Mercury Stock Solu*
ml. Prepare and store all me
solutions in borosilicate gl
Completely dissolve 0.1354 g
chloride in 75 ml of deionized
in a 100 ml glass volumetric
of concentrated HNO_3, an
volume to exactly 100 ml with
tilled water. Mix thoroughly.
is stable for at least 1 month.

6.2.3 *Sulfuric Acid, 5*
Dilute 25 ml of concentrated
ml with deionized distilled wa

6.2.4 *Intermediate Mercury*
lution, 10 μg Hg/ml. Prepare
Pipet 5.0 ml of the mercury
(6.2.2) into a 500-ml glass vo
and add 20 ml of the 5 perce
tion. Dilute to exactly 500 ml
distilled water. Thoroughly
tion.

6.2.5 *Working Mercury S*
tion, 200 ng Hg/ml. Prepar
Pipet 5.0 ml from the "Intern
ry Standard Solution" (6.2.4)
volumetric glass flask. Add
percent H_2SO_4 and 2 ml of the
sorbing solution taken as a bl
dilute to 250 ml with deio
water. Mix thoroughly.

7. *Procedure*—7.1 *Samplin*
the complexity of this m
should be trained and experie
test procedures to assure r
Since the amount of Hg th
generally is small, the method
fully applied to prevent cor
loss of sample.

7.1.1 *Pretest Preparation.*
eral procedure given in Met
4.1.1, except omit the dire
filter.

7.1.2 *Preliminary*
Follow the general proced
Method 5, Section 4.1.2, exc
Select a nozzle size based on t
locity heads to assure that
sary to change the nozzle s
maintain isokinetic sampling
liters/min (1.0 cfm).

Obtain samples over a pe
that accurately determine
emissions that occur in a 24-
the case of cyclic operations.
tests for the accurate determ
emissions that occur over t
the cycle. A minimum sam

e and concentration agree
of their average.

ium of 95 percent of the
ed when an aliquot of a
spiked with a known con-
cury (II) compound.

cing agent should be added
n cell is closed.

tion bottle bubbler should

on used should be as short
conditioned prior to use
standards yield linear and
ilts.

al stirring is done before
uld be done with the aer-

: tube should not be used
tioned as the Tygon above.
Use ACS reagent-grade
uivalent, unless otherwise

and Recovery. The rea-
mpling and recovery are as

Deionized distilled, meeting
tions for Type I Reagent
Test Method D1193-77 (in-
reference—see § 61.18). If
ions of organic matter are
be present, the analyst may
MnO$_4$ test for oxidizable or-
e this water in all dilutions
parations.

cid (*HNO_3*). 50 Percent (V/
volumes of concentrated
ized distilled water, being
add the acid to the water.

el. Indicating type, 6- to 16-
sly used, dry at 175° C (350°
he tester may use new silica

m Iodide (*KI*) *Solution,* 25
e 250 g of KI in deionized
nd dilute to 1 liter.

fonochloride (*ICl*) *Stock So-*
800 ml of 25 percent KI so-
ml of concentrated hydro-
Cl). Cool to room tempera-
ous stirring, slowly add 135
odate (KIO_3) and stir until
as dissolved. A *clear orange-*
urs when all the KIO_3 has
l to room temperature and
ml with deionized distilled
solution in amber glass bot-
egradation.

ng Solution, 0.1 M ICl.
the 1.0 M ICl stock solution
deionized distilled water.
ion in amber glass bottles
s to prevent degradation.
stable for at least 2 months.

Preparation and Analysis.
eded are listed below.

6.2.1 *Tin (II) Solution.* Prepare fresh daily and keep sealed when not being used. Completely dissolve 20 g of tin (II) chloride [or 25 g of tin (II) sulfate] crystals (Baker Analyzed reagent grade or any other brand that will give a clear solution) in 25 ml of concentrated HCl. Dilute to 250 ml with deionized distilled water. Do not substitute HNO_3, H_2SO_4, or other strong acids for the HCl.

6.2.2 *Mercury Stock Solution, 1 mg Hg/ml.* Prepare and store all mercury standard solutions in borosilicate glass containers. Completely dissolve 0.1354 g of mercury (II) chloride in 75 ml of deionized distilled water in a 100 ml glass volumetric flask. Add 10 ml of concentrated HNO_3, and adjust the volume to exactly 100 ml with deionized distilled water. Mix thoroughly. This solution is stable for at least 1 month.

6.2.3 *Sulfuric Acid, 5 Percent (V/V).* Dilute 25 ml of concentrated H_2SO_4 to 500 ml with deionized distilled water.

6.2.4 *Intermediate Mercury Standard Solution, 10 μg Hg/ml.* Prepare fresh weekly. Pipet 5.0 ml of the mercury stock solution (6.2.2) into a 500-ml glass volumetric flask and add 20 ml of the 5 percent H_2SO_4 solution. Dilute to exactly 500 ml with deionized distilled water. Thoroughly mix the solution.

6.2.5 *Working Mercury Standard Solution, 200 ng Hg/ml.* Prepare fresh daily. Pipet 5.0 ml from the "Intermediate Mercury Standard Solution" (6.2.4) into a 250-ml volumetric glass flask. Add 10 ml of the 5 percent H_2SO_4 and 2 ml of the 0.1 M ICl absorbing solution taken as a blank (7.2.3) and dilute to 250 ml with deionized distilled water. Mix thoroughly.

7. *Procedure*—7.1 *Sampling.* Because of the complexity of this method, testers should be trained and experienced with the test procedures to assure reliable results. Since the amount of Hg that is collected generally is small, the method must be carefully applied to prevent contamination or loss of sample.

7.1.1 *Pretest Preparation.* Follow the general procedure given in Method 5, Section 4.1.1, except omit the directions on the filter.

7.1.2 *Preliminary Determinations.* Follow the general procedure given in Method 5, Section 4.1.2, except as follows: Select a nozzle size based on the range of velocity heads to assure that it is not necessary to change the nozzle size in order to maintain isokinetic sampling rates below 28 liters/min (1.0 cfm).

Obtain samples over a period or periods that accurately determine the maximum emissions that occur in a 24-hour period. In the case of cyclic operations, run sufficient tests for the accurate determination of the emissions that occur over the duration of the cycle. A minimum sample time of 2 hours is recommended. In some instances, high Hg or high SO_2 concentrations make it impossible to sample for the desired minimum time. This is indicated by reddening (liberation of free iodine) in the first impinger. In these cases, the tester may divide the sample run into two or more subruns to insure that the absorbing solution is not depleted.

7.1.3 *Preparation of Sampling Train.* Clean all glassware [probe, impingers, and connectors] by rinsing with 50 percent HNO_3, tap water, 0.1 M ICl, tap water, and finally deionized distilled water. Place 100 ml of 0.1 M ICl in each of the first three impingers. Take care to prevent the absorbing solution from contacting any greased surfaces. Place approximately 200 g of preweighed silica gel in the fourth impinger. The tester may use more silica gel, but should be careful to ensure that it is not entrained and carried out from the impinger during sampling. Place the silica gel container in a clean place for later use in the sample recovery. Alternatively, determine and record the weight of the silica gel plus impinger to the nearest 0.5 g.

Install the selected nozzle using a Viton A O-ring when stack temperatures are less than 260° C (500° F). Use a fiberglass string gasket if temperatures are higher. See APTD-0576 (Citation 9 in Section 10) for details. Other connecting systems using either 316 stainless steel or Teflon ferrules may be used. 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. Assemble the train as shown in Figure 101-1, using (if necessary) a very light coat of silicone grease on all ground glass joints. Grease only the outer portion (see APTD-0576) to avoid possibility of contamination by the silicone grease.

NOTE: An empty impinger may be inserted between the third impinger and the silica gel to remove excess moisture from the sample stream.

After the sampling train has been assembled, turn on and set the probe, if applicable, at the desired operating temperature. Allow time for the temperatures to stabilize. Place crushed ice around the impingers.

7.1.4 *Leak-Check Procedures.* Follow the leak-check procedures outlined in Method 5, Sections 4.1.4.1 (Pretest Leak Check), 4.1.4.2 (Leak Checks During Sample Run), and 4.1.4.3 (Post-Test Leak Check).

7.1.5 *Mercury Train Operation.* Follow the general procedure given in Method 5, Section 4.1.5. For each run, record the data required on a data sheet such as the one shown in Figure 101-4.

7.1.6 *Calculation of Percent Isokinetic.* Same as Method 5, Section 4.1.6.

7.2 *Sample Recovery.* Begin proper cleanup procedure as soon as the probe is removed from the stack at the end of the sampling period.

Allow the probe to cool. When it can be safely handled, wipe off any external particulate matter near the tip of the probe nozzle and place a cap over it. Do not cap off the probe tip tightly while the sampling train is cooling. Capping would create a vacuum and draw liquid out from the impingers.

Before moving the sampling train to the cleanup site, remove the probe from the 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 impinger. Use either ground-glass stoppers, plastic caps, or serum caps to close these openings.

Transfer the probe and impinger assembly to a cleanup area that is clean, protected from the wind, and free of Hg contamination. The ambient air in laboratories located in the immediate vicinity of Hg-using facilities is not normally free of Hg contamination.

Inspect the train before and during assembly, and note any abnormal conditions. Treat the sample as follows:

7.2.1 *Container No. 1* (Impinger and Probe). Using a graduated cylinder, measure the liquid in the first three impingers to within ±1 ml. Record the volume of liquid present (e.g., see Figure 5-3 of Method 5). This information is needed to calculate the moisture content of the effluent gas. (Use only glass storage bottles and graduated cylinders that have been precleaned as in Section 7.1.3.) Place the contents of the first three impingers into a 1000-ml glass sample bottle.

Taking care that dust on the outside of the probe or other exterior surfaces does not get into the sample, quantitatively recover the Hg (and any condensate) from the probe nozzle, probe fitting, and probe liner as follows: Rinse these components with two 50-ml portions of 0.1 M ICl. Next, rinse the probe nozzle, fitting and liner, and each piece of connecting glassware between the probe liner and the back half of the third impinger with a maximum of 400 ml of deionized distilled water. Add all washings to the 1000-ml glass sample bottle containing the liquid from the first three impingers.

After all washings have been collected in the sample container, tighten the lid on the container to prevent leakage during shipment to the laboratory. Mark the height of the liquid to determine later whether leakage occurred during transport. Label the container to clearly identify its contents.

7.2.2 *Container No. 2* (Silica Gel). 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 its impinger to its original container and seal. The tester may use as aids a funnel to pour the silica gel and a rubber policeman to remove the silica gel from the impinger. The small amount of particles that may adhere to the impinger wall need not be removed. 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, weigh the spent silica gel (or silica gel plus impinger) to the nearest 0.5 g; record this weight.

7.2.3 *Container No. 3* (Absorbing Solution Blank). For a blank, place 50 ml of the 0.1 M ICl absorbing solution in a 100-ml sample bottle. Seal the container. Use this blank to prepare the working mercury standard solution (6.2.5).

7.3 *Sample Preparation.* Check the liquid level in each container to see whether liquid was lost during transport. If a noticeable amount of leakage occurred, either void the sample or use methods subject to the approval of the Administrator to account for the losses. Then follow the procedures below:

7.3.1 *Container No. 1* (Impinger and Probe). Carefully transfer the contents of Container No. 1 into a 1000-ml volumetric flask and adjust the volume to exactly 1000 ml with deionized distilled water.

7.3.2 *Dilutions.* Pipet a 2-ml aliquot from the diluted sample from 7.3.1 into a 250-ml volumetric flask. Add 10 ml of 5 percent H_2SO_4 and adjust the volume to exactly 250 ml with deionized distilled water. These solutions are stable for at least 72 hours.

NOTE: The dilution factor will be 250/2 for this solution.

7.4 *Analysis.* Calibrate the spectrophotometer and recorder and prepare the calibration curve as described in Sections 8.1 to 8.4.

7.4.1 *Mercury Samples.* Repeat the procedure used to establish the calibration curve with appropriately sized aliquots (1 to 5 ml) of each of the diluted samples (from Section 7.3.2) until two consecutive peak heights agree within ±3 percent of their average value. The peak maximum of an aliquot (except the 5-ml aliquot) must be greater than 10 percent of the recorder full scale. If the peak maximum of a 1.0-ml aliquot is off scale on the recorder, further dilute the original source sample to bring the Hg concentration into the calibration range of the spectrophotometer.

Run a blank and standard at least after every five samples to check the spectrophotometer calibration; recalibrate as necessary.

It is also recommended that at least one sample from each stack test be checked by

the method of standard a
firm that matrix effects ha
in the analysis.
7.4.2 *Container No. 2* (S
the spent silica gel (or silica
er) to the nearest 0.5 g
(This step may be conduc
8. *Calibration and Stan*
clean all glassware, both
follows: brush with soap a
rinse with tap water, soak
percent HNO_3, and then
ized distilled water.
8.1 *Flow Calibration.* A
ation system as shown in
the outlet pressure on the
inder regulator to a minim
500 mm Hg (10 psi), and u
ing valve and a bubble flow
meter to obtain a flow rate
min through the aeratio
flow calibration is compl
bubble flowmeter from the
8.2 *Optical Cell Heatin*
tion. Using a 50-ml gradua
50 ml of deionized distil
bottle section of the aerat
the bottle section to the b
the cell. Attach the aeratio
cal cell; and while aerating
determine the minimum v
er setting necessary to pre
of moisture in the optica
connecting tubing. (This s
exceed 20 volts.)
8.3 *Spectrophotometer*
Calibration. The mercury
measured by either peak
area.

NOTE: The temperature
fects the rate at which el
leased from a solution an
affects the shape of the
(area) and the point of
bance (peak height). Th
reproducible results, brin
room temperature before

Set the spectrophotome
253.7 nm, and make certa
is at the minimum tem
prevent water condensat
recorder scale as follow
graduated cylinder, add
distilled water to the a
and pipet 5.0 ml of the
standard solution into the

NOTE: Always add the H
tion to the aeration cell
deionized distilled water.

Place a Teflon-coated
bottle. Before attaching
to the bubbler section of
make certain that (1) th
arm stopcock (Figure 1
that Hg will not prematu
cal cell when the reduc

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ıs been completely spent
n of its condition. Trans-
:rom its impinger to its
ınd seal. The tester may
el to pour the silica gel
rnan to remove the silica
ger. The small amount of
adhere to the impinger
moved. Since the gain in
ed for moisture calcula-
ny water or other liquids
lica gel. If a balance is
ld, weigh the spent silica
us impinger) to the near-
s weight.

No. 3 (Absorbing Solu-
blank, place 50 ml of the
ing solution in a 100-ml
J the container. Use this
: the working mercury
6.2.5).

paration. Check the liquid
iner to see whether liquid
ransport. If a noticeable
: occurred, either void the
:thods subject to the ap-
ninistrator to account for
follow the procedures

No. 1 (Impinger and
transfer the contents of
ınto a 1000-ml volumetric
he volume to exactly 1000
distilled water.

Pipet a 2-ml aliquot from
e from 7.3.1 into a 250-ml
Add 10 ml of 5 percent
the volume to exactly 250
l distilled water. These so-
for at least 72 hours.

ion *factor* will be 250/2 for

'alibrate the spectrophoto-
er and prepare the calibra-
ribed in Sections 8.1 to 8.4.
Samples. Repeat the proce-
blish the calibration curve
.y sized aliquots (1 to 5 ml)
uted samples (from Section
consecutive peak heights
percent of their average
maximum of an aliquot
aliquot) must be greater
of the recorder full scale. If
ım of a 1.0-ml aliquot is off
corder, further dilute the
ample to bring the Hg con-
he calibration range of the
er.

ınd standard at least after
es to check the spectropho-
.ion; recalibrate as neces-

nmended that at least one
:h stack test be checked by

the method of standard additions to confirm that matrix effects have not interfered in the analysis.

7.4.2 *Container No. 2* (Silica Gel). 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.)

8. *Calibration and Standards*—Before use, clean all glassware, both new and used, as follows: brush with soap and water, liberally rinse with tap water, soak for 1 hour in 50 percent HNO_3, and then rinse with deionized distilled water.

8.1 *Flow Calibration.* Assemble the aeration system as shown in Figure 101-5. Set the outlet pressure on the aeration gas cylinder regulator to a minimum pressure of 500 mm Hg (10 psi), and use the flowmetering valve and a bubble flowmeter or wet test meter to obtain a flow rate of 1.5±0.1 liters/min through the aeration cell. After the flow calibration is complete, remove the bubble flowmeter from the system.

8.2 *Optical Cell Heating System Calibration.* Using a 50-ml graduated cylinder, add 50 ml of deionized distilled water to the bottle section of the aeration cell and attach the bottle section to the bubbler section of the cell. Attach the aeration cell to the optical cell; and while aerating at 1.5 liters/min, determine the minimum variable transformer setting necessary to prevent condensation of moisture in the optical cell and in the connecting tubing. (This setting should not exceed 20 volts.)

8.3 *Spectrophotometer and Recorder Calibration.* The mercury response may be measured by either peak height or peak area.

NOTE: The temperature of the solution affects the rate at which elemental Hg is released from a solution and, consequently, it affects the shape of the absorption curve (area) and the point of maximum absorbance (peak height). Therefore, to obtain reproducible results, bring all solutions to room temperature before use.

Set the spectrophotometer wavelength at 253.7 nm, and make certain the optical cell is at the minimum temperature that will prevent water condensation. Then set the recorder scale as follows: Using a 50-ml graduated cylinder, add 50 ml of deionized distilled water to the aeration cell bottle and pipet 5.0 ml of the working mercury standard solution into the aeration cell.

NOTE: Always add the Hg-containing solution to the aeration cell after the 50 ml of deionized distilled water.

Place a Teflon-coated stirring bar in the bottle. Before attaching the bottle section to the bubbler section of the aeration cell, make certain that (1) the aeration cell exit arm stopcock (Figure 101-3) is closed (so that Hg will not prematurely enter the optical cell when the reducing agent is being added) and (2) there is no flow through the bubbler. If conditions (1) and (2) are met, attach the bottle section to the bubbler section of the aeration cell through the side arm of the cell and immediately stopper the side arm. Stir the solution for 15 sec, turn on the recorder, open the aeration cell exit arm stopcock, and then immediately initiate aeration with continued stirring. Determine the maximum absorbance of the standard and set this value to read 90 percent of the recorder full scale.

8.4 *Calibration Curve.* After setting the recorder scale, repeat the procedure in Section 8.3 using 0.0-, 1.0-, 2.0-, 3.0-, 4.0-, and 5.0-ml aliquots of the working standard solution (final amount of Hg in the aeration cell is 0, 200, 400, 600, 800, and 1000 ng, respectively). Repeat this procedure on each aliquot size until two consecutive peaks agree within 3 percent of their average value. (Note: To prevent Hg carryover from one sample to another, do not close the aeration gas tank valve and do not disconnect the aeration cell from the optical cell until the recorder pen has returned to the baseline.) It should not be necessary to disconnect the aeration gas inlet line from the aeration cell when changing samples. After separating the bottle and bubbler sections of the aeration cell, place the bubbler section into a 600-ml beaker containing approximately 400 ml of deionized distilled water. Rinse the bottle section of the aeration cell with a stream of deionized distilled water to remove all traces of the tin (II) reducing agent. Also, to prevent the loss of Hg before aeration, remove all traces of the reducing agent between samples by washing with deionized distilled water. It will be necessary, however, to wash the aeration cell parts with concentrated HCl if any of the following conditions occur: (1) A white film appears on any inside surface of the aeration cell, (2) the calibration curve changes suddenly, or (3) the replicate samples do not yield reproducible results.

Subtract the average peak height (or peak area) of the blank (0.0-ml aliquot)—which should be less than 2 percent of recorder full scale—from the averaged peak heights of the 1.0-, 2.0-, 3.0-, 4.0-, and 5.0-ml aliquot standards. If the blank absorbance is greater than 2 percent of full-scale, the probable cause is Hg contamination of a reagent or carry-over of Hg from a previous sample. Plot the corrected peak height of each standard solution versus the corresponding final total Hg weight in the aeration cell (in ng) and draw the best-fit straight line. This line should either pass through the origin or pass through a point no further from the origin than ±2 percent of the recorder full scale. If the line does not pass through or very near to the origin, check for nonlinear-ity of the curve and for incorrectly prepared standards.

8.5 *Sampling Train Calibration.* Calibrate the sampling train components according to the procedures outlined in the following sections of Method 5: Section 5.1 (Probe Nozzle), Section 5.2 (Pitot Tube), Section 5.3 (Metering System), Section 5.4 (Probe Heater), Section 5.5 (Temperature Gauges), Section 5.7 (Barometer). Note that the leak check described in Section 5.6 of Method 5 applies to this method.

9. *Calculations—9.1 Dry Gas Volume.* Using the data from this test, calculate $V_{m(std)}$, the dry gas sample volume at standard conditions (corrected for leakage, if necessary) as outlined in Section 6.3 of Method 5.

9.2 *Volume of Water Vapor and Moisture Content.* Using the data obtained from this test, calculate the volume of water vapor $V_{w(std)}$ and the moisture content B_{ws} of the stack gas. Use Equations 5-2 and 5-3 of Method 5.

9.3 *Stack Gas Velocity.* Using the data from this test and Equation 2-9 of Method 2, calculate the average stack gas velocity v_s.

9.4 *Total Mercury.* For each source sample, correct the average maximum absorbance of the two consecutive samples whose peak heights agree within ±3 percent of their average for the contribution of the solution blank (see Section 8.4). Use the calibration curve and these corrected averages, to determine the final total weight of mercury in nanograms in the aeration cell for each source sample. Correct for any dilutions made to bring the sample in the working range of the spectrophotometer. Then calculate the Hg in µg (m_{Hg}) in the original solution as follows:

$$M_{Hg} = \frac{C_{Hg(AA)}(D.F.)V_f 10^{-3}}{S}$$

Eq. 101-1

where:

$C_{Hg(AA)}$ = Total nanograms of mercury in aliquot analyzed (reagent blank subtracted).

D.F. = Dilution factor for the Hg-containing solution (before adding to the aeration cell; e.g., D.F. = 250/2 if the source samples were diluted as described in Section 7.3.2.)

V_f = Solution volume of original sample, 1000 ml for samples diluted as described in Section 7.2.1.

10^{-3} = Conversion factor, µg/ng.

S = Aliquot volume added to aeration cell, ml.

9.5 *Mercury Emission Rate.* Calculate the Hg emission rate R in g/day for continuous operations using Equation 101-2. For cyclic operations, use only the time per day each stack is in operation. The total Hg emission rate from a source will be the summation of results from all stacks.

$$R = K \frac{m_{Hg} v_s A_s (86,400 \times 10^{-6})}{[V_{m(std)} + V_{w(std)}](T_s/P_s)}$$

Eq. 101-2

where:

A_s = Stack cross-sectional area, m² (ft²).

86,400 = Conversion factor, sec/day.

10^{-6} = Conversion factor, g/µg.

T_s = Absolute average stack gas temperature, °K (°R).

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

K = 0.3858 °K/mm Hg for metric units.
= 17.65 °R/in. Hg for English units.

9.6 *Isokinetic Variation and Acceptable Results.* Same as Method 5, Sections 6.11 and 6.12, respectively.

9.7 *Determination of Compliance.* Each performance test consists of three repetitions of the applicable test method. For the purpose of determining compliance with an applicable national emission standard, use the average of the results of all repetitions.

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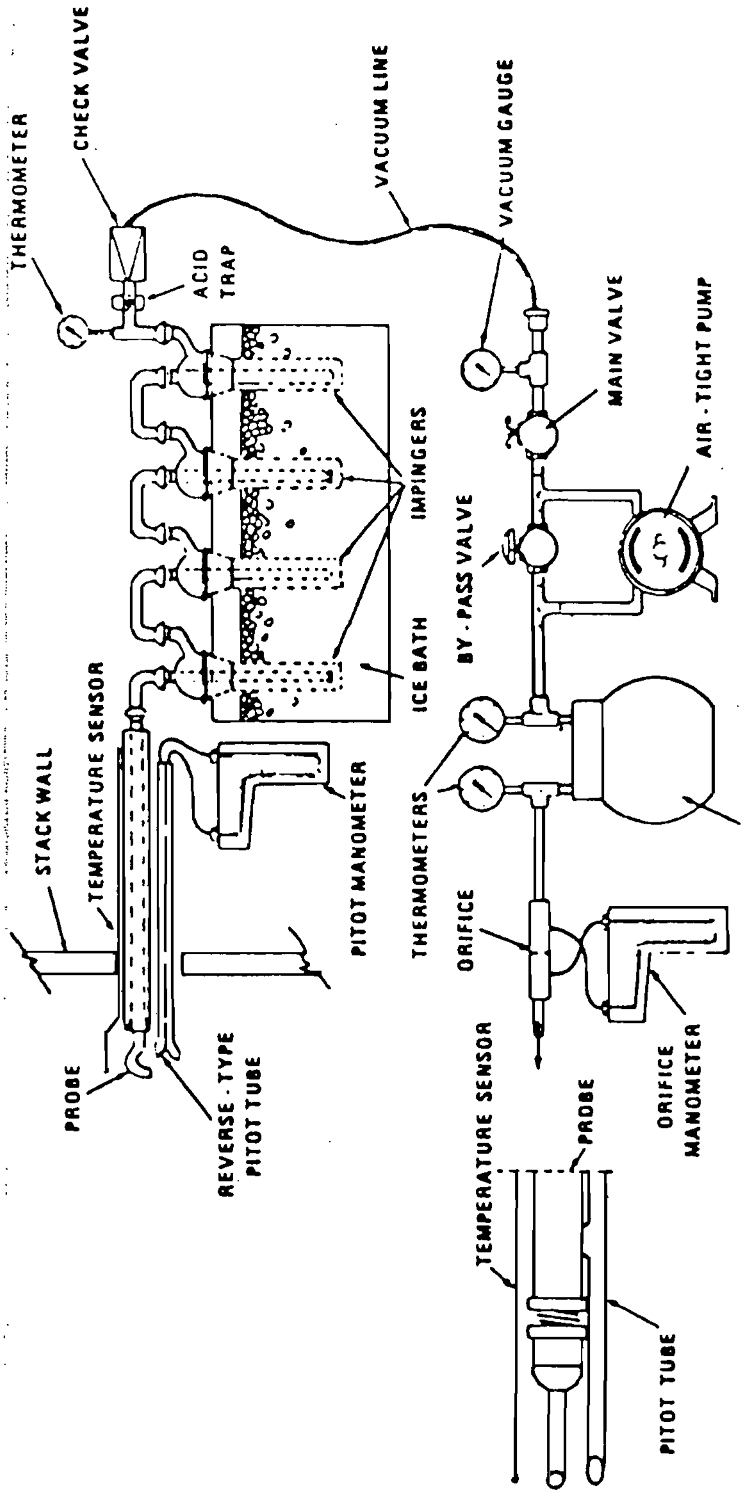
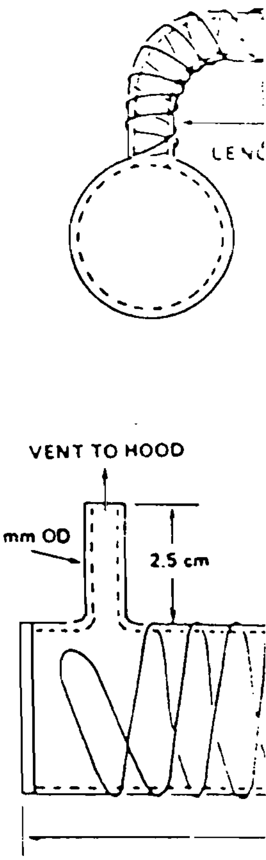


Figure 101-1 Mercury sampling train.



NOTES.
CELL WOUND WITH 24-
TOLERANCES ± 5 PERC

nission *Rate.* Calculate
ite R in g/day for contin-
sing Equation 101-2. For
ise only the time per day
operation. The total Hg
a source will be the sum-
rom all stacks.

$$\frac{_{Hg}v_sA_s(86{,}400 \times 10^{-6})}{V_{m(std)} + V_{w(std)})(T_s/P_s)}$$

:tional area, m² (ft²).
n factor, sec/day.
'actor, g/μg.
ige stack gas temperature.

t gas pressure, mm Hg (in.

Hg for metric units.
Hg for English units.

Variation and Acceptable
Method 5, Sections 6.11
'ely.
'ion *of Compliance.* Each
consists of three repeti-
cable test method. For the
nining compliance with an
al emission standard, use
e results of all repetitions.

y. 1. Addendum to Specifi-
erator Testing at Federal
CAPC. December 6, 1967.
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Absorption Spectrophoto-
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Park, NC. Publication No.
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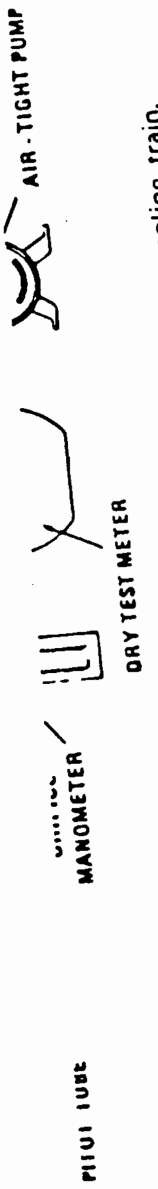
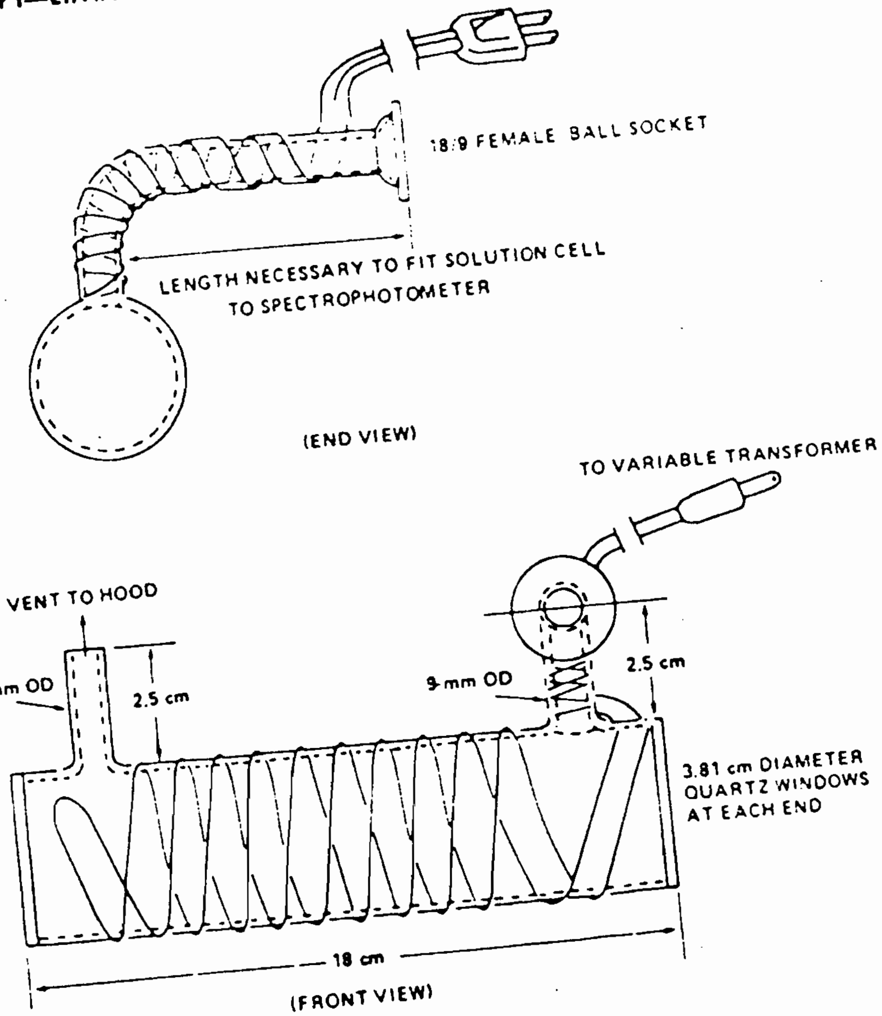


Figure 101-1 Mercury sampling train.



NOTES:
CELL WOUND WITH 24-GAUGE NICHROME WIRE
TOLERANCES ± 5 PERCENT

Figure 101-2. Optical cell.

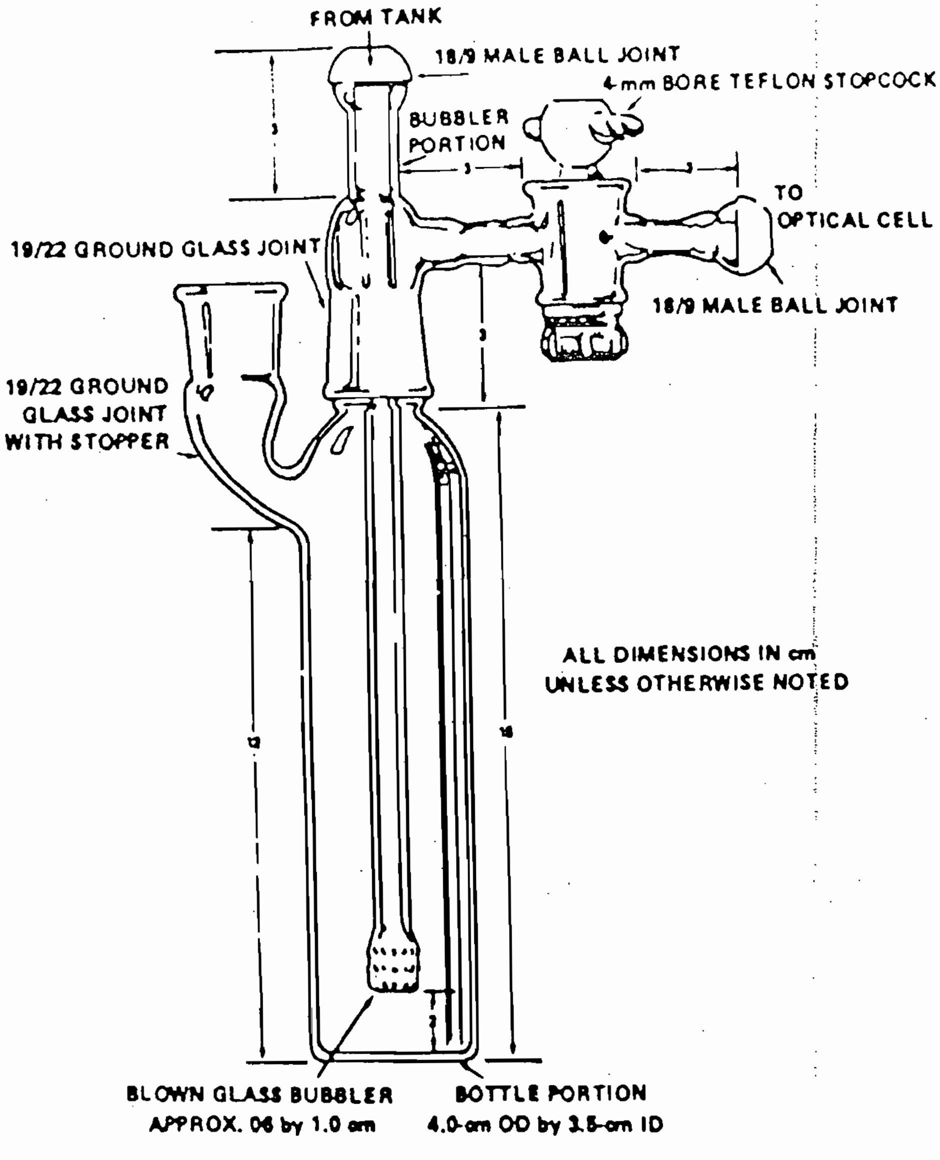
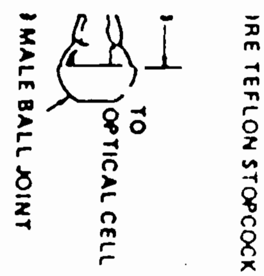


Figure 101-3. Aeration cell.

AMBIENT TEMPERATURE ______
BAROMETRIC PRESSURE ______
ASSUMED MOISTURE, % ______
PROBE LENGTH, m (ft) ______
NOZZLE IDENTIFICATION NO ______
AVERAGE CALIBRATED NOZZLE DIAMETER, cm (in.) ______
PROBE HEATER SETTING ______
LEAK RATE, m³/min (cfm) ______
PROBE LINER MATERIAL ______
STATIC PRESSURE mm Hg (in. Hg) ______
FILTER NO. ______

SCHEMATIC OF STACK CROSS SECTION

PLANT ______
LOCATION ______
OPERATOR ______
DATE ______
RUN NO. ______
SAMPLE BOX NO. ______
FILTER BOX NO. ______
METER ΔH@ ______
C FACTOR ______
PITOT TUBE COEFFICIENT, C_p ______



IONS IN cm
RWISE NOTED

PLANT ______
LOCATION ______
OPERATOR ______
DATE ______
RUN NO. ______
SAMPLE BOX NO. ______
FILTER BOX NO. ______
METER ΔH@ ______
C FACTOR ______
PITOT TUBE COEFFICIENT, C_p ______

SCHEMATIC OF STACK CROSS SECTION

AMBIENT TEMPERATURE ______
BAROMETRIC PRESSURE ______
ASSUMED MOISTURE, % ______
PROBE LENGTH, m (ft) ______
NOZZLE IDENTIFICATION NO. ______
AVERAGE CALIBRATED NOZZLE DIAMETER, cm (in.) ______
PROBE HEATER SETTING* ______
LEAK RATE, m^3/min (cfm) ______
PROBE LINER MATERIAL ______
STATIC PRESSURE, mm Hg (in. Hg) ______
FILTER NO.* ______

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	VACUUM mm Hg (in. Hg)	STACK TEMPERATURE (T_s) °C (°F)	VELOCITY HEAD (ΔP_s)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER mm H_2O (in. H_2O)	GAS SAMPLE VOLUME m^3 (ft^3)	GAS SAMPLE TEMPERATURE AT DRY GAS METER		FILTER HOLDER* TEMPERATURE °C (°F)	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER, °C (°F)
							INLET °C (°F)	OUTLET °C (°F)		
							Avg.	Avg.		
TOTAL							Avg.			
AVERAGE										

*IF APPLICABLE

Fig. 101-4. Mercury field data.

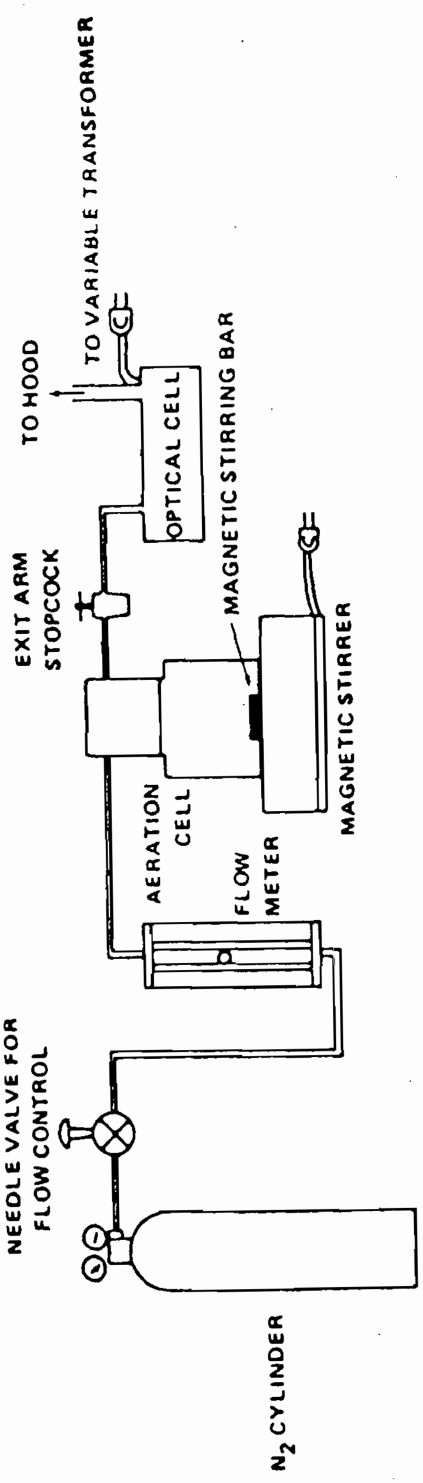


Figure 101-5. Schematic of aeration system.

METHOD 101A—DETERMINAT
LATE AND GASEOUS MERC
FROM SEWAGE SLUDGE INCI

INTRODUCTIO

This method is similar
except acidic potassium pe
tion is used instead of acidic
loride for collection.

1. *Applicability and Prin*
cability. This method app
mination of particulate and
ry (Hg) emissions from sew
erators and other sources as
regulations.

1.2 *Principle*. Particulate
emissions are withdrawn isc
the source and collected in
permanganate (KMn0$_4$) so
collected (in the mercuric
to elemental Hg, which is th
the solution into an optica
ured by atomic absorptio
metry.

2. *Range and Sensiti*
After initial dilution, the
method is 20 to 800 ng Hg
limit can be extended by fu
the sample.

2.2 *Sensitivity*. The se
method depends on the
photometer combination se

3. *Interfering Agents*—3.
cessive oxidizable organic
stack gas prematurely dep
solution and thereby prev
lection of Hg.

3.2 *Analysis*. Condens
vapor on the optical cell
positive interference.

4. *Precision*—Based on
tests, the within-laborato
ation was estimated to be
the concentration range of
m^3.

5. *Apparatus*—5.1 *Sam*
Sample Recovery. Same as
tions 5.1 and 5.2, respectiv
following variations:

5.1.1 *Probe Liner*. Sam
Section 5.1.2, except that
ahead of the impingers, th
the probe heating system
condensation of gaseous H

5.1.2 *Filter Holder* (O
cate glass with a rigid st
screen filter support (do
supports) and a silicone
gasket, designed to provi
against leakage from outs
filter. The filter holder
with a filter heating s
maintaining a temperatur

NOISE LEVEL REGULATIONS

AS AMENDED
11/15/84

RULES
of the
HILLSBOROUGH COUNTY
ENVIRONMENTAL PROTECTION COMMISSION
CHAPTER 1-10
NOISE

1.10.01 TERMINOLOGY

All technical terminology used in this Chapter not defined below shall be defined according to applicable publications of the American National Standards Institute (ANSI) or its successor body.

A. A-WEIGHTED SOUND LEVEL - The sound pressure leveling decibels as measured on a sound level meter using the A-weighting network. The level so read is designated dBA.

B. COMMERCIAL AREA - All property which is used primarily for the sale of merchandise or goods, or for the performances of a service, or for office or clerical work.

C. DECIBEL (dB) - A unit for describing the amplitude of sound, equal to 10 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure, which is 20 micronewtons per square meter.

D. EMERGENCY - Any occurrence or set of circumstances involving actual or imminent physical trauma or property damage which demands immediate action.

E. EMERGENCY WORK - Any work performed for the purpose of preventing or alleviating the physical trauma or property damage threatened or caused by an emergency.

F. INDUSTRIAL AREA - Any property which is used primarily for manufacturing, processing or an airport.

G. NOISE - Any sound which annoys or disturbs humans or causes or tends to cause an adverse psychological effect on humans.

H. NOISE DISTURBANCE - Sound which (a) is or may be harmful or injurious to the health or welfare of <u>any</u> person, or (b) unreasonably interferes with the enjoyment of life, property or outdoor recreation of a reasonable person with normal sensitivities, or (c) is of such character and in such quantity or level as to be detectable by a considerable number of persons so as to interfere with their health, repose, or safety or to cause severe annoyance or discomfort.

I. PUBLIC RIGHT OF WAY - Any street, avenue, boulevard, highway, sidewalk or alley or similar place normally accessible to the public which is owned or controlled by a governmental entity.

J. PUBLIC SPACE - Any real property or structures thereon normally accessible to the public which is owned or controlled by a governmental entity.

K. PURE TONE - Any sound which can be distinctly heard as a single pitch or a set of single pitches. For the purposes of measurement, a pure tone shall exist if the one-third octave band sound pressure level in the band with the tone exceeds arithmetic value the sound pressure levels of the two contiguous one-third octave bands by 5dB for center frequencies of 500 Hz and above and by 8dB for center frequencies between 160 and 400 Hz and by 15dB for center frequencies less than or equal to 125 Hz.

L. REAL PROPERTY LINE - An imaginary line along the ground surface, and its vertical plane extension, which separates the real property owned, rented or leased by one person from that owned, rented or leased by another person, excluding intrabuilding real property divisions.

M. RESIDENTIAL AREA - All property on which people live and sleep or parkland or hospitals or schools or nursing homes or that which is not commercial or industrial or the individual plots within a mobile home park assigned by the owner of the park.

N. SHORT DURATIONS - Any sound with a duration of less than one minute.

O. SOUND - An oscillation in pressure, stress, particle displacement, particle velocity or other physical parameter, in a medium with with internal forces. The description of sound may include any characteristic of such sound, including duration, intensity and frequency.

P. SOUND ANALYZER - A device for measuring the octave band of a sound as a function of frequency.

Q. SOUND LEVEL - The weighted sound pressure level obtained by the use of a metering characteristic and weighting A, B, or C as specified in American National Standards Institute specifications for sound level meters ANSI S1, 4-1971, or in successor publications. If the weighting employed is not indicated, the A-weighting shall apply.

R. SOUND LEVEL METER - An instrument which includes a microphone, amplifier, RMS detector, integrator or time averager, output meter, and weighting networks used to measure sound pressure levels. The output meter reads sound pressure level when properly calibrated, and the instrument is of Type 2 or better, as specified in the American National Standards Institute Publication S1.41972 or its successor publication.

S. SOUND PRESSURE - The instantaneous difference between the actual pressure and the average or barometric pressure at a given point in space, as produced by the presence of energy.

T. SOUND PRESSURE LEVEL - 20 times the logarithm to the base 10 of the ratio of the rms sound pressure to the reference pressure of 20 micronewtons per square meter (20 x 10^{-6} N/m^2). The sound pressure level is expressed in decibels.

U. SPECTATOR GAMES - Competative sports such as baseball, football, soccer and similar athletic events involving spectators.

1-10.02 PROHIBITIONS

A. NOISE DISTURBANCE PROHIBITED - No person shall make, continue or cause to be made or continued any noise disturbance. The continuation of a noise disturbance upon ones' property following notice of its existence shall be deemed to continue with the permission of the owner.

B. MAXIMUM SOUND LEVELS FOR RECEIVING LAND USE - Sound levels which exceed the limits set forth in this rule for the receiving land when measured at or within the property line of the receiving land use are declared to be noise pollution as defined by Section 3(28) of Chapter 84-446, Laws of Florida.

1-10.03 SOUND LEVEL LIMITS

A. BY RECEIVING LAND USE -

Table I

Receiving Land Use Category	Time	Sound Level Limit, dBA
Residential, Public Space, Agricultural or Institutional	7 A.M. - 10 P.M.	60
	10 P.M. - 7 A.M.	55
Commercial or Business	7 A.M. - 10 P.M.	65
	10 P.M. - 7 A.M.	60
Manufacturing or Industrial	At All Times	75

B. CORRECTION FOR CHARACTER OF SOUND - For any source of sound which emits a pure tone, the maximum sound level limits set forth in Table I shall be reduced by 5dBA. For any source of sound which is of short duration and is non-repetitive, the maximum sound level limits set forth in Table I shall be increased by 10dBA from 7 A.M. to 10 P.M.

C. AIR CONDITIONING OR AIR-HANDLING EQUIPMENT - No person shall operate or cause to be operated any air conditioning or air-handling equipment in such a manner as to exceed any of the following sound levels across a residential real property line:

Table II

Measurement Location	dBA
Any point on neighboring property line	60
Center of neighboring patio	55
Outside the neighboring living area window nearest the equipment location	55

1-10.04 EXCEPTIONS TO SOUND LEVEL LIMITS

It is not the intent of this chapter to regulate noises in circumstances where persons, property, wildlife or plant life are not affected by the noise. The following activities or sources are exempt from the requirements of Section 1-10.03 of this chapter:

A. The emission of sound for the purpose of alerting persons to the existence of an emergency, or in the performance of emergency work.

B. The unamplified human voice.

C. Reasonable operation of equipment or conduct of activities normal to residential or agricultural communities such as lawn care, soil cultivation, maintenance of trees, hedges and gardens, refuse collections, the use of lawn mowers, saws and tractors, street sweepers, mosquito fogging, tree trimming and limb chipping, and other normal community operations.

D. Reasonable operation of unamplified church bells or chimes when used for traditional religious purposes.

E. Events directly related to Gasparilla, Fourth of July, or officially authorized spectator games.

F. The lowing of cattle, the clucking of fowl, the neighing of horses, the baying of hounds and other normal sounds of reasonably cared for domestic animals.

1.10.05 MOTOR VEHICLES

A. MOTOR VEHICLES OPERATING ON PUBLIC RIGHT OF WAY - Motor vehicles on a public right of way are regulated as set forth in the Florida Motor Vehicle Noise Prevention and Control Act of 1974, Chapter 74-110, Laws of Florida.

B. RECREATIONAL MOTORIZED VEHICLES OPERATING OFF PUBLIC RIGHTS OF WAY - No person shall operate or cause to be operated any recreational motorized vehicle off a public right of way in such a manner that the sound level emitted therefrom violates the provisions of Section 1-10.03(A). This section shall apply to all recreational motorized vehicles, whether or not duly licensed and registered, including, but not limited to motorcycles, go-carts, amphibious craft, campers and dune buggies. All such vehicles shall use noise attenuating devices (exhaust mufflers).

C. MOTOR VEHICLES OPERATED AT FACILITIES FOR COMPETITIVE EVENTS -

1. All motor vehicles operated at facilities for competitive events are exempted from complying with Section 1-10.03(A).
2. Noise level shall not exceed 78 dBA when measured at or within the property line of residential properties.
3. Facilities for competitive events which might reasonable be expected to be a source of noise which exceeds the limits specified in Section 1-10.03(A) shall not operate between the hours of 11:30 P.M. and 12:00 noon.
4. Vehicles shall use noise attenuating devices (exhaust mufflers).

D. APPROVAL REQUIRED - No person shall construct, alter, expand or operate any installation or facility for competitive events, the use or operation of which might reasonably be expected to be a source of noise which exceeds the limits specified in Section 1-10.03(A), without first providing documentation and assurance of compliance with Section 1-10.05(C), and without first receiving written approval from the Environmental Director as provided for under Sections 10 and 11 of the Hillsborough County Environmental Protection Act.

The documentation and assurance above shall include but not be limited to, use of sound barriers, use of muffler devices, control of direction and volume of loud speakers and provisions for monitoring.

SMF/ljh

(SARA/RN)

WATER REGULATIONS

iewing accidental discharge procedures and

mit applications;
ing appeals;
ısistent removal (by the County) of pollutants
Federal Pretreatment Standards;
ıs the County may deem necessary to carry out the
ɛd herein.
elate solely to the matters covered by this ordinance
n all other fees chargeable by the County.

SECTION 13

DISCHARGE STANDARDS

ge Prohibition. No user shall contribute or cause to
ɔtly or indirectly, any pollutants or wastewater which
the operation or performance of the POTW. These
apply to all such users of a POTW whether or not the
ational Categorical Pretreatment Standards or any other
County Pretreatment Standards or Requirements. A user
he following substances to any POTW:
, solids or gases which by reason of nature or quantity
icent either alone or by interaction with other
fire or explosion or be injurious in any other way to
peration of the POTW. At no time, shall two successive
sion hazard meter, at the point of discharge into the
int in the system) be more than five percent (5%) nor
ver ten percent (10%) of the Lower Explosive Limit
Prohibited materials include, but are not limited to,
naphtha, benzene, toluene, sylene, ethers, alcohols,
peroxides, chlorates, perchlorates, bromates, carbides,
s and any other substances which the County, the State
the user is a fire hazard or a hazard to the system.

b. Solid or viscous substances which may cause obstruction to the flow in a sewer or other interference with the operation of the wastewater treatment facilities such as, but not limited to: grease, garbage with particles greater than one-half inch (1/2") in any dimension, animal guts or tissues, paunch manure, bones, hair, hides or fleshing, entrails, whole blood, feathers, ashes, cinders, sand, spent lime, stone or marble dust, metal, glass, straw, shavings, grass clippings, rags, spent grains, spent hops, wastepaper, wood, plastics, gas, tar, asphalt residues, residues from refining or processing of fuel or lubricating oil, mud, or glass grinding or polishing wastes.

c. Any wastewater having a pH less than 5.0, unless the POTW is specifically designed to accommodate such wastewater, or wastewater having any other corrosive property capable of causing damage or hazard to structures, equipment, and/or personnel of the POTW.

d. Any wastewater containing toxic pollutants in sufficient quantity, either single or by interaction with other pollutants, to injure or interfere with any wastewater treatment process, constitute a hazard to humans or animals, create a toxic effect in the receiving waters of the POTW, or to exceed the limitation set forth in a Categorical Pretreatment Standard. A toxic pollutant shall include but not be limited to any pollutant identified pursuant to Section 307(a) of the Act.

e. Any noxius or malodorous liquids, gases, or solids which either single or by interaction with other wastes are sufficient to create a public nuisance or hazard to life or are sufficient to prevent entry into the sewers for maintenance and repair.

f. Any substance which may cause the POTW's effluent or any other product of the POTW such as residues, sludges, or scums, to be unsuitable for reclamation and resue or to interfere with the reclamation process. In no case, shall a substance discharged to the POTW cause the POTW to be in non-compliance with sludge use or disposal criteria, guidelines, or regulations developed under Section 405 of the Act; any criteria, guidelines, or regulations affecting sludge use or disposal developed pursuant to the Solid Waste Disposal Act, the Clean Air Act, the Toxic Substances Control Act, or State criteria applicable to the sludge management method being used.

g. Any substance which will cause the POTW to violate its NPDES and/or State Disposal System Permit or the receving water quality standards.

h. Any wastewater with objectionable color not removed in the treatment process, such as, but not limited to, dye wastes and vegetable tanning solutions.

i. Any wastewater having a temperature which will inhibit biological activity in the POTW treatment plant resulting in interference, but in no case wastewater with a temperature at the introduction into the POTW which exceeds 40°C (104°F) unless the POTW treatment plant is designed to accommodate such temperature.

j. Any pollutants, including oxygen demanding pollutants (BOD, etc.) released at a flow rate and/or pollutant concentration which a user knows or has reason to know will cause interference with to the POTW. In no case shall a slug load have a flow rate or contain concentration or qualities of pollutants that exceed for any time period longer than fifteen (15) minutes more than five (5) times the average twenty-four (24) hour concentration, quantities, or flow during normal operation.

k. Any wastewater containing any radioactive wastes or isotopes of such halflife or concentration as may exceed limits established by the Director in compliance with the applicable State of Federal regulations.

l. Any wastewater which causes a hazard to human life or creates a public nuisance.

When the Director determines that a user(s) is contributing to the POTW, any of the above enumerated substances in such amounts as to interfere with the operation of the POTW, the Director shall: 1) advise the user(s); and 2) develop effluent limitation(s) for such user to correct the interference with the POTW.

13.2 Federal Categorical Pretreatment Standards. Upon the promulgation of the Federal Categorical Pretreatment Standards for a particular industrial subcategory, the Federal Standards, if more stringent than limitations imposed under this ordinance for sources in that subcategory, shall immediately supersede the limitations imposed under this ordinance. The Director shall notify all affected users of the applicable reporting requirments under 40 CFR, SEction 403.12.

13.3 Modification of Federal Categorical Pretreatment Standards. Where the County's wastewater treatment system achieves consistent removal of pollutants limited by Federal Pretreatment Standards, the County may apply to the Approval Authority for modification of specific limits in the Federal Pretreatment Standards. "Consistent Removal" shall mean reduction in the amount of a pollutant or alteration of the nature of the pollutant by the wastewater treatment system to a less toxic or harmless state in the effluent which is achieved by the system 95 percent of the samples taken when measured according to the procedures set forth in Section 403.7(c)(2) of (Title 40 of the Code of Federal Regulations, Part 403) - "General Pretreatment Regulations for Existing and New Sources of Pollution" promulgated pursuant to the Act. The County may then modify pollutant discharge limits in the Federal Pretreatment Standards if the requirements contained in 40 CFR, Part 403, Section 403.7, are fulfilled and prior approval from the Approval Authority is obtained.

13.4 Specific Pollutant Limitations. No person shall discharge wastewater containing concentrations or values in excess of:

MATERIAL OR CHARACTERISTIC	MATERIAL ALLOWABLE CONCENTRATION/VALUE		TAMPA
Arsenic as As	0.05	ppm	0.05
Barium as Ba	5.0	ppm	5.0
Boron as B	1.0	ppm	1.0
Cadmium as Cd	0.02	ppm	0.5
Chromium as CR+6	1.0	ppm	
Chromium (total)	3.0	ppm	2.5
Copper as Cu	2.0	ppm	1.8
Lead as Pb	0.3	ppm	0.3
Manganese as Mn	1.0	ppm	1.0
Mercury as Hg	0.005	ppm	0.005
Nickel as Ni	1.0	ppm	1.8
Selenium as Se	0.02	ppm	0.02
Silver as Ag	0.01	ppm	0.5
Zinc as Zn	3.0	ppm	1.8
pH	5.5-8.5		5.5-10.0
Temperature	104°F		

The total combinations of the above cannot exceed 10 mg/1.

All of the following shall be excluded from the treatment works unless certain conditions of pretreatment concentrations and volumes have been especially described and approved by the County:

- Antimony
- Berylium
- Bismuth
- Cobalt
- Molybdenum
- Tin
- Uranyl ion
- Rhenium
- Strontium
- Tellurium

Cyanides or cyanogen compounds capable of liberating hydrocyanic gas on acidification in excess of one mg/1 by weight as CN are prohibited.

13.5 State Requirements. State requirements and limitations on discharges shall apply in any case where they are more stringent than Federal requirements and limitations or those in this ordinance.

13.6 County's Right of Revision. The County reserves the right to establish by ordinance more stringent limitations or requirements on discharges to the wastewater disposal system if deemed necessary to comply with the purposes of this ordinance.

13.7 Excessive Discharge. No user shall ever increase the use of process water or, in any way, attempt to dilute a discharge as a partial or complete substitute for adequate treatment to achieve compliance with the limitations contained in the Federal Categorical Pretreatment Standards, or in any other pollutant-specific limitation developed by the County or State. (Comment: Dilution may be an acceptable means of complying with some of the prohibitions set forth herein, e.g. the pH prohibition.)

13.8 Accidental Discharges.

a. Each user shall provide protection from accidental discharge of prohibited materials or other substances regulated by this ordinance. Facilities to prevent accidental discharge of prohibited materials shall be provided and maintained at the owner or user's own cost and expense. The County may at its discretion require a user to submit detailed plans showing facilities and operating procedures to provide this protection. Such plans shall be submitted to the County for review, and shall be approved by the County. No user who commences contribution to the POTW after the effective date of this ordinance shall be permitted to introduce pollutants into the system until accidental discharge procdures have been approved by the County. Review and approval of such plans and operating procedures shall not relieve the Industrial User from the responsibility to modify the user's facility as necessary to meet the requirements of this ordinance. In the case of an accidental discharge, it is the responsibility of the user to immediately telephone and notify the POTW of the incident. The notification shall include location of discharge, type of waste, concentration and volume, and corrective actions.

b. Within five (5) days following an accidental discharge, the user shall submit to the Director a detailed written report describing the cause of the discharge and the measures to be taken by the user to prevent similar future occurrences. Such notification shall not relieve the user of any expense, loss, damage, or other liability which may be incurred as a result of damage to the POTW, fish kills, or any other damage to person or property; nor shall such notification relieve the user of any fines, civil penalties, or other liability which may be imposed by this ordinance or other applicable law.

c. Notice to Employees: A notice shall be permanently posted on the user's bulletin board or other prominent place advising mployees whom to call in the event of a dangerous discharge. Employers shall insure that all employees who may cause or suffer such a dangerous discharge to occur are advised of the emergency notification procedure.

13.9 Discharge of surface water runoff. There shall be no discharge of surface water runoff into the sanitary sewer system. Uncontaminated cooling water may be discharged into the storm drain system when in accordance with appropriate regulations and only after review and approval by the County.

13.10 Legal Action. If any person discharges sewage, industrial wastes or other wastes into the County's wastewater disposal system contrary to the provisions of this ordinance, then the County may commence an action for appropriate legal and/or equitable relief in the court of competent jurisdiction.

SECTION 14

REPEAL OF PRIOR ORDINANCE

14.1 Repeal of Hillsborough County Ordinance 84-6, as amended.

Hillsborough County Ordinance 84-6 relating to connection to water and wastewater facilities of Hillsborough County, is (together with all amendments) hereby repealed in its entirety.

SECTION 15

EFFECTIVE DATE

15.1 Effective Date.

This Ordinance shall become effective upon receipt of filing with the Department of State of Florida.

STATE OF FLORIDA)
)
COUNTY OF HILLSBOROUGH)

I, JAMES F. TAYLOR, JR., Clerk of the Circuit Court and Ex Officio Clerk of the Board of County Commissioners of Hillsborough County, Florida, do hereby certify that the above and foregoing is a true and correct copy of an ordinance adopted by the Board of County Commissioners of Hillsborough County, Florida, at its regular meeting of September 10, 1985, as the same appears of record in Minute Book 112 of the Public Records of Hillsborough County, Florida.

WITNESS my hand and official seal this 16th day of Sept., 1985

JAMES F. TAYLOR, JR., CLERK

By: Deputy Clerk

APPROVED BY COUNTY ATTORNEY
BY
Approved As To Form And
Legal Sufficiency.

TABLE I

DEPARTMENT OF WATER AND WASTEWATER UTILITIES
HILLSBOROUGH COUNTY, FLORIDA
FLOW ESTIMATES AND CAPACITY FEES
EFFECTIVE 7/01/85

WATER

RESIDENTIAL AND GENERAL CUSTOMER CLASS

PEAK FLOW (1) (In gallons per minute)	SERVICE AREA NORTHWEST	SOUTH-CENTRAL
1-20	$1,110.00	$ 720.00
21-50	2,775.00	1,300.00
51-75	4,162.50	2,700.00
76-100	5,550.00	3,500.00
101-125	6,937.50	4,500.00
125-150	8,325.00	5,400.00
151-200	11,100.00	7,200.00
201-300	15,550.00	10,800.00
301-500	27,750.00	18,000.00
501-750	41,625.00	27,000.00
751-1000	55,500.00	36,000.00
1001-1500	83,250.00	54,000.00
1501-3000	166,500.00	108,000.00

Definitions:

Residential Customer Class All individually metered residential dwelling units.

General Customer Class Any connection which is not in the residential classification.

(1) Peak flow is determined on the gallons per minute required for each water connection utilizing the American Water Works Association manual: Sizing Water Service Lines and Meters, AWWA Manual M 22.

WASTEWATER

RESIDENTIAL CUSTOMER CLASS (1)	SERVICE AREA NORTHWEST	CENTRAL	SOUTH
Individually metered residential dwelling unit	$1,450.00	$980.00	$850.00

TABLE I. (cont'd.)
DEPARTMENT OF WATER AND WASTEWATER UTILITIES
HILLSBOROUGH COUNTY, FLORIDA
FLOW ESTIMATES AND CAPACITY FEES
EFFECTIVE 7/01/85

GENERAL CUSTOMER CLASS (1)	SERVICE AREA		
	NORTHWEST	CENTRAL	SOUTH
Mastered metered residential per dwelling unit, factored at .60	$ 870.00	$588.00	$510.00
Commercial, per 225 gallons per day (2)	1,450.00	980.00	850.00

(1) Wastewater capacity fees for residential and general customer classes serviced by a low pressure sewer system will be reduced by a factor of 25%. This reduced fee is to account for a corresponding reduction in total daily wastewater flow contributed to the wastewater system.

(2) The minimum capacity fees are determined by reference to the Rules of the Department of Health and Rehabilitative Services, Chapter 100-6, Standards for Onsite Sewage Disposal System, Table II. Thes capacity fees are applied to each Commercial connection as a minimum charge. If the stated annual average daily flow is exceeded in any consecutive twelve (12) month period as monitored by the Utilities billing system, an additional charge ($6.44/gallon for Northwest, $4.36/gallon for Central, and $3.78/gallon for South) will be applied for the flow in excess of the flow with was the basis for the original capacity fee paid.

TYPE OF ESTABLISHMENT	GALLONS PER DAY	EQUIVALENT FACTORS*
COMMERCIAL:		
Airports		
(a) per passenger	5	0.02
(b) add per employee (per 8 hour shift)	20	0.09
Barber & beauty shops (per chair)	100	0.44
Bowling alleys (toilet wastes only per lane)	100	0.44
Country Club		
(a) per resident	100	0.44
(b) per member	25	0.11
(c) per employee (per 8 hour shift)	20	0.09
Dentist offices		
(a) Per wet chair	200	0.89
(b) per non-wet chair	50	0.22
Doctors offices (per doctor)	250	1.11
Factories, exclusive of industrial wastes (gallons per employee per 8 hour shift)		
(a) No showers provided	20	0.09
(b) Showers provided	35	0.16
Food Service operations		
(a) Ordinary restaurant (per seat)	50	0.22
(b) 24 hour restaurant (per seat)	75	0.33
(c) Single service articles only (per seat)	25	0.11
(d) Bar and cocktail lounge (per seat)	30	0.13
(e) Drive-in restaurant (per car space)	50	0.22
(f) Carry out only		
(1) per 100 square feet of floor space	50	0.22
(2) add per employee (per 8 hour shift)	20	0.09
(g) Institutions (per meal)	5	0.02

*1.0 Equivalent Factor Equals 225 Gallons Per Day

Best Available Copy

TABLE I. (cont'd.)

DEPARTMENT OF WATER AND WASTEWATER UTILITIES
HILLSBOROUGH COUNTY, FLORIDA
FLOW ESTIMATES AND CAPACITY FEES
EFFECTIVE 7/01/85

ESTIMATED DOMESTIC WASTEWATER FLOWS, (cont'd.)

Hotels & Motels		
(a) Regular (per room)	150	0.67
(b) Resort motels, camps, cottages (per person)	75	0.33
(c) Add for establishments with self service laundry facilities (per machine)	400	1.78
Office building (per employee per 8 hour shift)	20	0.09
Service stations (per water closet and per urinal)	250	1.11
Shopping centers without food or laundry (per 1,000 square feet of floor space)	100	0.44
Stadiums, race tracks, ball parks (per seat)	5	0.02
Stores (per 1,000 square feet of floor space)	100	0.44
Swimming and bathing facilities, public (per person)	10	0.04
Theatres		
(a) Indoor, auditoriums (per seat)	5	0.02
(b) Outdoor, drive-ins (per space)	10	0.04
Trailer or Mobile Home Park (per trailer space)	200	0.89
Travel trailer or recreational vehicle park		
(a) Travel trailer (overnight), without water and sewer hookup (per trailer space)	75	0.33
(b) Travel trailer (overnight), with water and sewer hookups (per trailer space)	100	0.44
INSTITUTIONAL:		
Churches (per seat)	3	0.01
Hospitals (per bed) (does not include kitchen wastewater flows)	200	0.89
Nursing, rest homes (per bed) (does not include kitchen wastewater flows)	100	0.44
Parks, public picnic		
(a) with toilets only (per person)	5	0.02
(b) with bathhouses, showers & toilets (per person)	10	0.04
Public institutions other than schools and hospitals (per person) (does not include kitchen wastewater flows)	100	0.44
Schools (per student)		
(a) Day-type	15	0.07
(b) Add for showers	5	0.02
(c) Add for cafeteria	5	0.02
(d) Add for day school workers	15	0.07
(e) Boarding-type	75	0.33

Work or construction camps, semi-permanent