Background Report Reference

AP-42 Section Number: 10.6.1

Background Report Section: 4

Reference Number: 31

Title: Results of the November 8 & 9, 1994 Relative Accuracy Certifications At The Louisiana Pacific Plant Located in Hayward, Wisconsin

Interpoll Laboratories, Inc.

November 1994

RESULTS OF THE NOVEMBER 8 & 9, 1994
RELATIVE ACCURACY CERTIFICATIONS
AT THE LOUISIANA PACIFIC PLANT
LOCATED IN HAYWARD, WISCONSIN

interpoll

Louisiana-Pacific Corporation

Route 8, Box 8263
Hayward, Wisconsin 54843
715/634-3332
FAX: 715/634-5117

November 23, 1994

Mr. Michael F. Wood, Director
Mr. Laxmi Kesari
Multi Media Enforcement & Strategic
Planning Division U.S. EPA
Aerials Rios Boulevard
1200 Pennsylvania N.W., 7th Floor
Room 7120A
Washington D.C. 20004

RE: Clean Air Enforcement Action - United States v. Louisiana Pacific Corporation
No. CV 93-0869 (W.D. La.)

Subject: Continuous Monitoring Equipment Certification: L-P Hayward OSB CO, Flow and Opacity Drift Test Results.

Gentlemen:

Enclosed please find the re-certification test results (Interpoll Labs. Inc. Report # 4-4294 dated November 21, 1994) for the Line #1 Dryer RTO carbon monoxide (CO) and Line #2 Press RTO Flow monitoring systems installed at Louisiana Pacific's OSB plant in Hayward, WI. These are submitted in conjunction with the September 30, 1994 *(request for an extension)* letter from Elizabeth Smith, Director of Environmental Affairs - Louisiana Pacific Corporation, Portland, Oregon. Attach these test results to you copy of the Interpoll Laboratories, Inc. Report No. 4-3688R dated September 27, 1994. Also enclosed are the Opacity Zero & Calibration Drift calculations of relative accuracy for the four (4) USI Opacity Monitors (one for each of the RTO stacks).

If you have any questions or need additional information please contact me.

Sincerely,

Robert W. Schultz
Environmental Engineer
Hayward, WI - Engineering Office

cc w/encls: Tom Parker - Graseby STI
Jim Lake - Hayward OSB Plant Manager
Liz Smith - Director of Environmental Affairs
Jim Ross - WI DNR
File: HA 613.0 CEMS

cc w/out encls: Julie Domike U.S. EPA
U.S. EPA, Region 5 Chicago, Il
Jim Evensen - Hayden Lake
Keith Seelig - Hayward Environmental
Bert Krages - Portland
Norm Radford Jr. - Vinson & Elkins, Dallas, TX
Brad Pyle - WI DNR Park Falls, WI
A.E. Cavadeas - Hayward Engineering
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RESULTS OF THE NOVEMBER 8 & 9, 1994 RELATIVE ACCURACY CERTIFICATIONS AT THE LOUISIANA PACIFIC PLANT LOCATED IN HAYWARD, WISCONSIN

Submitted to:

GRASEBY STI
45 Fir Street
Waldron, AR 72958

Attention:

Tom Parker

Reviewed by:

Daniel J. Despen
Manager
Stationary Source Testing Department

Report Number 4-4294
November 21, 1994
SP/slp

TABLE OF CONTENTS

APPENDICES:

ABBREVIATIONS

ACFM	actual cubic feet per minute
cc (ml)	cubic centimeter (milliliter)
DSCFM	dry standard cubic foot of dry gas per minute
DSML	dry standard milliliter
DEG-F (°F)	degrees Fahrenheit
DIA.	diameter
FP	finished product for plant
FT/SEC	feet per second
g	gram
GPM	gallons per minute
GR/ACF	grains per actual cubic foot
GR/DSCF	grains per dry standard cubic foot
g/dscm	grams per dry standard cubic meter
HP	horsepower
HRS	hours
IN.	inches
IN.HG.	inches of mercury
IN.WC.	inches of water
LB	pound
LB/DSCF	pounds per dry standard cubic foot
LB/HR	pounds per hour
$LB/10^6BTU$	pounds per million British Thermal Units heat input
LB/MMBTU	pounds per million British Thermal Units heat input
LTPD	long tons per day
MW	megawatt
mg/Nm^3	milligrams per dry standard cubic meter
ug/Nm^3	micrograms per dry standard cubic meter
microns (um)	micrometer
MIN.	minutes
ng	nanograms
ohm-cm	ohm-centimeter
PM	particulate matter
PPH	pounds per hour
PPM	parts per million
ppmC	parts per million carbon
ppm,d	parts per million, dry
ppm,w	parts per million, wet
ppt	parts per trillion
PSI	pounds per square inch
SQ.FT.	square feet
TPD	tons per day
ug	micrograms
v/v	percent by volume
w/w	percent by weight
$<$	$\leq$ (when following a number)

Standard conditions are defined as 68°F (20°C) and 29.92 IN. of mercury pressure.

g:\stack\wp\misc\abbrev.frm

1 INTRODUCTION

On November 8 & 9, 1994, Interpoll Laboratories personnel conducted Relative Accuracy Certification Tests of the CO CEM installed on the Line 1 Dryer RTO Stack, and the Flow Monitor installed on the Line 2 Press RTO Stack at the Louisiana Pacific Corporation Plant in Hayward, Wisconsin. The certifications were performed on the following:

Monitor Type	Manufacturer	Model	Serial No.	Location
CO	TECO	48	48-47743-279	Line 1 Dryer
Flow	United Sciences	100	9401658	Line 2 Press

On-site testing was performed by Ed Trowbridge and Ken Nuessmeier. Coordination between testing activities and plant operation was provided by Bob Schultz of Louisiana Pacific. The test was witnessed by Jim Ross of the Wisconsin Department of Natural Resources.

The Relative Accuracy Certifications were performed in accordance with Specification 4, CFR Title 40, Part 60 Appendix B (revised July 1, 1993). Evaluations were performed in accordance with EPA Method 10 (Ibid: Appendix A). A slip stream of exhaust gas was drawn from the exhaust gas stream using test ports provided by the plant using a heat-traced probe and filter assembly. After passing through the filter, the gas passed through a chilled condenser to remove moisture. The particulate-free dry gas was then split, half the sample was collected directly in 44-Liter Tedlar bags. The other half of the sample gas stream was passed through an alkaline potassium permanganate scrubber to remove interferences and then collected in 44-Liter Tedlar bags. Each set of bags was then analyzed: the scrubbed sample for CO, the unscrubbed sample for O_2 and CO_2. The CO_2 level was also measured in the scrubbed sample to correct for residual CO_2. The O_2, CO_2 and CO analyzers were calibrated on-site using EPA Protocol standard gases. A three-way valve on the probe was used to introduce standard gas for the "system bias check". The analog response of the CO analyzer was recorded using a strip chart recorder. Moisture determinations were performed in accordance with EPA Method 4. Volumetric Flow Rate Determinations were performed in accordance with EPA Method 2.

Twelve 21-minute test runs for CO were performed on the Line 1 Dryer RTO Stack using a 30-minute cycle. During each run, the sample probe was moved through a three-point traverse (1/6, 3/6, 5/6 of the stack dia).

The important results of the tests are summarized in Tables 1 & 2. Field data and all other supporting information are presented in the appendices.

2 SUMMARY AND DISCUSSION

The important results of the Relative Accuracy Certifications are summarized in Tables 1 & 2 . No difficulties were encountered in the field or in the data reduction. On the basis of this fact and a complete review of all of the data, it is our opinion that the concentrations reported herein are accurate and closely reflect the actual values which existed at the time the test was performed.

Table 1. Summary of the Results of the November 8, 1994 Relative Accuracy Certification of the **CO** CEM installed on the Line 1 Drver RTO Stack at the Louisiana Pacific Plant in Hayward, Wisconsin.

Run	Time (HRS)	CO(ppm,d) RM	CEM	DIFF
1	0945-1015	326	306	-20
2	1030-1100	366	360	-6
3	1115-1145	327	320	-7
4	1200-1230	356	353	-3
5*	1245-1315	374	401	27
6	1330-1400	394	389	-5
7*	1415-1445	329	308	-21
8	1500-1530	376	372	-4
9	1545-1615	394	389	-5
10*	1630-1700	411	358	-53
11	1715-1745	363	353	-10
12	1800-1830	291	283	-8
Average				10
Confidence Coefficient				11.5
Standard Deviation				5.13
Relative Accuracy				5.9

* Note: Runs 5, 7, and 10 not used in the calculation of relative accuracy.

Table 2. Summary of the Results of the November 9, 1994 Relative Accuracy Certification of the **Flow Monitor** installed on the Line 2 Press Stack at the Louisiana Pacific Plant in Hayward, Wisconsin.

Run	Time (HRS)	Flow (KCFM) RM	CEM	DIFF
1	1000-1030	110	100	-10
2	1045-1115	110	100	-10
3	1200-1230	110	101	-9
4	1245-1315	112	101	-11
5*	1330-1400	111	100	-11
6*	1415-1445	112	101	-11
7*	1500-1530	113	100	-13
8	1545-1615	110	101	-9
9	1630-1700	110	102	-8
10	1715-1745	109	101	-8
11	1800-1830	111	101	-10
12	1845-1915	110	101	-9
Average				10
Confidence Coefficient				0.92
Standard Deviation				1
Relative Accuracy				9.8

* Note: Runs 5, 6, and 7 not used in the calculation of relative accuracy.

2.1 Results of Volumetric Flow Rate Determinations

Test No. 2
Line 2 Press RTO Stack

Results of Volumetric Flow Rate Determination------Method 2

Date of Determination............	11-09-94
Time of Determination.......(HRS)	1000
Barometric pressure.......(IN.HG)	29.02
Pitot tube coefficient..........	.84
Number of sampling ports.........	2
Total number of points..........	16
Shape of duct....................	Round
Stack diameter...............(IN)	76
Duct area.................(SQ.FT)	31.50
Direction of flow...............	UP
Static pressure...........(IN.WC)	-.3
Avg. gas temp.............(DEG-F)	235
Moisture content..........(% V/V)	7.19
Avg. linear velocity.....(FT/SEC)	58.3
Gas density..............(LB/ACF)	.05369
Molecular weight......(LB/LBMOLE)	28.84
Mass flow of gas..........(LB/HR)	355243
Volumetric flow rate.............	
actual...................(ACFM)	110269
dry standard............(DSCFM)	75404

Test No. 2
Line 2 Press RTO Stack

Results of Volumetric Flow Rate Determination-------Method 2

Date of Determination............	11-09-94
Time of Determination.......(HRS)	1045
Barometric pressure.......(IN.HG)	29.02
Pitot tube coefficient..........	.84
Number of sampling ports.........	2
Total number of points...........	16
Shape of duct....................	Round
Stack diameter..............(IN)	76
Duct area................(SQ.FT)	31.50
Direction of flow...............	UP
Static pressure...........(IN.WC)	-.48
Avg. gas temp.............(DEG-F)	240
Moisture content..........(% V/V)	8.24
Avg. linear velocity.....(FT/SEC)	58.2
Gas density..............(LB/ACF)	.05303
Molecular weight......(LB/LBMOLE)	28.84
Mass flow of gas..........(LB/HR)	350177
Volumetric flow rate.............	
actual...................(ACFM)	110052
dry standard............(DSCFM)	73790

Test No. 2
Line 2 Press RTO Stack

Results of Volumetric Flow Rate Determination-------Method 2

Date of Determination............	11-09-94
Time of Determination.......(HRS)	1200
Barometric pressure.......(IN.HG)	29.02
Pitot tube coefficient..........	.84
Number of sampling ports.........	2
Total number of points..........	16
Shape of duct....................	Round
Stack diameter..............(IN)	76
Duct area.................(SQ.FT)	31.50
Direction of flow...............	UP
Static pressure...........(IN.WC)	-.5
Avg. gas temp.............(DEG-F)	243
Moisture content..........(% V/V)	8.55
Avg. linear velocity.....(FT/SEC)	58.1
Gas density..............(LB/ACF)	.05274
Molecular weight......(LB/LBMOLE)	28.84
Mass flow of gas..........(LB/HR)	347351
Volumetric flow rate.............	
actual...................(ACFM)	109771
dry standard............(DSCFM)	73032

Test No. 2
Line 2 Press RTO Stack

Results of Volumetric Flow Rate Determination-------Method 2

Date of Determination............	11-09-94
Time of Determination.......(HRS)	1245
Barometric pressure.......(IN.HG)	29.02
Pitot tube coefficient...........	.84
Number of sampling ports.........	2
Total number of points...........	16
Shape of duct....................	Round
Stack diameter...............(IN)	76
Duct area.................(SQ.FT)	31.50
Direction of flow................	UP
Static pressure...........(IN.WC)	-.55
Avg. gas temp.............(DEG-F)	240
Moisture content..........(% V/V)	6.81
Avg. linear velocity.....(FT/SEC)	59.2
Gas density..............(LB/ACF)	.05332
Molecular weight......(LB/LBMOLE)	28.84
Mass flow of gas..........(LB/HR)	357994
Volumetric flow rate.............	
actual....................(ACFM)	111908
dry standard............(DSCFM)	76190

Test No. 2
Line 2 Press RTO Stack

Results of Volumetric Flow Rate Determination-------Method 2

Date of Determination............	11-09-94
Time of Determination.......(HRS)	1330
Barometric pressure.......(IN.HG)	29.02
Pitot tube coefficient..........	.84
Number of sampling ports.........	2
Total number of points...........	16
Shape of duct....................	Round
Stack diameter..............(IN)	76
Duct area.................(SQ.FT)	31.50
Direction of flow................	UP
Static pressure...........(IN.WC)	-.46
Avg. gas temp.............(DEG-F)	241
Moisture content..........(% V/V)	6.42
Avg. linear velocity.....(FT/SEC)	58.5
Gas density..............(LB/ACF)	.05333
Molecular weight......(LB/LBMOLE)	28.84
Mass flow of gas..........(LB/HR)	353737
Volumetric flow rate.............	
actual...................(ACFM)	110545
dry standard............(DSCFM)	75484

Test No. 2
Line 2 Press RTO Stack

Results of Volumetric Flow Rate Determination-------Method 2

Date of Determination............	11-09-94
Time of Determination.......(HRS)	1415
Barometric pressure.......(IN.HG)	29.02
Pitot tube coefficient..........	.84
Number of sampling ports.........	2
Total number of points..........	16
Shape of duct...................	Round
Stack diameter..............(IN)	76
Duct area................(SQ.FT)	31.50
Direction of flow...............	UP
Static pressure...........(IN.WC)	-.47
Avg. gas temp............(DEG-F)	241
Moisture content..........(% V/V)	8.24
Avg. linear velocity.....(FT/SEC)	59.0
Gas density.............(LB/ACF)	.05296
Molecular weight......(LB/LBMOLE)	28.84
Mass flow of gas..........(LB/HR)	354633
Volumetric flow rate............	
actual..................(ACFM)	111608
dry standard...........(DSCFM)	74729

Test No. 2
Line 2 Press RTO Stack

Results of Volumetric Flow Rate Determination-------Method 2

Date of Determination............	11-09-94
Time of Determination.......(HRS)	1500
Barometric pressure.......(IN.HG)	29.02
Pitot tube coefficient..........	.84
Number of sampling ports.........	2
Total number of points...........	16
Shape of duct....................	Round
Stack diameter..............(IN)	76
Duct area................(SQ.FT)	31.50
Direction of flow...............	UP
Static pressure...........(IN.WC)	-.42
Avg. gas temp............(DEG-F)	241
Moisture content..........(% V/V)	7.49
Avg. linear velocity.....(FT/SEC)	59.5
Gas density.............(LB/ACF)	.05312
Molecular weight......(LB/LBMOLE)	28.84
Mass flow of gas..........(LB/HR)	358643
Volumetric flow rate.............	
actual...................(ACFM)	112528
dry standard............(DSCFM)	75971

Test No. 2
Line 2 Press RTO Stack

Results of Volumetric Flow Rate Determination-------Method 2

Date of Determination............	11-09-94
Time of Determination.......(HRS)	1545
Barometric pressure.......(IN.HG)	29.02
Pitot tube coefficient...........	.84
Number of sampling ports.........	2
Total number of points...........	16
Shape of duct....................	Round
Stack diameter...............(IN)	76
Duct area.................(SQ.FT)	31.50
Direction of flow................	UP
Static pressure...........(IN.WC)	-.43
Avg. gas temp.............(DEG-F)	238
Moisture content..........(% V/V)	7.23
Avg. linear velocity.....(FT/SEC)	58.2
Gas density..............(LB/ACF)	.05340
Molecular weight......(LB/LBMOLE)	28.84
Mass flow of gas..........(LB/HR)	352279
Volumetric flow rate.............	
actual...................(ACFM)	109953
dry standard............(DSCFM)	74754

Test No. 2
Line 2 Press RTO Stack

Results of Volumetric Flow Rate Determination-------Method 2

Date of Determination............	11-09-94
Time of Determination.......(HRS)	1630
Barometric pressure.......(IN.HG)	29.02
Pitot tube coefficient...........	.84
Number of sampling ports.........	2
Total number of points...........	16
Shape of duct....................	Round
Stack diameter...............(IN)	76
Duct area................(SQ.FT)	31.50
Direction of flow................	UP
Static pressure...........(IN.WC)	-.41
Avg. gas temp............(DEG-F)	237
Moisture content..........(% V/V)	6.57
Avg. linear velocity.....(FT/SEC)	58.4
Gas density.............(LB/ACF)	.05362
Molecular weight......(LB/LBMOLE)	28.84
Mass flow of gas..........(LB/HR)	355051
Volumetric flow rate.............	
actual...................(ACFM)	110369
dry standard............(DSCFM)	75689

Test No. 2
Line 2 Press RTO Stack

Results of Volumetric Flow Rate Determination-------Method 2

Date of Determination............	11-09-94
Time of Determination.......(HRS)	1715
Barometric pressure.......(IN.HG)	29.02
Pitot tube coefficient..........	.84
Number of sampling ports.........	2
Total number of points..........	16
Shape of duct...................	Round
Stack diameter..............(IN)	76
Duct area.................(SQ.FT)	31.50
Direction of flow................	UP
Static pressure...........(IN.WC)	-.4
Avg. gas temp............(DEG-F)	238
Moisture content..........(% V/V)	6.88
Avg. linear velocity.....(FT/SEC)	57.7
Gas density.............(LB/ACF)	.05348
Molecular weight......(LB/LBMOLE)	28.84
Mass flow of gas..........(LB/HR)	349939
Volumetric flow rate.............	
actual...................(ACFM)	109065
dry standard...........(DSCFM)	74441

Test No. 2
Line 2 Press RTO Stack

Results of Volumetric Flow Rate Determination-------Method 2

Date of Determination............	11-09-94
Time of Determination.......(HRS)	1800
Barometric pressure.......(IN.HG)	29.02
Pitot tube coefficient...........	.84
Number of sampling ports.........	2
Total number of points...........	16
Shape of duct....................	Round
Stack diameter..............(IN)	76
Duct area................(SQ.FT)	31.50
Direction of flow................	UP
Static pressure...........(IN.WC)	-.47
Avg. gas temp.............(DEG-F)	236
Moisture content..........(% V/V)	6.95
Avg. linear velocity.....(FT/SEC)	58.8
Gas density..............(LB/ACF)	.05360
Molecular weight......(LB/LBMOLE)	28.84
Mass flow of gas..........(LB/HR)	357559
Volumetric flow rate.............	
actual...................(ACFM)	111172
dry standard............(DSCFM)	76022

Test No. 2
Line 2 Press RTO Stack

Results of Volumetric Flow Rate Determination-------Method 2

Date of Determination............	11-09-94
Time of Determination.......(HRS)	1845
Barometric pressure.......(IN.HG)	29.02
Pitot tube coefficient..........	.84
Number of sampling ports.........	2
Total number of points...........	16
Shape of duct....................	Round
Stack diameter..............(IN)	76
Duct area.................(SQ.FT)	31.50
Direction of flow...............	UP
Static pressure...........(IN.WC)	-.48
Avg. gas temp.............(DEG-F)	235
Moisture content..........(% V/V)	6.99
Avg. linear velocity.....(FT/SEC)	58.4
Gas density..............(LB/ACF)	.05367
Molecular weight......(LB/LBMOLE)	28.84
Mass flow of gas..........(LB/HR)	355364
Volumetric flow rate.............	
actual...................(ACFM)	110349
dry standard............(DSCFM)	75536

APPENDIX A

SAMPLING TRAIN CALIBRATION DATA

Interpoll Laboratories, Inc.

Temperature Measurement Device
Calibration Sheet

Unit under test:

Vendor: OMEGA

Model: OMEGA

Serial Number: #38

Range: 0 – 2000 °F

Thermocouple Type: K

Date of Calibration: Oct 28th 1994

Technician: K. Nuessmeier

Method of Calibration:

☐ Comparison against ASTM mercury in glass thermometer using a thermostatted and insulated aluminum block designed to provide uniform temperature. The temperature is adjusted by adjusting the voltage on the block heater cartridge.

☐ Omega Model CL-300 Type K Thermocouple Simulator which provides 22 precise temperature equivalent millivolt signals. The CL-300 is cold junction compensated. Calibration accuracy is ± 0.1% of span (2100 °F) ± 1 degree (for negative temperatures add ± 2 degrees. The CL-300 simulates exactly the millivoltage of a Type K thermocouple at the indicated temperature.

Desired Temp (°F) Nominal	Temperature of Standard or Simulated Temp (°F)	Response of Unit Under Test (°F)	Deviation Δt (°F)	Deviation (%)
	TEMP			
0	0	4	.4	.87
100	100	97	3	.535
200	200	200	0	0
300	300	299	1	.132
400	400	399	1	.121
500	500	499	2	.208
600	600	600	0	0
700	700	699	1	~~[illegible]~~ .0086
800	800	801	+1	~~.739~~ .0079
900	900	899	1	~~[illegible]~~ .0073
1000	1000	1001	.1	.0068
1100	1100	1,099	1	.0064
1200	1,200	1,201	1	.006
1300	1,300	1,299	1	.0057
1400	1,400	1,401	1	.0053
1500	1,500	1,500	0	0
1600	1,600	1,602	2	~~970~~ .0097
1700	1,700	1,701	1	.0046
1800	1,800	1,803	3	.1327
1900	1,900	1,901	1	.0042
2000	2000	2001	1	.0041
2100	2,100	2,099	1	.034
		Averages:	1.27	.0096

OF = off scale response by unit under test (°F)

% dev = 100 Δt / (460 + t)

$$\frac{(100)(4)}{460 + 0}$$

☐ Unit in tolerance

☐ Unit was not in tolerance: recalibrated - See new calibration sheet.

S-433

Interpoll Laboratories, Inc.
(612) 786-6020

S-Type Pitot Tube Inspection Sheet

Pitot Tube No. 27-8

Pitot tube dimensions:

1. External tubing diameter (D_t) .316 IN.
2. Base to Side A opening plane (P_A) .460 IN.
3. Base to Side B opening plane (P_B) .460 IN.

Alignment:

4. α_1 < 10° 0
5. α_2 < 10° 0

6. B_1 < 5° 0
7. B_2 < 5° 0

8. Z <.125" 0
9. W <.0625" .01

Distance from Pitot to Probe Components:

10. Pitot to 0.500 IN. nozzle .750 IN.
11. Pitot to probe sheath 3.0 IN.
12. Pitot to thermocouple (parallel to probe) 3.0 IN.
13. Pitot to thermocouple (perpendicular to probe) .760 IN.

☒ Meets all EPA design criteria thus C_p = 0.84
☐ Does not meet EPA design criteria - thus calibrate in wind tunnel.
C_p = ______

Date of Inspection: 4-7-94

Inspected by: [signature]

CFR Title 40 Part 60 Appenidix A Method 2

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INTERPOLL LABORATORIES
(612)786-6020

Stack Sampling Department - QA
Aneroid Barometer Calibration Sheet

Date 10-28-94

Technician E Trowbridge

Mercury Column Barometer No. ULTIMETER MODEL 12

Aneroid Barometer No. SN-01002005

Actual Mercury Barometer Read	Ambient Temp.	Temperature Correction Factor	Adjsted Mercury Barometer Read	Initial Aneriod Barometer Read	Difference ($P_{ba}-P_{bm}$)
28.75	80	.134	28.616	28.58	.036

Has this barometer shown any consistent problems with calibration? Yes/No. If yes, explain. No

Has problem been alleviated? Yes/No. How?

*Note

Aneroid barometers will be calibrated periodically against a mercury column barometer. The aneroid barometer to be calibrated should be placed in close proximity to the mercury barometer and left to equilibrate for 20-30 minutes before calibrating. Aneriod barometer will be calibrated to the adjusted mercury barometer readings.

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APPENDIX B

REFERENCE METHOD RESULTS

Report No. 4-4294

GRASEBY STI - LP HAYWARD

Hayward, Wisconsin

Source: Line 1 Dryer RTO Stack

RUN 1	O2	CO	CO2	RUN 2	O2	CO	CO2
0945-1015				1030-1100			
1	16.8	380	3.9	1	16.4	439	4.1
2	16.7	411	3.9	2	16.4	469	4.2
3	16.6	452	4.0	3	16.4	398	4.1
4	16.6	339	3.8	4	16.3	368	4.2
5	16.8	302	3.7	5	16.6	348	3.9
6	16.6	335	4.0	6	16.7	362	3.9
7	17.1	304	3.5	7	16.4	495	4.3
8	16.7	433	4.0	8	16.1	486	4.4
9	16.4	435	4.1	9	16.1	402	4.3
10	16.5	415	4.1	10	16.3	401	4.2
11	16.5	432	4.1	11	16.4	427	4.2
12	16.9	459	3.5	12	16.3	520	4.3
13	17.3	459	3.2	13	16.1	409	4.4
14	16.9	270	3.7	14	16.4	403	4.1
15	16.9	298	3.7	15	16.4	361	4.1
16	16.5	384	4.0	16	16.8	338	3.9
17	16.8	328	3.5	17	16.7	354	3.9
18	17.1	350	3.6	18	16.5	313	4.0
19	17.7	314	2.7	19	16.6	283	3.9
20	17.6	220	3.0	20	16.6	276	3.9
21	17.6	218	3.0	21	16.8	279	3.8
22	16.9	325	3.3	22	16.6	354	4.0
23	17.9	279	2.6	23	16.5	282	4.0
24	17.6	237	3.3	24	16.7	274	3.9
25	17.9	217	2.8	25	16.6	286	3.9
26	17.6	208	3.1	26	16.7	323	3.9
27	18.3	242	2.3	27	16.6	380	4.0
28	17.3	310	3.4	28	16.4	334	4.1
29	18.0	223	2.5	29	16.5	316	4.0
30	17.2	214	3.3	30	16.5	307	4.0
Average	**17.1**	**326**	**3.45**	**Average**	**16.5**	**366**	**4.06**

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Report No. 4-4294

GRASEBY STI - LP HAYWARD
Hayward, Wisconsin

Source: Line 1 Dryer RTO Stack

RUN 3	O_2	CO	CO_2		RUN 4	O_2	CO	CO_2
1115-1145					1200-1230			
1	16.5	338	3.9		1	16.4	392	3.9
2	16.3	351	4.1		2	16.4	356	4.0
3	16.3	322	4.1		3	16.5	381	4.0
4	16.3	343	4.1		4	16.5	357	3.9
5	16.5	314	4.0		5	16.6	416	4.0
6	16.4	347	4.0		6	16.5	424	4.1
7	16.4	333	4.1		7	16.4	370	4.1
8	16.3	299	4.1		8	16.5	357	4.0
9	16.4	325	4.1		9	16.7	309	3.8
10	16.5	310	4.0		10	16.7	358	3.8
11	16.5	353	4.1		11	16.5	352	3.9
12	16.2	339	4.2		12	16.6	298	3.9
13	16.3	334	4.2		13	16.7	296	3.8
14	16.4	318	4.1		14	16.7	316	3.8
15	16.5	312	4.1		15	16.7	368	3.9
16	16.4	372	4.1		16	16.5	359	4.0
17	16.2	370	4.2		17	16.6	314	3.9
18	16.4	321	4.0		18	16.5	322	3.9
19	16.4	308	3.9		19	16.7	320	3.8
20	16.6	320	3.9		20	16.7	370	3.8
21	16.4	426	4.2		21	16.5	361	3.9
22	16.2	362	4.2		22	16.5	346	4.0
23	16.4	315	4.0		23	16.5	330	3.9
24	16.4	300	4.0		24	16.8	340	3.8
25	16.6	288	3.9		25	16.5	447	4.0
26	16.7	342	3.9		26	16.3	386	4.1
27	16.4	315	4.1		27	16.5	353	4.0
28	16.5	286	3.9		28	16.5	327	3.9
29	16.5	269	3.9		29	16.7	341	3.8
30	16.7	274	3.8		30	16.6	412	3.9
Average	**16.4**	**327**	**4.04**		**Average**	**16.6**	**356**	**3.92**

Report No. 4-4294

GRASEBY STI - LP HAYWARD
Hayward, Wisconsin

Source: Line 1 Dryer RTO Stack

RUN 5	O2	CO	CO2	RUN 6	O2	CO	CO2
1245-1315				1330-1400			
1	16.4	376	3.8	1	16.4	355	3.9
2	16.5	358	3.8	2	16.5	455	3.8
3	16.6	316	3.7	3	16.5	404	3.8
4	16.6	393	3.9	4	16.4	409	4.0
5	16.4	418	3.9	5	16.2	362	4.0
6	16.4	337	3.9	6	16.4	395	4.0
7	16.5	345	3.8	7	16.4	385	3.9
8	16.6	302	3.7	8	16.5	451	3.9
9	16.6	418	4.0	9	16.4	447	4.0
10	16.4	389	3.9	10	16.4	416	4.0
11	16.5	318	3.8	11	16.5	421	4.0
12	16.5	340	3.9	12	16.7	396	3.8
13	16.7	340	3.7	13	16.5	433	3.9
14	16.6	380	3.7	14	16.5	398	3.9
15	16.5	377	3.9	15	16.4	378	3.9
16	16.7	287	3.9	16	16.4	382	3.9
17	16.6	308	3.8	17	16.6	371	3.8
18	16.6	332	3.8	18	16.8	428	3.8
19	16.5	393	3.9	19	16.4	403	4.0
20	16.3	378	4.0	20	16.3	420	4.0
21	16.3	376	4.0	21	16.3	406	4.0
22	16.4	377	4.0	22	16.5	441	3.9
23	16.6	377	3.8	23	16.4	533	4.1
24	16.5	445	3.9	24	16.2	427	4.0
25	16.4	417	4.0	25	16.3	399	3.9
26	16.3	427	4.1	26	16.7	249	3.5
27	16.2	397	4.1	27	17.3	215	3.2
28	16.4	424	4.0	28	16.9	299	3.6
29	16.4	487	4.0	29	16.6	255	3.9
30	16.3	401	4.0	30	16.3	482	4.1
Average	**16.5**	**374**	**3.89**	**Average**	**16.5**	**394**	**3.88**

Report No. 4-4294

GRASEBY STI - LP HAYWARD
Hayward, Wisconsin

Source: Line 1 Dryer RTO Stack

RUN 7	O2	CO	CO2		RUN 8	O2	CO	CO2
1415-1445					1500-1530			
1	17.2	279	3.5		1	16.7	356	3.6
2	16.8	231	3.0		2	16.6	361	3.8
3	17.3	256	3.4		3	16.5	325	3.8
4	16.8	255	3.7		4	16.5	375	3.9
5	16.7	316	3.7		5	16.5	334	3.8
6	16.6	321	3.7		6	16.6	395	3.8
7	16.5	401	3.9		7	16.4	384	3.9
8	16.4	380	3.9		8	16.4	342	3.9
9	16.5	355	3.9		9	16.5	349	3.8
10	16.7	222	3.4		10	16.6	358	3.8
11	17.5	161	3.0		11	16.5	401	3.8
12	17.2	191	3.2		12	16.4	390	4.0
13	17.1	193	3.3		13	16.2	365	4.0
14	16.8	225	3.5		14	16.3	377	4.0
15	16.6	357	3.9		15	16.6	367	3.8
16	16.6	424	3.8		16	16.6	453	3.8
17	16.5	546	3.9		17	16.5	384	3.9
18	16.3	493	3.9		18	16.5	411	3.9
19	16.5	419	3.8		19	16.4	404	3.9
20	16.5	329	3.7		20	16.5	449	3.9
21	17.5	156	2.9		21	16.4	526	3.9
22	17.5	171	3.0		22	16.2	483	4.1
23	16.9	166	3.3		23	16.3	433	4.0
24	17.1	194	3.2		24	16.7	318	3.5
25	16.7	293	3.2		25	16.9	283	3.5
26	16.6	391	3.8		26	16.7	365	3.6
27	16.5	554	3.9		27	16.5	329	3.8
28	16.2	502	4.1		28	16.6	329	3.7
29	16.3	538	4.1		29	16.5	314	3.7
30	16.1	561	4.2		30	16.7	333	3.7
Average	**16.8**	**329**	**3.59**		**Average**	**16.5**	**376**	**3.82**

Report No. 4-4294

GRASEBY STI - LP HAYWARD
Hayward, Wisconsin

Source: Line 1 Dryer RTO Stack

RUN 9	O2	CO	CO2	RUN 10	O2	CO	CO2
1545-1615				1630-1700			
1	16.3	417	4.0	1	16.2	487	4.1
2	16.4	374	3.9	2	16.3	478	4.1
3	16.5	361	3.8	3	16.5	395	3.8
4	16.7	364	3.7	4	16.6	413	3.7
5	16.6	459	3.8	5	16.5	344	3.8
6	16.3	418	3.9	6	16.4	365	3.8
7	16.4	384	3.9	7	16.5	359	3.8
8	16.4	386	3.9	8	16.6	388	3.8
9	16.6	376	3.8	9	16.6	443	3.8
10	16.4	457	3.9	10	16.4	417	3.9
11	16.3	399	3.9	11	16.3	418	4.0
12	16.4	392	3.9	12	16.4	381	3.9
13	16.4	364	3.8	13	16.7	400	3.8
14	16.7	386	3.7	14	16.6	475	3.8
15	16.6	454	3.8	15	16.3	435	3.9
16	16.4	385	3.9	16	16.5	400	3.8
17	16.5	372	3.8	17	16.5	395	3.8
18	16.5	346	3.8	18	16.6	413	3.8
19	16.7	371	3.7	19	16.5	473	3.8
20	16.6	436	3.8	20	16.4	451	3.9
21	16.3	395	4.0	21	16.4	486	3.9
22	16.4	392	3.9	22	16.3	424	3.9
23	16.5	348	3.7	23	16.7	406	3.7
24	16.6	431	3.8	24	16.6	451	3.8
25	16.5	428	3.8	25	16.4	409	3.9
26	16.4	385	3.8	26	16.6	414	3.8
27	16.5	403	3.9	27	16.8	361	3.6
28	16.5	364	3.8	28	16.8	360	3.6
29	16.6	383	3.7	29	16.7	373	3.6
30	16.6	395	3.8	30	16.7	316	3.6
Average	**16.5**	**394**	**3.83**	**Average**	**16.5**	**411**	**3.82**

Report No. 4-4294

GRASEBY STI - LP HAYWARD
Hayward, Wisconsin

Source: Line 1 Dryer RTO Stack

RUN 11	O2	CO	CO2		RUN 12	O2	CO	CO2
1715-1745					1800-1830			
1	16.5	413	3.8		1	17.0	259	3.3
2	16.6	410	3.8		2	17.0	334	3.4
3	16.6	480	3.8		3	16.7	317	3.6
4	16.4	428	3.9		4	16.7	288	3.6
5	16.5	395	3.9		5	16.7	280	3.5
6	16.5	382	3.8		6	17.0	275	3.4
7	16.7	388	3.7		7	17.0	324	3.4
8	16.6	482	3.8		8	16.7	308	3.6
9	16.4	421	3.8		9	16.7	284	3.6
10	16.5	403	3.9		10	16.7	273	3.5
11	16.5	379	3.8		11	16.8	322	3.6
12	16.7	394	3.7		12	16.8	370	3.6
13	16.6	490	3.8		13	16.6	322	3.8
14	16.4	385	3.9		14	16.7	310	3.7
15	16.6	360	3.8		15	16.7	317	3.7
16	16.7	326	3.6		16	16.9	333	3.6
17	16.8	362	3.6		17	16.7	409	3.8
18	16.7	435	3.7		18	16.7	290	3.7
19	16.7	302	3.6		19	16.9	244	3.6
20	16.8	264	3.5		20	17.0	181	3.4
21	16.8	250	3.4		21	17.5	189	3.1
22	17.0	270	3.3		22	17.1	306	3.4
23	17.0	289	3.4		23	16.8	320	3.7
24	16.7	257	3.5		24	16.7	328	3.8
25	16.9	244	3.5		25	16.9	233	3.6
26	16.8	246	3.4		26	17.1	253	3.4
27	16.9	319	3.5		27	17.0	311	3.6
28	16.6	398	3.7		28	16.8	271	3.6
29	16.5	344	3.8		29	17.0	257	3.4
30	16.6	361	3.7		30	17.0	229	3.3
Average	**16.7**	**363**	**3.68**		**Average**	**16.9**	**291**	**3.54**

APPENDIX C

FIELD DATA SHEETS

INTERPOLL LABORATORIES, INC.

(612) 786-6020

EPA Method 2 Field Data Sheet

Job: G Kasoy/STI @ Hayward

Source: LINE 2 RTI PRESS STACK

Test: 2 Run 1 Date 11-9-94

Stack Dimen. 76 IN.

Dry Bulb 239 °F Wet bulb 119 °F

Manometer ☒ Reg. ☐ Exp ☐ Elec.

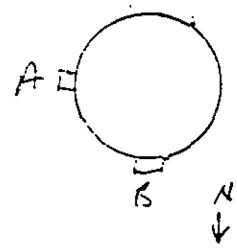
Barometric Pressure 29.02 IN.HG

Static Pressure -.30 IN.WC

Operators E. TROWBRIDGE - K. NIESSWAND

Pitot No. 27V-8 C_p .84

Drawing of Test Site

Cross-section View	Elevation View
	

Traverse Point No.	Fraction of Diameter	Distance From Stack Wall (IN.)	Distance From End of Port (IN.)	Velocity	Temp. of Gas (°F)
		Port Length:	6 IN.	Time Start: 1000	HRS
A 1	.1032	2.43	8.43	.72	
2	.105	7.98	13.98	.75	
3	.194	14.74	20.74	.72	
4	.323	24.55	30.55	.78	231
5	.677	51.45	57.45	.98	
6	.806	61.25	67.25	.95	
7	.895	68.02	74.02	.75	
8	.968	73.57	79.57	.73	
B 1				.70	
2				.82	
3				.88	239
4				.86	
5				.80	
6				.70	
7				.68	
8				.60	
		TS - 235			
		FPS - 57.88			
		ACFM - 108419			
		DSCFM - 78148			
Temp. Meas. Device & S/N:	PDT-38				Time End: 1030 HRS

R or nothing - reg. manometer; S - expanded; E - electronic

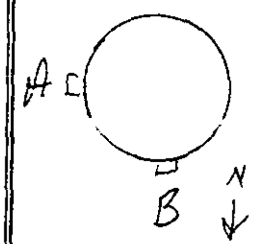
032594-G:\STACK\WP\FORMS\S-392.1

INTERPOLL LABORATORIES, INC.
(612) 786-6020

EPA Method 2 Field Data Sheet

Job: GLASBY STI/LP HAYWARD
Source: AENE 2 PRESS RTO STACK
Test: 2 Run 2 Date 11-9-94
Stack Dimen.: 76 IN.
Dry Bulb: 241 °F Wet bulb: 122 °F
Manometer ☐ Reg. ☐ Exp ☐ Elec.
Barometric Pressure: 29.02 IN.HG
Static Pressure: -.45 IN.WC
Operators: ET&KH
Pitot No.: 274-8 C_p .84

Drawing of Test Site

Cross-section View	Elevation View
	

Traverse Point No.	Fraction of Diameter	Distance From Stack Wall (IN.)	Distance From End of Port (IN.)	Velocity	Temp. of Gas (°F)
		Port Length:	IN.	Time Start: 1045 HRS	
A 1				.80	
2				.78	
3				.85	
4				.80	239
5				.82	
6				.90	
7				.75	
8				.73	
B 1				.70	
2				.80	
3				.88	
4				.88	241
5				.85	
6				.65	
7				.62	
8				.52	
				,	
		5757			
	AVG	188836			
		77252			
Temp. Meas. Device & S/N: PDT 38				Time End: 1115 HRS	

R or nothing = reg. manometer; S = expanded; E = electronic

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INTERPOLL LABORATORIES, INC.
(612) 786-6020

EPA Method 2 Field Data Sheet

Job GRISO BY STI/LP-HAYWARD
Source LINE 2. PRESS RTO STACK
Test 2 Run 3 Date 11-4-94
Stack Dimen. 76 IN.
Dry Bulb ____ °F Wet bulb 123 °F
Manometer ☒Reg. ☐Exp ☐Elec.
Barometric Pressure 29.02 IN.HG
Static Pressure -.50 IN.WC
Operators ET-KN
Pitot No. 27V-8 C_p .84

Drawing of Test Site

Cross-section View	Elevation View

Traverse Point No.	Fraction of Diameter	Distance From Stack Wall (IN.)	Distance From End of Port (IN.)	Velocity	Temp. of Gas (°F)
		Port Length:	IN.	Time Start: 1200 HRS	
A 1				.56	
2				.88	
3				.86	
4				.90	
5				.84	243
6				.78	
7				.65	
8				.63	
B 1				.60	
2				.62	
3				.78	
4				.85	244
5				.82	
6				.78	
7				.88	
8				.68	
	TS 243.5				
	FPS 57.45				
	ACFM - 108601				
	DSCFM - 76588				

Temp. Meas. Device & S/N: PDT 38 — Time End: 1230 HRS

R or nothing = reg. manometer; S = expanded; E = electronic

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1071

INTERPOLL LABORATORIES, INC.
(612) 786-6020

EPA Method 2 Field Data Sheet

Job GRASEBY STI
Source LINE 2 PRESS RTO STACK
Test 2 Run 4 Date 11-9-94
Stack Dimen. 76 IN.
Dry Bulb ___ °F Wet bulb 118 °F
Manometer ☒ Reg. ☐ Exp ☐ Elec.
Barometric Pressure 29.02 IN.HG
Static Pressure -.55 IN.WC
Operators ET/KD
Pitot No. 27V-9 C_p .84

Drawing of Test Site

Cross-section View	Elevation View

Traverse Point No.	Fraction of Diameter	Distance From Stack Wall (IN.)	Distance From End of Port (IN.)	Velocity	Temp. of Gas (°F)
		Port Length:	IN.	Time Start: 1245	HRS
A 1				.85	
2				.78	
3				.84	
4				.80	
5				.80	241
6				.75	
7				.70	
8				.78	
B 1				.60	
2				.72	
3				.76	
4				.92	239
5				.85	
6				.94	
7				.74	
8				.76	
	TS	240			
	ACFM	111043			
	DSCFM	78691			
Temp. Meas. Device & S/N:		PDT 38		Time End: 1315	HRS

R or nothing = reg. manometer; S = expanded; E = electronic

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INTERPOLL LABORATORIES, INC.

(612) 786-6020

EPA Method 2 Field Data Sheet

Job: GLASEBY STI
Source: Line 2 Press RTO Stack
Test: 2 Run: 5 Date: 11-9-94
Stack Dimen.: 76 IN.
Dry Bulb: °F Wet bulb: 117 °F
Manometer: ☒ Reg. ☐ Exp ☐ Elec.
Barometric Pressure: 29.02 IN.HG
Static Pressure: -.46 IN.WC
Operators: ET+KN
Pitot No.: 271-8 C_p .840

Drawing of Test Site

Cross-section View	Elevation View

Traverse Point No.	Fraction of Diameter	Distance From Stack Wall (IN.)	Distance From End of Port (IN.)	Velocity	Temp. of Gas (°F)
		Port Length: IN.		Time Start: 1330 HRS	
A 1				.57	
2				.88	
3				.85	
4				.88	242
5				.84	
6				.80	
7				.74	
8				.72	
B 1				.52	
2				.65	
3				.76	
4				.78	240
5				1.00	
6				.90	
7				.84	
8				.70	
	Ts	241			
	ACFM	109772			
	DSCFM	77698			
Temp. Meas. Device & S/N: PDT 38				Time End: 1400 HRS	

R or nothing = reg. manometer; S = expanded; E = electronic

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INTERPOLL LABORATORIES, INC.
(612) 786-6020

EPA Method 2 Field Data Sheet

Job GRASEBY STI
Source Unit 2 Pines RTO Stack
Test 2 Run 6 Date 11-4-94
Stack Dimen. 74 IN.
Dry Bulb ____ °F Wet bulb 122 °F
Manometer ☒Reg. ☐Exp ☐Elec.
Barometric Pressure 29.02 IN.HG
Static Pressure -.47 IN.WC
Operators ET - KN
Pitot No. 274-8 C_p .84

Drawing of Test Site

Cross-section View	Elevation View

Traverse Point No.	Fraction of Diameter	Distance From Stack Wall (IN.)	Distance From End of Port (IN.)	Velocity	Temp. of Gas (°F)
		Port Length:	IN.	Time Start: 1415 HRS	
A 1				.65	
2				.78	
3				.86	245
4				.95	
5				.84	
6				.70	
7				.87	
8				.68	
B 1				.58	239
2				.78	
3				.70	
4				.80	
5				.88	
6				.96	
7				.85	
8				.68	
	Ts				
	ACFM	110518			
	DSCFM	78112			
Temp. Meas. Device & S/N:	RDT - 38			Time End: 1445 HRS	

R or nothing = reg. manometer; S = expanded; E = electronic

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INTERPOLL LABORATORIES, INC.
(612) 786-6020

EPA Method 2 Field Data Sheet

Job: GLASBY STI/LP HAYWARD
Source: UNIT 2 PASS RTO STACK
Test: 2 Run: 7 Date: 11-9-94
Stack Dimen.: 76 IN.
Dry Bulb: ____ °F Wet bulb: 120 °F
Manometer: ☒ Reg. ☐ Exp ☐ Elec.
Barometric Pressure: 29.02 IN.HG
Static Pressure: -.40 IN.WC
Operators: ET-KN
Pitot No.: 27V-8 C_p: .84

Drawing of Test Site

Cross-section View	Elevation View

Traverse Point No.	Fraction of Diameter	Distance From Stack Wall (IN.)	Distance From End of Port (IN.)	Velocity	Temp. of Gas (°F)
		Port Length:	IN.	Time Start: 1500	HRS
A 1				.58	
2				.77	
3				.85	244
4				.95	
5				.88	
6				.75	
7				.85	
8				.80	
B 1				.60	238
2				.67	
3				.78	
4				.90	
5				1.00	
6				.98	
7				.85	
8				.62	
	TS	241			
	ACFM	111512			
	DSCFM	78437			

Temp. Meas. Device & S/N: PDT 38 Time End: 1530 HRS

R or nothing = reg. manometer; S = expanded; E = electronic

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INTERPOLL LABORATORIES, INC.
(612) 786-6020

EPA Method 2 Field Data Sheet

Job GRASEBY STI
Source Line 2 Press RTO Stack
Test 7 Run 5 Date 11-9-94
Stack Dimen. 76 IN.
Dry Bulb ___ °F Wet bulb 119 °F
Manometer ☒Reg. ☐Exp ☐Elec.
Barometric Pressure 29.02 IN.HG
Static Pressure -.43 IN.WC
Operators ET-KN
Pitot No. 27V-8 C_p .84

Drawing of Test Site

Cross-section View	Elevation View

Traverse Point No.	Fraction of Diameter	Distance From Stack Wall (IN.)	Distance From End of Port (IN.)	Velocity	Temp. of Gas (°F)
		Port Length:	IN.	Time Start: 1545 HRS	
A 1				.57	
2				.82	
3				.80	
4				.90	238
5				.78	
6				.75	
7				.70	
8				.75	
B 1				.48	239
2				.70	
3				.76	
4				.80	
5				1.00	
6				.88	
7				.75	
8				.78	
	T[illegible]	238.5			
	ACFM	109053			
	DSCFM	77471			
Temp. Meas. Device & S/N:	PDT 38			Time End: 1615 HRS	

R or nothing = reg. manometer; S = expanded; E = electronic

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INTERPOLL LABORATORIES, INC.
(612) 786-6020

EPA Method 2 Field Data Sheet

Job: Glasoly STI
Source: Line 2 Press RTO Stack
Test: 2 Run 9 Date 11-9-94
Stack Dimen.: 76 IN.
Dry Bulb: °F Wet bulb 117 °F
Manometer: ☒ Reg. ☐ Exp ☐ Elec.
Barometric Pressure: 29.02 IN.HG
Static Pressure: -.41 IN.WC
Operators: ET-KN
Pitot No.: 271-8 C_p .840

Drawing of Test Site

Cross-section View	Elevation View

Traverse Point No.	Fraction of Diameter	Distance From Stack Wall (IN.)	Distance From End of Port (IN.)	Velocity	Temp. of Gas (°F)
		Port Length:	IN.	Time Start: 1630 HRS	
A 1				.58	
2				.74	
3				.90	
4				.88	236
5				.84	
6				.78	
7				.84	
8				.80	
B 1				.48	239
2				.52	
3				.75	
4				.88	
5				.94	
6				.90	
7				.85	
8				.80	
	Ts	237.5			
	ACFM	119607			
	DSCFM	77980			
Temp. Meas. Device & S/N:	PDT 38			Time End: 1700 HRS	

R or nothing = reg. manometer; S = expanded; E = electronic

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INTERPOLL LABORATORIES, INC.
(612) 786-6020
EPA Method 2 Field Data Sheet

Job: Glasgow/STI
Source: Line 2 Press RTO Stack
Test 2 Run 1 Date 11-9-94
Stack Dimen. 76 IN.
Dry Bulb ____ °F Wet bulb 118 °F
Manometer ☒ Reg. ☐ Exp ☐ Elec.
Barometric Pressure 29.02 IN.HG
Static Pressure -.4 IN.WC
Operators ET-KN
Pitot No. 27V-8 C_p .84

Drawing of Test Site

Cross-section View	Elevation View

Traverse Point No.	Fraction of Diameter	Distance From Stack Wall (IN.)	Distance From End of Port (IN.)	Velocity	Temp. of Gas (°F)
		Port Length:	IN.	Time Start: 1715	HRS
A 1				.65	
2				.78	
3				.88	238
4				.78	
5				.92	
6				.88	
7				.75	
8				.65	
B 1				.52	238
2				.65	
3				.70	
4				.78	
5				.85	
6				.90	
7				.65	
8				.78	
	Ts	238			
	ACFM	108207			
	DSCFM	76931			
Temp. Meas. Device & S/N:		PTT-38			Time End: 1745 HRS

R or nothing = reg. manometer; S = expanded; E = electronic

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INTERPOLL LABORATORIES, INC.
(612) 786-6020

EPA Method 2 Field Data Sheet

Job: GLASSBY STI
Source: Line 2 ... RTO STACK
Test: 2 Run 1 Date 11-5-94
Stack Dimen.: 76 IN.
Dry Bulb ____ °F Wet bulb 118 °F
Manometer ☒Reg. ☐Exp ☐Elec.
Barometric Pressure 29.02 IN.HG
Static Pressure -.47 IN.WC
Operators ET-KN
Pitot No. 27V-8 C_p .840

Drawing of Test Site

Cross-section View	Elevation View

Traverse Point No.	Fraction of Diameter	Distance From Stack Wall (IN.)	Distance From End of Port (IN.)	Velocity	Temp. of Gas (°F)
		Port Length:	IN.	Time Start: 1800 HRS	
A 1				.60	
2				.82	
3				.90	
4				.95	237
5				.78	
6				.72	
7				.76	
8				.80	
B 1				.68	235
2				.66	
3				.78	
4				.75	
5				.95	
6				.86	
7				.82	
8				.77	
	TS	236			
	ACFM	110282			
	DSCFM	76617			
Temp. Meas. Device & S/N:		PDT-38			Time End: 1830 HRS

R or nothing = reg. manometer; S = expanded; E = electronic

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INTERPOLL LABORATORIES, INC.
(612) 786-6020

EPA Method 2 Field Data Sheet

Job: GRASEBY STT
Source: Line 2 Press RTO STACK
Test: 2 Run/2 Date: 11-9-94
Stack Dimen.: 76 IN.
Dry Bulb: ___ °F Wet bulb: 115 °F
Manometer: ☒ Reg. ☐ Exp ☐ Elec.
Barometric Pressure: 29.02 IN.HG
Static Pressure: -.48 IN.WC
Operators: ET-KN
Pitot No.: 274-8 Cp .840

Drawing of Test Site

Cross-section View	Elevation View

Traverse Point No.	Fraction of Diameter	Distance From Stack Wall (IN.)	Distance From End of Port (IN.)	Velocity	Temp. of Gas (°F)
		Port Length:	IN.	Time Start: 1845 HRS	
A 1				.58	
2				.72	
3				.92	234
4				.85	
5				.94	
6				.80	
7				.70	
8				.78	
B 1				.52	236
2				.65	
3				.73	
4				.92	
5				.84	
6				1.00	
7				.88	
8				.65	
	TS	235			
	ACFM	109450			
	DSCFM	79135			
Temp. Meas. Device & S/N:		PDT 38		Time End: 1915 HRS	

R or nothing = reg. manometer; S = expanded; E = electronic

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APPENDIX D

MEASUREMENT SYSTEM PERFORMANCE SPECIFICATIONS

INTERPOLL LABORATORIES

Calibration Error Check

Job ~~GRASOBY~~/STI

Test 1 Run 2 Date 11-7-94

Operator [illegible]

~~SO2~~ CO Calibration: Time(HRS) ________

***	Cylinder Value (ppm)	Analyzer Response (ppm)	Difference (ppm)	Span Value (ppm)	Percent of Span
Zero gas	0	0	0	1000	0
Mid level	249	250	1	1000	
High level	594	592	2	1000	

NO_x Calibration: Time(HRS) ________

***	Cylinder Value (ppm)	Analyzer Response (ppm)	Difference (ppm)	Span Value (ppm)	Percent of Span
Zero gas	0				
Mid level					
High level					

O_2 Calibration: Time(HRS) ________

***	Cylinder Value (ppm)	Analyzer Response (ppm)	Difference (ppm)	Span Value (ppm)	Percent of Span
Zero gas	0	0	0	25	0
Mid level	13.5	0	0	25	0
High level	21.2	21.0	.2	25	

CO_2 Calibration: Time(HRS) ________

***	Cylinder Value (ppm)	Analyzer Response (ppm)	Difference (ppm)	Span Value (ppm)	Percent of Span
Zero gas	0	0	0	20	0
Mid level	10.9	10	0	20	0
High level	16.4	16.4	0	20	0

Must be within 2% of the span for each calibration gas S-420-10

INTERPOLL LABORATORIES, INC
(612) 786-6020

CO System Bias Check

Job GRASEBY/STI-L/WAYWARD Source LINDI DRYER RTO
Test 1 Run 1 Date 1-18-94 Site STACK
Operator

Run	Time (HRS)	***	Cylinder Value (PPM)	Analyzer Resp (PPM) Cal. Err.	Analyzer Resp (PPM) Sys. Bias	Diff. CE-SB (PPM)	Span Val. (PPM)	% of Span
1	0850	Zero Gas	0	0	0	0	1000	0
		Upscale	594	592	592	0	1000	0
2	1020	Zero Gas	0	0	2	2	1000	.2
		Upscale	594	592	587	5	1000	.5
3	1105	Zero Gas	0	0	1	1	1000	
		Upscale	594	592	588	4	1000	.4
4	1148	Zero Gas	0	0	2	2	1000	.2
		Upscale	594	592	586	6	1000	.6
5	1232	Zero Gas	0	0	2	2	1000	.2
		Upscale	594	592	584	8	1000	.8
6	1317	Zero Gas	0	0	1	1	1000	.1
		Upscale	594	592	585	7	1000	.7
7	1404	Zero Gas	0	0	2	2	1000	.2
		Upscale	594	592	582	10	1000	1.0
8	1447	Zero Gas	0	0	3	3	1000	.3
		Upscale	594	592	586	6	1000	.6
9	1532	Zero Gas	0	0	2	2	1000	.2
		Upscale	594	592	582	10	1000	1.0
10	1617	Zero Gas	0	0	3	3	1000	.3
		Upscale	594	592	583	9	1000	.9
11	1702	Zero Gas	0	0	4	4	1000	.4
		Upscale	594	592	583	9	1000	.9
12	1747	Zero Gas	0	0	3	3	1000	.3
		Upscale	594	592	587	5	1000	.5

Must be within 5% of the span for the zero or upscale cal. gas.

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587

INTERPOLL LABORATORIES, INC
(612) 786-6020

02 System Bias Check

Job: Grasso BV IST I Source: Line 1 Dryer RTO
Test: 1 Run: 0 Date: 11-5-9? Site: STACK
Operator:

Run	Time (HRS)	***	Cylinder Value (PPM)	Analyzer Resp (PPM)		Diff. CE-SB (PPM)	Span Val. (PPM)	% of Span
				Cal. Err.	Sys. Bias			
1	0850	Zero Gas	0	0	0	0	25	0
		Upscale	13.5	13.5	13.5	0	25	0
2	1020	Zero Gas	0	0	0	0	25	0
		Upscale	13.5	13.5	13.6	.1	25	.4
3	1105	Zero Gas	0	0	0	0	25	0
		Upscale	13.5	13.5	13.6	.1	25	.4
4	1148	Zero Gas	0	0	0	0	25	0
		Upscale	13.5	13.5	13.6	.1	25	.4
5	1232	Zero Gas	0	0	.1	.1	25	.4
		Upscale	13.5	13.5	13.5	0	25	0
6	1317	Zero Gas	0	0	0	0	25	0
		Upscale	13.5	13.5	13.5	0	25	0
7	1404	Zero Gas	0	0	0	0	25	0
		Upscale	13.5	13.5	13.6	.1	25	.4
8	1447	Zero Gas	0	0	.1	.1	25	.4
		Upscale	13.5	13.5	13.5	0	25	0
9	1532	Zero Gas	0	0	0	0	25	0
		Upscale	13.5	13.5	13.5	0	25	0
10	1617	Zero Gas	0	0	.1	.1	25	.4
		Upscale	13.5	13.5	13.5	0	25	0
11	1702	Zero Gas	0	0	.1	.1	25	.4
		Upscale	13.5	13.5	13.6	.1	25	.4
12	1747	Zero Gas	0	0	.1	.1	25	.4
		Upscale	13.5	13.5	13.6	.1	25	.4

Must be within 5% of the span for the zero or upscale cal. gas.

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INTERPOLL LABORATORIES, INC
(612) 786-6020

CO2 System Bias Check

Job GRESOBI/STT Source LINCI DRYER TC
Test 1 Run ____ Date 11-5-94 Site STACK
Operator E TROWBRIDGE

Run	Time (HRS)	***	Cylinder Value (PPM)	Analyzer Resp (PPM) Cal. Err.	Analyzer Resp (PPM) Sys. Bias	Diff. CE-SB (PPM)	Span Val. (PPM)	% of Span
1	0550	Zero Gas	0	0	0	0	20	0
		Upscale	10.9	10.9	10.9	0	20	0
2	1020	Zero Gas	0	0	0	0	20	0
		Upscale	10.9	10.9	10.9	0	20	0
3	1105	Zero Gas	0	0	0	0	20	0
		Upscale	10.9	10.9	10.9	0	20	0
4	1148	Zero Gas	0	0	0.1	0.1	20	.5
		Upscale	10.9	10.9	10.9	0	20	0
5	1232	Zero Gas	0	0	.1	.1	20	.5
		Upscale	10.9	10.9	10.9	0	20	0
6	1317	Zero Gas	0	0	.1	.1	20	.5
		Upscale	10.9	10.9	10.9	0	20	0
7	1404	Zero Gas	0	0	.1	.1	20	.5
		Upscale	10.9	10.9	10.9	0	20	0
8	1447	Zero Gas	0	0	.1	.1	20	.5
		Upscale	10.9	10.9	10.9	0	20	0
9	1532	Zero Gas	0	0	.1	.1	20	.5
		Upscale	10.9	10.9	10.8	.1	20	.5
10	1617	Zero Gas	0	0	0	0	20	0
		Upscale	10.9	10.9	10.8	.1	20	.5
11	1702	Zero Gas	0	0			20	
		Upscale	10.9	10.9	10.8	.1	20	.5
12	1747	Zero Gas	0	0	0	0	20	0
		Upscale	10.9	10.9	10.9	0	20	0

Must be within 5% of the span for the zero or upscale cal. gas.

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INTERPOLL LABORATORIES, INC
(612) 786-6020
O2 System Bias Check

Job GRASEBY STI/UP HAYWARD Source Line 2 Press RTO
Test 2 Run 1-12 Date 7/19/94 Site STACK
Operator [illegible]

Run	Time (HRS)	***	Cylinder Value (PPM)	Analyzer Resp (PPM) Cal. Err.	Sys. Bias	Diff. CE-SB (PPM)	Span Val. (PPM)	% of Span
1	0930	Zero Gas	0	0	0	0	25	0
		Upscale	13.5	13.5	13.5	0	25	0
2	1032	Zero Gas	0	0	.1	.1	25	.4
		Upscale	13.5	13.5	13.5	0	25	0
3	1120	Zero Gas	0	0	0	0	25	0
		Upscale	13.5	13.5	13.5	0	25	0
4	1234	Zero Gas	0	0	0	0	25	0
		Upscale	13.5	13.5	13.5	0	25	0
5	1317	Zero Gas	0	0	0	0	25	0
		Upscale	13.5	13.5	13.5	0	25	0
6	1402	Zero Gas	0	0	0	0	25	0
		Upscale	13.5	13.5	13.5	0	25	0
7	1447	Zero Gas	0	0	.1	.1	25	.4
		Upscale	13.5	13.5	13.6	.1	25	.4
8	1532	Zero Gas	0	0	.1	.1	25	.4
		Upscale	13.5	13.5	13.6	.1	25	.4
9	1617	Zero Gas	0	0	0	0	25	0
		Upscale	13.5	13.5	13.5	0	25	0
10	1702	Zero Gas	0	0	0	0	25	0
		Upscale	13.5	13.5	13.6	.1	25	.4
11	1747	Zero Gas	0	0	.1	.1	25	.4
		Upscale	13.5	13.5	13.4	.1	25	.4
12	1832	Zero Gas	0	0	0	0	25	0
		Upscale	13.5	13.5	13.4	.1	25	.4

Must be within 5% of the span for the zero or upscale cal. gas.

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INTERPOLL LABORATORIES, INC
(612) 786-6020

CO_2 System Bias Check

Job: Glasrby/STI/LP Hayward   Source: Line 2 Press RTC
Test: 2 Run ____ Date: 11-4-94   Site: STACK
Operator: [illegible signature]

Run	Time (HRS)	***	Cylinder Value (PPM)	Analyzer Resp (PPM) Cal. Err.	Sys. Bias	Diff. CE-SB (PPM)	Span Val. (PPM)	% of Span
1		Zero Gas	0	0	0	0	20	0
		Upscale	10.9	10.9	10.9	0	20	0
2	1032	Zero Gas	0	0	.1	.1	20	.5
		Upscale	10.9	10.9	10.9	0	20	0
3	1120	Zero Gas	0	0	.1	.1	20	.5
		Upscale	10.9	10.9	11.0	.1	20	.5
4	1234	Zero Gas	0	0	.1	.1	20	.5
		Upscale	10.9	10.9	10.9	0	20	0
5	1317	Zero Gas	0	0	.1	.1	20	.5
		Upscale	10.9	10.9	10.9	0	20	0
6	1402	Zero Gas	0	0	0	0.1	20	.5
		Upscale	10.9	10.9	10.9	0	20	0
7	1447	Zero Gas	0	0	0	0	20	0
		Upscale	10.9	10.9	11.0	.1	20	.5
8	1532	Zero Gas	0	0	.1	.1	20	.5
		Upscale	10.9	10.9	10.9	0	20	0
9	1617	Zero Gas	0	0	.1	.1	20	.5
		Upscale	10.9	10.9	10.9	0	20	0
10	1702	Zero Gas	0	0	.1	.1	20	.5
		Upscale	10.9	10.9	11.0	.1	20	.5
11	1747	Zero Gas	0	0	0	0	20	0
		Upscale	10.9	10.9	10.9	0	20	0
12	1832	Zero Gas	0	0	.1	.1	20	.5
		Upscale	10.9	10.9	10.9	0	20	0

Must be within 5% of the span for the zero or upscale cal. gas.

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INTERPOLL LABORATORIES, INC
(612) 786-6020

O2 System Bias Check

Job: GRASEBY/STI - LP/HAYWARD   Source: LINE 2 PRESS RTO
Test: 2   Run: 1-12   Date: 11-9-94   Site: Stack
Operator:

Run	Time (HRS)	***	Cylinder Value (PPM)	Analyzer Resp (PPM) Cal. Err.	Analyzer Resp (PPM) Sys. Bias	Diff. CE-SB (PPM)	Span Val. (PPM)	% of Span
13	1917	Zero Gas	0	0	0	0	25	0
		Upscale	13.5	13.5	13.6	.1	25	.4
2		Zero Gas	0					
		Upscale						
3		Zero Gas	0					
		Upscale						
4		Zero Gas	0					
		Upscale						
5		Zero Gas	0					
		Upscale						
6		Zero Gas	0					
		Upscale						
7		Zero Gas	0					
		Upscale						
8		Zero Gas	0					
		Upscale						
9		Zero Gas	0					
		Upscale						
10		Zero Gas	0					
		Upscale						
11		Zero Gas	0					
		Upscale						
12		Zero Gas	0					
		Upscale						

Must be within 5% of the span for the zero or upscale cal. gas.

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APPENDIX E

CALIBRATION GAS CERTIFICATION SHEETS

Scott Specialty Gases, Inc.

1290 COMBERMERE STREET, TROY, MI 48083-0000
PHONE: 313-589-2950 FAX:313-589-2134

8/02/91

GENEX
4018 DUNCAN AVENUE

ST LOUIS MO 63110-0000

PROJECT #: 05-26600
PO #: 4970SA

CYLINDER #: AAL19103

ANALYTICAL ACCURACY: +-2%

COMPONENT	REQUESTED CONCENTRATION		ANALYSIS 1 (MOLES)	U/M
CARBON MONOXIDE	250.0	PPM	249. '	PPM
NITROGEN		BALANCE		N/A

NOTES: CERTIFIED MASTER GAS

ANALYTICAL METHOD: CMG

DATE OF ANALYSIS: 7/29/91

ANALYST: [signature] ANALYST

APPROVED BY: [signature] SUPERVISOR

Scott Specialty Gases, Inc.

1290 COMBERMERE STREET, TROY, MI 48083-0000
PHONE: 313-589-2950 FAX:313-589-2134

8/02/91

GENEX
4018 DUNCAN AVENUE

ST LOUIS MO 63110-0000

PROJECT #: 05-26600
PO #: 4970SA

CYLINDER #: ALM020902 ANALYTICAL ACCURACY: +-2%

COMPONENT	REQUESTED CONCENTRATION		ANALYSIS 1 (MOLES)	U/M
CARBON MONOXIDE	600.0	PPM	594.	PPM
NITROGEN	BALANCE			N/A

NOTES: CERTIFIED MASTER GAS

ANALYTICAL METHOD: CMG

DATE OF ANALYSIS: 7/29/91

ANALYST: [signature] ANALYST

APPROVED BY: [signature] SUPERVISOR

NATIONAL SPECIALTY GASES
630 UNITED DRIVE
DURHAM, N.C. 27713
(919) 544-3772

TO: TWIN CITY OXYGEN

CERTIFICATE OF ANALYSIS

DATE REPORTED:9/29/94 REFERENCE #:88-34130

MATERIAL SUBMITTED:OXYGEN, CARBON DIOXIDE IN NITROGEN, CERTIFIED CYL. #CC111962

INFORMATION REQUESTED:RATIO ANALYSIS

METHOD OF ANALYSIS:OXYGEN ANALYZER, INFRARED

RESULT OF INVESTIGATION:

COMPONENT	SPECIFICATION	CONCENTRATION
OXYGEN	13.5%	13.5%
CARBON DIOXIDE	11%	10.9%
NITROGEN		BALANCE

AUTHORIZED SIGNATURE

"THIS REPORT STATED ACCURATELY THE RESULTS OF THE INVESTIGATION MADE UPON THE MATERIAL SUBMITTED TO THE ANALYTICAL LABORATORY. EVERY EFFORT HAS BEEN MADE TO DETERMINE OBJECTIVELY, THE INFORMATION REQUESTED; HOWEVER, IN CONNECTION WITH ITS RENDERING OF THIS REPORT, NATIONAL SPECIALTY GASES SHALL HAVE NO LIABILITY IN EXCESS OF ITS ESTABLISHED CHARGE FOR THE SERVICE."

NATIONAL SPECIALTY GASES
630 UNITED DRIVE
DURHAM, N.C. 27713
(919) 544-3772

TO: TWIN CITY OXYGEN

CERTIFICATE OF ANALYSIS

DATE REPORTED: 12/13/93 REFERENCE #:88-28413

MATERIAL SUBMITTED:CARBON DIOXIDE AND OXYGEN IN NITROGEN, CERTIFIED CYL. #CC112272

INFORMATION REQUESTED:RATIO ANALYSIS

METHOD OF ANALYSIS:INFRARED AND OXYGEN ANALYZERS

RESULT OF INVESTIGATION:

COMPONENT	SPECIFICATION	CONCENTRATION
CO2	17%	16.4%
O2	21%	21.2%
N2		BALANCE

AUTHORIZED SIGNATURE

"THIS REPORT STATED ACCURATELY THE RESULTS OF THE INVESTIGATION MADE UPON THE MATERIAL SUBMITTED TO THE ANALYTICAL LABORATORY. EVERY EFFORT HAS BEEN MADE TO DETERMINE OBJECTIVELY, THE INFORMATION REQUESTED; HOWEVER, IN CONNECTION WITH ITS RENDERING OF THIS REPORT, NATIONAL SPECIALTY GASES SHALL HAVE NO LIABILITY IN EXCESS OF ITS ESTABLISHED CHARGE FOR THE SERVICE."

APPENDIX F

GAS ANALYZER SPECIFICATIONS

<u>SPECIFICATIONS FOR ACS MODEL 3300 CO NDIR</u>

Measuring principle	NDIR single beam method
Operating ranges	0 - 500 ppm 0 - 1000 ppm
Reproducibility	±0.5% of full scale
Stability	Zero drift; ±% of full scale/24H Span drift; ±% of full scale/24H
Noise	0.5% of full scale
Ambient temperature	-5 to 45^{0}C
Ambient humidity	Less than 90% RH
Response time (90% of final reading)	Electrical system; 2 sec, 3 sec, 5 sec (selectable with connector) Response of actual gas; Within 15 sec (depending on cell length)
Indicator	100 linear division
Output signal	OUTPUT 1; DC 0 - 1 V OUTPUT 2; DC 0 - 10 mV or DC 0 - 100 mV or DC 0 - 1 V or DC 4 - 20 mA (Allowable load resistance 500Ω max.)
Linearity	Better than ±2% of full scale (when linearizer is used)
Power supply	AC 115 V ± 10%, 60 Hz

Power consumption	Approx. 30 VA
Materials of gas-contacting parts	Measuring cell; SUS304 Window; CaF_2 Piping; Polyethylene
Sample gas flow rate	1ℓ/min ± 0.5ℓ/min
Sample gas temperature	0 to 55°C
Purging gas flow rate	1ℓ/min (to be flowed as occasion demands)
Warmup time	Approx. 2 hours
External dimensions	200 x 250 x 541 (H x W x D) mm
Weight	Approx. 11 kg
Finish Color	MUNSELL N1.5

Remarks: For combinations of measuring ranges for the dualcomponent analyzer, inquiry should be made to the manufacturer.

INTERPOLL LABORATORIES
4500 BALL ROAD N.E.
CIRCLE PINES, MN 55014-1819
(612) 786-6020

Servomex

1420
Oxygen Analyser
Instruction Manual

Ref : 01420/001A/0

Order as part No. 01420001A

was (7982-2842)

1.3 Sampling System

The sampling system of the analyser includes a combination filter/automatic flow control device, designed to keep a constant flow of sample gas through the measuring cell for varying input pressures and to prevent the entrance of particulate matter into the measuring cell. Excess flow is vented to the by-pass.

1.4 Specification

Performance Specification (typical)

Repeatability:	Better than +/-0.2% O2 under constant conditions.
Drift:	Less than 0.2% O2 per week under constant conditions. (Excluding variation due to barometric pressure changes; reading is proportional to barometric pressure.)

Outputs

Display:	3 1/2 digit LCD reading 0.0 to 100.0% oxygen with overrange capability.
Output:	0 to 1V (non-isolated) for 0 to 100% oxygen available on 'D' type connector located on the back panel of the instrument. Output impedance is less than 10 ohms.
Option:	4 - 20mA isolated, Max impedance 500 ohms.
Flow alarm output:	Change over relay contact rated at 3A/115V ac, 1A/240V ac or 1A/28V dc. 4 sets of single pole changeover contacts. Alarm becomes active when sample gas flow through the analyser fails.

Sample requirements

Condition:	Clean, dry gas with dew point 5 deg C below ambient temperature.
Inlet pressure:	0.5 to 3psig (3.5 to 21kPa). Inlet pressure changes within this range will change the reading by less than 0.1% O2. May be operated up to 10psig (70kPa) with degraded stability.
Flowrate:	1.5 to 6 litres/minute approximately depending on sample pressure.
Filtering:	0.6 micron replaceable filter integral to the automatic flow control device.

Response time:	Less than 15 secs. to 90% at an inlet pressure of 3psig (21kPa).
Inlet/vent connections:	1/4 inch OD tube (stainless steel) suitable for 6mm ID flexible tubing or 1/4 inch OD compression fittings.
Materials exposed to the sample:	Stainless steel, Pyrex glass, brass, platinum, epoxy resin, Viton, polypropylene and glass fibre filter.

Physical Characteristics

Case:	Steel and aluminium finished in epoxy powder paint.
Case classification:	IP 20 (IEC 529) when fitted into the Servomex 1400 series 19 inch case.
Dimensions:	See Figure 2.1.
Weight:	10Kg (22lb) approximately.

Electrical

AC Supply:	110 to 120V AC or 220 to 240V AC, +/-10%, 48 to 62Hz. Voltage selected by a voltage selector integral to the IEC supply plug.
Power required:	15VA maximum.

Environmental Limits

Operating ambient temperature:	0 to +40 deg C (32 to 104 deg F)
Storage temp. range:	-20 to +70 deg C (-4 to 158 deg F)
Relative humidity:	0-85%, non-condensing.

SPECIFICATIONS FOR ACS MODEL 3300 CO_2 NDIR

Measuring principle	NDIR single beam method
Measurable gas components and measuring range	0 - 20%
Reproducibility	±0.5% of full scale
Stability	Zero drift; ±% of full scale/24H Span drift; ±% of full scale/24H
Noise	0.5% of full scale
Ambient temperature	-5 to 45°C
Ambient humidity	Less than 90% RH
Response time (90% of final reading)	Electrical system; 2 sec, 3 sec, 5 sec (selectable with connector) Response of actual gas; Within 15 sec (depending on cell length)
Indicator	100 linear division
Output signal	OUTPUT 1; DC 0 - 1 V OUTPUT 2; DC 0 - 10 mV or DC 0 - 100 mV or DC 0 - 1 V or DC 4 - 20 mA (Allowable load resistance 500Ω max.)
Linearity	Better than ±2% of full scale (when linearizer is used)
Power supply	AC 115 V ± 10%, 60 Hz

Power consumption	Approx. 30 VA
Materials of gas-contacting parts	Measuring cell; SUS304 Window; CaF_2 Piping; Polyethylene
Sample gas flow rate	1ℓ/min ± 0.5ℓ/min
Sample gas temperature	0 to 55°C
Purging gas flow rate	1ℓ/min (to be flowed as occasion demands)
Warmup time	Approx. 2 hours
External dimensions	200 x 250 x 541 (H x W x D) mm
Weight	Approx. 11 kg
Finish Color	MUNSELL N1.5

Remarks: For combinations of measuring ranges for the dualcomponent analyzer, inquiry should be made to the manufacturer.

APPENDIX G

CEM INSTRUMENT INFORMATION SHEET

Interpoll Laboratories
(612)786-6020

CEM Relative Field Accuracy Certification Instrument Information Sheet

Plant Name LOUISIANA-PACIFIC CORP.

Plant Location HAYWARD, WI

Pollutant Gas Monitor Data:

Vendor TECO - Thermo Environmental Instruments, Inc

Model 48 S/N 48-47743-279

Location Line 1 DRYER RTO STACK

Gas(es): ☐ SO_2 ☐ NO_x ☒ CO

Type of System: ☐ In-situ ☒ Extractive

Installation Date JULY 24, 1994

Startup Date AUGUST 10, 1994

Data Recording System:

☐ Strip Chart Recorder ☐ Data Logger System

☒ Computer

Relative Accuracy Certification Units:

☒ ppm,dry ☐ LB/10^6BTU by O_2 F-Factor

☐ ppm,wet ☐ LB/10^6BTU by CO_2 F-Factor

Span Value (ppm):

SO_2

NO_x

CO 0-1000 ppm

~~Diluent~~ FLOW & Temperature Monitor Data:

Vendor USI - United Sciences, Inc.

Model 100 S/N 9401658

Location Line 2 Press RTO STACK

Gas: ☐ O_2 ☐ CO_2 ☒ Airflow - ultrasonic

Type of System: ☐ In-situ ☐ Extractive

Installation Date July 25, 1994

Startup Date August 10, 1994

Data Recording System:

☐ Strip Chart Recorder ☐ Data Logger System

☒ Computer

Output Units:

☐ % O_2,dry ☐ % CO_2,dry ☒ kacfm

☐ % O_2,wet ☐ % CO_2,wet ☒ temperature - °F

Span Gas Values (% v/v):

*********~~Oxygen~~ FLOW*********	***Carbon Dioxide***
Low ∅	
High 120 Kacfm	

Robert W. Schultz
Signature of Person
Responsible for Data

11-09-94
Date

S-253 RR-9/25

APPENDIX H

CEM DATA

DAILY CO SUMMARY REPORT

Line #1 Dryers CO ppm FIFTEEN MINUTE AVERAGES
LOUISIANA PACIFIC
Hayward, WI

TODAY'S DATE: 11-08-1994
TIME: 15:33:36

REPORTING PERIOD
DAY: November 8

Period	15 Read.	15 Stat.	30 Read.	30 Stat.	45 Read.	45 Stat.	60 Read.	60 Stat.	Hr. AVG. Read.	Hr. AVG. Stat
Hour 7	265.6	0	386.8	0	440.3	0	434.4	0	381.8	0
Hour 8	580.3	0	467.5	0	463.3	0	471.9	0	495.7	0
Hour 9	462.0	0	442.1	0	490.5	0	357.1	0	437.9	0
Hour 10	253.9	0	340.9	0	413.6	0	306.4	0	328.7	0
Hour 11	277.5	0	323.9	0	316.4	0	316.2	0	308.5	0
Hour 12	348.5	0	357.0	0	331.2	0	407.8	0	361.1	0
Hour 13	394.2	0	387.0	0	403.6	0	374.5	0	389.8	0
Hour 14	429.0	0	272.9	0	343.4	0	354.6	0	350.0	0
Hour 15	362.3	0	381.5	0	394.9	0	391.2	0	382.5	0
Hour 16	386.3	0	444.1	0	394.5	0	321.9	0	386.7	0
Hour 17	386.8	0	411.2	0	295.5	0	315.8	0	352.4	0
Hour 18	303.7	0	261.9	0	-1.0	-1	-1.0	-1	-1.0	-1
Hour 19	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 20	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 21	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 22	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 23	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 0	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 2	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 3	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 4	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 5	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 6	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1

#1	305.5	9:45 - 10:15	#7	308.15	2:15 - 2:45
#2	360	10:30 - 11:00	#8	371.9	3:00 - 3:30
#3	320.15	11:15 - 11:45	#9	388.75	3:45 - 4:15
#4	352.75	12:00 - 12:30	#10	358.2	4:30 - 5:00
#5	401	12:45 - 1:15	#11	353.35	5:15 - 5:45
#6	389.05	1:30 - 2:00	#12	282.8	6:00 - 6:30

DAILY FLOW SUMMARY REPORT

Line #2 Press FLOW kcfm FIFTEEN MINUTE AVERAGES
LOUISIANA PACIFIC
Hayward, WI

TODAY'S DATE: 11-09-1994
TIME: 19:15:30

REPORTING PERIOD
DAY: November 9

Period	15 Read.	15 Stat.	30 Read.	30 Stat.	45 Read.	45 Stat.	60 Read.	60 Stat.	Hr. AVG. Read.	Hr. AVG. Sta
Hour 7	100.2	0	100.3	0	100.3	0	102.6	0	100.9	0
Hour 8	101.8	0	103.1	0	100.8	0	102.6	0	102.0	0
Hour 9	102.2	0	101.8	0	101.1	0	100.1	0	101.3	0
Hour 10	101.4	0	98.8	0	99.5	0	98.3	0	[illegible]	0
Hour 11	100.2	0	102.2	0	[illegible]	0	101.1	0	101.2	0
Hour 12	101.2	0	101.2	0	99.2	0	102.4	0	101.0	0
Hour 13	100.6	0	101.2	0	101.2	0	99.4	0	100.6	0
Hour 14	101.1	0	100.8	0	100.6	0	101.3	0	100.9	0
Hour 15	101.4	0	99.5	0	99.8	0	101.5	0	100.5	0
Hour 16	100.7	0	100.0	0	100.4	0	102.6	0	101.0	0
Hour 17	100.4	0	99.7	0	103.1	0	100.9	0	101.0	0
Hour 18	99.0	0	102.0	0	99.6	0	101.6	0	100.6	0
Hour 19	100.0	0	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 20	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 21	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 22	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 23	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 0	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 2	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 3	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 4	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 5	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 6	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1

Run	Flow	Run	Flow
Run 1	100	Run 7	100
2	100	8	101
3	101	9	102
4	101	10	101
5	100	11	101
6	101	12	101

DAILY TEMP SUMMARY REPORT

Line #2 Press TEMP Deg-F FIFTEEN MINUTE AVERAGES
LOUISIANA PACIFIC
Hayward, WI

TODAY'S DATE: 11-09-1994
TIME: 19:16:15

REPORTING PERIOD
DAY: November 9

Period	15		30		45		60		Hr. AVG.	
	Read.	Stat.	Read.	Stat.	Read.	Stat.	Read.	Stat.	Read.	Sta
Hour 7	212.4	0	213.4	0	212.8	0	213.4	0	213.0	0
Hour 8	213.7	0	214.3	0	215.6	0	216.2	0	214.9	0
Hour 9	218.0	0	218.2	0	219.7	0	220.8	0	219.2	0
Hour 10	220.8	0	222.4	0	222.1	0	222.6	0	222.0	0
Hour 11	223.0	0	223.8	0	226.3	0	224.2	0	224.3	0
Hour 12	225.9	0	225.0	0	225.1	0	224.4	0	225.1	0
Hour 13	225.6	0	225.9	0	225.2	0	225.0	0	225.4	0
Hour 14	224.6	0	223.3	0	224.6	0	223.8	0	224.1	0
Hour 15	223.8	0	223.5	0	223.7	0	223.8	0	223.7	0
Hour 16	224.8	0	222.5	0	222.3	0	221.1	0	222.7	0
Hour 17	220.6	0	220.8	0	217.8	0	219.8	0	219.8	0
Hour 18	219.8	0	217.6	0	218.9	0	218.7	0	218.8	0
Hour 19	218.1	0	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 20	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 21	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 22	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 23	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Hour 1	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Hour 2	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Hour 3	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Hour 4	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Hour 5	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Hour 6	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0

DAILY FLOW SUMMARY REPORT

Line #2 Press FLOW kcfm FIFTEEN MINUTE AVERAGES
LOUISIANA PACIFIC
Hayward, WI

TODAY'S DATE: 11-09-1994 REPORTING PERIOD
TIME: 14:08:32 DAY: November 9

Period	15 Read.	15 Stat.	30 Read.	30 Stat.	45 Read.	45 Stat.	60 Read.	60 Stat.	Hr. AVG. Read.	Hr. AVG. Stat
Hour 7	100.2	0	100.3	0	100.3	0	102.6	0	100.9	0
Hour 8	101.8	0	103.1	0	100.8	0	102.6	0	102.0	0
Hour 9	102.2	0	101.8	0	101.1	0	100.1	0	101.3	0
Hour 10	101.4	0	98.8	0	99.5	0	98.3	0	99.5	0
Hour 11	100.2	0	102.2	0	101.3	0	101.1	0	101.2	0
Hour 12	101.2	0	101.2	0	99.2	0	~~102.4~~	0	~~101.0~~	0
Hour 13	100.6	0	101.2	0	101.2	0	99.4	0	100.6	0 100.0 RS
Hour 14	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 15	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 16	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 17	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 18	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 19	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 20	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 21	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 22	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 23	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 0	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 2	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 3	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 4	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 5	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 6	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1

DAILY FLOW SUMMARY REPORT

Line #2 Press FLOW kcfm FIFTEEN MINUTE AVERAGES
LOUISIANA PACIFIC
Hayward, WI

TODAY'S DATE: 11-09-1994 REPORTING PERIOD
TIME: 12:46:08 DAY: November 9

Period	15		30		45		60		Hr. AVG.	
	Read.	Stat.	Read.	Stat.	Read.	Stat.	Read.	Stat.	Read.	Sta
Hour 7	100.2	0	100.3	0	100.3	0	102.6	0	100.9	0
Hour 8	101.8	0	103.1	0	100.8	0	102.6	0	102.0	0
Hour 9	102.2	0	101.8	0	101.1	0	100.1	0	101.3	0
Hour 10	101.4	0	98.8	0	99.5	0	98.3	0	99.5	0
Hour 11	100.2	0	102.2	0	101.3	0	101.1	0	101.2	0
Hour 12	101.2	0	101.2	0	99.2	0	-1.0	-1	-1.0	-1
Hour 13	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 14	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 15	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 16	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 17	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 18	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 19	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 20	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 21	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 22	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 23	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 0	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 2	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 3	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 4	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 5	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 6	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1

DAILY TEMP SUMMARY REPORT

Line #2 Press TEMP Deg-F FIFTEEN MINUTE AVERAGES
LOUISIANA PACIFIC
Hayward, WI

TODAY'S DATE: 11-09-1994
TIME: 12:46:16

REPORTING PERIOD
DAY: November 9

Period	15		30		45		60		Hr. AVG.	
	Read.	Stat.	Read.	Stat.	Read.	Stat.	Read.	Stat.	Read.	Stat
Hour 7	212.4	0	213.4	0	212.8	0	213.4	0	213.0	0
Hour 8	213.7	0	214.3	0	215.6	0	216.2	0	214.9	0
Hour 9	218.0	0	218.2	0	219.7	0	220.8	0	219.2	0
Hour 10	220.8	0	222.4	0	222.1	0	222.6	0	222.0	0
Hour 11	~~223.0~~	0	~~223.8~~	0	226.3	0	224.2	0	224.3	0
Hour 12	225.9	0	225.0	0	225.1	0	-1.0	-1	-1.0	-1
Hour 13	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 14	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 15	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 16	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 17	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 18	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 19	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 20	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 21	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 22	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 23	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Hour 1	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Hour 2	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Hour 3	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Hour 4	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Hour 5	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Hour 6	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0

DAILY FLOW SUMMARY REPORT

Line #2 Press FLOW kcfm FIFTEEN MINUTE AVERAGES
LOUISIANA PACIFIC
Hayward, WI

TODAY'S DATE: 11-09-1994
TIME: 10:36:18

REPORTING PERIOD
DAY: November 9

Period	15		30		45		60		Hr. AVG.	
	Read.	Stat.	Read.	Stat.	Read.	Stat.	Read.	Stat.	Read.	Sta
Hour 7	100.2	0	100.3	0	100.3	0	102.6	0	100.9	0
Hour 8	101.8	0	103.1	0	100.8	0	102.6	0	102.0	0
Hour 9	102.2	0	101.8	0	101.1	0	100.1	0	101.3	0
Hour 10	101.4	0	98.8	0	-1.0	-1	-1.0	-1	-1.0	-1
Hour 11	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 12	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 13	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 14	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 15	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 16	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 17	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 18	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 19	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 20	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 21	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 22	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 23	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 0	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 2	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 3	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 4	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 5	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 6	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1

DAILY TEMP SUMMARY REPORT

Line #2 Press TEMP Deg-F FIFTEEN MINUTE AVERAGES
LOUISIANA PACIFIC
Hayward, WI

TODAY'S DATE: 11-09-1994
TIME: 10:36:27

REPORTING PERIOD
DAY: November 9

Period	15 Read.	15 Stat.	30 Read.	30 Stat.	45 Read.	45 Stat.	60 Read.	60 Stat.	Hr. AVG. Read.	Hr. AVG. Stat
Hour 7	212.4	0	213.4	0	212.8	0	213.4	0	213.0	0
Hour 8	213.7	0	214.3	0	215.6	0	216.2	0	214.9	0
Hour 9	218.0	0	218.2	0	219.7	0	220.8	0	219.2	0
Hour 10	220.8	0	222.4	0	-1.0	-1	-1.0	-1	-1.0	-1
Hour 11	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 12	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 13	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 14	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 15	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 16	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 17	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 18	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 19	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 20	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 21	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 22	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 23	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Hour 1	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Hour 2	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Hour 3	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Hour 4	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Hour 5	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Hour 6	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0

DAILY FLOW SUMMARY REPORT

Line #2 Press FLOW kcfm FIFTEEN MINUTE AVERAGES
LOUISIANA PACIFIC
Hayward, WI

TODAY'S DATE: 11-09-1994
TIME: 15:11:54

REPORTING PERIOD
DAY: November 9

Period	15 Read.	15 Stat.	30 Read.	30 Stat.	45 Read.	45 Stat.	60 Read.	60 Stat.	Hr. AVG. Read.	Hr. AVG. Stat
Hour 7	100.2	0	100.3	0	100.3	0	102.6	0	100.9	0
Hour 8	101.8	0	103.1	0	100.8	0	102.6	0	102.0	0
Hour 9	102.2	0	101.8	0	101.1	0	100.1	0	101.3	0
Hour 10	101.4	0	98.8	0	99.5	0	98.3	0	99.5	0
Hour 11	100.2	0	102.2	0	101.3	0	101.1	0	101.2	0
Hour 12	101.2	0	101.2	0	99.2	0	102.4	0	101.0	0
Hour 13	100.6	0	101.2	0	101.2	0	99.4	0	100.6	0
Hour 14	101.1	0	100.8	0	100.6	0	101.3	0	100.9	0
Hour 15	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 16	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 17	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 18	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 19	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 20	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 21	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 22	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 23	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 0	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 2	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 3	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 4	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 5	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1
Hour 6	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1	-1.0	-1

APPENDIX I

OPERATING DATA

LOUISIANA PACIFIC HAYWARD DAILY TONNAGE LINE II NOVEMBER 1994 LINE II November 1994

FISCAL FACTOR	43.0		39.6		39.3		40.7		39.7		39.2		39.2		39.1		38.5		TOTAL
DATE	1/4" FTG	1/4" LBS	3/8" FTG	3/8" LBS	7/16" FTG	7/16" LBS	15/32" FTG	15/32" LBS	1/2" FTG	1/2" LBS	19/32"SE FTG	19/32"SE LBS	19/32"H FTG	19/32"H LBS	23/32"SE FTG	23/32"SE LBS	23/32"H FTG	23/32"H LBS	DAILY LBS
10/30		0		0		0		0		0		0		0		0	688.908	828842.4	828,842
10/31		0	41.472	51,322	489.230	600,836		0		0		0		0		0	29.441	35421.2	687,578
11/01		0		0	729.365	895,751		0		0		0		0		0		0	895,751
11/02	12.289	16,513		0	718.613	882,547		0		0		0		0		0		0	899,060
11/03	39.938	53,667	82.944	102,643	559.120	686,669		0		0		0		0		0		0	842,979
11/04		0	13.824	17,107	397.835	488,591	322.560	410,256		0		0		0		0		0	915,954
11/05		0	76.800	95,040	270.600	332,331	341.760	434,676		0		0		0		0		0	862,047
11/06		0		0	697.108	856,136		0		0		0		0		0		0	856,136
11/07	5.120	6,880		0	716.820	880,345		0		0		0		0		0		0	887,225
11/08	19.457	26,145		0	704.276	864,939		0		0		0		0		0		0	891,084
11/09	19.457	26,145		0	706.068	867,140		0		0		0		0		0		0	893,285
11/10		0	70.656	87,437	632.594	776,905		0		0		0		0		0		0	864,341
11/11	48.130	64,675	36.864	45,619	541.199	664,660		0		0		0		0		0		0	774,954
11/12		0		0	25.089	30,812	670.080	852,258		0		0		0		0		0	883,070
11/13	95.237	127,975	43.008	53,222	396.043	486,390	11.520	14,652		0		0		0		0		0	682,239
11/14		0		0	745.493	915,559		0		0		0		0		0		0	915,559
11/15		0		0	723.989	889,149		0		0		0		0		0		0	889,149
		0		0		0		0		0		0		0		0		0	0
		0		0		0		0		0		0		0		0		0	0
		0		0		0		0		0		0		0		0		0	0
		0		0		0		0		0		0		0		0		0	0
		0		0		0		0		0		0		0		0		0	0
		0		0		0		0		0		0		0		0		0	0
		0		0		0		0		0		0		0		0		0	0
		0		0		0		0		0		0		0		0		0	0
		0		0		0		0		0		0		0		0		0	0
		0		0		0		0		0		0		0		0		0	0
		0		0		0		0		0		0		0		0		0	0
		0		0		0		0		0		0		0		0		0	0
		0		0		0		0		0		0		0		0		0	0
		0		0		0		0		0		0		0		0		0	0
		0		0		0		0		0		0		0		0		0	0
		0		0		0		0		0		0		0		0		0	0
		0		0		0		0		0		0		0		0		0	0
		0		0		0		0		0		0		0		0		0	0
TOTALS=	239.628	322000	365.568	452390	9053.442	11118758	1345.920	1711842	0.000	0	0.000	0	0.000	0	0.000	0	718.349	864264	14,469,255

18.6 TONS PER HR

DAILY PRODUCTION REPORT   HAYWARD   DATE: 11/9/94 ENV.   DLS

CALENDAR

LINE I — 7AM-7PM

	LOADS	#PANELS	SUR FTG	3/8 FTG
1/4		0	0	0
3/8		0	0	0
7/16	6	288	9216	10752
15/32		0	0	0
1/2		0	0	0
19/32SE		0	0	0
19/32H		0	0	0
23/32SE	37	1776	56832	108930
23/32H	88	4224	135168	259077
			TOTAL	378759

LINE II — 7AM-7PM

	LOADS	#PANELS	SUR FTG	3/8 FTG
1/4	19	912	29184	19457
3/8		0	0	0
7/16	189	9072	290304	338698
15/32		0	0	0
1/2		0	0	0
19/32SE		0	0	0
19/32H		0	0	0
23/32SE		0	0	0
23/32H		0	0	0
			TOTAL	358155

LINE I — 7PM-7AM

	LOADS	#PANELS	SUR FTG	3/8 FTG
1/4		0	0	0
3/8		0	0	0
7/16		0	0	0
15/32		0	0	0
1/2		0	0	0
19/32SE		0	0	0
19/32H		0	0	0
23/32SE		0	0	0
23/32H	130	6240	199680	382727
			TOTAL	382727

LINE II — 7PM-7AM

	LOADS	#PANELS	SUR FTG	3/8 FTG
1/4		0	0	0
3/8		0	0	0
7/16	205	9840	314880	367370
15/32		0	0	0
1/2		0	0	0
19/32SE		0	0	0
19/32H		0	0	0
23/32SE		0	0	0
23/32H		0	0	0
			TOTAL	367370

LINE I TOTALS

	LOADS	#PANELS	SUR FTG	3/8 FTG
1/4	0	0	0	0
3/8	0	0	0	0
7/16	6	288	9216	10752
15/32	0	0	0	0
1/2	0	0	0	0
19/32SE	0	0	0	0
19/32H	0	0	0	0
23/32SE	37	1776	56832	108930
23/32H	218	10464	334848	641803
TOTALS=		12528	400896	761485
		LINE I TOTAL =		761485

LINE II TOTALS

	LOADS	#PANELS	SUR FTG	3/8 FTG
1/4	19	912	29184	19457
3/8	0	0	0	0
7/16	394	18912	605184	706068
15/32	0	0	0	0
1/2	0	0	0	0
19/32SE	0	0	0	0
19/32H	0	0	0	0
23/32SE	0	0	0	0
23/32H	0	0	0	0
TOTALS=		19824	634368	725525
		LINE II TOTAL=		725525

DAILY PLANT TOTAL= 1487011

7AM-7PM TOTAL= 736913

7PM-7AM TOTAL= 750097

LINE I MTD TOTALS		MTD%
1/4	25601	0.4
3/8	193536	2.9
7/16	1603886	24.2
15/32	743040	11.2
1/2	1398749	21.1
19/32SE	158077	2.4
19/32H	209148	3.2
23/32SE	188419	2.8
23/32H	2110885	31.8

WTD #1	5107486
WTD #2	1523854
WTD #3	0
WTD #4	0
WTD #5	0
MTD TOTAL	6631340

PLANT WTD

WTD #1	10092182
WTD #2	2973112
WTD #3	0
WTD #4	0
WTD #5	0

PLANT MTD 13065294

LINE II MTD TOTALS		MTD%
1/4	96261	1.5
3/8	173568	2.7
7/16	5499805	85.5
15/32	664320	10.3
1/2	0	0.0
19/32SE	0	0.0
19/32H	0	0.0
23/32SE	0	0.0
23/32H	0	0.0

WTD #1	4984696
WTD #2	1449258
WTD #3	0
WTD #4	0
WTD #5	0
MTD TOTAL	6433954

MTD%=

1/4	0.9
3/8	2.8
7/16	54.4
15/32	10.8
1/2	10.7
19/32SE	1.2
19/32H	1.6
23/32SE	1.4
23/32H	16.2

LOUISIANA PACIFIC HAYWARD DAILY TONNAGE LINE I NOVEMBER 1994

LINE I November 1994

FISCAL FACTOR	41.2		41.3		39.5		40.5		40.2		38.6		40.4		39.5		38.2		
DATE	1/4" FTG	1/4" LBS	3/8" FTG	3/8" LBS	7/16" FTG	7/16" LBS	15/32" FTG	15/32" LBS	1/2" FTG	1/2" LBS	19/32"SE FTG	19/32"SE LBS	19/32"H FTG	19/32"H LBS	23/32"SE FTG	23/32"SE LBS	23/32"H FTG	23/32"H LBS	TOTAL DAILY LBS
10/30		0		0	390.667	482,230		0		0	362.360	437,097		0		0		0	919,326
10/31	18.433	23,732		0	77.058	95,118		0	481.268	604,593	12.160	14,668	138.621	175,009		0		0	913,121
11/01		0		0	172.037	212,358	334.080	422,820		0		0		0		0		0	635,178
11/02		0	53.760	69,384	363.786	449,048	5.760	7,290	333.816	419,356		0		0		0		0	945,079
11/03		0		0	50.177	61,937		0		0		0		0	79.489	98,119	650.635	776,696	936,752
11/04		0		0		0		0		0		0		0		0	794.894	948,905	948,905
11/05		0		0		0		0	395.254	496,538	158.077	190,680	209.148	264,049		0	23.552	28,115	979,383
11/06		0	139.776	180,398	277.768	342,870		0	278.521	349,892		0		0		0		0	873,160
11/07		0		0	406.796	502,139	380.160	481,140		0		0		0		0		0	983,279
11/08	25.601	32,961		0	322.569	398,171	23.040	29,160	391.158	491,392		0		0		0		0	951,685 = 19.8 TONS PER HR.
11/09		0		0	10.752	13,272		0		0		0		0	108.930	134,460	641.803	766,152	913,885
11/10	27.649	35,598		0	356.618	440,200		0		0		0		0	108.930	134,460	244.356	291,700	901,959
11/11		0		0	331.529	409,231		0		0		0		0		0	229.636	274,128	683,359
11/12		0	26.112	33,701	1.792	2,212		0	679.919	854,148		0		0		0		0	890,061
11/13		0		0	361.994	446,836		0	43.007	54,028		0		0		0	309.125	369,018	869,882
11/14		0	82.944	107,050		0		0	268.281	337,028	128.893	155,477	138.621	175,009		0	58.881	70,289	844,853
11/15	6.144	7,910		0		0		0	38.911	48,882		0		0		0	709.516	846,985	903,777
		0		0		0		0		0		0		0		0		0	0
		0		0		0		0		0		0		0		0		0	0
		0		0		0		0		0		0		0		0		0	0
		0		0		0		0		0		0		0		0		0	0
		0		0		0		0		0		0		0		0		0	0
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		0		0		0		0		0		0		0		0		0	0
		0		0		0		0		0		0		0		0		0	0
		0		0		0		0		0		0		0		0		0	0
		0		0		0		0		0		0		0		0		0	0
		0		0		0		0		0		0		0		0		0	0
		0		0		0		0		0		0		0		0		0	0
		0		0		0		0		0		0		0		0		0	0
		0		0		0		0		0		0		0		0		0	0
		0		0		0		0		0		0		0		0		0	0
		0		0		0		0		0		0		0		0		0	0
		0		0		0		0		0		0		0		0		0	0
		0		0		0		0		0		0		0		0		0	0
TOTALS=	77.827	100202	302.592	390533	3123.543	3855623	743.040	940410	2910.135	3655857	661.490	797922	488.390	614067	297.349	367040	3662.398	4371988	15,093,643

DAILY PRODUCTION REPORT HAYWARD DATE: 11/8/94 ENV. DLS

CALENDAR

LINE I — 7AM-7PM

7AM-7PM	LOADS	#PANELS	SUR FTG	3/8 FTG
1/4		0	0	0
3/8		0	0	0
7/16		0	0	0
15/32	12	576	18432	23040
1/2	185	8880	284160	378871
19/32SE		0	0	0
19/32H		0	0	0
23/32SE		0	0	0
23/32H		0	0	0
			TOTAL	401911

LINE II — 7AM-7PM

7AM-7PM	LOADS	#PANELS	SUR FTG	3/8 FTG
1/4	19	912	29184	19457
3/8		0	0	0
7/16	186	8928	285696	333322
15/32		0	0	0
1/2		0	0	0
19/32SE		0	0	0
19/32H		0	0	0
23/32SE		0	0	0
23/32H		0	0	0
			TOTAL	352778

LINE I — 7PM-7AM

7PM-7AM	LOADS	#PANELS	SUR FTG	3/8 FTG
1/4	25	1200	38400	25601
3/8		0	0	0
7/16	180	8640	276480	322569
15/32		0	0	0
1/2	6	288	9216	12288
19/32SE		0	0	0
19/32H		0	0	0
23/32SE		0	0	0
23/32H		0	0	0
			TOTAL	360458

LINE II — 7PM-7AM

7PM-7AM	LOADS	#PANELS	SUR FTG	3/8 FTG
1/4		0	0	0
3/8		0	0	0
7/16	207	9936	317952	370955
15/32		0	0	0
1/2		0	0	0
19/32SE		0	0	0
19/32H		0	0	0
23/32SE		0	0	0
23/32H		0	0	0
			TOTAL	370955

LINE I TOTALS

	LOADS	#PANELS	SUR FTG	3/8 FTG
1/4	25	1200	38400	25601
3/8	0	0	0	0
7/16	180	8640	276480	322569
15/32	12	576	18432	23040
1/2	191	9168	293376	391158
19/32SE	0	0	0	0
19/32H	0	0	0	0
23/32SE	0	0	0	0
23/32H	0	0	0	0
TOTALS=		19584	626688	762369
		LINE I TOTAL =		762369

LINE II TOTALS

	LOADS	#PANELS	SUR FTG	3/8 FTG
1/4	19	912	29184	19457
3/8	0	0	0	0
7/16	393	18864	603648	704276
15/32	0	0	0	0
1/2	0	0	0	0
19/32SE	0	0	0	0
19/32H	0	0	0	0
23/32SE	0	0	0	0
23/32H	0	0	0	0
TOTALS=		19776	632832	723733
		LINE II TOTAL=		723733

DAILY PLANT TOTAL= 1486102

7AM-7PM TOTAL= 754689

7PM-7AM TOTAL= 731413

LINE I MTD TOTALS		MTD%
1/4	25601	0.4
3/8	193536	3.3
7/16	1593134	27.1
15/32	743040	12.7
1/2	1398749	23.8
19/32SE	158077	2.7
19/32H	209148	3.6
23/32SE	79489	1.4
23/32H	1469082	25.0

WTD #1	5107486
WTD #2	762369
WTD #3	0
WTD #4	0
WTD #5	0
MTD TOTAL	5869855

PLANT WTD

WTD #1	10092182
WTD #2	1486102
WTD #3	0
WTD #4	0
WTD #5	0

PLANT MTD 11578284

LINE II MTD TOTALS		MTD%
1/4	76804	1.3
3/8	173568	3.0
7/16	4793737	84.0
15/32	664320	11.6
1/2	0	0.0
19/32SE	0	0.0
19/32H	0	0.0
23/32SE	0	0.0
23/32H	0	0.0

WTD #1	4984696
WTD #2	723733
WTD #3	0
WTD #4	0
WTD #5	0
MTD TOTAL	5708429

MTD%=

1/4	0.9
3/8	3.2
7/16	55.2
15/32	12.2
1/2	12.1
19/32SE	1.4
19/32H	1.8
23/32SE	0.7
23/32H	12.7

APPENDIX J

PROCEDURES

9. Entropy Environmentalists, Inc. Traverse Point Study. EPA Contract No. 68-02-3172. June 1977. 19 p.

10. Brown, J. and K. Yu. Test Report: Particulate Sampling Strategy in Circular Ducts. Emission Measurement Branch, Emission Standards and Engineering Division. U.S. Environmental Protection Agency, Research Triangle Park, NC. 27711. July 31, 1980. 12 p.

11. Hawksley, P.G.W., S. Badzioch, and J.H. Blackett. Measurement of Solids in Flue Gases. Leatherhead, England. The British Coal Utilisation Research Association, 1961. p. 129-133.

12. Knapp, K.T. The Number of Sampling Points Needed for Representative Source Sampling. In: Proceedings of the Fourth National Conference on Energy and the Environment. Theodore, L., et al. (ed.). Dayton, Dayton Section of the American Institute of Chemical Engineers. October 3-7, 1976. p. 563-568.

13. Smith, W.S. and D.J. Grove. A Proposed Extension of EPA Method 1 Criteria. "Pollution Engineering." *XV* (8):36-37. August 1983.

14. Gerhart, P.M. and M.J. Dorsey. Investigation of Field Test Procedures for Large Fans. *University of* Akron. Akron, OH. (EPRI Contract CS-1651). Final Report (RP-1649-5) December 1980.

15. Smith, W.S. and D.J. Grove. A New Look at Isokinetic Sampling—Theory and Applications. "Source Evaluation Society Newsletter." *VIII* (3):19-24. August 1983.

Method 2—Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)

1. *Principle and Applicability*

1.1 Principle. The average gas velocity in a stack is determined from the gas density and from measurement of the average velocity head with a Type S (Stausscheibe or reverse type) pitot tube.

1.2 Applicability. This method is applicable for measurement of the average velocity of a gas stream and for quantifying gas flow.

This procedure is not applicable at measurement sites which fail to meet the criteria of Method 1, Section 2.1. Also, the method cannot be used for direct measurement in cyclonic or swirling gas streams; Section 2.4 of Method 1 shows how to determine cyclonic or swirling flow conditions. When unacceptable conditions exist, alternative procedures, subject to the approval of the Administrator, U.S. Environmental Protection Agency, must be employed to make accurate flow rate determinations; examples of such alternative procedures are: (1) to install straightening vanes; (2) to calculate the total volumetric flow rate stoichiometrically, or (3) to move to another measurement site at which the flow is acceptable.

2. *Apparatus*

Specifications for the apparatus are given below. Any other apparatus that has been demonstrated (subject to approval of the Administrator) to be capable of meeting the specifications will be considered acceptable.

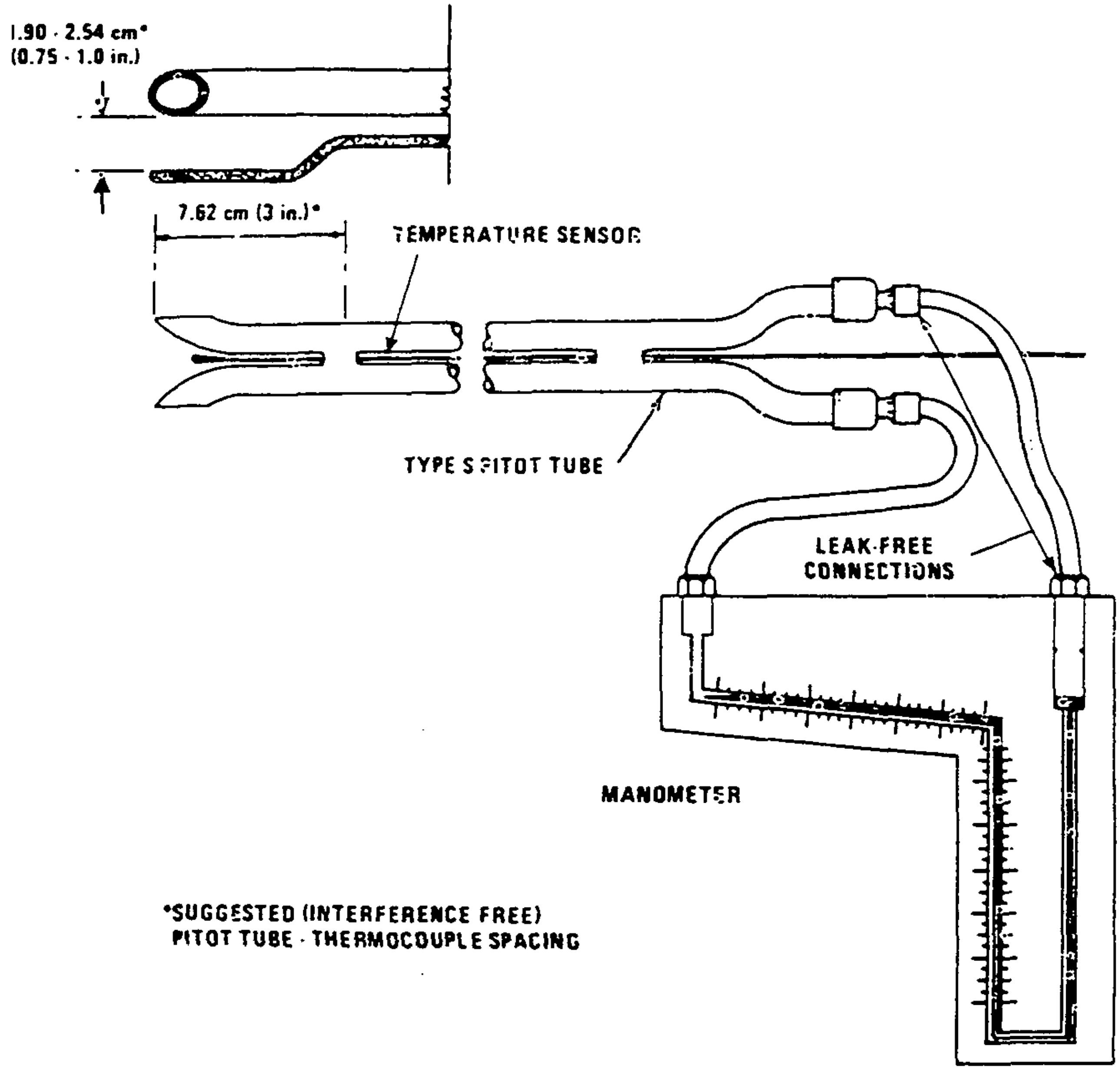
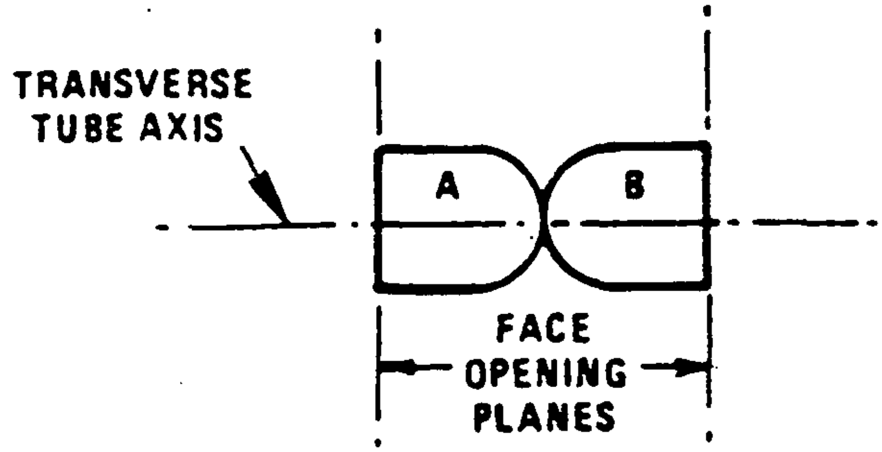


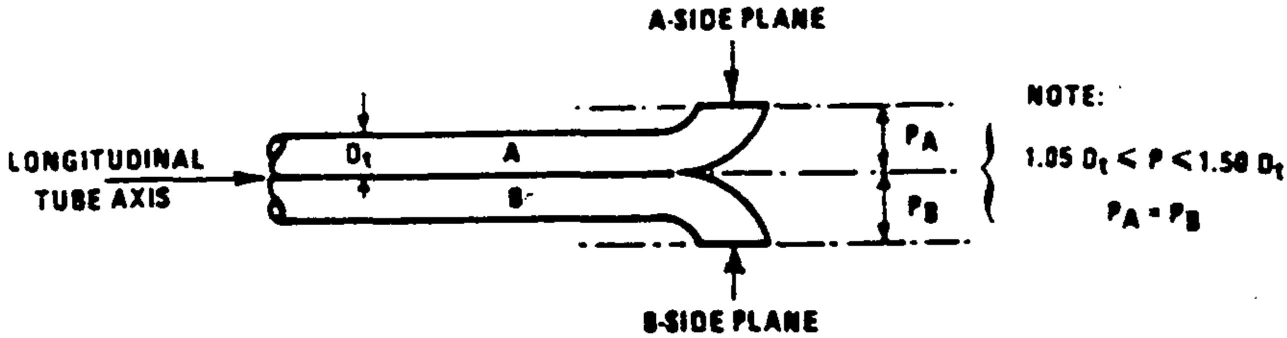
Figure 2-1. Type S pitot tube manometer assembly.

2.1 Type S Pitot Tube. The Type S pitot tube (Figure 2-1) shall be made of metal tubing (e.g., stainless steel). It is recommended that the external tubing diameter (dimension D_t Figure 2-2b) be between 0.48 and 0.95 centimeter ($\frac{3}{16}$ and $\frac{3}{8}$ inch). There shall be an equal distance from the base of each leg of the pitot tube to its face-opening plane (dimensions P_A and P_B Figure 2-2b); it is recommended that this distance be between 1.05 and 1.50 times the external tubing diameter. The face openings of the pitot tube shall, preferably, be aligned as shown in Figure 2-2; however, slight misalignments of the openings are permissible (see Figure 2-3).

The Type S pitot tube shall have a known coefficient, determined as outlined in Section 4. An identification number shall be assigned to the pitot tube; this number shall be permanently marked or engraved on the body of the tube.



(a)



(b)

(c)

Figure 2-2. Properly constructed Type S pitot tube, shown in: (a) end view; face opening planes perpendicular to transverse axis; (b) top view; face opening planes parallel to longitudinal axis; (c) side view; both legs of equal length and centerlines coincident, when viewed from both sides. Baseline coefficient values of 0.84 may be assigned to pitot tubes constructed this way.

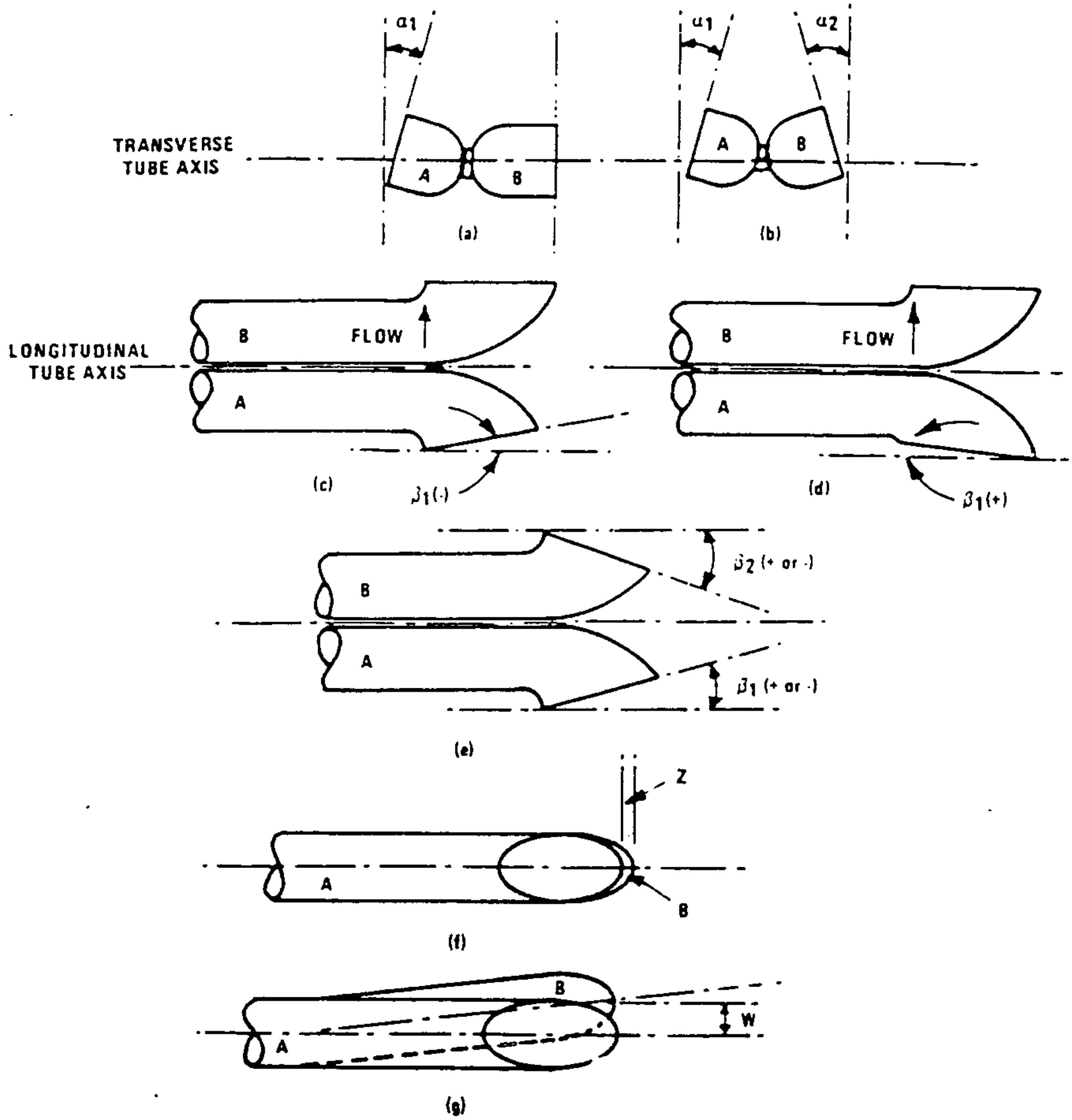


Figure 2-3. Types of face-opening misalignment that can result from field use or improper construction of Type S pitot tubes. These will not affect the baseline value of Cp(s) so long as $\alpha 1$ and $\alpha 2 < 10°$, $\beta 1$ and $\beta 2 < 5°$, $z < 0.32$ cm (1/8 in.) and $w < 0.08$ cm (1/32 in.) (citation 11 in Section 6).

A standard pitot tube may be used instead of a Type S, provided that it meets the specifications of Sections 2.7 and 4.2; note, however, that the static and impact pressure holes of standard pitot tubes are susceptible to plugging in particulate-laden gas streams. Therefore, whenever a standard pitot tube is used to perform a traverse, adequate proof must be furnished that the openings of the pitot tube have not plugged up during the traverse period; this can be done by taking a velocity head (Δp) reading at the final traverse point, cleaning out the impact and static holes of the standard pitot tube by "back-purging" with pressurized air, and then taking another Δp reading. If the Δp readings made before and after the air purge are the same (±5 percent), the traverse is acceptable. Otherwise, reject the run. Note that if Δp at the final traverse point is unsuitably low, another point may be selected. If "back-purging" at regular intervals is part of the procedure, then comparative Δp readings shall be taken, as above, for the last two back purges at which suitably high Δp readings are observed.

2.2 Differential Pressure Gauge. An inclined manometer or equivalent device is used. Most sampling trains are equipped with a 10-in. (water column) inclined-vertical manometer, having 0.01-in. H_2O divisions on the 0-to 1-in. inclined scale, and 0.1-in. H_2O divisions on the 1- to 10-in. vertical scale. This type of manometer (or other gauge of equivalent sensitivity) is satisfactory for the measurement of Δp values as low as 1.3 mm (0.05 in.) H_2O. However, a differential pressure gauge of greater sensitivity shall be used (subject to the approval of the Administrator), if any of the following is found to be true: (1) the arithmetic average of all Δp readings at the traverse points in the stack is less than 1.3 mm (0.05 in.) H_2O; (2) for traverses of 12 or more points, more than 10 percent of the individual Δp readings are below 1.3 mm (0.05 in.) H_2O; (3) for traverses of fewer than 12 points, more than one Δp reading is below 1.3 mm (0.05 in.) H_2O. Citation 18 in Section 6 describes commercially available instrumentation for the measurement of low-range gas velocities.

As an alternative to criteria (1) through (3) above, the following calculation may be performed to determine the necessity of using a more sensitive differential pressure gauge:

$$T = \frac{\sum_{i=1}^{n} \sqrt{\Delta p_i + K}}{\sum_{i=1}^{n} \sqrt{\Delta p_i}}$$

Where:

Δp_i = Individual velocity head reading at a traverse point, mm H_2O (in. H_2O).

n = Total number of traverse points.

K = 0.13 mm H_2O when metric units are used and 0.005 in. H_2O when English units are used.

If T is greater than 1.05, the velocity head data are unacceptable and a more sensitive differential pressure gauge must be used.

NOTE: If differential pressure gauges other than inclined manometers are used (e.g., magnehelic gauges), their calibration must be checked after each test series. To check the calibration of a differential pressure gauge, compare Δp readings of the gauge with those of a gauge-oil manometer at a minimum of three points, approximately representing the range of Δp values in the stack. If, at each point, the values of Δp as read by the differential pressure gauge and gauge-oil manometer agree to within 5 percent, the differential pressure gauge shall be considered to be in proper calibration. Otherwise, the test series shall either be voided, or procedures to adjust the measured Δp values and final results shall be used subject to the approval of the Administrator.

2.3 Temperature Gauge. A thermocouple, liquid-filled bulb thermometer, bimetallic thermometer, mercury-in-glass thermometer, or other gauge, capable of measuring temperature to within 1.5 percent of the minimum absolute stack temperature shall be used. The temperature gauge shall be attached to the pitot tube such that the sensor tip does not touch any metal; the gauge shall be in an interference-free arrangement with respect to the pitot tube face openings (see Figure 2-1 and also Figure 2-7 in Section 4). Alternate positions may be used if the pitot tube-temperature gauge system is calibrated according to the procedure of Section 4. Provided that a difference of not more than 1 percent in the average velocity measurement is introduced, the temperature gauge need not be attached to the pitot tube; this alternative is subject to the approval of the Administrator.

2.4 Pressure Probe and Gauge. A piezometer tube and mercury- or water-filled U-tube manometer capable of measuring stack pressure to within 2.5 mm (0.1 in.) Hg is used. The static tap of a standard type pitot tube or one leg of a Type S pitot tube with the face opening planes positioned parallel to the gas flow may also be used as the pressure probe.

2.5 Barometer. A mercury, aneroid, or other barometer capable of measuring atmospheric pressure to within 2.5 mm Hg (0.1 in. Hg) may be used. 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 the sampling point shall be applied at a rate of minus 2.5 mm (0.1 in.) Hg per 30-meter (100 foot) elevation increase or vice-versa for elevation decrease.

2.6 Gas Density Determination Equipment. Method 3 equipment, if needed (see Section 3.6), to determine the stack gas dry molecular weight, and Reference Method 4 or Method 5 equipment for moisture content determination; other methods may be used subject to approval of the Administrator.

2.7 Calibration Pitot Tube. When calibration of the Type S pitot tube is necessary (see Section 4), a standard pitot tube is used as a reference. The standard pitot tube shall, preferably, have a known coefficient, obtained either (1) directly from the National Bureau of Standards, Route 270, Quince Orchard Road, Gaithersburg, Maryland, or (2) by calibration against another standard pitot tube with an NBS-traceable coefficient. Alternatively, a standard pitot tube designed according to the criteria given in 2.7.1 through 2.7.5 below and illustrated in Figure 2-4 (see also Citations 7, 8, and 17 in Section 6) may be used. Pitot tubes designed according to these specifications will have baseline coefficients of about 0.99±0.01.

2.7.1 Hemispherical (shown in Figure 2-4), ellipsoidal, or conical tip.

2.7.2 A minimum of six diameters straight run (based upon *D*, the external diameter of the tube) between the tip and the static pressure holes.

2.7.3 A minimum of eight diameters straight run between the static pressure holes and the centerline of the external tube, following the 90 degree bend.

2.7.4 Static pressure holes of equal size (approximately 0.1 *D*), equally spaced in a piezometer ring configuration.

2.7.5 Ninety degree bend, with curved or mitered junction.

2.8 Differential Pressure Gauge for Type S Pitot Tube Calibration. An inclined manometer or equivalent is used. If the single-velocity calibration technique is employed (see Section 4.1.2.3), the calibration differential pressure gauge shall be readable to the nearest 0.13 mm H_2O (0.005 in. H_2O). For multivelocity calibrations, the gauge shall be readable to the nearest 0.13 mm H_2O (0.005 in. H_2O) for Δp values between 1.3 and 25 mm H_2O (0.05 and 1.0 in. H_2O), and to the nearest 1.3 mm H_2O (0.05 in. H_2O) for Δp values above 25 mm H_2O (1.0 in. H_2O). A special, more sensitive gauge will be required to read Δp values below 1.3 mm H_2O [0.05 in. H_2O] (see Citation 18 in Section 6).

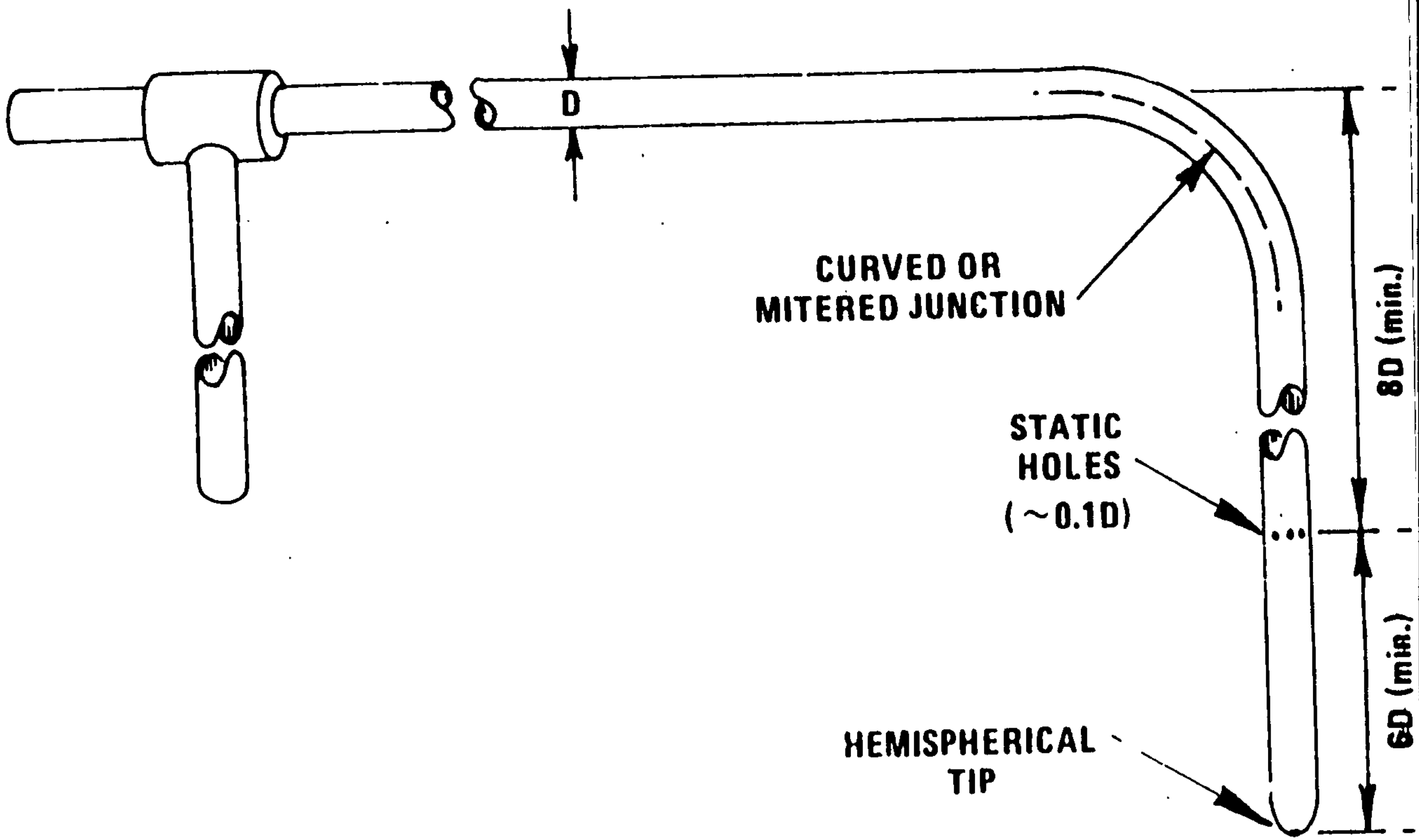


Figure 2-4. Standard pitot tube design specifications.

3. *Procedure*

3.1 Set up the apparatus as shown in Figure 2-1. Capillary tubing or surge tanks installed between the manometer and pitot tube may be used to dampen Δp fluctuations. It is recommended, but not required, that a pretest leak-check be conducted, as follows: (1) blow through the pitot impact opening until at least 7.6 cm (3 in.) H_2O velocity pressure registers on the manometer; then, close off the impact opening. The pressure shall remain stable for at least 15 seconds; (2) do the same for the static pressure side, except using suction to obtain the minimum of 7.6 cm (3 in.) H_2O. Other leak-check procedures, subject to the approval of the Administrator, may be used.

3.2 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. Record all necessary data as shown in the example data sheet (Figure 2-5).

3.3 Measure the velocity head and temperature at the traverse points specified by Method 1. Ensure that the proper differential pressure gauge is being used for the range of Δp values encountered (see Section 2.2). If it is necessary to change to a more sensitive gauge, do so, and remeasure the Δp and temperature readings at each traverse point. Conduct a post-test leak-check (mandatory), as described in Section 3.1 above, to validate the traverse run.

3.4 Measure the static pressure in the stack. One reading is usually adequate.

3.5 Determine the atmospheric pressure.

PLANT ____________________

DATE ____________ RUN NO. ____________

STACK DIAMETER OR DIMENSIONS, m(in.) ____________

BAROMETRIC PRESSURE, mm Hg (in. Hg) ____________

CROSS SECTIONAL AREA, m^2 (ft^2) ____________

OPERATORS ____________

PITOT TUBE I.D. NO. ____________

AVG. COEFFICIENT, C_p = ____________

LAST DATE CALIBRATED ____________

SCHEMATIC OF STACK CROSS SECTION

Traverse Pt. No.	Vel. Hd., Δp mm (in.) H_2O	Stack Temperature		P_g mm Hg (in.Hg)	$\sqrt{\Delta p}$
		t_s, °C (°F)	T_s, °K (°R)		
		Average			

Figure 2-5. Velocity traverse data.

3.6 Determine the stack gas dry molecular weight. For combustion processes or processes that emit essentially CO_2, O_2, CO, and N_2, use Method 3. For processes emitting essentially air, an analysis need not be conducted; use a dry molecular weight of 29.0. For other processes, other methods, subject to the approval of the Administrator, must be used.

3.7 Obtain the moisture content from Reference Method 4 (or equivalent) or from Method 5.

3.8 Determine the cross-sectional area of the stack or duct at the sampling location. Whenever possible, physically measure the stack dimensions rather than using blueprints.

4. *Calibration*

4.1 Type S Pitot Tube. Before its initial use, carefully examine the Type S pitot tube in top, side, and end views to verify that the face openings of the tube are aligned within the specifications illustrated in Figure 2-2 or 2-3. The pitot tube shall not be used if it fails to meet these alignment specifications.

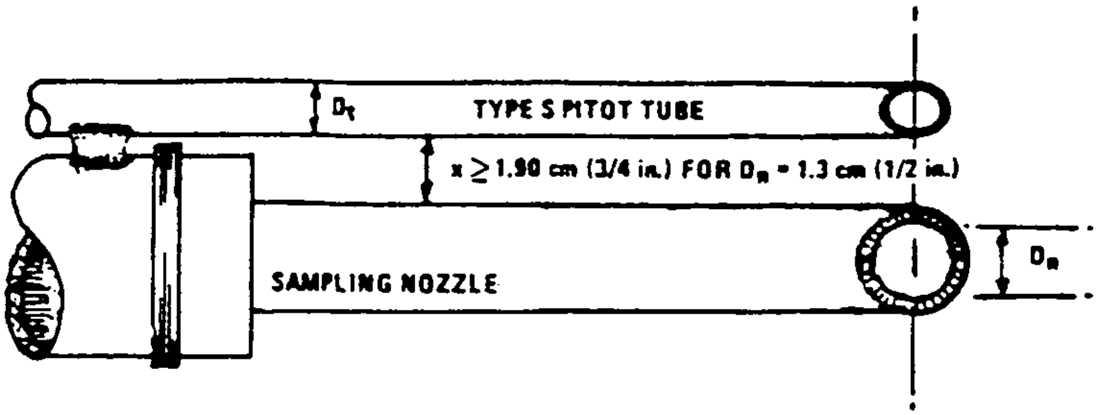
After verifying the face opening alignment, measure and record the following dimensions of the pitot tube: (a) the external tubing diameter (dimension D_t, Figure 2-2b); and (b) the base-to-opening plane distances (dimensions P_A and P_B, Figure 2-2b). If D_t is between 0.48 and 0.95 cm (3/16 and 3/8 in.) and if P_A and P_B are equal and between 1.05 and 1.50 D_t, there are two possible options: (1) the pitot tube may be calibrated according to the procedure outlined in Sections 4.1.2 through 4.1.5 below, or (2) a baseline (isolated tube) coefficient value of 0.84 may be assigned to the pitot tube. Note, however, that if the pitot tube is part of an assembly, calibration may still be required, despite knowledge of the baseline coefficient value (see Section 4.1.1).

If D_t, P_A, and P_B are outside the specified limits, the pitot tube must be calibrated as outlined in 4.1.2 through 4.1.5 below.

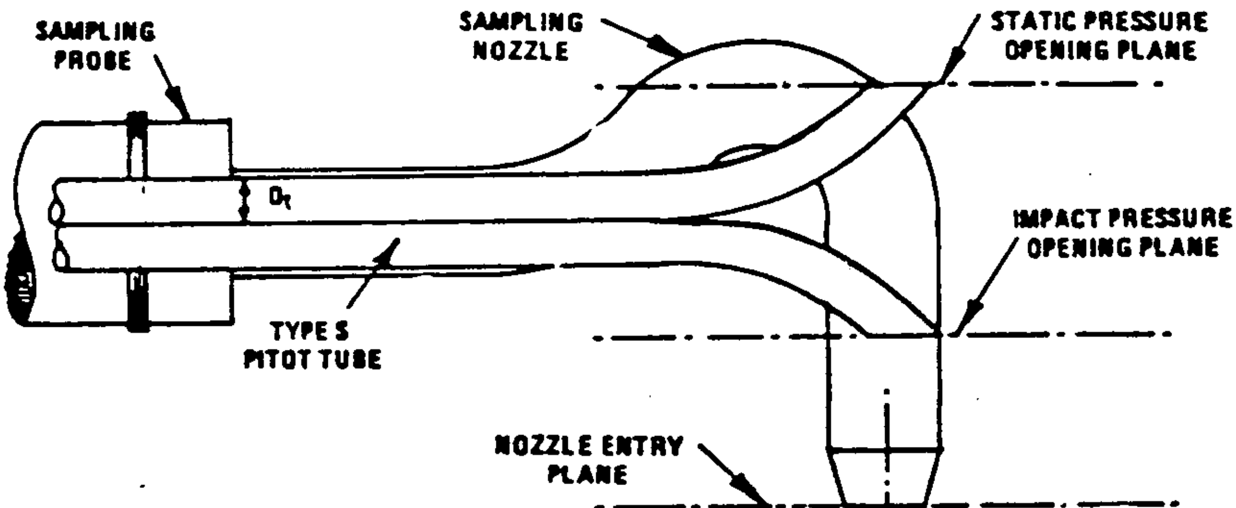
4.1.1 Type S Pitot Tube Assemblies. During sample and velocity traverses, the isolated Type S pitot tube is not always used; in many instances, the pitot tube is used in combination with other source-sampling components (thermocouple, sampling probe, nozzle) as part of an "assembly." The presence of other sampling components can sometimes affect the baseline value of the Type S pitot tube coefficient (Citation 9 in Section 6); therefore an assigned (or otherwise known) baseline coefficient value may or may not be valid for a given assembly. The baseline and assembly coefficient values will be identical only when the relative placement of the components in the assembly is such that aerodynamic interference effects are eliminated. Figures 2-6 through 2-8 illustrate interference-free component arrangements for Type S pitot tubes having external tubing diameters between 0.48 and 0.95 cm (3/16 and 3/8 in.). Type S pitot tube assemblies that fail to meet any or all of the specifications of Figures 2-6 through 2-8 shall be calibrated according to the procedure outlined in Sections 4.1.2 through 4.1.5 below, and prior to calibration, the values of the intercomponent spacings (pitot-nozzle, pitot-thermocouple, pitot-probe sheath) shall be measured and recorded.

NOTE: Do not use any Type S pitot tube assembly which is constructed such that the impact pressure opening plane of the pitot tube is below the entry plane of the nozzle (see Figure 2-6b).

4.1.2 Calibration Setup. If the Type S pitot tube is to be calibrated, one leg of the tube shall be permanently marked A, and the other, B. Calibration shall be done in a flow system having the following essential design features:



A. BOTTOM VIEW; SHOWING MINIMUM PITOT-NOZZLE SEPARATION.



B. SIDE VIEW; TO PREVENT PITOT TUBE FROM INTERFERING WITH GAS FLOW STREAMLINES APPROACHING THE NOZZLE, THE IMPACT PRESSURE OPENING PLANE OF THE PITOT TUBE SHALL BE EVEN WITH OR ABOVE THE NOZZLE ENTRY PLANE.

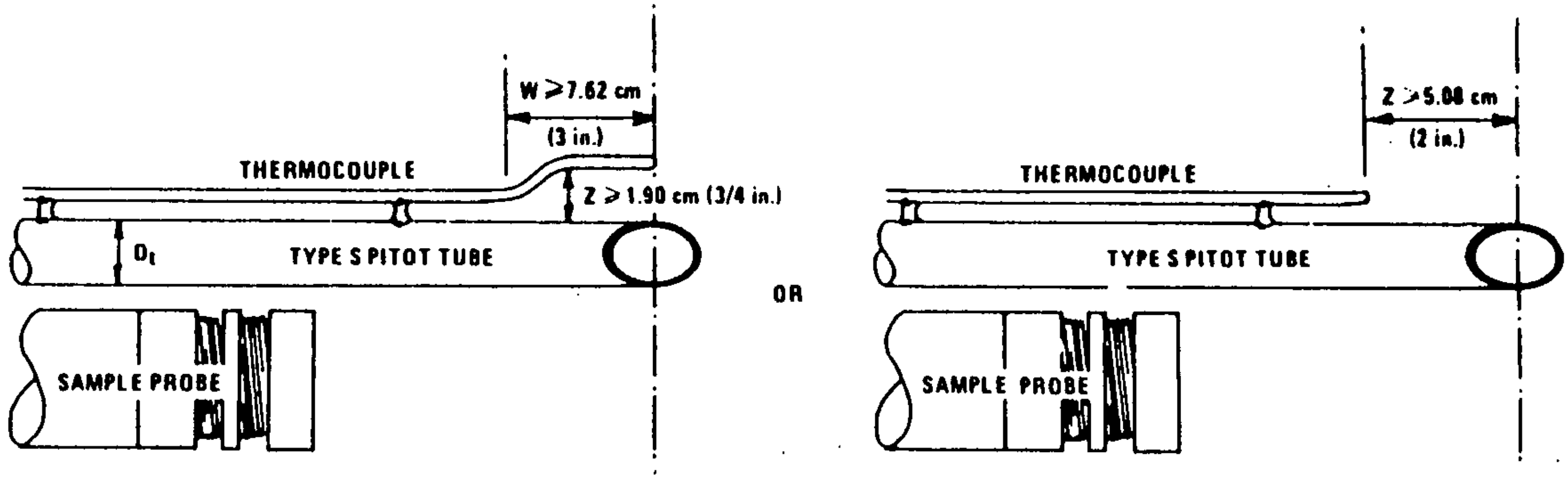


Figure 2-7. Proper thermocouple placement to prevent interference; D_t between 0.48 and 0.95 cm (3/16 and 3/8 in.).

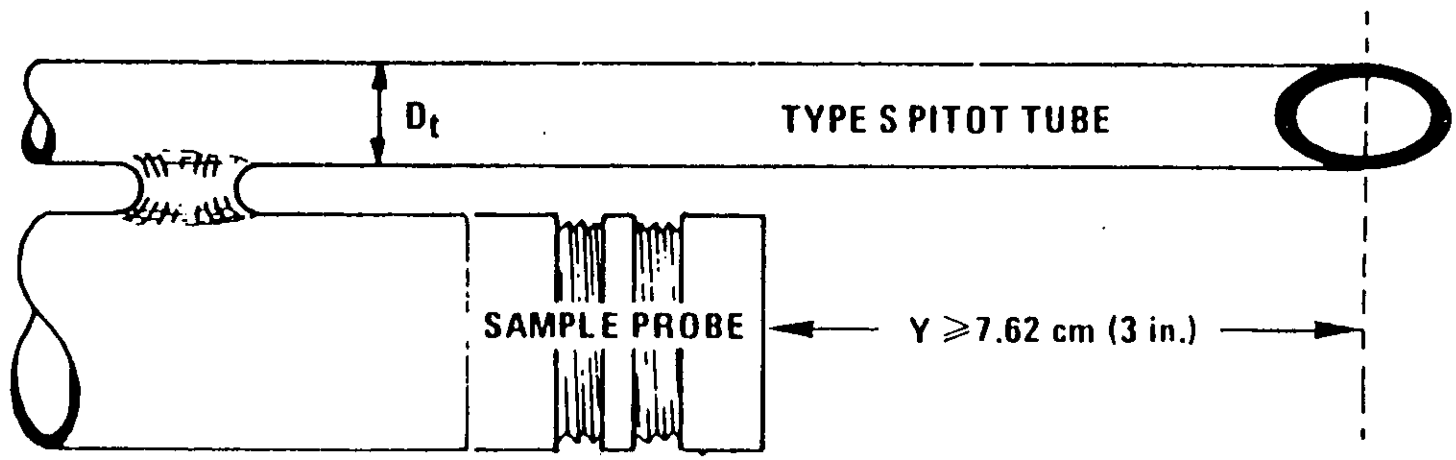


Figure 2-8. Minimum pitot-sample probe separation needed to prevent interference; D_t between 0.48 and 0.95 cm (3/16 and 3/8 in.).

4.1.2.1 The flowing gas stream must be confined to a duct of definite cross-sectional area, either circular or rectangular. For circular cross-sections, the minimum duct diameter shall be 30.5 cm (12 in.); for rectangular cross-sections, the width (shorter side) shall be at least 25.4 cm (10 in.).

4.1.2.2 The cross-sectional area of the calibration duct must be constant over a distance of 10 or more duct diameters. For a rectangular cross-section, use an equivalent diameter, calculated from the following equation, to determine the number of duct diameters:

$$D_e = \frac{2LW}{(L+W)} \qquad \text{Eq. 2-1}$$

Where:
D_e = Equivalent diameter
L = Length
W = Width

To ensure the presence of stable, fully developed flow patterns at the calibration site, or "test section," the site must be located at least eight diameters downstream and two diameters upstream from the nearest disturbances.

NOTE: The eight- and two-diameter criteria are not absolute; other test section locations may be used (subject to approval of the Administrator), provided that the flow at the test site is stable and demonstrably parallel to the duct axis.

4.1.2.3 The flow system shall have the capacity to generate a test-section velocity around 915 m/min (3,000 ft/min). This velocity must be constant with time to guarantee steady flow during calibration. Note that Type S pitot tube coefficients obtained by single-velocity calibration at 915 m/min (3,000 ft/min) will generally be valid to within ±3 percent for the measurement of velocities above 305 m/min (1,000 ft/min) and to within ±5 to 6 percent for the measurement of velocities between 180 and 305 m/min (600 and 1,000 ft/min). If a more precise correlation between C_p and velocity is desired, the flow system shall have the capacity to generate at least four distinct, time-invariant test-section velocities covering the velocity range from 180 to 1,525 m/min (600 to 5,000 ft/min), and calibration data shall be taken at regular velocity intervals over this range (see Citations 9 and 14 in Section 6 for details).

4.1.2.4 Two entry ports, one each for the standard and Type S pitot tubes, shall be cut in the test section; the standard pitot entry port shall be located slightly downstream of the Type S port, so that the standard and Type S impact openings will lie in the same cross-sectional plane during calibration. To facilitate alignment of the pitot tubes during calibration, it is advisable that the test section be constructed of plexiglas or some other transparent material.

4.1.3 Calibration Procedure. Note that this procedure is a general one and must not be used without first referring to the special considerations presented in Section 4.1.5. Note also that this procedure applies only to single-velocity calibration. To obtain calibration data for the A and B sides of the Type S pitot tube, proceed as follows:

4.1.3.1 Make sure that the manometer is properly filled and that the oil is free from contamination and is of the proper density. Inspect and leak-check all pitot lines; repair or replace if necessary.

4.1.3.2 Level and zero the manometer. Turn on the fan and allow the flow to stabilize. Seal the Type S entry port.

4.1.3.3 Ensure that the manometer is level and zeroed. Position the standard pitot tube at the calibration point (determined as outlined in Section 4.1.5.1), and align the tube so that its tip is pointed directly into the flow. Particular care should be taken in aligning the tube to avoid yaw and pitch angles. Make sure that the entry port surrounding the tube is properly sealed.

4.1.3.4 Read Δp_{std} and record its value in a data table similar to the one shown in Figure 2-9. Remove the standard pitot tube from the duct and disconnect it from the manometer. Seal the standard entry port.

4.1.3.5 Connect the Type S pitot tube to the manometer. Open the Type S entry port. Check the manometer level and zero. Insert and align the Type S pitot tube so that its A side impact opening is at the same point as was the standard pitot tube and is pointed directly into the flow. Make sure that the entry port surrounding the tube is properly sealed.

4.1.3.6 Read Δp_s and enter its value in the data table. Remove the Type S pitot tube from the duct and disconnect it from the manometer.

4.1.3.7 Repeat steps 4.1.3.3 through 4.1.3.6 above until three pairs of Δp readings have been obtained.

4.1.3.8 Repeat steps 4.1.3.3 through 4.1.3.7 above for the B side of the Type S pitot tube.

4.1.3.9 Perform calculations, as described in Section 4.1.4 below.

4.1.4 Calculations.

4.1.4.1 For each of the six pairs of Δp readings (i.e., three from side A and three from side B) obtained in Section 4.1.3 above, calculate the value of the Type S pitot tube coefficient as follows:

PITOT TUBE IDENTIFICATION NUMBER: ______________ DATE: ______________

CALIBRATED BY: ______________________________

	"A" SIDE CALIBRATION			
RUN NO.	Δp_{std} cm H_2O (in. H_2O)	$\Delta p_{(s)}$ cm H_2O (in. H_2O)	$C_{p(s)}$	DEVIATION $C_{p(s)} - \bar{C}_p(A)$
1				
2				
3				
		$\bar{C}_p$ (SIDE A)		

	"B" SIDE CALIBRATION			
RUN NO.	Δp_{std} cm H_2O (in. H_2O)	$\Delta p_{(s)}$ cm H_2O (in. H_2O)	$C_{p(s)}$	DEVIATION $C_{p(s)} - \bar{C}_p(B)$
1				
2				
3				
		$\bar{C}_p$ (SIDE B)		

$$\text{AVERAGE DEVIATION} = \sigma\,(\text{A OR B}) = \frac{\sum_{1}^{3} \left| C_p(s) - \bar{C}_p(\text{A OR B}) \right|}{3} \longleftarrow \text{MUST BE} \leq 0.01$$

$$\left| \bar{C}_p\,(\text{SIDE A}) - \bar{C}_p\,(\text{SIDE B}) \right| \longleftarrow \text{MUST BE} \leq 0.01$$

Figure 2-9. Pitot tube calibration data.

$$C_{p(s)} = C_{p(std)} \sqrt{\frac{\Delta p_{std}}{\Delta p_s}}$$

Equation 2-2

Where:

$C_{p(s)}$ = Type S pitot tube coefficient

$C_{p(std)}$ = Standard pitot tube coefficient; use 0.99 if the coefficient is unknown and the tube is designed according to the criteria of Sections 2.7.1 to 2.7.5 of this method.

Δp_{std} = Velocity head measured by the standard pitot tube, cm H_2O (in. H_2O)

Δp_s = Velocity head measured by the Type S pitot tube, cm H_2O (in. H_2O)

4.1.4.2 Calculate $\overline{C}_p$ (side A), the mean A-side coefficient, and $\overline{C}_p$ (side B), the mean B-side coefficient; calculate the difference between these two average values.

4.1.4.3 Calculate the deviation of each of the three A-side values of $C_{p(s)}$ from $\overline{C}_p$ (side A), and the deviation of each B-side value of $C_{p(s)}$ from $\overline{C}_p$ (side B). Use the following equation:

$$\text{Deviation} = C_{p(s)} - \overline{C}_p(\text{A or B})$$

Equation 2-3

4.1.4.4 Calculate δ, the average deviation from the mean, for both the A and B sides of the pitot tube. Use the following equation:

$$\sigma \text{ (side A or B)} = \frac{\sum_{1}^{3} |C_{p(s)} - \overline{C}_p(A \text{ or } B)|}{3}$$

Equation 2-4

4.1.4.5 Use the Type S pitot tube only if the values of δ (side A) and δ (side B) are less than or equal to 0.01 and if the absolute value of the difference between $\overline{C}_p$ (A) and $\overline{C}_p$ (B) is 0.01 or less.

4.1.5 Special considerations.

4.1.5.1 Selection of calibration point.

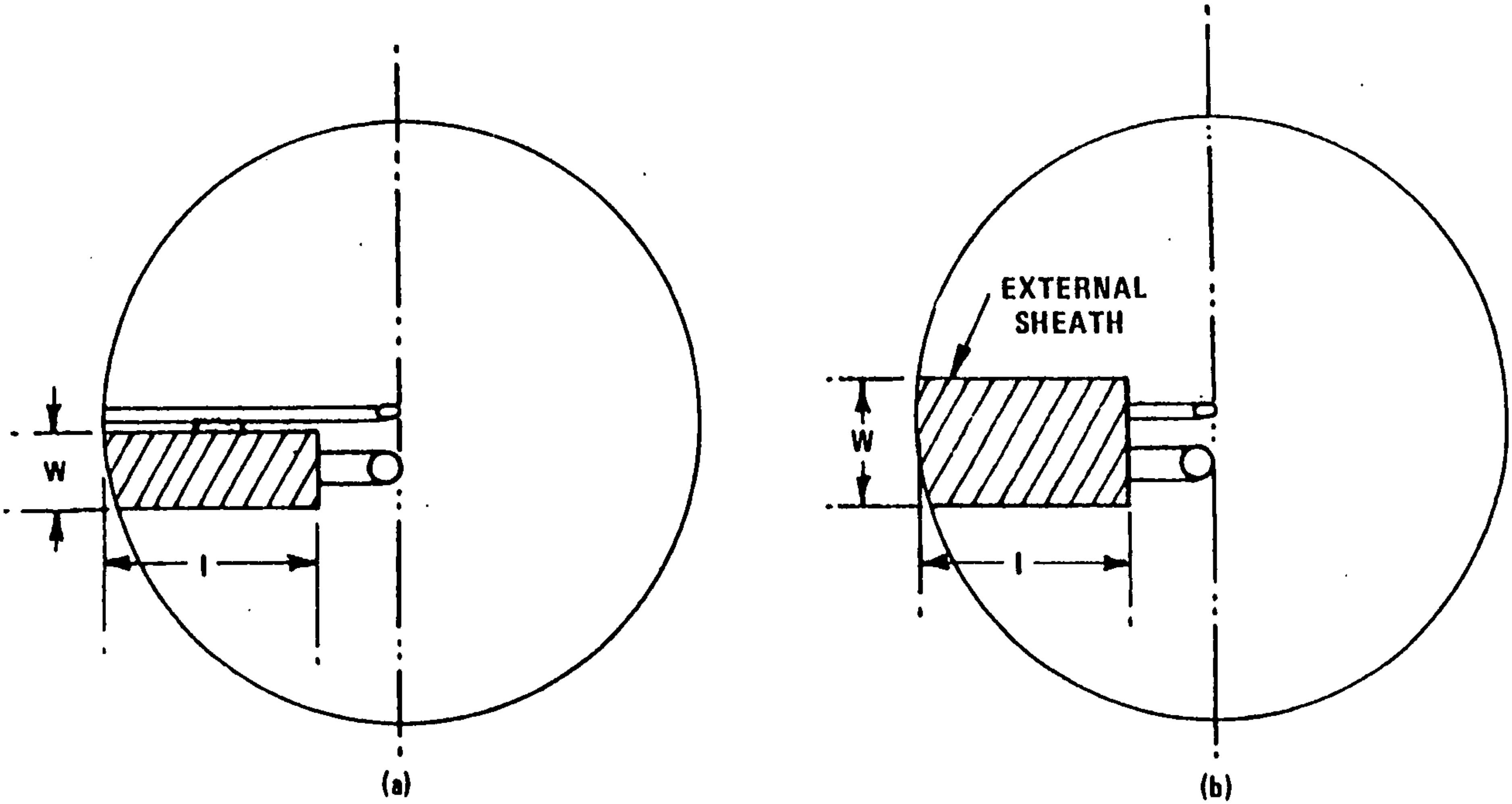
4.1.5.1.1 When an isolated Type S pitot tube is calibrated, select a calibration point at or near the center of the duct, and follow the procedures outlined in Sections 4.1.3 and 4.1.4 above. The Type S pitot coefficients so obtained, i.e., $\overline{C}_p$ (side A) and $\overline{C}_p$ (side B), will be valid, so long as either: (1) the isolated pitot tube is used; or (2) the pitot tube is used with other components (nozzle, thermocouple, sample probe) in an arrangement that is free from aerodynamic interference effects (see Figures 2-6 through 2-8).

4.1.5.1.2 For Type S pitot tube-thermocouple combinations (without sample probe), select a calibration point at or near the center of the duct, and follow the procedures outlined in Sections 4.1.3 and 4.1.4 above. The coefficients so obtained will be valid so long as the pitot tube-thermocouple combination is used by itself or with other components in an interference-free arrangement (Figures 2-6 and 2-8).

4.1.5.1.3 For assemblies with sample probes, the calibration point should be located at or near the center of the duct; however, insertion of a probe sheath into a small duct may cause significant cross-sectional area blockage and yield incorrect coefficient values (Citation 9 in Section 6). Therefore, to minimize the blockage effect, the calibration point may be a few inches off-center if necessary. The actual blockage effect will be negligible when the theoretical blockage, as determined by a projected-area model of the probe sheath, is 2 percent or less of the duct cross-sectional area for assemblies without external sheaths (Figure 2-10a), and 3 percent or less for assemblies with external sheaths (Figure 2-10b).

4.1.5.2 For those probe assemblies in which pitot tube-nozzle interference is a factor (i.e., those in which the pitot-nozzle separation distance fails to meet the specification illustrated in Figure 2-6a), the value of $C_{p(s)}$ depends upon the amount of free-space between the tube and nozzle, and therefore is a function of nozzle size. In these instances, separate calibrations shall be performed with each of the commonly used nozzle sizes in place. Note that the single-velocity calibration technique is acceptable for this purpose, even though the larger nozzle sizes (>0.635 cm or ¼ in.) are not ordinarily used for isokinetic sampling at velocities around 915 m/min (3,000 ft/min), which is the calibration velocity; note also that it is not necessary to draw an isokinetic sample during calibration (see Citation 19 in Section 6).

4.1.5.3 For a probe assembly constructed such that its pitot tube is always used in the same orientation, only one side of the pitot tube need be calibrated (the side which will face the flow). The pitot tube must still meet the alignment specifications of Figure 2-2 or 2-3, however, and must have an average deviation (δ) value of 0.01 or less (see Section 4.1.4.4).



$$\text{ESTIMATED SHEATH BLOCKAGE (\%)} = \left[\frac{l \times W}{\text{DUCT AREA}}\right] \times 100$$

Figure 2-10. Projected-area models for typical pitot tube assemblies.

4.1.6 Field Use and Recalibration.

4.1.6.1 Field Use.

4.1.6.1.1 When a Type S pitot tube (isolated tube or assembly) is used in the field, the appropriate coefficient value (whether assigned or obtained by calibration) shall be used to perform velocity calculations. For calibrated Type S pitot tubes, the A side coefficient shall be used when the A side of the tube faces the flow, and the B side coefficient shall be used when the B side faces the flow; alternatively, the arithmetic average of the A and B side coefficient values may be used, irrespective of which side faces the flow.

4.1.6.1.2 When a probe assembly is used to sample a small duct (12 to 36 in. in diameter), the probe sheath sometimes blocks a significant part of the duct cross-section, causing a reduction in the effective value of $C_{p(s)}$. Consult Citation 9 in Section 6 for details. Conventional pitot-sampling probe assemblies are not recommended for use in ducts having inside diameters smaller than 12 inches (Citation 16 in Section 6).

4.1.6.2 Recalibration.

4.1.6.2.1 Isolated Pitot Tubes. After each field use, the pitot tube shall be carefully reexamined in top, side, and end views. If the pitot face openings are still aligned within the specifications illustrated in Figure 2-2 or 2-3, it can be assumed that the baseline coefficient of the pitot tube has not changed. If, however, the tube has been damaged to the extent that it no longer meets the specifications of Figure 2-2 or 2-3, the damage shall either be repaired to restore proper alignment of the face openings or the tube shall be discarded.

4.1.6.2.2 Pitot Tube Assemblies. After each field use, check the face opening alignment of the pitot tube, as in Section 4.1.6.2.1; also, remeasure the intercomponent spacings of the assembly. If the intercomponent spacings have not changed and the face opening alignment is acceptable, it can be assumed that the coefficient of the assembly has not changed. If the face opening alignment is no longer within the specifications of Figures 2-2 or 2-3, either repair the damage or replace the pitot tube (calibrating the new assembly, if necessary). If the intercomponent spacings have changed, restore the original spacings or recalibrate the assembly.

4.2 Standard pitot tube (if applicable). If a standard pitot tube is used for the velocity traverse, the tube shall be constructed according to the criteria of Section 2.7 and shall be assigned a baseline coefficient value of 0.99. If the standard pitot tube is used as part of an assembly, the tube shall be in an interference-free arrangement (subject to the approval of the Administrator).

4.3 Temperature Gauges. After each field use, calibrate dial thermometers, liquid-filled bulb thermometers, thermocouple-potentiometer systems, and other gauges at a temperature within 10 percent of the average absolute stack temperature. For temperatures up to 405° C (761° F), use an ASTM mercury-in-glass reference thermometer, or equivalent, as a reference; alternatively, either a reference thermocouple and potentiometer (calibrated by NBS) or thermometric fixed points, e.g., ice bath and boiling water (corrected for barometric pressure) may be used. For temperatures above 405° C (761° F), use an NBS-calibrated reference thermocouple-potentiometer system or an alternate reference, subject to the approval of the Administrator.

If, during calibration, the absolute temperatures measured with the gauge being calibrated and the reference gauge agree within 1.5 percent, the temperature data taken in the field shall be considered valid. Otherwise, the pollutant emission test shall either be considered invalid or adjustments (if appropriate) of the test results shall be made, subject to the approval of the Administrator.

4.4 Barometer. Calibrate the barometer used against a mercury barometer.

5. *Calculations*

Carry out calculations, retaining at least one extra decimal figure beyond that of the acquired data. Round off figures after final calculation.

5.1 Nomenclature.

A = Cross-sectional area of stack, m^2 (ft^2).

B_{ws} = Water vapor in the gas stream (from Method 5 or Reference Method 4), proportion by volume.

C_p = Pitot tube coefficient, dimensionless.

K_p = Pitot tube constant,

$$34.97\ \frac{\text{m}}{\text{sec}}\left[\frac{(g/g\text{-mole})(\text{mm Hg})}{(°\text{K})(\text{mm H}_2\text{O})}\right]^{1/2}$$

for the metric system and

$$85.49\ \frac{\text{ft}}{\text{sec}}\left[\frac{(\text{lb/lb-mole})(\text{in. Hg})}{(°\text{R})(\text{in. H}_2\text{O})}\right]^{1/2}$$

for the English system.

M_d = Molecular weight of stack gas, dry basis (see Section 3.6) g/g-mole (lb/lb-mole).

M_s = Molecular weight of stack gas, wet basis, g/g-mole (lb/lb-mole).

$= M_d\,(1 - B_{ws}) + 18.0\,B_{ws}$

Eq. 2-5

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

P_g = Stack static pressure, mm Hg (in. Hg).

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

$= P_{bar} + P_g$

Eq. 2-6

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

Q_{sd}=Dry volumetric stack gas flow rate corrected to standard conditions, dscm/hr (dscf/hr).

t_s=Stack temperature, °C (°F).

T_s=Absolute stack temperature, °K, (°R).

$=273+t_s$ for metric.

Eq. 2-7

$=460+t_s$ for English.

Eq. 2-8

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

v_s=Average stack gas velocity, m/sec (ft/sec).

Δ_p=Velocity head of stack gas, mm H_2O (in. H_2O).

3,600=Conversion factor, sec/hr.

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

5.2 Average Stack Gas Velocity.

$$v_s = K_p C_p (\sqrt{\Delta p})_{avg} \sqrt{\frac{T_{s(avg)}}{P_s M_s}}$$

Equation 2-9

5.3 Average Stack Gas Dry Volumetric Flow Rate.

$$Q_{sd} = 3{,}600(1-B_{ws})v_s A \left(\frac{T_{std}}{T_{s\,(avg)}}\right)\left(\frac{P_s}{P_{std}}\right)$$

Eq. 2-10

6. *Bibliography*

1. Mark, L. S. Mechanical Engineers' Handbook. New York, McGraw-Hill Book Co., Inc. 1951.

2. Perry, J. H. Chemical Engineers' Handbook. New York. McGraw-Hill Book Co., Inc. 1960.

3. Shigehara, R. T., W. F. Todd, and W. S. Smith. Significance of Errors in Stack Sampling Measurements. U.S. Environmental Protection Agency, Research Triangle Park, NC (Presented at the Annual Meeting of the Air Pollution Control Association, St. Louis, MO, June 14-19, 1970.)

4. Standard Method for Sampling Stacks for Particulate Matter. In: 1971 Book of ASTM Standards, Part 23. Philadelphia, PA 1971. ASTM Designation D-2928-71.

5. Vennard, J. K. Elementary Fluid Mechanics. New York. John Wiley and Sons, Inc. 1947.

6. Fluid Meters—Their Theory and Application. American Society of Mechanical Engineers, New York, NY 1959.

7. ASHRAE Handbook of Fundamentals. 1972. p. 208.

8. Annual Book of ASTM Standards, Part 26. 1974. p. 648.

9. Vollaro, R. F. Guidelines for Type S Pitot Tube Calibration. U.S. Environmental Protection Agency. Research Triangle Park, NC (Presented at 1st Annual Meeting, Source Evaluation Society, Dayton, OH, September 18, 1975.)

10. Vollaro, R. F. A Type S Pitot Tube Calibration Study. U.S. Environmental Protection Agency, Emission Measurement Branch, Research Triangle Park, NC July 1974.

11. Vollaro, R. F. The Effects of Impact Opening Misalignment on the Value of the Type S Pitot Tube Coefficient. U.S. Environmental Protection Agency, Emission Measurement Branch, Research Triangle Park, NC. October 1976.

12. Vollaro, R. F. Establishment of a Basline Coefficient Value for Properly Constructed Type S Pitot Tubes. U.S. Environmental Protection Agency, Emission Measurement Branch, Research Triangle Park, NC. November 1976.

13. Vollaro, R. F. An Evaluation of Single-Velocity Calibration Technique as a Means of Determining Type S Pitot Tubes Coefficient. U.S. Environmental Protection Agency, Emission Measurement Branch, Research Triangle Park, NC. August 1975.

14. Vollaro, R. F. The Use of Type S Pitot Tubes for the Measurement of Low Velocities. U.S. Environmental Protection Agency, Emission Measurement Branch, Research Triangle Park, NC. November 1976.

15. Smith, Marvin L. Velocity Calibration of EPA Type Source Sampling Probe. United Technologies Corporation, Pratt and Whitney Aircraft Division, East Hartford, CN. 1975.

16. Vollaro, R. F. Recommended Procedure for Sample Traverses in Ducts Smaller than 12 Inches in Diameter. U.S. Environmental Protection Agency, Emission Measurement Branch, Research Triangle Park, NC. November 1976.

17. Ower, E. and R. C. Pankhurst. The Measurement of Air Flow, 4th Ed., London, Pergamon Press. 1966.

18. Vollaro, R. F. A Survey of Commercially Available Instrumentation for the Measurement of Low-Range Gas Velocities. U.S. Environmental Protection Agency, Emission Measurement Branch, Research Triangle Park, NC. November 1976. (Unpublished Paper)

19. Gnyp, A. W., C. C. St. Pierre, D. S. Smith, D. Mozzon, and J. Steiner. An Experimental Investigation of the Effect of Pitot Tube-Sampling Probe Configurations on the Magnitude of the S Type Pitot Tube Coefficient for Commercially Available Source Sampling Probes. Prepared by the Universi-

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, except that the span of the monitoring system shall be selected such that the average O_2 or CO_2 concentration is not less than 20 percent of the span.

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. 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 gas from the probe to the moisture removal system. A heated sample line is not required for systems that measure the O_2 or CO_2 concentration on a dry basis, or transport dry gases.

5.1.3 Sample Transport Line, Calibration Value Assembly, Moisture Removal System, Particulate Filter, Sample Pump, Sample Flow Rate Control, Sample Gas Manifold, and Data Recorder. Same as Method 6C, Sections 5.1.3 through 5.1.9, and 5.1.11, except that the requirements to use stainless steel, Teflon, and nonreactive glass filters do not apply.

5.1.4 Gas Analyzer. An analyzer to determine continuously the O2 or CO2 concentration in the sample gas stream. The analyzer shall 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.) shall be provided at the analyzer. The requirements for measuring and controlling the analyzer flow rate are not applicable if data are presented that demonstrate the analyzer is insensitive to flow variations over the range encountered during the test.

5.2 Calibration Gases. The calibration gases for CO_2 analyzers shall be CO_2 in N_2 or CO_2 in air. Alternatively, CO_2/SO_2, O_2/SO_2, or $O_2/CO_2/SO_2$ gas mixtures in N_2 may be used. Three calibration gases, as specified Section 5.3.1 through 5.3.3 of Method 6C, shall be used. 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 emissions (Section 7).

6.1 Calibration Concentration Verification. Follow Section 6.1 of Method 6C, 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 prior to its initial use in the field. Thereafter, recheck the measurement system if changes are made in the instrumentation that could alter the interference response (e.g., changes in the type of gas detector). Conduct the interference response in accordance with Section 5.4 of Method 20.

6.3 Measurement System Preparation, Analyzer Calibration Error, and Sampling System Bias Check. Follow Sections 6.2 through 6.4 of Method 6C.

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 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 sampling system bias check. 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 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. Follow Section 7.4 of Method 6C.

8. Quality Control Procedures

The following quality control procedures are recommended when the results of this method are used for an emission rate correction factor, or excess air determination. The tester should select one of the following options for validating measurement results:

8.1 If both O_2 and CO_2 are measured using 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. Use 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

For all CO_2 analyzers, and for O_2 analyzers that can be calibrated with zero gas, follow Section 8 of Method 6C, except express all concentrations as percent, rather than ppm.

For O_2 analyzers that use a low-level calibration gas in place of a zero gas, calculate the effluent gas concentration using Equation 3A-1.

$$C_{gas} = \frac{C_{ma} - C_{oa}}{C_m - C_o}(\bar{C} - C_m) + C_{ma} \qquad \text{Eq. 3A-1}$$

Where:

C_{gas} = Effluent gas concentration, dry basis, percent.

C_{ma} = Actual concentration of the upscale calibration gas, percent.

C_{oa} = Actual concentration of the low-level calibration gas, percent.

C_m = Average of initial and final system calibration bias check responses for the upscale calibration gas, percent.

C_o = Average of initial and final system calibration bias check responses for the low-level gas, percent.

$\bar{C}$ = Average gas concentration indicated by the gas analyzer, dry basis, percent.

10. Bibliography

Same as bibliography of Method 6C.

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, March 8, 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).

[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 ft^3). 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 section 6.1.

5.3.4 Filter. As recommended by NDIR manufacturer.

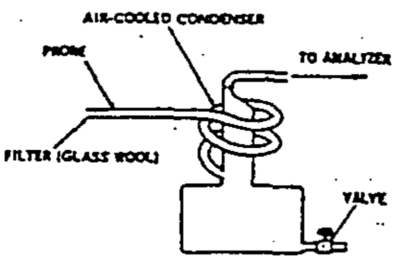


Figure 10-1. Continuous sampling train.

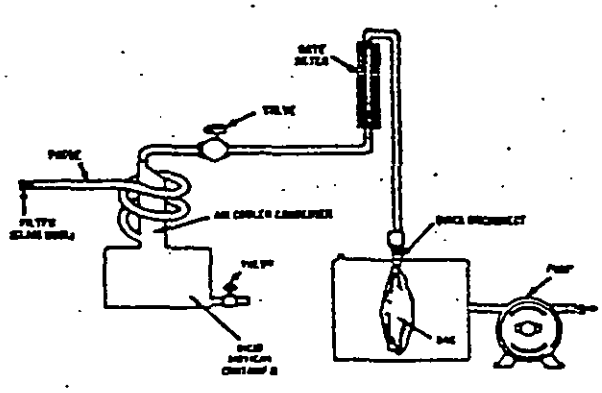


Figure 10-2. Integrated gas sampling train.

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.

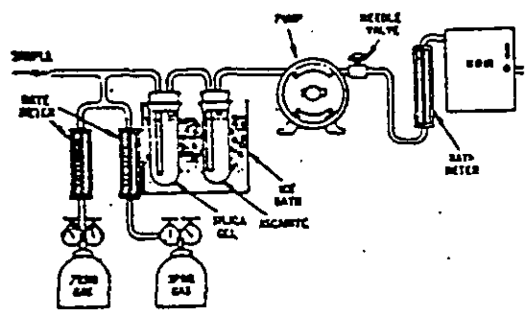


Figure 10-3. Analytical equipment.

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 section 7.2 and 8). CO_2 content of the gas may be determined by using the Method 3 integrated sample procedure, 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, 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 section 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*

Calculate the concentration of carbon monoxide in the stack using Equation 10-1.

$$C_{CO\ stack} = C_{CO\ NDIR}(1 - F_{CO_2})$$

Eq. 10-1

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. *Alternative Procedures*

10.1 Interference Trap. The sample conditioning system described in Method 10A sections 2.1.2 and 4.2, may be used as an alternative to the silica gel and ascarite traps.

11. *Bibliography*

1. McElroy, Frank, The Intertech NDIR-CO Analyzer. Presented at 11th Methods Conference on Air Pollution, University of California, Berkeley, CA. April 1, 1970.
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.
3. MSA LIRA Infrared Gas and Liquid Analyzer Instruction Book, Mine Safety Appliances Co., Technical Products Division, Pittsburgh, PA.
4. Models 215A, 315A, and 415A Infrared Analyzers, Beckman Instruments, Inc., Beckman Instructions 1635-B, Fullerton, CA. October 1967.
5. Continuous CO Monitoring System, Model A5611, Intertech Corp., Princeton, NJ.
6. UNOR Infrared Gas Analyzers, Bendix Corp., Ronceverte, WV

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 10A—Determination of Carbon Monoxide Emissions in Certifying Continuous Emission Monitoring Systems at Petroleum Refineries

1. Applicability and Principle

1.1 Applicability. This method applies to the measurement of carbon monoxide (CO) at petroleum refineries. This method serves as the reference method in the relative accuracy test for nondispersive infrared (NDIR) CO continuous emission monitoring systems (CEMS's) that are required to be installed in petroleum refineries on fluid catalytic cracking unit catalyst regenerators [40 CFR Part 60.105(a)(2)].

1.2 Principle. An integrated gas sample is extracted from the stack, passed through an alkaline permanganate solution to remove sulfur and nitrogen oxides, and collected in a Tedlar bag. The CO concentration in the sample is measured spectrophotometrically using the reaction of CO with p-sulfaminobenzoic acid.

1.3 Range and Sensitivity.

1.3.1 Range. Approximately 3 to 1800 ppm CO. Samples having concentrations below 400 ppm are analyzed at 425 nm, and samples having concentrations above 400 ppm are analyzed at 600 nm.

1.3.2 Sensitivity. The detection limit is 3 ppm based on three times the standard deviation of the mean reagent blank values.

1.4 Interferences. Sulfur oxides, nitric oxide, and other acid gases interfere with the colorimetric reaction. They are removed by passing the sampled gas through an alkaline potassium permanganate scrubbing solution. Carbon dioxide (CO_2) does not interfere, but, because it is removed by the scrubbing solution, its concentration must be measured independently and an appropriate volume correction made to the sampled gas.

1.5 Precision, Accuracy, and Stability.

1.5.1 Precision. The estimated intralaboratory standard deviation of the method is 3 percent of the mean for gas samples analyzed in duplicate in the concentration range of 39 to 412 ppm. The interlaboratory precision has not been established.

1.5.2 Accuracy. The method contains no significant biases when compared to an NDIR analyzer calibrated with National Bureau of Standards (NBS) standards.

1.5.3 Stability. The individual components of the colorimetric reagent are stable for at least 1 month. The colorimetric reagent must be used within 2 days after preparation to avoid excessive blank correction. The samples in the Tedlar[1] bag should be stable for at least 1 week if the bags are leak-free.

2. Apparatus

2.1 Sampling. The sampling train is shown in Figure 10A-1, and component parts are discussed below:

[1] Mention of trade names or commercial products in this publication does not constitute the endorsement or recommendation for use by the Environmental Protection Agency.

APPENDIX K

CALCULATION EQUATIONS

METHOD 2
CALCULATION EQUATIONS

$$\overline{V}_s = 85.49\ C_p\ (\sqrt{\Delta p})_{avg}\ \sqrt{\frac{T_{s(avg)}}{P_s\ M_s}}$$

$$Q_{s,\,d} = 60\ (1\ - B_{ws})\ \overline{V}_s\ A\ (\frac{528}{T_{s\ (avg)}})\ (\frac{P_s}{29.92})$$

$$Q_a = 60\ \overline{V}_s\ A$$

$$\dot{m}_g = \frac{4.995\ Q_{s,\,d}\ G_d}{1\ -\ B_{ws}}$$

$$RH^* = 100\ (vp_{twb}\ -\ 0.0003641\ P_s\ (T_{db}\ -\ T_{wb}))/vp_{tdb}$$

$$B^*_{ws} = RH(vp_{tdb})/P_s$$

$$\rho = \frac{4.585\ x\ 10^{-2}\ P_s M_s}{T_s\ (avg)}$$

*Alternate equations for calculating moisture content from wet bulb and dry bulb data.

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SYMBOLS

A	=	Cross Sectional area of stack, SQ. FT.
A_n	=	Cross sectional area of nozzle, SQ. FT.
B_{ws}	=	Water vapor in gas stream, proportion by volume
C_p	=	Pitot tube coefficient, dimensionless
C_a	=	Concentration of particulate matter in stack gas, wet basis, GR/ACF
C_s	=	Concentration of particulate matter in stack gas, dry basis, corrected to standard conditions, GR/DSCF
EA	=	Excess air, percent by volume
γ	=	Dry test meter correction factor, dimensionless
G_d	=	Specific gravity (relative to air), dimensionless
I	=	Isokinetic variation, percent by volume
M_d	=	Molecular weight of stack gas, dry basis, g/g - mole.
$\dot{m}_g$	=	Mass flow of wet flue gas, LB/HR
$\dot{m}_p$	=	Particulate mass flow, LB/HR
M_s	=	Molecular weight of stack gas, wet basis, g/g mole.
M_p	=	Total amount of particulate matter collected, g
P_{bar}	=	Atmospheric pressure, IN. HG. (uncompensated)
P_g	=	Stack static gas pressure, IN. WC.
P_s	=	Absolute pressure of stack gas, IN. HG.
P_{std}	=	Standard absolute pressure, 29.92 IN. HG.
A_a	=	Actual volumetric stack gas flow rate, ACFM
$Q_{s,d}$	=	Dry volumetric stack gas flow rate corrected to standard conditions, DSCFM
RH	=	Relative humidity, %

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T_{db}	=	Dry bulb temperature of stack gas, °F
T_{wb}	=	Wet bulb temperature of stack gas, °F
$T_{m(avg)}$	=	Absolute average dry gas meter temperature, °R
$T_{s(avg)}$	=	Absolute average stack temperature, °R
T_{std}	=	Standard absolute temperature, 528 °R (68 °F)
θ	=	Total sampling time, min.
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, CF
$V_{m(std)}$	=	Volume of gas sample measured by the dry gas meter corrected to standard conditions, DSCF
$V_{w(std)}$	=	Volume of water vapor in the gas sample corrected to standard conditions, SCF
$\bar{V}_s$	=	Average actual stack gas velocity, FT/SEC
vp_{tdb}	=	Vapor pressure at T_{db}, IN. HG.
vp_{twb}	=	Vapor pressure at T_{wb}, IN. HG.
$\overline{\Delta H}$	=	Average pressure differential across the orifice meter, IN. WC.
ΔP	=	Velocity pressure of stack gas, IN. WC.
γ	=	Dry test meter correction coefficient, dimensionless
ρ	=	Actual gas density, LB/ACF

METHOD 3
CALCULATION EQUATIONS

$$\%EA = \frac{100(\%O_2 - 0.5\%\ CO)}{0.264\%\ N_2 - \%O_2 + 0.5\%\ CO}$$

$$M_d = 0.44(\%CO_2) + 0.32\ (\%O_2) + 0.28\ (\%N_2 + \%CO)$$

$$M_s = M_d\ (I - B_{ws}) + 0.18\ B_{ws}$$

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

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CALCULATION EQUATIONS

METHOD 10

$$CO{\cdot}PPM{\cdot}DRY = CO_{CO_2} - free,\ dry,\ avg\ (1 - CO_2,\ d/100)$$

$$CO{\cdot}PPM{\cdot}WET = CO{\cdot}PPM{\cdot}DRY\ (1 - MC/100)$$

$$GR/DSCF = 5.0885\ X\ 10^{-4}\ (CO{\cdot}PPM{\cdot}DRY)$$

$$mg/dscm = 1.165\ (CO{\cdot}PPM{\cdot}DRY)$$

$$\dot{m} = 8.5714\ x\ 10^{-3}\ (GR/DSCF)\ (Q_{s,d})$$

$$E = \frac{2.9857\ x\ 10^{-3}\ F_d\ (GR/DSCF)}{20.9 - O_{2,\ d}}$$

where:

CO_{CO_2} - *free, dry, avg*

= average of two determinations of carbon monoxide on a dry, CO_2 - free integrated flue gas sample reported in ppm by volume

$CO_{2,\ d}$ = carbon dioxide concentration of flue gas on a dry percent by volume basis

$O_{2,\ d}$ = oxygen concentration of flue gas on a dry percent by volume basis

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MC	=	moisture content of flue gas on a percent by volume basis
CO·PPM·DRY	=	carbon monoxide concentration in ppm by volume on a dry basis
CO·PPM·WET	=	carbon monoxide concentration in ppm by volume on a wet or actual basis
GR/DSCF	=	concentration of carbon monoxide in flue gas on a grains per dry standard cubic foot basis (68 °F, 29.92 IN. HG.)
mg/dscm	=	concentration of carbon monoxide in flue gas on a milligrams per dry standard cubic meter basis (60 °F, 29.92 IN. HG.)
$\dot{m}$	=	emissions or mass rate of carbon monoxide on a LB/HR basis
$Q_{s,d}$	=	volumetric flow rate of flue gas in dry standard cubic feet per minute
E	=	emission factor of carbon monoxide in pounds of carbon monoxide emitted per million BTU heat input (LB/MMBTU)
F_d	=	F-Factor of respective fuel in dry standard cubic feet of exhaust gas at 0% oxygen per million BTU of heat input (DSCF/MMBTU)

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