Interpoll Laboratories, Inc.
4500 Ball Road N.E.
Circle Pines, Minnesota 55014-1819

TEL: (612) 786-6020
FAX: (612) 786-7854

RESULTS OF THE DECEMBER 7, 1993 AIR EMISSION COMPLIANCE TESTING AT THE LOUISIANA PACIFIC OSB PLANT IN TOMAHAWK, WISCONSIN

Submitted to:

LOUISIANA PACIFIC CORPORATION
Route 8, Box 8263
Hayward, Wisconsin 54843

Attention:

Sue Somers

Approved by:

Daniel J. Despen
Manager
Stationary Source Testing Department

Report Number 3-1854
January 11, 1994
SP/slp

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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
<	≤ (when following a number)

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

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

1 INTRODUCTION

On December 7, 1993 Interpoll Laboratories personnel conducted air emission compliance tests on the Dryer Stack at the Louisiana Pacific Plant located in Tomahawk, Wisconsin. On-site testing was performed by Mark Kaehler and Ken Rosenthal. Coordination between testing activities and plant operation was provided by Sue Somers of Louisiana Pacific.

The Dryer tested is a Model 1260 TNW/L dryer manufactured by MEC Company. Particulate emissions from the wafter dryers are controlled by primary cyclones followed by secondary multicyclones. Cleaned flue gas is emitted to the atmosphere by a 100-foot high radial steel stack which has a diameter of 59 inches.

The oxides of nitrogen samples were collected using an all-glass Method 7 sampling train. A heated stainless steel probe was used to extract the samples from the exhaust stream. A plug of glass-wool was used in the end of the probe to remove particulate material.

The NO_x samples were collected in volume-calibrated two-liter all-glass flasks. An aliquot of 25 cc of absorbing solution was added to each flask on-site; the flask was closed; inserted into the sampling train; and evacuated. The probe was then purged and the sample collected over a 15 second interval. The flask was then closed; the flask removed from the sampling train; shook for two minutes and then secured for transport to the laboratory.

Upon arrival at the laboratory, the NO_x samples are logged in, placed in a designated area and maintained at 72 °F for 24 hours to allow completion of the conversion of NO to NO_2 and absorption in the acidified peroxide reagent. The flasks are then shook to complete absorption; attached to a mercury manometer and the static pressure and temperature recorded. The samples are then recovered and analyzed by ion chromatography.

Formaldehyde samples were collected using EPA Method 0011 (SW 846 3rd Ed.). The samples were collected isokinetically using a Method 5 sampling train with an aqueous acidic 2,4-dinitrophenylhydrazine absorbing solution and analyzed by high performance liquid chromatography.

Integrated flue gas samples were extracted with the formaldehyde and oxides of nitrogen samples using a specially designed gas sampling system. Integrated flue gas samples were collected in 44-liter Tedlar bags housed in a protective aluminum container. After sampling was complete, the bags were sealed and returned to the laboratory for Orsat analysis. Prior to sampling, the Tedlar bags are leak checked at 15 IN.HG. vacuum with an in-line rotameter. Bags with any detectable inleakage are discarded. The integrated flue gas samples were also analyzed for carbon monoxide in accordance with EPA Method 10 (NDIR).

Testing at the Dryer Stack was conducted from two test ports oriented at 90 degrees on the stack. These test ports are located 5.0 stack diameters downstream of the nearest flow disturbance and 5.0 stack diameters upstream of the stack exit. A 20-point traverse was used to collect the particulate samples. Each traverse point was sampled 3 minutes to give a total sampling time of sixty minutes per run.

The important results of the test are summarized in Section 2. Detailed results are presented in Section 3. Field data and all other supporting information are presented in the appendices.

2 SUMMARY AND DISCUSSION

The important results of the results are presented in Tables 1 - 3. The oxides of nitrogen emission rate averaged 9.7 LB/HR. The carbon monoxide concentration averaged 67 ppm,d and the emission rate averaged 16.9 LB/HR. The formaldehyde concentration averaged 2.4 ug/Nm^3 and the emission rate averaged 0.519 LB/HR.

A carbon monoxide determination was performed on the face dryer and core dryer to verify compliance (600 ppm,d @ 7%O_2). The carbon monoxide concentration averaged 134 and 305 ppm,d @ 7%O_2 on the face dryer and the core dryer respectively.

No difficulties were encountered in the field by Interpoll Labs or in the laboratory evaluation of the samples which were conducted by Interpoll Labs. On the basis of these facts and a complete review of the data and results, it is our opinion that the results 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 December 7, 1993 **Oxides of Nitrogen Determinations** on the Dryer Stack at Louisiana Pacific Plant in Tomahawk, Wisconsin.

Time	Concentration (ppm,d)	Emission Rate (LB/HR)
1145-1246	26	10.9
1310-1411	26	10.7
1715-1957	18	7.4
Average	23	9.7

Table 2. Summary of the Results of the December 7, 1993 **Carbon Monoxide Determinations** on the Dryer Stack at Louisiana Pacific Plant in Tomahawk, Wisconsin.

Time	Concentration (ppm,d)	Emission Rate (LB/HR)
1145-1246	61	15.5
1310-1411	69	17.5
1715-1957	71	17.7
Average	67	16.9

Table 3. Summary of the Results of the December 7, 1993 **Formaldehyde Determinations** on the Dryer Stack at Louisiana Pacific Plant in Tomahawk, Wisconsin.

Time	Concentration (ppm,d)	Emission Rate (LB/HR)
1145-1246	1.7	0.473
1310-1411	2.4	0.659
1715-1957	1.6	0.424
Average	1.9	0.519

3 RESULTS

The results of all field and laboratory evaluations are presented in this section. Gas moisture results are presented first followed by the computer printout of the oxides of nitrogen, carbon monoxide, and formaldehyde determinations. Preliminary measurements including test port locations are given in the appendices.

The results have been calculated on a personal computer using programs written in Extended BASIC specifically for source testing calculations. EPA-published equations have been used as the basis of the calculation techniques in these programs.

The emission rates have been calculated using the product of the concentration times flow method.

3.1 Results of Orsat and Moisture Determinations

Test No. 1
Dryer Stack

Results of Orsat & Moisture Analyses-----Methods 3 & 4(%v/v)

	Run 1	Run 2	Run 3
Date of run	12-07-93	12-07-93	12-07-93
Dry basis (orsat)			
carbon dioxide............	0.50	0.40	0.75
oxygen....................	19.50	19.60	19.30
nitrogen..................	80.00	80.00	79.95
Wet basis (orsat)			
carbon dioxide............	0.42	0.34	0.63
oxygen....................	16.35	16.46	16.14
nitrogen..................	67.07	67.19	66.87
water vapor...............	16.17*	16.02*	16.36*
Dry molecular weight........	28.86	28.85	28.89
Wet molecular weight........	27.10	27.11	27.11
Specific gravity............	0.936	0.936	0.936
Water mass flow......(LB/HR)	0.00	0.00	0.00

* Free or condensed water in the gas stream.

FO	2.800	3.250	2.133

Test No. 3
Face Dryer

Results of Orsat & Moisture Analyses-----Methods 3 & 4(%v/v)

	Run 1
Date of run	12-08-93
Dry basis (orsat)	
carbon dioxide............	2.80
oxygen.....................	18.10
carbon monoxide...........	0.00
nitrogen..................	79.10

FO	1.000

Test No. 3
Core Dryer

Results of Orsat & Moisture Analyses-----Methods 3 & 4(%v/v)

	Run 1
Date of run	12-08-93
Dry basis (orsat)	
carbon dioxide............	3.00
oxygen.....................	17.80
carbon monoxide...........	0.00
nitrogen..................	79.20

FO 1.033

3.2 Results of Oxides of Nitrogen Determinations

Test No. 1
Dryer Stack

Results of Oxides of Nitrogen (NOx) Determinations---------Method 7

	Run 1A	Run 1B	Run 1C	Run 1D
Date of run.................	12-17-93	12-17-93	12-17-93	12-17-93
Time of run............(HRS)	1130	1145	1200	1215
Flask number................	1	2	3	4
Volume of flask.........(ML)	2086	2063	2055	2116
Data: time of sampling				
flask temperature..(DEG-F)	33.00	42.00	40.00	41.00
bar. press.........(IN.HG)	28.50	28.50	28.50	28.50
flask vacuum.......(IN.HG)	26.80	26.50	26.60	26.70
flask abs. press...(IN.HG)	1.70	2.00	1.90	1.80
Data: Time of Flask Opening				
flask temperature..(DEG-F)	68.00	68.00	68.00	68.00
lab. bar. press....(IN.HG)	28.88	28.88	28.88	28.88
flask static press.(IN.HG)	0.40	1.30	1.30	0.40
flask abs. press...(IN.HG)	29.28	30.18	30.18	29.28
Volume gas sampled....(DSML)	1891	1912	1911	1913
Moisture content......(%V/V)	16.36	16.36	16.36	16.36
Nitrate in gas sample...(JG)	88.0	161.0	151.0	112.0
NO2 in gas sample.......(JG)	65.3	119.5	112.0	83.1
<u>NOx Concentration</u>				
(GR/DSCF).................	0.0151	0.0273	0.0256	0.0190
(MG/DSCM).................	35	62	59	43
(PPM-DRY).................	18	33	31	23
(PPM-WET).................	15	27	26	19
NOX Emission rate....(LB/HR)	7.54	13.64	12.80	9.49

Test No. 1
Dryer Stack

Results of Oxides of Nitrogen (NOx) Determinations---------Method 7

	Run 2A	Run 2B	Run 2C	Run 2D
Date of run.................	12-17-93	12-17-93	12-17-93	12-17-93
Time of run............(HRS)	1310	1325	1340	1355
Flask number................	5	6	49	50
Volume of flask.........(ML)	2057	2100	2088	2084
Data: time of sampling				
flask temperature..(DEG-F)	42.00	42.00	36.00	36.00
bar. press.........(IN.HG)	28.50	28.50	28.50	28.50
flask vacuum.......(IN.HG)	26.60	26.80	26.70	26.80
flask abs. press...(IN.HG)	1.90	1.70	1.80	1.70
Data: Time of Flask Opening				
flask temperature..(DEG-F)	68.00	68.00	68.00	68.00
lab. bar. press....(IN.HG)	28.88	28.88	28.88	28.88
flask static press.(IN.HG)	1.40	1.40	0.10	-3.00
flask abs. press...(IN.HG)	30.28	30.28	28.98	25.88
Volume gas sampled....(DSML)	1920	1975	1865	1656
Moisture content......(%V/V)	17.01	17.01	17.01	17.01
Nitrate in gas sample...(JG)	115.0	106.0	141.0	124.0
NO2 in gas sample.......(JG)	85.3	78.6	104.6	92.0
NOx Concentration				
(GR/DSCF).................	0.0194	0.0174	0.0245	0.0243
(MG/DSCM).................	44	40	56	56
(PPM-DRY).................	23	21	29	29
(PPM-WET).................	19	17	24	24
NOX Emission rate....(LB/HR)	9.69	8.68	12.23	12.12

Test No. 1
Dryer Stack

Results of Oxides of Nitrogen (NOx) Determinations---------Method 7

	Run 3A	Run 3B	Run 3C	Run 3D
Date of run................	12-17-93	12-17-93	12-17-93	12-17-93
Time of run............(HRS)	1915	1930	1945	1955
Flask number................	51	52	53	54
Volume of flask.........(ML)	2064	1985	2083	2064
Data: time of sampling				
flask temperature..(DEG-F)	35.00	35.00	37.00	37.00
bar. press.........(IN.HG)	28.50	28.50	28.50	28.50
flask vacuum.......(IN.HG)	26.60	26.70	26.70	26.80
flask abs. press...(IN.HG)	1.90	1.80	1.80	1.70
Data: Time of Flask Opening				
flask temperature..(DEG-F)	68.00	68.00	68.00	68.00
lab. bar. press....(IN.HG)	28.88	28.88	28.88	28.88
flask static press.(IN.HG)	-1.40	0.10	0.10	0.10
flask abs. press...(IN.HG)	27.48	28.98	28.98	28.98
Volume gas sampled....(DSML)	1734	1772	1861	1851
Moisture content......(%V/V)	17.15	17.15	17.15	17.15
Nitrate in gas sample...(JG)	80.5	75.0	86.0	93.0
NO2 in gas sample.......(JG)	59.7	55.6	63.8	69.0
<u>NOx Concentration</u>				
(GR/DSCF)..................	0.0151	0.0137	0.0150	0.0163
(MG/DSCM)..................	34	31	34	37
(PPM-DRY)..................	18	16	18	19
(PPM-WET)..................	15	14	15	16
NOX Emission rate....(LB/HR)	7.37	6.72	7.34	7.98

3.3 Results of Carbon Monoxide Determinations

Test No. 1
Dryer Stack

Results of CO Determinations ---------------------Method 10

	Run 1	Run 2	Run 3
Date of run	12-07-93	12-07-93	12-07-93
Time run start/end.....(HRS)	1145-1246	1310-1411	1715-1957
Total sampling time....(MIN)	60.0	60.0	60.0
Moisture content......(%V/V)	16.17	16.02	16.36
O2 Concentration......(%V/V)	19.50	19.60	19.30
Volumetric flow rate (DSCFM)	58290	58212	57120
CO concentration............			
(GR/DSCF).................	0.0310	0.0351	0.0361
(MG/DSCM).................	71.06	80.38	82.71
(PPM-WET).................	51.14	57.95	59.38
(PPM-DRY).................	61.00	69.00	71.00
(PPM-DRY @ 7% O2).........	569.33	690.00	584.71
CO emission rate.....(LB/HR)	15.508	17.518	17.688

CO = Carbon monoxide

A trailing '<' symbol indicates that the true value is less than or equal to the reported value

3.4 Results of Formaldehyde Determinations

Test No. 1
Dryer Stack

Results of Formaldehyde Tests -------------- EPA Method 0011

	Run 1	Run 2	Run 3
Date of run	12-07-93	12-07-93	12-07-93
Time run start/end.....(HRS)	1145/1246	1310/1411	1715/1957
Static pressure......(IN.WC)	-0.61	-0.61	-0.61
Cross sectional area (SQ.FT)	18.99	18.99	18.99
Pitot tube coefficient......	.840	.840	.840
Water in sample gas			
condenser............(ML)	0.0	0.0	0.0
impingers..........(GRAMS)	213.0	225.0	228.0
desiccant..........(GRAMS)	23.0	23.0	19.0
total..............(GRAMS)	236.0	248.0	247.0
Formaldehyde in sample..(uG)	3470	4850	3140
Gas meter coefficient.......	1.0054	1.0054	1.0054
Barometric pressure..(IN.HG)	28.50	28.50	28.50
Avg. orif.pres.drop..(IN.WC)	2.70	2.76	2.65
Avg. gas meter temp..(DEF-F)	29.0	36.8	31.2
Volume through gas meter....			
at meter conditions...(CF)	54.67	55.68	54.29
standard conditions.(DSCF)	56.90	57.05	56.25
Total sampling time....(MIN)	60.00	60.00	60.00
Nozzle diameter.........(IN)	.239	.239	.239
Avg.stack gas temp ..(DEG-F)	131	130	131
Volumetric flow rate........			
actual..............(ACFM)	81779	81475	80386
dry standard.......(DSCFM)	58290	58212	57120
Isokinetic variation.....(%)	99.2	99.6	100.1
CH2O concentration..........			
(GR/DSCF)................	0.0009	0.0013	0.0009
(MG/DSCM)................	2.17	3.02	1.99
(PPM-DRY)................	1.74	2.42	1.59
(PPM-WET)................	1.46	2.03	1.33
CH2O emission rate...(LB/HR)	0.47320	0.65887	0.42444

CH2O = Formaldehyde

A trailing '<' symbol indicates that the true value is less than or equal to the reported value

APPENDIX A

RESULTS OF VOLUMETRIC FLOW RATE DETERMINATIONS

Interpoll Labs Report No. 3-1854
Louisiana Pacific
Tomahawk, WI

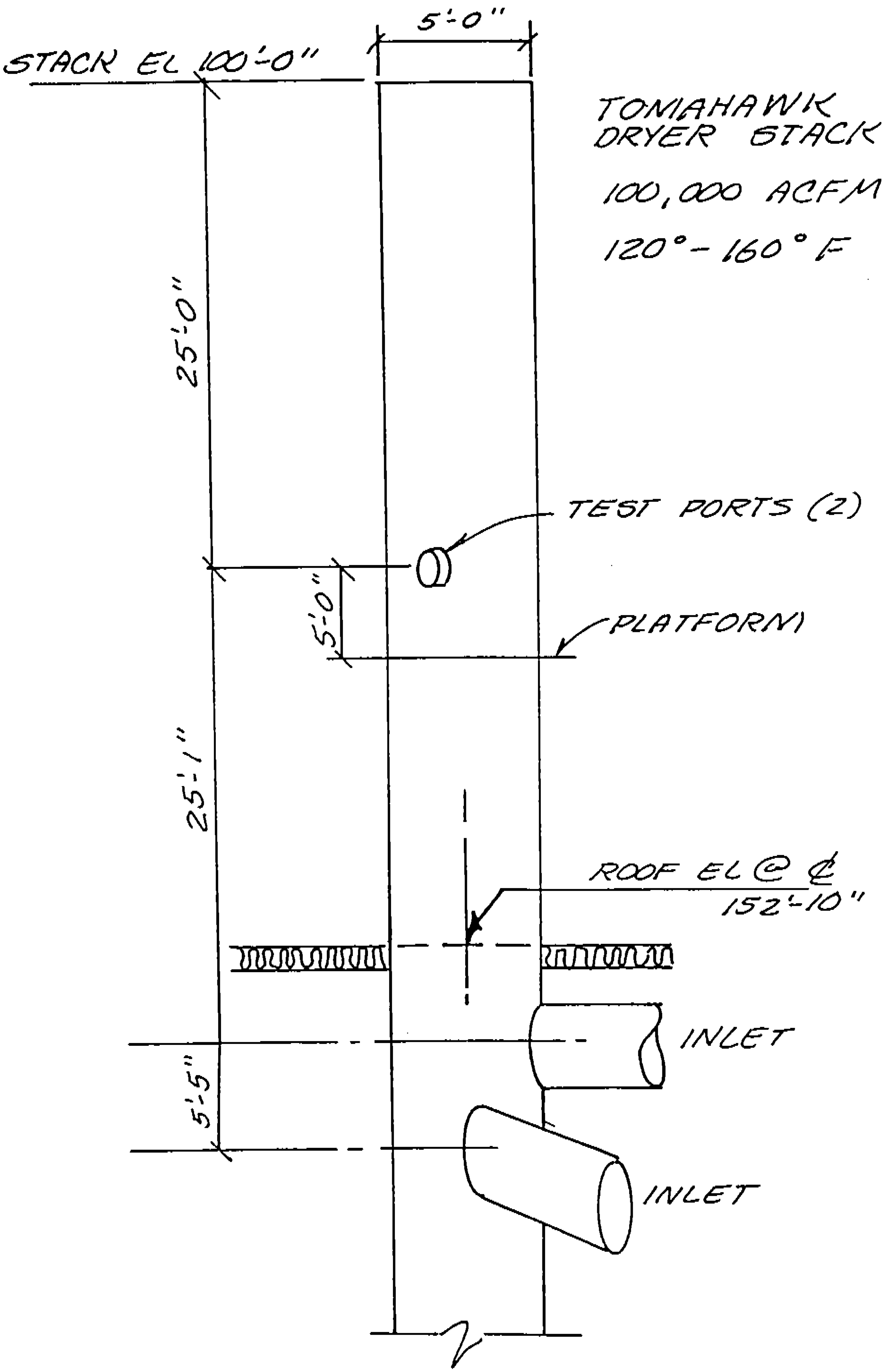
Test No. 1
Dryer Stack

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

Date of Determination............	12-07-93
Time of Determination.......(HRS)	1132
Barometric pressure.......(IN.HG)	28.5
Pitot tube coefficient...........	.84
Number of sampling ports.........	2
Total number of points...........	20
Shape of duct....................	Round
Stack diameter...............(IN)	59
Duct area.................(SQ.FT)	18.99
Direction of flow................	UP
Static pressure...........(IN.WC)	-.61
Avg. gas temp.............(DEG-F)	136
Moisture content..........(% V/V)	16.17
Avg. linear velocity.....(FT/SEC)	71.8
Gas density...............(LB/ACF)	.05930
Molecular weight......(LB/LBMOLE)	28.86
Mass flow of gas..........(LB/HR)	291094
Volumetric flow rate.............	
actual....................(ACFM)	81810
dry standard.............(DSCFM)	57784

APPENDIX B

LOCATION OF TEST PORTS

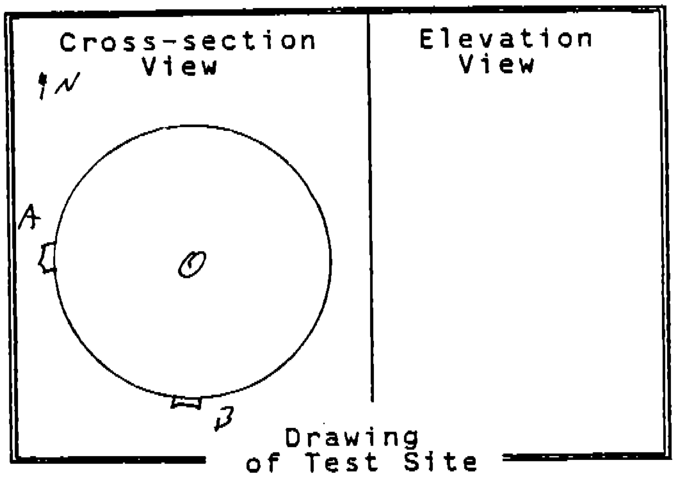

STACK EL 100'-0"
5'-0"
TOMAHAWK DRYER STACK
100,000 ACFM
120° - 160° F
25'-0"
TEST PORTS (2)
5'-0"
PLATFORM
25'-1"
ROOF EL @ ℄ 152'-10"
INLET
5'-5"
INLET

APPENDIX C

FIELD DATA SHEETS

INTERPOLL LABORATORIES - EPA METHOD 2 FIELD DATA SHEET

Job L.P. / Tomahawk, WI
Source Dryer / Stack
Test 1 Run 0 Date 12-7-93
Stack dimen. 59 IN.
Dry bulb 136 °F Wet bulb ___ °F
Manometer: ☒ Reg. ☐ Exp. ☐ Elec.
Barometric pressure 28.50 in Hg
Static pressure -.61 in WC
Operators M. Kuehler + K. Rosenthal
Pitot No. 29V-6 C_p .84



Drawing of Test Site

Traverse Point No.	Fraction of Diameter	Distance from Stack Wall (in)	Distance from End of Port (in)	Velocity Pressure (in WC)	Temperature of gas (°F)
		Port length: 4.25 in.		Time start: 1132 hrs	
A-1	.026	1.53	5.78	1.12	
2	.092	4.84	9.09	1.37	
3	.146	8.61	12.86	1.32	
4	.226	13.33	17.58	1.40	
5	.342	20.18	24.43	1.40	
6	.658	38.82	43.07	1.43	
7	.774	45.67	49.92	1.30	
8	.854	50.39	54.64	1.28	↑
9	.918	54.16	58.41	1.36	
10	.974	57.47	61.72	1.30	136
B-1				.95	↓
2				1.10	
3				1.25	
4				1.34	
5				1.32	
6				1.27	
7				1.30	
8				1.35	
9				1.38	
10				1.40	
Temp. meas. device & S/N: PDT-19/TC				Time end: 1137 hrs	

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

INTERPOLL LABORATORIES EPA METHOD 5/17 SAMPLE LOG SHEET

Job L.P. / Tomahawk, WI
Source Dryer / Stack
Method 0011 Filter holder: NA
Date 12-7-93 Test 1 Run 1
No. of traverse points 20
Filter type: NA

Sample Train Leak Check:

Pretest: < 0.02 cfm at 15 in. Hg. (vac) ☑
Postest: <0.02 cfm at 15 in. Hg. (vac) ☑

Particulate Catch Data: NA

No.s of filters used:
Recovery solvent(s)
☐ acetone
☐ other(s)

No. of probe wash bottles:
Sample recovered by:

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Impinger No. 1	685	472	213
Impinger No. 2			
Impinger No. 3			
~~Condenser~~ $MeCl_2$ Rinse	470	266	
Desiccant	1399	1376	23
Total			236

Integrated Gas Sampling Data:

Bag Pump No. 294 Box No. 22 Bag No. 1
Bag Material: 5-layer Aluminized Tedlar Size: 44 L
Pretest leak check: 0 cc/min at 20 in. Hg.
Time start: 1145 (HRS) Time end: 1245 (HRS)
Sampling rate: 400 cc/min Operator: M. Koehler
S/N of O_2 Analyzer used to monitor train outlet: 9

CF-

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job L.P. / Tomahawk, WI
Source Dryer / stack
Date 12-7-93 Test 1 Run 1

Operators M. Kaehler + K. Rosenthal
Meter Box No. 9 ^H@ 1.75 IN WC
Gasmeter coeff. 1.0054

Pitot No. 24V-6 Cp .84
Bar. Press. 28.50 inHg H2O 18 %
Nozzle No. 8-4 Nozzle Dia .252 IN.

Change moisture 16%

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dec. Vol. (cf)	VAC. inHg	Temperatures (°F) Stack	Probe	Oven	Impg.	Cas/In	Cas/Out	Oxygen (%v/v)
	1145	618.50											
A 10	3	621.20	1.33	2.60	1.16	9	136	243	258	34	23	23	17.8
9	6	623.85	1.38	2.72	3.89	10	135				24	24	18.0
8	9	626.60	1.42	2.80	6.66	11	135	247	255	34	26	24	18.3
7	12	629.36	1.40	2.78	9.42	11	133				27	24	18.3
6	15	632.17	1.43	2.85	2.21	12	131	244	259	34	28	25	18.3
5	18	635.02	1.50	3.01	5.09	13	129				29	25	18.4
4	21	637.92	1.48	3.09	8.00	13.5	129	250	263	35	29	25	18.4
3	24	640.70	1.41	2.94	0.84	13	130				30	26	18.6
2	27	643.62	1.37	2.87	3.66	12.5	130	253	261	35	30	26	18.6
1	30	646.15	1.08	2.26	6.15	9.5	130				31	26	18.6
B-10	33	648.99	1.38	2.88	8.97	12	131	251	264	35	32	27	18.5
9	36	651.86	1.39	2.90	1.81	12	132				33	28	18.6
8	39	654.63	1.30	2.74	4.56	12	127	247	260	34	33	28	18.5
7	42	657.30	1.24	2.61	7.25	11.5	129				34	28	18.4
6	45	660.05	1.29	2.72	0.00	12	129	250	257	34	34	29	18.3
5	48	662.80	1.28	2.69	2.74	12	130				35	29	18.4
4	51	665.64	1.33	2.91	5.53	12.5	129	252	257	36	36	30	18.6
3	54	668.36	1.29	2.73	8.28	11	129				36	30	18.5
2	57	670.94	1.12	2.37	0.86	10	129	248	259	36	37	30	18.3
1	60	673.17	.79	1.67	3.02	7	129				37	31	18.5
	(1246)												
	Θ = 60	Vm = 54.67		^H 2.70							Avg. = 29.0		

S-0037R

INTERPOLL LABORATORIES EPA METHOD 5/17 SAMPLE LOG SHEET

Job L.P. / Tomahawk, WI
Source Dryer / Stack
Method 0011 Filter holder: NA
Date 12-7-93 Test 1 Run 2
No. of traverse points 20
Filter type: NA

Sample Train Leak Check:

Pretest: < 0.02 cfm at 15 in. Hg. (vac) ☒
Postest: <0.02 cfm at 15 in. Hg. (vac) ☒

Particulate Catch Data: NA

No.s of filters used:

Recovery solvent(s)
☐ acetone
☐ other(s)

No. of probe wash bottles:
Sample recovered by:

Condensate Data:

Item	Weight (g)		
	Final	Tare	Difference
Impinger No. 1	699	474	225
Impinger No. 2			
Impinger No. 3			
~~Condenser~~ MeCl$_2$ Rinse	525 ~~416~~	266	
Desiccant	1357	1334	23
Total			248

Integrated Gas Sampling Data:

Bag Pump No. 294 Box No. 22 Bag No. 2
Bag Material: 5-layer Aluminized Tedlar Size: 44 L
Pretest leak check: 0 cc/min at 20 in. Hg.
Time start: 1310 (HRS) Time end: 1411 (HRS)
Sampling rate: 400 cc/min Operator: M. Koehler
S/N of O_2 Analyzer used to monitor train outlet: 9

CF-023

CF-[redacted]

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job L.P. / Tomahawk, WI.
Source Dryer / Stack
Date 12-7-93 Test 1 Run 2

Operators M. Kaehler + K. Rosenthal
Meter Box No. 9 ΔH@ 1.75 IN WC
Gasmeter coeff. 1.0054

Pitot No. 29V-6 Cp .84
Bar. Press. 28.50 inHg H2O 16 %
Nozzle No. B-4 Nozzle Dia .239 IN.

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Dgs. Vol. (cf)	VAC. inHg	Temperatures (°F) Stack	Probe	Oven	Impg.	Gas/In	Gas/Out	Oxygen (%v/v)
	1310	673.60											
B-10	3	676.30	1.32	2.76	6.36	8.5	130	248	259	35	32	31	18.0
9	6	679.14	1.38	2.91	9.20	10.5	129		-		35	31	18.3
8	9	681.95	1.30	2.75	1.97	10	129	246	263	35	36	32	18.4
7	12	684.80	1.40	2.96	4.84	12	130				37	32	18.5
6	15	687.67	1.30	2.75	7.61	11	130	251	264	36	37	32	18.6
5	18	690.38	1.25	2.65	0.33	10.5	130				38	33	18.4
4	21	693.25	1.31	2.77	3.12	11	131	254	260	36	39	33	18.2
3	24	695.97	1.28	2.72	5.88	10.5	130				39	33	18.4
2	27	698.60	1.18	2.52	8.54	9.5	128	250	261	37	40	34	18.5
1	30	701.14	1.05	2.24	1.05	8	128				41	34	18.3
A-10	33	703.95	1.32	2.80	3.86	11	132	248	262	37	41	34	18.1
9	36	706.85	1.42	3.01	6.77	12	132				41	35	18.7
8	39	709.66	1.31	2.79	9.57	11	130	250	258	37	41	35	18.7
7	42	712.48	1.34	2.85	2.40	10	131				42	35	18.3
6	45	715.27	1.32	2.81	5.21	11	132	252	255	36	42	35	18.2
5	48	718.24	1.38	2.94	8.09	12	131				42	36	18.5
4	51	720.99	1.35	2.88	0.94	11.5	130	249	259	36	42	36	18.5
3	54	723.87	1.32	2.82	3.76	11	130				42	36	18.4
2	57	726.67	1.30	2.77	6.56	10.5	131	251	262	36	43	36	18.4
1	60	729.28	1.13	2.41	9.17	9	131				43	37	18.3
	(1411)												
	θ = 60	Vm = 55.68		ΔH 2.76							Avg. = 36.8		

S-0037R

INTERPOLL LABORATORIES EPA METHOD 5/17 SAMPLE LOG SHEET

Job L.P. / Tomahawk, WI
Source Dryer /Stack
Method 0011 Filter holder: NA
Date 12-7-93 Test 1 Run 3
No. of traverse points 20
Filter type: NA

Sample Train Leak Check:

Pretest: < 0.02 cfm at 15 in. Hg. (vac) ☒
Postest: < 0.02 cfm at 15 in. Hg. (vac) ☒

Particulate Catch Data: NA

No.s of filters used:

Recovery solvent(s)
☐ acetone
☐ other(s)

No. of probe wash bottles:
Sample recovered by:

Condensate Data:

Item	Weight(g)		
	Final	Tare	Difference
Impinger No. 1	700	472	228
Impinger No. 2			
Impinger No. 3			
Condenser			
Desiccant	1418	1399	19
Total			247

Integrated Gas Sampling Data:

Bag Pump No. 29A Box No. 22 Bag No. 8
Bag Material: 5-layer Aluminized Tedlar Size: 44 L
Pretest leak check: 0 cc/min at 20 in. Hg.
Time start: 1715 (HRS) Time end: 1957 (HRS)
Sampling rate: 400 cc/min Operator: M. Kachler
S/N of O_2 Analyzer used to monitor train outlet: 9

CF-023

CF-[redacted]

INTERPOLL LABORATORIES EPA METHOD 5 FIELD DATA SHEET

Job L.P. / Tomahawk, WI
Source Dryer / Stack
Date 12-7-93 Test 1 Run 3

Operators M. Kaehler + K. Rosenthal
Meter Box No. 9 ^H@ 1.75 IN WC
Gasmeter coeff. 1.0054

Pitot No. 2AV-6 Cp .84
Bar. Press. 28.50 inHg H2O 16 %
Nozzle No. B-4 Nozzle Dia .235 IN.

Traverse Point No.	Sampling Time (min)	Sample Volume (cf)	Velocity Head (inWC)	Orifice Meter (inWC)	Obs. Vol. (cf)	VAC. inHg	Temperatures (°F) Stack	Probe	Oven	Impg.	Gas/In	Gas/Out	Oxygen (%v/v)
	(1715)	729.20											
A-10	3	732.30	1.15	2.45	2.32	8	130	249	263	34	28	28	18.1
9	6	735.04	1.28	2.67	5.03	10	131				29	28	18.0
8	9	737.99	1.49	3.10	7.96	12.5	132	253	261	34	31	28	18.1
7	12	740.90	1.40	2.92	0.80	12	132				32	29	18.4
6	15	743.65	1.32	2.77	3.57	11	131	255	263	34	32	29	18.5
5	18	746.46	1.39	2.89	6.40	11.5	131				27	27	18.2
4	21	749.23	1.33	2.76	9.16	10.5	132	247	260	35	28	27	18.2
3	24	752.07	1.40	2.92	1.99	11.5	131				29	28	18.1
2	27	754.90	1.38	2.88	4.81	11.5	131	250	256	35	31	28	18.2
1	30	757.44	1.10	2.30	7.34	9	131				32	28	18.2
B-10	33	760.10	1.22	2.56	0.00	9.5	131	246	258	35	33	28	18.1
9	36	762.67	1.20	2.51	2.64	9.5	132				35	29	18.1
8	39	765.42	1.23	2.58	5.32	10	132	246	259	36	36	29	18.1
7	42	768.08	1.25	2.63	8.02	10	131				36	30	18.2
6	45	770.75	1.20	2.53	0.68	9.5	131	247	262	36	37	30	18.3
5	48	773.52	1.31	2.76	3.46	11	131				37	31	18.1
4	51	776.18	1.31	2.77	6.24	11	130	251	260	35	38	31	18.2
3	54	778.96	1.28	2.71	8.99	11	131				38	32	18.3
2	57	781.62	1.10	2.33	1.54	9.5	130	250	257	35	39	32	18.2
1	60	783.99	.94	2.00	3.91	2.5	130				39	32	18.3
	(1957)												
	θ = 60	Vm = 54.29		^H 2.65							Avg. = 31.2		

Down 1731

Restart 1912

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EPA Method 7 Sample Collection
Field Data Sheet

Job L.P. TOMOHAWK

Date 12-7-93

Bar. Pressure 28.5 IN.HG.

Test Location DRYER STACK

Fuel Type NATURAL GAS

Sample Train No. BLUE

Technician K ROSENTHAL

Pump No. 29A

No.	Test Run Point	Flask No.	Time (HRS)	Vacuum (IN.HG.)	Flask Temp. (°F)	Leak Rate <0.4 IN.HG./MIN.
1	1-1-1	1	1130	26.80	33	☒ Yes ☐ No
2	1-1-2	2	1145	26.50	42	☒ Yes ☐ No
3	1-1-3	3	1200	26.60	40	☒ Yes ☐ No
4	1-1-4 Δ	4	1215	26.70	41	☒ Yes ☐ No
5	1-2-2	5	1310	26.60	42	☒ Yes ☐ No
6	1-2-3	6	1325	26.80	42	☒ Yes ☐ No
7	1-2-1	49	1340	26.70	36	☒ Yes ☐ No
8	1-2-2 Δ	50	1355	26.80	36	☒ Yes ☐ No
9	1-3-3	51	1915	26.60	35	☒ Yes ☐ No
10	1-3-1	52	1930	26.70	35	☒ Yes ☐ No
11	1-3-2	53	1945	26.70	37	☒ Yes ☐ No
12	1-3-3	54	1955	26.80	37	☒ Yes ☐ No
13	BLANK	}				☐ Yes ☐ No
14	BLANK	} Need	to be	poured		☐ Yes ☐ No
15						☐ Yes ☐ No
16						☐ Yes ☐ No
17						☐ Yes ☐ No
18						☐ Yes ☐ No
19						☐ Yes ☐ No
20						☐ Yes ☐ No
21						☐ Yes ☐ No
22						☐ Yes ☐ No
23						☐ Yes ☐ No
24						☐ Yes ☐ No
25						☐ Yes ☐ No
26						☐ Yes ☐ No
27						☐ Yes ☐ No

APPENDIX D

INTERPOLL LABORATORIES ANALYTICAL RESULTS

Interpoll Laboratories
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EPA Method 3 Data Reporting Sheet
Orsat Analysis

Job L.P. Tomahawk
Team Leader AK
Date Submitted 12-13-93
Test No. 1
Date of Analysis 12-24-93

Source Dryer
Test Site Stack
Date of Test 12-7-93
No. of Runs Completed
Technician C. Helgeson

Test/Run	Sample Log Number and Type	No. of An.	Buret Readings (ml)			Conc. CO_2 %v/v Dry	Conc. O_2 %v/v Dry	F_0
			Zero Pt.	After CO_2	After O_2			
1/1	1854-07	1	0.00	0.50	20.00	0.50	19.50	
		2	0.00	0.50	20.00	0.50	19.50	
	☐ B ☑ F	Avg				0.50	19.50	
1/2	-08	1	0.00	0.40	20.00	0.40	19.60	
		2	0.00	0.40	20.00	0.40	19.60	
	☐ B ☑ F	Avg				0.40	19.60	
1/3	-09	1	0.00	0.70	20.00	0.70	19.30	
		2	0.00	0.80	20.10	0.80	19.30	
	☐ B ☐ F	Avg				0.75	19.30	
		1						
		2						
	☐ B ☐ F	Avg						
		1						
		2						
	☐ B ☐ F	Avg						
		1						
		2						
	☐ B ☐ F	Avg						
		1						
		2						
	☐ B ☐ F	Avg						
		1						
		2						
	☐ B ☐ F	Avg						
		1						
		2						
	☐ B ☐ F	Avg						

☑ Ambient Air QA Check
☑ Orsat Analyzer System Leak Check
☐ F_0 Within EPA M-3 Guidelines for fuel type.

Where $F_0 = \frac{20.9 - O_2}{CO_2}$

F=Flask (250 cc all glass)
B=Tedlar Bag (5-layer)

EPA Method 3 Guidelines

Fuel Type	F0 Range
Coal:	
Anthracite/Lignite	1.016-1.130
Bituminous	1.083-1.230
Oil:	
Distillate	1.260-1.413
Residual	1.210-1.370
Gas:	
*Natural	1.600-1.836
Propane	1.434-1.586
Butane	1.405-1.553
Wood/Wood Bark	1.000-1.130

LSC-04-BR

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EPA Method 3 Data Reporting Sheet
Orsat Analysis

Job L. P. Tomahawk
Team Leader mk
Date Submitted 12-13-93
Test No. 3
Date of Analysis 12-17-93

Source Face Dryer
Test Site Drum
Date of Test 12-8-93
No. of Runs Completed 1
Technician C. Helgeson

Test/ Run	Sample Log Number and Type	No. of An.	Buret Readings (ml)			Conc. CO_2 %v/v Dry	Conc. O_2 %v/v Dry	F_0
			Zero Pt.	After CO_2	After O_2			
3/1	1854-	1	0.00	2.80	20.90	2.80	18.10	1.00
		2	0.00	2.80	20.90	2.80	18.10	1.00
	☐ B ☐ F	Avg				2.80	18.10	
		1						
		2						
	☐ B ☐ F	Avg						
		1						
		2						
	☐ B ☐ F	Avg						
		1						
		2						
	☐ B ☐ F	Avg						
		1						
		2						
	☐ B ☐ F	Avg						
		1						
		2						
	☐ B ☐ F	Avg						
		1						
		2						
	☐ B ☐ F	Avg						
		1						
		2						
	☐ B ☐ F	Avg						
		1						
		2						
	☐ B ☐ F	Avg						

☐ Ambient Air QA Check
☐ Orsat Analyzer System Leak Check
☐ F_0 Within EPA M-3 Guidelines for fuel type.

Where $F_0 = \frac{20.9 - O_2}{CO_2}$

F=Flask (250 cc all glass)
B=Tedlar Bag (5-layer)

EPA Method 3 Guidelines

Fuel Type	F0 Range
Coal:	
Anthracite/Lignite	1.016-1.130
Bituminous	1.083-1.230
Oil:	
Distillate	1.260-1.413
Residual	1.210-1.370
Gas:	
Natural	1.600-1.836
Propane	1.434-1.586
Butane	1.405-1.553
Wood/Wood Bark	1.000-1.130

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EPA Method 3 Data Reporting Sheet
Orsat Analysis

Job L.P. Tomahawk
Team Leader MK
Date Submitted 12-13-93
Test No. 3
Date of Analysis 12-17-93

Source Core Dryer
Test Site Drum
Date of Test 12-8-93
No. of Runs Completed 1
Technician C. Holgson

Test/ Run	Sample Log Number and Type	No. of An.	Buret Readings (ml)			Conc. CO_2 %v/v Dry	Conc. O_2 %v/v Dry	F_o
			Zero Pt.	After CO_2	After O_2			
3/2	1854-	1	0.00	3.00	20.80	3.00	17.80	1.03
		2	0.00	3.00	20.80	3.00	17.80	1.03
	☐ B ☐ F	Avg				3.00	17.80	
		1						
		2						
	☐ B ☐ F	Avg						
		1						
		2						
	☐ B ☐ F	Avg						
		1						
		2						
	☐ B ☐ F	Avg						
		1						
		2						
	☐ B ☐ F	Avg						
		1						
		2						
	☐ B ☐ F	Avg						
		1						
		2						
	☐ B ☐ F	Avg						
		1						
		2						
	☐ B ☐ F	Avg						
		1						
		2						
	☐ B ☐ F	Avg						

☐ Ambient Air QA Check
☐ Orsat Analyzer System Leak Check
☐ F_o Within EPA M-3 Guidelines for fuel type.

Where $F_o = \frac{20.9 - O_2}{CO_2}$

F=Flask (250 cc all glass)
B=Tedlar Bag (5-layer)

EPA Method 3 Guidelines

Fuel Type	F0 Range
Coal:	
Anthracite/Lignite	1.016-1.130
Bituminous	1.083-1.230
Oil:	
Distillate	1.260-1.413
Residual	1.210-1.370
Gas:	
Natural	1.600-1.836
Propane	1.434-1.586
Butane	1.405-1.553
Wood/Wood Bark	1.000-1.130

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EPA Method 7A Recovery and Analysis Data Sheet (1)

**************SOURCE*************	**************RECOVERY****************	*************ANALYTICAL************
Job LP/Tomahawk	Date of Recovery 12-20-93	Date of Analysis 12-22-93
Source Dryer Stack	Recovered by B. Drake	Analyst SMS
Date of Sampling 12-7-93	Recovery volume 500 ml	Eluent AS4A
Test No(s) 1	Barometric at time 28.88 IN.HG.	Chromatograph: Dionex System 4000i

Samples collected in accordance with EPA Method 7, CFR Title 40, Part 60, Appendix A. Samples analyzed in accordance with EPA Method 7A by ion chromatography. Mercury manometers used to measure flask pressures/vacuums in sampling and in recovery. Thommen Model TX 19 jewel barometer calibrated against laboratory mercury in glass barometer used to measure field barometric pressure. Three field blanks are prepared and the average used to correct measured nitrate concentrations. All samples are analyzed as a batch using a Dionex Model 4270 Chromatograph Data Intergrator. The integrator is programmed to give the actual concentration of the 500 ml recovered sample even if a subsequent dilution was made. The dilution is indicated here as well as on the chromatogram.

$C_{RS} = DF(C_{DS})$ $\quad$ $M_{NO_3} = (C_{RS} - \overline{C}_B)V_R$ $\quad$ $\overline{C}_B = (C_{B1} + C_{B2} + C_{B3})/3$

where: C_{RS} = concentration of nitrate in 500 ml recovered sample in ug/ml

DF = dilution factor

C_{DS} = concentration of nitrate of a 500 ml recovered sample which has been diluted by a factor of DF to bring it into the proper range for the ion chromatograph. This value is an intermediate number and is not outputted by the electronic integrator which is programmed to output the concentration of the original undiluted 500 ml recovered sample.

M_{NO_3} = total mass of nitrate in micrograms in the 500 ml recovered sample and/or in the 2L flask.

C_B = average conc. of nitrate in 500 ml recovered samples from the three field blanks (ug/ml)

C_{B1}, C_{B2}, C_{B3} = conc. of nitrate in 500 ml recovered samples from the three field blanks (ug/ml)

V_R = recovery volume for samples and field blanks in ml

S-340(1)

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EPA Method 7A Recovery and Analysis Data Sheet (2)

	Sample Log ID No.	Flask No.	Test/ Run	Final Flask Conditions				Chrom Run No.	DF	Nitrate Concentration (ug/ml)		Total nitrate in Sample (ug) ($M_{NO_3^-}$)
				t_f (°F)	+	-	Δ Pg (IN.HG.)			Uncorr. for blank C_{RS}	Corr. for blank ($C_{RS} - C_B$)	
1	1854-10	1	1-1-1	68	✓		0.40		1	0.176	0.176	88.0
2	-11	2	1-1-2		✓		1.30		1	0.322	0.322	161
3	-12	3	1-1-3		✓		1.30		1	0.301	0.301	151
4	-13	4	1-1-1		✓		0.40		1	0.224	0.224	112
5	-14	5	1-2-2		✓		1.40		1	[illegible] 0.229	0.229	115
6	-15	6	1-2-3		✓		1.40		1	[illegible] ~~0.246~~ 0.212	0.212	106
7	-16	49	1-2-1		✓		0.10		1	0.281	0.281	141
8	-17	50	1-2-2			✓	3.00		1	0.247	0.247	124
9	-18	51	1-3-3			✓	1.40		1	0.161	0.161	80.5
10	-19	52	1-3-1		✓		0.10		1	0.150	0.150	75.0
11	-20	53	1-3-2		✓		0.10		1	0.172	0.172	86.0
12	-21	54	1-3-3	↓	✓		0.10		1	0.186	0.186	93.0
13												
14												
15												
16												
17												
18												
19												
20												
21												
22												
23												
24												
25												
26												
27												
Blank 1									1	CB1		
Blank 2									1	CB2		
Blank 3									1	CB3		

$\bar{C}_B$ = ____

S-340(2) R-9/85

INTERPOLL LABORATORIES
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S-305RR
(9/90)

EPA Method 10 NDIR Analysis

Job Name L.P. Tomahawk, WI
Source Dryer / Stack
Date of Analysis 12-7-93
Technician Mark Kaehler

NDIR Analyzer: ☒ Fugi ACS Model 3300
☐ Mon. Lab Model 8310
☐ Dasibi Model 3003
Range: 0 - 500 ppm
Flow rate: 1000 cc/min

Pretest Calibration

	Conc.	Reading	Vendor	Cyl. Number
Zero gas:	0 ppm	0 ppm	TCO	TWH-630672
Upscale gas:	144.8 ppm	143 ppm	Scott	CC-114302
Upscale gas:	312 ppm	314 ppm	Scott	CC-109767
Upscale gas:	ppm	ppm		

Post-test Calibration

	Conc.	Reading	Vendor	Cyl. Number
Zero gas:	ppm	ppm		
Upscale gas:	ppm	ppm		
Upscale gas:	ppm	ppm		
Upscale gas:	ppm	ppm		

Sample Description Test/Run	Sample Log Number	CO Conc. (ppm, Dry)		
		Dilution Factor	Reading	Actual ppm
1/1		1	61	61
1/2		1	69	69
1/3		1	71	71

Sample Description Test/Run	Sample Log Number	CO Conc. (ppm, Dry)		
		Dilution Factor	Reading	Actual ppm

Note 1: If sample dilution is required the sample is diluted with CO-free gas prior to analysis.

Note 2: The Fugi ACS model 3300 has a rejection ratio for CO to CO_2 greater then 100,000:1 and the Mon. Labs Model 8310 and Dasibi Model 3003 have rejection ratios greater then 200,000:1 and thus CO_2 removal prior to analysis is not required.

Note 3: The analyzer must be zeroed and spanned immediately before and after sample analysis. Additional checks may be performed between sample analyses if required.

INTERPOLL LABORATORIES INC.

Formaldehyde Results By EPA Method 0011
For LP/Tomahawk Collected 12/13/93

Item	Field Spike*			Test 3			
	Actual	Found	% Recovery	F. Blank	Run 1	Run 2	Run 3
Source							
Log #		1854-02		1854-01	1854-03	1854-04	1854-05
Date Analyzed		1/6/94		1/6/94	1/6/94	1/6/94	1/6/94
Mass (ug)**	750	766	102	2.35	3470	4850	3140

* = The lab blank contained a total of 2.57 ug of formaldehyde which has been subtracted from the field spike only.

** = Total Mass of formaldehyde in the sample in ug.

1554 (01-06)
(07-09)
(10-21)

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Sample Deposition

Job L.P. / Tomahawk, WI.
Field Engineer M. Kaehler
Date Submitted 12-10-93
Test No. 1
Source Dryer
Test Site Stack
Date of Test 12-7-93
No. of Runs Completed 3

No.	Sample Type	Analysis	Comments
3+1	Probe Wash: ☐ Acetone ☒ MeCl$_2$ ☐ DI Water ☐	☐ As per EPA M-5 ☐ As per EPA M-29 ☐ As per EPA M-201A ☒ Other 0011	Probe Wash Combined with The Impingers
—	Filter: ☐ 4" Glass ☐ SS Thimble ☐ 2.5" Glass ☐ Pallflex	☐ As per EPA M-5 ☐ As per EPA M-29 ☐ As per EPA M-201A ☐ As per EPA M-17 ☐ Other	
3+1	Impingers: ☐ DI Water ☐ 3%H$_2$O$_2$ ☐ 1N NaOH ☐ KOH (Cr VI) ☐ H$_2$SO$_4$ (HCl) ☒ 2,4-DNPH ☐ ☐	☐ MN Protocol ☐ WI Protocol ☐ As per EPA M-202 ☐ As per EPA M-6,8 ☐ Acid Gases ☐ Formaldehyde ☐ As per EPA M-29 ☐ As per EPA M-26 ☒ Other 0011	
3*	Integrated Gas Sample ☐ Tedlar Bag ☒ Bulbs	☒ As per EPA M-3 ☒ As per EPA M-10 ☐ Other	CO Done in the Field
12	Oxides of Nitrogen (NO$_x$)	☒ As per EPA M-7A ☐ Other	
—	☐ Fuel Sample ☐ Aggregate	☐ Attached Form S-0163	
—	Particle Size	☐ X-Ray Sedigraph ☐ Cascade Impactor ☐ Other	
—	Misc Samples ☐ ☐	☐ As per EPA M-6 ☐ As per EPA M-7A ☐ Other	

Type of Source: Dryer

Fuel Type:

Coal:	Wood:	Oil:	
☐ Bituminous	☒ ~~Wood Waste~~	☐ Waste Oil	☒ Natural Gas
☐ Anthracite	☐ Dust	☐ No. 2	☐ RDF
☐ Lignite	☐ Bark	☐ No. 6	☐ Other

S-278
G:\STACK\WP\FORMS\S-278.LAS

* Labels will say 1 of 2, second bulb had to be evacuated.

Received 12/13/93 1200

APPENDIX E

PROCESS INFORMATION

Louisiana–Pacific Corporation
Northern Division
Rt. 8, Box 8263
Hayward, Wisconsin 54843
(715) 634–3454

LETTER OF TRANSMITTAL

DATE: 01/05/94	JOB NO.
ATTENTION: Kathy Eichstadt	
RE: Tomahawk Test	

TO Interpoll Laboratories, Inc.
4500 Ball Road NE
Circle Pines, MN 55014–1819

RECEIVED
JAN 0 6 1994
INTERPOLL LABORATORIES

WE ARE SENDING YOU

☒ Attached ☐ Under separate cover via ____________ the following items:

☐ Shop Drwgs. ☐ Prints ☐ Plans ☐ Samples ☐ Specifications

☐ Copy of Letter ☐ Change Order ☐ ____________

COPIES	DATE	NO.	DESCRIPTION
1			Process data for Tomahawk testing Dec. 7 & 8, 1993 (33 Pages)

THESE ARE TRANSMITTED as checked below:

☐ For Approval
☒ For Your Use
☐ As Requested
☐ For Review & Comment
☐ FOR BIDS DUE ____________ 199 .

☐ Approved As Submitted
☐ Approved As Noted
☐ Returned For Corrections
☐ Resubmit ____ copies for approval

☐ Submit ____ copies for distribution
☐ Return ____ corrected prints
☐ ____________
☐ ____________

REMARKS

Copy To: File

Signed: Sue Somers /ka
Sue Somers

TOMAHAWK TESTING 12-7-93
PROCESS DATA

PAGE

DRYER TESTING 12-7-93

TEST SCHEDULE / PROCESS DATA SUMMARY

DATE	TONS FINISHED PRODUCT/HR.	mmBTU of gas used per hr.	POLLUTANT	TESTING TIMES RUN #1	TESTING TIMES RUN #2	TESTING TIMES RUN #3
DRYER OUTLET TESTING (WOOD)						
12-7	11.79	47.67	HCHO, CO, NOx,	1145-1245	1310-1410	1715-1730 1915-2000

PRETEST INFORMATION FOR TOMAHAWK, WISCONSIN

1. Description of the air pollution control equipment associated with the process:

THERMAL OIL HEATER

a) Particulate emissions from the GEKA thermal oil heater are controlled by a cyclone installed in series with a baghouse.

b) The baghouse is designed to operate at a pressure drop of 2 to 6 inches of water column.

c) The maximum design airflow through the stack is 32,600 acfm. The rated heat input capacity of the heater is 30mm BTUs. Control efficiencies of the cyclone and baghouse are estimated to be 50% and 99% respectively.

d) Collected material is presently stored temporarily on site. In the future this material will be either landfilled or spread as a soil amendment.

DRYER

a) Particulate emissions from each MEC dryer are controlled by a set of multicyclones installed in series with a E-TUBE wet electrostatic precipitator.

b) Specific multicyclone operating parameters are not monitored. The wet electrostatic precipitator operates within the following ranges:

voltage - 45 to 65 kv

amperage - 50 to 600 ma

spark rate - up to 300 sparks per minute

c) The maximum design airflow through the stack is 100,000 acfm. The rated heat input capacity of each burner is 32mm BTUs. Control efficiencies of the multicyclones and wet electrostatic precipitators are estimated to be 60% and 90% respectively.

   d) Collected material is mixed with bark and sold or burned in the thermal oil heater.

2. Diagrams of the sampling trains are enclosed in the attachments.

3. Descriptions of the sampling and analysis procedures are enclosed in the attachments.

4. Sketches indicating the flow of the exhaust gases through the equipment are enclosed in the attachments.

5. a) Elevation views of each stack are shown in the attachments.

   b) Cross-sectional views of each stack are provided in the attachments.

6. Estimated flue gas conditions are indicated on the attached stack drawings.

7. PROCESS AND CONTROL EQUIPMENT OPERATING DATA

   a) THERMAL OIL HEATER OPERATING DATA:

      1) Design heat input is 30mm BTU's per hour. Operating heat input will be determined by f factor. Heat output will be estimated based on an efficiency of 66%.

      2) Type of fuel to be burned is green wood bark and fines.

      3) Acfm of exhaust gas through the thermal oil heater will be determined.

      4) Tons of fuel burned in the thermal oil heater on a dry basis during testing will be determined based on the number of ram infeed counts and moisture content of the fuel during testing.

5) Plant production rate during testing will be determined from board weights and press charts.

6) Thermal oil heater operating parameters to be recorded during testing include the following:

- refractory temperature
- incoming oil temperature
- outgoing oil temperature
- Fuel feed setting
- thermal oil temperature setpoint

7) Thermal oil heater control equipment operating parameters to be recorded during testing include the following:

- baghouse pressure drop

b. . DRYER OPERATING DATA

1) The moisture content of wet and dry wafers will be recorded during testing.

2) It is anticipated that the plant will process a minimum of 99% green wood and a maximum of 1% dry dead wood.

3) It is anticipated that the plant will process approximately 90% hardwood and 10% softwood as required by the air emission permit during testing.

4) The dryer inlet and outlet temperatures during testing will be recorded.

5) Design airflow rate is 80,000 acfm. Actual airflow rate will be determined during testing.

6) The fuels to be burned during testing are dry fines and natural gas as described in Table 1. Waste oil is not used as a fuel for this process. Liquid resin waste is not used as a fuel for this process.

7) The heat content of the dry fines fuel will be determined by analysis.

8) The dryer drums are 12' in diameter and 60' long.

9) Dryer production rate (lbs of dy material produced per hour) will be determined as follows:

$$\frac{\text{pounds of dryer production}}{\text{HR}} = \frac{\text{tons of finished product/HR} \times 2000 \text{ lbs}}{1-(\text{board trim \%} + \text{fines \%})}$$

The maximum permitted production rate is 7,674 tons of finished product per month This is equivalent to 10.3 tons per hour for a 31 day month.The maximum permitted hourly production rate is 12.6 tons of finished product per hour. At an estimated 7% board trim and 8% fines, each dryer is required to produce 14,800 lbs. per hour of material to reach the maximum hourly permitted plant production rate.

The design rate of each dryer is estimated to be 29,105 lbs per hour of dry material.

The test rate is anticipated to be greater than or equal to 90% of the maximum hourly permit rate.

10) The level of the dry bins will be recorded before and after testing.

11) Additional dryer operating parameters to be recorded during testing include:

- Wet bin feed rate

12) Additional electrostatic precipitator operating parameters to be recorded during testing include:

- Voltage
- Amperage
- Quench chamber inlet temperature
- Quench chamber outlet temperature

c) PRESS OPERATING DATA

1) Nominal board thickness will be recorded

2) The number of sheet produced per hour will be determined by multiplying the number of press loads (as recorded on the press chart).

3) Pounds of resin used per hour will be recorded.

4) Pounds of wax used per hour will be recorded.

5) Type of resin used will be recorded.

6) Press temperature will be recorded.

7) There are two exhaust fans with a design airflow of 100,000 acfm. Actual acfm will be determined during sampling.

d) PAINT DRYING OVEN OPERATING DATA:

1) The amount of paint applied per hour will be monitored and recorded.

8. Copies of the field data forms to be used are included in the attachments.

9. The names and titles of testing personal are not available at this time. Testing will be preformed by Interpoll Laboratories, Inc.

TOMAHAWK TESTING 12-7-93

DRYER TESTING 12-7-93 production data for runs 1 and 2

DATA START TIME= 11:40 END TIME=14:00 TOTAL DATA TIME= 2.25 hrs

BOARD WEIGHTS - LBS

WEIGHTS OF APPROXIMATELY EVERY 25TH
UNTRIMMED BOARD FROM TAPES

192	203
192	206
200	206
201	203
198	201
197	207

200.50 LB = AVERAGE UNTRIMMED MAT WEIGHT

182.46 LB = AVERAGE FINISHED BOARD WEIGHT (UNTRIMMED MAT WEIGHT - TRIM WEIGHT)

9.0% = TRIM

39.10 , (lb per cubic foot)

PLANT PRODUCTION RATE for runs 1 and 2

2.25 =HOURS DURING TESTING
37.00 =PRESSLOADS
296.00 =NO. OF (8' X 16') BOARDS PRODUCED (PRESSLOADS x 8 BOARDS/LOAD)
54008 =LBS FINISHED PRODUCT (BOARDS x WEIGHT OF FINISHED BOARD)
24004 =LBS FINISHED PRODUCT PRODUCED PER HOUR (LBS FINISHED PROD./TESTING HOURS)
12.00 =TONS FINISHED PRODUCT PRODUCED PER HOUR (LB FINISHED PROD PROD/HR / 2000 LB)

note: the press was down for the last 10 minutes of run 2, however the dryers were maintained at a steady operating rate until testing was completed. Therefore the 12 tons per hour rate achieved during the period from 11:45 - 14:00 will be considered to the be the operational rate during the entire test period for runs 1 and 2.

TOMAHAWK TESTING Production rate data (continued)
DRYER TESTING 12-7-93
production data for run 3
DATA START TIME= 17:10 END TIME=17:30
19:10 19:30 TOTAL DATA TIME=

Press production has not been used to estimate the dryer production rate during run 3
The press ran intermittently during this portion of the test due to various operational problems (see press report
For this reason, the dryer production rate during run 3 will be estimated by comparing the average feed rate
for the first two runs to the average feed rate for run 3

Average feed rate surface and core dryers from 11:40 - 14:1 58.2

Average feed rate surface and core dryers from 17:10 - 17:30
and 19:10 - 20:00 = 55.2

12.00 =TONS FINISHED PRODUCT PRODUCED PER HOUR (LB FINISHED PROD
PROD/HR / 2000 LB) for runs 1 and 2

11.38 =TONS FINISHED PRODUCT PRODUCED PER HOUR (LB FINISHED PROD
PROD/HR / 2000 LB) for run 3 (55.2/58.2) x 12 tons f.p.)

11.79 =TONS FINISHED PRODUCT PRODUCED PER HOUR (LB FINISHED PROD
PROD/HR / 2000 LB) for all three runs

<u>DRYER PRODUCTION RATE: average for all three runs</u>
235876 =LBS FINISHED PRODUCT PRODUCED PER HOUR (tons finished product x 200 lb)
284188 =LB OF DRYER PRODUCTION / HR (LB OF FINISHED PROD./
(1-(% TRIM + % FINES)

8.0% =%FINES
9.0% =%TRIM

TOMAHAWK TESTING 12-7-93
Fuel burning rate - natural gas

fuel counts (uncorrected)

time	core	face
11:30	874962	738059
14:00	875268	738369
difference	306	310
17:00	875454	738548
17:30	875514	738606
difference	60	58
19:00	875670	738752
20:00	875799	738879
difference	129	127

total	495	495
total hours	4	4
counts per hour	123.75	123.75
total both dryers/h	247.50	

fuel counts (corrected)

correction factor		192.600

total both dryers/h	47669	cubic feet
btu/cu. ft =	1000	
btu/hr=	47,668,500	
mmbtu/hr=	47.67	

Note - moisture readings are not accurate until ≈ 18:00 when meter was re-calibrated

①

() = INTERPOLATED

DRYER DATA SHEET

PAGE 1 OF 4

PLANT: TOMAHAWK 12-7-93

READINGS BY: John Haveri

FUEL CALIBRATION: CORE SURFACE

	CORE	CORE	CORE	CORE	CORE	¼ CORE	½ CORE	HR CORE	FACE	FACE	FACE	FACE	FACE	¼ FACE	¼ FACE	HR FACE	HR INLET
TIME	OUTLET SET POINT	FEED RATE	DRYER INLET TEMP	DRYER OUTLET TEMP	½ FUEL COUNT	DRY BIN LEVEL	WET BIN LEVEL	OUTLET FLAKE MOISTURE	OUTLET SET POINT	FEED RATE	DRYER INLET TEMP	DRYER OUTLET TEMP	½ FUEL COUNT	DRY BIN LEVEL	WET BIN LEVEL	OUTLET FLAKE MOISTURE	FLAKE MOISTURE
7:30	242	40	778	221	874458	65%	[illegible]	6.8%	223	43	594	207	737591	60%	40%	11.2%	43.4%
7:40	242	41	788	238					223	43	594	230					
7:50	242	44	775	242					223	46	648	244					
8:00	242	47	809	243	874525	60%	40%		223	49	575	228	737675	50%	50%		
8:10	242	51	868	240					223	58	675	221					
8:20	242	54	950	245					223	59	1004	225					
8:30	MISSED	—			874591	70%	65%	4.8%	MISSED	—			737738	55%	55%	4.1%	42.5%
8:40	242	57	1004	241					223	59	1029	222					
8:50	242	59	990	244					223	59	992	223					
9:00	242	59	992	241	874667	70%	85%		223	60	1018	223	737811	75%	65%		
9:10	242	60	1005	241					223	60	570	182					
9:20	242	62	1015	239			[illegible]		198	40	198	188			[illegible]		
9:30	242	62	1035	235	874717	60%	65%	3%	223	35	236	232	737815	65%	80%	DOWN	43.5%
9:40	242	62	1030	233				[illegible]	223	45	855	232					
9:50	239	62	1026	235					223	53	966	226					
10:00	239	66	1034	234	874787	45%	40%	[illegible]	223	61	1093	222	737875	65%	65%		
10:10	239	60	1028	236				4%	223	63	1049	226				4.0%	
10:20	239	60	1028	240			[illegible]		223	63	1105	223			[illegible]		
10:30	239	60	1002	242	874861	80%	70%		217	63	1089	220	737950	60%	80%		44.5%
10:40	234	30	931	234				4.9%	217	33	921	227				7.9%	
10:50	234	30	748	220					217	33	243	218					
11:00	234	30	271	238	874899	60%	FULL		217	31	268	251	737992	60%	Full	[illegible]	
11:10	234	54	894	243					217	57	918	229					
11:20	234	57	985	227					217	59	1098	214					

//

③

PLANT: TOMAHAWK 12-7-93
READINGS BY: John Haveri
FUEL CALIBRATION: CORE SURFACE

DRYER DATA SHEET

PAGE 3 OF 4

	CORE	CORE	CORE	CORE	CORE	CORE	CORE	CORE	FACE	FACE	FACE	FACE	FACE	FACE	FACE	FACE	INLET
TIME	OUTLET SET POINT	FEED RATE	DRYER INLET TEMP	DRYER OUTLET TEMP	FUEL COUNT	DRY BIN LEVEL	WET BIN LEVEL	OUTLET FLAKE MOISTURE	OUTLET SET POINT	FEED RATE	DRYER INLET TEMP	DRYER OUTLET TEMP	FUEL COUNT	DRY BIN LEVEL	WET BIN LEVEL	OUTLET FLAKE MOISTURE	FLAKE MOISTURE
15:30	DOWN								DOWN								
15:40	DOWN								DOWN								
15:50	DOWN								DOWN								
16:00	DOWN								DOWN								
16:10	DOWN								DOWN								
16:20	221	[illegible]	680	222					205	38	842	243	[illegible]				
16:30	221	49	777	225	875314	55%	29%	~~8.38~~	206	50	793	210	734485	55%	40%	~~4.18~~	~~48.26~~
16:40	221	51	728	222					206	52	824	204					
16:50	221	53	724	220					206	54	834	203					
17:00	[illegible]	[illegible]	[illegible]	[illegible]	875454	80%	45%		198	54	885	228	738548	80%	30%		
17:10	~~224~~ 224	~~53~~ 54	~~925~~ 913	~~224~~ 223	(875474)				206	56	945	206	(738567)				
17:20	224	55	965	225					207	57	1005	205					
17:30	224	25*	616	210	875514	90%	90%	~~12.28~~	207	27*	673	210	738606	90%	45%	~~5.78~~	~~37.56~~
17:40	224	25	333	206					207	27	485	207					
17:50	230	32	237	215					225	27	205	199					
18:00	230	40	833	246	875534	80%	100%		225	35	593	220	738620	80%	90%		
18:10	236	50	876	241					199	46	871	230					
18:20	236	50	948	239				4.8 ok	225	50	983	231				6.4 ok	39.8 OK
18:30	MISSED —			—	875602	85%	60%	4.8%	MISSED —			—	738686	80%	80%	6.4%	39.8%
18:40	236	55	940	241					225	55	1033	223					
18:50	236	55	998	238					224	55	970	226					
19:00	238	55	1003	239	875670	45%	50%		224	55	942	223	738752	75%	60%		
19:10	238	55	1020	242	(875691)				224	55	1000	224	(738773)				
19:20	235	55	1028	241					220	55	1011	220					

* NOTE - THIS FEED RATE WAS ENTERED IMMEDIATELY AFTER THE DRYERS WERE SLOWED DOWN [illegible]

④

PLANT: TOMAHAWK 12-7-93

READINGS BY: John Haveri

FUEL CALIBRATION: CORE SURFACE

DRYER DATA SHEET

PAGE 4 OF 4

	CORE	CORE	CORE	CORE	CORE	CORE	CORE	CORE	FACE	FACE	FACE	FACE	FACE	FACE	FACE	FACE	INLET
TIME	OUTLET SET POINT	FEED RATE	DRYER INLET TEMP	DRYER OUTLET TEMP	FUEL COUNT	DRY BIN LEVEL	WET BIN LEVEL	OUTLET FLAKE MOISTURE	OUTLET SET POINT	FEED RATE	DRYER INLET TEMP	DRYER OUTLET TEMP	FUEL COUNT	DRY BIN LEVEL	WET BIN LEVEL	OUTLET FLAKE MOISTURE	FLAKE MOISTURE
1930	235	55	1026	236	875733	80%	55%	4.0%	222	55	1053	221	738814	80%	65%	5.6%	42%
19:40	235	55	1028	237					220	55	1019	219					
19:50	235	55	1031	245					220	55	986	220					
20:00	235	55	1019	233	875774		65%	8.0%	220	55	993	222	738879	80%	60%		
20:10			[illegible]														

②

12-7-93

PLANT: TOMAHAWK

READINGS BY: John P. Hayes

FUEL CALIBRATION: CORE SURFACE

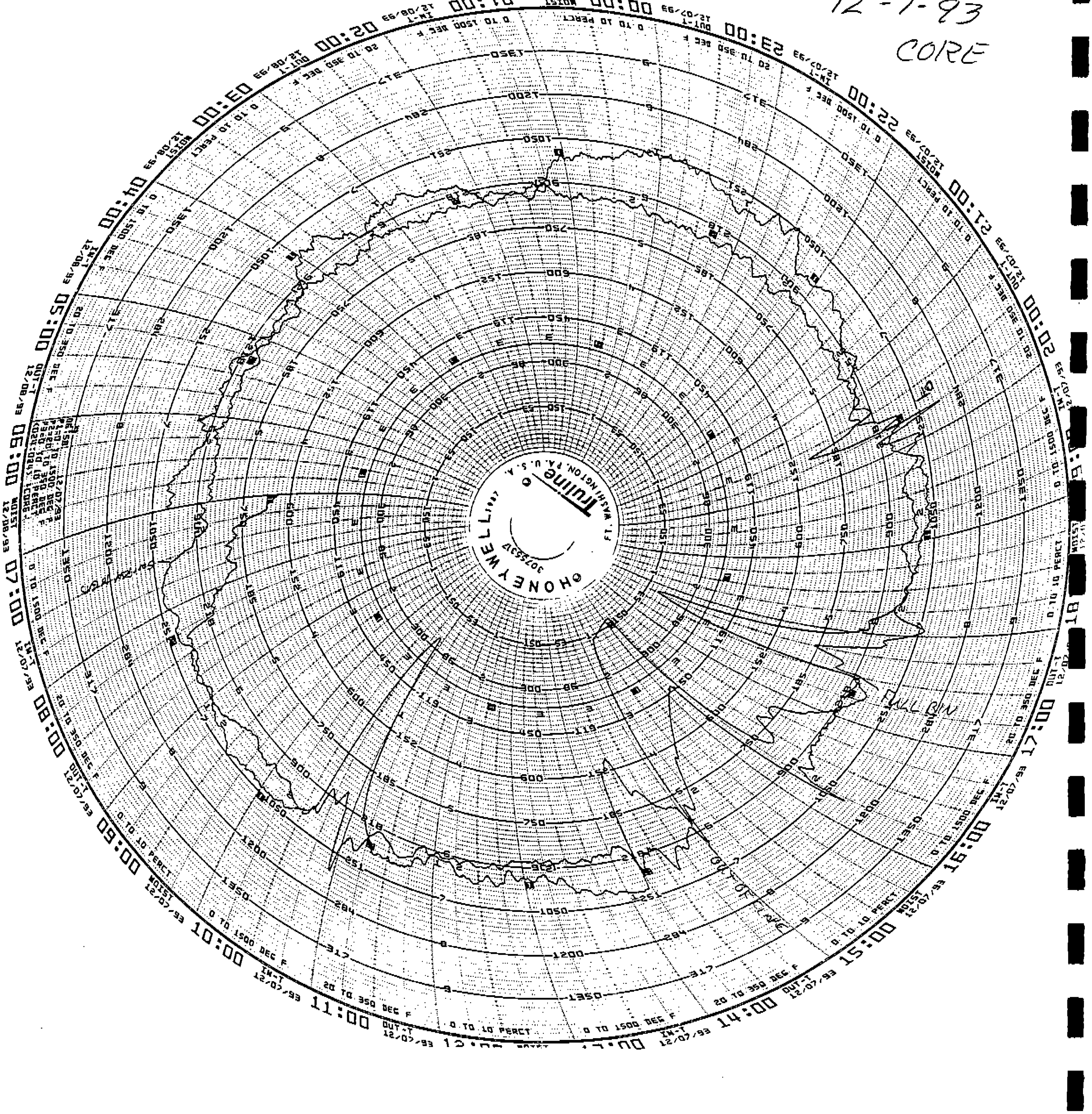
DRYER DATA SHEET

PAGE 2 OF 4

	CORE	CORE	CORE	CORE	CORE	CORE	CORE	CORE	FACE	FACE	FACE	FACE	FACE	FACE	FACE	FACE	INLET
TIME	OUTLET SET POINT	FEED RATE	DRYER INLET TEMP	DRYER OUTLET TEMP	FUEL COUNT	DRY BIN LEVEL	WET BIN LEVEL	OUTLET FLAKE MOISTURE	OUTLET SET POINT	FEED RATE	DRYER INLET TEMP	DRYER OUTLET TEMP	FUEL COUNT	DRY BIN LEVEL	WET BIN LEVEL	OUTLET FLAKE MOISTURE	FLAKE MOISTURE
11:30	231	57	985	229	874962	60%	70%	3.8%	217	59	1110	214	738059	65%	80%	4.4%	47%
11:40	231	57	987	236	(874982)				216	57	932	215	(738079)				
11:50	225	57	943	225					216	57	982	218					
12:00	225	57	925	227	875021	60%	70%		214	57	966	213	738119	65%	80%		
12:10	225	57	923	225					214	57	888	214					
12:20	225	57	957	225					214	57	879	214					
12:30	225	58	959	227	875072	55%	70%	4.6%	214	58	930	214	738171	45%	80%	6.0%	38.6%
12:40	225	58	952	224					214	58	1046	213					
12:50	221	58	938	225					214	58	1070	209					
13:00	221	58	939	221	875135	55%	90%		207	58	1038	203	738235	40%	80%		
13:10	221	58	946	221					206	59	911	203					
13:20	221	59	947	220					207	59	891	208					
13:30	221	59	990	221	875194	50%	90%	8.8%	206	59	911	206	738297	45%	95%	8.8%	41.7%
13:40	221	59	986	220					206	59	1110	201					
13:50	221	60	993	221					206	60	946	202					
14:00	221	60	1006	221	875268	65%	65%		205	59	881	207	738369	60%	65%		
14:10	221	60	1023	219	(875282)				205	59	907	206	(738382)				
14:20	221	30	741	235					205	39	708	212					
14:30	MISSED		—	—	875310	100%	55%	8.6%	MISSED		—	—	738408	100%	45%	13.4%	42.5%
14:40	221	35	689	232					205	40	624	219					
14:50	221	45	768	226					205	47	777	222					
15:00	221	45	804	217	875349	75%	15%		205	47	322	204	738446	80%	25%	[illegible]	
15:10	221	45	372	203					205	47	128	185					
15:20	221	45	193	178					205	47	95	159					

14

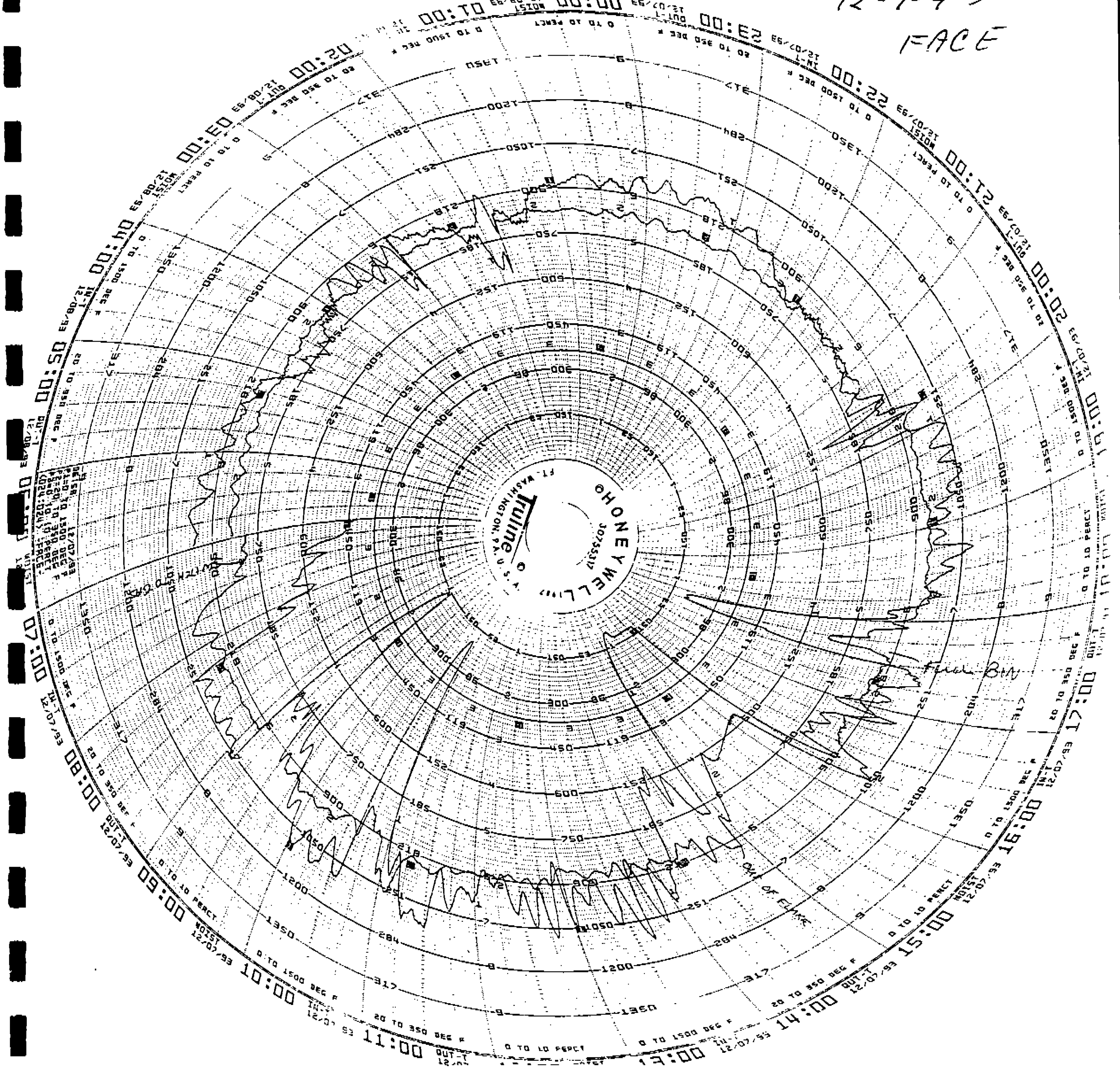
DRYER CHART
12-7-93
CORE



LOUISIANA - PACIFIC
P.O. BOX 190
TOMAHAWK, WI 54487

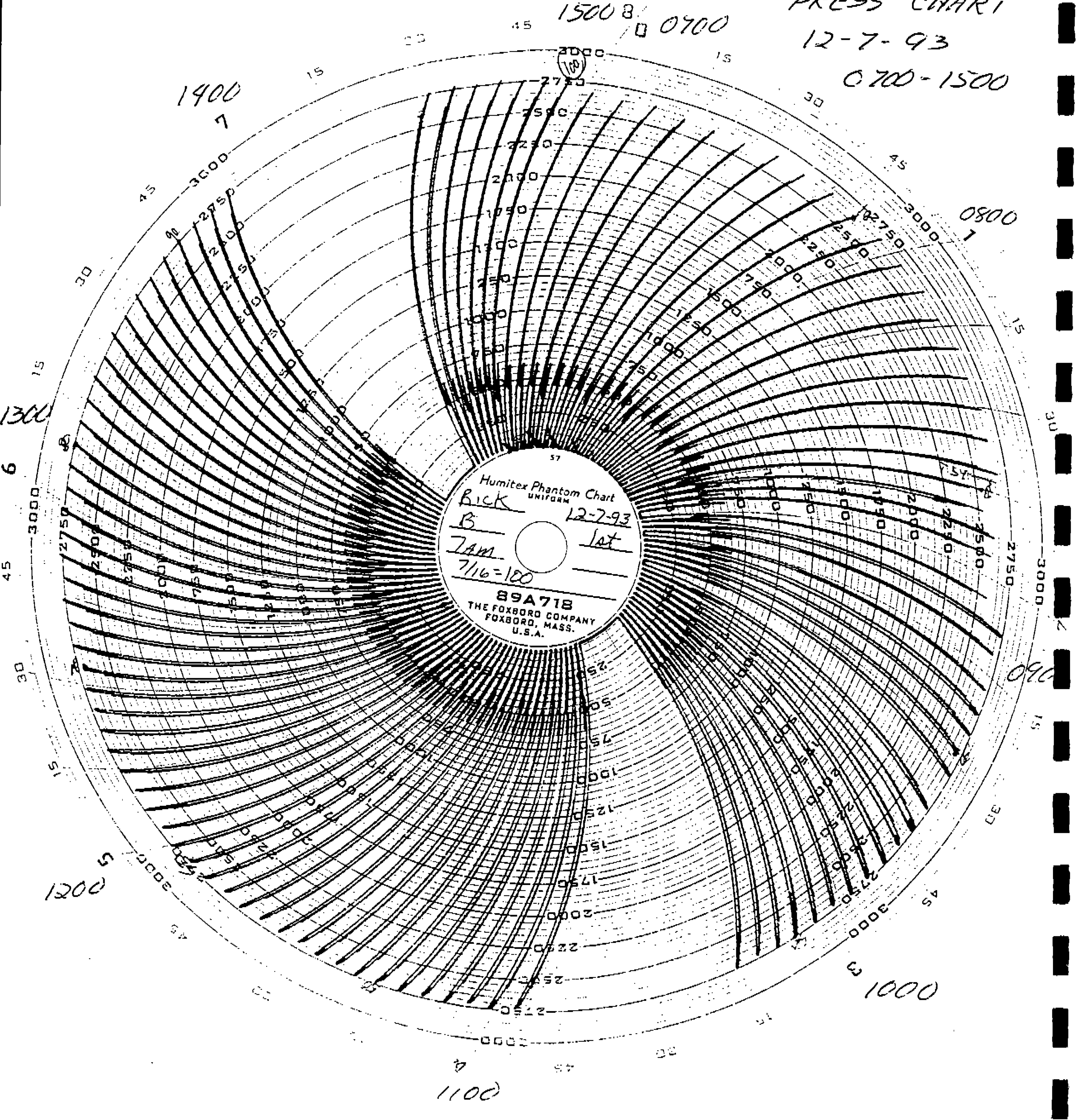
15

DRYER CHART
12-7-93
FACE



16 E-17

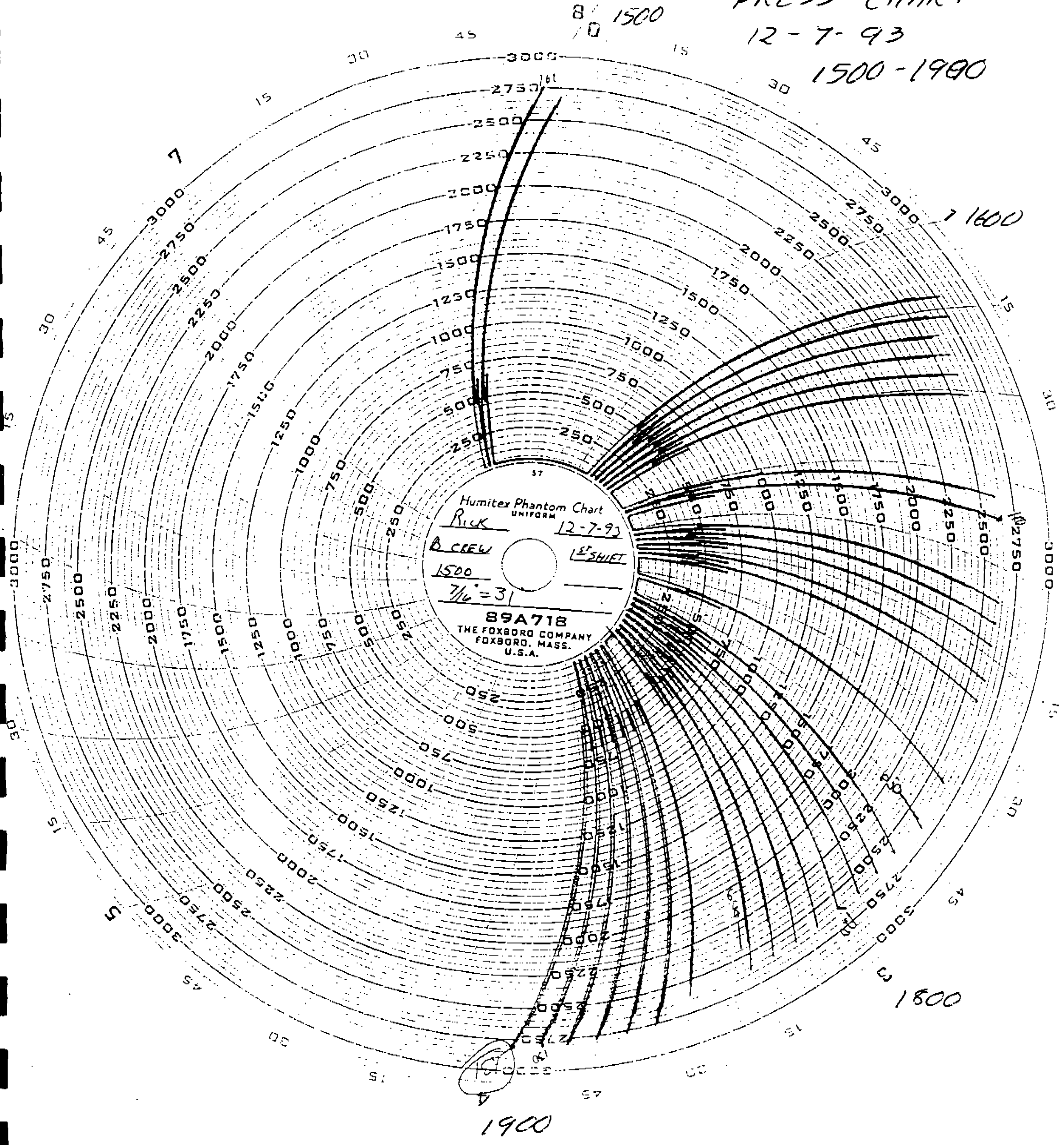
PRESS CHART
12-7-93
0700-1500



PRESSLOADS
1145 - 1400 = 37

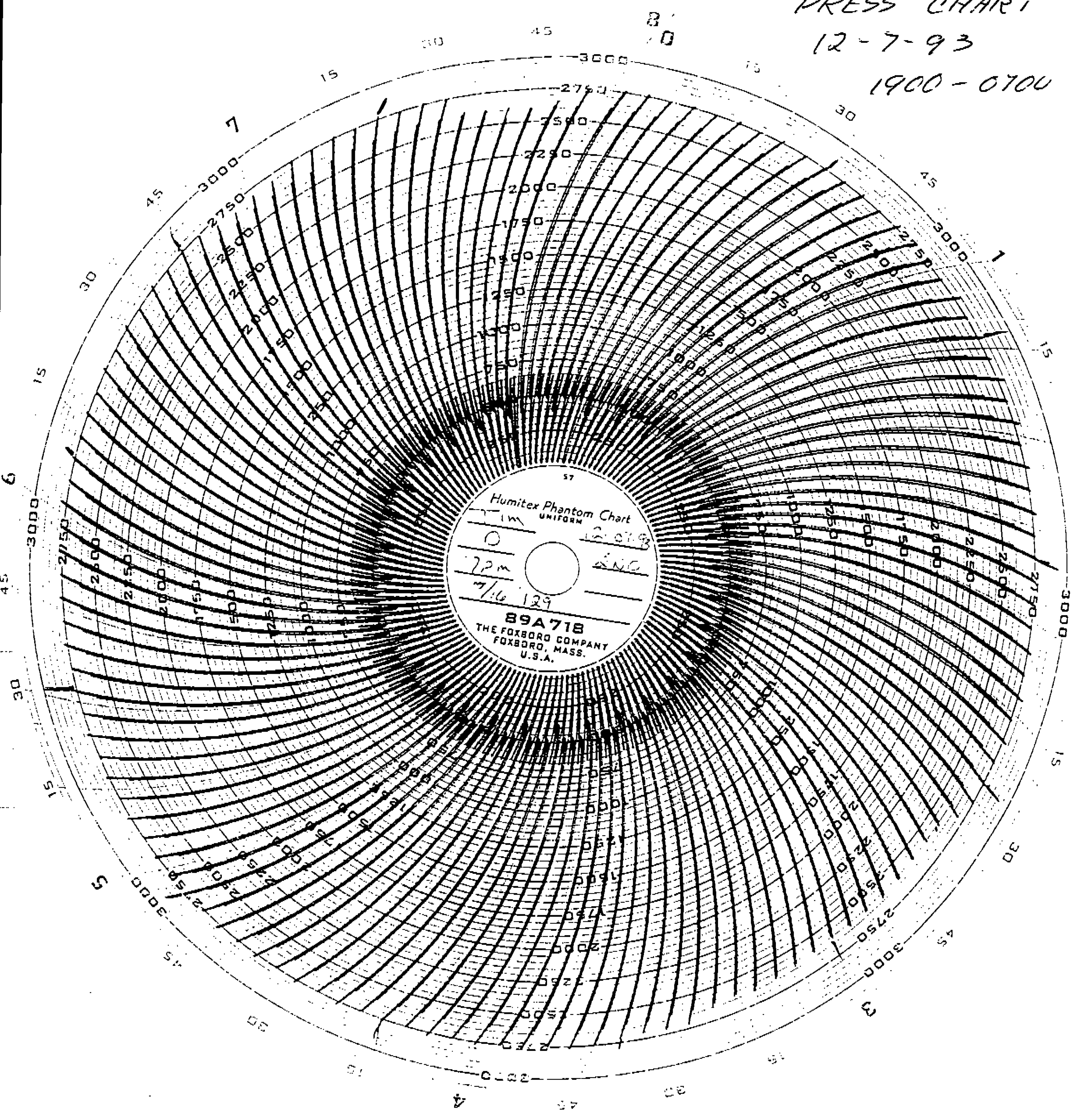
LOUISIANA - PACIFIC
P.O. BOX 190
TOMAHAWK WI 54487

PRESS CHART
12-7-93
1500-1900



18

PRESS CHART
12-7-93
1900 - 0700



LOUISIANA - PACIFIC
P.O. BOX 190
TOMAHAWK, WI 54487

19

PRESS REPORT

LOUISIANA PACIFIC
TOMAHAWK WI

Line Sp.	From	To
505	0700	0845
759	0845	14:28
754	14:28	14:35
650	14:35	1825
600	1825	:
	:	:

Press Temp.	222° c.
Press Blown Down	—
	Time
Former Hyd. Radiator	—
FCOS Hyd. Radiator	—
Spinnerheads flushed	—

Date:	12-7-93
Operator:	Rick
Crew:	B
Shift:	1AX
Thickness:	7/16
No. of P/L's:	131
Footage:	156,506
Downtime:	186 min.

	From	To	M	E	O	Explanation of Downtime
D	0855	0858	3			CHARGE FORMERS
O	0910	0912	2			CHARGE FORMERS
W	0931	0933	2			CHARGE FORMERS
N	0933	0934		1		JOG LOADER CAGE
41— T	1020	1053	33			SHUTTLE ~~TRAPPED~~ JUMPED CHAIN
I	1359	1430	31			SHUTTLE JUMPED CHAIN
M	1504	1610	66			CORE DIST. SCREW PLUGGED & RE-TIME INJECTOR SHUTTLE
E	1633	1647	14			PLUG IN FLOP GATE

M–Mechanical E–Electrical O–Operator

Press Loads				
10	20	30	40	50
60	70	80	90	100
110	120	130	|	

Core ETube Shutdown		Face ETube Shutdown		Hammermill to dump		
From	To	From	To	From	To	
				0729	1900	689 min.

20 E-21

FROM	TO	M	E	O	EXPLANATION
1655	1702	7			BLENDER PLUG - SURF
1714	1716	2			SURF BLENDER PLUG. CHARGE FORMERS
1724	1734	10			SURF. BLEND. SYST. PLUG.
1739	1748	9			FLOP GATE PLUG
1823	1829	6			

180

21

PRESS REPORT

LOUISIANA PACIFIC
TOMAHAWK WI

Line Sp.	From	To
759	7:00	7:00
	:	:
	:	:
	:	:
	:	:
	:	:

Press Temp.	222 °C
Press Blown Down	
	Time
Former Hyd. Radiator	:
FCOS Hyd. Radiator	:
Spinnerheads flushed	9:14

Date:	12-7-93
Operator:	TIM
Crew:	D
Shift:	2ND
Thickness:	7/16"
No. of P/L's:	195
Footage:	232,967
Downtime:	-0'-

	From	To	M	E	O	Explanation of Downtime
D	:	:				
O	:	:				
W	:	:				
N	:	:				
T	:	:				
I	:	:				
M	:	:				
E	:	:				

M–Mechanical E–Electrical O–Operator

Press Loads

Core ETube Shutdown		Face ETube Shutdown		Hammermill to dump		
From	To	From	To	From	To	
				7:00	8:30	-90-
				10:56	11:17	21
				1:30	1:53	-23-
				3:00	3:25	-25-
				5:28	6:00	-32-
						-191-

22

Date:	12/8/93
Shift:	
Crew:	
By:	LARRY

E-TUBE REPORT

STACK TESTING PAGE 1 OF 6

SURFACE E-TUBE	8.00 7	810 8	820 9	830 10	840 ~~11~~	850 ~~12~~	900 ~~1~~	910 ~~2~~	920 ~~3~~	930 ~~4~~	940 ~~5~~	950 ~~6~~
Quench Ch. Inlet Temp.	206.8	201.7			200.7	201.5	201.3	186.1	179.4	182.3	195.1	199.6
Quench Ch. Outlet Tem.	132.7	139.5			140.0	139.9	140.2	113.5	99.0	96.2	125.8	136.0
Primary Current	65	55			60	55	55	85	65	55	55	45
Precipatator Voltage	46	48			50	50	50	46	56	44	46	46
Precipatator Current	260	170			200	190	200	320	260	220	190	150
Spark Rate	27.7	27.8			27.7	27.7	27.9	27.4	28.5	28.1	28.0	28.2
Dryer Inlet Temp.												
Dryer Outlet Tem.												

CORE E-TUBE	800 7	810 8	820 9	830 10	840 11	850 12	900 1	910 2	920 3	930 4	940 5	950 6
Quench Ch. Inlet Temp.	192.0	192.1			191.2	193.5	192.1	192.3	191.2	188.3	186.4	187.8
Quench Ch. Outlet Tem.	135.6	139.9			142.2	142.7	142.7	142.8	143.2	143.3	143.0	143.4
Primary Current	55	40			50	50	55	40	45	45	55	50
Precipatator Voltage	48	48			48	50	48	52	48	50	50	50
Precipatator Current	190	200			200	180	180	210	160	180	160	200
Spark Rate	30.0	30.2			30.0	29.9	30.0	29.8	30.0	30.0	29.9	30.0
Dryer Inlet Temp.												
Dryer Outlet Tem.												

Date:	12/7/93
Shift:	
Crew:	
By:	LARRY

E-TUBE REPORT

STACK TESTING PAGE 2 OF 6

SURFACE E-TUBE	1000 7	1010 8	1020 9	1030 10	1040 11	1050 12	1100 1	1110 2	1120 3	1130 4	1140 5	1150 6
Quench Ch. Inlet Temp.	201.1	202.2	201.3	199.7	198.3	187.3	200.2	209.7	202.5	201.4	200.6	197.7
Quench Ch. Outlet Tem.	141.6	140.6	142.7	141.9	131.7	101.5	114.1	135.9	142.2	138.6	139.1	139.4
Primary Current	45	50	50	55	70	70	60	45	40	60	55	55
Precipatator Voltage	48	50	48	50	48	44	46	48	48	50	48	48
Precipatator Current	170	180	180	220	300	240	210	150	170	200	230	190
Spark Rate	27.9	27.6	27.8	27.5	27.5	27.6	28.2	28.0	28.0	27.4	27.6	28.0
Dryer Inlet Temp.												
Dryer Outlet Tem.												

CORE E-TUBE	1000 7	1010 8	1020 9	1030 10	1040 11	1050 12	1100 1	1110 2	1120 3	1130 4	1140 5	1150 6
Quench Ch. Inlet Temp.	188.1	188.7	188.7	192.2	190.3	177.0	186.2	189.0	186.6	186.4	187.0	183.9
Quench Ch. Outlet Tem.	143.7	143.8	143.1	142.7	131.1	101.7	115.8	135.2	139.8	141.7	141.4	139.6
Primary Current	50	30	50	55	80	75	65	50	50	45	50	50
Precipatator Voltage	48	44	48	50	48	48	48	48	48	50	48	50
Precipatator Current	210	70	170	180	300	300	230	150	150	200	160	160
Spark Rate	30.0	30.3	30.4	30.0	29.7	29.9	29.9	30.2	30.0	29.9	30.0	30.0
Dryer Inlet Temp.												
Dryer Outlet Tem.												

E-TUBE REPORT

Date: 12/7/93
Shift:
Crew:
By: LARRY

STACK TESTING

PAGE 3 OF 6

SURFACE E-TUBE	1200 7	1210 8	1220 9	1230 10	1240 11	1250 12	100 1	110 2	120 3	130 4	140 5	150 6
Quench Ch. Inlet Temp.	195.4	195.5	194.6	194.4	194.7	194.7	189.9	189.3	191.1	190.3	189.7	189.9
Quench Ch. Outlet Tem.	139.2	138.1	138.2	139.0	141.5	142.3	138.7	138.5	137.4	141.7	142.7	141.9
Primary Current	50	55	55	55	50	25	55	50	55	55	45	50
Precipatator Voltage	48	48	48	48	48	44	48	48	48	50	48	48
Precipatator Current	200	210	190	180	190	110	210	220	200	160	190	190
Spark Rate	28.1	27.8	27.8	27.7	28.0	28.2	28.1	27.8	27.5	28.2	27.7	28.0
Dryer Inlet Temp.												
Dryer Outlet Tem.												

CORE E-TUBE	1200 7	1210 8	1220 9	1230 10	1240 11	1250 12	100 1	110 2	120 3	130 4	140 5	150 6
Quench Ch. Inlet Temp.	182.5	182.4	181.8	181.8	182.2	181.3	179.3	178.8	178.7	179.2	179.4	179.1
Quench Ch. Outlet Tem.	138.1	138.1	139.4	139.9	139.2	138.1	137.9	137.7	138.6	140.3	140.5	140.9
Primary Current	50	55	50	50	60	65	55	65	60	50	45	50
Precipatator Voltage	50	48	48	48	50	50	48	48	50	50	50	50
Precipatator Current	170	220	210	170	220	230	200	220	220	190	180	190
Spark Rate	29.9	30.1	29.9	30.7	29.9	30.0	30.0	30.0	30.0	29.9	29.9	29.9
Dryer Inlet Temp.												
Dryer Outlet Tem.												

Date:	12/7/93
Shift:	
Crew:	
By:	LARRY

E–TUBE REPORT

STACK TESTING

PAGE 4 OF 6

SURFACE E–TUBE	200 7	210 8	220 9	230 10	240 11	250 12	300 1	310 2	320 3	330 4	340 5	350 6
Quench Ch. Inlet Temp.	191.0	190.0	188.4	187.8	191.0	191.5	186.1	175.0		156.2		
Quench Ch. Outlet Tem.	137.7	138.3	126.3	123.6	123.9	127.8	100.4	91.4		83.4		
Primary Current	60	55	70	70	60	30	80	65		50		
Precipatator Voltage	48	48	48	46	46	30	46	42		46		
Precipatator Current	210	210	300	270	240	60	350	220		200		
Spark Rate	27.7	27.6	27.6	27.7	27.6	29.0	26.9	28.5		27.5		
Dryer Inlet Temp.							DRYERS					
Dryer Outlet Tem.							DOWN					

CORE E–TUBE	200 7	210 8	220 9	230 10	240 11	250 12	300 1	310 2	320 3	330 4	340 5	350 6
Quench Ch. Inlet Temp.	178.6	177.1	179.4	178.3	181.2	181.1	178.1	167.6		143.7		
Quench Ch. Outlet Tem.	141.4	142.7	126.7	117.9	126.7	128.1	132.6	94.8		84.4		
Primary Current	50	45	70	50	70	65	60	75		70		
Precipatator Voltage	48	50	48	42	48	48	46	50		48		
Precipatator Current	190	210	240	200	230	220	210	270		280		
Spark Rate	29.9	30.0	29.8	30.7	30.1	30.0	30.1	29.8		30.0		
Dryer Inlet Temp.							DRYER					
Dryer Outlet Tem.							DOWN					

E - T U B E
R E P O R T

Date:	12/7/93
Shift:	
Crew:	
By:	LARRY

STACK TESTING. PAGE 5 OF 8

SURFACE E-TUBE	400 7	410 8	420 9	430 10	440 11	450 12	500 1	510 2	520 3	530 4	540 5	550 6
Quench Ch. Inlet Temp.			182.9	193.7	190.0	189.4	194.5	190.3	189.0	189.5	186.1	165.9
Quench Ch. Outlet Tem.			108.9	123.4	128.4	129.7	130.7	134.9	139.3	130.2	117.1	95.3
Primary Current			35	40	45	55	55	50	50	65	65	75
Precipatator Voltage			44	44	44	46	46	46	46	46	46	46
Precipatator Current			110	160	170	180	190	180	180	270	300	230
Spark Rate			27.8	27.5	27.9	27.6	27.7	27.7	28.0	27.4	27.5	27.8
Dryer Inlet Temp.	DRYER											
Dryer Outlet Tem.	DOWN											

CORE E-TUBE	400 7	410 8	420 9	430 10	440 11	450 12	500 1	510 2	520 3	530 4	540 5	550 6
Quench Ch. Inlet Temp.			161.3	175.6	177.7	177.7	179.0	179.7	179.4	180.2	169.3	162.4
Quench Ch. Outlet Tem.			113.0	124.0	126.6	128.1	133.7	137.2	138.6	125.6	98.9	95.4
Primary Current			30	45	50	50	60	55	50	80	90	85
Precipatator Voltage			42	44	44	44	48	48	46	46	48	46
Precipatator Current			130	190	190	200	200	180	160	260	270	350
Spark Rate			30.1	30.0	29.9	29.9	30.0	30.0	30.1	29.8	29.7	39.0
Dryer Inlet Temp.	DRYER											
Dryer Outlet Tem.	DOWN											

Date: 12/7/03	
Shift: /	
Crew:	
By: LARRY	

E-TUBE REPORT

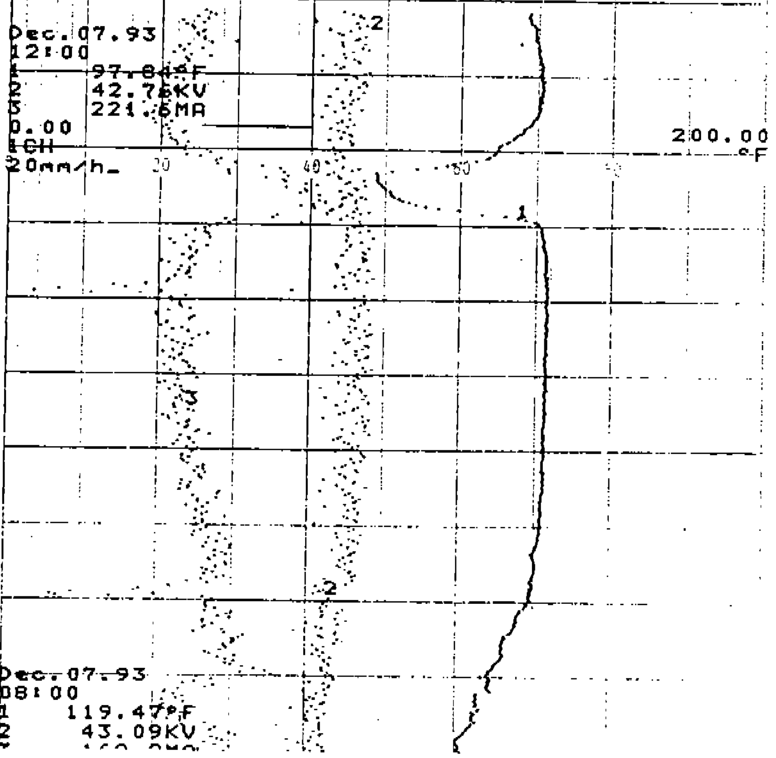
STACK TESTING PAGE 6 OF 6

SURFACE E-TUBE	600 7	610 8	620 9	630 10	640 11	650 12	700 1	710 2	720 3	730 4	740 5	750 6
Quench Ch. Inlet Temp.	184.5	193.7	198.9	202.1	202.4	203.0	202.7	202.5	202.5	200.4	200.7	200.8
Quench Ch. Outlet Tem.	114.2	125.5	132.7	137.2	138.2	137.8	137.5	139.2	140.3	141.0	140.0	140.8
Primary Current	50	50	50	50	50	55	55	55	55	50	55	55
Precipatator Voltage	44	44	46	46	48	48	48	48	48	48	48	48
Precipatator Current	190	180	190	180	190	210	200	210	190	190	220	230
Spark Rate	29.0	28.3	27.8	27.7	27.4	27.8	27.6	28.0	27.8	27.8	27.8	27.8
Dryer Inlet Temp.												
Dryer Outlet Tem.												

CORE E-TUBE	600 7	610 8	620 9	630 10	640 11	650 12	700 1	710 2	720 3	730 4	740 5	750 6
Quench Ch. Inlet Temp.	180.6	189.7	187.4	189.9	190.6	189.9	188.0	190.7	191.5	190.9	189.2	193.2
Quench Ch. Outlet Tem.	127.5	133.1	137.5	140.1	140.6	141.8	141.7	141.6	142.1	142.7	142.2	141.1
Primary Current	45	55	40	50	50	60	55	60	55	55	65	25
Precipatator Voltage	48	46	48	48	48	50	50	48	50	48	48	20
Precipatator Current	190	180	170	210	200	200	190	200	190	200	200	50
Spark Rate	30.5	29.9	29.9	29.9	30.0	30.0	29.9	30.0	30.0	29.9	30.0	30.5
Dryer Inlet Temp.												
Dryer Outlet Tem.												

```
           1.000       600.0
  4  SKIP
  5  SKIP
  6  SKIP

 CH DIGITAL ZONE(mm)    PARTIAL
  1   ON       0-100
  2   ON       0-100
  3   ON       0-100
  4   ON       0-100
  5   ON       0-100
  6   ON       0-100

 MESSAGE 1 =
         2 =
         3 =
         4 =
         5 =

Dec.10.93 09:15
1    140.74°F         2    44.62KV
3     99.9MA

Dec.10.93 09:15
1    140.05°F         2    45.18KV
3    103.3MA

Dec.10.93 08:35
CHART SPEED  20mm/h      (2)20mm/h
TREND INTVL  AUTO(45sec)
CH  RANGE    LEFT END   SCALE LEFT
TAG No.      RIGHT END  SCALE RIGHT
 1  6V(SCALE)
               1.000V      0.00°F
               5.000     200.00
 2  6V(SCALE)
               1.000V      0.00KV
               5.000     100.00
 3  2V(SCALE)
               0.000V      0.0MA
               1.000     600.0
 4  SKIP
 5  SKIP
 6  SKIP
CH DIGITAL ZONE(mm)    PARTIAL
 1   ON       0-100
 2   ON       0-100
 3   ON       0-100
 4   ON       0-100
 5   ON       0-100
 6   ON       0-100

MESSAGE 1 =
        2 =
        3 =
        4 =
```

```
 Dec.10.93 07:51
 CHART SPEED  20mm/h      (2)20mm/h
 TREND INTVL  AUTO(45sec)
 CH  RANGE    LEFT END   SCALE LEFT
 TAG No.      RIGHT END  SCALE RIGHT
  1  6V(SCALE)
                1.000V      0.00°F
                5.000     200.00
  2  6V(SCALE)
                1.000V      0.00KV
                5.000     100.00
  3  2V(SCALE)
                0.000V      0.0MA
                1.000     600.0
  4  SKIP
  5  SKIP
  6  SKIP
 CH DIGITAL ZONE(mm)    PARTIAL
  1   ON       0-100
  2   ON       0-100
  3   ON       0-100
  4   ON       0-100
  5   ON       0-100
  6   ON       0-100

 MESSAGE 1 =
         2 =
         3 =
         4 =
         5 =
```



```
Dec.07.93
12:00
1   97.84°F
2   42.76KV
3  221.6MA
0.00
1CH
20mm/h
```

```
Dec.07.93
08:00
1   119.47°F
2    43.09KV
```

CORE

12-7

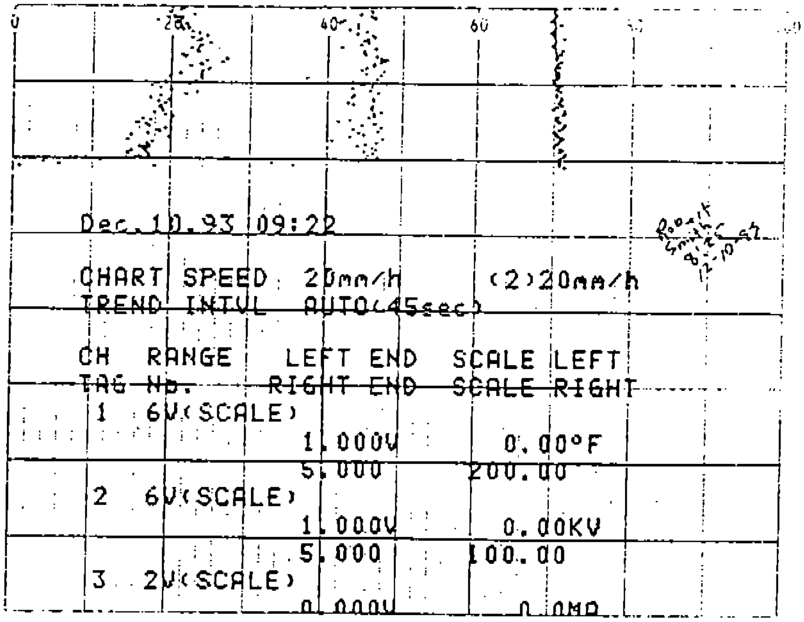
12-10

OVER →

29

LOUISIANA - PACIFIC
P.O. BOX 190
TOMAHAWK, WI 54487

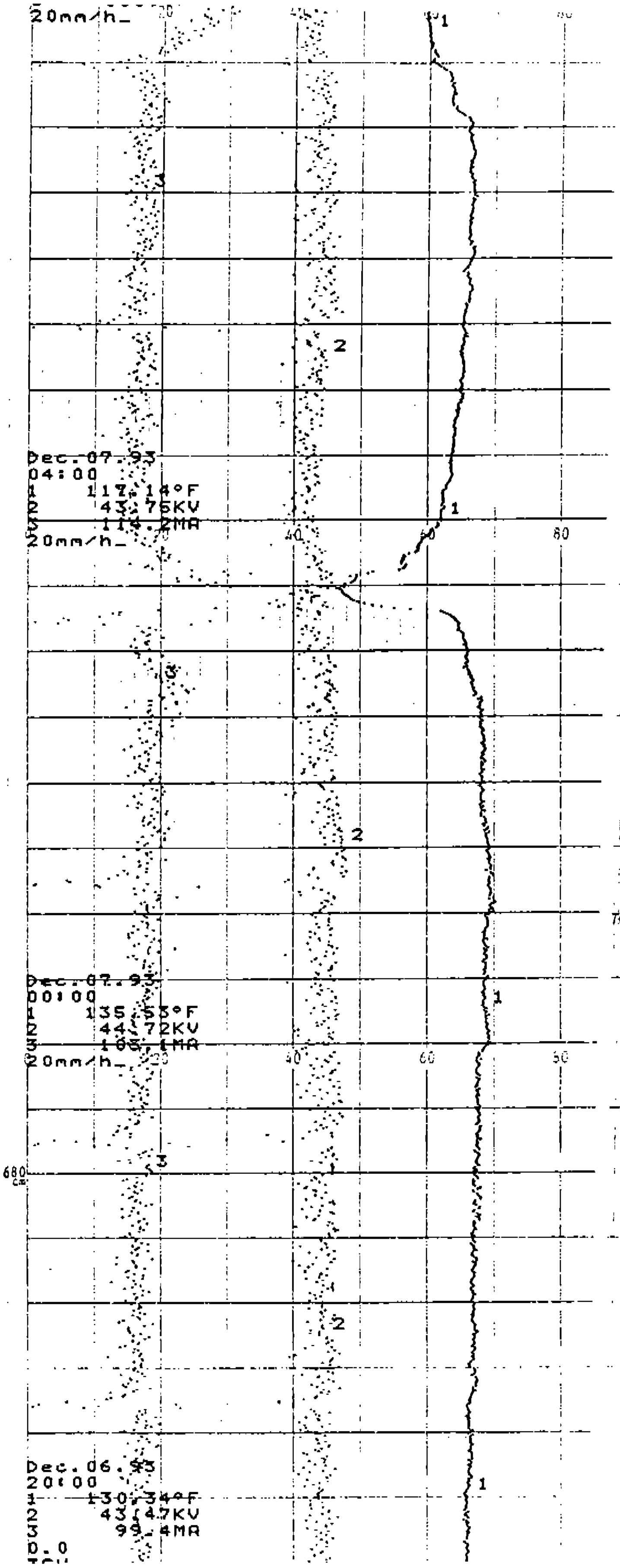
E-30

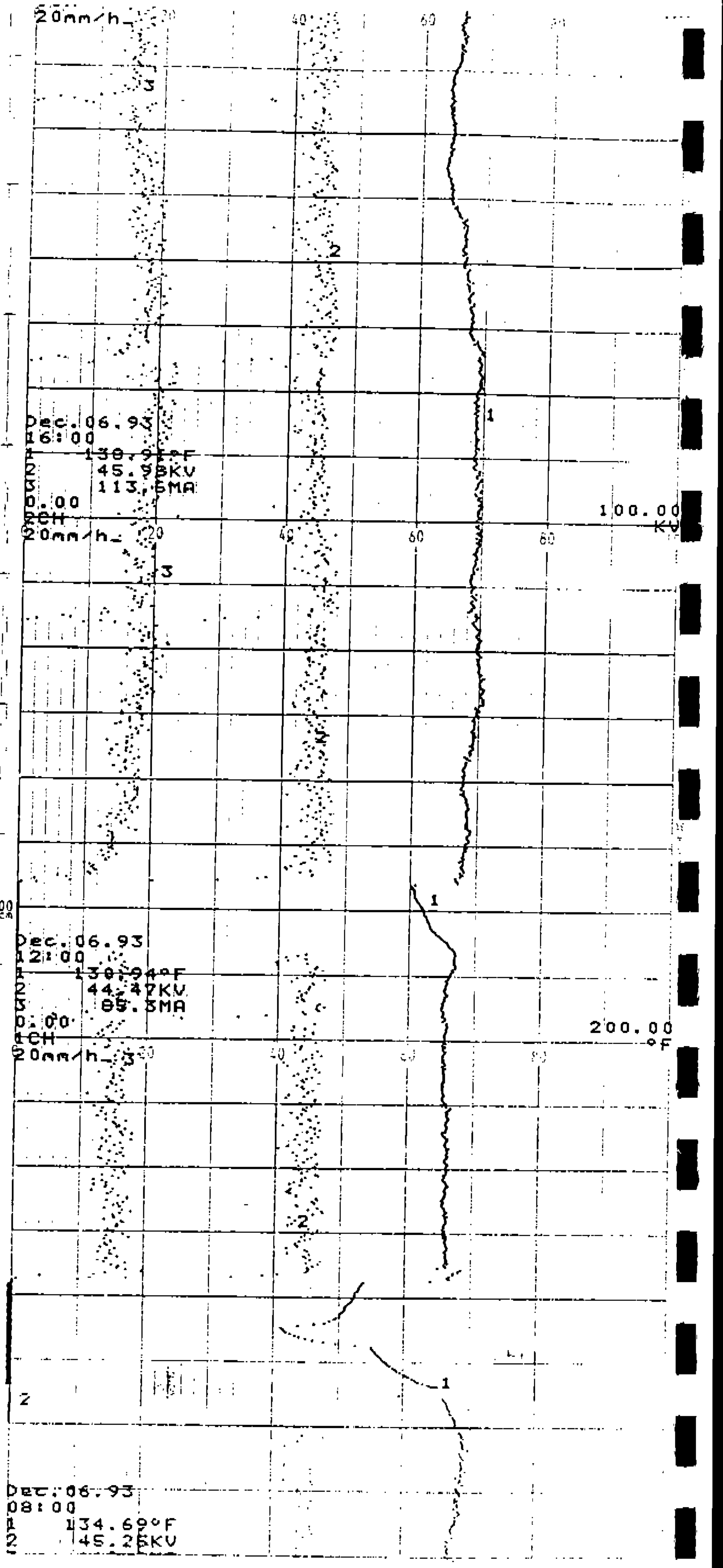


```
Dec.10.93 09:22

CHART SPEED  20mm/h       (2)20mm/h
TREND INTVL  AUTO(45sec)

CH   RANGE     LEFT END   SCALE LEFT
TAG  No.      RIGHT END   SCALE RIGHT
 1   6V(SCALE)
                 1.000V       0.00°F
                 5.000      200.00
 2   6V(SCALE)
                 1.000V       0.00KV
                 5.000      100.00
 3   2V(SCALE)
                 0.000V       0.0MA
```

Robert Smith 8:25 12-10-93

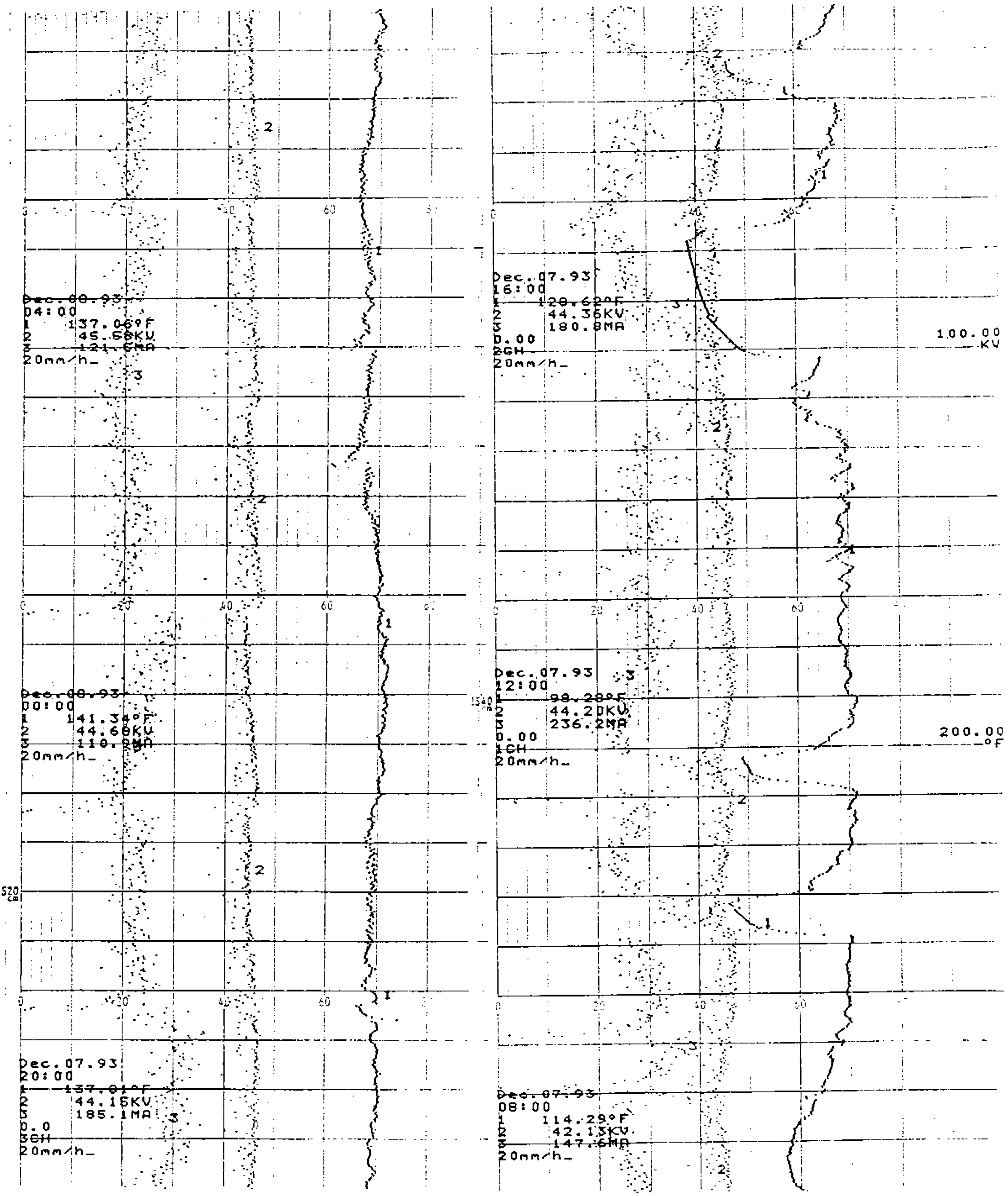
CHART RECORDER
STOPPED PRINTING.
CORE
12-7 to 12-10





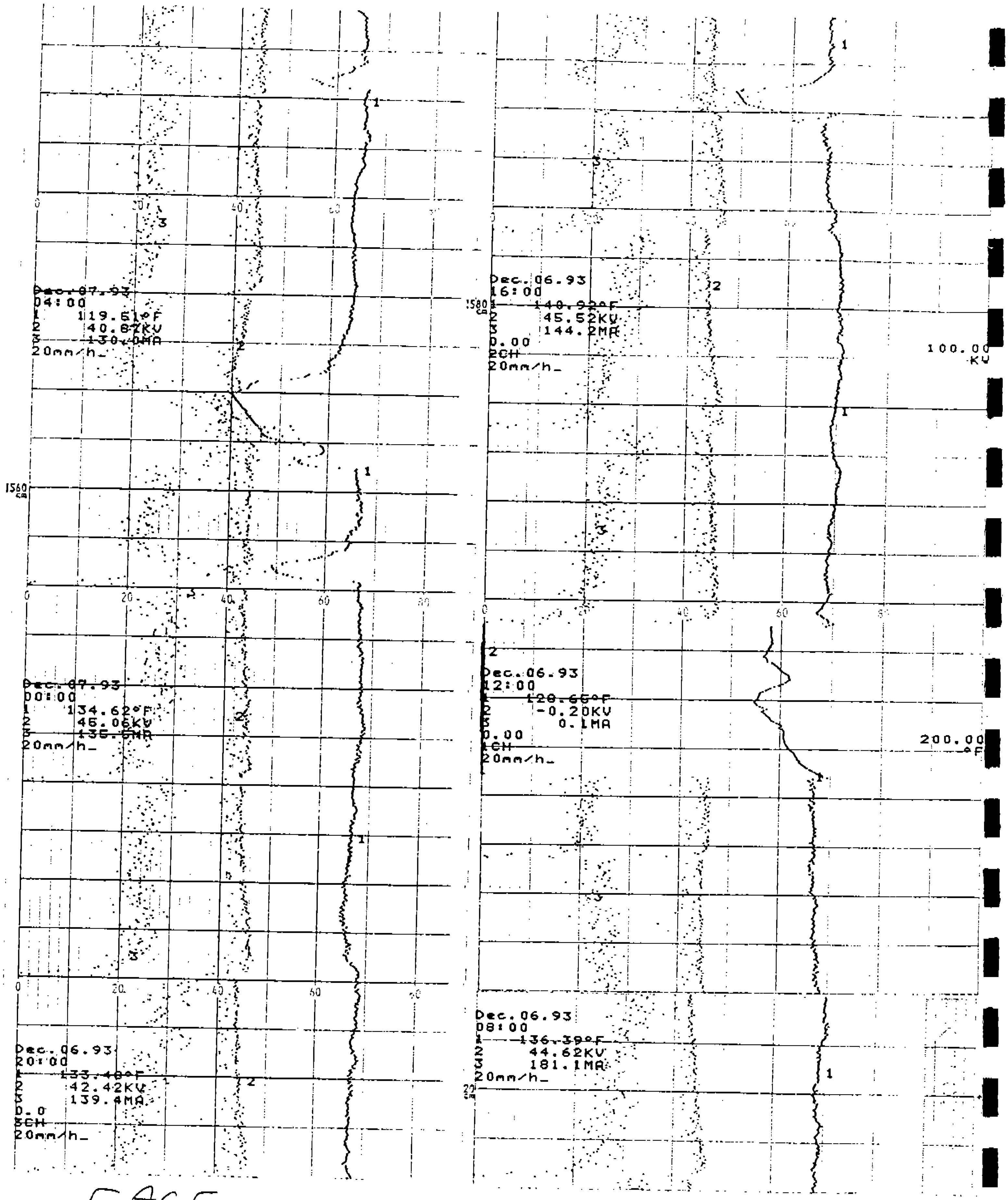
CORE
12-6
12-7

LOUISIANA - PACIFIC
P.O. BOX 190
TOMAHAWK, WI 54487



FACE
12-07
12-08

LOUISIANA - PACIFIC
P.O. BOX 190
TOMAHAWK, WI 54487



FACE
12-06
12-07

LOUISIANA - PACIFIC
P.O. BOX 190
TOMAHAWK, WI 54487

APPENDIX F

PROCEDURES

Flow

Flow determinations were carried out in accordance with EPA Method 2, CFR Title 40, Part 60, Appendix A (Revised July 1, 1987). A type S pitot was used to sense velocity pressure and an inclined manometer was used to measure velocity pressures. Gas temperatures were measured using a calibrated Type K thermocouple and digital temperature meter. Gas density (i.e. molecular weight) was calculated from the composition of the gas which was determined by Orsat.

Gas Flow Density

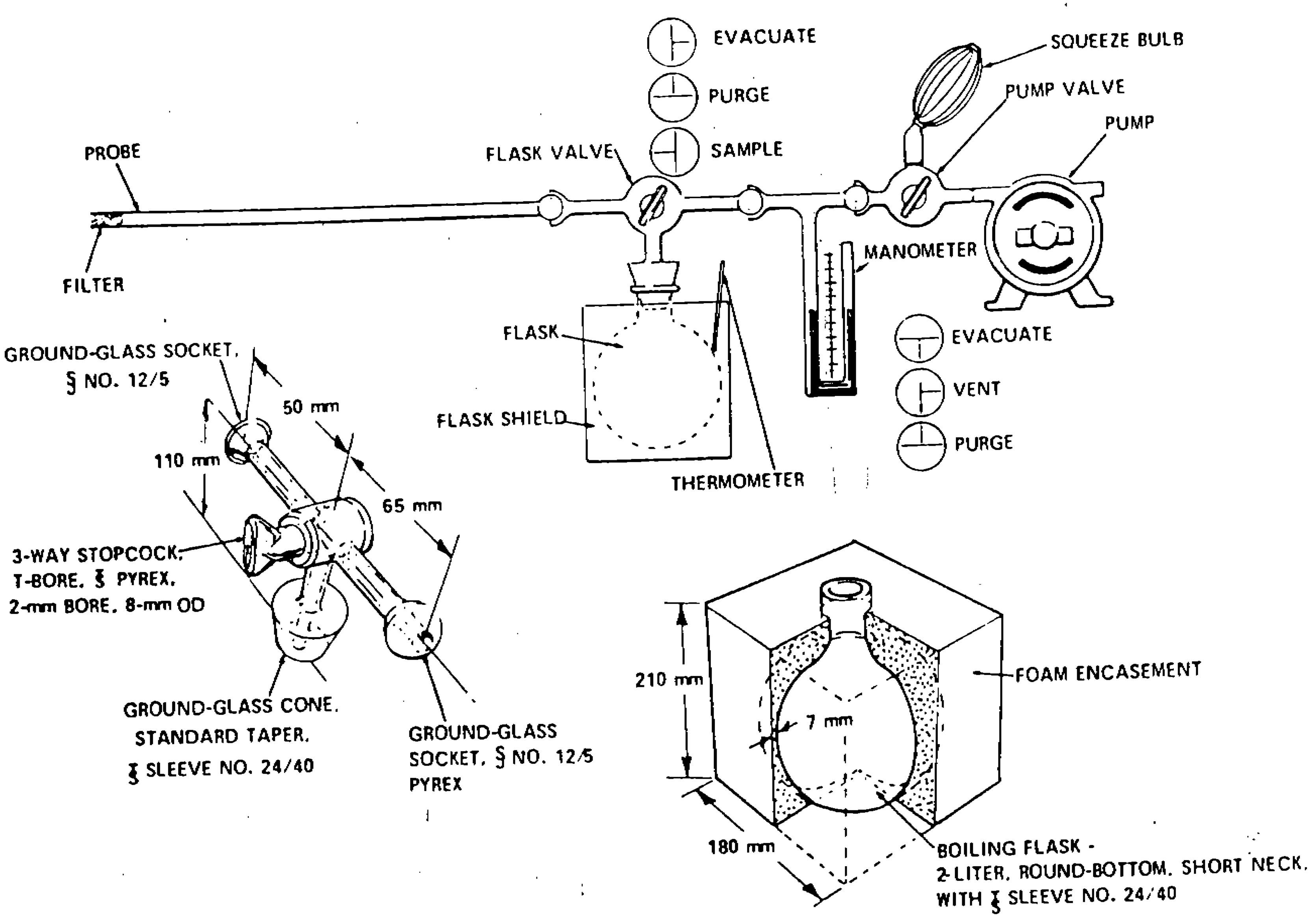
Gas compositions were determined as per Method 3 by Orsat analysis of an integrated gas sample collected from the stack during the oxides of nitrogen determinations. Standard commercially prepared solutions were used in the Orsat analyzer (sat. KOH for carbon dioxide and reduced methylene blue for oxygen).

Oxides of Nitrogen

Oxides of nitrogen concentrations were collected in accordance with EPA Method 7 (see above-cited reference) with a specially designed all glass manifold and valving assembly and a heated stainless steel-lined probe. Samples were collected in two-liter evacuated insulated flasks which contained 25 cc of acidified peroxide solution (Method 7 reagent). Nine sets or more of three samples each were collected over a period of 4.5 to 5 hours.

The sampling train was leak checked through the probe at the beginning and end of the test and, in addition, the system leak checked at the time of evacuation of each flask. Before the samples were collected, the probe was purged to eliminate dead volume effects and to raise the temperature of the probe outlet and manifold assembly to minimize condensation of moisture. A plug of microfiber glass wool inserted in the probe inlet was used to prevent particulate material from entering into the flask. The temperature of the flask, vacuum in the flask and barometric pressure at the time of sampling was recorded for each flask. After sampling was complete, as evidenced by the in-line vacuum gauge, the flask valve was closed, the flask assembly disconnected from the manifold/valve assembly and the flask shook for several minutes to promote oxidation and absorption. The recovered oxides of nitrogen samples were returned to the laboratory and analyzed immediately by ion chromatography as per EPA 7A.

The internal volume of each numbered flask assembly has been measured prior to initial use by filling with water, weighing before and after and then converting the weight of water to volume by means of the density of water at room temperature. Flask volumes are stored in the computer and recalled automatically in the computer calculation.



Sampling train, flask valve, and flask.

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).

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[1] Mention of trade names or specific products does not constitute endorsement by the Environmental Protection Agency.

5.2.6 Flexible Bag. Tedlar, or equivalent, with a capacity of 60 to 90 liters (2 to 3 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.

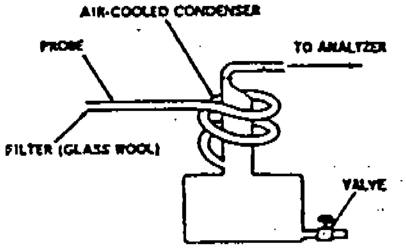

Figure 10-1. Continuous sampling train.

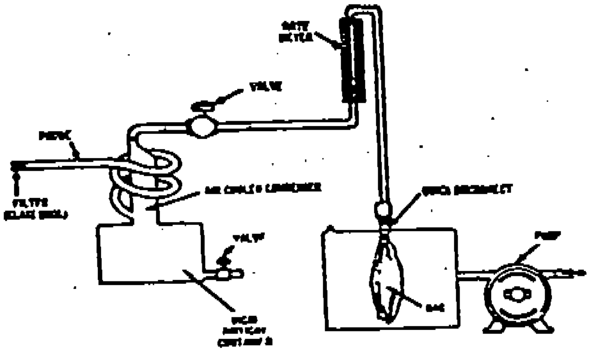

Figure 10-2. Integrated gas sampling train.

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.

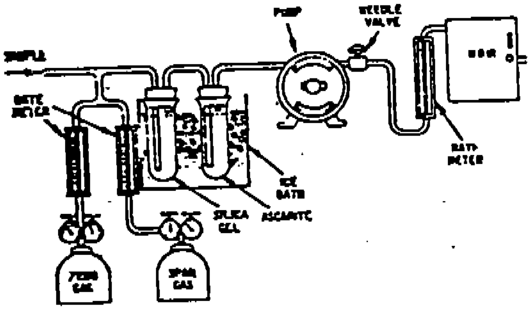

Figure 10-3. Analytical equipment.

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.

$$C_{CO\ stack} = C_{CO\ NDIR}(1 - F_{CO_2}) \qquad \text{Eq. 10-1}$$

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*

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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:

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[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.

EPA
METHOD 0011

SAMPLING FOR FORMALDEHYDE EMISSIONS FROM STATIONARY SOURCES

1.0 SCOPE AND APPLICATION

1.1 This method is applicable to the determination of Destruction and Removal Efficiency (DRE) of formaldehyde, CAS Registry number 50-00-0, and possibly other aldehydes and ketones from stationary sources as specified in the regulations. The methodology has been applied specifically to formaldehyde; however, many laboratories have extended the application to other aldehydes and ketones. Compounds derivatized with 2,4-dinitrophenylhydrazine can be detected as low as 6.4×10^{-8} lbs/cu ft (1.8 ppbv) in stack gas over a 1 h sampling period, sampling approximately 45 cu ft.

2.0 SUMMARY OF METHOD

2.1 Gaseous and particulate pollutants are withdrawn isokinetically from an emission source and are collected in aqueous acidic 2,4-dinitrophenylhydrazine. Formaldehyde present in the emissions reacts with the 2,4-dinitrophenylhydrazine to form the formaldehyde dinitrophenylhydrazone derivative. The dinitrophenylhydrazone derivative is extracted, solvent-exchanged, concentrated, and then analyzed by high performance liquid chromatography.

3.0 INTERFERENCES

3.1 A decomposition product of 2,4-dinitrophenylhydrazine, 2,4-dinitroaniline, can be an analytical interferent if concentrations are high. 2,4-dinitroaniline can coelute with the 2,4-dinitrophenylhydrazone of formaldehyde under high performance liquid chromatography conditions which may be used for the analysis. High concentrations of highly oxygenated compounds, especially acetone, that have the same retention time or nearly the same retention time as the dinitrophenylhydrazone of formaldehyde and that also absorb at 360 nm will interfere with the analysis.

Formaldehyde, acetone, and 2,4-dinitroaniline contamination of the aqueous acidic 2,4-dinitrophenylhydrazine (DNPH) reagent is frequently encountered. The reagent must be prepared within five days of use in the field and must be stored in an uncontaminated environment both before and after sampling in order to minimize blank problems. Some level of acetone contamination is unavoidable, because acetone is ubiquitous in laboratory and field operations. However, the acetone contamination must be minimized.

4.0 APPARATUS AND MATERIALS

4.1 A schematic of the sampling train is shown in Figure 1. This sampling train configuration is adapted from EPA Method 5 procedures. The sampling train consists of the following components: Probe Nozzle, Pitot Tube, Differential Pressure Gauge, Metering System, Barometer, and Gas Density Determination Equipment.

4.1.1 Probe Nozzle: Quartz or glass with sharp, tapered (30° angle) leading edge. The taper shall be on the outside to preserve a constant inner diameter. The nozzle shall be buttonhook or elbow design. A range of nozzle sizes suitable for isokinetic sampling should be available in increments of 0.16 cm (1/16 in), e.g., 0.32 to 1.27 cm (1/8 to 1/2 in), or larger if higher volume sampling trains are used. Each nozzle shall be calibrated according to the procedures outlined in Section 8.1.

4.1.2 Probe Liner: Borosilicate glass or quartz shall be used for the probe liner. The tester should not allow the temperature in the probe to exceed 120 ± 14°C (248 ± 25°F).

4.1.3 Pitot Tube: The Pitot tube shall be Type S, as described in Section 2.1 of EPA Method 2, or any other appropriate device. The pitot tube shall be *attached to the probe to allow constant monitoring of the stack gas velocity. The impact (high pressure) opening plane of the pitot tube shall be even with or above the nozzle entry plane (see EPA Method 2, Figure 2-6b) during sampling. The Type S pitot tube assembly shall have a known coefficient, determined as outlined in Section 4 of EPA Method 2.

4.1.4 Differential Pressure Gauge: The differential pressure gauge shall be an inclined manometer or equivalent device as described in Section 2.2 of EPA Method 2. One manometer shall be used for velocity-head readings and the other for orifice differential pressure readings.

4.1.5 Impingers: The sampling train requires a minimum of four impingers, connected as shown in Figure 1, with ground glass (or equivalent) vacuum-tight fittings. For the first, third, and fourth impingers, use the Greenburg-Smith design, modified by replacing the tip with a 1.3-cm inside diameter (1/2 in) glass tube extending to 1.3 cm (1/2 in) from the bottom of the flask. For the second impinger, use a Greenburg-Smith impinger with the standard tip. Place a thermometer capable of measuring temperature to within 1°C (2°F) at the outlet of the fourth impinger for monitoring purposes.

4.1.6 Metering System: The necessary components are a vacuum gauge, leak-free pump, thermometers capable of measuring temperature within 3°C (5.4°F), dry-gas meter capable of measuring volume to within 1%, and related equipment as shown in Figure 1. At a minimum, the pump should be capable of 4 cfm free flow, and the dry gas meter should have a recording capacity of 0-999.9 cu ft with a resolution of 0.005 cu ft. Other metering systems may be used which are capable of maintaining sampling rates within 10% of isokinetic collection and of determining sample volumes to within 2%. The metering system may be used in conjunction with a pitot tube to enable checks of isokinetic sampling rates.

4.1.7 Barometer: The barometer may be mercury, aneroid, or other barometer capable of measuring atmospheric pressure to within 2.5 mm Hg (0.1 in Hg). In many cases, the barometric reading may be obtained from a nearby National Weather Service Station, in which case the station value (which is the absolute barometric pressure) is requested and an adjustment for elevation differences between the weather station and sampling point is applied at a rate of minus 2.5 mm Hg (0.1 in Hg) per 30 m (100 ft) elevation increase (vice versa for elevation decrease).

4.1.8 Gas Density Determination Equipment: Temperature sensor and pressure gauge (as described in Sections 2.3 and 2.4 of EPA Method 2), and gas analyzer, if necessary (as described in EPA Method 3). The temperature sensor ideally should be permanently attached to the pitot tube or sampling probe in a fixed configuration such that the tip of the sensor extends beyond the leading edge of the probe sheath and does not touch any metal. Alternatively, the sensor may be attached just prior to use in the field. Note, however, that if the temperature sensor is attached in the field, the sensor must be placed in an interference-free arrangement with respect to the Type S pitot tube openings (see EPA Method 2, Figure 2-7). As a second alternative, if a difference of no more than 1% in the average velocity measurement is to be introduced, the temperature gauge need not be attached to the probe or pitot tube.

4.2 Sample Recovery

4.2.1 Probe Liner: Probe nozzle and brushes; Teflon® bristle brushes with stainless steel wire handles are required. The probe brush shall have extensions of stainless steel, Teflon®, or inert material at least as long as the probe. The brushes shall be properly sized and shaped to brush out the probe liner, the probe nozzle, and the impingers.

4.2.2 Wash Bottles: Three wash bottles are required. Teflon® or glass wash bottles are recommended; polyethylene wash bottles should not be used because organic contaminants may be extracted by exposure to organic solvents used for sample recovery.

4.2.3 Graduated Cylinder and/or Balance: A graduated cylinder or balance is required to measure condensed water to the nearest 1 mL or 1 g. Graduated cylinders shall have divisions not >2 mL. Laboratory balances capable of weighing to ±0.5 g are required.

4.2.4 Amber Glass Storage Containers: One-liter wide-mouth amber flint glass bottles with Teflon®-lined caps are required to store impinger water samples. The bottles must be sealed with Teflon® tape.

4.2.5 Rubber Policeman and Funnel: A rubber policeman and funnel are required to aid in the transfer of materials into and out of containers in the field.

5.0 REAGENTS

Reagent grade chemicals or better grades shall be used in all tests. Unless otherwise indicated, all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available.

5.1 Water: HPLC-grade water is used in preparation of DNPH reagent and in all other applications in the sampling train.

5.2 Silica Gel: Silica gel shall be indicating type, 6-16 mesh. If the silica gel has been used previously, dry at 175°C (350°F) for 2 h before using. New silica gel may be used as received. Alternatively, other types of desiccants (equivalent or better) may be used.

5.3 Crushed Ice: Quantities ranging from 10-50 lb may be necessary during a sampling run, depending upon ambient temperature. Samples which have been taken must be stored and shipped cold; sufficient ice for this purpose must be allowed.

5.4 2,4-Dinitrophenylhydrazine Reagent: The 2,4-dinitrophenylhydrazine reagent must be prepared in the laboratory within five days of sampling use in the field. Preparation of DNPH can also be done in the field, with consideration of appropriate procedures required for safe handling of solvent in the field. When a container of prepared DNPH reagent is opened in the field, the contents of the opened container should be used within 48 hours. All laboratory glassware must be washed with detergent and water and rinsed with water, methanol, and methylene chloride prior to use.

NOTE: The glassware must not be rinsed with acetone or unacceptable levels of acetone contamination will be introduced. If field preparation of DNPH is performed, caution must be exercised in avoiding acetone contamination.

Reagent bottles for storage of cleaned DNPH derivatizing solution must be rinsed with acetonitrile and dried before use. Baked glassware is not essential for preparation of DNPH reagent.

NOTE: DNPH crystals or DNPH solution should be handled with plastic gloves at all times, with prompt and extensive use of running water in case of skin exposure.

5.4.1 Preparation of Aqueous Acidic DNPH: The following materials and reagents are required for preparation of the reagent.

5.4.1.1 Bottles/Caps: amber 1- or 4 L bottles with Teflon®-lined caps are required for storing cleaned DNPH solution. Additional 4-L bottles are required to collect waste organic solvents.

5.4.1.2 Large Glass Container: at least one large glass container (8 to 16 L) is required for mixing the aqueous acidic DNPH solution.

5.4.1.3 Stir Plate/Large Stir Bars/Stir Bar Retriever: a magnetic stir plate and large stir bar are required for the mixing of the aqueous acidic DNPH solution. A stir bar retriever is needed for removing the stir bar from the large container holding the DNPH solution.

5.4.1.4 Buchner Filter/Filter Flask/Filter Paper: a large filter flask (2-4 L) with a buchner filter, appropriate rubber stopper, filter paper, and connecting tubing are required for filtering the aqueous acidic DNPH solution prior to cleaning.

5.4.1.5 Separatory Funnels: at least one large separatory funnel (2 L) is required for cleaning the DNPH prior to use.

5.4.1.6 Beakers: beakers (150 mL, 250 mL, and 400 mL) are useful for holding/measuring organic liquids when cleaning the aqueous acidic DNPH solution and for weighing DNPH crystals.

5.4.1.7 Funnels: at least one large funnel is needed for pouring the aqueous acidic DNPH into the separatory funnel.

5.4.1.8 Graduated Cylinders: at least one large graduated cylinder (1 to 2 L) is required for measuring HPLC-grade water and acid when preparing the DNPH solution.

5.4.1.9 Top-Loading Balance: a one-place top loading balance is needed for weighing out the DNPH crystals used to prepare the aqueous acidic DNPH solution.

5.4.1.10 Spatulas: spatulas are needed for weighing out DNPH when preparing the aqueous DNPH solution.

5.4.1.11 HPLC-Grade Water: water (HPLC-grade) is required to mix the aqueous DNPH solution.

5.4.1.12 Hydrochloric Acid: reagent grade hydrochloric acid (approximately 12N) is required for acidifying the aqueous DNPH solution.

5.4.1.13 2,4-Dinitrophenylhydrazine: a supply of moist solid 2,4-dinitrophenylhydrazine (DNPH) is required for preparation of aqueous acidic DNPH solution. The quantity of water may vary from 10 to 30%. Reagent grade or equivalent is required.

5.4.1.14 Methylene Chloride: methylene chloride (suitable for residue and pesticide analysis, GC/MS, HPLC, GC, Spectrophotometry or equivalent) is required for cleaning the aqueous acidic DNPH solution, rinsing glassware, and recovery of sample trains.

5.4.1.15 Cyclohexane: cyclohexane (HPLC grade) is required for cleaning the aqueous acidic DNPH solution.

NOTE: Do not use spectroanalyzed grades of cyclohexane if this sampling methodology is extended to aldehydes and ketones with four or more carbon atoms.

5.4.1.16 Methanol: methanol (HPLC grade or equivalent) is required for rinsing glassware.

5.4.1.17 Acetonitrile: acetonitrile (HPLC grade or equivalent) is required for rinsing glassware.

5.4.1.18 Formaldehyde: Analytical grade or equivalent formaldehyde is required for preparation of standards. If other aldehydes or ketones are used, analytical grade or equivalent is required.

5.4.2 Preparation of Aqueous Acidic DNPH Derivatizing Reagent: Each batch of DNPH reagent should be prepared and purified within five days of sampling, according to the procedure described below.

5.4.2.1 Place an 8-L container under a fume hood on a magnetic stirrer. Add a large stir bar and fill the container half full of HPLC-grade water. Save the empty bottle from HPLC-grade water. Start the stirring bar and adjust the stir rate to be as fast as possible. Using a graduated cylinder, measure 1.4 mL of concentrated hydrochloric acid. Slowly pour the acid into the stirring water. Fumes may be generated and the water may become warm. Weigh the DNPH crystals on a one-place balance (see Table 1 for approximate amounts) and add to the stirring acid solution. Fill the 8 L container to the 8 L mark with HPLC water and stir overnight. If all of the DNPH crystals have dissolved overnight, add additional DNPH and stir for two more hours. Continue the process of adding DNPH with additional stirring until a saturated solution has been formed. Filter the DNPH solution using vacuum filtration. Gravity filtration may be used, but a much longer time is required. Store the filtered solution in an amber bottle at room temperature.

TABLE 1. APPROXIMATE AMOUNT OF CRYSTALLINE DNPH USED TO PREPARE A SATURATED SOLUTION

Amount of Moisture in DNPH	Weight Required per 8 L of Solution
10 weight percent	31 g
15 weight percent	33 g
30 weight percent	40 g

Within five days of proposed use, place about 1.6 L of the DNPH reagent in a 2 L separatory funnel. Add approximately 200 mL of methylene chloride and stopper the funnel. Wrap the stopper of the funnel with paper towels to absorb any leakage. Invert and vent the funnel. Then shake vigorously for 3 minutes. Initially, the funnel should be vented frequently (every 10 - 15 sec). After the layers have separated, discard the lower (organic) layer.

Extract the DNPH a second time with methylene chloride and finally with cyclohexane. When the cyclohexane layer has separated from the DNPH reagent, the cyclohexane layer will be the top layer in the separatory funnel. Drain the lower layer (the cleaned extracted DNPH reagent solution) into an amber bottle that has been rinsed with acetonitrile and allowed to dry.

5.4.3 <u>Quality Control</u>: Take two aliquots of the extracted DNPH reagent. The size of the aliquots is dependent upon the exact sampling procedure used, but 100 mL is reasonably representative. To ensure that the background in the reagent is acceptable for field use, analyze one aliquot of the reagent according to the procedure of EPA Draft Method 8315. Save the other aliquot of aqueous acidic DNPH for use as a method blank when the analysis is performed.

5.4.4 <u>Shipment to the Field</u>: Tightly cap the bottle containing extracted DNPH reagent using a Teflon®-lined cap. Seal the bottle with Teflon® tape. After the bottle is labeled, the bottle may be placed in a friction-top can (paint can or equivalent) containing a 1 -2 inch layer of granulated charcoal and stored at ambient temperature until use.

If the DNPH reagent has passed the Quality Control criteria, the reagent may be packaged to meet necessary shipping requirements and sent to the sampling area. If the Quality Control criteria are not met, the reagent solution may be re-extracted or the solution may be re-prepared and the extraction sequence repeated.

If the DNPH reagent is not used in the field within five days of extraction, an aliquot may be taken and analyzed as described Draft Method 8315. If the reagent meets the Quality Control requirements, the reagent may be used. If the reagent does not meet Quality Control requirements, the reagent must be discarded and new reagent must be prepared and tested.

5.4.5 Calculation of Acceptable Levels of Impurities in DNPH Reagent: The acceptable impurity level (AIL, µg/mL) is calculated from the expected analyte level in the sampled gas (EAL, ppbv), the volume of air that will be sampled at standard conditions (SVOL, L), the formula weight of the analyte (FW, g/mol), and the volume of DNPH reagent that will be used in the impingers (RVOL, mL):

$$AIL = 0.1 \times [EAL \times SVOL \times FW/22.4 \times (FW + 180)/FW]/(RVOL \times 1000).$$

where 0.1 is the acceptable contaminant level, 22.4 is a factor relating ppbv to g/L, 180 is a factor relating the underivatized analyte to the derivatized analyte, and 1000 is a unit conversion factor.

5.4.6 Disposal of Excess DNPH Reagent: Excess DNPH reagent may be returned to the laboratory and recycled or treated as aqueous waste for disposal purposes. 2,4-Dinitrophenylhydrazine is a flammable solid when dry so water should not be evaporated from the solution of the reagent.

5.5 Field Spike Standard Preparation: To prepare a formaldehyde field spiking standard at 4.01 mg/mL, use a 500µL syringe to transfer 0.5 mL of 37% by weight of formaldehyde (401 mg/mL) to a 50 mL volumetric flask containing approximately 40 mL of methanol. Dilute to 50 mL with methanol.

6.0 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

6.1 Because of the complexity of this method, field personnel should be trained in and experienced with the test procedures in order to obtain reliable results.

6.2 Laboratory Preparation:

6.2.1 All the components shall be maintained and calibrated according to the procedure described in APTD-0576, unless otherwise specified.

6.2.2 Weigh several 200- to 300-g portions of silica gel in airtight containers to the nearest 0.5 g. Record on each container the total weight of the silica gel plus containers. As an alternative to preweighing the silica gel, it may instead be weighed directly in the impinger or sampling holder just prior to train assembly.

6.3 Preliminary Field Determinations:

6.3.1 Select the sampling site and the minimum number of sampling points according to EPA Method 1 or other relevant criteria. Determine the stack pressure, temperature, and range of velocity heads using EPA Method 2. A leak-check of the pitot lines according to EPA Method 2, Section 3.1, must be performed. Determine the stack gas moisture content using EPA Approximation Method 4 or its alternatives to establish estimates of isokinetic sampling-rate settings. Determine the stack gas dry molecular weight, as described in EPA Method 2, Section 3.6. If integrated EPA Method 3 sampling is used for molecular weight determination, the integrated bag sample shall be taken simultaneously with, and for the same total length of time as, the sample run.

6.3.2 Select a nozzle size based on the range of velocity heads so that it is not necessary to change the nozzle size in order to maintain isokinetic sampling rates below 28 L/min (1.0 cfm). During the run, do not change the nozzle.

Ensure that the proper differential pressure gauge is chosen for the range of velocity heads encountered (see Section 2.2 of EPA Method 2).

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

6.3.4 A minimum of 45 ft^3 of sample volume is required for the determination of the Destruction and Removal Efficiency (DRE) of formaldehyde from incineration systems (45ft^3 is equivalent to one hour of sampling at 0.75 dscf). Additional sample volume shall be collected as ecessitated by the capacity of the DNPH reagent and analytical detection limit constraints. To determine the minimum sample volume required, refer to sample calculations in Section 10.

6.3.5 Determine the total length of sampling time needed to obtain the identified minimum volume by comparing the anticipated average sampling rate with the volume requirement. Allocate the same time to all traverse points defined by EPA Method 1. To avoid timekeeping errors, the length of time sampled at each traverse point should be an integer or an integer plus 0.5 min.

6.3.6 In some circumstances (e.g., batch cycles) it may be necessary to sample for shorter times at the traverse points and to obtain smaller gas-volume samples. In these cases, careful documentation must be maintained in order to allow accurate calculation of concentrations.

6.4 <u>Preparation of Collection Train</u>:

6.4.1 During preparation and assembly of the sampling train, keep all openings where contamination can occur covered with Teflon® film or aluminum foil until just prior to assembly or until sampling is about to begin.

6.4.2 Place 100 mL of cleaned DNPH solution in each of the first two impingers, and leave the third impinger empty. If additional capacity is required for high expected concentrations of formaldehyde in the stack gas, 200 mL of DNPH per impinger may be used or additional impingers may be used for sampling. Transfer approximately 200 to 300 g of pre-weighed silica gel from its container to the fourth impinger. Care should be taken to ensure that the silica gel is not entrained and carried out from the impinger during sampling. Place the silica gel container in a clean place for later use in the sample recovery. Alternatively, the weight of the silica gel plus impinger may be determined to the nearest 0.5 g and recorded.

6.4.3 With a glass or quartz liner, install the selected nozzle using a Viton-A O-ring when stack temperatures are <260°C (500°F) and a woven glass-fiber gasket when temperatures are higher. See APTD-0576 (Rom, 1972) for details. Other connecting systems utilizing either 316 stainless steel or Teflon® ferrules may be used. Mark the probe with heat-resistant tape or by some other method to denote the proper distance into the stack or duct for each sampling point.

6.4.4 Assemble the train as shown in Figure 1. During assembly, do not use any silicone grease on ground-glass joints upstream of the impingers. Use Teflon® tape, if required. A very light coating of silicone grease may be used on ground-glass joints downstream of the impingers, but the silicone grease should be limited to the outer portion (see APTD-0576) of the ground-glass joints to minimize silicone grease contamination. If necessary, Teflon® tape may be used to seal leaks. Connect all temperature sensors to an appropriate potentiometer/display unit. Check all temperature sensors at ambient temperature.

6.4.5 Place crushed ice all around the impingers.

6.4.6 Turn on and set the probe heating system at the desired operating temperature. Allow time for the temperature to stabilize.

6.5 Leak-Check Procedures:

6.5.1 Pre-test Leak Check:

6.5.1.1 After the sampling train has been assembled, turn on and set the probe heating system at the desired operating temperature. Allow time for the temperature to stabilize. If a Viton-A O-ring or other leak-free connection is used in assembling the probe nozzle to the probe liner, leak-check the train at the sampling site by plugging the nozzle and pulling a 381-mm Hg (15 in Hg) vacuum.

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

6.5.1.2 If an asbestos string is used, do not connect the probe to the train during the leak check. Instead, leak-check the train by first attaching a carbon-filled leak check impinger to the inlet and then plugging the inlet and pulling a 381-mm Hg (15 in Hg) vacuum. (A lower vacuum may be used if this lower vacuum is not exceeded during the test.) Then connect the probe to the train and leak-check at about 25 mm Hg (1 in Hg) vacuum. Alternatively, leak-check the probe with the rest of the sampling train in one step at 381 mm Hg (15 in Hg) vacuum. Leakage rates in excess of 4% of the average sampling rate or >0.00057 m^3/min (0.02 cfm), whichever is less, are acceptable.

6.5.1.3 The following leak check instructions for the sampling train described in APTD-0576 and APTD-0581 may be helpful. Start the pump with the fine-adjust valve fully open and coarse-adjust valve completely closed. Partially open the coarse-adjust valve and slowly close the fine-adjust valve until the desired vacuum is reached. Do not reverse direction of the fine-adjust valve, as liquid will back up into the train. If the desired vacuum is exceeded, either perform the leak check at this higher vacuum or end the leak check, as shown below, and start over.

6.5.1.4 When the leak check is completed, first slowly remove the plug from the inlet to the probe. When the vacuum drops to 127 mm (5 in) Hg or less, immediately close the coarse-adjust valve. Switch off the pumping system and reopen the fine-adjust valve. Do not reopen the fine-adjust valve until the coarse-adjust valve has been closed to prevent the liquid in the impingers from being forced backward into the sampling line and silica gel from being entrained backward into the third impinger.

6.5.2 Leak Checks During Sampling Runs:

6.5.2.1 If, during the sampling run, a component change (i.e., impinger) becomes necessary, a leak check shall be conducted immediately after the interruption of sampling and before the change is made. The leak check shall be done according to the procedure described in Section 6.5.1, except that it shall be done at a vacuum greater than or equal to the maximum value recorded up to that point in the test. If the leakage rate is found to be no greater than 0.00057 m^3/min (0.02 cfm) or 4% of the average sampling rate (whichever is less), the results are acceptable. If a higher leakage rate is obtained, the tester must void the sampling run.

NOTE: Any correction of the sample volume by calculation reduces the integrity of the pollutant concentration data generated and must be avoided.

6.5.2.2 Immediately after a component change and before sampling is re-initiated, a leak check similar to a pre-test leak check must also be conducted.

6.5.3 Post-test Leak Check:

6.5.3.1 A leak check is mandatory at the conclusion of each sampling run. The leak check shall be done with the same procedures as the pre-test leak check, except that the post-test leak check shall be conducted at a vacuum greater than or equal to the maximum value reached during the sampling run. If the leakage rate is found to be no greater than 0.00057 m^3/min (0.02 cfm) or 4% of the average sampling rate (whichever is less), the results are acceptable. If, however, a higher leakage rate is obtained, the tester shall record the leakage rate and void the sampling run.

6.6 Sampling Train Operation:

6.6.1 During the sampling run, maintain an isokinetic sampling rate to within 10% of true isokinetic, below 28 L/min (1.0 cfm). Maintain a temperature around the probe of 120° ± 14°C (248° ± 25°F).

6.6.2 For each run, record the data on a data sheet such as the one shown in Figure 2. Be sure to record the initial dry-gas meter reading. Record the dry-gas meter readings at the beginning and end of each sampling time increment, when changes in flow rates are made, before and after each leak check, and when sampling is halted. Take other readings required by Figure 2 at least once at each sample point during each time increment and additional readings when significant adjustments (20% variation in velocity head readings) necessitate additional adjustments in flow rate. Level and zero the manometer. Because the manometer level and zero may drift due to vibrations and temperature changes, make periodic checks during the traverse.

6.6.3 Clean the stack access ports prior to the test run to eliminate the chance of sampling deposited material. To begin sampling, remove the nozzle cap, verify that the filter and probe heating systems are at the specified temperature, and verify that the pitot tube and probe are properly positioned. Position the nozzle at the first traverse point, with the tip pointing directly into the gas stream. Immediately start the pump and adjust the flow to isokinetic conditions. Nomographs, which aid in the rapid adjustment of the isokinetic sampling rate without excessive computations, are available. These nomographs are designed for use when the Type S pitot tube coefficient is 0.84 ± 0.02 and the stack gas equivalent density (dry molecular weight) is equal to 29 ± 4. APTD-0576 details the procedure for using the nomographs. If the stack gas molecular weight and the pitot tube coefficient are outside the above ranges, do not use the nomographs unless appropriate steps are taken to compensate for the deviations.

6.6.4 When the stack is under significant negative pressure (equivalent to the height of the impinger stem), take care to close the coarse-adjust valve before inserting the probe into the stack in order to prevent liquid from backing up through the train. If necessary, the pump may be turned on with the coarse-adjust valve closed.

6.6.5 When the probe is in position, block off the openings around the probe and stack access port to prevent unrepresentative dilution of the gas stream.

6.6.6 Traverse the stack cross section, as required by EPA Method 1, being careful not to bump the probe nozzle into the stack walls when sampling near the walls or when removing or inserting the probe through the access port, in order to minimize the chance of extracting deposited material.

6.6.7 During the test run, make periodic adjustments to keep the temperature around the probe at the proper levels. Add more ice and, if necessary, salt, to maintain a temperature of <20°C (68°F) at the silica gel outlet. Also, periodically check the level and zero of the manometer.

6.6.8 A single train shall be used for the entire sampling run, except in cases where simultaneous sampling is required in two or more separate ducts or at two or more different locations within the same duct, or in cases where equipment failure necessitates a change of trains. An additional train or additional trains may also be used for sampling when the capacity of a single train is exceeded.

6.6.9 When two or more trains are used, separate analyses of components from each train shall be performed. If multiple trains have been used because the capacity of a single train would be exceeded, first impingers from each train may be combined, and second impingers from each train may be combined.

6.6.10 At the end of the sampling run, turn off the coarse-adjust valve, remove the probe and nozzle from the stack, turn off the pump, record the final dry gas meter reading, and conduct a post-test leak check. Also, leak check the pitot lines as described in EPA Method 2. The lines must pass this leak check in order to validate the velocity-head data.

6.6.11 Calculate percent isokineticity (see Method 2) to determine whether the run was valid or another test should be made.

7.0 SAMPLE RECOVERY

7.1 Preparation:

7.1.1 Proper cleanup procedure begins as soon as the probe is removed from the stack at the end of the sampling period. Allow the probe to cool. When the probe can be handled safely, wipe off all external particulate matter near the tip of the probe nozzle and place a cap over the tip to prevent losing or gaining particulate matter. Do not cap the probe tip tightly while the sampling train is cooling because a vacuum will be created, drawing liquid from the impingers back through the sampling train.

7.1.2 Before moving the sampling train to the cleanup site, remove the probe from the sampling train and cap the open outlet, being careful not to lose any condensate that might be present. Remove the umbilical cord from the last impinger and cap the impinger. If a flexible line is used, let any condensed water or liquid drain into the impingers. Cap off any open impinger inlets and outlets. Ground glass stoppers, Teflon® caps, or caps of other inert materials may be used to seal all openings.

7.1.3 Transfer the probe and impinger assembly to an area that is clean and protected from wind so that the chances of contaminating or losing the sample are minimized.

7.1.4 Inspect the train before and during disassembly, and note any abnormal conditions.

7.1.5 Save a portion of all washing solutions (methylene chloride, water) used for cleanup as a blank. Transfer 200 mL of each solution directly from the wash bottle being used and place each in a separate, pre-labeled sample container.

7.2 Sample Containers:

7.2.1 Container 1: Probe and Impinger Catches. Using a graduated cylinder, measure to the nearest mL, and record the volume of the solution in the first three impingers. Alternatively, the solution may be weighed to the nearest 0.5 g. Include any condensate in the probe in this determination. Transfer the impinger solution from the graduated cylinder into the amber flint glass bottle. Taking care that dust on the outside of the probe or other exterior surfaces does not get into the sample, clean all surfaces to which the sample is exposed (including the probe nozzle, probe fitting, probe liner, first impinger, and impinger connector) with methylene chloride. Use less than 500 mL for the entire wash (250 mL would be better, if possible). Add the washings to the sample container.

7.2.1.1 Carefully remove the probe nozzle and rinse the inside surface with methylene chloride from a wash bottle. Brush with a Teflon® bristle brush, and rinse until the rinse shows no visible particles or yellow color, after which make a final rinse of the inside surface. Brush and rinse the inside parts of the Swagelok® fitting with methylene chloride in a similar way.

7.2.1.2 Rinse the probe liner with methylene chloride. While squirting the methylene chloride into the upper end of the probe, tilt and rotate the probe so that all inside surfaces will be wetted with methylene chloride. Let the methylene chloride drain from the lower end into the sample container. The tester may use a funnel (glass or polyethylene) to aid in transferring the liquid washes to the container. Follow the rinse with a Teflon® brush. Hold the probe in an inclined position, and squirt methylene chloride into the upper end as the probe brush is being pushed with a twisting action through the probe. Hold the sample container underneath the lower end of the probe, and catch any methylene chloride, water, and particulate matter that is brushed from the probe. Run the brush through the probe three times or more. With stainless steel or other metal probes, run the brush through in the above prescribed manner at least six times since there may be small crevices in which particulate matter can be entrapped. Rinse the brush with methylene chloride or water, and quantitatively collect these washings in the sample container. After the brushings, make a final rinse of the probe as described above.

NOTE: Two people should clean the probe in order to minimize sample losses. Between sampling runs, brushes must be kept clean and free from contamination.

7.2.1.3 Rinse the inside surface of each of the first three impingers (and connecting tubing) three separate times. Use a small portion of methylene chloride for each rinse, and brush each surface to which sample is exposed with a Teflon® bristle brush to ensure recovery of fine particulate matter. Water will be required for the recovery of the impingers in addition to the specified quantity of methylene chloride. There will be at least two phases in the impingers. This two-phase mixture does not pour well, and a significant amount of the impinger catch will be left on the walls. The use of water as a rinse makes the recovery quantitative. Make a final rinse of each surface and of the brush, using both methylene chloride and water.

7.2.1.4 After all methylene chloride and water washings and particulate matter have been collected in the sample container, tighten the lid so that solvent, water, and DNPH reagent will not leak out when the container is shipped to the laboratory. Mark the height of the fluid level to determine whether leakage occurs during transport. Seal the container with Teflon® tape. Label the container clearly to identify its contents.

7.2.1.5 If the first two impingers are to be analyzed separately to check for breakthrough, separate the contents and rinses of the two impingers into individual containers. Care must be taken to avoid physical carryover from the first impinger to the second. The formaldehyde hydrazone is a solid which floats and froths on top of the impinger solution. Any physical carryover of collected moisture into the second impinger will invalidate a breakthrough assessment.

7.2.2 Container 2: Sample Blank. Prepare a blank by using an amber flint glass container and adding a volume of DNPH reagent and methylene chloride equal to the total volume in Container 1. Process the blank in the same manner as Container 1.

7.2.3 Container 3: Silica Gel. Note the color of the indicating silica gel to determine whether it has been completely spent and make a notation of its condition. The impinger containing the silica gel may be used as a sample transport container with both ends sealed with tightly fitting caps or plugs. Ground-glass stoppers or Teflon® caps may be used. The silica gel impinger should then be labeled, covered with aluminum foil, and packaged on ice for transport to the laboratory. If the silica gel is removed from the impinger, the tester may use a funnel to pour the silica gel and a rubber policeman to remove the silica gel from the impinger. It is not necessary to remove the small amount of dust particles that may adhere to the impinger wall and are difficult to remove. Since the gain in weight is to be used for moisture calculations, do not use water or other liquids to transfer the silica gel. If a balance is available in the field, the spent silica gel (or silica gel plus impinger) may be weighed to the nearest 0.5 g.

7.2.4 Sample containers should be placed in a cooler, cooled by although not in contact with ice. Sample containers must be placed vertically and, since they are glass, protected from breakage curing shipment. Samples should be cooled during shipment so they will be received cold at the laboratory.

8.0 CALIBRATION

8.1 Probe Nozzle: Probe nozzles shall be calibrated before their initial use in the field. Using a micrometer, measure the inside diameter of the nozzle to the nearest 0.025 mm (0.001 in). Make measurements at three separate places across the diameter and obtain the average of the measurements. The difference between the high and low numbers shall not exceed 0.1 mm (0.004 in). When the nozzles become nicked or corroded, they shall be replaced and calibrated before use. Each nozzle must be permanently and uniquely identified.

8.2 Pitot tube: The Type S pitot tube assembly shall be calibrated according to the procedure outlined in Section 4 of EPA Method 2, or assigned a nominal coefficient of 0.84 if it is not visibly nicked or corroded and if it meets design and intercomponent spacing specifications.

8.3 Metering system:

8.3.1 Before its initial use in the field, the metering system shall be calibrated according to the procedure outlined in APTD-0576. Instead of physically adjusting the dry-gas meter dial readings to correspond to the wet-test meter readings, calibration factors may be used to correct the gas meter dial readings mathematically to the proper values. Before calibrating the metering system, it is suggested that a leak check be conducted. For metering systems having diaphragm pumps, the normal leak check procedure will not detect leakages within the pump. For these cases, the following leak check procedure will apply: make a ten-minute calibration run at 0.00057 m^3/min (0.02 cfm). At the end of the run, take the difference of the measured wet-test and dry-gas meter volumes and divide the difference by 10 to get the leak rate. The leak rate should not exceed 0.00057 m^3/min (0.02 cfm).

8.3.2 After each field use, check the calibration of the metering system by performing three calibration runs at a single intermediate orifice setting (based on the previous field test). Set the vacuum at the maximum value reached during the test series. To adjust the vacuum, insert a valve between the wet-test meter and the inlet of the metering system. Calculate the average value of the calibration factor. If the calibration has changed by more than 5%, recalibrate the meter over the full range of orifice settings, as outlined in APTD-0576.

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

NOTE: If the dry-gas-meter coefficient values obtained before and after a test series differ by >5%, either the test series must be voided or calculations for test series must be performed using whichever meter coefficient value (i.e., before or after) gives the lower value of total sample volume.

8.4 Probe heater: The probe heating system must be calibrated before its initial use in the field according to the procedure outlined in APTD-0576. Probes constructed according to APTD-0581 need not be calibrated if the calibration curves in APTD-0576 are used.

8.5 Temperature gauges: Each thermocouple must be permanently and uniquely marked on the casting. All mercury-in-glass reference thermometers must conform to ASTM E-1 63C or 63F specifications. Thermocouples should be calibrated in the laboratory with and without the use of extension leads. If extension leads are used in the field, the thermocouple readings at ambient air temperatures, with and without the extension lead, must be noted and recorded. Correction is necessary if the use of an extension lead produces a change >1.5%.

8.5.1 Impinger and dry-gas meter thermocouples: For the thermocouples used to measure the temperature of the gas leaving the impinger train, three-point calibration at ice water, room air, and boiling water temperatures is necessary. Accept the thermocouples only if the readings at all three temperatures agree to ±2°C (3.6°F) with those of the absolute value of the reference thermometer.

8.5.2 Probe and stack thermocouple: For the thermocouples used to indicate the probe and stack temperatures, a three-point calibration at ice water, boiling water, and hot oil bath temperatures must be performed. Use of a point at room air temperature is recommended. The thermometer and thermocouple must agree to within 1.5% at each of the calibration points. A calibration curve (equation) may be constructed (calculated) and the data extrapolated to cover the entire temperature range suggested by the manufacturer.

8.6 Barometer: Adjust the barometer initially and before each test series to agree to within ±2.5 mm Hg (0.1 in Hg) of the mercury barometer or the corrected barometric pressure value reported by a nearby National Weather Service Station (same altitude above sea level).

8.7 Triple-beam balance: Calibrate the triple-beam balance before each test series, using Class S standard weights. The weights must be within ±0.5% of the standards, or the balance must be adjusted to meet these limits.

9.0 CALCULATIONS

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

9.1 Calculation of Total Formaldehyde:

To determine the total formaldehyde in mg, use the following equation:

$$\text{Total mg formaldehyde} = C_d \times V \times DF \times ([\text{g/mole aldehyde}]/[\text{g/mole DNPH derivative}]) \times 10^{-3}\ \text{mg}/\mu\text{g}$$

where:

C_d = measured concentration of DNPH-formaldehyde derivative, µg/mL

V = organic extract volume, mL

DF = dilution factor

9.2 Formaldehyde concentration in stack gas:

Determine the formaldehyde concentration in the stack gas using the following equation:

$$C_f = K\ [\text{total formaldehyde, mg}]\ /\ V_{m(std)}$$

where:

K = 35.31 ft^3/m^3 if $V_{m(std)}$ is expressed in English units

= 1.00 m^3/m^3 if $V_{m(std)}$ is expressed in metric units

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

9.3 Average Dry Gas Meter Temperature and Average Orifice Pressure Drop are obtained from the data sheet.

9.4 Dry Gas Volume: Calculate $V_{m(std)}$ and adjust for leakage, if necessary, using the equation in Section 6.3 of EPA Method 5.

9.5 Volume of Water Vapor and Moisture Content: Calculate the volume of water vapor and moisture content from equations 5-2 and 5-3 of EPA Method 5.

10.0 DETERMINATION OF VOLUME TO BE SAMPLED

To determine the minimum sample volume to be collected, use the following sequence of equations.

10.1 From prior analysis of the waste feed, the concentration of formaldehyde (FORM) introduced into the combustion system can be calculated. The degree of destruction and removal efficiency that is required is used to determine the maximum amount of FORM allowed to be present in the effluent. This amount may be expressed as:

$\text{Max FORM}_i\text{ Mass} =$

$$[\,(WF)\,(\text{FORM}_i\text{ conc})\,(100 - \%DRE)\,] / 100$$

where:

WF = mass flow rate of waste feed per h, g/h (lb/h)

FORM_i = concentration of FORM (wt %) introduced into the combustion process

DRE = percent Destruction and Removal Efficiency required

Max FORM = mass flow rate (g/h [lb/h]) of FORM emitted from the combustion source

10.2 The average discharge concentration of the FORM in the effluent gas is determined by comparing the Max FORM with the volumetric flow rate being exhausted from the source. Volumetric flow rate data are available as a result of preliminary EPA Method 1 - 4 determinations:

$$\text{Max FORM}_i\text{ conc} = [\text{Max FORM}_i\text{ Mass}\,] / DV_{eff(std)}$$

where:

$DV_{eff(std)}$ = volumetric flow rate of exhaust gas, dscm (dscf)

FORM_i conc = anticipated concentration of the FORM in the exhaust gas stream, g/dscm (lb/dscf)

10.3 In making this calculation, it is recommended that a safety margin of at least ten be included.

$$[LDL_{FORM} \times 10] / [\text{FORM}_{i\ conc}] = V_{tbc}$$

where:

LDL_{FORM} = detectable amount of FORM in entire sampling train

V_{tbc} = minimum dry standard volume to be collected at dry-gas meter

10.4 The following analytical detection limits and DNPH Reagent Capacity (based on a total volume of 200 mL in two impingers) must also be considered in determining a volume to be sampled.

Table 2. Instrument Detection Limits and Reagent Capacity for Formaldehyde Analysis[1]

Analyte	Detection Limit, ppbv[2]	Reagent Capacity, ppmv
formaldehyde	1.8	66
acetaldehyde	1.7	70
acrolein	1.5	75
acetone/propionaldehyde	1.5	75
butyraldehyde	1.5	79
methyl ethyl ketone	1.5	79
valeraldehyde	1.5	84
isovaleraldehyde	1.4	84
hexaldehyde	1.3	88
benzaldehyde	1.4	84
o-/m-/p-tolualdehyde	1.3	89
dimethylbenzaldehyde	1.2	93

[1] Oxygenated compounds in addition to formaldehyde are included for comparison with formaldehyde; extension of the methodology to other compounds is possible.

[2] Detection limits are determined in solvent. These values therefore represent the optimum capability of the methodology.

11.0 QUALITY CONTROL

11.1 Sampling: See EPA Manual 600/4-77-027b for Method 5 quality control.

11.2 Analysis: The quality assurance program required for this method includes the analysis of field and method blanks, procedure validations, and analysis of field spikes. The assessment of combustion data and positive identification and quantitation of formaldehyde are dependent on the integrity of the samples received and the precision and accuracy of the analytical methodology. Quality Assurance procedures for this method are designed to monitor the performance of the analytical methodology and to provide the required information to take corrective action if problems are observed in laboratory operations or in field sampling activities.

11.2.1 Field Blanks: Field blanks must be submitted with the samples collected at each sampling site. The field blanks include the sample bottles containing aliquots of sample recovery solvents, methylene chloride and water, and unused DNPH reagent. At a minimum, one complete sampling train will be assembled in the field staging area, taken to the sampling area, and leak-checked at the beginning and end of the testing (or for the same total number of times as the actual sampling train). The probe of the blank train must be heated during the sample test. The train will be recovered as if it were an actual test sample. No gaseous sample will be passed through the Blank sampling train.

11.2.2 Method Blanks: A method blank must be prepared for each set of analytical operations, to evaluate contamination and artifacts that can be derived from glassware, reagents, and sample handling in the laboratory.

11.2.3 Field Spike: A field spike is performed by introducing 200 µL of the Field Spike Standard into an impinger containing 200 mL of DNPH solution. Standard impinger recovery procedures are followed and the field spike sample is returned to the laboratory for analysis. The field spike is used as a check on field handling and recovery procedures. An aliquot of the field spike standard is retained in the laboratory for derivatization and comparative analysis.

12.0 METHOD PERFORMANCE

12.1 Method performance evaluation: The following expected method performance parameters for precision, accuracy, and detection limits are provided in Table 3.

Table 3. Expected Method Performance for Formaldehyde

Parameter	Precision	[1]Accuracy[2]	Detection Limit[3]
Matrix: Dual trains	±15% RPD	±20%	1.5×10^{-7} lb/ft^3 (1.8 ppbv)

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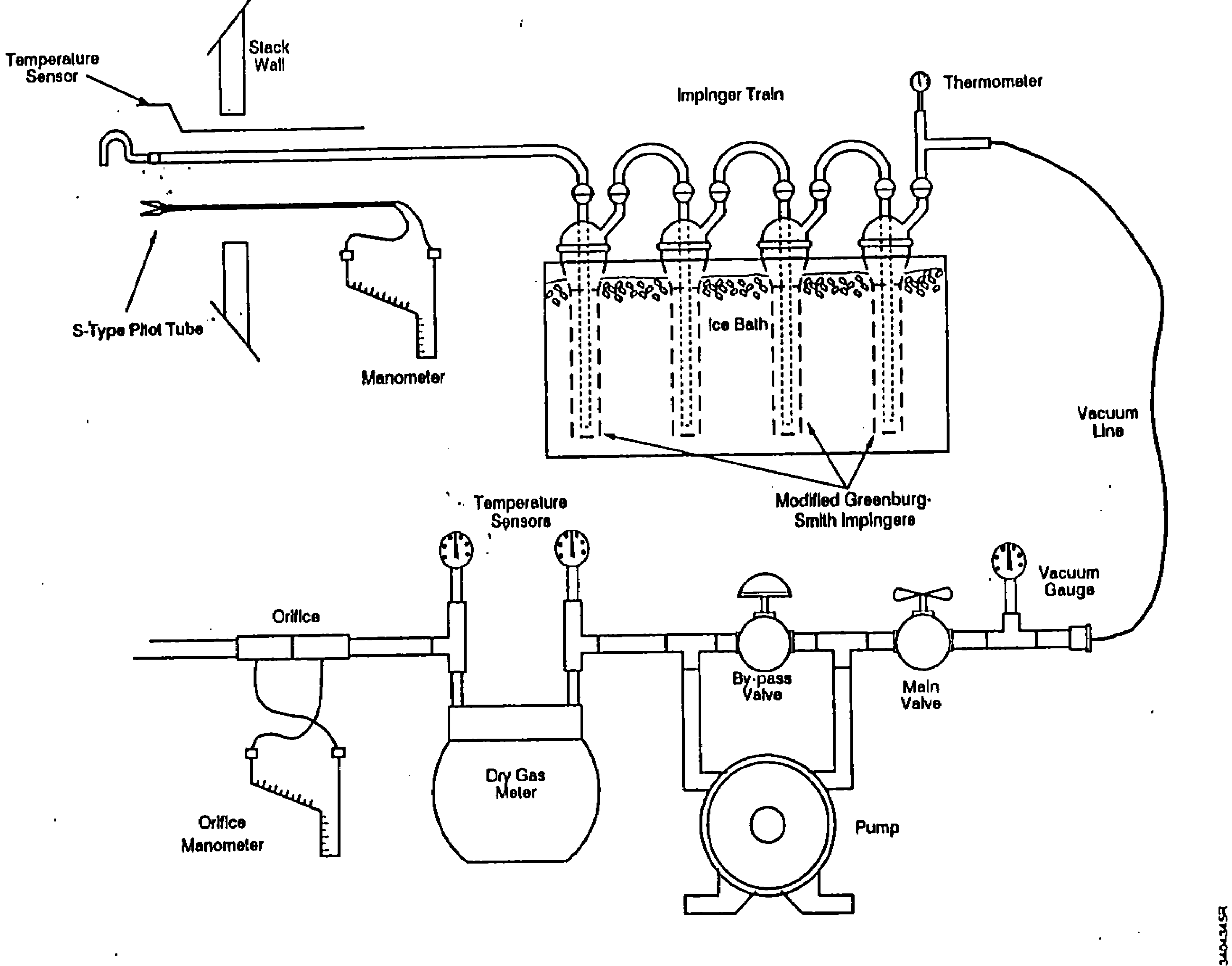
[1] Relative percent difference limit for dual trains.

[2] Limit for field spike recoveries.

[3] The lower reporting limit having less than 1% probability of false positive detection.



Formaldehyde Sampling Train

Plant ____________________

Location ____________________

Operator ____________________

Date ____________________

Run No. ____________________

Sample Box No. ____________________

Meter Box No. ____________________

Meter H@ ____________________

C Factor ____________________

Pitot Tube Coefficient C_p ____________________

Schematic of Stack Cross Section

Ambient Temperature ____________________

Barometric Pressure ____________________

Assumed Moisture % ____________________

Probe Length, m(ft) ____________________

Nozzle Identification No. ____________________

Average Calibrated Nozzle Diameter, cm (in) ____________________

Probe Heating Setting ____________________

Leak Rate, m^3/min. (cfm) ____________________

Probe Liner Material ____________________

Static Pressure, mm Hg (in. Hg) ____________________

Filter No. ____________________

Traverse Point Number	Sampling Time (0) Min.	Vacuum mm Hg (in. Hg)	Stack Temperature (T_s) °C (°F)	Velocity Head (P_s) mm (in) H_2O	Pressure Differential Across Orifice Meter mm (H_2O) (in H_2O)	Gas Sample Volume m^3 (ft^3)	Gas Sample Temp. at Dry Gas Meter		Filter Holder Temperature °C(°F)	Temperature of Gas Leaving Last Impinger °C(°F)
							Inlet °C(°F)	Outlet °C(°F)		
Total							Avg.	Avg.		
Average										

3404346R

Figure 2. Field Data Sheet

APPENDIX G

CALCULATION EQUATIONS

CALCULATION EQUATIONS

METHOD 7

$$V_{m(std)} = 17.64\ (V_f - 25)\ [\frac{p_f}{T_f} - \frac{P_i}{T_i}]$$

$$C_s = 6.243\ x\ 10^{-5}\ \frac{M}{V_{m(std)}}$$

$$E = \frac{2090\ C_s F}{20.9\ -\ \overline{B}_{O_2}}$$

$$C_s\ (GR/DSCF) = 7000\ C_s$$

$$C_s\ (MG/DSCM) = 1.60186\ x\ 10^7\ C_s$$

$$C_s\ (ppm\text{-}dry) = 8.37552\ x\ 10^6\ C_s$$

$$C_s\ (ppm\text{-}3\%\ O_2) = 8.37552\ x\ 10^6\ C_s\ \{1 + [\frac{\overline{B}'_{O_2} - 3}{20.9\ -\ B'_{O_2}}]\}$$

$$C_s\ (ppm\text{-}wet) = 8.37552\ x\ 10^6\ C_s\ (1 - \frac{MC}{100})$$

G:\STACK\WP\METHODS\EQ.M7

SYMBOLS

$\bar{B}\ O_2$ = Average oxygen content in flue gas, % v/v

C_s = Concentration of nitrogen oxides in flue gas, dry basis, corrected to standard conditions, LB/DSCF

C_s (GR/DSCF) = Concentration of nitrogen oxides in flue gas, dry basis, corrected to standard conditions, GR/DSCF

C_s (MG/DSCM)= Concentration of nitrogen oxides in flue gas, dry basis, corrected to standard conditions, MG/DSCM

E = Emission factor, LB/10^6BTU

F = F-Factor for given fuel type, DSCF/10^4BTU

M = Mass of nitrogen oxides as nitrogen dioxide in gas sample, ug

MC = Moisture content of flue gas, %

P_f = Final absolute pressure in flask, IN. HG

P_i = Initial absolute pressure in flask, IN. HG

C_s (ppm-dry) = Concentration of nitrogen oxides in flue gas, dry basis, (v/v), ppm

C_s (ppm-3% O_2) = Concentration of nitrogen oxides in flue gas, dry basis, corrected to 3% O_2, (v/v) ppm

C_s (ppm-wet) = Concentration of nitrogen oxides in flue gas, wet basis, (v/v), ppm

T_f = Final absolute temperature in flask, °R

T_i = Initial absolute temperature in flask, °R

V_f = Volume of flask and valve, cc

$V_{m(std)}$ = Sample volume at standard conditions, dry basis, cc

CALCULATION EQUATIONS

METHOD 10

$$CO \cdot PPM \cdot DRY = CO_{CO_2\text{-free},dry,avg}\ (1 - CO_{2,d}/100)$$

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

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

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

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

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

Where

$CO_{CO_2\text{-free},dry,avg}$ = 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

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 ^{o}F, 29.92 IN.HG.)

mg/dscm = concentration of carbon monoxide in flue gas on a milligrams per dry standard cubic meter basis (60 ^{o}F, 29.92 IN.HG.)

$\dot{m}$ = emission 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)

CALCULATION EQUATIONS

Chromotropic Acid Method for Formaldehyde

$$m_t = \frac{m_a \times V_{soln}}{V_{aliq}}$$

where m_t = mass of formaldehyde in total sample in ug

m_a = mass of formaldehyde in aliquot in ug

V_{soln} = volume of total sample in cc (500 cc normally)

V_{aliq} = volume of aliquot taken for analysis in cc

$$\text{PPM}\cdot\text{DRY} = \frac{.0283\ m_t}{V_{std}}$$

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

$$\text{GR/DSCF} = 5.45 \times 10^{-4}\ (\text{PPM}\cdot\text{DRY})$$

$$\text{mg/dscm} = 1.249\ (\text{PPM}\cdot\text{DRY})$$

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

where PPM•DRY = concentration of formaldehyde in parts per million by volume on a dry basis

PPM•WET = concentration of formaldehyde in parts per million by volume on an actual or wet basis

MC = moisture content of gas on a percent by volume basis

GR/DSCF = concentration of formaldehyde in gas on a grains per dry standard cubic foot basis (68^{o}F, 29.92 IN.HG.)

m = emission or mass rate of formaldehyde in pounds per hour (LB/HR)

APPENDIX H

SAMPLING EQUIPMENT CALIBRATION DATA

INTERPOLL LABORATORIES
EPA Method 5 Gas Metering System
Quality Control Check Data Sheet

Job L.P. / Tomahawk, WI

Date 12-7-93

Operator M. Kaehler

Module No. 9

Instructions: Operate the control module at a flow rate equal to ^H@ for 10 minutes before attaching the umbilical. Record the following data:

Bar press 28.50 in. Hg. T = 1.0054 ^H@ 1.75 in. W.C.

Time (min)	Volume (CF)	Meter Temp. (°F)	
		Inlet	Outlet
[redacted]	(610.50)	[redacted]	
2.5	612.30	7	6
5.0	614.10	9	6
7.5	615.90	12	7
10	617.70	14	9
[redacted]	V_m = 7.20	Avg(t_m)= 8.75 °F	

Calculate Y_{cn} as follows:

$$Y_{cn} = \frac{1.786}{T\ V_m}\left[\frac{(t_m + 460)}{P_b}\right]^{0.5}$$

$$Y_{cn} = \frac{1.786}{(1.0054)(7.20)}\left[\frac{(8.75) + 460}{(28.50)}\right]^{0.5}$$

Y_{cn} = 1.001

If Y_{cn} is not within the range of 0.97 to 1.03, "the volume metering system should be investigated before beginning."

CFR Title 40, Part 60, Appendix A, Method 5, Section 4.4.1

S-432

Interpoll Laboratories, Inc.
(612) 786-6020

Meter Box Calibration and Usage Status

Date of Report: December 13, 1993

Meter Box No.: 9 (Rockwell Dry Test Meter Serial No. 949231)

Date of Last Calibration:	November 26, 1993
Calibration Technician:	D. Brennan
Wet Test Meter No.:	American Meter AL-20

Date of Use	Report No.	Initial Meter Reading	Final Meter Reading	Volume/Job (cu. ft.)	Total Volume* (cu. ft.)
December 7, 1993	3-1854	618.50	783.99	165.49	165.49

* Total volume through meter since last calibration.

Date 11/26/93

Bar. Press. 29.15 in. Hg

INTERPOLL LABORATORIES, INC.
METER CALIBRATION SHEET
EPA METHOD 5

Control Module No. 9

Serial No. DTM 949 231

Wet Test Meter No. AL-20

Technician D. BRENNAN

ΔH (in. WC)		Gas Volume Wet Test Meter (ft³)	* Cal. Index φ (%)	* Diff. Wet Test Meter ΔP_w (in.WC)	Gas Volume Dry test meter (ft³)		Gas temperatures			Time θ (min/sec)	Meter Coeff. Y	Orifice Const. ΔH@	C_f
nominal	actual				V_{di}	V_{df}	Wet Test t_w (°F)	Dry Test t_{di} (°F)	Dry Test t_{do} (°F)				
0.5	.50	2	99.85	0.01	601.500	603.532	65.5	81	73	4:58	1.0030	1.73	
1.2	1.2	3	99.91	0.025	601.000	607.035	65.5	82	74	4:47	1.0080	1.71	
2.0	2.0	3	99.93	0.055	587.000	590.034	65.5	86	72	3:44	1.0026	1.74	
3.3	3.3	5	100.00	0.09	590.500	595.541	65.5	84	73	4:53	1.0078	1.76	
4.7	4.7	5	100.02	0.12	596.000	601.050	65.5	86	74	4:08	1.0054	1.79	
	2	3	4	5	6	7	8	9	10	11/11 Avg.	1.0054	1.75	

Positive leak check performed by D. BRENNAN

Meter was in tolerance ☒

Meter was not in tolerance ☐: readjusted linkage

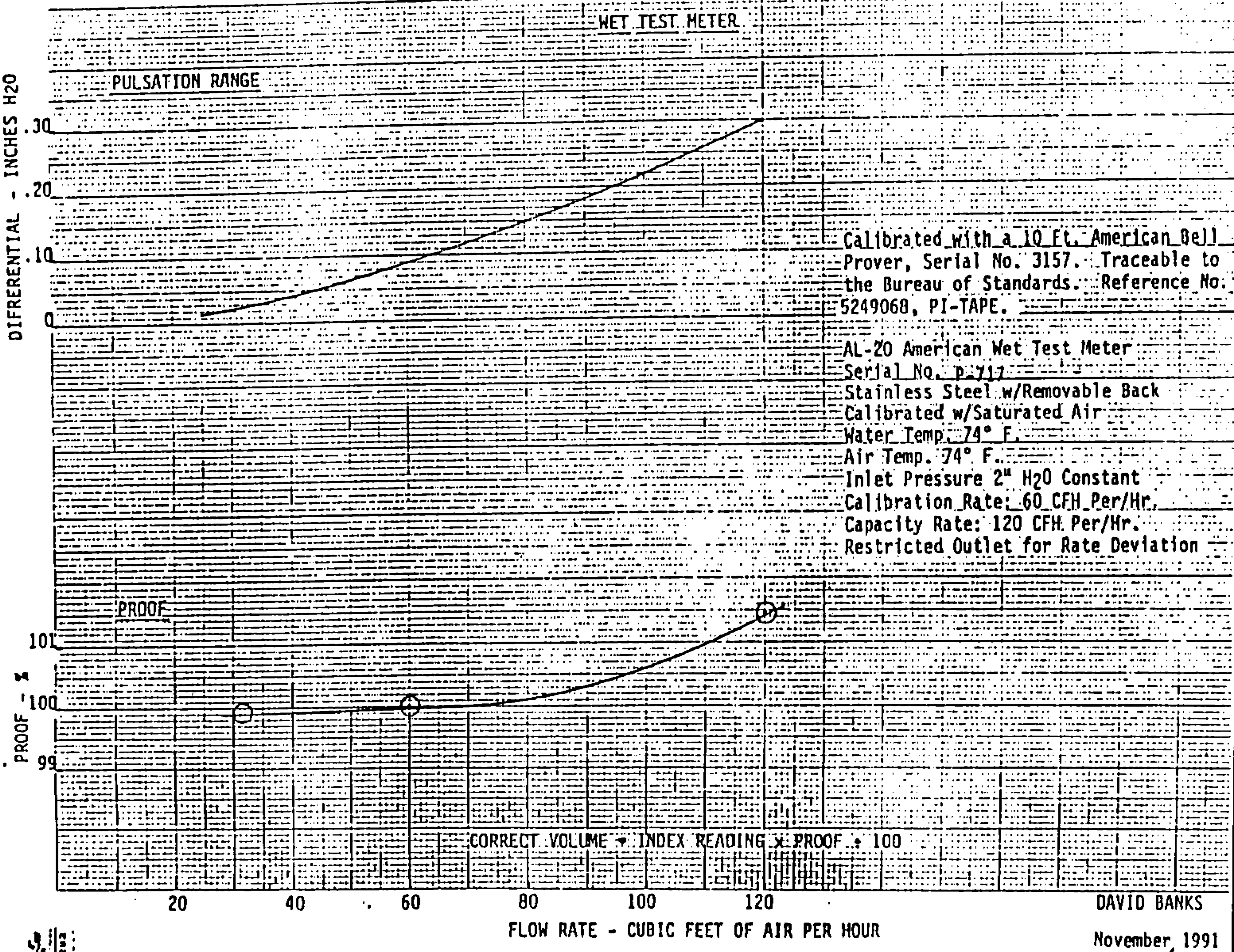
Meter was not in tolerance ☐: changed dry test meters

Approved by Date 11/29/93

* Based on AL-20 wet test meter calibration in Nov. 1991 against Bell Prover (NBS Traceable) - Carl Poe Co.

S0102RR 11/91

DIFFERENTIAL PRESSURE AND PROOF CALIBRATION CURVES



Calibrated with a 10 Ft. American Bell Prover, Serial No. 3157. Traceable to the Bureau of Standards. Reference No. 5249068, PI-TAPE.

AL-20 American Wet Test Meter
Serial No. P-717
Stainless Steel w/Removable Back
Calibrated w/Saturated Air
Water Temp. 74° F.
Air Temp. 74° F.
Inlet Pressure 2" H_2O Constant
Calibration Rate: 60 CFH Per/Hr.
Capacity Rate: 120 CFH Per/Hr.
Restricted Outlet for Rate Deviation

DAVID BANKS

November, 1991

Interpoll Laboratories, Inc.
(612) 786-6020

Nozzle Calibration
Data Sheet

Date of Calibration: 12-07-93
Technician: Mark Kaehler

Nozzle Number 8-4

The nozzle is rotated in 60 degree increments and the diameter at each point is measured to the nearest 0.001 inch. The observed readings and average are shown below.

Position	Diameter (inches)
1	.238
2	.239
3	.240
Average:	.239

Interpoll Laboratories, Inc.

Temperature Measurement Device Calibration Sheet

Unit under test:
Vendor Beckman
Model HD 110T
Serial Number 10913005
Range 0-2000 °F
Thermocouple Type K
Date of Calibration 9-13-93
Technician Mark Kaehler

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)	(%)
0	0	-3	3	.65
100	100	93	7	1.25
200	200	197	3	.45
300	300	295	5	.66
400	400	392	8	.93
500	500	492	8	.83
600	600	594	6	.57
700	700	695	5	.43
800	800	800	0	0
900	900	902	2	.15
1000	1000	1007	7	.48
1100	1100	1111	11	.71
1200	1200	1217	17	1.02
1300	1300	1317	17	.97
1400	1400	1422	22	1.18
1500	1500	1520	20	1.02
1600	1600	1621	21	1.02
1700	1700	1716	16	.74
1800	1800	1814	14	.62
1900	1900	1907	7	.30
2000	2000	OL	–	–
2100	2100	OL	–	–
		Averages:	9.95	.70

OF = off scale response by unit under test (°F)
% dev = 100 Δt / (460 + t)

☑ 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. 29-6

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° 1
7. B_2 < 5° 1

8. Z <.125" .02
9. W <.0625" .02

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: 4-7-93

Inspected by:

CFR Title 40 Part 60 Appenidix A Method 2

S-348

4-7-93 G:\STACK\WP\FORMS\S-348

INTERPOLL LABORATORIES
(612)786-6020

Stack Sampling Department - QA
Aneroid Barometer Calibration Sheet

Date 9-13-93

Technician Mark Koehler

Mercury Column Barometer No. LAB-1

Aneroid Barometer No. 560815

Actual Mercury Barometer Read	Ambient Temp.	Temperature Correction Factor	Adjsted Mercury Barometer Read	Initial Aneriod Barometer Read	Difference $(P_{ba}-P_{bm})$
28.770	72	.114	28.656	28.760	.104

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

Has problem been alleviated? Yes/No. How?

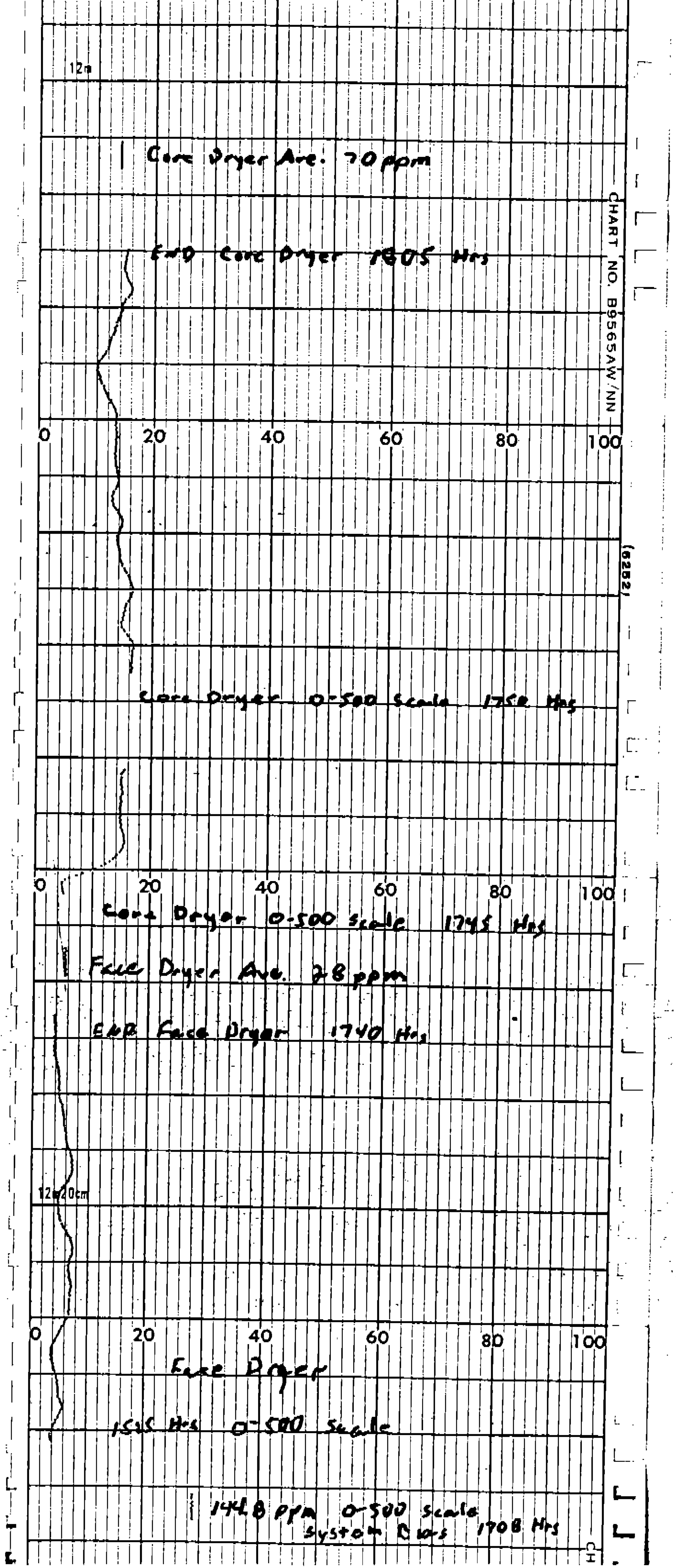
*Note

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.

S-312

APPENDIX I

CARBON MONOXIDE STRIPCHART


12n
Core Dryer Ave. 70 ppm
END Core Dryer 1805 Hrs
CHART NO. B9565AW/NN
0
20
40
60
80
100
(6282)
Core Dryer 0-500 Scale 1750 Hrs
0
20
40
60
80
100
Core Dryer 0-500 scale 1745 Hrs
Face Dryer Ave. 28 ppm
END Face Dryer 1740 Hrs
12n 20cm
0
20
40
60
80
100
Face Dryer
1535 Hrs 0-500 Scale
144.8 ppm 0-500 scale
System Bias 1708 Hrs
CH