United States
Environmental Protection Agency
Wood Heater Certification Test Report

Jotul North America
F400

Volume 1 of 1

LoKee

Testing Laboratory

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TEST SERIES INFORMATION

Unit name and model number: F400

Type of unit: Wood Heater

Manufacturer: Jotul North America
Address: 400 Riverside Street
Portland, ME 04104

Contact: Shawn Malloy
Phone Number: 1-207-797-5912
Fax Number: 1-207-772-0523

Observers: Shawn Malloy

Date Received: 3/31/2000 Aged: 4/4-5/2000 Dates Tested: 4/7-12/2000

Tested by: LoKee Testing Lab using EPA Methods 28, 28A and 5H where applicable.

Test Location: 13235 Prairie Circle East
Sumner, WA 98390-7250
Test Site Elevation: 500 feet above sea level

LoKee's Field Team

Team Members: Chip Wadington
Cindy Kingman
Deborah Wadington

The following pages contain (1) test unit storage information, (2) a diagram showing the height and location of the stack components and sampling ports, and (3) copies of the certification test notices and cancellations sent to the EPA.

STOVE STORAGE INFORMATION

1. **Temporary Storage at LoKee**

   A single, steel, banding strap is place around the unit, preventing opening of the loading door.

2. **Permanent Storage**

   After certification is granted, additional banding is placed both horizontally and vertically around the unit to prevent access to the interior of the unit. An address label is then taped over the intersecting bands to act as a seal. Warning labels are affixed on the unit. The unit is then shipped via common carrier to the manufacturer's designated storage facility unless otherwise noted. A sample of the warning label follows.

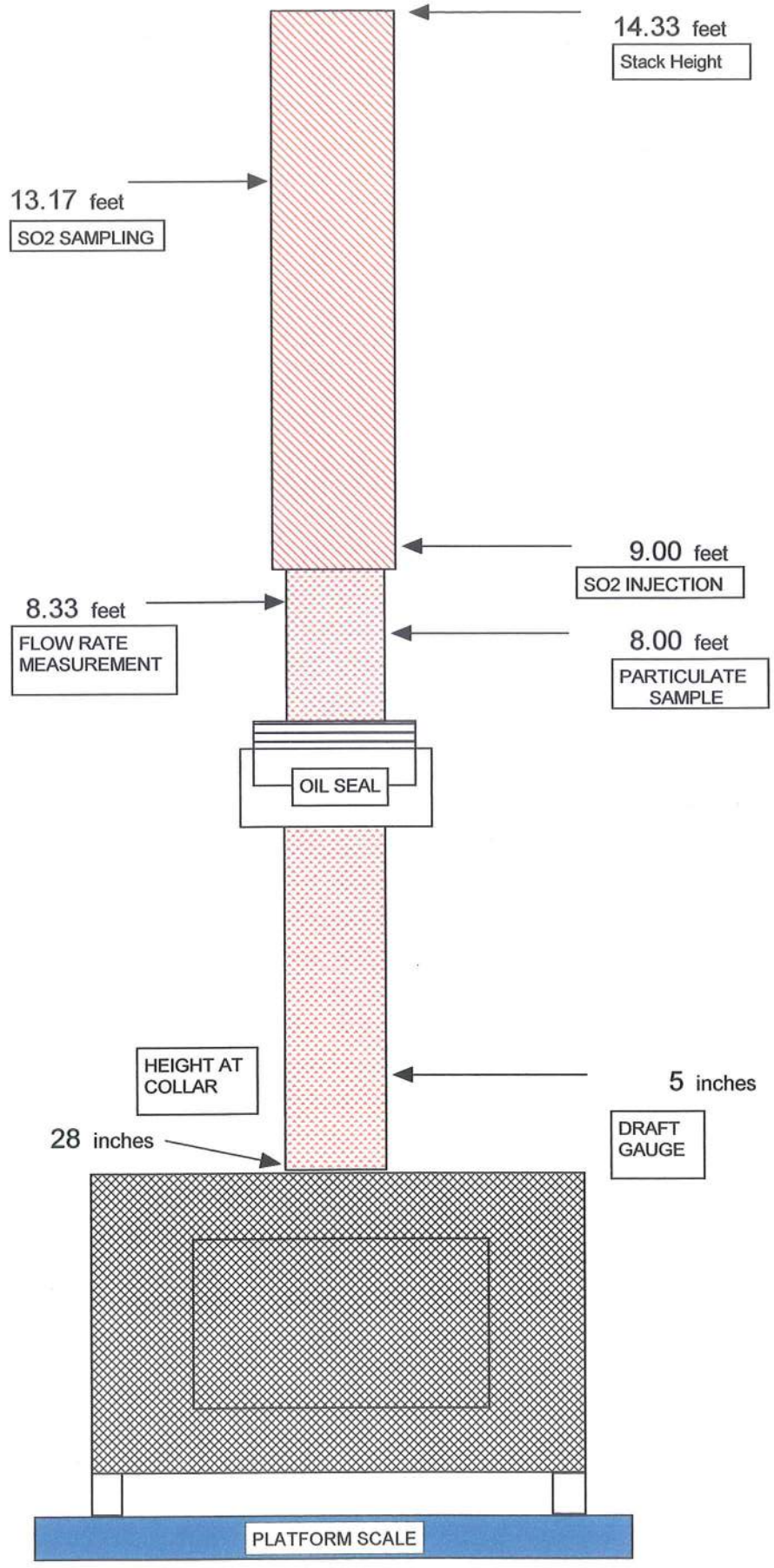
WARNING

SEALED EPA TEST UNIT

DO NOT TAMPER WITH SEALS
TO DO SO WILL VOID CERTIFICATION

JOTUL NORTH AMERICA
F400

Model: F400 **Date:** 04/12/00



AGING DATA SHEET

UNIT : F400 DATE: 4-4-00

Hr #	DATE	TIME	TEMP Top 1	TEMP Firebox 2
1	4-4	1350	318	641
2	"	1450	501	370
3	"	1550	551	601
4	"	1650	338	622
5	"	1750	278	498
6	4-5	1515	577	887
7	"	1615	317	598
8	"	1715	428	348
9	"	1815	592	591
10	"	1915	358	631
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				

Hr #	DATE	TIME	TEMP 1	TEMP 2
26				
27				
28				
29				
30				
31				
32				
33				
34				
35				
36				
37				
38				
39				
40				
41				
42				
43				
44				
45				
46				
47				
48				
49				
50				

COMMENTS:

4-4-00 Stove lit 1015

4-5-00 " " 1110

LOKEE TESTING LABORATORY.
13235 PRAIRIE CIRCLE EAST, SUMNER, WA 98390-7250
Phone (360)-897-9685

To: Robert C. Marshall, Jr., US EPA
From: Chip Wadington, LoKee Testing Laboratory
Subject: Wood Stove Certification Test Notification

This is to notify EPA that:

Manufacturer's Name: **JOTUL USA INC.**
Address: **400 Riverside Street**
Portland, ME 04104

Contact: **Shawn Malloy**
Phone: **1-207-797-5912**

has scheduled the Model **#F400** for certification testing at LoKee according to the following:

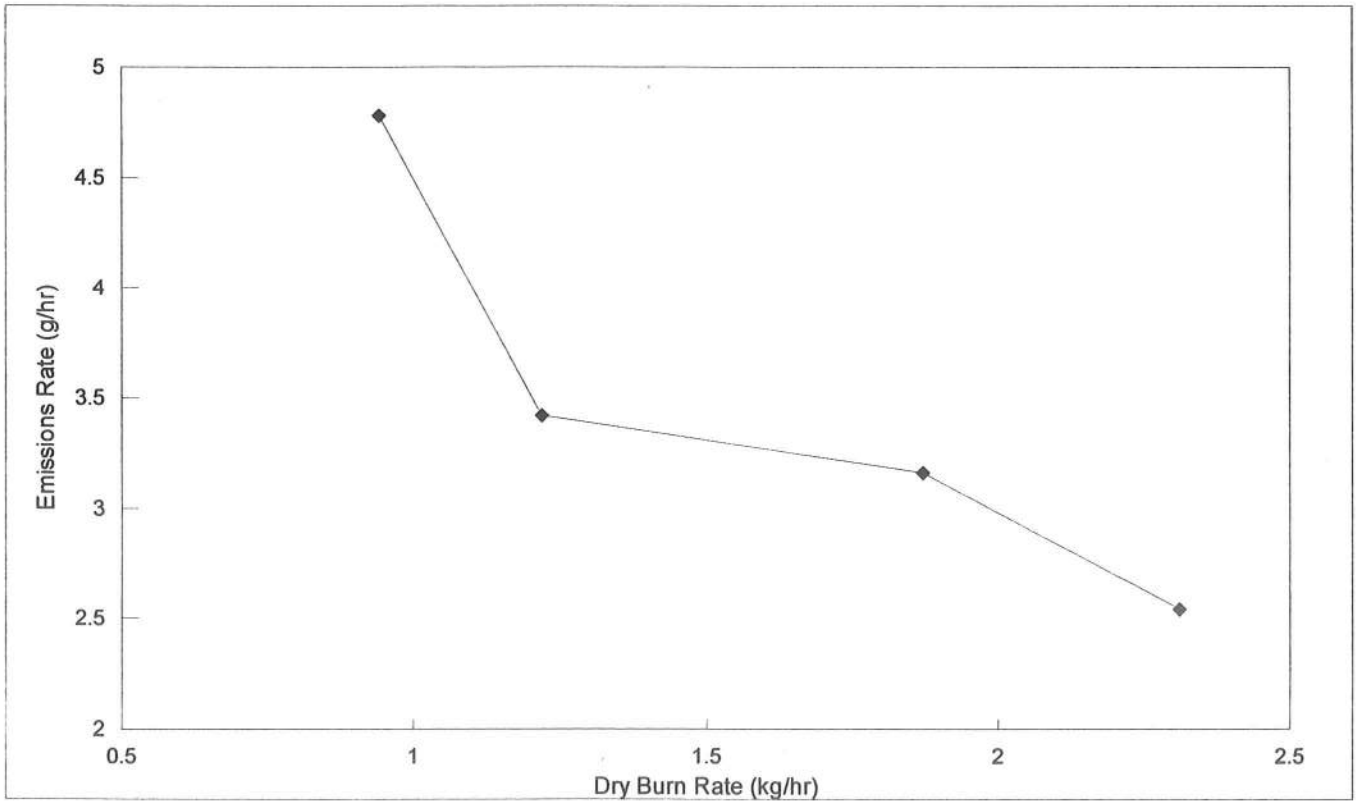
Dates Scheduled	Date Notification Sent	Date Notification Canceled	Testing Activity (if any)
2/7-11/2000	1/5/2000		None
2/14-18/2000	1/5/2000		None
2/21-25/2000	1/5/2000		None
2/28-2/3/2000	1/5/2000		None
3/27-31/2000	2/25/2000		None
4/3-7/2000	2/25/2000		Cert started
4/10-14/2000	2/25/2000		Cert complete
4/17-21/2000	2/25/2000		None
4/24-28/2000	2/25/2000		none

Wood Heater Emission Test Summary

Laboratory/Wood Heater Information

Stove Manufacturer:	**Jotul**
Model Identification:	**F400**
Stove Type> 1=cat, 2=noncat, 3=pellet:	**2**
Laboratory Name:	**LoKee Testing Lab**
Laboratory Contact:	**CHIP WADINGTON**
Telephone no.:	**360-897-9685**
Test Dates:	**4/7-12/2000**
Test Methods Used	
Method 28/Other:	**28**
Sampling Method:	**5H**

Run no.	Burn Rate (kg/hr)	Emission Rate (g/hr)	Heat Output (Btu/hr)	Wtd Avg (g/hr) 3.77
1	0.94	4.78	11335	
2	1.22	3.42	14711	
3	1.87	3.16	22549	
4	2.31	2.54	27854	



Unit : Jotul F400

DATA SUMMARY

	RUN #	1	3	4	2				
Particulate Emissions:									
Concentration:	grains/dscf:	.1922	.1072	.0750	.0526				
Emissions Rate	grams/hr:	4.78	3.42	3.16	2.54				
Emissions Factor	grams/kg:	5.11	2.79	1.69	1.10				
Front Half Catch	% of total	32.90	25.09	39.34	38.55				
Total Mass Captured	total catch:	1.1356	.5022	.1993	.1751				
Heat Output (EPA Default):	BTU/hr	11286.5	14759.2	22500.6	27806.2				
Fuel Burn Rates:									
Average kg/hr (dry)	Kg/hr	0.94	1.22	1.87	2.31				
Fuel Moisture Content:									
Kindling (wet basis)	%	13.917	14.040	14.821	12.562				
Pretest Fuel (wet basis)	%	16.162	17.643	17.241	16.452				
Test Fuel (wet basis)	%	17.961	16.994	16.304	17.164				
Air to Fuel Ratio		-	-	-	-				
Average Stack Gas									
Avg CO_2	%	6.27	6.68	8.37	9.22				
Avg O_2	%	-	-	-	-				
Avg CO	%	1.19	0.96	0.66	0.58				
Avg Moisture	%	6.65	7.31	8.12	8.69				
Avg Stack Gas Emissions:									
CO	g/Kg	163.51	129.18	76.44	62.77				
	g/hr	153.04	158.12	142.64	144.76				

Unit : Jotul F400

	RUN #	1	3	4	2				
Avg Stack Gas Flow Rate									
EPA CMB	dscfm	6.40	8.20	10.83	12.45				
Tracer Gas	dscfm	7.372	8.570	9.336	10.469				
Draft (static)	in H_2O	-.036	-.041	-.055	-.056				
Proportionality Average	%	100	100	100	100				
Average Temperatures									
Stack Gas	°F	298	352	494	552				
Firebox	°F	645	651	781	772				
Secondary	°F	789	893	1096	1089				
Catalytic Combustor	°F	-	-	-	-				
Top	°F	369	406	520	571				
Left Side	°F	278	322	383	412				
Back	°F	284	293	353	366				
Right Side	°F	275	298	361	377				
Bottom	°F	215	229	244	242				
Temperature Change	°F	-74.8	-41.2	-37.2	-31.2				
Test Chamber Enviroment									
Average Barometer	in. Hg	30.20	30.09	30.09	30.21				
Average Temperature	°F	75	80	81	81				
Ambient Moisture	% H_2O	1.3	1.25	1.3	1.2				
Relative Humidity	%RH	38.0	39.5	38.5	36.0				
Air Velocity	m/sec	0	0	0	0				
Fuel Weight and Burn Time									
Density (dry basis)	gm/cm^3	-	-	-	-				
Coal Bed Weight	lbs	3.1	2.8	2.6	2.7				
Pre Test Fuel (inc kindling)	lbs	44.1	41.6	39.1	41.2				
Test Fuel	lbs	13.2	13.0	12.7	13.3				
Burn Time	min	315	240	155	130				

TABLE 1 ----- RAW DATA

CLIENT : Jotul TEST No. : 1

MODEL: F400 DATE: 07-Apr-00

TIME (MIN.)	METER READING (C F)	DELTA H (IN. H2O)	METER TEMP. (DEG. F)	PERCENT CO (%)	PERCENT CO2 (%)	SO2 COCENTR. PPM
0	158.000	0.150	80	1.24	5.60	450
5	159.500	0.160	82	1.09	3.80	425
10	161.121	0.160	82	0.49	1.90	425
15	162.743	0.140	82	0.51	2.00	450
20	164.274	0.130	82	0.57	2.20	475
25	165.725	0.120	82	0.64	2.40	500
30	167.104	0.110	82	0.72	2.70	525
35	168.417	0.120	82	0.73	3.00	500
40	169.795	0.120	82	0.87	3.50	500
45	171.174	0.280	82	0.19	12.50	325
50	173.293	0.280	82	0.11	12.00	325
55	175.412	0.280	82	0.11	12.10	325
60	177.531	0.280	82	0.17	9.70	325
65	179.651	0.280	82	0.07	11.00	325
70	181.770	0.280	82	0.04	12.40	325
75	183.889	0.280	83	0.03	13.00	325
80	186.016	0.270	85	0.06	11.20	325
85	188.159	0.270	85	0.06	10.00	325
90	190.302	0.270	85	0.06	9.40	325
95	192.444	0.270	85	0.13	8.70	325
100	194.587	0.240	85	0.23	8.50	350
105	196.577	0.180	86	0.53	8.70	400
110	198.325	0.180	86	0.71	8.40	400
115	200.074	0.160	86	0.84	7.90	425
120	201.719	0.130	86	1.06	7.50	475
125	203.192	0.130	86	1.04	7.40	475
130	204.664	0.130	86	1.02	7.60	475
135	206.137	0.130	86	0.99	7.80	475
140	207.609	0.130	86	0.74	7.50	475
145	209.082	0.140	86	0.89	7.00	450
150	210.636	0.100	86	1.34	5.90	525
155	211.968	0.110	86	1.39	5.80	500
160	213.367	0.110	86	1.54	5.80	500
165	214.767	0.110	86	1.48	5.90	500
170	216.166	0.110	86	1.56	5.90	500
175	217.565	0.110	87	1.61	5.60	500
180	218.969	0.100	88	2.16	5.10	525
185	220.311	0.100	88	2.21	5.00	525
190	221.653	0.100	89	2.21	5.00	525
195	223.000	0.100	89	1.97	5.40	525
200	224.348	0.090	89	2.04	5.20	550
205	225.634	0.090	89	2.11	5.20	550
210	226.920	0.090	89	2.26	5.00	550
215	228.206	0.090	90	2.24	4.90	550

220	229.496	0.090	90	2.24	4.90	575
225	230.731	0.090	90	1.28	5.40	550
230	232.021	0.090	90	1.29	5.30	575
235	233.256	0.090	90	1.31	5.30	575
240	234.491	0.090	90	1.35	5.30	575
245	235.725	0.090	90	1.52	5.20	575
250	236.960	0.090	90	1.53	5.10	575
255	238.194	0.090	90	1.33	5.50	575
260	239.429	0.080	91	1.53	5.60	575
265	240.668	0.080	91	1.67	5.50	575
270	241.907	0.080	91	1.68	5.30	575
275	243.146	0.080	91	1.80	5.20	575
280	244.385	0.080	91	1.86	5.20	600
285	245.573	0.080	91	1.95	4.90	600
290	246.760	0.080	91	2.05	4.50	600
295	247.948	0.080	91	2.06	4.40	600
300	249.135	0.080	91	1.81	3.80	600
305	250.323	0.007	91	1.90	3.80	625
310	251.463	0.070	91	1.93	3.90	625
315	252.603	0.070	91	2.02	4.10	625
320						

TABLE 2---RAW DATA

CLIENT : Jotul TEST No. 1

MODEL: F400 DATE: 07-Apr-00

****

METER CAL. FACTOR (Y)	0.989	Wt. WOOD BURNED(LB)	13.2 Lbs
BAROMETRIC PRESS.(Pb)	30.2 in Hg	WET,FUEL MOISTURE %	17.961 %
LEAK RATE POST (Lp)	0.011 cfm	Wt. PART. COLLECTED	1.1356 g
WATER VOL. (V1c)	138.1 Ml	METER VOLUME Vm	94.603 mcf
TEST TIME (MIN)	315 min	HC MOLE FRACTION	0.0132

TABLE 3 -----FIELD DATA AVERAGES

CLIENT :Jotul TEST No. 1

MODEL: F400 DATE: 07-Apr-00

****

AVG DELTA H	-------	0.14 in H2O		AVG PRCNT CO	-------	1.19	%
AVG METER TEMP. Tm	-------	87 deg F		AVG PRCNT CO2	-------	6.27	%
AVG PPM SO2	-------	489	PPM	AVG BAL CO2/CO	-------	5.27	%

TABLE 4 ----- CALCULATIONS

CLIENT : Jotul TEST No. 1

MODEL: F400 DATE: 07-Apr-00

****

STD SAMPLE VOL. Vm(std) -----	91.25	dscf	STACK GAS FLOW Qsd -------	383.985	dscf/Hr
				6.40	& dscf/min
VOL. WATER VAPOR Vw(std) ----	6.500	scf	PARTICULATE CONCTRT. Cs ------	0.0124	g/dscf
PRCNT MSTR Bws -------	6.65	%	PARTC.EMISS. RATE E -------	4.78	g/Hr
BURN RATE BR -------	0.94	Kg/Hr	MOLES OF GAS PER Lb WOOD Nt --	0.48	Lb-mole/Lb
CO EMISSION RATE -------	153.04	g/Hr	PART.EMISS. RATE ------	5.11	g/Kgdry fuel
	& 163.51	g/Kgdry fuel			

TABLE 5 ----- PROPORTIONAL RATE VARIATION

CLIENT : Jotul TEST No. : 1

MODEL: F400 DATE: 07-Apr-00

TIME INTEVAL Ti	PPM * Vm	PROPRTN. RATE VAR. PR	PROPRTN RATE VAR. AVERAGE
5	658.0	97	100
10	670.3	99	
15	670.7	99	
20	670.3	99	
25	670.6	99	
30	670.8	99	
35	670.6	99	
40	670.3	99	
45	670.8	99	
50	670.3	99	
55	670.3	99	
60	670.3	99	
65	670.6	99	
70	670.3	99	
75	669.7	99	
80	670.3	99	
85	674.1	100	
90	674.1	100	
95	673.8	100	
100	674.1	100	
105	673.5	100	
110	675.4	100	
115	675.8	100	
120	675.3	100	
125	675.8	100	
130	675.3	100	
135	675.8	100	
140	675.3	100	
145	675.8	100	
150	675.4	100	
155	675.3	100	
160	675.6	100	
165	676.0	100	
170	675.6	100	
175	674.9	100	
180	676.1	100	
185	677.9	100	
190	677.3	100	
195	679.2	100	
200	679.7	101	
205	679.3	100	
210	679.3	100	
215	678.7	100	
220	680.2	101	

225	680.8	101
230	680.2	101
235	680.8	101
240	680.8	101
245	680.2	101
250	680.8	101
255	680.2	101
260	680.2	101
265	681.7	101
270	681.7	101
275	681.7	101
280	681.7	101
285	682.1	101
290	681.5	101
295	682.1	101
300	681.5	101
305	682.1	101
310	681.7	101
315	681.8	101
320		
325		

5,5106

COMPUTER INPUT DATA SHEET #1

4.78 at .94 kg/ht

Client: JOTUL U.S.A., INC.

Address: 400 RIVERSIDE STREET
PORTLAND, ME 04104

Phone: 207-797-5912 Fax: 207-772-0523

Run No.: 1 Date of Test: 4-7-2000 Burn Rate: .936

Model No.: ☒ min ☐ min-1.25 ☐ fan

Stove Type: ☐ Cat ☒ Non Cat ☐ Pellet ☐ 1.25-1.9 ☐ max ☐ insert

Dry Gas Meter: Y Factor: .989 (0.000) (Data Sheet #2)
Post Leak Rate: .011 cfm (.000) (Data Sheet #2)
Time: 315 min. (000) (Data Sheet #2)

Dry Gas Meter Volume: 94.603 cf ✓ (00.000) (Data Sheet #2)

6.40 calc

Stack Flow: 7.372 ✓ dscfm (00.000) (Data Sheet #2)

Δ H: .138 ✓ in. H_2O (.000) (Data Sheet #2)

Barometric Pressure: 30.20 ✓ in. Hg (00.00) (Data Sheet #2)

H_2O Captured: 138.1 ✓ g (00.0) (Data Sheet #3)

Total Particulate Catch: 1.1356 ✓ g (0.0000) (Data Sheet #6)

Flue Gas Moisture: 6.6567 % (00.000) (Data Sheet #7)

Particulate Emission: .1922 ✓ gr/dscf (0.0000) (Data Sheet #7)

Ambient Moisture: 1.3 % (0.00) (Data Sheet #8)

Stove Weight: — lbs (000) (Data Sheet #8)

Total Fuel Consumed During Burn: 13.2 lbs (00.0) (Data sheet #8)

Fuel Higher Heating Value (dry): — BTU/lb (0000) (Data Sheet #8)

Fuel % Moisture (dry): 21.893 % (wet): 17.961 % (00.00) (Data Sheet #10)

Stack Static Pressure: -.036 in. H_2O (0.000) (Data Sheet #12)

Temperature (Average Room) Combustion Air: 75 °F (00) Data Sheet #14)

Stove Temperature Change: -74.8 °F (00.0) (Data Sheet #14)

METER BOX DATA SHEET PAGE # 2

Page: 1 of 3

UNIT: F400 RUN: 1 DATE: 4-7-00

Meter Box: 5H Y Factor: .989

Leak checks: 15 " Hg @ .020 cfm ___/___ " Hg @ ___/___ cfm

15 " Hg @ .011 cfm ___/___ " Hg @ ___/___ cfm

Inject SO^2 @ 100 cc/min. Nozzle: Probe @ 3/8 " od Initial Volume: 1.500

95

ROTO: PRESS: .15			SAMPLING RATIO: 26 : 1				BP: 30.20		
MIN	TIME	METER READING	SAMPLE MDCF	STACK DSCFM	DELTA H	METER TEMP	SO2 PPM	ROTO TEMP	PUMP VACC
0	1235	158.000	——	7.749	.15	80	450	80	1.0
5	40	159.500	——	8.175	.16	82	425	82	3.0
10	45	161.121	161.121	8.175	.16	82	425	82	1.0
15	50	162.743	162.743	7.721	.14	82	450	82	1.0
20	55	164.274	164.274	7.314	.13	82	475	82	1.0
25	1300	165.725	165.725	6.949	.12	82	500	82	1.0
30	05	167.104	167.104	6.618	.11	82	525	82	1.0
35	10	168.417	168.417	6.949	.12	82	500	82	1.0
40	15	169.795	169.795	6.949	.12	82	500	82	1.0
45	20	171.174	171.174	10.690	.28	82	325	82	3.0
50	25	173.293	173.293	10.690	.28	82	325	82	3.0
55	30	175.412	175.412	10.690	.28	82	325	82	3.0
ROTO PRESS: .15			TOTALS:	98.669	2.05	982	BP.: 30.20		
60	1335	177.531	177.531	10.690	.28	82	325	82	3.0
65	40	179.651	179.651	10.690	.28	82	325	82	3.0
70	45	181.770	181.770	10.690	.28	82	325	82	3.0
75	50	183.889	183.889	10.670	.28	83	325	83	3.0
80	55	186.016	186.016	10.631	.27	85	325	85	3.0
85	1400	188.159	188.159	10.631	.27	85	325	85	3.0
90	05	190.302	190.302	10.631	.27	85	325	85	3.0
95	10	192.444	192.444	10.631	.27	85	325	85	3.0
100	15	194.587	194.587	9.872	.24	85	350	85	3.0
105	20	196.577	196.577	8.622	.18	86	400	86	2.0
110	25	198.325	198.325	8.622	.18	86	400	86	2.0
115	30	200.074	200.074	8.115	.16	86	425	86	2.0
			TOTALS:	120.495	2.96	1012	MAX VACC =		
TOTAL Cu Ft.			TOTALS:	219.164	5.01	1994	AVG. BP:		

METER BOX DATA SHEET PAGE # 2

Page: 2 of 3

UNIT: F400 RUN: 1 DATE: 4-7-00

Meter Box: SH Y Factor: .989

Leak checks: 15 " Hg @ .020 cfm ____ " Hg @ ____ cfm

15 " Hg @ .011 cfm ____ " Hg @ ____ cfm

Inject SO^2 @ 100 cc/min. Nozzle : Probe @ 3/8 " od Initial Volume: 1.500

ROTO: PRESS: .14			SAMPLING RATIO: 26 : 1				BP: 30.20		
MIN	TIME	METER READING	SAMPLE MDCF	STACK DSCFM	DELTA H	METER TEMP	SO2 PPM	ROTO TEMP	PUMP VACC
120	1435	201.719	201.719	7.261	.13	86	475	86	2.0
125	40	203.192	203.192	7.261	.13	86	475	86	2.0
130	45	204.664	204.664	7.261	.13	86	475	86	2.0
135	50	206.137	206.137	7.261	.13	86	475	86	2.0
140	55	207.609	207.609	7.261	.13	86	475	86	2.0
145	1500	209.082	209.082	7.664	.14	86	450	86	2.0
150	05	210.636	210.636	6.569	.10	86	525	86	2.0
155	10	211.968	211.968	6.898	.11	86	500	86	2.0
160	15	213.367	213.367	6.898	.11	86	500	86	2.0
165	20	214.767	214.767	6.898	.11	86	500	86	2.0
170	25	216.166	216.166	6.898	.11	86	500	86	2.0
175	30	217.565	217.565	6.885	.11	87	500	87	2.0
ROTO PRESS: .14			TOTALS:	85.015	1.44	1033	BP.: 30.20		
180	1535	218.969	218.969	6.545	.10	88	525	88	2.0
185	40	220.311	220.311	6.545	.10	88	525	88	2.0
190	45	221.653	221.653	6.533	.10	89	525	89	2.0
195	50	223.000	223.000	6.533	.10	89	525	89	2.0
200	55	224.348	224.348	6.236	.09	89	550	89	1.0
205	1600	225.634	225.634	6.236	.09	89	550	89	1.0
210	05	226.920	226.920	6.236	.09	89	550	89	1.0
215	10	228.206	228.206	6.225	.09	90	550	90	1.0
220	15	229.496	229.496	5.954	.09	90	575	90	1.0
225	20	230.731	230.731	6.225	.09	90	550	90	1.0
230	25	232.021	232.021	5.954	.09	90	575	90	1.0
235	30	233.256	233.256	5.954	.09	90	575	90	1.0
			TOTALS:	75.176	1.12	1071	MAX VACC =		
TOTAL Cu Ft.			TOTALS:	160.191	2.56	2104	AVG. BP:		

METER BOX DATA SHEET PAGE # 2

Page: 3 of 3

UNIT: F400 RUN: 1 DATE: 4-7-00

Meter Box: 5H Y Factor: .989

Leak checks: 15 " Hg @ .020 cfm ✓ " Hg @ ✓ cfm

15 " Hg @ .011 cfm ✓ " Hg @ ✓ cfm

Inject SO^2 @ 100 cc/min. Nozzle: Probe @ 3/8 " od Initial Volume: 1.500

ROTO: PRESS: .14			SAMPLING RATIO: 24 : 1				BP: 30.20		
MIN	TIME	METER READING	SAMPLE MDCF	STACK DSCFM	DELTA H	METER TEMP	SO2 PPM	ROTO TEMP	PUMP VACC
240	1635	234.491	234.491	5.954	.09	90	575	90	1.0
245	40	235.725	235.725	5.954	.09	90	575	90	1.0
250	45	236.960	236.960	5.954	.09	90	575	90	1.0
255	50	238.194	238.194	5.954	.09	90	575	90	1.0
260	55	239.429	239.429	5.943	.08	91	575	91	1.0
265	1700	240.668	240.668	5.943	.08	91	575	91	1.0
270	05	241.907	241.907	5.943	.08	91	575	91	1.0
275	10	243.146	243.146	5.943	.08	91	575	91	1.0
280	15	244.385	244.385	5.696	.08	91	600	91	1.0
285	20	245.573	245.573	5.696	.08	91	600	91	1.0
290	25	246.760	246.760	5.696	.08	91	600	91	1.0
295	30	247.948	247.948	5.696	.08	91	600	91	1.0
ROTO PRESS: .14			TOTALS:	70.372	1.00	1088	BP.: 30.20		
300	1735	249.135	249.135	5.696	.08	91	600	91	1.0
305	40	250.323	250.323	5.468	.07	91	625	91	1.0
310	45	251.463	251.463	5.468	.07	91	625	91	1.0
315	50	252.603	252.603	5.468	.07	91	625	91	1.0
320									
325									
330									
335									
340									
345									
350									
355							÷64		
			TOTALS:	471.827	8.860	5550	MAX VACC =		3.0
TOTAL Cu Ft.		94.603	TOTALS:	7.372	.138	87	AVG. BP: 30.20		

547

PARTICULATE CATCH / MOISTURE DATA SHEET # 3

UNIT : F400 RUN : 1 DATE : 4-7-00

SCALE CHECK	LEVEL	ZEROED
INITIAL :	✓	✓
FINAL :	✓	✓

SCALE	WEIGHT
295.0 g	295.0
590.0 g	590.0
885.0 g	885.0

IMPINGER	#1	#2	#3	#4
FINAL WT	703.7	600.1	516.1	888.7
INITIAL WT	593.7	593.7	513.9	869.2
NET WT GRAMS	110.0 ✓	6.4 ✓	2.2 ✓	19.5 ✓

TOTAL CATCH : 138.1 ✓ GRAMS H_2O

FRONT HALF

FILTER #	18F	
FINAL WT g	.8680 ✓	
INITIAL WT g	.6690 ✓	
NET WT g	.1990 ✓	

BEAKER #	51
DESC.	ACETONE
FINAL WT g	105.0507 ✓
INITIAL WT g	104.8756 ✓
NET WT g	.1751 ✓
VOL. DESC. m	125

BACK HALF

FILTER #	18B	
FINAL WT g	.5570 ✓	
INITIAL WT g	.4300 ✓	
NET WT g	.1270 ✓	

BEAKER #	52	53	54	55	
DESC.	ACETONE	METHCHLOR	H_2O	H_2O	
FINAL WT g	107.8619 ✓	105.8394 ✓	107.3909 ✓	93.5941 ✓	
INITIAL WT g	107.5006 ✓	105.7378 ✓	107.3124 ✓	93.4958 ✓	
NET WT g	.3613 ✓	.1016 ✓	.0785 ✓	.0983 ✓	.1768 ✓
VOL. DESC ml	200	75	125	125	350

WOODSTOVE DATA SHEET #4-1
INITIAL FILTER WEIGHTS (TARE WEIGHTS)

Into Dessicator: Date 10-28-99 Time: 1725 By: [illegible]

Manufacturer: S+S Grade: #25 GLASS Front Size: 11CM Lot No.: ZB921

Back Size: 8.2CM Lot No.: ZB911

	DATE: 11-1	BY: [illegible]	DATE: 11-4	BY: [illegible]	DATE:	BY:
FILTER #	FIRST WEIGHT	TIME	SECOND WEIGHT	TIME	THIRD WEIGHT	TIME
11B	.4291	1911	.4291	1818	JOTUL #3CB R#4	
12B	.4316	1912	.4313	1819	JOTUL #3CBII R#1	
13B	.4299	1913	.4298	1820	JOTUL #3CBII R#2	
14B	.4306	1914	.4306	1821	JOTUL #3CBII R#3	
15B	.4313	1915	.4313	1822	JOTUL #3CBII R#4	
16B	.4319	1916	.4315	1822		
17B	.4278	1916	.4277	1823		
18B	.4302	1917	.4300	1824	JOTUL F400 R#1	
19B	.4288	1918	.4285	1825	JOTUL F400 R#2	
20B	.4340	1919	.4340	1826	JOTUL F400 R#3	
11F	.66610	1928	.6659	1835	JOTUL #3CB R#4	
12F	.6837	1929	.6833	1836	JOTUL #3CBII R#1	
13F	.6707	1930	.6704	1837	JOTUL #3CBII R#2	
14F	.6719	1931	.6722	1838	JOTUL #3CBII R#3	
15F	.6673	1932	.6674	1839	JOTUL #3CBII R#4	
16F	.6809	1933	.6806	1840		
17F	.6657	1934	.66654	1840		
18F	.6693	1935	.6690	1841	JOTUL F400 R#1	
19F	.6744	1935	.6745	1842	JOTUL F400 R#2	
20F	.66547	1936	.6655	1843	JOTUL F400 R#3	

Checked by: [signature] Date: 11-4-99 Time: 1905

BALANCE ROOM ENVIRONMENTAL CONDITIONS

DATE	TIME	BY	WB	DB	% RH
11-1	1815	[illegible]	5	73	46
11-4	1805	[illegible]	5	76	46

BEAKER TARE WEIGHTS DATA SHEET #4-2

Into Dessicator: Date : 1-18-2000 Time : 0700 By : DKW

	DATE: 1-21-00	BY: DKW	DATE: 1-23-00	BY:	DATE:	BY:
BEAKER #	FIRST WEIGHT	TIME	SECOND WEIGHT	TIME	THIRD WEIGHT	TIME
41	105.4903	2120	105.4906	1215		
42	104.6708	2121	104.6712	1217		
43	107.3607	2122	107.3609	1218	JOTUL #3CBII	
44	107.7970	2123	107.7966	1219	R#3	
45	94.9398	2124	94.9403	1220		
46	106.0518	2125	106.0513	1221		
47	107.0394	2126	107.0390	1222		
48	97.7533	2127	97.7534	1224	JOTUL #3CBII	
49	108.3605	2128	108.3602	1225	R#4	
50	96.5368	2129	96.5364	1226		
51	104.8760	2129	104.8756	1227		
52	107.5011	2130	107.5006	1228	JOTUL F400	
53	105.7382	2131	105.7378	1229	R#1	
54	107.3129	2132	107.3124	1229		
55	93.4956	2133	93.4958	1230		

BALANCE ROOM ENVIRONMENTAL CONDITIONS

DATE	TIME	BY	WB	DB	% RH
1-21	2115	DKW		74	41
1-23	1210	DKW		73	44

Checked by : KM

Date : 1-23-00

Time : 17:40

WOODSTOVE DATA SHEET # 4-3 : CONSTANT WEIGHTS

UNIT : F400 **RUN :** 1 **DATE :** 4-7-00

Beaker #	Date	Time	By	First Weight	Date	Time	By	Second Weight	Date	Time	By	Third Weight	Date	Time	By
51	4-8	0900	[illegible]	105.0511	4-9	1757	[illegible]	105.0507	4-10	1336	[illegible]	✓			
52	4-8	0900	[illegible]	107.8624	4-9	1758	[illegible]	107.8619	4-10	1337	[illegible]	✓			
53	4-8	2030	[illegible]	105.8397	4-10	1338	[illegible]	105.8389	4-10	1758	[illegible]	105.8394	4/11	1154	[illegible]
54	4-8	0900	[illegible]	107.3912	4-9	1759	[illegible]	107.3909	4-10	1339	[illegible]	✓			
55	4-8	0900	[illegible]	93.5941	4-9	1800	[illegible]	93.5941	4-10	1340	[illegible]	✓			

Filter #	Date	Time	By	First Weight	Date	Time	By	Second Weight	Date	Time	By	Third Weight	Date	Time	By
18F	4-7	1825	[illegible]	.8679	4-8	2053	[illegible]	.8680	4-9	1801	[illegible]	✓			
18B	4-7	1825	[illegible]	.5573	4-8	2054	[illegible]	.5570	4-9	1801	[illegible]	✓			

SCALE ROOM ENVIRONMENTAL CONDITIONS

Weighing Session	Date	Time	By	WB	DB	%RH
1	4-8	2050	[illegible]		78	48
2	4-9	1755	[illegible]		78	47
3	4-10	1335	[illegible]		78	49
4	4-10	1755	[illegible]		78	49

Weighing Session	Date	Time	By	WB	DB	%RH
5	4-11	1150	[illegible]		78	48
6						
7						
8						

BLANK PROCESSING DATA SHEET # 5

UNIT : F400 RUN : 1 DATE : 4-7-2000

BLANKS DONE : 12-27-99

BEAKER	A	B	C
	200 ml ACETONE	75 ml DICHLOR	200 ml WATER
	FISHER OPTIMA LOT #	FISHER OPTIMA LOT #	
FINAL WEIGHT	108.9011	106.3073	106.9666
TARE WEIGHT	108.9003	106.3062	106.9651
NET WEIGHT	.0008	.0011	.0015

TARE BEAKERS INTO DESC : TIME : 11:30 DATE : 12-20-99

DATE : 12-22 BY : DFW DATE : 12-23 BY : DFW DATE : BY :

BEAKER	1 ST WT	TIME	2 ND WT	TIME	3 RD WT	TIME
A	108.8999	1940	108.9003	1948	✓	
B	106.3058	1941	106.3062	1949	✓	
C	106.9647	1942	106.9651	1950	✓	

FINAL BEAKERS INTO DESC : TIME : 1330 DATE : 12-24-99

DATE : 12-24 BY : DFW DATE : 12-25 BY : DFW DATE : 12-27 BY : DFW

BEAKER	1 ST WT	TIME	2 ND WT	TIME	3 RD WT	TIME
A	108.8999	2021	108.9016	1816	108.9011	1224 ✓
B	106.3061	2022	106.3077	1817	106.3073	1225 ✓
C	106.9643	2023	106.9670	1818	106.9666	1226 ✓

TARE QC

DATE	TIME	BY	WB	DB	%
12-22	1935	DFW		77	47
12-23	1945	DFW		75	48

FINAL QC

DATE	TIME	BY	WB	DB	%
1224	1945	DFW		76	45
12-25	1740	DFW		75	38
12-27	1210	DFW		76	46

NET PARTICULATE CATCH CALCULATION DATA SHEET #6

UNIT : F400 RUN : 1 DATE : 4-7-2000

BLANK CALCULATIONS

Acetone : .0008 g ÷ 200 ml = .000004 g/ml
Dicholoromethane : .0011 g ÷ 75 ml = .000015 g/ml
Distilled Water : .0015 g ÷ 200 ml = .000008 g/ml

FRONT HALF CATCH

FILTERS : .1990 (Total Catch) g - 1 (# of Filters) (.0000 g) (Blank Value / Filter) = .1990 g

BEAKERS : .1751 (Total Catch) g - 125 (ml Acetone) (.0005 .000004 g) (Blank Value / ml Acetone) = .1746 g

TOTAL FRONT HALF CATCH : .3736 g

BACK HALF CATCH

FILTERS : .1270 (Total Catch) g - 1 (# of Filters) (.0000 g) (Blank Value / Filter) = .1270 g

BEAKERS :

Acetone : .3613 (Total Catch) g - 200 (ml Acetone) (.0008 .000004 g) (Blank Value / ml Acetone) = .3605 g

Extract : .1016 (Total Catch) g - 75 (ml Dichloromethane) (.0011 .000015 g) (Blank Value / Dichloromethane) = .1005 g

Water : .1768 (Total Catch) g - 350 (ml Water) (.0028 .000008 g) (Blank Value / Water) = .1740 g

TOTAL BACK HALF CATCH : .7620 g

TOTAL CATCH : 1.1356 g

% FRONT HALF : 32.90 %

CALCULATIONS DATA SHEET # 7

UNIT : F400 RUN : 1 DATE : 4-7-2000

1) Vm (std) = $\dfrac{(94.603\ \text{Vm})(17.64)(.989\ \text{mcf})\left(30.20\ \text{" Hg} + \dfrac{.138\ \text{" } H_2O}{13.6}\right)}{(547\ \text{TmA})}$ = $\dfrac{91.1517}{000.0000}$ dscf

30.2101

2) Vw (std) = (.04707) (138.1 ml H_2O) = $\dfrac{6.5004}{00.0000}$ scf

3) Asw = $\dfrac{(6.5004\ \text{scf})}{(6.5004\ \text{scf} + 91.1517\ \text{dscf})}$ = $\dfrac{.0666}{.0000}$ Bws × 100 = $\dfrac{6.6567}{00.0000}$ % H_2O

97.6521

4) Cs = $\dfrac{(1.1356\ \text{g.})}{(91.1517\ \text{dscf})}$ (15.43) = $\dfrac{.1922}{0.0000}$ gr / dscf

5) Estimated g / hr = $\dfrac{(1.1356\ \text{g.})}{(91.1517\ \text{dscf})}$ ($\dfrac{7.372}{00.0000}$ dscfm) (60) = $\dfrac{5.5106}{00.0000}$ g / hr

Vm =	total cubic feet pulled on meter box during test	(p. 2)	(000.000 Vm)
mcf =	meter correction factor (Y factor) of meter box used for test	(p. 2)	(0.000 mcf)
" Hg =	average barometric pressure during test	(p. 2)	(00.00 " Hg)
" H_2O =	average delta H for test	(p. 2)	(.000 " H_2O)
TmA =	average meter temperature for test in degrees Absolute	(p. 2)	(000 TmA)
ml H_2O =	total water caught during test	(p. 3)	(000.0 ml H_2O)
g. =	total particulate catch for test	(p. 6)	(00.0000 g.)
dscfm =	average stack flow during test	(p. 2)	(00.000 dscf)

TEST DATA SHEET # 8

UNIT : F400 RUN : 1 DATE : 4-7-00

Test Chamber Air Velocity Start : Ø Stop : Ø Avg.: Ø

Wet Bulb / Dry Bulb

Pre : WB : 60 DB : 76 = 38 % RH 1.2 % H_2O

Post : WB : 64 DB : 81 = 38 % RH 1.4 % H_2O

Average : 38 %RH 1.3 % H_2O

Empty Stove Weight (lbs) : ✓ w/ stack & oil seal : Wet : ✓ Dry : 390.0

Kindling Weight (lbs) : Paper : .2 Wood : 3.0

Preburn Fuel Weight : 11.0 + 13.5 + 13.8 + 2.8 Total : 41.1

Kindling & Preburn Fuel Weight (wood only) (lbs) : Total : 44.1

Coal Bed Wt Range (lbs) : 3.3 - 2.7 Scale : 393.3 - 392.7

Upper : .25 x fuel weight : Always round DOWN to nearest tenth

Lower : .20 x fuel weight : Always round UP to nearest tenth Actual Coal Bed Weight : 3.1

Maximum Coal Bed Removal (lbs) : ((3.3 (Upper) + 2.7 (Lower)) ÷ 2) .25 = .7

Test Fuel (.75" x 1.5" x 5" spacers) = 20 pcs

Dimensions	Length in inches	No. Pcs	Weight in lbs	% of Load
2" x 4"	13	3	5.2	39.4
4" x 4"	13	2	8.0	60.6

Test Fuel Weight : 13.2 lbs

Estimated Dry Burn Rate : 2.371

$$\frac{13.2 - (13.2 \times .17961)}{2.2046} \times \frac{60}{\frac{315}{\text{TIME}}} = .936 \text{ kg / hr}$$

Estimated BTU's/hr : 19,140 x $\frac{63}{100}$ x $\frac{.936}{\text{DBR}}$ = 1128648 BTU's/hr

EPA Default Efficiencies : Non-cat : 63 Cat : 72 Pellet : 78

295 = .99

WOOD STOVE OPERATING DATA PAGE #9

Unit : F-400 Run : 1 Date : 4-7-00

FIRE STARTED: 0815

WARM UP AND PREBURN:

PRIMARY AIR : Set wide open for all warm-up / preburn fuel charges. Then set to 1/16" at start of preburn.

SECONDARY AIR : N/A CAT BYPASS : N/A

CHARCOAL BED PREPARATION :

Raked and leveled prior to each warm-up / preburn charge. At 1 1/2 min. prior to loading last fuel, raked and leveled. In stove 40 sec.

TEST:

DOOR wide open during loading 1 min. 0 sec.

PRIMARY AIR : Opened full for first 5 min., then set to run setting of 1/16".

SECONDARY AIR : N/A CAT BYPASS : N/A

FAN:

ON / ~~OFF~~ during warm-up

ON / ~~OFF~~ during preburn

ON / ~~OFF~~ first _____ minutes of test

ON / ~~OFF~~ balance of test run

Fan speed set at N/A

WOOD DATA: KINDLING: A mix of the grades listed below:

	SIZE	MILL	GRADE	SPECIES
PREBURN:	2x4	Manke/Tacoma	Std. or better	s. grn D fir
TEST:	2x4	Packwood	# 2 or better	s. grn D fir
	4x4	Packwood	# 2 or better	s. grn D fir

PELLET FUEL MANUFACTURER : N/A BRAND : N/A

All Grades WCLB rules:

WARM UP INFORMATION:

All pre-burn / warm up fuel pieces were either 16 or 12 inches.

1st warm up / pre-burn fuel charge (11.0 lbs.) added at 0825

2nd warm up / pre-burn fuel charge (13.5 lbs.) added at 0925

3rd warm up / pre-burn fuel charge (13.8 lbs.) added at 1020

4th warm up / pre-burn fuel charge (2.8 lbs.) added at 1130

5th warm up / pre-burn fuel charge (_____ lbs.) added at _____

TEST DATA SHEET #10

Unit : F400 Run : 1 Date : 4-7-00

Room Temperature : 70 °F Correction Factor : 0

Uncorrected Values are corrected for room temperature : Yes _____ No ✓

Time Test Fuel moisture reading taken : 1110

Calibration Checks : X ✓ Y ✓ 12.0 12.1 22.0 22.1

pc #	Dimen.	Use	TOP		BOTTOM		SIDE		Avg Corrected
			Uncor	Cor.	Uncor.	Cor.	Uncor.	Cor.	
1	2"×4"×8'	K	16.0	17.0	14.5	15.5	15.0	16.0	16.167
2									
3									
4	2"×4"×8'	P	17.5	18.7	18.0	19.2	18.0	19.2	19.033
5	2"×4"×8'	P	17.5	18.7	18.0	19.2	18.0	19.2	19.033
6	2"×4"×8'	P	18.0	19.2	18.5	19.8	19.0	20.3	19.767
7	2"×4"×8'	P							57.833
8	2"×4"×8'	P							
9									
10									
11									
12	2×4×13	T	17.5	18.7	18.0	19.2	18.0	19.2	19.033
13	"	T	21.0	22.5	21.5	23.1	21.0	22.5	22.700
14	"	T	23.5	25.2	23.0	24.7	23.5	25.2	25.033
15	4×4×13	T	17.5	18.7	17.5	18.7	18.0	19.2	18.867
16	"	T	22.0	23.7	22.5	24.1	22.0	23.7	23.833
17									109.466
18									
19									
20	Spacers	T	22.0	23.7	23.0	24.7	23.0	24.7	

Key for Use : K = Kindling P = Pretest Fuel T = Test Fuel

	KINDLING	PRETEST FUEL	TEST FUEL
Dry Moisture % :	16.167 %	19.278 %	21.893 %
Wet Moisture % :	13.917 %	16.162 %	17.961 %

To obtain Wet from Dry : $\frac{100 \times \%\ \text{Dry Reading}}{100 + \%\text{Dry Reading}}$ = % Moisture, Wet Basis

Acceptable Ranges : 16 - 20 % wet: 19 - 25 % dry (17.5 - 22.5 on Meter Uncor. reading) at 70°

WEIGHT: 39?.1

UNIT: F400

GAS DATA SHEET # 12

RUN: 1 DATE: 4-7-00 PAGE: 1 of 3

TIME	SCALE	FUEL	DROP	V.	CO_2	V.	O_2	V.	CO	BAL	WB	DB	% H_2O	CAL WB	STACK	STATIC	SO_2 PPM
0 1235	406.3	13.2	—	.223	5.6	—	—	.124	1.24	4.5	—	—	—	—	313	-.040	450
5 40	406.0	12.9	.3	.155	3.8			.109	1.09	3.5					379	-.040	425
10 45	405.7	12.6	.3	.079	1.9			.049	.49	3.9					268	.036	425
15 50	405.5	12.4	.2	.082	2.0			.051	.51	3.9					234	.034	450
20 55	405.4	12.3	.1	.089	2.2			.057	.57	3.8					226	.031	475
25 1300	405.2	12.1	.2	.096	2.4			.064	.64	3.7					216	.030	500
30 05	405.0	11.9	.2	.108	2.7			.072	.72	3.7					207	.029	525
35 10	404.7	11.6	.3	.122	3.0			.073	.73	4.1					204	.030	500
40 15	404.5	11.4	.2	.140	3.5			.087	.87	4.0					203	.030	500
45 20	403.7	10.6	.8	.498	12.5			.019	.19	64.2					452	.054	325
50 25	403.0	9.9	.7	.478	12.0			.011	.11	104.9					468	.056	325
55 30	402.3	9.2	.7	.482	12.1			.011	.11	105.8					482	.058	325
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	3652	-.468	*****
60 1335	401.8	8.7	.5	.389	9.7			.017	.17	55.9					457	.055	325
65 40	401.2	8.1	.6	.441	11.0			.007	.07	149.0					464	.056	325
70 45	400.7	7.6	.5	.497	12.4			.004	.04	282.6					489	.057	325
75 50	400.0	6.9	.7	.518	13.0			.003	.03	381.2					503	.057	325
80 55	399.5	6.4	.5	.448	11.2			.006	.06	175.1					476	.055	325
85 1400	399.1	6.0	.4	.400	10.0			.006	.06	156.2					463	.054	325
90 05	398.7	5.6	.4	.378	9.4			.006	.06	147.6					449	.053	325
95 10	398.3	5.2	.4	.347	8.7			.013	.13	64.7					430	.051	325
100 15	398.0	4.9	.3	.339	8.5			.023	.23	36.2					419	.050	350
105 20	397.6	4.5	.4	.347	8.7			.053	.53	16.2					412	.050	400
110 25	397.3	4.2	.3	.335	8.4			.071	.71	11.7					406	.049	400
115 30	396.9	3.8	.4	.316	7.9			.084	.84	9.3					384	.048	425
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	5352	-.635	*****
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	9004	-1.103	*****

WEIGHT: 39;.1

UNIT: F400

GAS DATA SHEET # 12

RUN: 1 DATE: 4-7-2000 PAGE: 2 of 3

TIME	SCALE	FUEL	DROP	V.	CO_2	V.	O_2	V.	CO	BAL	WB	DB	% H_2O	CAL WB	STACK	STATIC	SO_2 PPM
120 1435	396.6	3.5	.3	.300	7.5	—	—	.106	1.06	7.0					358	-.046	475
125 40	396.3	3.2	.3	.297	7.4			.104	1.04	7.1					347	-.044	475
130 45	396.1	3.0	.2	.306	7.6			.102	1.02	7.5					337	-.043	475
135 50	395.8	2.7	.3	.314	7.8			.099	.99	7.9					335	-.043	475
140 55	395.6	2.5	.2	.302	7.5			.074	.74	10.1					336	-.042	475
145 1500	395.4	2.3	.2	.280	7.0			.089	.89	7.8					328	-.041	450
150 05	395.2	2.1	.2	.238	5.9			.134	1.34	4.4					303	-.039	525
155 10	395.2	2.1	0	.232	5.8			.139	1.39	4.1					287	-.036	500
160 15	395.1	2.0	.1	.233	5.8			.154	1.54	3.8					278	-.034	500
165 20	395.0	1.9	.1	.235	5.9			.148	1.48	3.9					270	-.033	500
170 25	394.9	1.8	.1	.236	5.9			.156	1.56	3.8					264	-.032	500
175 30	394.8	1.7	.1	.226	5.6			.161	1.61	3.5					260	-.031	500
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	3707	-.464	*****
180 1535	394.7	1.6	.1	.206	5.1			.216	2.16	2.4					252	-.030	525
185 40	394.6	1.5	.1	.202	5.0			.221	2.21	2.3					247	-.029	525
190 45	394.5	1.4	.1	.201	5.0			.221	2.21	2.3					244	-.029	525
195 50	394.5	1.4	0	.215	5.4			.197	1.97	2.7					243	-.028	525
200 55	394.4	1.3	.1	.209	5.2			.204	2.04	2.5					241	-.028	550
205 1600	394.4	1.3	0	.207	5.2			.211	2.11	2.4					238	-.027	550
210 05	394.3	1.2	.1	.201	5.0			.226	2.26	2.2					237	-.027	550
215 10	394.3	1.2	0	.196	4.9			.224	2.24	2.2					235	-.027	550
220 15	394.2	1.1	.1	.197	4.9			.224	2.24	2.2					233	-.027	575
225 20	394.1	1.0	.1	.215	5.4			.128	1.28	4.2					229	-.026	550
230 25	394.0	.9	.1	.214	5.3			.129	1.29	4.1					228	-.026	575
235 30	394.0	.9	0	.213	5.3			.131	1.31	4.0					227	-.026	575
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	2854	.330	*****
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	6561	.794	*****

WEIGHT : 392.1

GAS DATA SHEET # 12

UNIT : F400 RUN : 1 DATE : 4-7-00 PAGE : 3 of 3

TIME	SCALE	FUEL	DROP	V.	CO_2	V.	O_2	V.	CO	BAL	WB	DB	% H_2O	CAL WB	STACK	STATIC	SO_2 PPM
240 1635	393.9	.8	.1	.212	5.3	—	—	.135	1.35	3.9					226	-.027	575
245 40	393.9	.8	0	.209	5.2			.152	1.52	3.4					227	-.026	575
250 45	393.8	.7	.1	.206	5.1			.153	1.53	3.3					225	-.026	575
255 50	393.8	.7	0	.221	5.5			.133	1.33	4.1					224	-.026	575
260 55	393.7	.6	.1	.225	5.6			.153	1.53	3.7					224	-.026	575
265 1700	393.6	.5	.1	.219	5.5			.167	1.67	3.3					224	-.026	575
270 05	393.6	.5	0	.214	5.3			.168	1.68	3.2					223	-.026	575
275 10	393.6	.5	0	.208	5.2			.180	1.80	2.9					223	-.026	575
280 15	393.5	.4	.1	.207	5.2			.186	1.86	2.8					223	-.025	600
285 20	393.4	.3	.1	.196	4.9			.195	1.95	2.5					221	-.025	600
290 25	393.3	.2	.1	.181	4.5			.205	2.05	2.2					219	-.026	600
295 30	393.3	.2	0	.177	4.4			.206	2.06	2.1					217	-.026	600
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	2676	-.311	*****
300 1735	393.2	.1	.1	.153	3.8			.181	1.81	2.1					213	-.025	600
305 40	393.2	.1	0	.154	3.8			.190	1.90	2.0					208	-.025	625
310 45	393.2	.1	0	.156	3.9			.193	1.93	2.0					206	-.024	625
315 50	393.1	0	.1	.164	4.1			.202	2.02	2.0					204	-.024	625
																	÷64
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	19072	-2.306	*****
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	298	-.036	*****

PREBURN DATA SHEET #13

UNIT: F400 RUN: 1 DATE: 4-7-00 PAGE: 1 of 1

TIME	SCALE	DROP	STACK	TOP	LF SIDE	BACK	RT SIDE	BOTTOM	FIREBOX	SEC/CAT	AMBIENT	STATIC	COMMENTS
0 / 1130	395.6	—	455	520	476	378	440	275	991	1226	82	.035	PREBURN START: # — UP
5 / 35	395.3	.3	393	509	451	385	429	284	826	1139	83	.048	COAL BED SCALE RANGE:
10 / 40	395.1	.2	377	494	437	385	419	287	793	1114	82	.046	393.3 - 392.7
15 / 45	394.9	.2	358	468	416	383	401	288	752	1058	81	.045	PRIMARY AIR: 1/16"
20 / 50	394.8	.1	348	448	398	377	388	288	735	1046	80	.044	SECONDARY AIR: N/A
25 / 55	394.6	.2	343	432	376	365	370	284	702	1097	78	.043	FAN: N/A
30 / 1200	394.4	.2	339	429	366	358	362	280	685	1093	78	.043	PUMPS ON AT: 1200
35 / 05	394.2	.2	343	430	356	348	355	275	672	1172	76	.043	CHECK WB/DB: N/A
40 / 10	394.0	.2	351	441	346	335	347	267	661	1199	76	.044	
45 / 15	393.8	.2	344	442	345	330	344	263	658	1073	76	.043	
50 / 20	393.6	.2	358	434	340	324	340	259	665	1051	76	.044	
55 / 25	393.4	.2	348	428	339	318	336	254	688	989	75	.044	
*****	****	***	****	*****	*****	****	*****	*****	*****	*****	*****	****	
60 / 1230	393.2	.2	334	413	339	313	333	250	677	892	75	.042	
65 / 35	393.1	.1	313	389	334	310	328	247	708	746	75	.040	321.6
70 / 40													
75 / 45													
80 / 50													
/													
/													
/													
/													
/													
/													
/													

TEMPERATURE DATA SHEET # 14

UNIT: F400 RUN: 1 DATE: 4-7-00 PAGE 1 of 3

TIME	TOP	LT SIDE	BACK	RT SIDE	BOTTOM	FIREBOX	SEC/CAT	AMBIENT	FURNACE	SAMPLE	SAMP IMP	C-GAS	GAS IMP	SO_2 IMP	321.6
0 1235	389	334	310	328	247	708	746	75	1340	252	52	251	36	39	
5 40	343	324	304	318	245	699	545	74	1352	253	49	254	36	38	
10 45	316	311	302	305	243	581	428	74	1357	254	49	254	35	37	
15 50	275	287	292	279	236	470	391	72	1363	252	50	249	35	38	
20 55	262	276	286	268	232	456	391	72	1365	250	50	248	37	37	
25 1300	246	265	277	255	229	451	391	71	1363	248	49	245	35	37	
30 05	232	250	265	239	222	459	378	69	1360	247	49	241	36	37	
35 10	222	239	254	227	217	479	396	68	1355	242	49	238	36	37	
40 15	213	227	244	219	213	478	459	67	1351	240	49	235	37	36	
45 20	453	222	234	211	207	463	1160	67	1343	237	48	236	35	36	
50 25	538	221	229	210	204	481	1199	67	1342	236	47	237	36	35	
55 30	594	231	224	216	201	505	1222	68	1343	235	46	235	37	36	
TOTAL	4083	3187	3221	3075	2696	6230	7726	844	*****	*****	*****	*****	*****	*****	
60 1335	581	241	222	224	200	514	1218	70	1346	234	46	235	37	36	
65 40	585	251	222	232	200	539	1269	71	1351	238	47	237	37	36	
70 45	621	263	224	242	198	583	1361	73	1354	238	47	238	37	35	
75 50	649	275	225	253	197	614	1400	73	1351	241	47	239	37	35	
80 55	630	288	228	265	195	635	1304	73	1349	245	48	242	37	35	
85 1400	616	300	232	276	194	649	1249	73	1349	247	48	244	37	35	
90 05	583	306	234	284	194	663	1195	74	1350	249	49	247	37	36	
95 10	547	312	238	290	195	691	1151	74	1352	252	49	250	38	37	
100 15	527	314	243	294	195	701	1166	75	1352	252	50	251	38	35	
105 20	518	315	248	298	197	698	1069	74	1352	253	50	253	38	36	
110 25	514	315	251	300	198	716	1087	73	1347	252	52	252	37	36	
115 30	503	314	257	303	200	728	1061	74	1342	251	52	249	37	35	
TOTAL	6874	3494	2824	3261	2363	7731	14500	877	*****	*****	*****	*****	*****	*****	
TOTAL	10957	6681	6045	6336	5059	13961	22226	1721	*****	*****	*****	*****	*****	*****	

TEMPERATURE DATA SHEET # 14

UNIT : F400 RUN : 1 DATE : 4-7-00 PAGE 2 of 3

TIME	TOP	LT SIDE	BACK	RT SIDE	BOTTOM	FIREBOX	SEC/CAT	AMBIENT	FURNACE	SAMPLE	SAMP IMP	C-GAS	GAS IMP	SO_2 IMP	321.6
120/1435	473	313	266	303	203	734	1033	75	1339	252	51	249	37	35	
125/40	450	311	274	305	206	737	1037	74	1337	249	53	249	38	36	
130/45	441	309	282	305	209	728	1049	74	1337	249	53	250	38	37	
135/50	438	308	291	304	211	723	1060	75	1337	248	54	249	36	36	
140/55	441	307	300	304	213	716	1076	76	1337	247	54	248	35	34	
145/1500	436	305	309	304	215	727	988	75	1338	247	54	248	36	35	
150/05	411	302	315	303	217	722	848	74	1337	246	54	247	34	35	
155/10	381	303	320	302	219	729	790	76	1338	246	55	247	35	36	
160/15	363	303	323	302	221	742	768	76	1337	246	55	246	37	36	
165/20	349	299	325	301	223	734	765	76	1337	246	55	246	36	38	
170/25	338	296	326	300	224	731	745	76	1337	247	55	247	34	36	
175/30	328	294	325	298	225	727	732	77	1337	247	56	246	35	37	
TOTAL	4849	3650	3656	3631	2586	8750	10891	904	*****	*****	*****	*****	*****	*****	
180/1535	320	292	325	297	225	726	689	76	1335	247	56	247	35	36	
185/40	310	287	324	295	226	729	686	76	1334	248	58	247	36	37	
190/45	304	287	324	294	226	728	681	76	1333	247	58	247	35	37	
195/50	301	283	324	292	225	713	665	76	1331	247	58	247	36	37	
200/55	296	281	320	288	224	708	657	77	1330	248	58	248	37	34	
205/1600	291	281	317	285	223	702	650	77	1328	248	58	248	36	34	
210/15	292	277	316	284	223	685	645	77	1327	248	58	248	36	35	
215/10	288	277	313	281	223	672	640	78	1327	249	58	248	36	35	
220/15	285	275	311	279	221	673	637	77	1326	249	58	248	36	36	
225/20	280	273	308	277	220	685	617	77	1326	248	58	249	37	36	
230/25	278	270	307	276	219	674	612	78	1326	248	58	247	36	37	
235/30	274	267	304	273	217	657	618	78	1325	247	58	245	37	37	
TOTAL	3519	3350	3790	3421	2672	8352	7797	923	*****	*****	*****	*****	*****	*****	
TOTAL	8368	7000	7446	7052	5258	17102	18688	1827	*****	*****	*****	*****	*****	*****	

TEMPERATURE DATA SHEET # 14

UNIT: F400 RUN: 1 DATE: 4-7-00 PAGE 3 of 3

TIME	TOP	LT SIDE	BACK	RT SIDE	BOTTOM	FIREBOX	SEC/CAT	AMBIENT	FURNACE	SAMPLE	SAMP IMP	C-GAS	GAS IMP	SO_2 IMP	321.6
240 1635	273	264	303	272	217	649	620	77	1324	248	58	244	37	37	
245 40	272	263	300	269	217	642	610	77	1324	247	58	244	36	35	
250 45	270	262	299	268	216	637	609	78	1323	247	58	243	36	36	
255 50	270	260	298	267	215	644	637	77	1328	247	58	243	37	35	
260 55	270	259	298	265	215	667	635	77	1330	247	59	243	37	35	
265 1700	272	258	296	264	215	672	636	77	1332	247	59	243	37	36	
270 05	273	257	296	264	215	674	633	78	1333	246	59	243	37	36	
275 10	271	257	295	264	215	679	624	78	1332	246	59	242	37	37	
280 15	271	257	294	264	216	671	630	78	1332	246	60	243	37	36	
285 20	270	256	292	264	216	664	608	77	1333	247	60	244	38	36	
290 25	269	256	290	263	216	650	583	78	1334	246	60	242	36	35	
295 30	266	255	289	261	216	641	573	78	1334	246	60	241	37	36	
TOTAL	3247	3104	3550	3185	2589	7890	7398	930	*****	*****	*****	*****	*****	*****	
300 1735	261	252	286	259	215	573	559	77	1334	246	60	241	35	36	
305 40	255	250	283	256	215	594	544	77	1333	245	59	240	34	35	
310 45	252	247	281	254	215	579	538	77	1333	245	59	240	34	35	
315 50	249	243	277	250	215	599	536	77	1333	245	59	239	34	35	
							321.6								
							246.8								
							-74.8	ΔT							
									÷64						
TOTAL	23589	17777	18168	17592	13766	41278	50489	4786	*****	*****	*****	*****	*****	*****	
TOTAL	369	278	284	275	215	645	789	75	*****	*****	*****	*****	*****	*****	

ZERO / SPAN CHECK DATA SHEET #15-1

Date: 4-7-00 Analyte: CO_2 (15-1)

Source: F400 Run #: 1

Zero Cyl. #: TX 79373 Conc.: 0.00 % CO_2 Cyl. Press.: 960 PSI

Certified by: AIR LIQUIDE Date: 9-22-1998

Span Cyl. #: CC52330 Conc.: 12.79 % CO_2 Cyl. Press.: 1750 PSI

Certified by: AIR LIQUIDE Date: 2-10-2000

Analyzer: Make: HORIBA Model: PIR-2000 SN: 407069

Range: 0 - 25.0 % CO_2 Analyzer Output: 0 - 1.0 v.

Flow: 1.5 SCFH Measured by: Rotameter

EPA Span Value = 25.0 % CO_2

EPA Control Limits = ± 2.5% of 25.0 % CO_2 = ± 0.625 % CO_2

Method 28 A = ± .2 % of 25.0 % CO_2 = ± .05 % CO_2

PRE RUN Audit: by: D. Wadington Time: 1115 Temp: 85 °F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %	
	Meter	DVM	%	Meter	DVM	%			
ZERO	00.0	.000	00.0	00.0	-.002	-.098	-.098 ✓	-.393	✓
SPAN	51.2	.512	12.79	51.0	.510	12.761	-.029 ✓	-.115	✓

POST RUN Audit: by: D. Wadington Time: 1805 Temp: 79 °F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %	
	Meter	DVM	%	Meter	DVM	%			
ZERO	00.0	.000	00.0	00.3	.003	.027	.027 ✓	.109	✓
SPAN	51.2	.512	12.79	51.0	.510	12.761	-.029 ✓	-.115	✓

± Conc. Difference = Act % - Exp (Std) %

Zero % Difference = $\frac{\text{Act \% (ppm) - Exp \% (ppm)}}{\text{Full Scale Value}}$ X 100

Span % Difference = $\frac{\text{Act \% (ppm) - Exp \% (ppm)}}{\text{Full Scale Value}}$ X100

ZERO / SPAN CHECK DATA SHEET #15-2

Date : 4-7-00 Analyte : O_2 (15-2)

Source : F400 Run # : 1

Zero Cyl. # : TX79373 Conc. : 0.00 % O_2 Cyl. Press. : 960 PSI

Certified by : AIR LIQUIDE Date : 9-22-1998

Span Cyl. # : CC52330 Conc. : 12.69 % O_2 Cyl. Press. : 1750 PSI

Certified by : AIR LIQUIDE Date : 2-10-2000

Analyzer : Make : TELEDYNE Model : 320 A SN : 37400

Range : 0 - 25.0 % O_2 Analyzer Output : 0 - 1.0 v.

Flow : 1.5 SCFH Measured by : Rotameter

EPA Span Value = 25.0 % O_2

EPA Control Limits = ± 2.5% of 25.0 % O_2 = ± 0.625 % O_2

Method 28 A = ± .2 % of 25.0 % O_2 = ± .05 % O_2

PRE RUN Audit : by : D. Whaley Time : 1115 Temp : 85 ° F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.0	.001	.050	.050	.200
SPAN	12.7	.508	12.69	12.7	.510	12.737	.047	.187

POST RUN Audit : by : D. Whaley Time : 1805 Temp : 79 ° F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.0	.002	.075	.075	.291
SPAN	12.7	.508	12.69	12.7	.509	12.712	.022	.088

± Conc. Difference = Act % - Exp (Std) %

Zero % Difference = $\frac{\text{Act \% (ppm) - Exp \% (ppm)}}{\text{Full Scale Value}}$ X 100

Span % Difference = $\frac{\text{Act \% (ppm) - Exp \% (ppm)}}{\text{Full Scale Value}}$ X100

ZERO / SPAN CHECK DATA SHEET #15-3

Date : 4-7-00 Analyte : CO (15-3)

Source : F400 Run # : 1

Zero Cyl. # : TX79373 Conc. : 0.00 % CO Cyl. Press. : 960 PSI

Certified by : AIR LIQUIDE Date : 9-22-1998

Span Cyl. # : CC52330 Conc. : 4.75 % CO Cyl. Press. : 1750 PSI

Certified by : AIR LIQUIDE Date : 2-10-2000

Analyzer : Make : HORIBA Model : PIR-2000 SN : 408005

Range : 0 - 10.0 % CO Analyzer Output : 0 - 1.0 v.

Flow : 1.5 SCFH Measured by : Rotameter

EPA Span Value = 10.0 % CO

EPA Control Limits = ± 2.5% of 10.0 % CO = ± 0. 25 % CO

Method 28 A = ± .2 % of 10.0 % CO = ± .02 % CO

PRE RUN Audit : by : D. Washington Time : 1115 Temp : 85 ° F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.0	.000	.004	.004 ✓	.042 ✓
SPAN	47.5	.475	4.75	47.5	.475	4.752 ✓	.002 ✓	.021 ✓

POST RUN Audit : by : D. Washington Time : 1805 Temp : 78 ° F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.0	.000	.004	.004 ✓	.042 ✓
SPAN	47.5	.475	4.75	47.5	.475	4.752 ✓	.002 ✓	.021 ✓

± Conc. Difference = Act % - Exp (Std) %

Zero % Difference = $\frac{\text{Act \% (ppm) - Exp \% (ppm)}}{\text{Full Scale Value}}$ X 100

Span % Difference = $\frac{\text{Act \% (ppm) - Exp \% (ppm)}}{\text{Full Scale Value}}$ X100

ZERO / SPAN CHECK DATA SHEET #15-4

Date : 4-7-00 Analyte : SO_2 (15-4)

Source : F400 Run # : 1

Zero Cyl. # : TX79373 Conc. : 0.00 ppm SO_2 Cyl. Press. : 960 PSI

Certified by : AIR LIQUIDE Date : 9-22-1998

Span Cyl. # : CC67475 Conc. : 1260 ppm SO_2 Cyl. Press. : 650 PSI

Certified by : AIR LIQUIDE Date : 9-22-1998

Analyzer : Make : HORIBA Model : PIR-2000 SN : 403019

Range : 0 - 2500 ppm SO_2 Analyzer Output : 0 - 1.0 v.

Flow : 1.5 SCFH Measured by : Rotameter

EPA Span Value = 2500 ppm SO_2

EPA Control Limits = ± 2.5% of 2500 ppm SO_2 = ± 62.5 ppm SO_2

PRE RUN Audit : by : A. Washington Time : 1110 Temp : 85 ° F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	PPM	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.1	.001	30.359	30.359	1.214
SPAN	50.4	.504	1260	50.0	.500	1250.200	-9.800	-.392

POST RUN Audit : by : A. Washington Time : 1810 Temp : 77 ° F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	PPM	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.4	.004	22.936	22.936	.917
SPAN	50.4	.504	1260	49.6	.496	1240.302	-19.698	-.788

± Conc. Difference = Act % - Exp (Std) %

Zero % Difference = $\frac{\text{Act \% (ppm) - Exp \% (ppm)}}{\text{Full Scale Value}} \times 100$

Span % Difference = $\frac{\text{Act \% (ppm) - Exp \% (ppm)}}{\text{Full Scale Value}} \times 100$

QUALITY CHECKS DATA SHEET # 16

UNIT : F400 RUN : 1 DATE : 4-7-00

Thermocouple Check :

T/C # 1	— °F	T/C # 13	62.8 °F
T/C # 2	— °F	T/C # 14	62.2 °F
T/C # 3	61.1 °F	T/C # 15	63.2 °F
T/C # 4	54.9 °F	T/C # 16	52.7 °F
T/C # 5	54.0 °F	T/C # 17	51.5 °F
T/C # 6	53.7 °F	T/C # 18	67.8 °F
T/C # 7	53.7 °F	T/C # 19	55.8 °F
T/C # 8	53.3 °F	T/C # 20	51.1 °F
T/C # 9	54.5 °F	T/C # 21	— °F
T/C # 10	54.8 °F	T/C # 22	— °F
T/C # 11	51.0 °F	T/C # 23	55.5 °F
T/C # 12	72.0 °F	T/C # 24	— °F

Thermocouple Readout :

Pretest zero and span check and calibration — post test zero and span — % difference

ZERO : -2.3 °F Adj. to 0.0 °F — ZERO 2.6 °F Difference .130 %

SPAN : 2001.3 °F Adj. to 2000.0 °F — SPAN 2004.8 °F Difference .240 %

Thermocouple Readout Pretest Linearity Check

0	= 0.0 °F	200	= 202.0 °F	400	= 399.3 °F
600	= 601.6 °F	800	= 801.7 °F	1000	= 1000.7 °F
1200	= 1198.3 °F	1400	= 1399.2 °F	1600	= 1599.8 °F
1800	= 1800.0 °F	2000	= 2000.0 °F		

Sample Train Leak Check	Pre ✓	Post ✓
C-gas Train Leak Check	Pre ✓	Post ✓
SO_2 Train Leak Check	Pre ✓	Post ✓
Static Gauge Zero Check	Pre X	Post ✓

Scale Check Pre : 404.4 - 394.4

Post : 403.1 - 393.1

Stack Cleaned Prior to Test Run : YES X NO _____

TABLE 1 ----- RAW DATA

CLIENT : Jotul TEST No. : 3

MODEL: F400 DATE: 11-Apr-00

TIME (MIN.)	METER READING (C F)	DELTA H (IN. H2O)	METER TEMP. (DEG. F)	PERCENT CO (%)	PERCENT CO2 (%)	SO2 COCENTR. PPM
0	307.500	0.150	81	1.03	5.10	400
5	309.000	0.260	81	0.34	2.50	300
10	311.036	0.110	83	0.61	2.00	450
15	312.405	0.100	83	0.61	1.80	475
20	313.702	0.100	83	0.71	1.90	475
25	314.998	0.110	83	0.80	3.50	450
30	316.367	0.220	83	0.64	12.90	325
35	318.261	0.260	83	0.55	9.90	300
40	320.312	0.370	83	0.11	13.00	250
45	322.773	0.370	84	0.07	12.00	250
50	325.242	0.300	86	0.06	13.80	275
55	327.504	0.300	87	0.05	13.70	275
60	329.775	0.300	87	0.03	13.70	275
65	332.046	0.300	87	0.03	14.10	275
70	334.316	0.300	87	0.07	11.60	275
75	336.587	0.210	87	0.47	9.00	325
80	338.509	0.190	87	0.63	8.30	350
85	340.294	0.160	87	0.60	8.00	375
90	341.960	0.190	87	0.60	7.80	350
95	343.745	0.190	87	0.56	7.60	350
100	345.530	0.190	86	0.59	7.40	350
105	347.308	0.190	86	0.65	7.30	350
110	349.087	0.190	86	0.55	7.60	350
115	350.865	0.190	86	0.69	6.90	350
120	352.644	0.160	86	0.71	6.70	375
125	354.305	0.160	86	0.86	6.30	375
130	355.966	0.140	86	1.29	5.70	400
135	357.524	0.140	86	1.42	5.50	400
140	359.081	0.140	86	1.49	5.30	400
145	360.639	0.140	86	1.52	5.50	400
150	362.197	0.140	86	1.66	5.20	400
155	363.754	0.140	86	1.76	5.00	400
160	365.312	0.140	86	1.76	4.90	400
165	366.869	0.130	86	1.41	5.50	425
170	368.335	0.100	86	1.46	5.30	475
175	369.647	0.100	88	1.53	5.30	475
180	370.969	0.090	90	1.27	5.30	500
185	372.233	0.070	90	1.38	5.00	575
190	373.333	0.060	90	1.23	4.70	600
195	374.387	0.050	91	1.17	4.90	650
200	375.364	0.050	91	1.17	4.90	650
205	376.340	0.050	91	1.28	4.70	650
210	377.317	0.050	91	1.31	4.70	675
215	378.257	0.050	91	1.51	4.70	675

220	379.198	0.050	91	1.61	4.40	700
225	380.105	0.050	91	1.69	4.20	700
230	381.011	0.050	91	1.84	4.10	700
235	381.918	0.040	91	1.82	3.90	725
240	382.794	0.040	91	1.80	4.10	725
245						

TABLE 2---RAW DATA

CLIENT : Jotul TEST No. 3

MODEL: F400 DATE: 11-Apr-00

****

METER CAL. FACTOR (Y)	0.989		Wt. WOOD BURNED(LB)	13.0	Lbs
BAROMETRIC PRESS.(Pb)	30.09	in Hg	WET,FUEL MOISTURE %	16.994	%
LEAK RATE POST (Lp)	0.002	cfm	Wt. PART. COLLECTED	0.5022	g
WATER VOL. (V1c)	121.3	Ml	METER VOLUME Vm	75.294	mcf
TEST TIME (MIN)	240	min	HC MOLE FRACTION	0.0132	

TABLE 3 -----FIELD DATA AVERAGES

CLIENT :Jotul TEST No. 3

MODEL: F400 DATE: 11-Apr-00

****

AVG DELTA H	-------	0.15 in H2O		AVG PRCNT CO	-------	0.96	%
AVG METER TEMP. Tm	-------	87 deg F		AVG PRCNT CO2	-------	6.68	%
AVG PPM SO2	-------	442	PPM	AVG BAL CO2/CO	-------	6.96	%

TABLE 4 ----- CALCULATIONS

CLIENT : Jotul TEST No. 3

MODEL: F400 DATE: 11-Apr-00

****

STD SAMPLE VOL. Vm(std) -----	72.35	dscf	STACK GAS FLOW Qsd -------	492.252	dscf/Hr & 8.20 dscf/min
VOL. WATER VAPOR Vw(std) ----	5.710	scf	PARTICULATE CONCTRT. Cs ------	0.0069	g/dscf
PRCNT MSTR Bws -------	7.31	%	PARTC.EMISS. RATE E -------	3.42	g/Hr
BURN RATE BR -------	1.22	Kg/Hr	MOLES OF GAS PER Lb WOOD Nt --	0.47	Lb-mole/Lb
CO EMISSION RATE -------	158.12 & 129.18	g/Hr g/Kgdry fuel	PART.EMISS. RATE ------	2.79	g/Kgdry fuel

TABLE 5 ----- PROPORTIONAL RATE VARIATION

CLIENT : Jotul TEST No. : 3

MODEL: F400 DATE: 11-Apr-00

TIME INTEVAL Ti	PPM * Vm	PROPRTN. RATE VAR. PR	PROPRTN RATE VAR. AVERAGE
5	582.7	97	100
10	592.3	99	
15	596.1	99	
20	596.1	99	
25	595.6	99	
30	596.1	99	
35	595.7	99	
40	595.6	99	
45	595.1	99	
50	595.4	99	
55	598.3	100	
60	600.1	100	
65	600.1	100	
70	599.9	100	
75	600.1	100	
80	600.1	100	
85	600.2	100	
90	600.1	100	
95	600.2	100	
100	600.7	100	
105	598.9	100	
110	599.3	100	
115	598.9	100	
120	599.3	100	
125	599.4	100	
130	599.4	100	
135	599.7	100	
140	599.3	100	
145	599.7	100	
150	599.7	100	
155	599.3	100	
160	599.7	100	
165	599.3	100	
170	599.6	100	
175	598.6	100	
180	600.9	100	
185	603.7	101	
190	604.1	101	
195	603.5	101	
200	605.4	101	
205	604.8	101	
210	605.4	101	
215	604.9	101	
220	605.6	101	

225	605.3	101
230	604.6	101
235	605.3	101
240	605.5	101
245		
250		

COMPUTER INPUT DATA SHEET #1

3,5723

Client: JOTUL U.S.A., INC.

Address: 400 RIVERSIDE STREET
PORTLAND ME. 04104

3,42 at 1,22 kg/hr

Phone: 207-797-5912 Fax: 207-772-0523

Run No.: 3 Date of Test: 4-11-2000 Burn Rate: 1.224

Model No.: F400 ☐ min ☒ min-1.25 ☐ fan

Stove Type: ☐ Cat ☒ Non Cat ☐ Pellet ☐ 1.25-1.9 ☐ max ☐ insert

Dry Gas Meter: Y Factor: .989 (0.000) (Data Sheet #2) Post Leak Rate: .002 cfm (.000) (Data Sheet #2) Time: 240 min. (000) (Data Sheet #2)

Dry Gas Meter Volume: 75.294 cf (00.000) (Data Sheet #2)

Stack Flow: 8.570 (8.2) dscfm (00.000) (Data Sheet #2) Δ H: .155 in. H_2O (.000) (Data Sheet #2)

Barometric Pressure: 30.09 in. Hg (00.00) (Data Sheet #2)

H_2O Captured: 121.3 g (00.0) (Data Sheet #3)

Total Particulate Catch: .5022 g (0.0000) (Data Sheet #6)

Flue Gas Moisture: 7.3204 % (00.000) (Data Sheet #7)

Particulate Emission: .1072 gr/dscf (0.0000) (Data Sheet #7)

Ambient Moisture: 1.25 % (0.00) (Data Sheet #8)

Stove Weight: — lbs (000) (Data Sheet #8)

Total Fuel Consumed During Burn: 13.0 lbs (00.0) (Data sheet #8)

Fuel Higher Heating Value (dry): — BTU/lb (0000) (Data Sheet #8)

Fuel % Moisture (dry): 20.473 % (wet): 16.994 % (00.00) (Data Sheet #10)

Stack Static Pressure: -.041 in. H_2O (0.000) (Data Sheet #12)

Temperature (Average Room) Combustion Air: 80 °F (00) Data Sheet #14)

Stove Temperature Change: -41.2 °F (00.0) (Data Sheet #14)

METER BOX DATA SHEET PAGE # 2

Page: 1 of 3

UNIT: F400 RUN: 3 DATE: 4-11-2000

Meter Box: 5H Y Factor: .989

Leak checks: 17 " Hg @ .001 cfm _____ " Hg @ _____ cfm

5H 15 " Hg @ .002 cfm _____ " Hg @ _____ cfm

Inject SO^2 @ 100 cc/min. Nozzle: Probe @ 3/8 " od Initial Volume: 1.500

ROTO: PRESS: .15			SAMPLING RATIO: 29			: 1	BP: 30.10		
MIN	TIME	METER READING	SAMPLE MDCF	STACK DSCFM	DELTA H	METER TEMP	SO2 PPM	ROTO TEMP	PUMP VACC
0	1400	307.500	—	8.673	.15	81	400	81	1.0
5	05	309.000	—	11.564	.26	81	300	81	2.0
10	10	311.036	311.036	7.681	.11	83	450	83	1.0
15	15	312.405	312.405	7.277	.10	83	475	83	1.0
20	20	313.702	313.702	7.277	.10	83	475	83	1.0
25	25	314.998	314.998	7.681	.11	83	450	83	1.0
30	30	316.367	316.367	10.635	.22	83	325	83	3.0
35	35	318.261	318.261	11.521	.26	83	300	83	3.0
40	40	320.312	320.312	13.826	.37	83	250	83	3.0
45	45	322.773	322.773	13.800	.37	84	250	84	3.0
50	50	325.242	325.242	18.500	.30	86	275	86	4.0
55	55	327.504	327.504	12.477	.30	87	275	87	4.0
ROTO PRESS: .14			TOTALS:	124.912	2.65	1000	BP.: 30.10		
60	1500	329.775	329.775	12.477	.30	87	275	87	4.0
65	05	332.046	332.046	12.477	.30	87	275	87	4.0
70	10	334.316	334.316	12.477	.30	87	275	87	4.0
75	15	336.587	336.587	10.557	.21	87	325	87	4.0
80	20	338.509	338.509	9.803	.19	87	350	87	3.0
85	25	340.294	340.294	9.149	.16	87	375	87	3.0
90	30	341.960	341.960	9.803	.19	87	350	87	3.0
95	35	343.745	343.745	9.803	.19	87	350	87	3.0
100	40	345.530	345.530	9.821	.19	86	350	86	3.0
105	45	347.308	347.308	9.821	.19	86	350	86	3.0
110	50	349.087	349.087	9.821	.19	86	350	86	3.0
115	55	350.865	350.865	9.821	.19	86	350	86	2.0
			TOTALS:	125.830	2.60	1040	MAX VACC =		
TOTAL Cu Ft.			TOTALS:	250.742	5.25	2040	AVG. BP:		

METER BOX DATA SHEET PAGE # 2

Page: 2 of 3

UNIT: F400 RUN: 3 DATE: 4-11-00

Meter Box: SH Y Factor: .989

Leak checks: 17 " Hg @ .001 cfm _____ " Hg @ _____ cfm

15 " Hg @ .002 cfm _____ " Hg @ _____ cfm

Inject SO^2 @ 100 cc/min. Nozzle : Probe @ 3/8 " od Initial Volume: 1.500

ROTO: PRESS: .14			SAMPLING RATIO: 29			: 1	BP: 30.08		
MIN	TIME	METER READING	SAMPLE MDCF	STACK DSCFM	DELTA H	METER TEMP	SO2 PPM	ROTO TEMP	PUMP VACC
120	1600	352.644	352.644	9.160	.16	86	375	86	2.0
125	05	354.305	354.305	9.160	.16	86	375	86	2.0
130	10	355.966	355.966	8.588	.14	86	400	86	2.0
135	15	357.524	357.524	8.588	.14	86	400	86	2.0
140	20	359.081	359.081	8.588	.14	86	400	86	2.0
145	25	360.639	360.639	8.588	.14	86	400	86	2.0
150	30	362.197	362.197	8.588	.14	86	400	86	2.0
155	35	363.754	363.754	8.588	.14	86	400	86	2.0
160	40	365.312	365.312	8.588	.14	86	400	86	2.0
165	45	366.869	366.869	8.082	.13	86	425	86	2.0
170	50	368.335	368.335	7.232	.10	86	475	86	2.0
175	55	369.647	369.647	7.205	.10	88	475	88	2.0
ROTO PRESS: .14			TOTALS:	100.955	1.63	1034	BP.: 30.08		
180	1700	370.969	370.969	6.820	.09	90	500	90	2.0
185	05	372.233	372.233	5.931	.07	90	575	90	2.0
190	10	373.333	373.333	5.683	.06	90	600	90	2.0
195	15	374.387	374.387	5.237	.05	91	650	91	2.0
200	20	375.364	375.364	5.237	.05	91	650	91	2.0
205	25	376.340	376.340	5.237	.05	91	650	91	2.0
210	30	377.317	377.317	5.043	.05	91	675	91	2.0
215	35	378.257	378.257	5.043	.05	91	675	91	2.0
220	40	379.198	379.198	4.863	.05	91	700	91	2.0
225	45	380.105	380.105	4.863	.05	91	700	91	2.0
230	50	381.011	381.011	4.863	.05	91	700	91	2.0
* 235	55	381.918	381.918	4.695	.04	91	725	91	2.0
			TOTALS:	63.515	.660	1089	MAX VACC =		
TOTAL Cu Ft.			TOTALS:	164.470	2.29	2123	AVG. BP: 30.09		

METER BOX DATA SHEET PAGE # 2

Page: 3 of 3

UNIT: F400 RUN: 3 DATE: 4-11-00

Meter Box: 5H Y Factor: .989

Leak checks: 17 " Hg @ .001 cfm _____ " Hg @ _____ cfm

15 " Hg @ .002 cfm _____ " Hg @ _____ cfm

Inject SO^2 @ 100 cc/min. Nozzle: Probe @ 3/8 " od Initial Volume: 1.500

ROTO: PRESS: .14 SAMPLING RATIO: 29 : 1 BP: 30.08

MIN	TIME	METER READING	SAMPLE MDCF	STACK DSCFM	DELTA H	METER TEMP	SO2 PPM	ROTO TEMP	PUMP VACC
240	1800	382.794	382.794	4.695	.04	91	725	91	20
245									
250									
255									
260									
265									
270									
275									
280									
285									
290									
295									
ROTO PRESS:			TOTALS:				BP.:		
300									
305									
310									
315									
320									
325									
330									
335									
340				.49					
345									
350									
355				419.907	7.58	4254			
			TOTALS:			87	MAX VACC =		4.0
TOTAL Cu Ft.		75.294	TOTALS:	8.570	.155	547	AVG. BP:		30.09

PARTICULATE CATCH / MOISTURE DATA SHEET # 3

UNIT : F400 RUN : 3 DATE : 4/1/00

SCALE CHECK	LEVEL	ZEROED
INITIAL :	✓	✓
FINAL :	✓	✓

SCALE	WEIGHT
295.0 g	295.0
590.0 g	590.0
885.0 g	885.0

IMPINGER	#1	#2	#3	#4
FINAL WT	685.4	601.0	516.2	882.8
INITIAL WT	589.8	593.6	513.6	867.1
NET WT GRAMS	95.6	7.4	2.6	15.7

TOTAL CATCH : 121.3 GRAMS H_2O

FRONT HALF

FILTER #	20F	
FINAL WT g	.7509	
INITIAL WT g	.6655	
NET WT g	.0854	

BEAKER #	61
DESC.	ACETONE
FINAL WT g	99.3877
INITIAL WT g	99.3467
NET WT g	.0410
VOL. DESC. m	100

BACK HALF

FILTER #	20B	
FINAL WT g	.4940	
INITIAL WT g	.4340	
NET WT g	.0600	

BEAKER #	62	63	64	65	
DESC.	ACETONE	METHCHLOR	H_2O	H_2O	
FINAL WT g	98.0370	93.2640	104.8304	98.5022	
INITIAL WT g	97.8657	93.2146	104.7866	98.4461	
NET WT g	.1713	.0494	.0438	.0561	.0999
VOL. DESC ml	175	75	150	175	(325)

WOODSTOVE DATA SHEET #4-1
INITIAL FILTER WEIGHTS (TARE WEIGHTS)

Into Dessicator: Date 10-28-99 Time: 1725 By: [illegible]

Manufacturer: S+S Grade: #25 GLASS Front Size: 11CM Lot No.: ZB921

Back Size: 8.2CM Lot No.: ZB911

	DATE: 11-1	BY: [illegible]	DATE: 11-4	BY: [illegible]	DATE:	BY:
FILTER #	FIRST WEIGHT	TIME	SECOND WEIGHT	TIME	THIRD WEIGHT	TIME
11B	.4291	1911	.4291	1818	JOTUL #3CB R#4	
12B	.4316	1912	.4313	1819	JOTUL #3CBII R#1	
13B	.4299	1913	.4298	1820	JOTUL #3CBII R#2	
14B	.4306	1914	.4306	1821	JOTUL #3CBII R#3	
15B	.4313	1915	.4313	1822	JOTUL #3CBII R#4	
16B	.4319	1916	.4315	1822		
17B	.4278	1916	.4277	1823		
18B	.4302	1917	.4300	1824	JOTUL F400 R#1	
19B	.4288	1918	.4285	1825	JOTUL F400 R#2	
20B	.4340	1919	.4340	1826	JOTUL F400 R#3	

11F	.66610	1928	.6659	1835	JOTUL #3CB R#4	
12F	.6837	1929	.6833	1836	JOTUL #3CBII R#1	
13F	.6707	1930	.6704	1837	JOTUL #3CBII R#2	
14F	.6719	1931	.6722	1838	JOTUL #3CBII R#3	
15F	.6673	1932	.6674	1839	JOTUL #3CBII R#4	
16F	.6805	1933	.6806	1840		
17F	.6657	1934	.66054	1840		
18F	.6693	1935	.6690	1841	JOTUL F400 R#1	
19F	.6744	1935	.6745	1842	JOTUL F400 R#2	
20F	.66540	1936	.6655	1843	JOTUL F400 R#3	

Checked by: [signature] Date: 11-4-99 Time: 1905

BALANCE ROOM ENVIRONMENTAL CONDITIONS

DATE	TIME	BY	WB	DB	% RH
11-1	1815	[illegible]	5	73	46
11-4	1805	[illegible]	5	76	46

BEAKER TARE WEIGHTS DATA SHEET #4-2

Into Dessicator: Date : 1-18-2000 Time : 0700 By : [illegible]

	DATE: 1-21-00	BY: [illegible]	DATE: 1-23-00	BY: [illegible]	DATE:	BY:
BEAKER #	FIRST WEIGHT	TIME	SECOND WEIGHT	TIME	THIRD WEIGHT	TIME
56	104.1714	2134	104.1710	1231		
57	97.4119	2134	97.4114	1233		
58	96.8964	2135	96.8960	1234	JOTUL F400 R#2	
59	105.3560	2136	105.3557	1235		
60	106.7320	2137	106.7316	1236		
61	99.3472	2138	99.3467	1236		
62	97.8661	2139	97.8657	1237		
63	93.2148	2140	93.2146	1238	JOTUL F400 R#3	
64	104.7871	2140	104.7866	1239		
65	98.4457	2141	98.4461	1240		

BALANCE ROOM ENVIRONMENTAL CONDITIONS

DATE	TIME	BY	WB	DB	% RH	
1-21	2115	[illegible]		77	47	Checked by : [illegible]
1-23	1210	[illegible]		73	44	Date : 1-23-00
						Time : 17:41

WOODSTOVE DATA SHEET # 4-3 : CONSTANT WEIGHTS

UNIT : F400 RUN : 3 DATE : 4-11-00

Beaker #	Date	Time	By	First Weight	Date	Time	By	Second Weight	Date	Time	By	Third Weight	Date	Time	By
61	4-12	1040		99.3874	4-13	2140		99.3877	4-15	1645					
62	4-12	1040		98.0374	4-13	2141		98.0370	4-15	1647					
63	4-12	1645		93.2638	4-13	2143		93.2640	4-15	1648					
64	4-12	1040		104.8300	4-13	2144		104.8304	4-15	1649					
65	4-12	1040		98.5018	4-13	2145		98.5022	4-15	1650					

Filter #	Date	Time	By	First Weight	Date	Time	By	Second Weight	Date	Time	By	Third Weight	Date	Time	By
20F	4-11	1840	CP	.7514	4-12	1739		.7509	4-13	2147					
20B	4-11	1840	CP	.4942	4-12	1740		.4940	4-13	2148					

SCALE ROOM ENVIRONMENTAL CONDITIONS

Weighing Session	Date	Time	By	WB	DB	%RH
1	4-12	1730			77	49
2	4-13	2130			76	48
3	4-14	1640			75	49
4						

Weighing Session	Date	Time	By	WB	DB	%RH
5						
6						
7						
8						

BLANK PROCESSING DATA SHEET # 5

UNIT: F400 RUN: 3 DATE: 4-11-2000

BLANKS DONE: 12-27-99

BEAKER	A	B	C
	200 ml ACETONE	75 ml DICHLOR	200 ml WATER
	FISHER OPTIMA LOT #	FISHER OPTIMA LOT #	
FINAL WEIGHT	108.9011	106.3073	106.9666
TARE WEIGHT	108.9003	106.3062	106.9651
NET WEIGHT	.0008	.0011	.0015

TARE BEAKERS INTO DESC: TIME: 11:30 DATE: 12-20-99

DATE: 12-22 BY: DFW DATE: 12-23 BY: DFW DATE: BY:

BEAKER	1 ST WT	TIME	2 ND WT	TIME	3 RD WT	TIME
A	108.8999	1940	108.9003	1948	✓	
B	106.3058	1941	106.3062	1949	✓	
C	106.9647	1942	106.9651	1950	✓	

FINAL BEAKERS INTO DESC: TIME: 1330 DATE: 12-24-99

DATE: 12-24 BY: DFW DATE: 12-25 BY: DFW DATE: 12-27 BY: DFW

BEAKER	1 ST WT	TIME	2 ND WT	TIME	3 RD WT	TIME
A	1088999	2021	108.9016	1816	108.9011	1224 ✓
B	106.3061	2022	106.3077	1817	106.3073	1225 ✓
C	106.9643	2023	106.9670	1818	106.9666	1226 ✓

TARE QC

DATE	TIME	BY	WB	DB	%
12-22	1935	DFW		77	47
12-23	1945	DFW		75	48

FINAL QC

DATE	TIME	BY	WB	DB	%
12-24	1945	DFW		76	45
12-25	1740	DFW		75	38
12-27	1210	DFW		76	46

NET PARTICULATE CATCH CALCULATION DATA SHEET #6

UNIT : F400 RUN : 3 DATE : 4-11-2000

BLANK CALCULATIONS

Acetone : ,0008 g ÷ 200 ml = ,000004 g/ml
Dicholoromethane : ,0011 g ÷ 75 ml = ,000015 g/ml
Distilled Water : ,0015 g ÷ 200 ml = ,000008 g/ml

FRONT HALF CATCH

FILTERS : ,0854 (Total Catch) g - 1 (# of Filters) (.0000 g) (Blank Value / Filter) = ,0854 g

BEAKERS : ,0410 (Total Catch) g - 100 (ml Acetone) (,0004 / ,000004 g) (Blank Value / ml Acetone) = ,0406 g

TOTAL FRONT HALF CATCH : ,1260 g

BACK HALF CATCH

FILTERS : ,0600 (Total Catch) g - 1 (# of Filters) (.0000 g) (Blank Value / Filter) = ,0600 g

BEAKERS :

Acetone : ,1713 (Total Catch) g - 175 (ml Acetone) (.0007 / ,000004 g) (Blank Value / ml Acetone) = ,1706 g

Extract : ,0494 (Total Catch) g - 75 (ml Dichloromethane) (,0011 / ,000015 g) (Blank Value / Dichloromethane) = ,0483 g

Water : ,0999 (Total Catch) g - 325 (ml Water) (,0026 / ,000008 g) (Blank Value / Water) = ,0973 g

TOTAL BACK HALF CATCH : ,3762 g

TOTAL CATCH : ,5022 g

% FRONT HALF : 25.09 %

CALCULATIONS DATA SHEET # 7

UNIT : F400 RUN : 3 DATE : 4-11-2000

1) Vm (std) = $\dfrac{(75.294\ \text{Vm})(17.64)(.989\ \text{mcf})\left(30.09\text{" Hg} + \dfrac{.155\text{" } H_2O}{13.6}\right)}{(547\ \text{TmA})}$ = $\dfrac{72.2861}{000.0000}$ dscf

30.1014

2) Vw (std) = (.04707)(121.3 ml H_2O) = $\dfrac{5.7096}{00.0000}$ scf

3) Asw = $\dfrac{(5.7096\ \text{scf})}{(5.7096\ \text{scf} + 72.2861\ \text{dscf})}$ = $\dfrac{.0732}{.0000}$ Bws × 100 = $\dfrac{7.3204}{00.0000}$ % H_2O

77.9957

4) Cs = $\dfrac{(.5022\ \text{g.})}{(72.2861\ \text{dscf})}$ (15.43) = $\dfrac{.1072}{0.0000}$ gr / dscf

5) Estimated g / hr = $\dfrac{(.5022\ \text{g.})}{(72.2861\ \text{dscf})}$ ($\dfrac{8.570}{00.0000}$ dscfm) (60) = $\dfrac{3.5723}{00.0000}$ g / hr

Vm =	total cubic feet pulled on meter box during test	(p. 2)	(000.000 Vm)
mcf =	meter correction factor (Y factor) of meter box used for test	(p. 2)	(0.000 mcf)
" Hg =	average barometric pressure during test	(p. 2)	(00.00 " Hg)
" H_2O =	average delta H for test	(p. 2)	(.000 " H_2O)
TmA =	average meter temperature for test in degrees Absolute	(p. 2)	(000 TmA)
ml H_2O =	total water caught during test	(p. 3)	(000.0 ml H_2O)
g. =	total particulate catch for test	(p. 6)	(00.0000 g.)
dscfm =	average stack flow during test	(p. 2)	(00.000 dscf)

TEST DATA SHEET # 8

UNIT: F400 RUN: 3 DATE: 4-11-2000

Test Chamber Air Velocity Start: Ø Stop: Ø Avg.: Ø

Wet Bulb / Dry Bulb

Pre : WB: 60 DB: 74 = 43 % RH 1.3 % H_2O

Post : WB: 61 DB: 78 = 36 % RH 1.2 % H_2O

Average: 39.5 %RH 1.25 % H_2O

Empty Stove Weight (lbs): - w/ stack & oil seal : Wet: - Dry: 390.0

Kindling Weight (lbs): Paper: .1 Wood: 3.2

Preburn Fuel Weight: 14.7 + 11.7 + 8.5 + 3.5 Total: 38.4

Kindling & Preburn Fuel Weight (wood only) (lbs): Total: 41.6

Coal Bed Wt Range (lbs): 3.2 - 2.6 Scale: 393.2 - 392.6

Upper : .25 x fuel weight : Always round DOWN to nearest tenth

Lower : .20 x fuel weight : Always round UP to nearest tenth Actual Coal Bed Weight: 2.8

Maximum Coal Bed Removal (lbs): $((\frac{3.2}{\text{Upper}} + \frac{2.6}{\text{Lower}}) \div 2) .25 =$ .7

Test Fuel (.75" x 1.5" x 5" spacers) = 20 pcs

Dimensions	Length in inches	No. Pcs	Weight in lbs	% of Load
2" x 4"	13	3	5.3	40.8
4" x 4"	13	2	7.7	59.2

Test Fuel Weight: 13.0 lbs

Estimated Dry Burn Rate: 2.209

$$\frac{13.0 - (13.0 \times .16994)}{2.2046} \times \frac{60}{\frac{240}{\text{TIME}}} = 1.224 \text{ kg / hr}$$

Estimated BTU's/hr: $19{,}140 \times \frac{63}{100} \times \frac{1.224}{\text{DBR}} = 14759.24$ BTU's/hr

EPA Default Efficiencies: Non-cat: 63 Cat: 72 Pellet: 78

WOOD STOVE OPERATING DATA PAGE #9

Unit : F400 Run : 3 Date : 4-11-2000

FIRE STARTED: 0835

WARM UP AND PREBURN:

PRIMARY AIR : Set wide open for all warm-up / preburn fuel charges. Then set to 1/8" at start of preburn.

SECONDARY AIR : N/A CAT BYPASS : N/A

CHARCOAL BED PREPARATION :

Raked and leveled prior to each warm-up / preburn charge. At 1 1/2 min. prior to loading last fuel, raked and leveled. In stove 35 sec.

TEST:

DOOR wide open during loading 0 min. 55 sec.

PRIMARY AIR : Opened full for first 5 min., then set to run setting of 1/8".

SECONDARY AIR : N/A CAT BYPASS : N/A

FAN:

ON / (OFF) during warm-up

ON / (OFF) during preburn

ON / (OFF) first _____ minutes of test

ON / (OFF) balance of test run

Fan speed set at N/A

WOOD DATA: KINDLING: A mix of the grades listed below:

	SIZE	MILL	GRADE	SPECIES
PREBURN:	2x4	Manke/Tacoma	Std. or better	s. grn D fir
TEST:	2x4	Packwood	# 2 or better	s. grn D fir
	4x4	Packwood	# 2 or better	s. grn D fir

PELLET FUEL MANUFACTURER : N/A BRAND : N/A

All Grades WCLB rules:

WARM UP INFORMATION:

All pre-burn / warm up fuel pieces were either 12 or 16 inches.

1st warm up / pre-burn fuel charge (14.7 lbs.) added at 0845

2nd warm up / pre-burn fuel charge (11.7 lbs.) added at 0955

3rd warm up / pre-burn fuel charge (8.5 lbs.) added at 1110

4th warm up / pre-burn fuel charge (3.5 lbs.) added at 1240

5th warm up / pre-burn fuel charge (_____ lbs.) added at _____

TEST DATA SHEET #10

Unit : F400 Run : 3 Date : 4- -2000

Room Temperature : 71 °F Correction Factor : 0

Uncorrected Values are corrected for room temperature : Yes _____ No ✓

Time Test Fuel moisture reading taken : 1105

Calibration Checks : X ✓ Y ✓ 12.0 12.2 22.0 22.0

pc #	Dimen.	Use	TOP		BOTTOM		SIDE		Avg Corrected
			Uncor	Cor.	Uncor.	Cor.	Uncor.	Cor.	
1	2"×4"×8'	K	14.5	15.5	16.0	17.0	15.5	16.5	16.333
2									
3									
4	2"×4"×8'	P	18.5	19.8	19.0	20.3	19.0	20.3	20.133
5	2"×4"×8'	P	20.0	21.4	20.0	21.4	20.0	21.4	21.400
6	2"×4"×8'	P	22.0	23.7	21.0	22.5	20.5	22.0	22.733
7	2"×4"×8'	P							64.266
8	2"×4"×8'	P							
9									
10									
11									
12	2×4×13	T	19.5	20.9	19.0	20.3	19.5	20.9	20.700
13	"	T	18.0	19.2	17.5	18.7	18.0	19.2	19.033
14	"	T	20.0	21.4	19.5	20.9	20.0	21.4	21.233
15	4×4×13	T	21.0	22.5	20.5	22.0	21.5	23.1	22.533
16	"	T	18.0	19.2	17.5	18.7	17.5	18.7	18.867
17									102.366
18									
19									
20	Spacers	T	18.5	19.8	19.0	20.3	18.0	19.2	19.767

Key for Use : K = Kindling P = Pretest Fuel T = Test Fuel

	KINDLING	PRETEST FUEL	TEST FUEL
Dry Moisture % :	16.333 %	21.422 %	20.473 %
Wet Moisture % :	14.040 %	17.643 %	16.994 %

To obtain Wet from Dry : $\frac{100 \times \%\ \text{Dry Reading}}{100 + \%\text{Dry Reading}}$ = % Moisture, Wet Basis

Acceptable Ranges : 16 - 20 % wet: 19 - 25 % dry (17.5 - 22.5 on Meter Uncor. reading) at 70°

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GAS DATA SHEET # 12

UNIT: F400 RUN: 3 DATE: 4-1/2000 PAGE: 1 of 3

TIME	SCALE	FUEL	DROP	V.	CO_2	V.	O_2	V.	CO	BAL	WB	DB	% H_2O	CAL WB	STACK	STATIC	SO_2 PPM
0 1400	405.8	13.0	-	.203	5.1	-	-	.103	1.03	4.9					300	-.039	400
5 05	405.4	12.6	.4	.103	2.5			.034	.34	7.4					334	-.033	300
10 10	405.2	12.4	.2	.081	2.0			.061	.61	3.2					355	-.035	450
15 15	405.1	12.3	.1	.075	1.8			.061	.61	3.0					228	-.032	475
20 20	404.9	12.1	.2	.078	1.9			.071	.71	2.7					217	-.031	475
25 25	404.7	11.9	.2	.141	3.5			.080	.80	4.3					221	-.031	450
30 30	404.0	11.2	.7	.517	12.9			.064	.64	20.1					467	.051	325
35 35	403.2	10.4	.8	.395	9.9			.055	.55	17.8					490	-.056	300
40 40	402.2	9.4	1.0	.519	13.0			.011	.11	113.9					597	-.063	250
45 45	401.5	8.7	.7	.478	12.0			.007	.07	161.6					578	-.062	250
50 50	400.6	7.8	.9	.553	13.8			.006	.06	216.3					621	-.065	275
55 55	399.8	7.0	.8	.547	13.7			.005	.05	253.5					627	-.066	275
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	4935	-.564	*****
00 1500	399.0	6.2	.8	.546	13.7			.003	.03	401.9					619	-.066	275
05 05	398.2	5.4	.8	.562	14.1			.003	.03	413.7					627	-.066	275
10 10	397.5	4.7	.7	.465	11.6			.007	.07	157.2					542	-.065	275
15 15	397.1	4.3	.4	.361	9.0			.047	.47	19.0					524	-.063	325
20 20	396.6	3.8	.5	.334	8.3			.063	.63	13.2					481	-.058	350
25 25	396.3	3.5	.3	.320	8.0			.060	.60	13.2					452	-.055	375
30 30	396.0	3.2	.3	.312	7.8			.060	.60	12.9					439	-.054	350
35 35	395.7	2.9	.3	.305	7.6			.056	.56	13.5					425	-.052	350
40 40	395.4	2.6	.3	.297	7.4			.059	.59	12.5					414	-.051	350
45 45	395.2	2.4	.2	.291	7.3			.065	.65	11.1					406	-.050	350
50 50	394.9	2.1	.3	.306	7.6			.055	.55	13.8					408	-.050	350
55 55	394.7	1.9	.2	.276	6.9			.069	.69	9.9					389	-.049	350
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	5726	-.679	*****
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	10661	-1.243	*****

WEIGHT: 39.6 GAS DATA SHEET # 12

UNIT: F400 RUN: 3 DATE: 4-11-2000 PAGE: 2 of 3

TIME	SCALE	FUEL	DROP	V.	CO_2	V.	O_2	V.	CO	BAL	WB	DB	% H_2O	CAL WB	STACK	STATIC	SO_2PPM
120 1600	394.5	1.7	.2	.268	6.7	-	-	.071	.71	9.4					378	-.048	375
125 05	394.4	1.6	.1	.253	6.3			.086	.86	7.3					371	-.046	375
130 10	394.3	1.5	.1	.227	5.7			.129	1.29	4.4					344	-.044	400
135 15	394.2	1.4	.1	.221	5.5			.142	1.42	3.9					330	-.042	400
140 20	394.1	1.3	.1	.214	5.3			.149	1.49	3.6					319	-.041	400
145 25	394.0	1.2	.1	.219	5.5			.152	1.52	3.6					311	-.039	400
150 30	393.9	1.1	.1	.208	5.2			.166	1.66	3.1					302	-.038	400
155 35	393.8	1.0	.1	.200	5.0			.176	1.76	2.8					296	-.036	400
160 41	393.7	.9	.1	.197	4.9			.176	1.76	2.8					292	-.036	400
165 45	393.7	.9	0	.220	5.5			.141	1.41	3.9					287	-.035	425
170 50	393.6	.8	.1	.213	5.3			.146	1.46	3.6					272	-.033	475
175 55	393.5	.7	.1	.211	5.3			.153	1.53	3.4					267	-.031	475
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	3769	-.469	*****
180 1700	393.4	.6	.1	.212	5.3			.127	1.27	4.1					264	-.031	500
185 05	393.3	.5	.1	.199	5.0			.138	1.38	3.6					244	-.028	575
190 10	3933	.5	0	.189	4.7			.123	1.23	3.8					234	-.027	600
195 15	393.2	.4	.1	.196	4.9			.117	1.17	4.2					221	-.025	650
200 20	393.2	.4	0	.198	4.9			.117	1.17	4.2					219	-.025	650
205 25	393.2	.4	0	.190	4.7			.128	1.28	3.7					216	-.024	650
210 30	393.1	.3	.1	.191	4.7			.131	1.31	3.6					213	-.024	675
215 35	393.0	.2	.1	.191	4.7			.151	1.51	3.1					210	-.024	675
220 40	393.0	.2	0	.179	4.4			.161	1.61	2.8					208	-.023	700
225 45	392.9	.1	.1	.168	4.2			.169	1.69	2.5					203	-.022	700
230 50	392.9	.1	0	.164	4.1			.184	1.84	2.2					201	-.022	700
235 55	392.9	.1	0	.158	3.9			.182	1.82	2.2					198	-.021	725
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	2631	-.296	*****
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	6400	-.765	*****

WEIGHT: 392.8 lb

GAS DATA SHEET # 12

UNIT: F400 RUN: 3 DATE: 4-11-2000 PAGE: 3 of 3

TIME	SCALE	FUEL	DROP	V.	CO_2	V.	O_2	V.	CO	BAL	WB	DB	% H_2O	CAL WB	STACK	STATIC	SO_2 PPM
240/1800	392.8	⊘	.1	.164	4.1	-	-	.180	1.80	2.3					196	.021	725
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	196	.021	*****
																	÷49
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	17257	2.029	*****
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	352	-.041	*****

PREBURN DATA SHEET

UNIT: F400 RUN: 3 DATE: 4-11-2000 PAGE: 1 of 1

TIME	SCALE	DROP	STACK	TOP	LF SIDE	BACK	RT SIDE	BOTTOM	FIREBOX	SEC/CAT	AMBIENT	STATIC	COMMENTS
0/1240	396.1	0	389	411	409	384	381	284	795	733	79	.046	PREBURN START: # 2.9 UP
5/45	395.9	.2	339	395	404	384	371	287	776	681	80	.046	COAL BED SCALE RANGE:
10/50	395.7	.2	314	366	385	374	356	288	759	641	78	.043	393.2 → 392.6
15/55	395.4	.3	312	355	369	366	342	286	733	697	78	.043	PRIMARY AIR: 1/8"
20/1300	395.2	.2	327	358	356	349	330	281	662	900	78	.043	SECONDARY AIR: N/A
25/05	394.9	.3	337	366	351	344	322	275	673	906	77	.045	FAN: N/A
30/10	394.5	.4	390	427	349	331	315	266	698	1040	77	.048	PUMPS ON AT: 1310
35/15	394.2	.3	397	460	351	324	315	261	712	1020	78	.049	CHECK WB/DB: N/A
40/20	393.8	.4	410	496	355	319	318	254	744	1081	78	.050	
45/25	393.5	.3	419	503	357	317	321	251	742	1189	79	.051	
50/30	393.2	.3	367	469	356	313	330	247	713	791	78	.046	
55/35	393.1	.1	329	404	347	309	324	242	731	712	79	.044	
*****	****	***	****	*****	*****	****	*****	*****	*****	*****	*****	****	
60/1340	393.1	0	316	379	341	308	319	241	713	696	79	.041	
65/45	393.0	.1	304	353	334	307	313	240	687	679	78	.040	
70/50	393.0	0	301	342	328	305	308	240	698	674	79	.039	
75/55	392.9	.1	301	328	324	300	300	238	724	670	78	.039	
80/1400	392.8	.1	300	322	322	296	298	237	720	668	78	.039	295.0
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UNIT: F400 RUN: 3 DATE: 4-1-2000 PAGE 1 of 3

TIME	TOP	LT SIDE	BACK	RT SIDE	BOTTOM	FIREBOX	SEC/CAT	AMBIENT	FURNACE	SAMPLE	SAMP IMP	C-GAS	GAS IMP	SO_2 IMP	295.0
0 1400	322	322	296	298	237	720	668	78	1336	246	49	243	37	39	
5 05	292	317	295	294	240	626	536	79	1340	246	43	243	38	39	
10 10	283	310	293	283	239	554	413	77	1340	245	44	243	38	39	
15 15	260	294	285	267	237	499	380	78	1342	245	43	243	37	36	
20 20	242	276	270	251	231	515	373	77	1339	245	44	243	36	35	
25 25	233	264	266	239	225	527	396	78	1336	244	44	242	36	35	
30 30	354	252	254	229	218	478	1170	77	1329	243	45	241	37	35	
35 35	491	248	250	225	213	479	1046	76	1328	243	45	241	35	36	
40 40	619	259	244	226	207	507	1285	76	1329	244	47	234	35	37	
45 45	631	273	241	232	205	520	1365	77	1331	245	46	230	36	38	
50 50	638	298	238	243	202	570	1398	78	1333	247	47	235	37	36	
55 55	708	325	233	259	201	622	1455	78	1335	247	48	237	37	35	
TOTAL	5123	3438	3165	3046	2655	6617	10491	929	*****	*****	*****	*****	*****	*****	
60 1500	725	347	242	278	202	669	1467	78	1338	249	48	241	38	37	
65 05	737	368	249	298	205	720	1478	80	1342	249	49	243	36	36	
70 10	680	387	260	325	208	754	1155	80	1347	247	49	243	34	35	
75 15	644	395	264	332	209	746	1215	80	1348	247	49	245	34	35	
80 20	585	391	259	340	213	741	1265	80	1348	246	49	250	35	34	
85 25	541	388	287	343	217	765	1217	81	1348	246	49	258	35	34	
90 30	528	382	293	344	220	772	1185	80	1348	246	50	258	36	34	
95 35	503	378	302	345	222	775	1147	81	1346	245	50	252	38	35	
100 40	485	373	311	346	225	776	1101	81	1344	245	50	248	37	35	
105 45	473	371	318	347	228	771	1089	81	1343	244	50	247	36	37	
110 50	473	365	323	345	230	773	1136	81	1341	244	51	245	36	37	
115 55	454	366	327	344	232	774	1023	82	1340	243	51	244	35	34	
TOTAL	6828	4511	3435	3987	2611	9036	14478	965	*****	*****	*****	*****	*****	*****	
TOTAL	11951	7949	6600	7033	5266	15653	24969	1894	*****	*****	*****	*****	*****	*****	

TEMPERATURE DATA SHEET # 14

UNIT: F400 RUN: 3 DATE: 4-11-2000 PAGE 2 of 3

TIME	TOP	LT SIDE	BACK	RT SIDE	BOTTOM	FIREBOX	SEC/CAT	AMBIENT	FURNACE	SAMPLE	SAMP IMP	C-GAS	GAS IMP	SO_2 IMP	295.0
120/1600	439	360	331	343	235	777	1044	80	1339	243	51	244	35	35	
125/05	426	358	331	341	236	770	993	81	1338	242	51	243	36	36	
130/10	402	354	333	340	237	749	897	81	1337	242	51	242	36	34	
135/15	381	352	334	338	238	742	859	81	1337	243	51	242	34	35	
140/20	367	350	335	334	238	731	828	80	1337	243	51	243	35	37	
145/25	352	344	333	330	240	713	812	80	1337	244	51	243	37	36	
150/30	344	342	332	325	240	696	784	81	1337	245	51	244	37	35	
155/35	340	339	330	318	240	680	765	80	1336	246	52	244	37	36	
160/40	331	335	332	316	240	674	759	80	1336	247	52	245	37	36	
165/45	328	332	325	314	238	681	798	80	1335	247	52	248	37	36	
170/50	322	330	323	310	238	669	792	81	1336	248	53	247	37	36	
175/55	315	320	319	306	238	659	799	81	1336	248	53	247	37	36	
TOTAL	4347	4116	3958	3915	2858	8541	10130	966	*****	*****	*****	*****	*****	*****	
180/1700	314	317	315	304	238	661	769	81	1336	248	54	246	37	37	
185/05	305	313	311	300	238	642	736	82	1335	249	55	246	37	35	
190/10	296	306	309	297	239	634	684	82	1334	249	56	246	36	35	
195/15	285	298	296	292	240	616	677	81	1333	250	58	245	37	34	
200/20	282	295	300	289	241	610	674	81	1333	250	59	245	35	35	
205/25	278	290	298	287	241	602	677	81	1333	250	59	246	36	35	
210/30	272	284	293	282	241	589	675	82	1332	250	59	246	36	37	
215/35	268	280	288	277	241	581	657	82	1332	249	60	246	37	36	
220/40	264	277	279	275	240	575	651	82	1331	249	60	246	35	36	
225/45	260	272	280	271	238	563	625	82	1331	249	60	245	36	35	
230/50	256	269	277	267	237	554	616	83	1331	249	61	245	34	35	
235/55	252	265	274	264	236	542	608	82	1330	249	61	245	35	34	
TOTAL	3332	3466	3520	3405	2870	7169	8049	981	*****	*****	*****	*****	*****	*****	
TOTAL	7679	7582	7478	7320	5728	15710	18179	1947	*****	*****	*****	*****	*****	*****	

TEMPERATURE DATA SHEET # 14

UNIT: F400 RUN: 3 DATE: 4-11-2000 PAGE 3 of 3

TIME	TOP	LT SIDE	BACK	RT SIDE	BOTTOM	FIREBOX	SEC/CAT	AMBIENT	FURNACE	SAMPLE	SAMP IMP	C-GAS	GAS IMP	SO_2 IMP	295.0
240/800	246	262	268	260	233	523	593	83	1313	241	59	241	34	34	
TOTAL	246	262	268	260	233	523	593	83	*****	*****	*****	*****	*****	*****	
				295.0											
				253.8											
			ΔT	-41.2											
									÷49						
TOTAL	19876	15793	14346	14613	11227	31886	43741	3924	*****	*****	*****	*****	*****	*****	
TOTAL	406	322	293	298	229	651	893	80	*****	*****	*****	*****	*****	*****	

ZERO / SPAN CHECK DATA SHEET #15-1

Date : 4-11-2000 Analyte : CO_2 (15-1)

Source : F400 Run # : 3

Zero Cyl. # : TX 79373 Conc. : 0.00 % CO_2 Cyl. Press. : 960 PSI

Certified by : AIR LIQUIDE Date : 9-22-1998

Span Cyl. # : CC52330 Conc. : 12.79 % CO_2 Cyl. Press. : 1750 PSI

Certified by : AIR LIQUIDE Date : 2-10-2000

Analyzer : Make : HORIBA Model : PIR-2000 SN : 407069

Range : 0 - 25.0 % CO_2 Analyzer Output : 0 - 1.0 v.

Flow : 1.5 SCFH Measured by : Rotameter

EPA Span Value = 25.0 % CO_2

EPA Control Limits = ± 2.5% of 25.0 % CO_2 = ± 0.625 % CO_2

Method 28 A = ± .2 % of 25.0 % CO_2 = ± .05 % CO_2

PRE RUN Audit : by : D. Washington Time : 1218 Temp : 84 ° F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.0	.000	.048	-.048	-.192
SPAN	51.2	.512	12.79	50.9	.509	12.736	-.054	-.216

POST RUN Audit : by : D. Washington Time : 1820 Temp : 77 ° F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.0	-.002	.098	-.098	-.393
SPAN	51.2	.512	12.79	51.0	.510	12.761	-.029	-.115

± Conc. Difference = Act % - Exp (Std) %

Zero % Difference = $\frac{\text{Act \% (ppm) - Exp \% (ppm)}}{\text{Full Scale Value}}$ X 100

Span % Difference = $\frac{\text{Act \% (ppm) - Exp \% (ppm)}}{\text{Full Scale Value}}$ X100

ZERO / SPAN CHECK DATA SHEET #15-2

Date : 4-11-2000 Analyte : O_2 (15-2)

Source : F400 Run # : 3

Zero Cyl. # : TX79373 Conc. : 0.00 % O_2 Cyl. Press. : 960 PSI

Certified by : AIR LIQUIDE Date : 9-22-1998

Span Cyl. # : CC52330 Conc. : 12.69 % O_2 Cyl. Press. : 1750 PSI

Certified by : AIR LIQUIDE Date : 2-10-2000

Analyzer : Make : TELEDYNE Model : 320 A SN : 37400

Range : 0 - 25.0 % O_2 Analyzer Output : 0 - 1.0 v.

Flow : 1.5 SCFH Measured by : Rotameter

EPA Span Value = 25.0 % O_2

EPA Control Limits = ± 2.5% of 25.0 % O_2 = ± 0.625 % O_2

Method 28 A = ± .2 % of 25.0 % O_2 = ± .05 % O_2

PRE RUN Audit : by : D. Wadsworth Time : 1215 Temp : 84 ° F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.1	.002	.075	.075 ✓	.299 ✓
SPAN	12.7	.508	12.69	12.7	.510	12.737 ✓	.047	.187 ✓

POST RUN Audit : by : D. Wadsworth Time : 1820 Temp : 77 ° F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.0	.001	.050 ✓	.050 ✓	.200 ✓
SPAN	12.7	.508	12.69	12.7	.508	12.687 ✓	-.003 ✓	-.012 ✓

± Conc. Difference = Act % - Exp (Std) %

Zero % Difference = $\frac{\text{Act \% (ppm) - Exp \% (ppm)}}{\text{Full Scale Value}}$ X 100

Span % Difference = $\frac{\text{Act \% (ppm) - Exp \% (ppm)}}{\text{Full Scale Value}}$ X100

ZERO / SPAN CHECK DATA SHEET #15-3

Date : 4-11-2000 Analyte : CO (15-3)

Source : F400 Run # : 3

Zero Cyl. # : TX79373 Conc. : 0.00 % CO Cyl. Press. : 960 PSI

Certified by : AIR LIQUIDE Date : 9-22-1998

Span Cyl. # : CC52330 Conc. : 4.75 % CO Cyl. Press. : 1750 PSI

Certified by : AIR LIQUIDE Date : 2-10-2000

Analyzer : Make : HORIBA Model : PIR-2000 SN : 408005

Range : 0 - 10.0 % CO Analyzer Output : 0 - 1.0 v.

Flow : 1.5 SCFH Measured by : Rotameter

EPA Span Value = 10.0 % CO

EPA Control Limits = ± 2.5% of 10.0 % CO = ± 0. 25 % CO

Method 28 A = ± .2 % of 10.0 % CO = ± .02 % CO

PRE RUN Audit : by : D Woodington Time : 1215 Temp : 84 ° F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %	
	Meter	DVM	%	Meter	DVM	%			
ZERO	00.0	.000	00.0	00.0	.000	.004	.004 ✓	.042	✓
SPAN	47.5	.475	4.75	47.4	.474	4.742 ✓	-.008 ✓	-.079	✓

POST RUN Audit : by : D. Woodington Time : 1810 Temp : 77 ° F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %	
	Meter	DVM	%	Meter	DVM	%			
ZERO	00.0	.000	00.0	00.1	.001	.014	.014	.142	✓
SPAN	47.5	.475	4.75	47.5	.475	4.752 ✓	.002 ✓	.021	✓

± Conc. Difference = Act % - Exp (Std) %

Zero % Difference = $\frac{\text{Act \% (ppm) - Exp \% (ppm)}}{\text{Full Scale Value}}$ X 100

Span % Difference = $\frac{\text{Act \% (ppm) - Exp \% (ppm)}}{\text{Full Scale Value}}$ X100

ZERO / SPAN CHECK DATA SHEET #15-4

Date : 4-11-2000 Analyte : SO_2 (15-4)

Source : F400 Run # : 3

Zero Cyl. # : TX79373 Conc. : 0.00 ppm SO_2 Cyl. Press. : 960 PSI

Certified by : AIR LIQUIDE Date : 9-22-1998

Span Cyl. # : CC67475 Conc. : 1260 ppm SO_2 Cyl. Press. : 650 PSI

Certified by : AIR LIQUIDE Date : 9-22-1998

Analyzer : Make : HORIBA Model : PIR-2000 SN : 403019

Range : 0 - 2500 ppm SO_2 Analyzer Output : 0 - 1.0 v.

Flow : 1.5 SCFH Measured by : Rotameter

EPA Span Value = 2500 ppm SO_2

EPA Control Limits = ± 2.5% of 2500 ppm SO_2 = ± 62.5 ppm SO_2

PRE RUN Audit : by : D. Wadington Time : 1215 Temp : 84 °F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %	
	Meter	DVM	PPM	Meter	DVM	%			
ZERO	00.0	.000	00.0	00.4	.004	22.936 ✓	22.936 ✓	.917	✓
SPAN	50.4	.504	1260	49.8	.498	1245.251 ✓	-14.749 ✓	-.590	✓

POST RUN Audit : by : D. Wadington Time : 1825 Temp : 76 °F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %	
	Meter	DVM	PPM	Meter	DVM	%			
ZERO	00.0	.000	00.0	00.5	.005	25.410 ✓	25.410 ✓	1.016	✓
SPAN	50.4	.504	1260	49.8	.498	1245.251	-14.749 ✓	-.590	✓

± Conc. Difference = Act % - Exp (Std) %

Zero % Difference = $\frac{\text{Act \% (ppm) - Exp \% (ppm)}}{\text{Full Scale Value}}$ X 100

Span % Difference = $\frac{\text{Act \% (ppm) - Exp \% (ppm)}}{\text{Full Scale Value}}$ X100

QUALITY CHECKS DATA SHEET # 16

UNIT: F400 RUN: 3 DATE: 4-11-2000

Thermocouple Check :

T/C # 1	—	°F	T/C # 13	64.8	°F
T/C # 2	—	°F	T/C # 14	62.7	°F
T/C # 3	63.5	°F	T/C # 15	66.3	°F
T/C # 4	59.0	°F	T/C # 16	62.1	°F
T/C # 5	58.5	°F	T/C # 17	61.8	°F
T/C # 6	58.2	°F	T/C # 18	68.0	°F
T/C # 7	58.2	°F	T/C # 19	59.7	°F
T/C # 8	57.9	°F	T/C # 20	55.9	°F
T/C # 9	57.9	°F	T/C # 21	—	°F
T/C # 10	59.0	°F	T/C # 22	—	°F
T/C # 11	56.2	°F	T/C # 23	59.3	°F
T/C # 12	72.3	°F	T/C # 24	—	°F

Thermocouple Readout :

Pretest zero and span check and calibration — post test zero and span — % difference

ZERO: -1.1 °F Adj. to 0.0 °F — ZERO 4.3 °F Difference .215 %

SPAN 2004.2 °F Adj. to 2000.0 °F — SPAN 1999.7 °F Difference -.015 %

Thermocouple Readout Pretest Linearity Check

0	= 0.0 °F	200	= 203.7 °F	400	= 400.8 °F
600	= 602.3 °F	800	= 802.7 °F	1000	= 1001.5 °F
1200	= 1198.9 °F	1400	= 1399.7 °F	1600	= 1600.0 °F
1800	= 1800.1 °F	2000	= 2000.0 °F		

Sample Train Leak Check	Pre ✓	Post ✓
C-gas Train Leak Check	Pre ✓	Post ✓
SO_2 Train Leak Check	Pre ✓	Post ✓
Static Gauge Zero Check	Pre X	Post ✓

Scale Check Pre: 405.4 - 395.4

Post: 402.5 - 392.5

Stack Cleaned Prior to Test Run : YES _____ NO X

TABLE 1 ----- RAW DATA

CLIENT : Jotul TEST No. : 4

MODEL: F400 DATE: 12-Apr-00

TIME (MIN.)	METER READING (C F)	DELTA H (IN. H2O)	METER TEMP. (DEG. F)	PERCENT CO (%)	PERCENT CO2 (%)	SO2 COCENTR. PPM
0	384.000	0.150	78	0.57	5.70	325
5	385.500	0.130	79	0.93	7.10	350
10	386.916	0.130	79	0.53	9.70	350
15	388.333	0.150	80	0.26	13.70	325
20	389.864	0.150	80	0.09	14.00	325
25	391.395	0.140	81	0.08	14.50	325
30	392.931	0.120	82	0.10	15.10	350
35	394.364	0.120	82	0.08	15.10	350
40	395.796	0.120	82	0.09	14.70	350
45	397.228	0.120	82	0.08	13.20	350
50	398.661	0.120	83	0.13	10.60	350
55	400.098	0.120	83	0.22	9.40	350
60	401.536	0.110	84	0.48	8.30	375
65	402.884	0.110	84	0.52	8.00	375
70	404.231	0.110	84	0.52	7.70	375
75	405.579	0.110	84	0.58	7.50	375
80	406.927	0.110	84	0.56	7.50	375
85	408.274	0.110	84	0.50	7.70	375
90	409.622	0.090	85	0.63	7.20	400
95	410.890	0.080	86	0.81	6.60	425
100	412.088	0.090	87	0.82	6.60	400
105	413.366	0.100	87	0.86	6.40	375
110	414.729	0.090	87	0.87	6.20	400
115	416.006	0.100	87	1.06	6.00	375
120	417.369	0.100	87	1.12	5.30	375
125	418.732	0.100	87	1.21	5.20	375
130	420.094	0.090	89	1.25	4.90	400
135	421.381	0.090	89	1.40	4.60	400
140	422.668	0.090	90	1.25	4.90	400
145	423.960	0.090	90	1.23	4.90	400
150	425.251	0.090	90	1.06	4.70	400
155	426.543	0.090	90	1.08	4.70	400
160						

TABLE 2---RAW DATA

CLIENT : Jotul TEST No. 4

MODEL: F400 DATE: 12-Apr-00

****

METER CAL. FACTOR (Y)	0.989		Wt. WOOD BURNED(LB)	12.7	Lbs
BAROMETRIC PRESS.(Pb)	30.09	in Hg	WET,FUEL MOISTURE %	16.304	%
LEAK RATE POST (Lp)	0.001	cfm	Wt. PART. COLLECTED	0.1993	g
WATER VOL. (V1c)	77.1	Ml	METER VOLUME Vm	42.543	mcf
TEST TIME (MIN)	155	min	HC MOLE FRACTION	0.0132	

TABLE 3 -----FIELD DATA AVERAGES

CLIENT :Jotul TEST No. 4

MODEL: F400 DATE: 12-Apr-00

****

AVG DELTA H	-------	0.11 in H2O	AVG PRCNT CO	-------	0.66	%
AVG METER TEMP. Tm	-------	85 deg F	AVG PRCNT CO2	-------	8.37	%
AVG PPM SO2	-------	371 PPM	AVG BAL CO2/CO	-------	12.77	%

TABLE 4 ----- CALCULATIONS

CLIENT : Jotul TEST No. 4

MODEL: F400 DATE: 12-Apr-00

****

STD SAMPLE VOL. Vm(std) -----	41.05	dscf	STACK GAS FLOW Qsd -------	649.992	dscf/Hr
				10.83	& dscf/min
VOL. WATER VAPOR Vw(std) ----	3.629	scf	PARTICULATE CONCTRT. Cs ------	0.0049	g/dscf
PRCNT MSTR Bws -------	8.12	%	PARTC.EMISS. RATE E -------	3.16	g/Hr
BURN RATE BR -------	1.87	Kg/Hr	MOLES OF GAS PER Lb WOOD Nt --	0.41	Lb-mole/Lb
CO EMISSION RATE -------	142.64	g/Hr	PART.EMISS. RATE ------	1.69	g/Kgdry fuel
	76.44	& g/Kgdry fuel			

TABLE 5 ----- PROPORTIONAL RATE VARIATION

CLIENT : Jotul TEST No. : 4

MODEL: F400 DATE: 12-Apr-00

TIME INTEVAL Ti	PPM * Vm	PROPRTN. RATE VAR. PR	PROPRTN RATE VAR. AVERAGE
5	475.7	97	100
10	483.1	99	
15	483.0	99	
20	484.2	99	
25	483.7	99	
30	484.4	99	
35	486.2	100	
40	485.9	100	
45	485.9	100	
50	485.7	100	
55	486.6	100	
60	486.5	100	
65	488.2	100	
70	487.8	100	
75	488.2	100	
80	488.2	100	
85	487.8	100	
90	487.8	100	
95	488.5	100	
100	489.4	100	
105	491.0	101	
110	490.9	101	
115	490.6	101	
120	490.9	101	
125	490.9	101	
130	489.7	100	
135	492.6	101	
140	492.2	101	
145	493.6	101	
150	493.3	101	
155	493.6	101	
160			
165			

COMPUTER INPUT DATA SHEET #1

Client: JOTUL U.S.A., INC.

Address: 400 RIVERSIDE STREET

PORTLAND ME 04104

Phone: 207-797-5912 Fax: 207-772-0523

Run No.: 4 Date of Test: 4-12-2000 Burn Rate: 1.866

Model No.: F400 ☐ min ☐ min-1.25 ☐ fan

Stove Type: ☐ Cat ☒ Non Cat ☐ Pellet ☒ 1.25-1.9 ☐ max ☐ insert

3.16 at 1.82 kg/hr

Dry Gas Meter: Y Factor: .989 (0.000) (Data Sheet #2) Post Leak Rate: .001 cfm (.000) (Data Sheet #2) Time: 155 min. (000) (Data Sheet #2)

Dry Gas Meter Volume: 42.543 cf (00.000) (Data Sheet #2)

Stack Flow: 9.336 dscfm (00.000) (Data Sheet #2) Δ H: .110 in. H_2O (.000) (Data Sheet #2)

Barometric Pressure: 30.09 in. Hg (00.00) (Data Sheet #2)

H_2O Captured: 77.1 g (00.0) (Data Sheet #3)

Total Particulate Catch: .1993 g (0.0000) (Data Sheet #6)

Flue Gas Moisture: 8.1337 % (00.000) (Data Sheet #7)

Particulate Emission: .0750 gr/dscf (0.0000) (Data Sheet #7)

Ambient Moisture: 1.3 % (0.00) (Data Sheet #8)

Stove Weight: — lbs (000) (Data Sheet #8)

Total Fuel Consumed During Burn: 12.7 lbs (00.0) (Data sheet #8)

Fuel Higher Heating Value (dry): — BTU/lb (0000) (Data Sheet #8)

Fuel % Moisture (dry): 19.480 % (wet): 16.304 % (00.00) (Data Sheet #10)

Stack Static Pressure: -.055 in. H_2O (0.000) (Data Sheet #12)

Temperature (Average Room) Combustion Air: 81 °F (00) Data Sheet #14)

Stove Temperature Change: -37.2 °F (00.0) (Data Sheet #14)

METER BOX DATA SHEET PAGE # 2

Page: 1 of 2

UNIT: F400 RUN: 4 DATE: 4-12-2000

Meter Box: 5H Y Factor: .989

Leak checks: 15 " Hg @ .003 cfm _____ " Hg @ _____ cfm

.20 15 " Hg @ .001 cfm _____ " Hg @ _____ cfm

Inject SO^2 @ 100 cc/min. Nozzle: Probe @ 3/8 " od Initial Volume: 1,506

ROTO: PRESS: .13			SAMPLING RATIO: 36 : 1				BP: 30.10		
MIN	TIME	METER READING	SAMPLE MDCF	STACK DSCFM	DELTA H	METER TEMP	SO2 PPM	ROTO TEMP	PUMP VACC
0	1250	384.000	—	10.733	.15	78	325	78	1.0
5	55	385.500	—	9.948	.13	79	350	79	1.0
10	1300	386.916	386.916	9.948	.13	79	350	79	1.0
15	05	388.333	388.333	10.694	.15	80	325	80	1.0
20	10	389.864	389.864	10.694	.15	80	325	80	1.0
25	15	391.395	391.395	10.674	.14	81	325	81	2.0
30	20	392.931	392.931	9.893	.12	82	350	82	2.0
35	25	394.364	394.364	9.893	.12	82	350	82	2.0
40	30	395.796	395.796	9.893	.12	82	350	82	2.0
45	35	397.228	397.228	9.893	.12	82	350	82	2.0
50	40	398.661	398.661	9.875	.12	83	350	83	2.0
55	45	400.098	400.098	9.875	.12	83	350	83	2.0
ROTO PRESS: .13			TOTALS:	122.013	1.57	971	BP.: 30.08		
60	1350	401.536	401.536	9.194	.11	84	375	84	2.0
65	55	402.884	402.884	9.194	.11	84	375	84	2.0
70	1400	404.231	404.231	9.194	.11	84	375	84	2.0
75	05	405.579	405.579	9.194	.11	84	375	84	2.0
80	10	406.927	406.927	9.194	.11	84	375	84	2.0
85	15	408.274	408.274	9.194	.11	84	375	84	2.0
90	20	409.622	409.622	8.603	.09	85	400	85	2.0
95	25	410.890	410.890	8.082	.08	86	425	86	2.0
100	30	412.088	412.088	8.572	.09	87	400	87	2.0
105	35	413.366	413.366	9.143	.10	87	375	87	2.0
110	40	414.729	414.729	8.572	.09	87	400	87	2.0
115	45	416.006	416.006	9.143	.10	87	375	87	2.0
			TOTALS:	107.679	1.21	1023	MAX VACC =		
TOTAL Cu Ft:			TOTALS:	229.292	2.78	1994	AVG. BP:		

METER BOX DATA SHEET PAGE # 2

Page: 2 of 2

UNIT: F400 RUN: 4 DATE: 4-12-2000

Meter Box: SH Y Factor: .989

Leak checks: 15 " Hg @ .003 cfm _____ " Hg @ _____ cfm

15 " Hg @ .001 cfm _____ " Hg @ _____ cfm

Inject SO^2 @ 100 cc/min. Nozzle : Probe @ 3/8 " od Initial Volume: 1500

ROTO: PRESS: 13 SAMPLING RATIO: 36 : 1 BP: 30.08

MIN	TIME	METER READING	SAMPLE MDCF	STACK DSCFM	DELTA H	METER TEMP	SO2 PPM	ROTO TEMP	PUMP VACC
120	1450	417.369	417.369	9,143	.10	87	375	87	2.0
125	55	418.732	418.732	9,143	.10	87	375	87	2.0
130	1500	420.094	420.094	8.541	.09	89	400	89	2.0
135	05	421.381	421.381	8.541	.09	89	400	89	2.0
140	10	422.668	422.668	8.525	.09	90	400	90	2.0
145	15	423.960	423.960	8.525	.09	90	400	90	2.0
150	20	425.251	425.251	8.525	.09	90	400	90	2.0
155	25	426.543	426.543	8.525	.09	90	400	90	2.0
160									
165				69.468	.740	712			
170									
175					.32				
ROTO PRESS:			TOTALS:				BP.:		
180									
185									
190									
195									
200									
205									
210									
215									
220									
225									
230									
235				298.760	3.52	2706	.32		
			TOTALS:			85	MAX VACC =		2.0
TOTAL Cu Ft.		42.543	TOTALS:	9.336	.110	545	AVG. BP:		30.09

PARTICULATE CATCH / MOISTURE DATA SHEET # 3

UNIT : F400 RUN : 4 DATE : 4-12-00

SCALE CHECK	LEVEL	ZEROED
INITIAL :	✓	✓
FINAL :	✓	✓

SCALE	WEIGHT
295.0 g	295.0
590.0 g	590.0
885.0 g	885.0

IMPINGER	#1	#2	#3	#4
FINAL WT	650.9	606.3	514.7	889.9
INITIAL WT	586.0	602.9	513.8	882.0
NET WT GRAMS	64.9	3.4	.9	7.9

TOTAL CATCH : 77.1 GRAMS H_2O

FRONT HALF

FILTER #	21F	
FINAL WT g	.7279	
INITIAL WT g	.6779	
NET WT g	.0500	

BEAKER #	66
DESC.	ACETONE
FINAL WT g	96.5429
INITIAL WT g	96.5141
NET WT g	.0288
VOL. DESC. m	100

BACK HALF

FILTER #	21B	
FINAL WT g	.4416	
INITIAL WT g	.4243	
NET WT g	.0173	

BEAKER #	67	68	69	76	
DESC.	ACETONE	METHCHLOR	H_2O	H_2O	
FINAL WT g	106.2949	94.1736	109.0120	107.5004	
INITIAL WT g	106.2278	94.1628	108.9976	107.4851	
NET WT g	.0671	.0108	.0144	.0153	.0297
VOL. DESC ml	125	75	150	150	(300)

FILTER TARE WEIGHTS DATA SHEET #4-1

Into Dessicator : Date : 4-10-2000 Time : 1725 By : DFW

Manufacturer S & S Grade : # 25 Glass Front Size : 11 cm Lot No. : ZB921

Back Size: 8.2 cm Lot No. : ZB911

	DATE: 4-11-2000	BY: DFW	DATE: 4-12-2000	BY: DFW	DATE:	BY:
FILTER #	FIRST WEIGHT	TIME	SECOND WEIGHT	TIME	THIRD WEIGHT	TIME
21B	.4240	1917	.4243	1103	✓ JOUL F400 R#4	
22B	.4422	1918	.4423	1104	✓	
23B	.4297	1919	.4300	1105	✓	
24B	.4333	1920	.4334	1106	✓	
25B	.4436	1921	.4437	1107	✓	
26B	.4279	1922	.4282	1108	✓	
27B	.4249	1923	.4248	1109	✓	
28B	.4256	1924	.4254	1110	✓	
29B	.4289	1925	.4292	1111	✓	
30B	.4397	1926	.4400	1112	✓	
21F	.6776	1927	.6779	1113	✓ JOUL F400 R#4	
22F	.6731	1928	.6734	1114	✓	
23F	.6675	1929	.6679	1115	✓	
24F	.6838	1930	.6839	1116	✓	
25F	.6708	1931	.6712	1117	✓	
26F	.6778	1932	.6774	1118	✓	
27F	.6783	1933	.6782	1119	✓	
28F	.6733	1934	.6737	1120	✓	
29F	.6711	1935	.6713	1121	✓	
30F	.6812	1936	.6814	1122	✓	

Checked by: C Washington Date: 4-12-00 Time: 1130

BALANCE ROOM ENVIRONMENTAL CONDITIONS

DATE	TIME	BY	WB	DB	% RH
4-11	1910	DFW	)	78	48
4-12	1100	DFW	)	76	49

BEAKER TARE WEIGHTS DATA SHEET #4-2

Into Dessicator: Date : 3-30-2000 Time : 1650 By : DFW

	DATE: 4-02	BY: DFW	DATE: 4-03	BY: DFW	DATE:	BY:
BEAKER #	FIRST WEIGHT	TIME	SECOND WEIGHT	TIME	THIRD WEIGHT	TIME
66	96.5139	2138	(96.5141)	0858	"	
67	106.2274	2139	(106.2278)	0859	"	
68	94.1625	2140	(94.1628)	0900	" TOTAL F40	
69	108.9982	2140	(108.9986)	0902	" R#4	
70	107.4848	2141	(107.4851)	0903	"	
71	105.3708	2142	(105.3711)	0904	"	
72	103.8323	2143	(103.8328)	0905	"	
73	104.3593	2143	(104.3597)	0906	"	
74	107.5138	2144	(107.5141)	0907	"	
75	99.6741	2145	(99.6746)	0909	"	
76	103.8082	2146	(103.8086)	0910	"	
77	107.3922	2146	(107.3926)	0911	"	
78	94.5009	2147	(94.5014)	0912	"	
79	97.6250	2148	(97.6255)	0912	"	
80	109.1320	2149	(109.1322)	0913	"	
81	101.4684	2149	(101.4687)	0914	"	
82	97.4829	2150	(97.4832)	0915	"	
83	98.3327	2151	(98.3331)	0917	"	
84	105.5598	2152	(105.5603)	0918	"	
85	98.0005	2153	(98.0006)	0919	"	
86	104.7508	2153	(104.7512)	0920	"	
87	105.9210	2154	(105.9215)	0921	"	
88	100.0093	2155	(100.0097)	0922	"	
89	120.6786	2156	(120.6788)	0923	"	
90	106.4104	2156	(106.4107)	0924	"	

BALANCE ROOM ENVIRONMENTAL CONDITIONS

DATE	TIME	BY	WB	DB	% RH	
4-1-00	2135	DFW		72	48	Checked by : C. Wadsworth
4-3-00	0855	DFW		78	48	Date : 4-3-2000
						Time : 1015

WOODSTOVE DATA SHEET # 4-3 : CONSTANT WEIGHTS

UNIT : F402 RUN : 4 DATE : 4-12-00

Beaker #	Date	Time	By	First Weight	Date	Time	By	Second Weight	Date	Time	By	Third Weight	Date	Time	By
66	4-13	2015		96.5434	4-14	2137		96.5429	4-16	1628					
67	4-13	2015		106.2954	4-14	2138		106.2949	4-16	1629					
68	4-13	2015		94.1740	4-14	2139		94.1736	4-16	1630					
69	4-13	2015		109.0133	4-14	2140		109.0130	4-16	1632					
70	4-13	2015		107.5008	4-14	2142		107.5004	4-16	1633					

Filter #	Date	Time	By	First Weight	Date	Time	By	Second Weight	Date	Time	By	Third Weight	Date	Time	By
21F	4-12	1630	CP	.7283	4-13	2150		.7279	4-14	1651					
21B	4-12	1630	CP	.4420	4-13	2151		.4416	4-14	1652					

SCALE ROOM ENVIRONMENTAL CONDITIONS

Weighing Session	Date	Time	By	WB	DB	%RH
1	4-13	2130			76	48
2	4-14	1640			75	49
3	4-14	2135			76	49
4	4-16	1625			78	44

Weighing Session	Date	Time	By	WB	DB	%RH
5						
6						
7						
8						

BLANK PROCESSING DATA SHEET # 5

UNIT : F400 RUN : 4 DATE : 4-12-2000

BLANKS DONE : 12-27-99

BEAKER	A	B	C
	200 ml ACETONE	75 ml DICHLOR	200 ml WATER
	FISHER OPTIMA LOT #	FISHER OPTIMA LOT #	
FINAL WEIGHT	108.9011	106.3073	106.9666
TARE WEIGHT	108.9003	106.3062	106.9651
NET WEIGHT	.0008	.0011	.0015

TARE BEAKERS INTO DESC : TIME : 11:30 DATE : 12-20-99

DATE : 1222 BY : DFW DATE : 1223 BY : DFW DATE : BY :

BEAKER	1 ST WT	TIME	2 ND WT	TIME	3 RD WT	TIME
A	108.8999	1940	108.9003	1948	✓	
B	106.3058	1941	106.3062	1949	✓	
C	106.9647	1942	106.9651	1950	✓	

FINAL BEAKERS INTO DESC : TIME : 1330 DATE : 12-24-99

DATE : 12-24 BY : DFW DATE : 12-25 BY : DFW DATE : 12-27 BY : DFW

BEAKER	1 ST WT	TIME	2 ND WT	TIME	3 RD WT	TIME
A	108.8999	2021	108.9016	1816	108.9011	1224 ✓
B	106.3061	2022	106.3077	1817	106.3073	1225 ✓
C	106.9643	2023	106.9670	1818	106.9666	1226 ✓

TARE QC

DATE	TIME	BY	WB	DB	%
12-22	1935	DFW		77	47
12-23	1945	DFW		75	48

FINAL QC

DATE	TIME	BY	WB	DB	%
1224	1945	DFW		76	45
12-25	1740	DFW		75	38
12-27	1210	DFW		76	46

NET PARTICULATE CATCH CALCULATION DATA SHEET #6

UNIT : F400 RUN : 4 DATE : 4-12-2000

BLANK CALCULATIONS

Acetone : .0008 g ÷ 200 ml = .000004 g/ml
Dicholoromethane : .0011 g ÷ 75 ml = .000015 g/ml
Distilled Water : .0015 g ÷ 200 ml = .000008 g/ml

FRONT HALF CATCH

FILTERS : .0500 (Total Catch) g - 1 (# of Filters) (.0000 g) (Blank Value / Filter) = .0500 g

BEAKERS : .0288 (Total Catch) g - 100 (ml Acetone) (.0004 / .000004 g) (Blank Value / ml Acetone) = .0284 g

TOTAL FRONT HALF CATCH : .0784 g

BACK HALF CATCH

FILTERS : .0173 (Total Catch) g - 1 (# of Filters) (.0000 g) (Blank Value / Filter) = .0173 g

BEAKERS :

Acetone : .0671 (Total Catch) g - 125 (ml Acetone) (.0005 / .000004 g) (Blank Value / ml Acetone) = .0666 g

Extract : .0108 (Total Catch) g - 75 (ml Dichloromethane) (.0011 / .000015 g) (Blank Value / Dichloromethane) = .0097 g

Water : .0297 (Total Catch) g - 300 (ml Water) (.0024 / .000008 g) (Blank Value / Water) = .0273 g

TOTAL BACK HALF CATCH : .1209 g

TOTAL CATCH : .1993 g

% FRONT HALF : 39.34 %

CALCULATIONS DATA SHEET # 7

UNIT : F400 RUN : 4 DATE : 4-12-2000

1) Vm (std) = $\dfrac{(42.543 \text{ Vm})(17.64)(.989 \text{ mcf})\left(30.09 \text{ " Hg} + \dfrac{.110 \text{ " } H_2O}{13.6}\right)}{(545 \text{ TmA})}$ = $\dfrac{40.9888}{000.0000}$ dscf

30.0981

2) Vw (std) = (.04707) (77.1 ml H_2O) = $\dfrac{3.6291}{00.0000}$ scf

3) Asw = $\dfrac{(3.6291 \text{ scf})}{(3.6291 \text{ scf} + 40.9888 \text{ dscf})}$ = $\dfrac{.0813}{.0000}$ Bws × 100 = $\dfrac{8.1337}{00.0000}$ % H_2O

44.6179

4) Cs = $\dfrac{(.1993 \text{ g.})}{(40.9888 \text{ dscf})}$ (15.43) = $\dfrac{.0750}{0.0000}$ gr / dscf

5) Estimated g / hr = $\dfrac{(.1993 \text{ g.})}{(40.9888 \text{ dscf})}$ ($\dfrac{9.336}{00.0000}$ dscfm) (60) = $\dfrac{2.7237}{00.0000}$ g / hr

Vm =	total cubic feet pulled on meter box during test	(p. 2)	(000.000 Vm)
mcf =	meter correction factor (Y factor) of meter box used for test	(p. 2)	(0.000 mcf)
" Hg =	average barometric pressure during test	(p. 2)	(00.00 " Hg)
" H_2O =	average delta H for test	(p. 2)	(.000 " H_2O)
TmA =	average meter temperature for test in degrees Absolute	(p. 2)	(000 TmA)
ml H_2O =	total water caught during test	(p. 3)	(000.0 ml H_2O)
g. =	total particulate catch for test	(p. 6)	(00.0000 g.)
dscfm =	average stack flow during test	(p. 2)	(00.000 dscf)

TEST DATA SHEET # 8

UNIT : F400 RUN : 4 DATE : 4-12-2000

Test Chamber Air Velocity Start : Ø Stop : Ø Avg.: Ø

Wet Bulb / Dry Bulb

Pre : WB : 60 DB : 74 = 43 % RH 1.3 % H_2O

Post : WB : 64 DB : 83 = 34 % RH 1.3 % H_2O

Average : 38.5 %RH 1.3 % H_2O

Empty Stove Weight (lbs) : _____ w/ stack & oil seal : Wet : _____ Dry : 390.0

Kindling Weight (lbs) : Paper : 1.2 Wood : 3.5

Preburn Fuel Weight : 10.1 + 8.6 + 12.4 + 2.4 + 2.1 Total : 35.6

Kindling & Preburn Fuel Weight (wood only) (lbs) : Total : 39.1

Coal Bed Wt Range (lbs) : 3.1 - 2.6 Scale : 393.1 - 392.6

Upper : .25 x fuel weight : Always round DOWN to nearest tenth

Lower : .20 x fuel weight : Always round UP to nearest tenth Actual Coal Bed Weight : 2.6

Maximum Coal Bed Removal (lbs) : ((3.1 (Upper) + 2.6 (Lower)) ÷ 2) .25 = .7

Test Fuel (.75" x 1.5" x 5" spacers) = 20 pcs

Dimensions	Length in inches	No. Pcs	Weight in lbs	% of Load
2" x 4"	13	3	5.2	40.9
4" x 4"	13	2	7.5	59.1

Test Fuel Weight : 12.7 lbs

Estimated Dry Burn Rate : 2.071

$$\frac{12.7 - (12.7 \times .16304)}{2.2046} \times \frac{60}{\frac{155}{\text{TIME}}} = 1.866 \text{ kg / hr}$$

Estimated BTU's/hr : $19{,}140 \times \frac{63}{100} \times \frac{1.866}{\text{DBR}} = 22{,}500.60$ BTU's/hr

EPA Default Efficiencies : Non-cat : 63 Cat : 72 Pellet : 78

WOOD STOVE OPERATING DATA PAGE #9

Unit : F400 Run : 4 Date : 4-12-2000

FIRE STARTED: 0835

WARM UP AND PREBURN:

PRIMARY AIR : Set wide open for all warm-up / preburn fuel charges. Then set to .5" at start of preburn.

SECONDARY AIR : N/A CAT BYPASS : N/A

CHARCOAL BED PREPARATION :

Raked and leveled prior to each warm-up / preburn charge. At 1 1/2 min. prior to loading last fuel, raked and leveled. In stove 35 sec.

TEST:

DOOR wide open during loading 0 min. 50 sec.

PRIMARY AIR : Opened full for first 5 min., then set to run setting of .5'.

SECONDARY AIR : N/A CAT BYPASS : N/A

FAN:

ON / (OFF) during warm-up

ON / (OFF) during preburn

ON / (OFF) first _____ minutes of test

ON / (OFF) balance of test run

Fan speed set at N/A

WOOD DATA: KINDLING: A mix of the grades listed below:

	SIZE	MILL	GRADE	SPECIES
PREBURN:	2x4	Manke/Tacoma	Std. or better	s. grn D fir
TEST:	2x4	Packwood	# 2 or better	s. grn D fir
	4x4	Packwood	# 2 or better	s. grn D fir

PELLET FUEL MANUFACTURER : N/A BRAND : N/A

All Grades WCLB rules:

WARM UP INFORMATION:

All pre-burn / warm up fuel pieces were either 12 or 16 inches.

1st warm up / pre-burn fuel charge (10.1 lbs.) added at 0850

2nd warm up / pre-burn fuel charge (8.6 lbs.) added at 0945

3rd warm up / pre-burn fuel charge (12.4 lbs.) added at 1025

4th warm up / pre-burn fuel charge (2.4 lbs.) added at 1145

5th warm up / pre-burn fuel charge (2.1 lbs.) added at 1215

TEST DATA SHEET #10

Unit : F400 Run : 4 Date : 4-12-2000

Room Temperature : 70 °F Correction Factor : Ø

Uncorrected Values are corrected for room temperature : Yes _____ No ✓

Time Test Fuel moisture reading taken : 1045

Calibration Checks : X ✓ Y ✓ 12.0 12.1 22.0 22.0

pc #	Dimen.	Use	TOP		BOTTOM		SIDE		Avg Corrected
			Uncor	Cor.	Uncor.	Cor.	Uncor.	Cor.	
1	2"×4"×8'	K	17.5	18.7	16.0	17.0	15.5	16.5	17.400
2									
3									
4	2"×4"×8'	P	18.0	19.2	18.5	19.8	18.5	19.8	19.600
5	2"×4"×8'	P	18.5	19.8	18.5	19.8	18.5	19.8	19.800
6	2"×4"×8'	P	21.0	22.5	22.0	23.7	21.5	23.1	23.100
7	2"×4"×8'	P							62.500
8	2"×4"×8'	P							
9									
10									
11	2×4×13	T	18.0	19.2	18.0	19.2	18.0	19.2	19.200
12	"	T	18.0	19.2	18.5	19.8	18.5	19.8	19.600
13	"	T	18.5	19.8	18.5	19.8	18.5	19.8	19.800
14	4×4×13	T	18.5	19.8	18.5	19.8	18.0	19.2	19.600
15	"	T	18.0	19.2	18.0	19.2	18.0	19.2	19.200
16									97.400
17									
18									
19									
20	Spacers	T	18.5	19.8	19.0	20.3	19.0	20.3	20.133

Key for Use : K = Kindling P = Pretest Fuel T = Test Fuel

	KINDLING	PRETEST FUEL	TEST FUEL
Dry Moisture % :	17.400 %	20.833 %	19.480 %
Wet Moisture % :	14.821 %	17.241 %	16.304 %

To obtain Wet from Dry : $\frac{100 \times \%\ \text{Dry Reading}}{100 + \%\text{Dry Reading}}$ = % Moisture, Wet Basis

Acceptable Ranges : 16 - 20 % wet: 19 - 25 % dry (17.5 - 22.5 on Meter Uncor. reading) at 70°

V GHT 39[illegible]

GAS DATA SHEET #2

UNIT: F400 RUN: 4 DATE: 4-12-2000 PAGE: 1 of 2

TIME	SCALE	FUEL	DROP	V.	CO_2	V.	O_2	V.	CO	BAL	WB	DB	% H_2O	CAL WB	STACK	STATIC	SO_2 PPM
0 1250	405.3	12.7	Ø	.228	5.7	–	–	.057	.57	9.9					439	-.054	325
5 55	404.8	12.2	.5	.283	7.1			.093	.93	7.6					476	-.055	350
10 1300	404.0	11.4	.8	.387	9.7			.053	.53	18.1					558	-.062	350
15 05	402.9	10.3	1.1	.546	13.7			.026	.26	51.8					646	-.065	325
20 10	401.9	9.3	1.0	.558	14.0			.009	.09	148.6					685	-.067	325
25 15	400.8	8.2	1.1	.579	14.5			.008	.08	172.6					697	-.068	325
30 20	399.8	7.2	1.0	.603	15.1			.010	.10	145.2					706	-.069	350
35 25	398.8	6.2	1.0	.602	15.1			.008	.08	179.4					713	-.070	350
40 30	398.0	5.4	.8	.587	14.7			.006	.06	229.6					702	-.070	350
45 35	397.3	4.7	.7	.528	13.2			.008	.08	157.3					670	-.068	350
50 40	396.7	4.1	.6	.422	10.6			.013	.13	78.7					615	-.066	350
55 45	396.2	3.6	.5	.376	9.4			.022	.22	41.9					586	-.064	350
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	7493	-.778	*****
60 1350	395.8	3.2	.4	.333	8.3			.048	.48	17.2					547	-.061	375
65 55	395.5	2.9	.3	.322	8.0			.052	.52	15.3					524	-.061	375
70 1400	395.2	2.6	.3	.308	7.7			.052	.52	14.7					494	-.059	375
75 05	394.8	2.2	.4	.301	7.5			.058	.58	12.9					484	-.059	375
80 10	394.6	2.0	.2	.301	7.5			.056	.56	13.3					474	-.056	375
85 15	394.3	1.7	.3	.310	7.7			.050	.50	15.4					471	-.054	375
90 20	394.0	1.4	.3	.290	7.2			.063	.63	11.4					451	-.052	400
95 25	393.8	1.2	.2	.266	6.6			.081	.81	8.1					434	-.050	425
100 30	393.7	1.1	.1	.266	6.6			.082	.82	8.1					422	-.050	400
105 35	393.5	.9	.2	.257	6.4			.086	.86	7.4					412	-.048	375
110 40	393.4	.8	.1	.250	6.2			.087	.87	7.1					404	-.048	400
115 45	393.3	.7	.1	.239	6.0			.106	1.06	5.6					392	-.046	375
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	5514	-.644	*****
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	13007	-1.422	*****

WEIGHT : 394.6

GAS DATA SHEET # 12

UNIT : F400 RUN : 4 DATE : 4-12-2000 PAGE : 2 of 2

TIME	SCALE	FUEL	DROP	V.	CO_2	V.	O_2	V.	CO	BAL	WB	DB	% H_2O	CAL WB	STACK	STATIC	SO_2 PPM
120 1450	393.2	.6	.1	.212	5.3	–	–	.112	1.12	4.7					378	.046	375
125 55	393.1	.5	.1	.209	5.2			.121	1.21	4.3					370	.045	375
130 1500	393.0	.4	.1	.195	4.9			.125	1.25	3.9					356	.043	400
135 05	392.9	.3	.1	.184	4.6			.140	1.40	3.3					350	.042	400
140 10	392.8	.2	.1	.196	4.9			.125	1.25	3.9					346	.042	400
145 15	392.8	.2	0	.197	4.9			.123	1.23	4.0					343	.041	400
150 20	392.7	.1	.1	.191	4.7			.106	1.06	4.5					336	.040	400
155 25	392.6	0	.1	.189	4.7			.108	1.08	4.3					330	.040	400
160 30																	
165 35																	
170 40																	
175 45																	
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	2819	-.339	*****
180 1550																	
																	÷32
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	15816	-1.761	*****
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	494	-.055	*****

PREBURN DATA SHEET #15

UNIT: F400 RUN: 4 DATE: 4-12-2000 PAGE: 1 of 1

TIME	SCALE	DROP	STACK	TOP	LF SIDE	BACK	RT SIDE	BOTTOM	FIREBOX	SEC/CAT	AMBIENT	STATIC	COMMENTS
0/1145	395.0	—	494	490	459	417	432	293	875	1033	76	.057	PREBURN START: # 1.9 UP
5/50	394.7	.3	509	517	453	415	426	296	859	1176	78	.058	COAL BED SCALE RANGE:
10/55	394.2	.5	491	518	448	410	415	294	827	1125	77	.057	393.1 - 392.6
15/1200	393.8	.4	490	513	438	402	402	290	809	1165	78	.056	PRIMARY AIR: .5
20/05	393.4	.4	496	518	430	397	394	284	802	1200	78	.056	SECONDARY AIR: N/A
25/10	393.1	.3	498	519	429	392	389	278	804	1238	77	.056	FAN: N/A
30/15	394.9	.3	484	524	428	383	385	272	796	1177	78	.056	PUMPS ON AT: 1215
35/20	394.5	.4	512	509	414	381	378	268	763	1254	79	.056	CHECK WB/DB: N/A
40/25	394.0	.5	495	511	403	376	379	263	738	1224	79	.056	
45/30	393.7	.3	492	506	396	373	381	261	716	1331	79	.055	added 2.1 at 1215
50/35	393.3	.4	486	509	388	368	380	257	713	1304	79	.055	
55/40	393.0	.3	490	513	385	363	380	256	720	1116	79	.056	
*****	****	***	****	*****	*****	****	*****	*****	*****	*****	*****	****	
60/1245	392.8	.2	467	494	380	359	383	257	718	1082	79	.056	
65/50	392.6	.2	439	399	378	394	360	253	739	833	81	.054	356.8 ΔT
70/55													
75/1300													
80/05													
/													
/													
/													
/													
/													
/													
/													

TEMPERATURE DATA SHEET # 14

UNIT: F400 RUN: 4 DATE: 4-12-2000 PAGE 1 of 2

TIME	TOP	LT SIDE	BACK	RT SIDE	BOTTOM	FIREBOX	SEC/CAT	AMBIENT	FURNACE	SAMPLE	SAMP IMP	C-GAS	GAS IMP	SO_2 IMP	3566
0/1250	476	378	357	381	257	734	957	79	1328	249	65	244	38	35	
5/55	496	371	351	369	258	820	1094	78	1340	250	45	244	37	35	
10/1300	545	350	342	341	256	613	1017	77	1334	251	46	237	36	36	
15/05	631	337	335	325	252	611	1357	77	1333	250	46	230	37	38	
20/10	701	333	326	316	246	628	1368	78	1333	250	46	238	38	35	
25/15	737	341	319	314	241	656	1429	78	1336	251	46	242	37	35	
30/20	753	361	314	321	237	699	1509	79	1340	251	46	244	37	35	
35/25	768	383	311	339	232	769	1517	79	1342	249	46	248	35	36	
40/30	768	399	310	358	230	807	1605	80	1341	250	47	250	35	36	
45/35	743	411	311	373	229	820	1591	81	1340	249	47	249	35	36	
50/40	688	426	315	386	228	841	1310	81	1341	249	48	248	36	36	
55/45	649	431	318	390	228	864	1221	82	1340	248	48	248	36	36	
TOTAL	7865	4521	3909	4213	2894	8862	15980	949	*****	*****	*****	*****	*****	*****	
60/1350	579	432	326	395	228	894	1202	82	1338	247	48	246	36	36	
65/55	569	428	333	397	230	903	1175	81	1336	246	48	245	36	35	
70/1400	539	420	343	398	231	899	1190	81	1335	245	49	247	37	36	
75/05	513	415	354	395	233	895	1154	81	1334	244	49	247	36	35	
80/10	499	411	362	393	233	891	1116	81	1333	244	49	244	35	35	
85/15	497	403	372	388	237	888	1116	82	1332	244	48	244	35	37	
90/20	482	398	379	386	239	894	1135	82	1332	244	49	246	37	36	
95/25	465	395	385	383	241	921	980	82	1332	245	49	246	37	36	
100/30	444	392	390	381	243	903	987	82	1332	245	49	251	37	36	
105/35	432	391	395	379	245	888	965	82	1332	246	49	250	35	34	
110/40	426	389	398	376	247	804	958	81	1333	246	50	248	36	34	
115/45	413	384	398	369	250	773	902	81	1333	247	50	246	34	36	
TOTAL	5878	4858	4435	4646	2857	10493	12880	978	*****	*****	*****	*****	*****	*****	
TOTAL	13743	9379	8344	8853	5751	19355	28,860	1927	*****	*****	*****	*****	*****	*****	

TEMPERATURE DATA SHEET # 14

UNIT: F400 RUN: 4 DATE: 4-12-2000 PAGE 2 of 2

TIME	TOP	LT SIDE	BACK	RT SIDE	BOTTOM	FIREBOX	SEC/CAT	AMBIENT	FURNACE	SAMPLE	SAMP IMP	C-GAS	GAS IMP	SO_2 IMP	3568
120 / 140	399	378	394	360	253	739	833	81	1333	247	50	247	35	36	
125 / 55	387	371	388	354	254	718	820	81	1333	247	50	248	36	37	
130 / 1500	371	366	379	345	256	698	808	83	1333	247	50	248	36	37	
135 / 05	364	362	375	341	256	701	756	83	1333	248	49	248	35	37	
140 / 10	354	355	366	335	256	706	774	83	1330	248	49	249	34	35	
145 / 15	349	350	360	331	258	700	781	83	1328	247	49	247	34	36	
150 / 20	343	347	350	326	260	698	728	83	1326	248	49	246	33	35	
155 / 25	334	339	342	322	261	682	724	83	1329	248	49	246	34	34	
160 / 30															
165 / 35															
170 / 40															
175 / 45															
TOTAL	2901	2868	2954	2714	2054	5642	6224	660	*****	*****	*****	*****	*****	*****	
180 / 1550															
				356.8											
				319.6											
			ΔT	-37.2											
									÷32						
TOTAL	16644	12247	11248	11567	7805	24997	35084	2587	*****	*****	*****	*****	*****	*****	
TOTAL	520	383	353	361	244	781	1,096	81	*****	*****	*****	*****	*****	*****	

ZERO / SPAN CHECK DATA SHEET #15-1

Date : 4-12-2000 Analyte : CO_2 (15-1)

Source : F400 Run # : 4

Zero Cyl. # : TX 79373 Conc. : 0.00 % CO_2 Cyl. Press. : 960 PSI

Certified by : AIR LIQUIDE Date : 9-22-1998

Span Cyl. # : CC52330 Conc. : 12.79 % CO_2 Cyl. Press. : 1750 PSI

Certified by : AIR LIQUIDE Date : 2-10-2000

Analyzer : Make : HORIBA Model : PIR-2000 SN : 407069

Range : 0 - 25.0 % CO_2 Analyzer Output : 0 - 1.0 v.

Flow : 1.5 SCFH Measured by : Rotameter

EPA Span Value = 25.0 % CO_2

EPA Control Limits = ± 2.5% of 25.0 % CO_2 = ± 0.625 % CO_2

Method 28 A = ± .2 % of 25.0 % CO_2 = ± .05 % CO_2

PRE RUN Audit : by : D. Washington Time : 1140 Temp : 76 °F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.1	.001	.023	.023 ✓	.091 ✓
SPAN	51.2	.512	12.79	51.3	.513	12.837	.047 ✓	.186 ✓

POST RUN Audit : by : D Washington Time : 1540 Temp : 75 °F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.2	.002	.002	.002 ✓	.009 ✓
SPAN	51.2	.512	12.79	51.3	.513	12.837	.047 ✓	.186 ✓

± Conc. Difference = Act % - Exp (Std) %

Zero % Difference = $\frac{\text{Act \% (ppm) - Exp \% (ppm)}}{\text{Full Scale Value}}$ X 100

Span % Difference = $\frac{\text{Act \% (ppm) - Exp \% (ppm)}}{\text{Full Scale Value}}$ X100

ZERO / SPAN CHECK DATA SHEET #15-2

Date : 4-12-2000 Analyte : O_2 (15-2)

Source : F400 Run # : 4

Zero Cyl. # : TX79373 Conc. : 0.00 % O_2 Cyl. Press. : 960 PSI

Certified by : AIR LIQUIDE Date : 9-22-1998

Span Cyl. # : CC52330 Conc. : 12.69 % O_2 Cyl. Press. : 1750 PSI

Certified by : AIR LIQUIDE Date : 2-10-2000

Analyzer : Make : TELEDYNE Model : 320 A SN : 37400

Range : 0 - 25.0 % O_2 Analyzer Output : 0 - 1.0 v.

Flow : 1.5 SCFH Measured by : Rotameter

EPA Span Value = 25.0 % O_2

EPA Control Limits = ± 2.5% of 25.0 % O_2 = ± 0.625 % O_2

Method 28 A = ± .2 % of 25.0 % O_2 = ± .05 % O_2

PRE RUN Audit : by : A. Washington Time : 1140 Temp : 76 ° F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.0	.001	0.00	0.00	.000
SPAN	12.7	.508	12.69	12.6	.506	12.637	.053	-.212

POST RUN Audit : by : A. Washington Time : 1540 Temp : 75 ° F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.0	.000	.025	.025	.100
SPAN	12.7	.508	12.69	12.7	.507	12.662	.028	-.112

± Conc. Difference = Act % - Exp (Std) %

Zero % Difference = $\frac{\text{Act \% (ppm) - Exp \% (ppm)}}{\text{Full Scale Value}}$ X 100

Span % Difference = $\frac{\text{Act \% (ppm) - Exp \% (ppm)}}{\text{Full Scale Value}}$ X100

ZERO / SPAN CHECK DATA SHEET #15-3

Date : 4-12-2000 Analyte : CO (15-3)

Source : F400 Run # : 4

Zero Cyl. # : TX79373 Conc. : 0.00 % CO Cyl. Press. : 960 PSI

Certified by : AIR LIQUIDE Date : 9-22-1998

Span Cyl. # : CC52330 Conc. : 4.75 % CO Cyl. Press. : 1750 PSI

Certified by : AIR LIQUIDE Date : 2-10-2000

Analyzer : Make : HORIBA Model : PIR-2000 SN : 408005

Range : 0 - 10.0 % CO Analyzer Output : 0 - 1.0 v.

Flow : 1.5 SCFH Measured by : Rotameter

EPA Span Value = 10.0 % CO

EPA Control Limits = ± 2.5% of 10.0 % CO = ± 0. 25 % CO

Method 28 A = ± .2 % of 10.0 % CO = ± .02 % CO

PRE RUN Audit : by : [signature] Time : 1140 Temp : 76 ° F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.0	.000	.004	.004 ✓	.042 ✓
SPAN	47.5	.475	4.75	47.2	.472	4.722 ✓	-.028 ✓	-.279 ✓

POST RUN Audit : by : [signature] Time : 1540 Temp : 75 ° F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.0	.000	.004	.004 ✓	.042 ✓
SPAN	47.5	.475	4.75	47.3	.473	4.732 ✓	-.018 ✓	-.179 ✓

± Conc. Difference = Act % - Exp (Std) %

Zero % Difference = $\frac{\text{Act \% (ppm) - Exp \% (ppm)}}{\text{Full Scale Value}}$ X 100

Span % Difference = $\frac{\text{Act \% (ppm) - Exp \% (ppm)}}{\text{Full Scale Value}}$ X100

ZERO / SPAN CHECK DATA SHEET #15-4

Date : 4-12-2000 Analyte : SO_2 (15-4)

Source : F400 Run # : 4

Zero Cyl. # : TX79373 Conc. : 0.00 ppm SO_2 Cyl. Press. : 960 PSI

Certified by : AIR LIQUIDE Date : 9-22-1998

Span Cyl. # : CC67475 Conc. : 1260 ppm SO_2 Cyl. Press. : 650 PSI

Certified by : AIR LIQUIDE Date : 9-22-1998

Analyzer : Make : HORIBA Model : PIR-2000 SN : 403019

Range : 0 - 2500 ppm SO_2 Analyzer Output : 0 - 1.0 v.

Flow : 1.5 SCFH Measured by : Rotameter

EPA Span Value = 2500 ppm SO_2

EPA Control Limits = ± 2.5% of 2500 ppm SO_2 = ± 62.5 ppm SO_2

PRE RUN Audit : by : D. Wadington Time : 1140 Temp : 76 °F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %	
	Meter	DVM	PPM	Meter	DVM	%			
ZERO	00.0	.000	00.0	00.3	.003	20.462 ✓	20.462 ✓	.818	✓
SPAN	50.4	.504	1260	50.0	.500	1250.200	-9.800 ✓	-.392	✓

POST RUN Audit : by : D. Wadington Time : 1535 Temp : 77 °F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %	
	Meter	DVM	PPM	Meter	DVM	%			
ZERO	00.0	.000	00.0	00.3	.003	20.462 ✓	20.462 ✓	.818	✓
SPAN	50.4	.504	1260	50.1	.501	1252.674 ✓	-7.326 ✓	-.293	✓

± Conc. Difference = Act % - Exp (Std) %

Zero % Difference = $\frac{\text{Act \% (ppm) - Exp \% (ppm)}}{\text{Full Scale Value}}$ X 100

Span % Difference = $\frac{\text{Act \% (ppm) - Exp \% (ppm)}}{\text{Full Scale Value}}$ X100

QUALITY CHECKS DATA SHEET # 16

UNIT: F400 RUN: 4 DATE: 4-12-2000

Thermocouple Check :

T/C # 1	— °F	T/C # 13	68.5 °F
T/C # 2	— °F	T/C # 14	67.3 °F
T/C # 3	68.1 °F	T/C # 15	69.4 °F
T/C # 4	64.2 °F	T/C # 16	60.4 °F
T/C # 5	63.7 °F	T/C # 17	60.2 °F
T/C # 6	63.5 °F	T/C # 18	70.5 °F
T/C # 7	63.6 °F	T/C # 19	64.6 °F
T/C # 8	63.3 °F	T/C # 20	61.6 °F
T/C # 9	64.3 °F	T/C # 21	— °F
T/C # 10	64.5 °F	T/C # 22	— °F
T/C # 11	61.2 °F	T/C # 23	65.2 °F
T/C # 12	72.0 °F	T/C # 24	— °F

Thermocouple Readout :

Pretest zero and span check and calibration

ZERO : .9 °F Adj. to 0.0 °F

SPAN : 1998.4 °F Adj. to 2000.0 °F

post test zero and span

ZERO .5 °F Difference .025 %

SPAN 2003.6 °F Difference .180 %

Thermocouple Readout Pretest Linearity Check

0	= 0.0 °F	200	= 201.6 °F	400	= 399.0 °F
600	= 601.2 °F	800	= 801.3 °F	1000	= 1000.4 °F
1200	= 1198.1 °F	1400	= 1399.0 °F	1600	= 1599.6 °F
1800	= 1799.9 °F	2000	= 2000.0 °F		

Sample Train Leak Check	Pre ✓	Post ✓
C-gas Train Leak Check	Pre X	Post ✓
SO_2 Train Leak Check	Pre X	Post ✓
Static Gauge Zero Check	Pre X	Post ✓

Scale Check Pre : 403.6 − 393.6

Post : 402.4 − 392.4

Stack Cleaned Prior to Test Run : YES ____ NO X

TABLE 1 ----- RAW DATA

CLIENT : Jotul TEST No. : 2

MODEL: F400 DATE: 10-Apr-00

TIME (MIN.)	METER READING (C F)	DELTA H (IN. H2O)	METER TEMP. (DEG. F)	PERCENT CO (%)	PERCENT CO2 (%)	SO2 COCENTR. PPM
0	253.500	0.150	80	0.87	6.30	325
5	255.500	0.170	80	0.86	11.00	300
10	257.694	0.170	81	0.30	12.90	300
15	259.897	0.170	83	0.13	15.30	300
20	262.115	0.140	84	0.14	16.20	325
25	264.171	0.140	85	0.12	16.00	325
30	266.234	0.140	85	0.13	15.40	325
35	268.298	0.140	87	0.17	15.90	325
40	270.376	0.140	88	0.06	14.20	325
45	272.462	0.140	88	0.04	12.00	325
50	274.549	0.140	89	0.05	10.00	325
55	276.642	0.140	89	0.34	8.30	325
60	278.736	0.120	89	0.61	7.80	350
65	280.681	0.120	89	0.78	7.50	350
70	282.625	0.120	89	0.89	7.30	350
75	284.569	0.110	89	0.96	6.90	375
80	286.384	0.120	89	0.91	6.90	350
85	288.329	0.120	89	0.71	7.10	350
90	290.273	0.140	90	0.53	7.50	325
95	292.375	0.120	90	0.73	6.50	350
100	294.326	0.140	90	0.82	6.30	325
105	296.428	0.140	90	0.92	5.70	325
110	298.529	0.140	90	0.84	5.40	325
115	300.630	0.140	90	0.88	5.30	325
120	302.732	0.140	90	1.05	5.00	325
125	304.833	0.140	90	1.01	5.00	325
130	306.935	0.140	90	0.77	5.20	325
135						

TABLE 2---RAW DATA

CLIENT : Jotul TEST No. 2

MODEL: F400 DATE: 10-Apr-00

****

METER CAL. FACTOR (Y)	0.989		Wt. WOOD BURNED(LB)	13.3	Lbs
BAROMETRIC PRESS.(Pb)	30.21	in Hg	WET,FUEL MOISTURE %	17.164	%
LEAK RATE POST (Lp)	0.006	cfm	Wt. PART. COLLECTED	0.1751	g
WATER VOL. (V1c)	104.1	Ml	METER VOLUME Vm	53.435	mcf
TEST TIME (MIN)	130	min	HC MOLE FRACTION	0.0132	

TABLE 3 -----FIELD DATA AVERAGES

CLIENT :Jotul TEST No. 2

MODEL: F400 DATE: 10-Apr-00

****

AVG DELTA H	-------	0.14	in H2O	AVG PRCNT CO	-------	0.58	%
AVG METER TEMP. Tm	-------	88	deg F	AVG PRCNT CO2	-------	9.22	%
AVG PPM SO2	-------	330	PPM	AVG BAL CO2/CO	-------	15.93	%

TABLE 4 ----- CALCULATIONS

CLIENT : Jotul TEST No. 2

MODEL: F400 DATE: 10-Apr-00

****

STD SAMPLE VOL. Vm(std) -----	51.48	dscf	STACK GAS FLOW Qsd -------	747.182	dscf/Hr & 12.45 dscf/min
VOL. WATER VAPOR Vw(std) ----	4.900	scf	PARTICULATE CONCTRT. Cs ------	0.0034	g/dscf
PRCNT MSTR Bws -------	8.69	%	PARTC.EMISS. RATE E -------	2.54	g/Hr
BURN RATE BR -------	2.31	Kg/Hr	MOLES OF GAS PER Lb WOOD Nt --	0.38	Lb-mole/Lb
CO EMISSION RATE -------	144.76 & 62.77	g/Hr g/Kgdry fuel	PART.EMISS. RATE ------	1.10	g/Kgdry fuel

TABLE 5 ----- PROPORTIONAL RATE VARIATION

CLIENT : Jotul TEST No. : 2

MODEL: F400 DATE: 10-Apr-00

TIME INTEVAL Ti	PPM * Vm	PROPRTN. RATE VAR. PR	PROPRTN RATE VAR. AVERAGE
5	635.0	97	100
10	642.4	99	
15	643.3	99	
20	645.9	99	
25	647.4	99	
30	649.0	100	
35	648.1	99	
40	650.7	100	
45	652.6	100	
50	652.3	100	
55	653.6	100	
60	653.9	100	
65	654.1	100	
70	653.7	100	
75	653.7	100	
80	653.9	100	
85	654.1	100	
90	653.2	100	
95	655.2	101	
100	654.9	101	
105	655.2	101	
110	654.9	101	
115	654.9	101	
120	655.2	101	
125	654.9	101	
130	655.2	101	
135			
140			

COMPUTER INPUT DATA SHEET #1

2,1395

Client: JOTUL U.S.A., INC.

Address: 400 RIVERSIDE STREET

PORTLAND ME. 04104

2.54 at 231 kg/hr

Phone: 207-797-5912 Fax: 207-772-0523

Run No.: 2 Date of Test: 4-10-2000 Burn Rate: 2.306

Model No.: F400 ☐ min ☐ min-1.25 ☐ fan

Stove Type: ☐ Cat ☒ Non Cat ☐ Pellet ☐ 1.25-1.9 ☒ max ☐ insert

Dry Gas Meter: Y Factor: .989 (0.000) (Data Sheet #2) Post Leak Rate: .006 cfm (.000) (Data Sheet #2) Time: 130 min. (000) (Data Sheet #2)

Dry Gas Meter Volume: 53.435 cf (00.000) (Data Sheet #2)

Stack Flow: 10.469 dscfm (00.000) (Data Sheet #2) Δ H: .138 in. H_2O (.000) (Data Sheet #2)

Barometric Pressure: 30.21 in. Hg (00.00) (Data Sheet #2)

H_2O Captured: 104.1 g (00.0) (Data Sheet #3)

Total Particulate Catch: .1751 g (0.0000) (Data Sheet #6)

Flue Gas Moisture: 8.7020 % (00.000) (Data Sheet #7)

Particulate Emission: .0526 gr/dscf (0.0000) (Data Sheet #7)

Ambient Moisture: 1.2 % (0.00) (Data Sheet #8)

Stove Weight: — lbs (000) (Data Sheet #8)

Total Fuel Consumed During Burn: 13.3 lbs (00.0) (Data sheet #8)

Fuel Higher Heating Value (dry): — BTU/lb (0000) (Data Sheet #8)

Fuel % Moisture (dry): 20.720 % (wet): 17.164 % (00.00) (Data Sheet #10)

Stack Static Pressure: .056 in. H_2O (0.000) (Data Sheet #12)

Temperature (Average Room) Combustion Air: 81 °F (00) Data Sheet #14)

Stove Temperature Change: -31.2 °F (00.0) (Data Sheet #14)

METER BOX DATA SHEET PAGE # 2

Page: 1 of 2

UNIT: F400 RUN: 2 DATE: 4-10-2000

Meter Box: 5H Y Factor: .989

Leak checks: 16 " Hg @ .005 cfm _____ " Hg @ _____ cfm

16 " Hg @ .006 cfm _____ " Hg @ _____ cfm

Inject SO^2 @ 100 cc/min. Nozzle: Probe @ 3/8 " od Initial Volume: 2.000

ROTO: PRESS: .15			SAMPLING RATIO: 36 : 1				BP: 30.22		
MIN	TIME	METER READING	SAMPLE MDCF	STACK DSCFM	DELTA H	METER TEMP	SO2 PPM	ROTO TEMP	PUMP VACC
0	1420	253.500	—	10.737	.15	80	325	80	2.0
5	25	255.500	—	11.632	.17	80	300	80	2.0
10	30	257.694	257.694	11.610	.17	81	300	81	3.0
15	35	259.897	259.897	11.567	.17	83	300	83	3.0
20	40	262.115	262.115	10.658	.14	84	325	84	3.0
25	45	264.171	264.171	10.638	.14	85	325	85	3.0
30	50	266.234	266.234	10.638	.14	85	325	85	3.0
35	55	268.298	268.298	10.599	.14	87	325	87	3.0
40	1500	270.376	270.376	10.580	.14	88	325	88	3.0
45	05	272.462	272.462	10.580	.14	88	325	88	3.0
50	10	274.549	274.549	10.561	.14	89	325	89	3.0
55	15	276.642	276.642	10.561	.14	89	325	89	3.0
ROTO PRESS: .15			TOTALS:	130.361	1.78	1019	BP.: 30.22		
60	1520	278.736	278.736	9.806	.12	89	350	89	3.0
65	25	280.681	280.681	9.806	.12	89	350	89	3.0
70	30	282.625	282.625	9.806	.12	89	350	89	3.0
75	35	284.569	284.569	9.153	.11	89	375	89	3.0
80	40	286.384	286.384	9.806	.12	89	350	89	3.0
85	45	288.329	288.329	9.806	.12	89	350	89	3.0
90	50	290.273	290.273	10.542	.14	90	325	90	3.0
95	55	292.375	292.375	9.789	.12	90	350	90	3.0
100	1600	294.326	294.326	10.542	.14	90	325	90	3.0
105	05	296.428	296.428	10.542	.14	90	325	90	3.0
110	10	298.529	298.529	10.542	.14	90	325	90	3.0
115	15	300.630	300.630	10.542	.14	90	325	90	3.0
			TOTALS:	120.682	1.53	1074	MAX VACC =		
TOTAL Cu Ft.			TOTALS:	251.043	3.31	2093	AVG. BP:		

METER BOX DATA SHEET PAGE # 2

Page: 2 of 2

UNIT: F400 RUN: 2 DATE: 4-10-2000

Meter Box: SH Y Factor: .989

Leak checks: 16 " Hg @ .005 cfm _____ " Hg @ _____ cfm

16 " Hg @ .006 cfm _____ " Hg @ _____ cfm

Inject SO^2 @ 100 cc/min. Nozzle : Probe @ 3/8 " od Initial Volume: 2.000

ROTO: PRESS: .15 SAMPLING RATIO: 36 : 1 BP: 30.20

MIN	TIME	METER READING	SAMPLE MDCF	STACK DSCFM	DELTA H	METER TEMP	SO2 PPM	ROTO TEMP	PUMP VACC
120	1620	302.732	302.732	10.542	.14	90	325	90	3.0
125	25	304.833	304.833	10.542	.14	90	325	90	3.0
130	30	306.935	306.935	10.542	.14	90	325	90	3.0
135				31.624	(.42)	270			
140									
145									
150									
155									
160									
165									
170									
175									
ROTO PRESS:			TOTALS:				BP.:		
180									
185									
190									
195									
200									
205									
210									
215									
220									
225									
230									
235						2363	1.21		
			TOTALS:	282.469	3.23	88	MAX VACC =		3.0
TOTAL Cu Ft.		53.435	TOTALS:	10.469	.138	548	AVG. BP:		30.21

PARTICULATE CATCH / MOISTURE DATA SHEET # 3

UNIT : F 400 RUN : 2 DATE : 4-10-00

SCALE CHECK	LEVEL	ZEROED
INITIAL :	✓	✓
FINAL :	✓	✓

SCALE	WEIGHT
295.0 g	295.0
590.0 g	590.0
885.0 g	885.0

IMPINGER	#1	#2	#3	#4
FINAL WT	684.1	589.1	515.5	868.1
INITIAL WT	600.0	582.6	513.7	856.4
NET WT GRAMS	84.1 ✓	6.5 ✓	1.8 ✓	11.7 ✓

TOTAL CATCH : 104.1 ✓ GRAMS H_2O

FRONT HALF

FILTER #	19F	
FINAL WT g	.7202	✓
INITIAL WT g	.6745 ✓	
NET WT g	.0457 ✓	

BEAKER #	56	
DESC.	ACETONE	
FINAL WT g	104.1932	✓
INITIAL WT g	104.1710	✓
NET WT g	.0222	✓
VOL. DESC. m	100	

BACK HALF

FILTER #	19B	
FINAL WT g	.4401	✓
INITIAL WT g	.4285 ✓	
NET WT g	.0116 ✓	

BEAKER #	57	58	59	60	
DESC.	ACETONE	METHCHLOR	H_2O	H_2O	
FINAL WT g	97.4526 ✓	96.9187 ✓	105.3735 ✓	106.7502 ✓	
INITIAL WT g	97.4114 ✓	96.8960 ✓	105.3557 ✓	106.7316 ✓	
NET WT g	.0412 ✓	.0227 ✓	.0178 ✓	.0186 ✓	.0364 ✓
VOL. DESC ml	140	75	150	175	(325)

WOODSTOVE DATA SHEET #4-1
INITIAL FILTER WEIGHTS (TARE WEIGHTS)

Into Dessicator: Date 10-28-99 Time: 1725 By: MG

Manufacturer: S+S Grade: #25 GLASS Front Size: 11 CM Lot No.: ZB921

Back Size: 8.2 CM Lot No.: ZB911

	DATE: 11-1	BY: MG	DATE: 11-4	BY: MG	DATE:	BY:
FILTER #	FIRST WEIGHT	TIME	SECOND WEIGHT	TIME	THIRD WEIGHT	TIME
11B	.4291	1911	.4291	1818	JOTUL #3CB R#4	
12B	.4316	1912	.4313	1819	JOTUL #3CBII R#1	
13B	.4299	1913	.4298	1820	JOTUL #3CBII R#2	
14B	.4306	1914	.4306	1821	JOTUL #3CBII R#3	
15B	.4313	1915	.4313	1822	JOTUL #3CBII R#4	
16B	.4319	1916	.4315	1822		
17B	.4278	1916	.4277	1823		
18B	.4302	1917	.4300	1824	JOTUL F400 R#1	
19B	.4288	1918	.4285	1825	JOTUL F400 R#2	
20B	.4340	1919	.4340	1826	JOTUL F400 R#3	
11F	.66610	1928	.6659	1835	JOTUL #3CB R#4	
12F	.6837	1929	.6833	1836	JOTUL #3CBII R#1	
13F	.6707	1930	.6704	1837	JOTUL #3CBII R#2	
14F	.6719	1931	.6722	1838	JOTUL #3CBII R#3	
15F	.6673	1932	.6674	1839	JOTUL #3CBII R#4	
16F	.6809	1933	.6806	1840		
17F	.6657	1934	.66054	1840		
18F	.6693	1935	.6690	1841	JOTUL F400 R#1	
19F	.6744	1935	.6745	1842	JOTUL F400 R#2	
20F	.6654	1936	.6655	1843	JOTUL F400 R#3	

Checked by: [signature] Date: 11-4-99 Time: 1905

BALANCE ROOM ENVIRONMENTAL CONDITIONS

DATE	TIME	BY	WB	DB	% RH
11-1	1815	MG	5	73	46
11-4	1805	MG	5	76	46

BEAKER TARE WEIGHTS DATA SHEET #4-2

Into Dessicator: Date : 1-18-2000 Time : 0700 By : [illegible]

	DATE: 1-21-00	BY: [illegible]	DATE: 1-23-00	BY:	DATE:	BY:
BEAKER #	FIRST WEIGHT	TIME	SECOND WEIGHT	TIME	THIRD WEIGHT	TIME
56	104.1714	2134	(104.1710)	1231		
57	97.4119	2134	(97.4114)	1233		
58	96.8964	2135	(96.8960)	1234	JOTUL F400	
59	105.3560	2136	(105.3557)	1235	R#2	
60	106.7320	2137	(106.7316)	1236		
61	99.3472	2138	(99.3467)	1236		
62	97.8661	2139	(97.8657)	1237		
63	93.2148	2140	(93.2146)	1238	JOTUL F400	
64	104.7871	2140	(104.7866)	1239	R#3	
65	98.4457	2141	(98.4461)	1240		

BALANCE ROOM ENVIRONMENTAL CONDITIONS

DATE	TIME	BY	WB	DB	% RH	
1-21	2115	[illegible]		77	47	Checked by : [illegible]
1-23	1210	[illegible]		73	44	Date : 1-23-00
						Time : 12:41

WOODSTOVE DATA SHEET # 4-3 : CONSTANT WEIGHTS

UNIT : F400 RUN : 2 DATE : 4-10-00

Beaker #	Date	Time	By	First Weight	Date	Time	By	Second Weight	Date	Time	By	Third Weight	Date	Time	By
56	4-11	1100		104.1928	4-12	1734		104.1932	4-13	2133		✓			
57	4-11	1145		97.4521	4-12	1735		97.4526	4-13	2135		✓			
58	4-11	1100		96.9183	4-12	1736		96.9187	4-13	2136		✓			
59	4-11	1100		105.3724	4-12	1737		105.3734	4-13	2137		105.3735	4-14	1644	✓
60	4-11	1100		106.7498	4-12	1738		106.7502	4-13	2139		✓			

Filter #	Date	Time	By	First Weight	Date	Time	By	Second Weight	Date	Time	By	Third Weight	Date	Time	By
19F	4-10	1730	CP	.7206	4-11	1155		.7202	4-11	1914		✓			
19B	4-10	1730	CP	.4405	4-11	1156		.4401	4-11	1915		✓			

SCALE ROOM ENVIRONMENTAL CONDITIONS

Weighing Session	Date	Time	By	WB	DB	%RH
1	4-11	1150			78	48
2	4-11	1910			78	48
3	4-12	1730			77	49
4	4-13	2130			77	48

Weighing Session	Date	Time	By	WB	DB	%RH
5	4-14	1640			75	49
6						
7						
8						

BLANK PROCESSING DATA SHEET # 5

UNIT : F400 RUN : 2 DATE : 4-10-2000

BLANKS DONE : 12-27-99

BEAKER	A	B	C
	200 ml ACETONE	75 ml DICHLOR	200 ml WATER
	FISHER OPTIMA LOT #	FISHER OPTIMA LOT #	
FINAL WEIGHT	108.9011	106.3073	106.9666
TARE WEIGHT	108.9003	106.3062	106.9651
NET WEIGHT	.0008	.0011	.0015

TARE BEAKERS INTO DESC : TIME : 11:30 DATE : 12-20-99

DATE : 12-22 BY : DFW DATE : 12-23 BY : DFW DATE : BY :

BEAKER	1 ST WT	TIME	2 ND WT	TIME	3 RD WT	TIME
A	108.8999	1940	108.9003	1948	✓	
B	106.3058	1941	106.3062	1949	✓	
C	106.9647	1942	106.9651	1950	✓	

FINAL BEAKERS INTO DESC : TIME : 1330 DATE : 12-24-99

DATE : 12-24 BY : DFW DATE : 12-25 BY : DFW DATE : 12-27 BY : DFW

BEAKER	1 ST WT	TIME	2 ND WT	TIME	3 RD WT	TIME
A	1088999	2021	108.9016	1816	108.9011	1224 ✓
B	106.3061	2022	106.3077	1817	106.3073	1225 ✓
C	106.9643	2023	106.9670	1818	106.9666	1226 ✓

TARE QC

DATE	TIME	BY	WB	DB	%
12-22	1935	DFW		77	47
12-23	1945	DFW		75	48

FINAL QC

DATE	TIME	BY	WB	DB	%
12-24	1945	DFW		76	45
12-25	1740	DFW		75	38
12-27	1210	DFW		76	46

NET PARTICULATE CATCH CALCULATION DATA SHEET #6

UNIT: F400 RUN: 2 DATE: 4-10-2000

BLANK CALCULATIONS

Acetone: .0008 g ÷ 200 ml = .000004 g/ml
Dicholoromethane: .0011 g ÷ 75 ml = .000015 g/ml
Distilled Water: .0015 g ÷ 200 ml = .000008 g/ml

FRONT HALF CATCH

FILTERS: .0457 ✓ g - 1 (.0000 g) = .0457 ✓ g
Total Catch # of Filters Blank Value / Filter

BEAKERS: .0222 ✓ g - 100 (.0004 .000004 g) = .0218 ✓ g
Total Catch ml Acetone Blank Value / ml Acetone

TOTAL FRONT HALF CATCH: .0675 ✓ g

BACK HALF CATCH

FILTERS: .0116 ✓ g - 1 (.0000 g) = .0116 ✓ g
Total Catch # of Filters Blank Value / Filter

BEAKERS:
Acetone: .0412 ✓ g - 140 (.0006 .000004 g) = .0406 ✓ g
Total Catch ml Acetone Blank Value / ml Acetone

Extract: .0227 ✓ g - 75 (.0011 .000015 g) = .0216 ✓ g
Total Catch ml Dichloromethane Blank Value / Dichloromethane

Water: .0364 ✓ g - 325 (.0026 .000008 g) = .0338 ✓ g
Total Catch ml Water Blank Value / Water

TOTAL BACK HALF CATCH: .1076 ✓ g

TOTAL CATCH: .1751 ✓ g

% FRONT HALF: 38.55 ✓ %

CALCULATIONS DATA SHEET # 7

UNIT : F400 RUN : 2 DATE : 4-10-2000

1) Vm (std) = $\dfrac{(53.435\ \text{Vm})(17.64)(.989\ \text{mcf})\left(30.21\ \text{" Hg} + \dfrac{.138\ \text{" } H_2O}{13.6}\right)}{(548\ \text{TmA})} = \dfrac{51.4086}{000.0000}$ dscf

(30.2201)

2) Vw (std) = (.04707)(104.1 ml H_2O) = $\dfrac{4.9000}{00.0000}$ scf

3) Asw = $\dfrac{(4.9000\ \text{scf})}{(4.9000\ \text{scf} + 51.4086\ \text{dscf})} = \dfrac{.0870}{.0000}$ Bws × 100 = $\dfrac{8.7020}{00.0000}$ % H_2O

56.3086

4) Cs = $\dfrac{(.1751\ \text{g.})}{(51.4086\ \text{dscf})}$ (15.43) = $\dfrac{.0526}{0.0000}$ gr / dscf

5) Estimated g / hr = $\dfrac{(.1751\ \text{g.})}{(51.4086\ \text{dscf})}$ ($\dfrac{10.469}{00.0000}$ dscfm) (60) = $\dfrac{2.1395}{00.0000}$ g / hr

Vm =	total cubic feet pulled on meter box during test	(p. 2)	(000.000 Vm)
mcf =	meter correction factor (Y factor) of meter box used for test	(p. 2)	(0.000 mcf)
" Hg =	average barometric pressure during test	(p. 2)	(00.00 " Hg)
" H_2O =	average delta H for test	(p. 2)	(.000 " H_2O)
TmA =	average meter temperature for test in degrees Absolute	(p. 2)	(000 TmA)
ml H_2O =	total water caught during test	(p. 3)	(000.0 ml H_2O)
g. =	total particulate catch for test	(p. 6)	(00.0000 g.)
dscfm =	average stack flow during test	(p. 2)	(00.000 dscf)

TEST DATA SHEET # 8

UNIT : F400 RUN : 2 DATE : 4-10-2000

Test Chamber Air Velocity Start : Ø Stop : Ø Avg.: Ø

Wet Bulb / Dry Bulb

Pre : WB : 61 DB : 78 = 36 % RH 1.2 % H_2O

Post : WB : 61 DB : 78 = 36 % RH 1.2 % H_2O

Average : 36 %RH 1.2 % H_2O

Empty Stove Weight (lbs) : ✓ w/ stack & oil seal : Wet : ✓ Dry : 390.3

Kindling Weight (lbs) : Paper : .2 Wood : 2.8

Preburn Fuel Weight : 12.1 + 14.0 + 12.3 Total : 38.4

Kindling & Preburn Fuel Weight (wood only) (lbs) : Total : 41.2

Coal Bed Wt Range (lbs) : 3.3 - 2.7 Scale : 393.6 - 393.0

Upper : .25 x fuel weight : Always round DOWN to nearest tenth

Lower : .20 x fuel weight : Always round UP to nearest tenth Actual Coal Bed Weight : 2.7

Maximum Coal Bed Removal (lbs) : ((3.3 (Upper) + 2.7 (Lower)) ÷ 2) .25 = .7

Test Fuel (.75" x 1.5" x 5" spacers) = 20. pcs

Dimensions	Length in inches	No. Pcs	Weight in lbs	% of Load
2" x 4"	13	3	5.3	39.8
4" x 4"	13	2	8.0	60.2

Test Fuel Weight : 13.3 lbs

Estimated Dry Burn Rate : 2.283

$$\frac{13.3 - (13.3 \times .17164)}{2.2046} \times \frac{60}{\frac{130}{\text{TIME}}} = 2.306 \text{ kg / hr}$$

Estimated BTU's/hr : 19,140 x $\frac{63}{100}$ x $\frac{2.306}{\text{DBR}}$ = 27,80621 BTU's/hr

EPA Default Efficiencies : Non-cat : 63 Cat : 72 Pellet : 78

WOOD STOVE OPERATING DATA PAGE #9

Unit : F400 Run : 2 Date : 4-10-2000

FIRE STARTED: 1000

WARM UP AND PREBURN:

PRIMARY AIR : Set wide open for all warm-up / preburn fuel charges. Then set to wide open at start of preburn.

SECONDARY AIR : N/A CAT BYPASS : N/A

CHARCOAL BED PREPARATION :

Raked and leveled prior to each warm-up / preburn charge. At 1 1/2 min. prior to loading last fuel, raked and leveled. In stove 45 sec.

TEST:

DOOR wide open during loading 0 min. 50 sec.

PRIMARY AIR : Opened full for first 5 min., then set to run setting of wide open.

SECONDARY AIR : N/A CAT BYPASS : N/A

FAN:

ON / (OFF) during warm-up

ON / (OFF) during preburn

ON / (OFF) first ALL minutes of test

ON / (OFF) balance of test run

Fan speed set at N/A

WOOD DATA: KINDLING: A mix of the grades listed below:

	SIZE	MILL	GRADE	SPECIES
PREBURN:	2x4	Manke/Tacoma	Std. or better	s. grn D fir
TEST:	2x4	Packwood	# 2 or better	s. grn D fir
	4x4	Packwood	# 2 or better	s. grn D fir

PELLET FUEL MANUFACTURER : N/A BRAND : N/A

All Grades WCLB rules:

WARM UP INFORMATION:

All pre-burn / warm up fuel pieces were either 12 or 16 inches.

1st warm up / pre-burn fuel charge (12.1 lbs.) added at 1015

2nd warm up / pre-burn fuel charge (14.0 lbs.) added at 1115

3rd warm up / pre-burn fuel charge (12.3 lbs.) added at 1245

4th warm up / pre-burn fuel charge (_____ lbs.) added at _____

5th warm up / pre-burn fuel charge (_____ lbs.) added at _____

TEST DATA SHEET #10

Unit : F400 Run : 2 Date : 4-10-2000

Room Temperature : 69 °F Correction Factor : 4

Uncorrected Values are corrected for room temperature : Yes _____ No ✓

Time Test Fuel moisture reading taken : 1205

Calibration Checks : X ✓ Y ✓ 12.0 12.1 22.0 22.1

pc #	Dimen.	Use	TOP		BOTTOM		SIDE		Avg Corrected
			Uncor	Cor.	Uncor.	Cor.	Uncor.	Cor.	
1	2"×4"×8'	K	12.5	13.3	14.0	14.9	14.0	14.9	14.367
2									
3									
4	2"×4"×8'	P	17.5	18.7	18.0	19.2	17.5	18.7	18.867
5	2"×4"×8'	P	18.5	19.8	18.5	19.8	18.5	19.8	19.800
6	2"×4"×8'	P	19.0	20.3	19.0	20.3	19.5	20.9	20.500
7	2"×4"×8'	P	18.3	19.8	18.0	19.2	18.5	19.8	19.600
8	2"×4"×8'	P							78.767
9									
10									
11									
12									
13	2×4×13	T	17.5	18.7	17.5	18.7	18.0	19.2	18.867
14	"	T	19.0	20.3	19.5	20.9	18.5	19.8	20.333
15	"	T	18.5	19.8	18.5	19.8	19.0	20.3	19.967
16	4×4×13	T	18.0	19.2	18.0	19.2	18.5	19.8	19.406
17	"	T	23.5	25.2	23.5	25.2	23.0	24.7	25.033
18									103.606
19									
20	Spacers	T	19.5	20.9	18.0	19.2	18.0	19.2	19.767

Key for Use : K = Kindling P = Pretest Fuel T = Test Fuel

	KINDLING	PRETEST FUEL	TEST FUEL
Dry Moisture % :	14.367 %	19.692 %	20.720 %
Wet Moisture % :	12.562 %	16.452 %	17.164 %

To obtain Wet from Dry : $\frac{100 \times \%\ \text{Dry Reading}}{100 + \%\text{Dry Reading}}$ = % Moisture, Wet Basis

Acceptable Ranges : 16 - 20 % wet: 19 - 25 % dry (17.5 - 22.5 on Meter Uncor. reading) at 70°

W[illegible]HT 393 A

GAS DATA SHEET #2

UNIT: F400 RUN: 2 DATE: 4-10-2000 PAGE: 1 of 2

TIME	SCALE	FUEL	DROP	V.	CO_2	V.	O_2	V.	CO	BAL	WB	DB	% H_2O	CAL WB	STACK	STATIC	SO_2 PPM
0 1420	406.3	13.3	—	.253	6.3	-	-	.087	.87	7.2					417	-.049	325
5 25	405.4	12.4	.9	.441	11.0			.086	.86	12.8					490	-.057	300
10 30	404.4	11.4	1.0	.515	12.9			.030	.30	42.4					560	-.062	300
15 35	403.1	10.1	1.3	.610	15.3			.013	.13	114.0					748	-.066	300
20 40	401.8	8.8	1.3	.647	16.2			.014	.14	112.5					787	-.068	325
25 45	400.6	7.6	1.2	.640	16.0			.012	.12	129.2					798	-.069	325
30 50	399.6	6.6	1.0	.616	15.4			.013	.13	115.1					772	-.067	325
35 55	398.7	5.7	.9	.633	15.9			.017	.17	91.1					766	-.067	325
40 1500	397.7	4.7	1.0	.569	14.2			.006	.06	222.5					730	-.066	325
45 05	397.1	4.1	.6	.480	12.0			.004	.04	272.9					680	-.064	325
50 10	396.6	3.6	.5	.400	10.0			.005	.05	185.2					629	-.062	325
55 15	396.1	3.1	.5	.331	8.3			.034	.34	24.0					572	-.059	325
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	8049	-.756	*****
60 1526	395.8	2.8	.3	.313	7.8			.061	.61	12.7					541	.057	350
65 25	395.5	2.5	.3	.301	7.5			.078	.78	9.6					517	-.056	350
70 30	395.2	2.2	.3	.291	7.3			.089	.89	8.1					499	.054	350
75 35	394.9	1.9	.3	.278	6.9			.096	.96	7.2					487	-.053	375
80 40	394.7	1.7	.2	.277	6.9			.091	.91	7.6					475	-.053	350
85 45	394.4	1.4	.3	.284	7.1			.071	.71	9.9					479	-.053	350
90 50	394.1	1.1	.3	.301	7.5			.053	.53	14.1					492	-.054	325
95 55	393.9	.9	.2	.259	6.5			.073	.73	8.8					465	-.052	350
100 1600	393.7	.7	.2	.253	6.3			.082	.82	7.7					453	.051	325
105 05	393.6	.6	.1	.229	5.7			.092	.92	6.2					430	.049	325
110 10	393.4	.4	.2	.217	5.4			.084	.84	6.4					422	.049	325
115 15	393.3	.3	.1	.211	5.3			.088	.88	5.9					411	.047	325
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	5671	-.628	*****
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	13720	-1.384	*****

WEIGHT: 3[illegible].0

GAS DATA SHEET # 12

UNIT: F400 RUN: 2 DATE: 4-10-2000 PAGE: 2 of 2

TIME	SCALE	FUEL	DROP	V.	CO_2	V.	O_2	V.	CO	BAL	WB	DB	% H_2O	CAL WB	STACK	STATIC	SO_2 PPM
120 1620	393.2	.2	.1	.201	5.0	-	-	.105	1.05	4.7					400	.047	325
125 25	393.1	.1	.1	.201	5.0			.101	1.01	4.9					393	.046	325
130 30	393.0	~~0~~	.1	.207	5.2			.077	.77	6.7					390	.046	325
135 35																	
140 40																	
145 45																	
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	1183	-.139	*****
																	÷.27
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	14903	-1.523	*****
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	552	-.056	*****

PREBURN DATA SHEET #13

UNIT: F400 RUN: 2 DATE: 4-10-2000 PAGE: 1 of 1

TIME	SCALE	DROP	STACK	TOP	LF SIDE	BACK	RT SIDE	BOTTOM	FIREBOX	SEC/CAT	AMBIENT	STATIC	COMMENTS
0/1245	404.2	—	408	463	464	369	439	319	722	604	81	.041	PREBURN START: # — UP
5/50	403.3	.9	578	523	436	368	412	317	660	1080	79	.057	COAL BED SCALE RANGE:
10/55	402.4	.9	651	633	407	363	380	308	606	1392	79	.061	393.6 - 393.0
15/1300	401.1	1.3	729	740	398	353	359	298	619	1343	79	.066	PRIMARY AIR: WIDE OPEN
20/05	399.9	1.2	794	795	400	345	355	285	642	1190	80	.068	SECONDARY AIR: N/A
25/10	398.7	1.2	807	835	402	340	362	275	679	1218	81	.068	FAN: N/A
30/15	397.5	1.2	810	851	419	337	372	267	713	1254	81	.068	PUMPS ON AT: 1320
35/20	396.6	1.1	753	842	433	338	383	261	744	1242	84	.066	CHECK WB/DB: N/A
40/25	395.9	1.1	726	813	438	338	394	259	791	1396	82	.066	
45/30	395.1	.8	698	775	445	342	410	257	831	1432	83	.065	
50/35	394.6	.5	657	746	454	346	421	257	865	1451	84	.063	
55/40	394.2	.4	609	676	455	354	426	257	948	1351	84	.062	
*****	****	***	****	*****	*****	****	*****	*****	*****	*****	*****	****	
60/1345	393.9	.3	548	608	452	361	429	261	941	1158	83	.059	
65/50	393.7	.2	514	570	448	368	430	265	945	1014	84	.056	
70/55	393.6	.1	473	518	445	374	428	269	917	959	83	.053	
75/1400	393.4	.2	454	483	439	380	421	273	888	925	82	.051	
80/05	393.3	.1	437	457	435	383	414	276	854	911	81	.050	
85/10	393.2	.1	427	439	424	384	403	276	832	905	76	.049	
90/15	393.1	.1	421	425	415	383	393	275	816	899	75	.049	
95/20	393.0	.1	412	419	416	324	388	278	805	890	79	.049	365.0 AT
/													
/													
/													
/													

TEMPERATURE DATA SHEET # 14

UNIT: F400 RUN: 2 DATE: 4-10-2000 PAGE 1 of 2

TIME	TOP	LT SIDE	BACK	RT SIDE	BOTTOM	FIREBOX	SEC/CAT	AMBIENT	FURNACE	SAMPLE	SAMP IMP	C-GAS	GAS IMP	SO_2 IMP	365.0
0 1420	419	416	324	388	278	805	890	79	1326	244	60	246	39	38	
5 25	481	402	382	372	281	770	1131	78	1328	244	57	243	37	36	
10 30	615	376	378	354	276	703	1203	79	1326	244	55	242	36	34	
15 35	721	363	371	339	266	702	1279	78	1327	248	53	245	36	36	
20 40	779	366	363	340	257	723	1335	79	1329	249	52	251	37	36	
25 45	815	375	359	348	251	756	1364	80	1333	251	52	253	36	35	
30 50	809	392	353	361	246	790	1359	81	1336	250	52	249	36	35	
35 55	801	406	352	377	242	823	1406	81	1339	248	53	249	35	35	
40 1500	789	431	353	395	238	853	1382	83	1342	248	53	249	36	35	
45 05	753	441	354	406	238	882	1313	82	1340	248	53	249	36	37	
50 10	705	451	357	413	236	856	1227	84	1339	247	53	247	36	36	
55 15	636	463	363	414	237	814	1136	84	1337	245	54	242	36	36	
TOTAL	8323	4882	4309	4507	3046	9507	15025	968	*****	*****	*****	*****	*****	*****	
60 1520	593	464	366	410	238	828	1089	84	1335	244	54	242	37	36	
65 25	560	453	371	399	239	809	1059	82	1333	243	55	240	36	38	
70 30	529	448	377	389	238	790	1035	84	1331	241	55	239	36	37	
75 35	509	437	379	383	238	767	1013	81	1331	240	55	238	36	37	
80 40	492	430	382	375	238	756	1017	83	1330	239	55	236	36	37	
85 45	485	421	383	368	236	755	1051	82	1330	239	54	236	36	37	
90 50	495	414	385	365	234	755	1116	83	1330	238	54	235	36	37	
95 55	484	417	385	364	233	757	973	82	1330	238	54	235	36	36	
100 1600	472	413	381	363	231	756	944	82	1330	237	54	236	35	36	
105 05	447	411	378	358	229	744	893	82	1330	236	54	236	35	36	
110 10	429	405	371	354	229	749	874	80	1330	236	54	236	35	36	
115 15	416	396	367	352	228	748	847	80	1331	235	54	236	35	35	
TOTAL	5911	5109	4525	4480	2811	9244	11911	985	*****	*****	*****	*****	*****	*****	
TOTAL	14234	9991	8834	8987	5857	18721	26936	1953	*****	*****	*****	*****	*****	*****	

TEMPERATURE DATA SHEET # 14

UNIT: F400 RUN: 2 DATE: 4-10-2000 PAGE 2 of 2

TIME	TOP	LT SIDE	BACK	RT SIDE	BOTTOM	FIREBOX	SEC/CAT	AMBIENT	FURNACE	SAMPLE	SAMP IMP	C-GAS	GAS IMP	SO_2 IMP	365.0
120/620	399	388	356	349	228	736	825	79	1330	234	54	236	35	35	
125/25	390	378	355	343	230	704	819	77	1329	234	54	235	34	35	
130/30	382	371	348	337	231	690	816	78	1328	233	54	234	34	35	
135/35															
140/40															
145/45															
TOTAL	1171	1137	1059	1029	689	2130	2460	234	*****	*****	*****	*****	*****	*****	
				365.0											
				333.8											
			ΔT	-31.2											
									÷27						
TOTAL	15405	11128	9893	10016	6546	20851	29396	2187	*****	*****	*****	*****	*****	*****	
TOTAL	571	412	366	371	242	772	1089	81	*****	*****	*****	*****	*****	*****	

ZERO / SPAN CHECK DATA SHEET #15-1

Date : 4-10-2000 Analyte : CO_2 (15-1)

Source : F400 Run # : 2

Zero Cyl. # : TX 79373 Conc. : 0.00 % CO_2 Cyl. Press. : 960 PSI

Certified by : AIR LIQUIDE Date : 9-22-1998

Span Cyl. # : CC52330 Conc. : 12.79 % CO_2 Cyl. Press. : 1750 PSI

Certified by : AIR LIQUIDE Date : 2-10-2000

Analyzer : Make : HORIBA Model : PIR-2000 SN : 407069

Range : 0 - 25.0 % CO_2 Analyzer Output : 0 - 1.0 v.

Flow : 1.5 SCFH Measured by : Rotameter

EPA Span Value = 25.0 % CO_2

EPA Control Limits = ± 2.5% of 25.0 % CO_2 = ± 0.625 % CO_2

Method 28 A = ± .2 % of 25.0 % CO_2 = ± .05 % CO_2

PRE RUN Audit : by : D. Wadsworth Time : 1230 Temp : 79 ° F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.0	.002	-.098	-.098 ✓	.393 ✓
SPAN	51.2	.512	12.79	51.4	.514	12.862 ✓	.072 ✓	.287 ✓

POST RUN Audit : by : D. Wadsworth Time : 1640 Temp : 79 ° F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.0	.003	-.123	-.123 ✓	-.493 ✓
SPAN	51.2	.512	12.79	51.4	.514	12.862 ✓	.072 ✓	.287 ✓

± Conc. Difference = Act % - Exp (Std) %

Zero % Difference = $\frac{\text{Act \% (ppm) - Exp \% (ppm)}}{\text{Full Scale Value}}$ X 100

Span % Difference = $\frac{\text{Act \% (ppm) - Exp \% (ppm)}}{\text{Full Scale Value}}$ X100

ZERO / SPAN CHECK DATA SHEET #15-2

Date : 4-10-2000 Analyte : O_2 (15-2)

Source : F400 Run # : 2

Zero Cyl. # : TX79373 Conc. : 0.00 % O_2 Cyl. Press. : 960 PSI

Certified by : AIR LIQUIDE Date : 9-22-1998

Span Cyl. # : CC52330 Conc. : 12.69 % O_2 Cyl. Press. : 1750 PSI

Certified by : AIR LIQUIDE Date : 2-10-2000

Analyzer : Make : TELEDYNE Model : 320 A SN : 37400

Range : 0 - 25.0 % O_2 Analyzer Output : 0 - 1.0 v.

Flow : 1.5 SCFH Measured by : Rotameter

EPA Span Value = 25.0 % O_2

EPA Control Limits = ± 2.5% of 25.0 % O_2 = ± 0.625 % O_2

Method 28 A = ± .2 % of 25.0 % O_2 = ± .05 % O_2

PRE RUN Audit : by : D. Washington Time : 1230 Temp : 79 ° F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.0	.001	.050 ✓	.050 ✓	.200 ✓
SPAN	12.7	.508	12.69	12.7	.510	12.737 ✓	.047 ✓	.187 ✓

POST RUN Audit : by : D. Washington Time : 1640 Temp : 79 ° F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.0	.000	.025 ✓	.025 ✓	.100 ✓
SPAN	12.7	.508	12.69	12.7	.509	12.712 ✓	.022 ✓	.088 ✓

± Conc. Difference = Act % - Exp (Std) %

Zero % Difference = $\frac{\text{Act \% (ppm) - Exp \% (ppm)}}{\text{Full Scale Value}}$ X 100

Span % Difference = $\frac{\text{Act \% (ppm) - Exp \% (ppm)}}{\text{Full Scale Value}}$ X100

ZERO / SPAN CHECK DATA SHEET #15-3

Date : 4-10-2000 Analyte : CO (15-3)

Source : F400 Run # : 2

Zero Cyl. # : TX79373 Conc. : 0.00 % CO Cyl. Press. : 960 PSI

Certified by : AIR LIQUIDE Date : 9-22-1998

Span Cyl. # : CC52330 Conc. : 4.75 % CO Cyl. Press. : 1750 PSI

Certified by : AIR LIQUIDE Date : 2-10-2000

Analyzer : Make : HORIBA Model : PIR-2000 SN : 408005

Range : 0 - 10.0 % CO Analyzer Output : 0 - 1.0 v.

Flow : 1.5 SCFH Measured by : Rotameter

EPA Span Value = 10.0 % CO

EPA Control Limits = ± 2.5% of 10.0 % CO = ± 0. 25 % CO

Method 28 A = ± .2 % of 10.0 % CO = ± .02 % CO

PRE RUN Audit : by : D. Washington Time : 1230 Temp : 79 ° F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.0	.000	.004	.004 ✓	.042 ✓
SPAN	47.5	.475	4.75	47.3	.473	4.732 ✓	-.018 ✓	-.179

POST RUN Audit : by : D. Washington Time : 1640 Temp : 79 ° F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.1	.001	.014	.014 ✓	.142 ✓
SPAN	47.5	.475	4.75	47.3	.473	4.732 ✓	-.018	-.179

± Conc. Difference = Act % - Exp (Std) %

Zero % Difference = $\frac{\text{Act \% (ppm) - Exp \% (ppm)}}{\text{Full Scale Value}}$ X 100

Span % Difference = $\frac{\text{Act \% (ppm) - Exp \% (ppm)}}{\text{Full Scale Value}}$ X100

ZERO / SPAN CHECK DATA SHEET #15-4

Date: 4-10-2000 Analyte: SO_2 (15-4)

Source: F400 Run #: 2

Zero Cyl. #: TX79373 Conc.: 0.00 ppm SO_2 Cyl. Press.: 960 PSI

Certified by: AIR LIQUIDE Date: 9-22-1998

Span Cyl. #: CC67475 Conc.: 1260 ppm SO_2 Cyl. Press.: 650 PSI

Certified by: AIR LIQUIDE Date: 9-22-1998

Analyzer: Make: HORIBA Model: PIR-2000 SN: 403019

Range: 0 - 2500 ppm SO_2 Analyzer Output: 0 - 1.0 v.

Flow: 1.5 SCFH Measured by: Rotameter

EPA Span Value = 2500 ppm SO_2

EPA Control Limits = ± 2.5% of 2500 ppm SO_2 = ± 62.5 ppm SO_2

PRE RUN Audit: by: D. Wadsworth Time: 1240 Temp: 80 °F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	PPM	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.5	.005	25.410	25.410	1.016
SPAN	50.4	.504	1260	50.5	.505	1262.571	2.571	.103

POST RUN Audit: by: D. Wadsworth Time: 1645 Temp: 78 °F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	PPM	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.4	.004	22.936	22.936	.917
SPAN	50.4	.504	1260	50.6	.506	1265.046	5.046	.202

± Conc. Difference = Act % - Exp (Std) %

Zero % Difference = $\frac{\text{Act \% (ppm) - Exp \% (ppm)}}{\text{Full Scale Value}}$ X 100

Span % Difference = $\frac{\text{Act \% (ppm) - Exp \% (ppm)}}{\text{Full Scale Value}}$ X100

QUALITY CHECKS DATA SHEET # 16

UNIT: F400 RUN: 2 DATE: 4-10-2000

Thermocouple Check :

T/C # 1	— °F	T/C # 13	61.1 °F
T/C # 2	— °F	T/C # 14	60.0 °F
T/C # 3	60.5 °F	T/C # 15	61.6 °F
T/C # 4	57.5 °F	T/C # 16	59.4 °F
T/C # 5	56.8 °F	T/C # 17	59.5 °F
T/C # 6	56.6 °F	T/C # 18	63.1 °F
T/C # 7	56.7 °F	T/C # 19	58.5 °F
T/C # 8	56.4 °F	T/C # 20	55.8 °F
T/C # 9	56.9 °F	T/C # 21	— °F
T/C # 10	57.0 °F	T/C # 22	— °F
T/C # 11	55.9 °F	T/C # 23	58.9 °F
T/C # 12	63.8 °F	T/C # 24	— °F

Thermocouple Readout :

Pretest zero and span check and calibration

ZERO : 1.4 °F Adj. to 0.0 °F

SPAN : 1995.4 °F Adj. to 2000.0 °F

post test zero and span % difference

ZERO 2.2 °F Difference .110 %

SPAN 2004.9 °F Difference .245 %

Thermocouple Readout Pretest Linearity Check

0	= 0.0 °F	200	= 201.6 °F	400	= 398.9 °F
600	= 601.2 °F	800	= 801.4 °F	1000	= 1000.5 °F
1200	= 1198.1 °F	1400	= 1399.1 °F	1600	= 1599.6 °F
1800	= 1800.0 °F	2000	= 2000.0 °F		

Sample Train Leak Check	Pre ✓	Post ✓
C-gas Train Leak Check	Pre ✓	Post ✓
SO_2 Train Leak Check	Pre ✓	Post ✓
Static Gauge Zero Check	Pre X	Post ✓

Scale Check Pre : 404.8 - 394.8

Post : 402.8 - 392.8

Stack Cleaned Prior to Test Run : YES ____ NO X

Calibration Data

Inspection Certificate

Phillips Morris Scale Company
Pioneers in Weighing Systems
934 Elliott Avenue W.
Seattle, WA 98119
Ph#(206)284-6090
Fax#(206)282-6612

Customer: LOKEE TESTING
Address: 13235 Prairie Circle E
Sumner, WA 98390
Technician: Patrick McClellan
Authorization Signature: _____

Date of Inspection: 10-6-99
Next Inspection Due: 4-00

Certification Type
✓ Standard
__ ISO 9000
__ MIL STD-45662

Equipment Tested

Indicator
Make: Weightronix
Model: WI-110
SR#: 16409
Class: III
Cap.: 1000 x .1 lbs

Base

Options Installed
Printer: _____
Score Board: _____
Computer: _____
Other: _____

Pre-test	Post-test	Manufacturer Tolerance
Ø	Ø	
500.3	499.9	
1000.6	1000.0	
Ø	Ø	

Corner Test P ✓ F __
Shift Test P ✓ F __
Static Test 2 min. ✓ 5 min. __

Weight Kit#: _____ NIST#: _____

Serial Numbers of Weights Used (or copy of certificate)

TO 7821				
TO 7822				

Any changes to document or scale not authorized by Phillips & Morris Scale Company VOIDS this certificate.

WASHINGTON STATE DEPARTMENT OF

AGRICULTURE

ONSUMER & PRODUCER PROTECTION DIVISION
/EIGHTS & MEASURES SECTION
METROLOGY LABORATORY
?747 29TH AVENUE SOUTHWEST
UMWATER WASHINGTON 98512

REPORT OF TEST

Test Item
Test Weights
Type: Cast Iron
Nominal Value/Range: 1000 & 500 lb
Serial No: See table 1 below
WO No: L1596

Submitted By
Phillips Scale Company
934 Elliott Ave. W
Seattle, WA 98119

Purchase Order No: ALEC
Alec Jorgensen, (206) 284-6090

Table 1

Nominal Value	Manufacture	Qty	Serial Number
1000 lb	Rice Lake	8	WA183-9, WA184-0, WA184.1, WA184-2, WA184-3, WA184-4, WA184-5 & WA184-6
1000 lb	Toledo	1	WA184-7
500 lb	Toledo	11	117, 401, 407, 1WWM, T07821, T07822, T07823, T07824, WA152-8, WA153-0 & WA153-1

Condition of Test Item:
Good - The test item displays some wear or other degradation.

Measurement Results: The test item described above was found/adjusted to be within the National Institute of Standards and Technology (NIST) Tolerance Class F values.

Measurement Method & Traceability: Measurements were made IAW the NIST handbook 145, SOP 8, Tolerance Testing of Mass Standards by Modified Substitution. Standards are traceable to the NIST (reports on file) and which are part of a comprehensive measurement assurance program for ensuring continued accuracy and traceability within the level of uncertainty reported by this laboratory.

General Conditions / Notes: *Unless otherwise stated or provided for* :

- The results of this test apply only to the test item stated on this report.
- The following test items were found out of tolerance and adjusted: 1000 lb SN: WA184-7; 500 lb SN: 401, T07822, T07823 & 1WWM
- Measurement Room Ambient Conditions: Temperature 21.0 °C ± 1 °C; Relative Humidity 41.0 % ± 5 % RH; Barometric Pressure 758.0 mmHg

DATE OF ISSUE: August 27, 1998

QUALITY CONTROL SERVICES Inc.

2340 S.E. 11Th. Avenue Portland, Oregon 97214-5306
(503) 236-2712 / FAX:(503) 235-2535

CERTIFICATE OF CALIBRATION

Customer and Contact

Lokee Testing Labs
13235 Prairie Circle East
Sumner, WA. 98390
Chip Wadington

Report Number: QCS-00002878

INSTRUMENT INFORMATION

Item	Make	Model	Serial Number	Units	Cal. Date	Last Cal.	Cal. Due
Balance	Sartorius	A120S	37010004	Grams	12/13/1999	05/25/1999	05/2000

Readability	Range Calibrated	Location	Customer ID	SOP Used	Tolerance Used
0.0001	0-100	Lab	N/A	QCS #004	Factory

Functional Checks

Cornerload ☑ Linearity 0 - 1/2 - Full Capacity ☑ Reproduceability ☑

CALIBRATION DATA

Standard	As Found Instrument	Tolerance +/-	As Left Instrument
100	99.9986	0.0002	100.0000
50	49.9993	0.0002	50.0000
20	19.9997	0.0002	20.0000
10	9.9998	0.0002	10.0000
5	4.9999	0.0002	5.0000
1	1.0000	0.0002	1.0000

CALIBRATION STANDARDS

Item	Make	Model	Serial Number	Units	Cal. Date	Cal. Due	NIST Traceable ID#
Weight Set	R.Lake/Troemner	5MG-25KG	A45	Grams	07/09/1999	07/2000	822/262273-9

Comments / Info Concerning This Calibration:

Permanent Information Concerning This Instrument:
12/99 CUSTOMER REQUESTED SPECIFIC 6 POINT CHECK.

Technician: D.Deleasa

Signature: D. Delea

CALIBRATIONS ARE PERFORMED UNDER AMBIENT CONDITIONS USING MANUFACTURER'S SPECIFICATIONS FOR THE PASS/FAIL RESULTS. RESULTS MAY BE INFULENCED BY THE AGE OF THE INSTRUMENT AND ENVIRONMENTAL CONDITIONS. CALIBRATION DATA SHOULD BE REVIEWED TO INSURE THAT THE INSTRUMENT IS PERFORMING TO ITS INTENDED ACCURACY. CALIBRATIONS CONFORM TO ANSI / NCSL Z540-1-1994 SPECSIFICATIONS.

QUALITY CONTROL SERVICES Inc.

2340 S.E. 11Th. Avenue Portland, Oregon 97214-5306
(503) 236-2712 / FAX:(503) 235-2535

CERTIFICATE OF CALIBRATION

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Lokee Testing Labs.
13235 Prairie Circle East
Sumner, WA. 98390
Chip Wadington

INSTRUMENT INFORMATION

Item	Make	Model	Serial Number	Units	Last Cal. Date	Cal. Date	Cal. Due
Balance	Sartorius	A120S	37010004	Grams	11/21/1998	05/25/1999	11/1999

Readability	Range Calibrated	Location	Customer ID	SOP Used	Limits Used
0.0001	0-100	Lab	N/A	QCS #004	Factory

Functional Checks

Cornerload ☑ Linearity 0 - 1/2 - Full Capacity ☑ Reproduceability ☑

CALIBRATION DATA

Standard	As Found Instrument	Limit +/-	As Left Instrument
100	100.0018	0.0002	100.0000
50	50.0009	0.0002	50.0000
20	20.0004	0.0002	20.0000
10	10.0002	0.0002	10.0000
5	5.0001	0.0002	5.0000
1	1.0001	0.0002	1.0000

CALIBRATION STANDARDS

Item	Make	Model	Serial Number	Units	Cal. Date	Cal. Due	NIST Traceable ID#
Weight Set	Rice Lake	1MG-20KG	A45	Grams	07/07/1998	07/1999	822/251337

Comments / Info:

Technician: D.Deleasa

Signature: D. Deleasa

ALL CALIBRATION STANDARDS ARE TRACEABLE TO THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (N.I.S.T.). ALL WORK IS PERFORMED USING PROPER MANUFACTURER AND/OR INDUSTRIAL SERVICE TECHNIQUES AND IS WARRANTED FOR 30 DAYS. CALIBRATIONS CONFORM TO ANSI / NCSL Z540 / MIL STANDARD 45662A.

Thermocouple Calibration Record Semi-Annual

Thermocouples Check against
Reference Thermometer serial number 9123454
Ice Water Bath 32°
Boiling Water 212°
Room Temperature 73°
Barometric Pressure 30.50
DATE: 11-20-99

TC	Location	Ice Bath Temp	Boiling Water Temp
1	Wet Bulb	32.1	211.7
2	Dry Bulb	32.2	211.6
3	Stack	32.1	211.8
4	Stove Top	32.1	211.2
5	Left Side	32.0	212.0
6	Back	32.1	212.3
7	Right Side	32.0	211.8
8	Bottom	32.1	211.6
9	Firebox	32.1	211.3
10	Secondary/Cat	32.1	211.9
11	Ambient	32.3	211.7
12	Tube Furnace	32.1	212.0
13	Sample Box	32.0	211.3
14	Impinger Out	32.1	211.6
15	C. Gas Box	32.0	212.1
16	C. Gas Out	32.2	211.7
17	SO2 Out	32.2	211.7
18	Upper Ambient	32.1	211.9
19			
20			
21			
22			
23	Calibrator	32.2	211.9
24	Oven	32.1	211.5

Thermocouple Readout Semi-Annual Calibration Data Sheet

Date: 11-20-99
Ambient Temperature: 75
Technician: Chip W.

Thermocouple Number: T/C Readout
Barometric Pressure: 30.50
Reference: Mercury in glass FISHER #9123454
Other: OMEGA CL-300

Reference Point No. [a]	Source [b]	Reference Thermometer Temperature °F	Thermocouple Potentiometer Temperature °F	Difference (%)[c]
32	Ice Water	32°	32°	∅
212	Boiling Water	212°	211.9°	.047
250	Omega	250.0	249.8	.080
300	Omega	300.0	299.4	.200
400	Omega	400.0	398.4	.200
500	Omega	500.0	499.2	.160
600	Omega	600.0	601.0	-.167
700	Omega	700.0	698.9	.157
800	Omega	800.0	801.3	-.163
900	Omega	900.0	898.8	.133
1000	Omega	1000.0	1000.2	-.020
1200	Omega	1200.0	1197.8	.183
1400	Omega	1400.0	1398.9	.079
1600	Omega	1600.0	1599.4	.038
1800	Omega	1800.0	1799.9	.006
2000	Omega	2000.0	2000.0	∅

[a] Every 50°F for each reference point
[b] Type of Calibration System Used
[c] $\frac{\text{(reference temperature) - (thermocouple temperature)}}{\text{reference temperature}} * 100$

TRACEABILITY DOCUMENTATION Semi-Annual

S02 INJECTION ROTAMETER, DRY GAS METER AND SLING PSYCHROMETER THERMOMETERS IN LAB. CHECKED AGAINST FISHER SN 9123454 (NIST).

DATE: 11-20-99

SO^2 INJECTION ROTAMETER FISHER SN 9123454

NIST Traceable

Actual	°C = °F	°F
0°	32.0	32.0
22.5	72.5	72.5
41.0	93.5	93.1
68.0	154.4	154.6

DRY GAS METER THERMOCOUPLES

Actual	°C = °F	5H in	5H out	KK
0	32°	32.2	32.4	32.2
22.0	71.6	71.1	71.4	71.4
39.8	103.6	103.1	103.5	103.5
66.9	152.4	152.0	152.1	152.5

SLING PSYCHROMETER

Actual	°C = °F	Wet Bulb	Dry Bulb
0	32°	32.0	32.0
10.5	51.4	51.4	51.3
17.1	62.8	62.8	62.8
27.3	81.1	81.2	81.1

Conversions = °F = (°C × 1.8) + 32 °C = (°F-32)÷1.8

VANEOMETER CALIBRATION

LoKee Testing Lab uses a Dwyer Model #480 Vaneometer to measure test chamber air velocity. The manufacturer's specifications for accuracy are ± 5.0% to 100 FPM and ± 10% from FPM to top of scale. LoKee Testing Lab insures that the instrument is level and clean prior to taking each reading. According to EPA personnel (Westlin, RTP) no further calibration of the instrument is necessary.

DRAFT GAUGE CALIBRATION

LoKee Testing Lab uses a Dwyer model 115-AV 0-0.25" inclined water manometer (readability resolution ± 0.001" of water) to measure the static pressure in the stack. Once leveled and zeroed as per the manufacturer's written operating instructions, the Dwyer manometer is a primary standard and requires no additional calibration.

The manometer is leveled and zeroed at the start of each test run, checked as necessary during the run to verify the settings have not changed and again at the end of each test run. The results of each check are recorded on Data Sheet #16 in each test run.

BAROMETER CALIBRATION

LoKee Testing Lab uses a Princo Model 469 NOVA Mercury Barometer to measure barometric pressure. When installed and maintained as per the manufacturer's written operating instruction, the Princo Model 469 Mercury Barometer is a primary standard and needs no further calibration.

MOISTURE METER CALIBRATION

The Delmhorst Model RC-1C, SN 16152 Moisture Meter is calibrated each time the meter is used by adjusting the zero and span calibration. The potentiometers of each calibration point (X = zero, Y = span) are adjusted until the meter is calibrated correctly. The meter is then checked against a calibration block (Delmhorst Model MCS-1, moisture content standard at 12.0% and 22.0%) in its normal operating range of 11-25%.

LoKee Testing Lab also has a second moisture meter, Delmhorst Model G-30, SN 2477 to use as a backup.

POST TEST METER BOX AUDIT DATA SHEET # 32

UNIT: Total F400 DATE: 4-14-00

TEST DATA

RUN #	1	2	3	4	5	6	7	8	9	10
AVG. ΔH	.138	.138	.155	.110						
MAX VAC	3.0	3.0	4.0	2.0						

Avg. Test Series ΔH: .135 in H_2O Test Series Max Vac: 4.0 in Hg

Audit Dry Gas Meter: K2 Correction (Y) Factor: 1.014 (mcf)

Test Dry Gas Meter: H Correction (Y) Factor: .989 (mcf)

AUDIT DATA

		Audit # 1	Audit #2	Audit #3
BP		30.04	30.04	30.04
VAC		4.0	4.0	4.0
AUDIT METER :				
VOL.	Final	938.800	944.189	951.378
(Vw)	Initial	933.500	938.800	944.189
	Vol.	5.300	5.389	7.189
TEMP (°F)	Initial	84	88	88
(Tw)	Mid	86	88	88
	Final	88	88	88
(°F / °A)	**Avg.**	(86)	(88)	(88)
ΔH	Initial	.135	.135	.135
	Mid	.135	.135	.135
	Final	.135	.135	.135
	Avg.	.135	.135	.135
DRY GAS METER :				
VOL.	Final	433.300	438.700	445.900
(Vd)	Initial	428.000	433.300	438.700
	Vol.	5.300	5.400	7.200
TEMP (°F)	Initial	75	75	75
(Tm)	Mid	75	75	75
	Final	75	75	75
(°F / °A)	**Avg.**	(75)	(75)	(75)

$$Y = \frac{(Vw)(mcf)(BP)(Tm)}{(Vd)\left(BP + \frac{DH}{13.6}\right)(Tw)} \qquad \text{Y Factor \% Diff.} = \frac{\text{Act} - \text{Exp}}{\text{Exp}} \times 100$$

NOTE : mcf = meter correction (Y) factor for Dry Gas Meter used as a transfer standard

RUN 1

$$Y = \frac{(5.300)(30.04)(.989)(535)}{(5.300)\left(30.04 + \frac{.135}{13.6}\right)(546)} = \frac{84241.46}{86958.48} = .969$$

$$\Delta\% = \frac{(.969 - .990)}{.990} \times 100 = -2.121\ \%$$

RUN 2

$$Y = \frac{(5.389)(30.04)(.989)(535)}{(5.400)\left(30.04 + \frac{.135}{13.6}\right)(548)} = \frac{85656.08}{88923.74} = .963$$

$$\Delta\% = \frac{(.963 - .990)}{.990} \times 100 = -2.727\ \%$$

RUN 3

$$Y = \frac{(7.189)(30.04)(.989)(535)}{(7.200)\left(30.04 + \frac{.135}{13.6}\right)(548)} = \frac{114266.38}{118564.99} = .964$$

$$\Delta\% = \frac{(.964 - .990)}{.990} \times 100 = -2.626\ \%$$

NOTE : The Y factor % difference must be < ± 5.0 % to be acceptable

INTERPOLATED Y FACTOR

$\frac{.1}{(A)}$ inch H_2O $\Delta H = \frac{.993}{(C)}$ Calculated calibration Y factor from calibrations

$\frac{.2}{(B)}$ inch H_2O $\Delta H = \frac{.983}{(D)}$ Calculated calibration Y factor from calibrations

$\frac{.2}{(B)} - \frac{.1}{(A)} = .1 \times 100 = \frac{10}{(E)}$

$\frac{.983}{(D)} - \frac{.993}{(C)} = -.010 \quad \frac{10}{(E)} \quad \frac{-.001}{(F)}$

$\frac{.135}{\text{Avg}\,\Delta H} - \frac{.1}{(A)} = .035 \times 100 = \frac{3.5}{(G)}$

$\left[\frac{-.001}{(F)} \times \frac{3.5}{(G)}\right] + \frac{.993}{(C)} = \frac{.990}{\text{Interpolated Y factor}}$

Volume Metering System Leak Check : 0.000 inch H_2O in one minute

DRY GAS METER CALIBRATION

DATE: 11-20-99 DRY GAS METER: H BOX: 5

BAROMETRIC PRESSURE, Pb 30.14 in. Hg. K^2_{mcf} = 1.014

Orifice Manometer Setting, ΔH, in. H_2O		.1	.2	.3	.5	.75	1.0
Gas Volume Wet Test Meter Vw ft^3	Final	861.943	866.820	871.717	876.623	881.544	886.479
	Initial	857.075	861.943	866.820	871.717	876.623	881.544
	Vw ft^3	4.868	4.877	4.897	4.906	4.921	4.935
Gas Volume Dry Test Meter Vd ft^3	Final	950.000	955.000	960.000	965.000	970.000	975.000
	Initial	945.000	950.000	955.000	960.000	965.000	970.000
	Vw ft^3	5.000	5.000	5.000	5.000	5.000	5.000
Wet Test Meter Temperature tw	Initial	67	77	79	81	81	81
	Middle	72	78	80	81	81	81
	Final	77	79	81	81	81	81
	Average	72	78	81 (541)	81	81	81
Dry Test Meter Temperature tm	Initial	75	75	76	77	78	79
	Middle	75	76	77	78	78	79
	Final	75	76	77	78	79	79
	Average	75	76	77 (537)	78	79	79 (539)
$Y = \frac{(W_{mcf})(Vw)(Pb)(tm)}{Vd\left[Pb + \frac{\Delta H}{13.6}\right](tw)}$		.993	.983	.985	.988	.991	.995

Average Y= .989

METER BOX CALIBRATION

Date : 06/08/99
Calibrated By : J.C.
Dry Gas Meterbox ID : K2

Barometric Pressure, Pb = 27.41 in. Hg
Vacuum = 0.0 in. Hg

Orifice Manometer Setting, Delta H in. H20		0.10	0.10	0.10	0.10	0.10	0.10
Gas Volume Wet Test Meter Vw, cu. ft.		5.000	5.000	5.000	5.000	5.000	5.000
Gas Volume Dry Gas Meter							
M Final		905.062	910.109	915.164	920.215	925.284	930.346
M Initial		900.000	905.062	910.109	915.164	920.215	925.284
Vd, cu. ft.		5.062	5.047	5.055	5.051	5.069	5.062
Wet Test Meter							
tw Deg F		79	79	80	80	80	80
tw Deg A		539	539	540	540	540	540
Dry Gas Meter Outlet, tmo	1)	88	90	90	91	91	91
	2)	89	90	91	91	91	91
	3)	90	91	91	91	91	91
Dry Gas Meter Inlet tmi	1)	91	95	98	101	103	103
	2)	93	97	99	102	103	104
	3)	96	99	101	103	104	104
Mean tm, Deg F		91	94	95	97	97	97
Mean tm, Deg A		551	554	555	557	557	557

Results :

Y =	1.009	1.017	1.016	1.020	1.018	1.019

Averages :

Y = 1.017

1.014

METER BOX CALIBRATION

Date : 06/08/99
Calibrated By : J.C.
Dry Gas Meterbox ID : K2

Barometric Pressure, Pb = 27.41 in. Hg
Vacuum = 0.0 in. Hg

Orifice Manometer Setting, Delta H in. H20		0.20	0.20	0.20	0.20	0.20	0.20
Gas Volume Wet Test Meter Vw, cu. ft.		5.000	5.000	5.000	5.000	5.000	5.000
Gas Volume Dry Gas Meter							
M Final		935.565	940.624	945.687	950.756	955.828	960.905
M Initial		930.500	935.565	940.624	945.687	950.756	955.828
Vd, cu. ft.		5.065	5.059	5.063	5.069	5.072	5.077
Wet Test Meter							
tw Deg F		79	80	80	80	80	80
tw Deg A		539	540	540	540	540	540
Dry Gas Meter Outlet, tmo	1)	91	91	91	92	92	92
	2)	91	91	92	92	92	92
	3)	91	91	92	92	92	92
Dry Gas Meter Inlet tmi	1)	94	97	100	102	104	105
	2)	95	98	101	104	104	105
	3)	97	100	102	104	105	105
Mean tm, Deg F		93	95	96	98	98	99
Mean tm, Deg A		553	555	556	558	558	559

Results :

Y =	1.012	1.015	1.017	1.018	1.018	1.018

Averages :

Y = 1.016

METER BOX CALIBRATION

Date : 06/08/99
Calibrated By : J.C.
Dry Gas Meterbox ID : K2

Barometric Pressure, Pb = 27.43 in. Hg
Vacuum = 0.0 in. Hg

Orifice Manometer Setting, Delta H in. H20		0.30	0.30	0.30	0.30	0.30	0.30
Gas Volume Wet Test Meter Vw, cu. ft.		5.000	5.000	5.000	5.000	5.000	5.000
Gas Volume Dry Gas Meter							
M Final		966.054	971.113	976.179	981.252	986.332	991.415
M Initial		961.000	966.054	971.113	976.179	981.252	986.332
Vd, cu. ft.		5.054	5.059	5.066	5.073	5.080	5.083
Wet Test Meter							
tw Deg F		80	80	80	80	80	80
tw Deg A		540	540	540	540	540	540
Dry Gas Meter Outlet, tmo	1)	89	90	91	91	91	92
	2)	90	91	91	92	92	92
	3)	90	91	91	92	92	92
Dry Gas Meter Inlet tmi	1)	95	97	100	103	104	105
	2)	97	99	102	103	104	105
	3)	98	100	103	104	105	105
Mean tm, Deg F		93	95	96	98	98	99
Mean tm, Deg A		553	555	556	558	558	559

Results :

Y =	1.012	1.014	1.016	1.017	1.016	1.017

Averages :

Y = 1.015

METER BOX CALIBRATION

Date : 06/08/99
Calibrated By : J.C.
Dry Gas Meterbox ID : K2

Barometric Pressure, Pb = 27.43 in. Hg
Vacuum = 0.0 in. Hg

Orifice Manometer Setting, Delta H in. H20		0.50	0.50	0.50	0.50	0.50	0.50
Gas Volume Wet Test Meter							
Vw, cu. ft.		5.000	5.000	5.000	5.000	5.000	5.000
Gas Volume Dry Gas Meter							
M Final		996.581	1001.670	1006.754	1011.842	1016.925	1022.010
M Initial		991.500	996.581	1001.670	1006.754	1011.842	1016.925
Vd, cu. ft.		5.081	5.089	5.084	5.088	5.083	5.085
Wet Test Meter							
tw Deg F		79	80	80	80	80	80
tw Deg A		539	540	540	540	540	540
Dry Gas Meter Outlet, tmo	1)	91	92	92	92	92	92
	2)	91	92	92	92	92	92
	3)	92	92	92	92	93	93
Dry Gas Meter Inlet tmi	1)	99	101	102	103	104	105
	2)	101	102	102	104	105	106
	3)	102	102	103	104	105	106
Mean tm, Deg F		96	97	97	98	99	99
Mean tm, Deg A		556	557	557	558	559	559

Results :

Y =	1.014	1.012	1.013	1.014	1.016	1.017

Averages :

Y = 1.014

METER BOX CALIBRATION

Date : 06/08/99
Calibrated By : J.C.
Dry Gas Meterbox ID : K2

Barometric Pressure, Pb = 27.43 in. Hg
Vacuum = 0.0 in. Hg

Orifice Manometer Setting, Delta H in. H20		0.75	0.75	0.75	0.75	0.75	0.75
Gas Volume Wet Test Meter Vw, cu. ft.		5.000	5.000	5.000	5.000	5.000	5.000
Gas Volume Dry Gas Meter							
M Final		1027.177	1032.266	1037.367	1042.467	1047.571	1052.678
M Initial		1022.100	1027.177	1032.266	1037.367	1042.467	1047.571
Vd, cu. ft.		5.077	5.089	5.101	5.100	5.104	5.107
Wet Test Meter							
tw Deg F		80	80	80	80	80	80
tw Deg A		540	540	540	540	540	540
Dry Gas Meter Outlet, tmo	**1)**	91	92	92	93	93	94
	2)	91	92	93	93	94	94
	3)	92	92	93	94	94	94
Dry Gas Meter Inlet tmi	**1)**	97	102	103	104	105	106
	2)	99	103	104	105	105	106
	3)	102	103	104	105	106	106
Mean tm, Deg F		95	97	98	99	100	100
Mean tm, Deg A		555	557	558	559	560	560

Results :

Y =	1.010	1.012	1.011	1.013	1.013	1.013

Averages :

Y = **1.012**

METER BOX CALIBRATION

Date : 06/08/99
Calibrated By : J.C.
Dry Gas Meterbox ID : K2

Barometric Pressure, Pb = 27.43 in. Hg
Vacuum = 0.0 in. Hg

Orifice Manometer Setting, Delta H In. H20		1.00	1.00	1.00	1.00	1.00	1.00
Gas Volume Wet Test Meter Vw, cu. ft.		5.000	5.000	5.000	5.000	5.000	5.000
Gas Volume Dry Gas Meter							
M Final		1058.090	1063.183	1068.279	1073.379	1078.486	1083.599
M Initial		1053.000	1058.090	1063.183	1068.279	1073.379	1078.486
Vd, cu. ft.		5.090	5.093	5.096	5.100	5.107	5.113
Wet Test Meter							
tw Deg F		80	80	80	80	80	80
tw Deg A		540	540	540	540	540	540
Dry Gas Meter Outlet, tmo	1)	90	91	92	93	94	94
	2)	90	91	92	93	94	95
	3)	91	91	93	94	94	95
Dry Gas Meter Inlet tmi	1)	101	102	103	103	104	105
	2)	101	102	103	104	104	106
	3)	102	103	103	104	105	106
Mean tm, Deg F		96	97	98	99	99	100
Mean tm, Deg A		556	557	558	559	559	560

Results :

Y =	1.009	1.009	1.011	1.011	1.011	1.012

Averages :

Y = 1.011

Wet Test Meter Serial Number AA455 Date 4/16/99

Range of Wet Test Meter Flow Rate 0 - 0.25

Volume of Test Flask Va= 37.850 liters

Satisfactory Leak Check? YES

Ambient Temperature of Equilibrate Liquid in Wet Test Meter and Reservoir 69 deg. F

Test Number	Manometer Reading, a mm H2O	Final Volume (Vf), l	Initial Volume (Vi), l	Total Volume (Vm),b l	Flask Volume (Va), l	Percent Error, c %
1	0	3.0 (12 revs)	0*	3.0	3.012	0.40%
2	0	3.0 (12 revs)	0*	3.0	3.008	0.28%
3	0	3.0 (12 revs)	0*	3.0	3.014	0.47%

*Reset for each test

a - Must be less than 10 mm H2O (0.4 "H2O)

Calculations:

b - Vm - Vf - Vi

c - % error = 100(Vm - Va)/Va = $\frac{(100)(3.012-3.000)}{3.000}$ (±1%) = 0.40%

WET TEST METER CALIBRATION LOG

WET TEST METER CALIBRATION LOG

SO_2 ROTAMETER CALIBRATION

Last Cal. : 4-10-99 By : C.W. Date : 11-20-99 By : C. Washington

Manufacturer : SKC-WEST
SKC ACCUFLOW Digital Flow Calibrator: Model 712 SN : 311325

Barometric Pressure : 30.48 " Hg Temperature : 69

RUN #	50 CC/MINUTE DIGICAL VOLUME	100 CC/MINUTE DIGICAL VOLUME	150 CC/MINUTE DIGICAL VOLUME
1	55.0	128.0	185.0
2	55.2	127.8	185.1
3	54.9	128.1	185.3
4	55.2	127.9	185.0
5	55.0	128.1	185.3
6	55.1	128.4	185.6
7	55.2	128.5	185.5
8	55.4	128.3	185.4
9	55.1	128.1	185.6
10	55.2	128.4	185.3
AVERAGE	55.1 cc/min	128.2 cc/min	185.3 cc/min

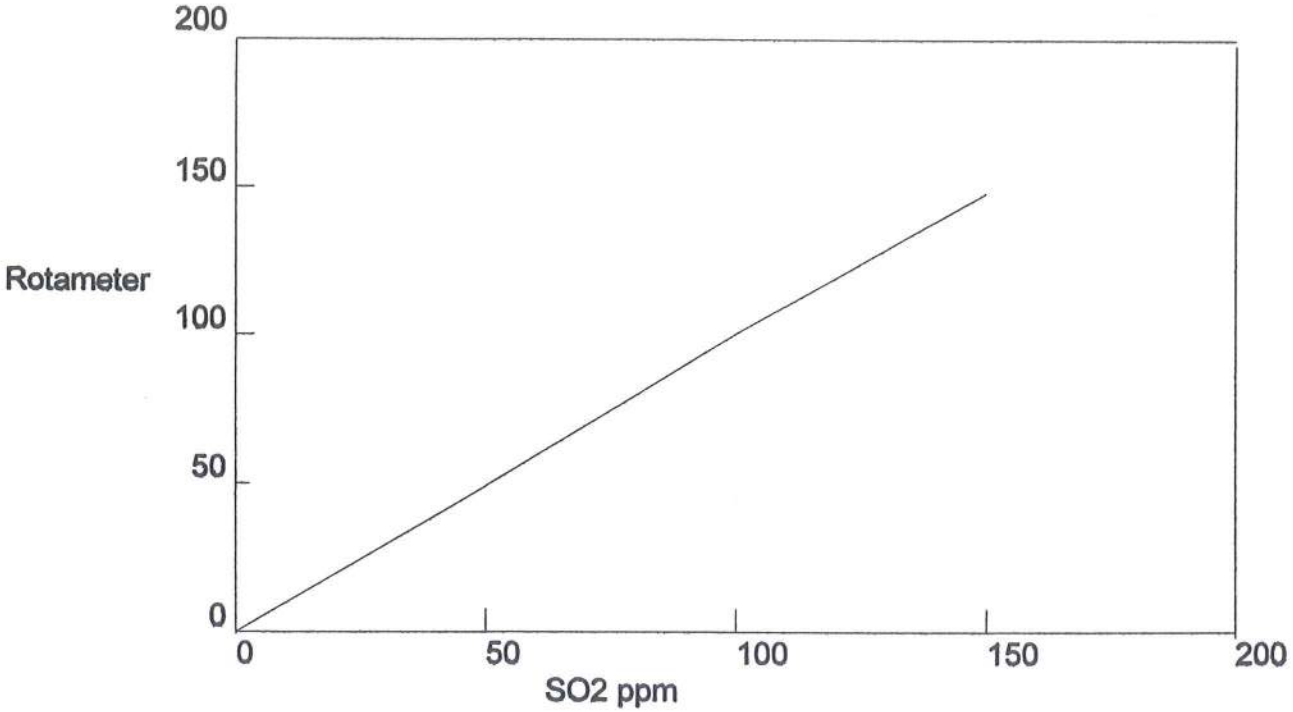
SETTING	cc/min
0	0.0
50	55.1
100	128.2
150	185.3

Rotometer setting for 100 cc/minute based on regression with this data.

100 CC / MINUTE = 81.2

SO2 Rotameter

20-Nov-99



Regression Output:

Constant	-2.2
Std Err of Y Est	5.4221766847
R Squared	0.9970364173
No. of Observations	4
Degrees of Freedom	2
X Coefficient(s)	1.258
Std Err of Coef.	0.0484974226

TRACER GAS TRAIN RESPONSE TIME

DATE: 11-20-99

Elapsed Time	SO_2 Conc. (v.)	SO_2 Conc. (v.)	SO_2 Conc. (v.)
00 sec	.504	.502	.507
15	.240	.235	.225
30	.060	.061	.063
45	.017	.018	.018
60	.011	.011	.012
75	.008	.007	.007
90	.004	.003	.003
105	.003	.001	.002
120	.001	.000	.001
135			
150			
165			
180			
Initial Response	13	12	12
95 % Response	38	37	38
Flow Rate	1.5	1.5	1.5

CEM GAS TRAIN RESPONSE TIME

Elapsed Time	CO_2 Conc. (v.)	CO_2 Conc. (v.)	CO_2 Conc. (v.)	O_2 Conc. (v.)	O_2 Conc. (v.)	O_2 Conc. (v.)	CO Conc. (v.)	CO Conc. (v.)	CO Conc. (v.)
00 sec	.495	.496	.496	.500	.500	.500	.507	.508	.508
15	.489	.478	.476	.565	.559	.560	.202	.219	.207
30	.201	.204	.200	.740	.729	.733	.050	.050	.049
45	.117	.120	.117	.809	.811	.810	.005	.007	.007
60	.048	.050	.045	.820	.820	.821	.001	.001	.003
75	.032	.031	.029	.827	.828	.827	.000	.000	.001
90	.020	.018	.017	.830	.831	.830	.000	.000	.000
105	.011	.010	.010	.831	.831	.832	.000	.000	.000
120	.005	.005	.004	.831	.834	.833	.000	.000	.000
135									
150									
165									
180									
Initial Response									
95 % Response									
Flow Rate									

ORSAT ANALYSIS DATA SHEET

DATE : 11-20-99

Gas	1	2	3	AVE	CONC	TANK ID
CO_2	0	0	0	0	N_2	TX-79373
O_2	0	0	0	0	N_2	
CO	0	0	0	0	N_2	
CO_2	12.4	12.4	12.4	12.4	12.4	CC-52549
O_2	12.5	12.5	12.5	12.5	12.51	
CO	5.1	5.0	5.1	5.07	5.08	
CO_2	21.0	21.0	21.0	21.0	21.00	AAL 7152
O_2	21.0	20.9	21.00	20.7	21.00	
CO	8.5	8.5	8.5	8.5	8.51	
CO_2	6.2	6.3	6.3	6.27	6.25	AAL 21084
O_2	6.3	6.2	6.2	6.23	6.24	
CO	2.0	2.0	2.0	2.00	2.01	
CO_2						
O_2						
CO						

F400

CO_2 ANALYZER
MULTIPOINT CALIBRATION REPORT FORM

Date: 3-31-2000

Analyzer: Make: HORIBA Model: PIR 2000 SN: 407069

Calibration by: C. Wadington

Cal Gas Flow: 1.5 SCFH Measured by: Rotameter

BP: 30.50 Instrument ID: PRINCO

Temp: 76 Instrument ID: TR

Analyzer last calibrated: _____ By: _____

Cylinders:

1. # TX 79373 Concentration: 00.00 % CO_2 Cyl. Press.: 960 PSI
   Certified by: Air Liquide Date: 9-22-98
2. # CC52330 Concentration: 12.79 % CO_2 Cyl. Press.: 1750 PSI
   Certified by: Air Liquide Date: 2-10-2000
3. # CC55904 Concentration: 21.23 % CO_2 Cyl. Press.: 1610 PSI
   Certified by: Air Liquide Date: 2-14-2000
4. # AAL 21084 Concentration: 6.25 % CO_2 Cyl. Press.: 1320 PSI
   Certified by: Scott Specialty Gases Date: 5-15-97

Analyzer: **Calibrated Range:** 0-25.0 % **Output:** 0-1.0 V.
Flow: 1.5 SCFH **Measured by:** Rotameter

Calibration Results

Point #	CYL. #	% CO2	EXPECTED METER	EXPECTED DVM	ACTUAL METER	ACTUAL DVM	ADJ. METER	ADJ. DVM	% DIF.	POTENTIOMETER UNADJ.	POTENTIOMETER ADJ.
1	1	0.00	0.00	.000	0.00	.000	—	—			
2	2	12.79	51.2	.512	50.8	.508	51.2	.512			
3	3	21.23	84.9	.849	84.6	.846	—	—			
4	4	6.25	25.0	.250	25.3	.253	—	—			
5	1	0.00	00.0	.000	0.00	.000	—	—			

.5 = 12.510

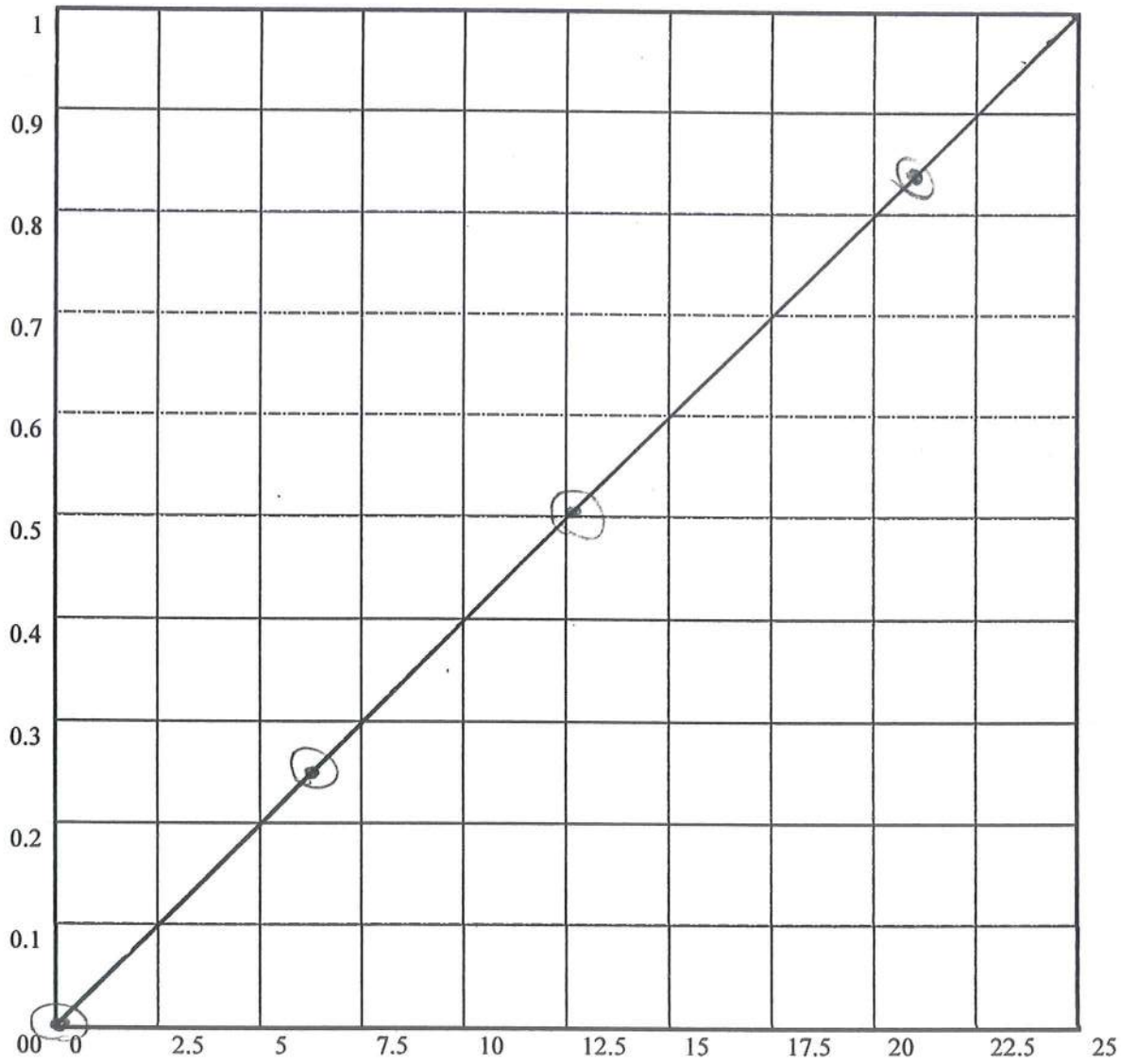
CO_2 Linear Regression Results:

Y = MX +B
Slope (M) = .0019212

Y Intercept (B) = .0398141

Correlation Coefficient (r) = .9999862

r^2 = .9999725

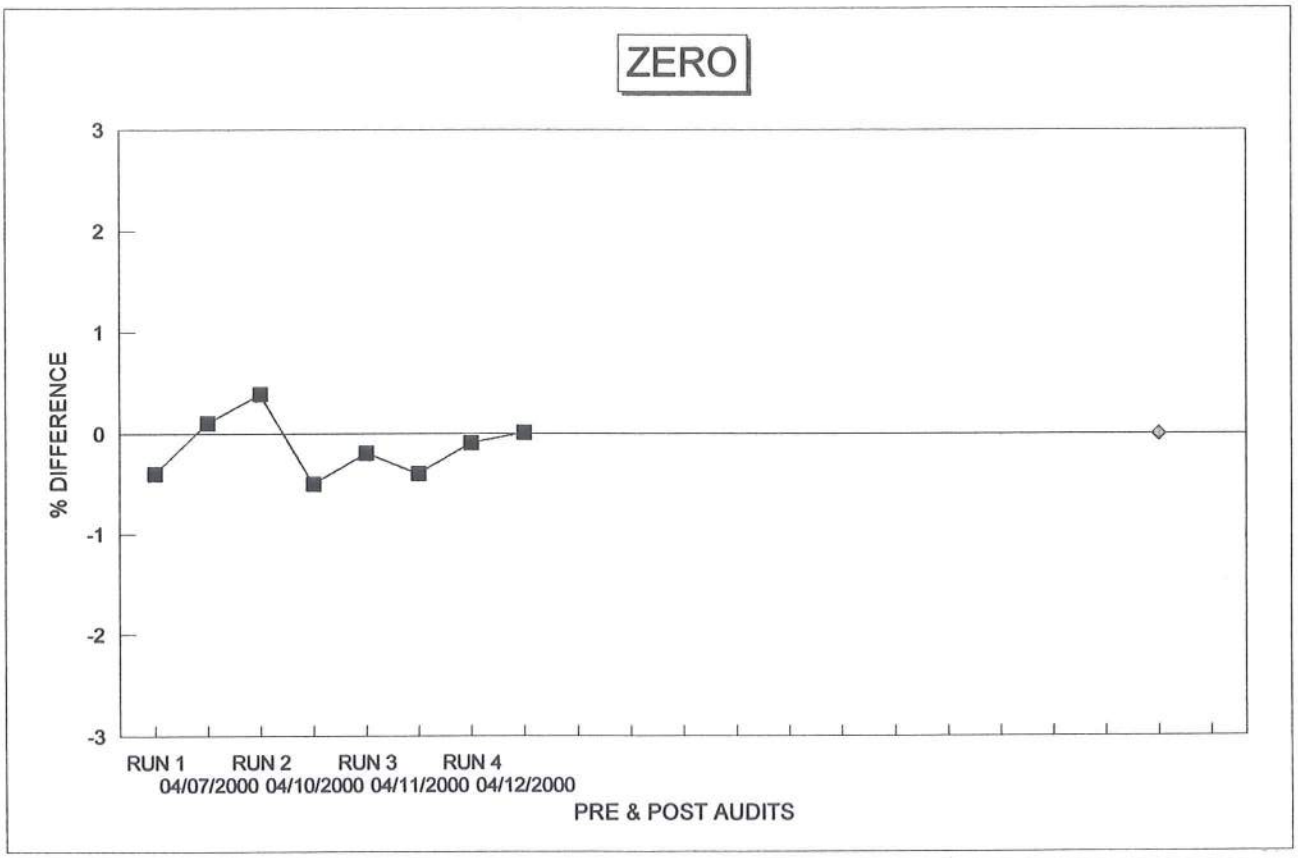


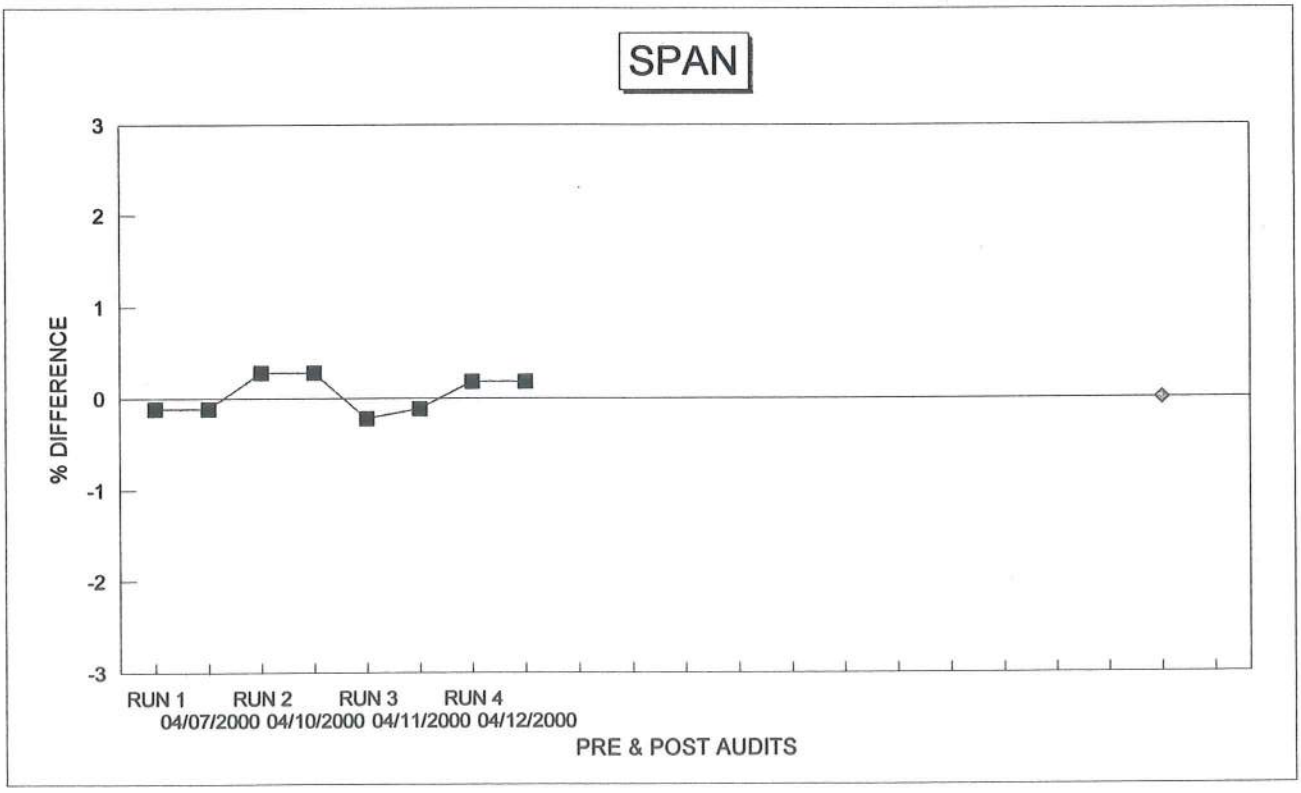
EPA Span Value = ± 2.0% of 25% CO_2 = ± .5%

Cal Volts = Cal Volt Conc - Std Conc = ± Conc Diff = ± Δ %

.846 = 21.133 - 21.23 = -.097 = -.386

.1253 = 6.320 - 6.25 = .070 = .280


ZERO
3
2
1
0
-1
-2
-3
% DIFFERENCE
RUN 1
RUN 2
RUN 3
RUN 4
04/07/2000 04/10/2000 04/11/2000 04/12/2000
PRE & POST AUDITS


SPAN
3
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1
0
-1
-2
-3
% DIFFERENCE
RUN 1
RUN 2
RUN 3
RUN 4
04/07/2000 04/10/2000 04/11/2000 04/12/2000
PRE & POST AUDITS

O_2 ANALYZER
MULTIPOINT CALIBRATION REPORT FORM

Date: 3-31-2000

Analyzer: Make: TELEDYNE Model: 320A SN: 37400

Calibration by: C. Wadington

Cal Gas Flow: 1.5 SCFH Measured by: Rotameter

BP: 30.50 Instrument ID: PRINCO

Temp: 76 Instrument ID: TR

Analyzer last calibrated: _____ By: _____

Cylinders:

1. # TX 79373 Concentration: 00.00% O_2 Cyl. Press.: 960 PSI
   Certified by: Air Liquide Date: 9-22-98
2. # CC52330 Concentration: 12.69 % O_2 Cyl. Press.: 1750 PSI
   Certified by: Air Liquide Date: 2-10-2000
3. # CC55904 Concentration: 21.10 % O_2 Cyl. Press.: 1610 PSI
   Certified by: Air Liquide Date: 2-14-2000
4. # AAL 21084 Concentration: 6.24 % O_2 Cyl. Press.: 1320 PSI
   Certified by: Scott Specialty Gases Date: 5-15-97

Analyzer: **Calibrated Range:** 0-25.0 % **Output:** 0-1.0 V.
Flow: 1.5 SCFH **Measured by:** Rotameter

Calibration Results

Point #	CYL. #	% O2	EXPECTED METER	EXPECTED DVM	ACTUAL METER	ACTUAL DVM	ADJ. METER	ADJ. DVM	% DIF.	POTENTIOMETER UNADJ.	POTENTIOMETER ADJ.
1	1	0.00	0.00	.000	0.00	.000	—	—			
2	2	12.69	12.7	.508	12.7	.508	—	—			
3	3	21.10	21.1	.844	21.2	.846	—	—			
4	4	6.24	6.24	.250	6.2	.248	—	—			
5	1	0.00	0.00	.000	0.00	.000	—	—			

.5 = 12.488

O_2 Linear Regression Results:

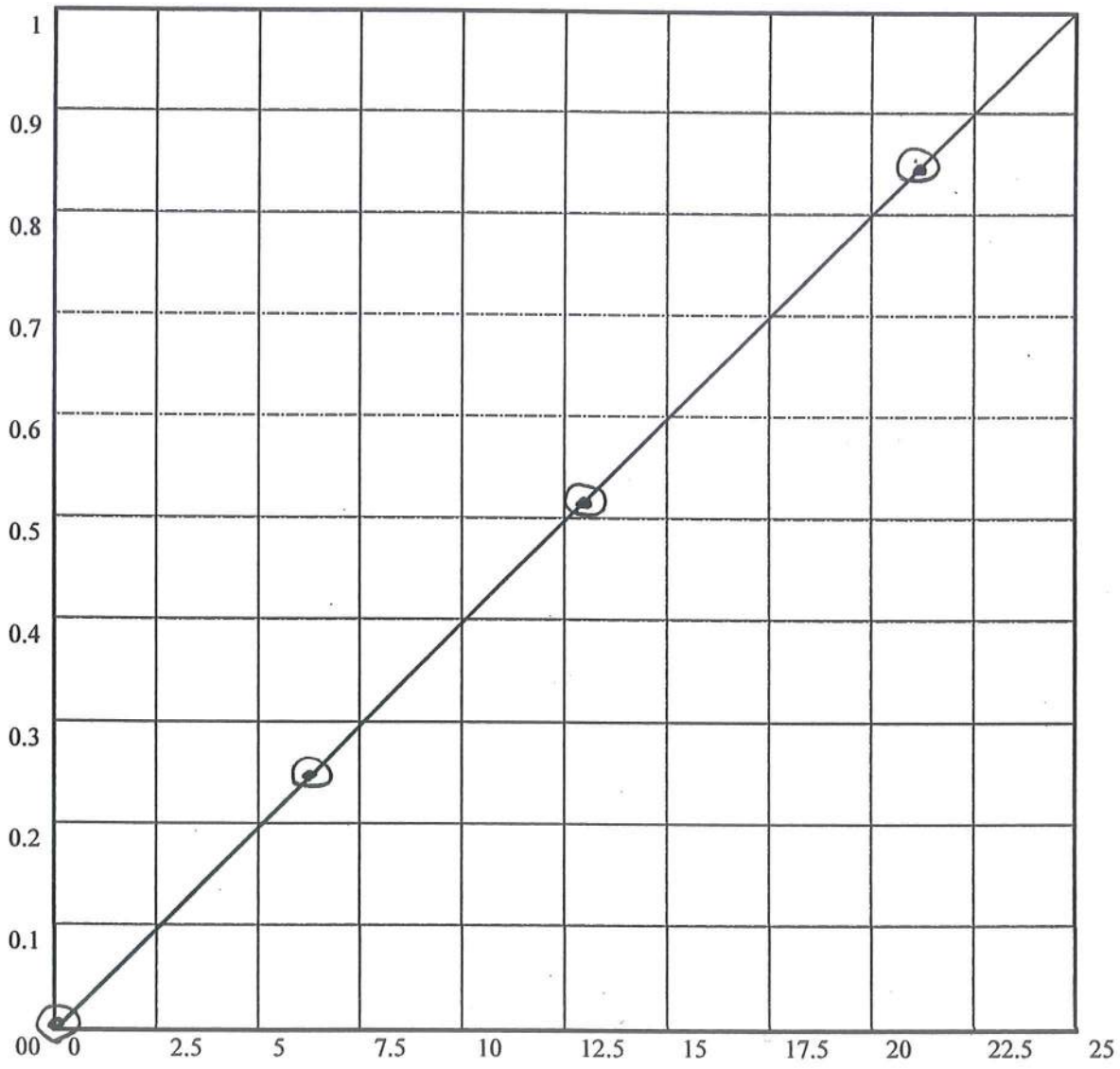
Y = MX +B

Slope (M) = -.0009983

Y Intercept (B) = .0401197

Correlation Coefficient (r) = .9999961

r^2 = .9999922

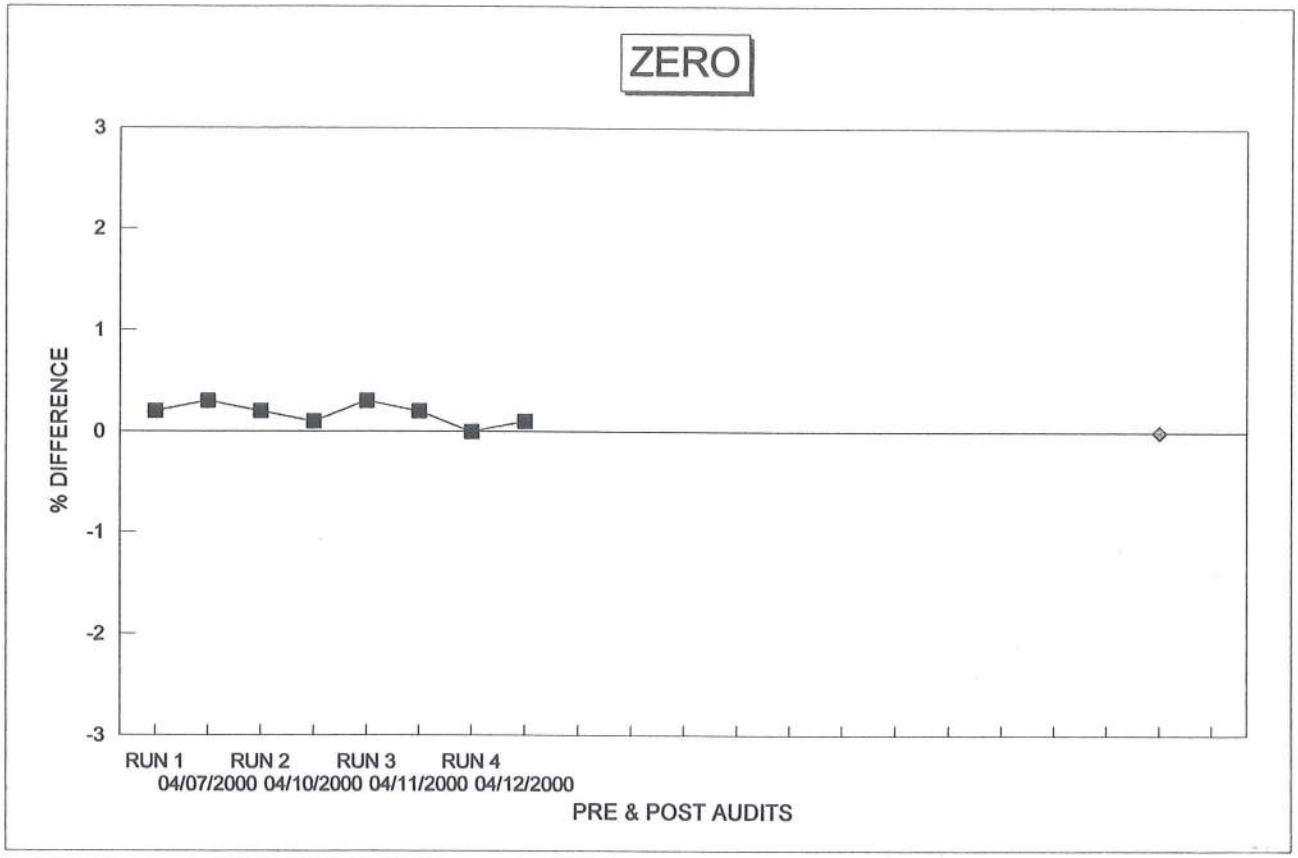


EPA Span Value = ± 2.0% of 25% CO_2 = ± .5%

Cal Volts = Cal Volt Conc - Std Conc = ± Conc Diff = ± Δ %

.846 = 21.133 - 21.100 = .033 = .132

.248 = 6.195 - 6.240 = -.045 = -.180


ZERO
3
2
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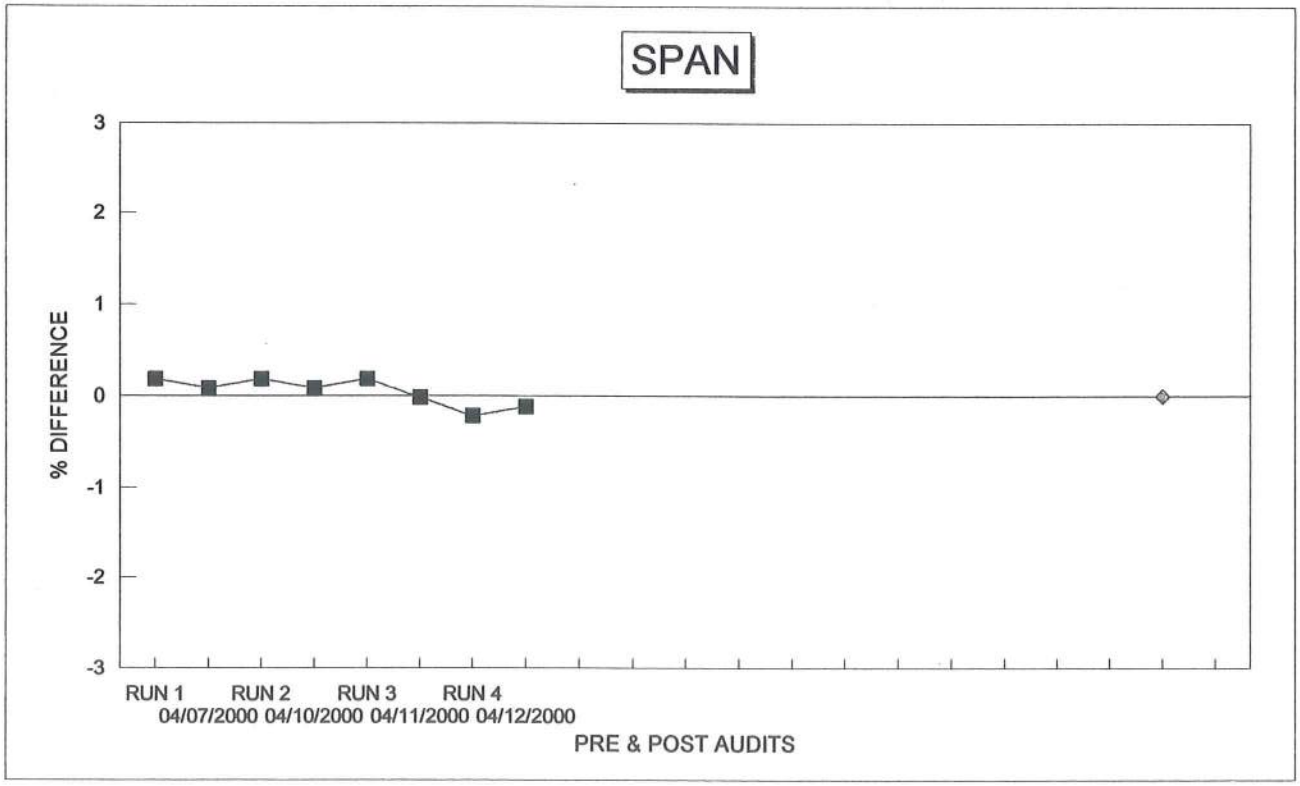
-1
-2
-3
% DIFFERENCE
RUN 1
RUN 2
RUN 3
RUN 4
04/07/2000 04/10/2000 04/11/2000 04/12/2000
PRE & POST AUDITS


SPAN
3
2
1
0
-1
-2
-3
% DIFFERENCE
RUN 1
RUN 2
RUN 3
RUN 4
04/07/2000 04/10/2000 04/11/2000 04/12/2000
PRE & POST AUDITS

CO ANALYZER
MULTIPOINT CALIBRATION REPORT FORM

Date: 3312000

Analyzer: Make: HORIBA Model: PIR 2000 SN: 408005

Calibration by: C. Wadington

Cal Gas Flow: 1.5 SCFH Measured by: Rotameter

BP: 30.50 Instrument ID: PRINCO

Temp: 76 Instrument ID: TR

Analyzer last calibrated: _____ By: _____

Cylinders:

1. # TX 79373 Concentration: 00.00 % **CO** Cyl. Press.: 960 PSI
   Certified by: Air Liquide Date: 9-22-98
2. # CC52330 Concentration: 4.75 % **CO** Cyl. Press.: 1750 PSI
   Certified by: Air Liquide Date: 2-10-2000
3. # CC55904 Concentration: 8.60 % **CO** Cyl. Press.: 1610 PSI
   Certified by: Air Liquide Date: 2-14-2000
4. # AAL 21084 Concentration: 2.01 % **CO** Cyl. Press.: 1320 PSI
   Certified by: Scott Specialty Gases Date: 5-15-97

Analyzer: **Calibrated Range:** 0-10.0 % **Output:** 0-1.0 V.
Flow: 1.5 SCFH **Measured by:** Rotameter

Calibration Results

Point #	CYL. #	% CO	EXPECTED METER	EXPECTED DVM	ACTUAL METER	ACTUAL DVM	ADJ. METER	ADJ. DVM	% DIF.	POTENTIOMETER UNADJ.	POTENTIOMETER ADJ.
1	1	0.00	0.00	.000	0.00	.000	—	—			
2	2	4.75	47.5	.475	49.1	.491	47.5	.475			
3	3	8.60	86.0	.860	86.0	.860	—	—			
4	4	2.01	20.1	.201	20.0	.200	—	—			
5	1	0.00	0.00	.000	0.00	.000	—	—			

.5 = 5.002

CO Linear Regression Results:

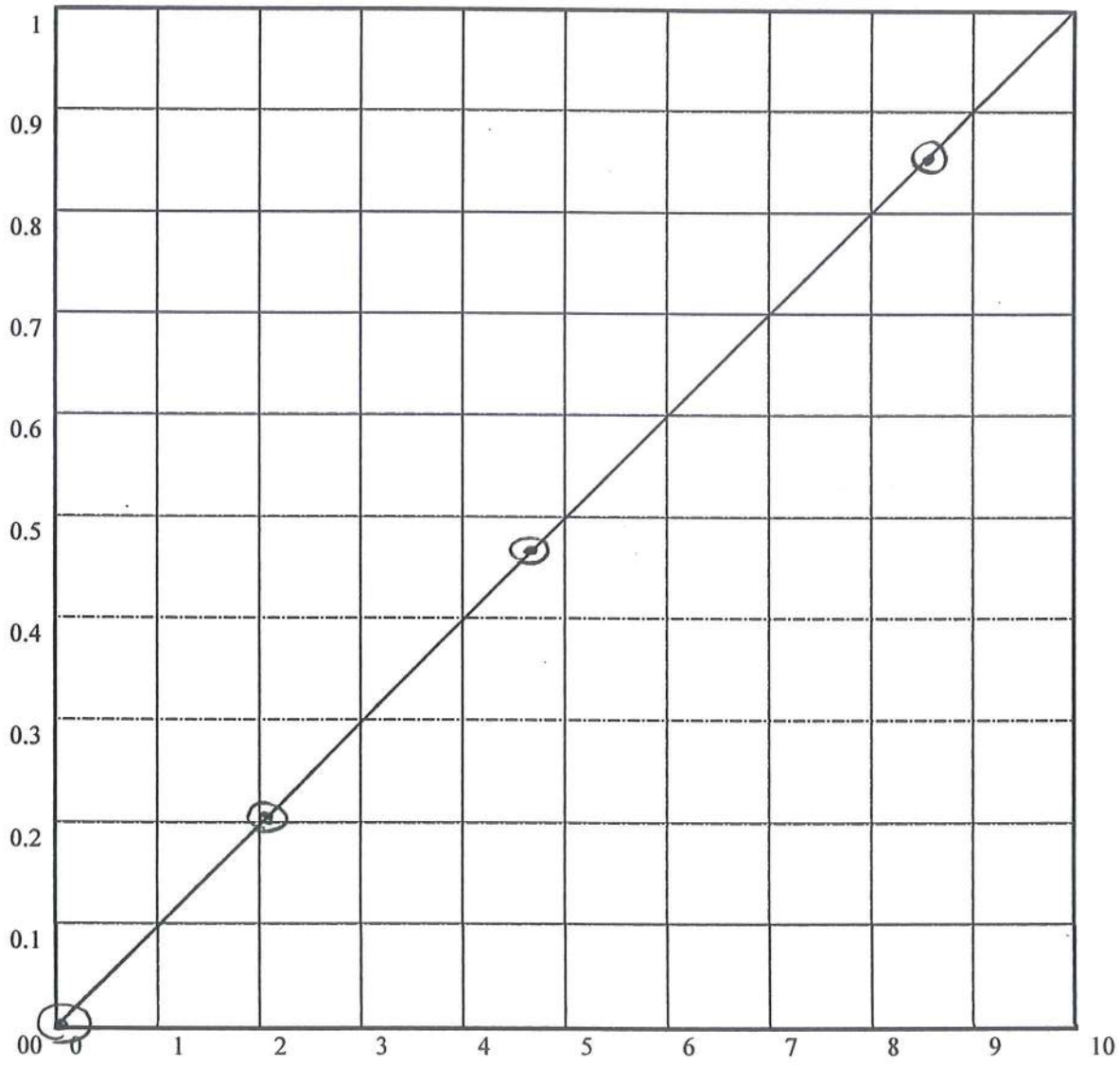
Y = MX +B

Slope (M) = -.0004190

Y Intercept (B) = .1000440

Correlation Coefficient (r) = .9999992

r^2 = .9999984

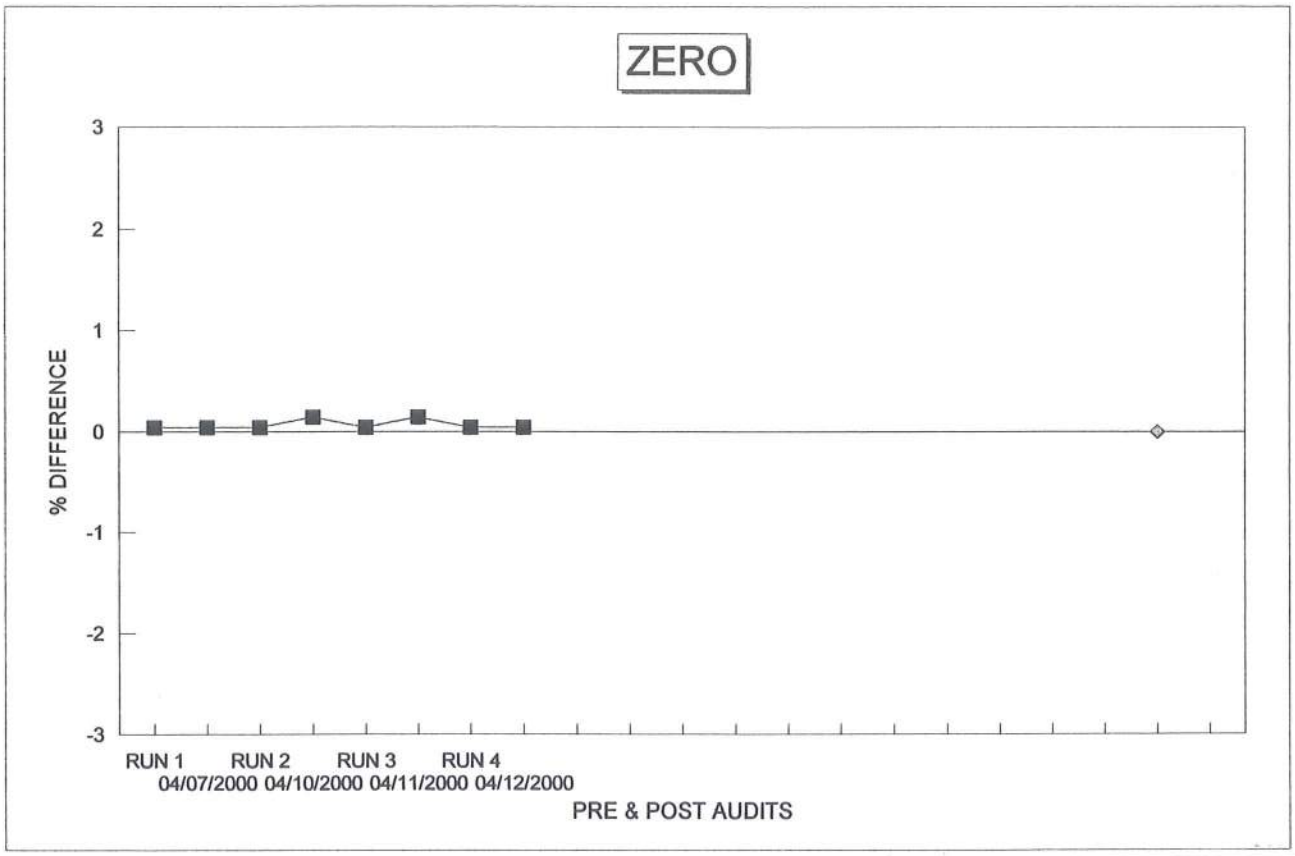


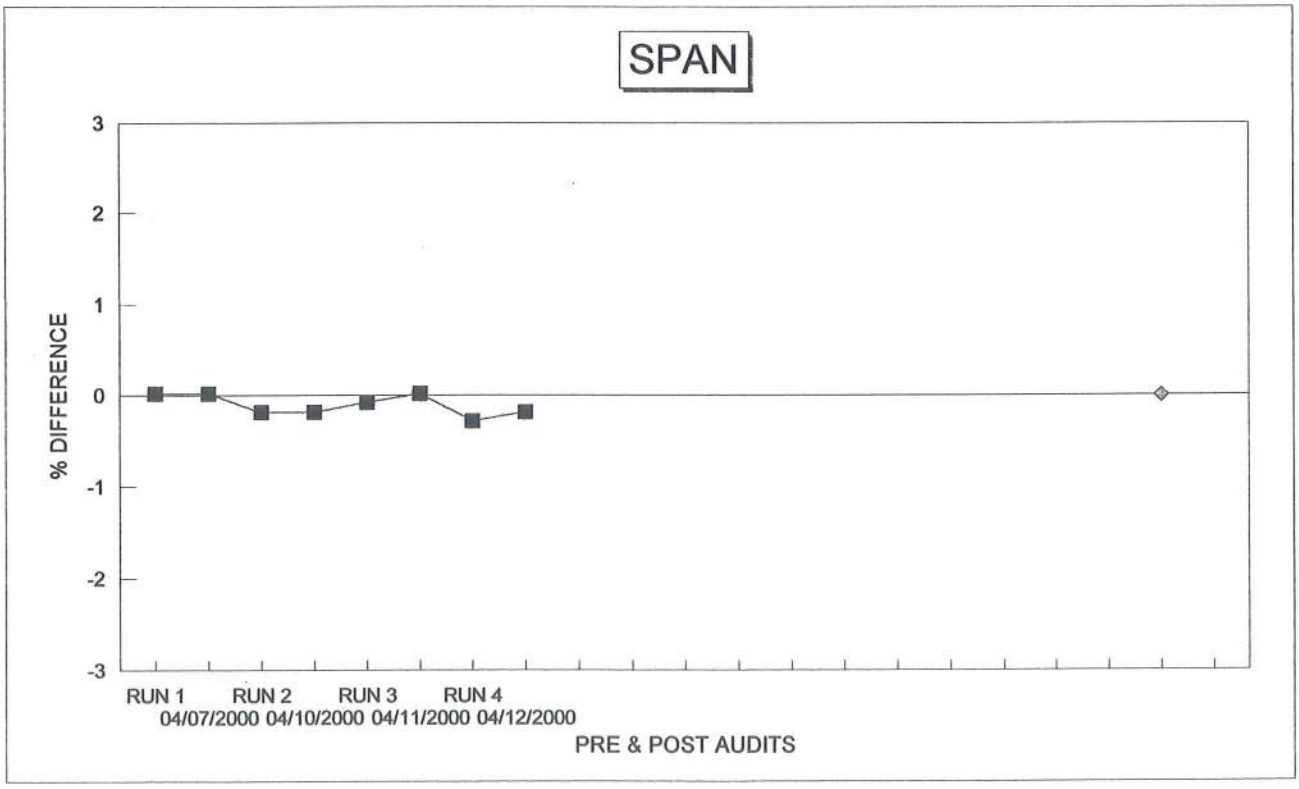
EPA Span Value = ± 2.0% of 10% CO = ± .2%

Cal Volts = Cal Volt Conc - Std Conc = ± Conc Diff = ± Δ %

.860 = 8.600 - 8.606 = 0 = Ø

.200 = 2.000 - 2.010 = -.010 = -.100


ZERO
3
2
1
0
-1
-2
-3
% DIFFERENCE
RUN 1
RUN 2
RUN 3
RUN 4
04/07/2000 04/10/2000 04/11/2000 04/12/2000
PRE & POST AUDITS


SPAN
3
2
1
0
-1
-2
-3
% DIFFERENCE
RUN 1
RUN 2
RUN 3
RUN 4
04/07/2000 04/10/2000 04/11/2000 04/12/2000
PRE & POST AUDITS

SO_2 ANALYZER
MULTIPOINT CALIBRATION REPORT FORM

Date: 3-31-2000

Analyzer: Make: HORIBA Model: PIR 2000 SN: 403019

Calibration by: C. Wadington

Cal Gas Flow: 1.5 SCFH Measured by: Rotameter

BP: 30.50 Instrument ID: PRINCO

Temp: 76 Instrument ID: TR

Analyzer last calibrated: _____ By: _____

Cylinders:

1. # TX 79373 Concentration: 00.00 % SO_2 Cyl. Press.: 960 PSI
   Certified by: Air Liquide Date: 9-22-98
2. # CC67475 Concentration: 1260 % SO_2 Cyl. Press.: 650 PSI
   Certified by: Air Liquide Date: 9-22-98
3. # ALMO 49127 Concentration: 1770 % SO_2 Cyl. Press.: 1150 PSI
   Certified by: Scott Specialty Gases Date: 5-15-97
4. # ALMO 52285 Concentration: 506 % SO_2 Cyl. Press.: 1000 PSI
   Certified by: Scott Specialty Gases Date: 5-15-97

Analyzer: **Calibrated Range:** 0-2500 PPM **Output:** 0-1.0 V.
Flow: 1.5 SCFH **Measured by:** Rotameter

Calibration Results

Point #	CYL. #	PPM SO2	EXPECTED METER	EXPECTED DVM	ACTUAL METER	ACTUAL DVM	ADJ. METER	ADJ. DVM	% DIF.	POTENTIOMETER UNADJ.	POTENTIOMETER ADJ.
1	1	0.00	0.00	.000	00.0	.000	—	—			
2	2	1260	50.4	.504	50.8	.508	50.4	.504			
3	3	1770	70.8	.708	71.2	.712	—	—			
4	4	506	20.2	.202	19.2	.192	—	—			
5	1	0.00	0.00	.000	0.00	.000	—	—			

.5 = 1250.200

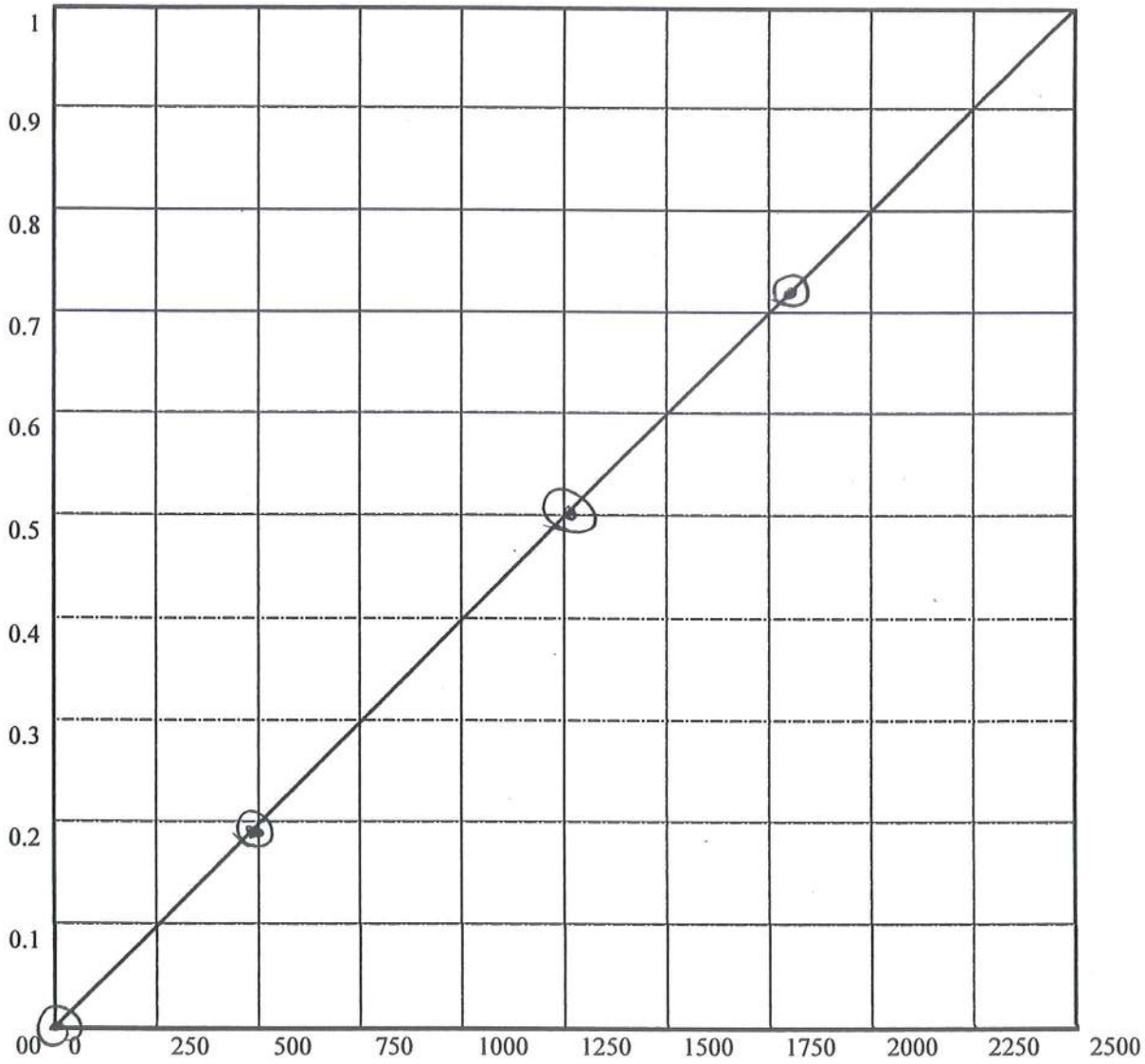
SO_2 Linear Regression Results:

Y = MX +B
Slope (M) = -.0051706

Y Intercept (B) = .0004040

Correlation Coefficient (r) = .9998615

r^2 = .9997229



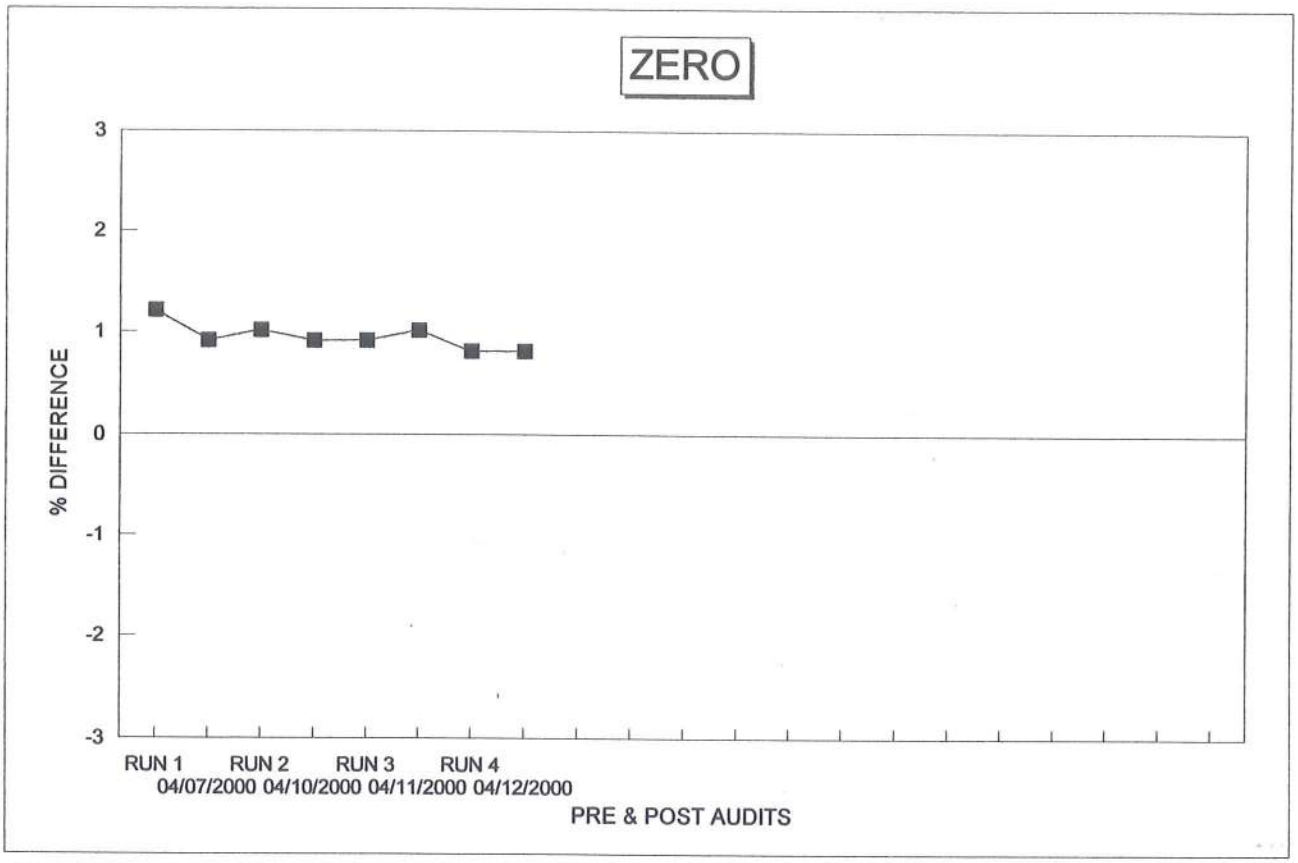
EPA Span Value = ± 2.0% of 2500 PPM SO2 = ± 50 PPM
Cal Volts = Cal Volt Conc - Std Conc = ± Conc Diff = ± Δ %

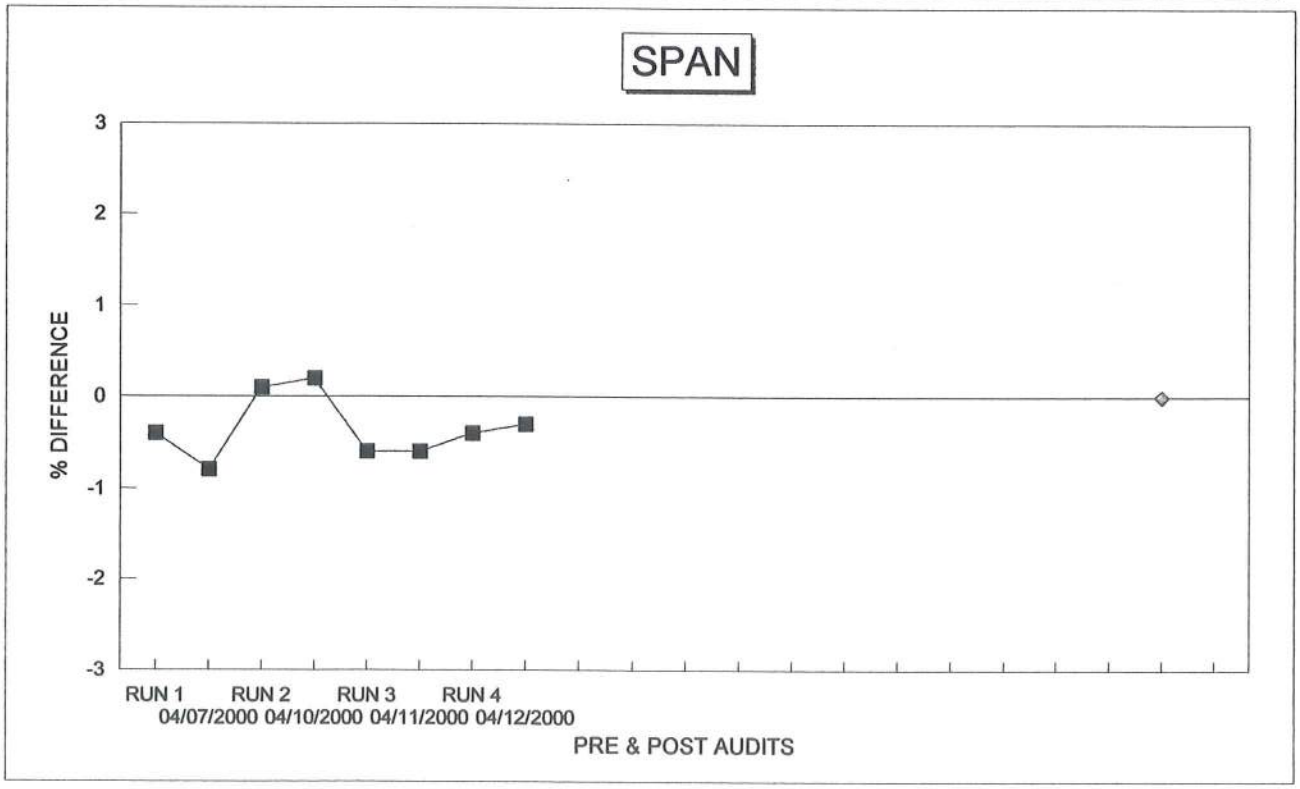
.712 = 1780.000 - 1770.0 = 10.000 = .400

.192 = 480.000 - 506.0 = -26.000 = -1.04

SO2

Jotul F400





Scott Specialty Gases

Shipped From: 500 WEAVER PARK RD
LONGMONT CO 80501
Phone: 303-442-4700 Fax: 303-772-7673

CERTIFICATE OF ANALYSIS

ENERGY & ENV MEASUREMENT

C/O ED WADINGTON
3730 N. PELLEGRINO DR.
TUCSON AZ 85749

PROJECT #: 08-34135-005
PO#: VERBAL
ITEM #: 08024520 4AL
DATE: 4/24/97

CYLINDER #: AAL21084
FILL PRESSURE: 2015 PSIA
BLEND TYPE : CERTIFIED MASTER GAS

ANALYTICAL ACCURACY: +/-2%
PRODUCT EXPIRATION: 4/24/2000

COMPONENT	REQUESTED GAS CONC MOLES		ANALYSIS (MOLES)	
CARBON DIOXIDE	6.25	%	6.25	%
CARBON MONOXIDE	2.	%	2.01	%
OXYGEN	6.25	%	6.24	%
NITROGEN		BALANCE		BALANCE

CGA 590 2015 PSIA

ANALYST: Diana Beehler
DIANA BEEHLER

AIR LIQUIDE

1451 THORNE RD.
TACOMA, WA 98421
TEL: (253) 383-3637

THE ONLY LIABILITY OF THIS COMPANY FOR GAS WHICH FAILS TO COMPLY WITH THE ANALYSIS SHALL BE REPLACEMENT THEREOF BY THE COMPANY WITHOUT EXTRA COST.

DO NOT REMOVE THIS TAG

AIR LIQUIDE

GASES FOR RESEARCH AND DEVELOPMENT

CYL # CC52330 CGA 590

PRES 1650 VOL 150 cf

TEST # 04100 DATE 02-10-00

Analytical Method GC + Paramagnetic

	Requested	Analyzed
Hydrogen		
Nitrogen	Bal.	Bal.
Argon		
Air		
Carbon Monoxide	5%	4.75%
Methane		
Oxygen	12.5%	12.69%
Helium		
Carbon Dioxide	12.5%	12.79%

SIGNED

AIR LIQUIDE

1451 THORNE RD.
TACOMA, WA 98421
TEL: (253) 383-3637

THE ONLY LIABILITY OF THIS COMPANY FOR GAS WHICH FAILS TO COMPLY WITH THE ANALYSIS SHALL BE REPLACEMENT THEREOF BY THE COMPANY WITHOUT EXTRA COST.

DO NOT REMOVE THIS TAG

AIR LIQUIDE

GASES FOR RESEARCH AND DEVELOPMENT

CYL # CC55904 CGA 590

PRES 1650 VOL 150 cf

TEST # 04500 DATE 02-14-00

Analytical Method GC / Paramagnetic

	Requested	Analyzed
Hydrogen		
Nitrogen	Bal.	Bal.
Argon		
Air		
Carbon Monoxide	8.5%	8.60%
Methane		
Oxygen	21%	21.10%
Helium		
Carbon Dioxide	21%	21.23%

SIGNED

Scott Specialty Gases

500 WEAVER PARK RD,LONGMONT,CO 80501 Phone: 303-442-4700 Fax: 303-772-7873

CERTIFICATE OF ANALYSIS: Interference-Free™ Multi-Component EPA Protocol Gas

Customer
ENERGY & ENV MEASUREMENT

C/O ED WADINGTON
3730 N. PELLEGRINO DR.
TUCSON,AZ 85749

Assay Laboratory

SCOTT SPECIALTY GASES
500 WEAVER PARK RD
LONGMONT,CO 80501

Project No.: 08-34135-001
P.O. No.: VERBAL

ANALYTICAL INFORMATION

This certification was performed according to EPA Traceability Protocol For Assay & Certification of Gaseous Calibration Standards; Procedure #G1; September, 1993.

Cylinder Number: ALM052285 Certification Date: 4/21/97 Exp. Date: 4/21/2000
Cylinder Pressure***: 1996 PSIG

COMPONENT	CERTIFIED CONCENTRATION	ANALYTICAL ACCURACY**
SULFUR DIOXIDE *	506 PPM	+/- 1% NIST Traceable
NITROGEN	BALANCE	

*** Do not use when cylinder pressure is below 150 psig.
** Analytical accuracy is inclusive of usual known error sources which at least include precision of the measurement processes.
Product certified as +/- 1% analytical accuracy is directly traceable to NIST standards.
* This Protocol has been certified using corrected NIST SO2 standard values, per EPA guidance dated 7/24/96 and will not correlate with uncorrected Protocols.

REFERENCE STANDARD

TYPE/SRM NO.	EXPIRATION DATE	CYLINDER NUMBER	CONCENTRATION	COMPONENT
NTRM 1661	9/27/98	ALM059505	488.5 PPM	SO2/N2

INSTRUMENTATION

INSTRUMENT/MODEL/SERIAL#	LAST DATE CALIBRATED	ANALYTICAL PRINCIPLE
FTIR System/8220/AAB9400251	03/20/97	Scott Enhanced FTIR

ANALYZER READINGS

(Z = Zero Gas R = Reference Gas T = Test Gas r = Correlation Coefficient)

First Triad Analysis

SULFUR DIOXIDE *

Date: 04/14/97 Response Unit: PPM

Z1 = 0.3847	R1 = 487.72	T1 = 505.77
R2 = 488.79	Z2 = 1.8201	T2 = 505.89
Z3 = 1.8426	T3 = 505.78	R3 = 488.89
Avg. Concentration:	505.8	PPM

Second Triad Analysis

Date: 04/21/97 Response Unit: PPM

Z1 = 0.3241	R1 = 488.29	T1 = 505.43
R2 = 488.83	Z2 = 1.8098	T2 = 505.75
Z3 = 0.8340	T3 = 505.74	R3 = 488.68
Avg. Concentration:	505.8	PPM

Calibration Curve

Concentration = A + Bx + Cx2 + Dx3 + Ex4
r = 0.999990
Constants: A = 0.000000
B = 1.000000 C = 0.000000
D = 0.000000 E = 0.000000

Special Notes:

ANALYST: Devon VonFeldt
Devon VonFeldt

AIR LIQUIDE™

CERTIFICATE of ANALYSIS

Interference-Free Multi-Component EPA Protocol Gases

Cyl. Number:	Cyl. Pressure:*	Lot Number:
CC67475	1900 psig	N.A.
Assay Date:	**Expiration Date:**	**Document Number:**
04/02/98	04/01/01	881463
Customer:	**P.O. Number:**	**Item Number**
AL COMPRESSED	031798CS	N.A.
*Mixture is valid only to 150 psig		N.A.

COMPONENT Name	REQUESTED Concentration	ASSAY Concentration
Sulfur Dioxide	1250 ppm	1260 ± 11 ppm ppm
Nitrogen	Balance	Balance

EPA Protocol, Section No. 2.2, Procedure: G-1

Analyst:	WR
Calculated by:	WR
Approved by:	WR

REFERENCE STANDARD EMPLOYED FOR ANALYSIS

Std name	Conc.	Units	Std. Error	Comp.	Balance	Cyl. No.	Exp. Date	Sample No.
82745x	500.0	ppm	4.9	SO2	N2	CC63100	09/27/98	97080209
GMIS22	1510.0	ppm	13.0	SO2	N2	CC10208	07/25/99	N.A.

COMPONENT 1 GAS ANALYZER EMPLOYED

Manufacturer:	KVB/ANALECT
Model Number:	EN3024
Serial Number:	3024
MPR Last Calibrated:	03/18/98
Analytical Principle:	FTIR

3/26/98	Trial 1	Trial 2	Trial 3	Units
Zero	0.3	0.4	0.4	VDC
Reference#1	493.7	496.0	488.3	VDC
Reference#2	1476.8	1483.5	1478.1	VDC
Candidate	1241.2	1231.4	1239.9	VDC
Result	1266.1	1256.1	1264.7	ppm
MEAN ANALYTICAL RESULT:				1262.3 ppm

4/2/98	Trial 4	Trial 5	Trial 6	Units
Zero	0.0	0.1	0.0	VDC
Reference#1	496.6	494.8	490.5	VDC
Reference#2	1487.6	1480.7	1482.0	VDC
Candidate	1238.4	1233.9	1237.1	VDC
Result	1263.2	1258.7	1261.9	ppm
MEAN ANALYTICAL RESULT:				1261.3 ppm

Analytical uncertainty and NIST traceability are in compliance with EPA-600/R-97/121

Analyst:	Calculated by:	Approved by:

AIR LIQUIDE AMERICA CORPORATION
11426 Fairmont Parkway • La Porte, TX 77571-6000 • 800/248-1427 • 281/474-8400 • Fax: 281/474-8419

Scott Specialty Gases

500 WEAVER PARK RD,LONGMONT,CO 80501 Phone: 303-442-4700 Fax: 303-772-7673

CERTIFICATE OF ANALYSIS: EPA PROTOCOL GAS

Customer
ENERGY & ENV MEASUREMENT

C/O ED WADINGTON
3730 N. PELLEGRINO DR.
TUCSON,AZ 85749

Assay Laboratory

SCOTT SPECIALTY GASES
500 WEAVER PARK RD
LONGMONT,CO 80501

Project No.: 08-34135-003
P.O. No.: VERBAL

ANALYTICAL INFORMATION

This certification was performed according to EPA Traceability Protocol For Assay & Certification of Gaseous Calibration Standards; Procedure #G1; September, 1993.

Cylinder Number: ALM049127 **Certification Date:** 4/21/97 **Exp. Date:** 4/21/2000
Cylinder Pressure*:** 1860 PSIG

COMPONENT	CERTIFIED CONCENTRATION	ANALYTICAL ACCURACY**
SULFUR DIOXIDE *	1,770 PPM	+/- 1% NIST TRACEABLE
NITROGEN	BALANCE	

*** Do not use when cylinder pressure is below 150 psig.

** Analytical accuracy is inclusive of usual known error sources which at least include precision of the measurement processes. Product certified as +/- 1% analytical accuracy is directly traceable to NIST standards.

* This Protocol has been certified using corrected NIST SO2 standard values, per EPA guidance dated 7/24/96 and will not correlate with uncorrected Protocols.

REFERENCE STANDARD

TYPE/SRM NO.	EXPIRATION DATE	CYLINDER NUMBER	CONCENTRATION	COMPONENT
NTRM-R-1696	7/03/98	ALM057797	3131. PPM	SULFUR DIOXIDE

INSTRUMENTATION

INSTRUMENT/MODEL/SERIAL#	LAST DATE CALIBRATED	ANALYTICAL PRINCIPLE
FTIR System/8220/AAB9400251	03/20/97	Scott Enhanced FTIR

ANALYZER READINGS

(Z = Zero Gas R = Reference Gas T = Test Gas r = Correlation Coefficient)

First Triad Analysis

SULFUR DIOXIDE *

Date: 04/14/97	Response Unit: PPM	
Z1 = 0.7210	R1 = 3127.7	T1 = 1767.1
R2 = 3131.7	Z2 = 4.6770	T2 = 1768.1
Z3 = 4.6770	T3 = 1768.1	R3 = 3133.7
Avg. Concentration:	1768.	PPM

Second Triad Analysis

Date: 04/21/97	Response Unit: PPM	
Z1 = 0.4020	R1 = 3125.8	T1 = 1770.2
R2 = 3132.3	Z2 = 6.6540	T2 = 1769.3
Z3 = 4.9410	T3 = 1770.9	R3 = 3134.9
Avg. Concentration:	1770.	PPM

Calibration Curve

Concentration = A + Bx + Cx2 + Dx3 + Ex4	
r = 0.999990	1696
Constants:	A = 0.00000
B = 1.00000	C = 0.00000
D = 0.00000	E = 0.00000

Special Notes:

ANALYST: Devon VonFeldt
DEVON VONFELDT

Certificate of Analysis

ANALYTICAL CONTROL LABORATORY ANALYSIS

ACETONE - OPTIMA

Catalog No.: A-929 January 13, 1997

Lot No.: 972630

This is to certify that this lot was tested and found to comply with the specifications for this product. The following are the actual analytical results obtained:

TESTS	ACTUAL ANALYSIS
Aldehyde	0.0005%
Assay	99.6%
Color	5 APHA
Density (g/mL) at 25°C	0.7851
Description	Clear, Colorless Liquid
Fluorescence Background (as Quinine Sulfate)	Not More Than 1 PPB
Identification	Pass Test
Isopropyl Alcohol	0.01%
Methanol	0.03%
Optical Absorbance at 350nm	0.001
at 340nm	0.05
at 330nm	0.69
Pesticide Residue Analysis (as Heptachlor Epoxide)	Not More Than 10 ng/L
Refractive Index at 25°C	1.3560
Residue after Evaporation	0.3 PPM
Solubility in Water	Pass Test
Substances Reducing Permanganate	Pass Test
Titratable Acid	0.0003 Meq/g.
Titratable Base	0.0001 Meq/g.
Water (H_2O)	0.4%

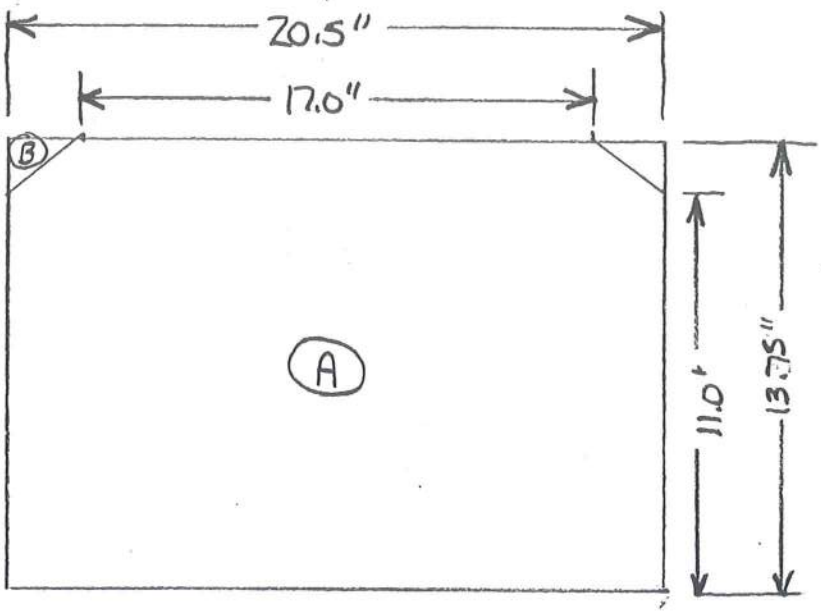
Approved By: Robert Dowd

Robert Dowd
Q.C. Laboratory Manager

Fisher Scientific

Chemical Division
1 Reagent Lane
Fair Lawn, N.J. 07410
(201) 796-7100

Jotul F400 Volume and Fuel Load Calculations



A = 13.75 × 20.5 × 11.25 = 3171.094

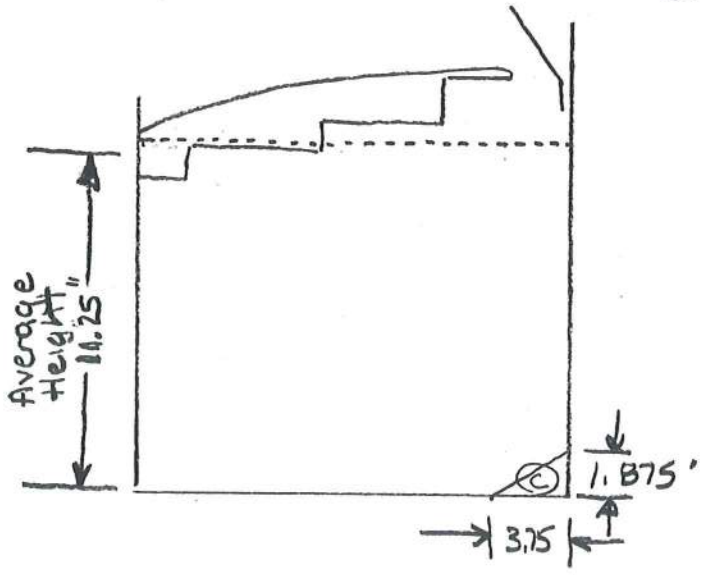
(-2x) B = .5(9 × 1.75 × 2.5) = 19.688

- C = .5(3.75 × 1.875 × 20.5) = 72.070

3059.648

÷ 1728.000

Volume in ft^3 = 1.771



Fuel Load

Low	Ideal	High
11.2	12.394	13.6

Jotul North America
400 Riverside Street
Portland, ME 04104

4/5/2000

Chip Wadington
LoKee Testing Laboratory
13235 Prairie Circle East
Sumner, WA 98390

RE: **Air Settings for the F400**

Dear Chip,

Here are the air settings for the F400. These are approximate.

Low	0"-. 1"
Med-low	. 1"-. 2"
Med high	. 2"-. 5" (possibly higher)
High	Wide open

These measurements are made across the slider gap (opening). I suggest measuring these against the control rod for reference.

Thanks,

Roger Purinton

PARTS LIST FOR THE F 400 CASTINE WOODSTOVE

CONSULT YOUR DEALER FOR PART NUMBERS AND REPLACEMENT PARTS.

1	ASHLIP
2	LEFT DOOR
3	RIGHT DOOR
4	RIGHT SIDE PANEL
5	FRONT PANEL
6	TOP CASTING
7	UPPER BACK PANEL
8	SMOKE OUTLET
9	BACK PANEL
10	LEFT SIDE PANEL
11	LEG (long leg)
12	UPPER BOTTOM PANEL
13	FRONT DOOR SHAFT (exterior)
	LATCH
	NUT
	SPRING
14	RIGHT BURN PLATE
15	RIGHT GLASS PANEL
16	LEFT GLASS PANEL
17	AIR WASH MANIFOLD
18	TOP BAFFLE (stainless steel)
19	BAFFLE COVER (cast iron)
20	AIR INSPECTION COVER
21	REAR BURN PLATE
22	FIRE BRICK (3)
23	BOTTOM GRATE
24	LEFT BURN PLATE
25	LOWER BOTTOM PANEL
26	ASHPAN HOUSING
*	ASHPAN
27	AIR SLIDER/VALVE
28	AIR DEVIDER
29	DOOR PINS
30	AIR CONTROL LEVER (chrome)
	ALLEN HEAD SCREW
31	ASHPAN DOOR
*	ASHPAN DOOR PIN
32	ASH DOOR HANDLE
	LOOP HANDLE
	SET SCREW
	LATCH
	SPRING
	NUT

* NOT SHOWN

APPENDIX A:

ALTERNATE FLOOR PROTECTION

All floor protection materials must be non-combustible ie. metal, brick, stone, mineral fiber boards). Any combustible material may not be used.

The easiest means of determining if a proposed alternate floor material meets requirements listed in this manual is to follow this procedure.

R-value = thermal resistance
k-value = thermal conductivity
C-value = thermal conductance

1. Convert the specification to R-value;
   a. If R-value is given, no conversion is needed.
   b. If k-value is given with a required thickness (T) in inches: R=1/k X T.
   c. If C-value is given: R=1/C.
2. Determine the R-value of the proposed alternate floor protector.
   a. Use the formula in Step 1 to convert values not expressed as "R".
   b. For multiple layers, add R-values of each layer to determine overall R-value.
3. If the overall R-value of the sustem is greater than the R-value of the specified floor protector, the alternate is acceptable.

EXAMPLE:

The specified floor protector should be 3/4" thick material with a k-factor of 0.84. The proposed alternate is 4" brick with a C-factor of 1.25 over
1/8" mineral board witha k-factor of 0.29.

Step A. Use formula above to convert specifications to R-value.
R=1/k X T= 1/.84 X .75 = .893

Step B. Calculate R of proposed system.
4" brick of C-1.25, therefore
R brick = 1/C = 1/1.25 = 0.80.
1/8" mineral board of k = 0.29 therefore
R mineral board = 1/.29 X 0.125 = 0.431

Total R = R brick + R mineral board=
0.8 + 0.431=**1.231**

Step C. Compare proposed system R = 1.231 to specified R of 0.893. Since R is greater than required, the system is acceptable.

Definitions:

Thermal conductance =

$$C = \frac{Btu}{(hr)(ft^2)(F)} = \frac{W}{(m^2)(K)}$$

Thermal conductivity =

$$k = \frac{Btu}{(hr)(ft^2)(F)} = \frac{W}{(m^2)(K)} = \frac{(Btu)}{(hr)(ft)(F)}$$

Thermal resistance =

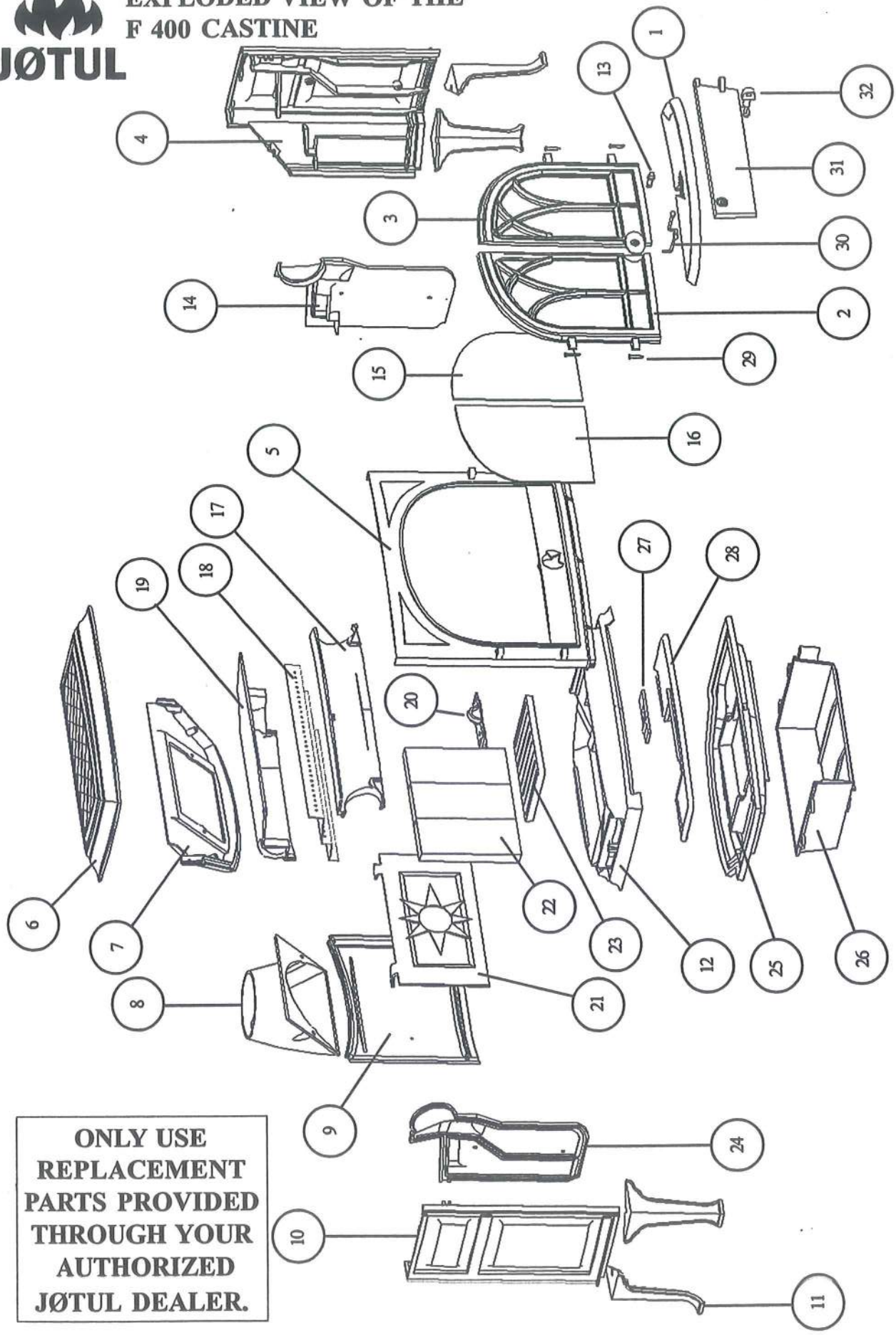
$$R = \frac{Btu}{(hr)(ft^2)(F)} = \frac{(m^2)(K)}{W} = \frac{(Btu)(inch)}{(hr)(ft^2)(F)}$$

THE JØTUL F 400 CASTINE WOODSTOVE REQUIRES FLOOR PROTECTION WITH A **MINIMUM INSULATING R VALUE OF 0.5.**

ALCOVE INSTALLATION REQUIRE A MINIMUM R VALUE OF 1.6. (IF A UL/ULC or WHI LISTED HEARTH PAD IS NOT USED.)

JØTUL

EXPLODED VIEW OF THE F 400 CASTINE



ONLY USE REPLACEMENT PARTS PROVIDED THROUGH YOUR AUTHORIZED JØTUL DEALER.

The Outside Air Kit includes an adapter to mount onto the stove that will except the fresh air pipe. **Installation will require some additional materials:**

a. the appropriate length of metallic pipe for a conduit of the outside air (3" diameter).
b. a rain/weather resistant cap for the outside of the house.
c. a rodent screen- that is no larger than 1/4" mesh

Outside air may be required if:

1. The F 400 Castine does not "draw" steadily, smoke rollout occurs, fuel burns poorly, or back-drafts occur whether or not there is combustion present.

2. Existing fuel-fired equipment in the house, such as fireplaces or other heating appliances, smell, do not operate properly, suffer smoke roll-out when opened, or back -draft whether or not there is combustion present.

3. Opening a window slightly on a calm (wind less) day alleviates any of the above symptoms.

4. The house is equipped with a well-sealed vapor barrier and tight fitting windows and/or has any powered devices that exhaust house air.

5. There is excessive condensation on the windows in the winter.

6. A ventilation system is installed in the house.

If these or other indications suggest that infiltration air is inadequate, additional combustion air should be provided from the outdoors. Outside combustion air can be provided to the appliance by the following means:

1. Direct connection: the F 400 Castine has been tested and listed for use use with a outside air kit This outside air kit is connected directly to the stove, be sure to follow the instructions provided with the kit.

2. Indirect method: outside air is ducted to a point no closer than (12") 300mm from the appliance, to avoid affecting the performance of the appliance.

3. A mechanical ventilation system: if the house has a ventilation system (air change or heat recovery):
   a. the ventilation system may be able to provide sufficient combustion make-up air for the solid -fuel fired appliance.
   b.the homeowner should be informed that the ventilation system might need to be rebalanced by a ventilation technician after installation of the appliance.

Floor Bracket Kit (part #750304)

Use of the Floor Bracket Kit is required in all mobile home installations to secure the stove to the floor. Complete installation instructions and diagrams are supplied with each Floor Bracket Kit.

Rear Heatshield (part # 154385)

A stove rear heatshield has been specifically designed for the F 400 Castine to reduce clearances off the rear of the stove to combustible materials. Use of the heatshield DOES NOT affect the clearance off the sides of the appliance. See pages 11-12 for specific clearance requirements. Complete installation instructions are supplied with the heatshield.

NO OTHER TYPE OF HEATSHIELD MAY BE USED ON THE REAR OF THE F 400 Castine.

Bottom Heatshield (part # 154384)

A bottom heatshield has been specifically designed for the F 400 Castine. It is required in all alcove installations. Use of the bottom heat shield DOES NOT affect the floor protection requirements discribed on page 9 of this manual.

NO OTHER TYPE OF HEATSHIELD MAY BE USED ON THE BOTTOM OF THE F 400 Castine.

Stove-Top Thermometer (part # 5002)

Jøtul recommends the use of a magnetic stove-top thermometer to monitor the surface temperature of the stove. The optimum surface temperature range for the most efficient, clean burn is between 400° and 600°.

General Maintenance

Like your car, regular maintenance prolongs the life of your appliance. The following procedures do not take long and are generally inexpensive, but when done consistently, increase the life of your appliance and in turn, increase your years of enjoyment.

At least once a year you should perform the following maintenance procedures:

- Thoroughly clean the stove. Enamel surfaces should be cleaned with soap and water.
- Empty stove of all soot and ashes. Only use a vacuum for this job if the vacuum is specifically designed for ashes.
- Inspect the stove; using a strong light inspect the stove inside and out for cracks or leaks. Replace all cracked parts and repair any cement leaks with furnace cement.

Gaskets

Check door and window gaskets for tightness. To check the seal of the front doors, close and latch the doors on a dollar bill and slowly try to pull the dollar bill free. If it can be easily removed then the seal is too loose. Check several spots around the door, and repeat the procedure on the ash pan door as well.

If gaskets need to be replaced, scrape out the old gasket and cement and clean the area with a wire brush. Apply a small bead of cement and push in the new gasket. After closing and latching the doors wipe clean, any excessive cement that has come from beneath the gasketing.

GASKET LIST FOR THE F 400 CASTINE

Description	Order #	Size	Length
Top Plate Gasket	100038	3/8" LD	7'
Smoke Outlet Gasket	200028	3/16" LD/SA	3'
Ash Housing Gasket	200028	3/16" LD/SA	4'
Ash Door Gasket	200024	5/16" LD	4'
Glass Gasket	100038	3/8" LD	5'
Right door Gasket	100038	5/16" LD	5'
Left door Gasket	100038	5/16" LD	

The F 400 Castine is designed to burn cleanly and efficiently when used according to the guidelines expressed in these operating instructions. However, to maintain the proper performance, a yearly chimney inspection and cleaning in necessary. Failure to keep the chimney system free of creosote and build up could result in a serious chimney fire.

ACCESSORIES

Many accessories have been manufactured for use with the Jøtul F 400 Castine. ONLY USE ACCESSORIES THAT ARE SPECIFICALLY DESIGNED FOR THE JØTUL F 400 CASTINE.

Firescreen (part # 129650)

The F 400 Castine has been approved for use as an open fireplace, with front door open. This feature is especially nice when the ambience of a fire is desired. Some care should be taken when operating the stove as a fireplace.

- Always have the firescreen in place, attached to the stove front.
- Never over load the stove, for the best appearance burn in the traditional three log configuration.
- Reminder, when burning the stove with the screen in place, you are sacrificing efficiency for aesthetics, and you will be consuming wood at a much faster rate.

WARNING: OPERATE YOUR JØTUL F 400 CASTINE WITH THE FRONT DOORS FULLY OPEN AND THE FIRESCREEN IN PLACE OR FULLY CLOSED. A PARTIALLY OPENED DOORS MAY RESULT IN OVERFIRING. ALSO, IF THE DOORS ARE LEFT PARTLY OPEN, GAS AND FLAME MAY BE DRAWN OUT OF THE STOVE OPENING, CREATING RISKS FROM BOTH FIRE AND SMOKE.

Outside Air Kit (part #154335)

In certain installations it may be necessary to provide outside air to your F 400 Castine wood stove. Guidelines to determine the need for additional combustion air may not be adequate for every situation. If in doubt, it is advisable to provide additional air.

MAINTENANCE

Ash remomal: OF COURSE, FOR YOUR PROTECTION ALWAYS WEAR SAFETY GLOVES WHEN HANDLING THE ASH PAN.

Ash removal will be required periodically depending on how frequently the stove is used. Conveniently, the F 400 Castine is equipped with an ash pan assembly for easy ash removal, without the need for opening the front doors.

The ash pan door is located under the front ashlip of the stove. To open the ash door place the receptacle end of your specially designed ash tool onto the square fitting of the ash door latch. Rotate the door counterclockwise to unlatch the door and clockwise to latch the door.

WITH A GLOVED HAND grasp the ash pan handle and remove the ash pan. Always close the ash pan door before leaving to dispose of the ashes.

The ashes should be placed in a metal container equipped with a tight sealing lid. The container should be placed on a noncombustible floor or on the ground, well away from all combustible materials, pending final disposal. If the ashes are disposed of by burial in soil or otherwise locally dispersed, they should be retained in the closed container until all cinders have thoroughly cooled.

Glass Care:

Cleaning: On occasion it will be necessary to clean the carbon deposits and fly ash off of the glass. If the carbon and fly ash are allowed to remain on the glass for an extended period of time it could eventually cause the glass to become etched and cloudy. Any creosote, which might deposit on the glass, will burn off during the next hot fire.
The proper cleaning procedure is as follows:

1. Glass needs to be COMPLETELY COOL.
2. Only use a cleaner that is specifically designed for this purpose. The use of abrasives will damage the glass and ultimately leave the glass frosted.
3. Rinse and dry glass completely, before burning your stove.

IMPORTANT:
REPLACE GLASS ONLY WITH A CERAMIC GLASS PANEL SPECIFICALLY DESIGNED FOR THE JØTUL F 400 CASTINE. DO NOT USE SUBSTITUTES. REPLACEMENT GLASS PANELS CAN BE ORDERED THROUGH YOUR JØTUL DEALER.

Glass Removal: Always operate the doors slowly and cautiously to avoid cracking or breaking the glass. Never use the door to push wood into the firebox. If the glass becomes cracked or broken follow this procedure for replacement:

NEVER OPERATE THE STOVE WITH A CRACKED OR BROKEN GLASS PANEL.

1. Remove the doors from the stove and place on a flat surface.
2. Carefully remove all of the glass clips from the inside of the doors.
3. Gently remove the glass panel and gasketing.
4. Remove all remaining debris from the glass area using a wire brush.
5. Apply a small bead of gasket/stove cement and the new gasket. Do not overlap the ends of the gasket rope.
6. Center the new glass panel over the gasket and reinstall the glass clips. See figure 13.
7. It may be necessary to retighten the glass clips after the stove has be burned and the gasketing has been seated.

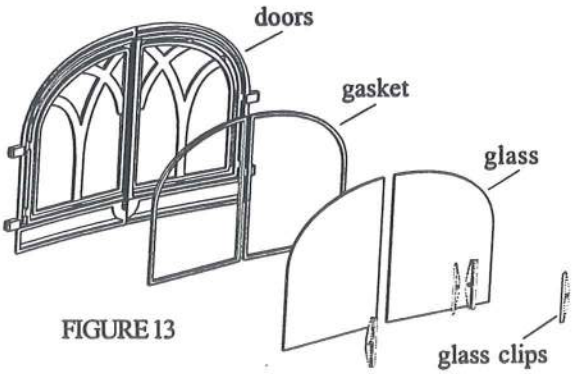


FIGURE 13

IMPORTANT:
The side of the glass treated with an infrared coating (marked on the perimeter) should always be facing outward. It is extremely important to tighten the glass clips slowly and in a repeating pattern, like tightening the lugs on an automobile wheel.

Starting and Maintaining a Fire

Burn only solid wood directly on the bottom grate of the stove, do not elevate the fire in any way.

The ash pan door on the stove must always be securely closed when the stove is in operation.

Burning the stove with the ashpan open will over-fire the stove and cause interior damage.

With the primary air control lever in the full open position, start with several sheets of crumbled newspaper placed directly on the grate. On top of the newspaper, place several pieces of small dry kindling (approx. 1" in diameter) with two to three larger logs (approx. 3" to 5" in diameter) on top.

Light the fire and close the door, slowly building the fire by adding larger and larger logs. Be sure to follow the break-in procedure before creating a fire that will damage the stove.

Once the stove has reached a surface temperature range of between 400° and 600°, adjust the primary air control lever as necessary to generate the heat output and burn time desired.

Jøtul recommends the use of a magnetic stove top thermometer to monitor the surface temperature of the stove. The optimum surface temperature range for the most efficient burn is between 400° and 600°. See figure 12 below for the optimum locations of a stove-top thermometer.

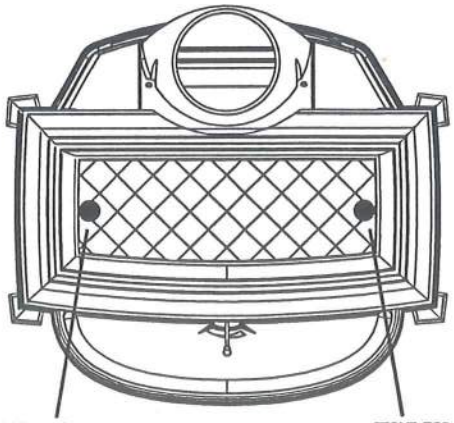


FIGURE 12

NEVER OVERFIRE THE STOVE. IF ANY PART OF THE STOVE OR CHIMNEY GLOWS, YOU ARE OVERFIRING, AND A HOUSE FIRE OR SERIOUS DAMAGE TO THE STOVE OR CHIMNEY COULD RESULT. IMMEDIATELY CLOSE DOWN THE AIR CONTROL IF YOU NOTICE THIS CONDITION.

Adding Fuel

When reloading the stove while it is still hot and a bed of hot embers still exist, follow this reloading procedure:

- Always wear gloves when tending to the stove.
- Push the air control lever to the full open position (far right).
- Wait a few seconds before opening the door.
- Use a stove tool or poker to distribute the hot embers equally around the firebox.
- Load the fuel, usually with smaller logs first.
- Close the door, be sure to latch the door tightly.
- Wait 5 – 10 minutes before adjusting the primary air to the desired heat output setting.
  (If you have at least a 2" thick ember bed when reloading, it may be possible to close the door and immediately adjust the air control setting).

The Formation of Creosote

When wood is burned slowly and at low temperatures, it produces tar and other organic vapors, which combine with moisture to form creosote. The slow moving smoke carries the creosote vapors, which condense in the cooler chimney flues, and this creosote then sticks to the chimney walls.

The creosote that accumulates in the chimney is highly flammable and is the **fuel** of chimney fires. To prevent chimney fires it is important to have the chimney and chimney connector pipe inspected and/or cleaned semi-annually. A qualified chimney sweep or other authorized service person can provide this service.

It is also important to remember that chimney size, temperature and height all affect draft which in turn affects the formation of creosote. Be sure to follow the installation and operation guidelines established in this manual.

WARNING:
DO NOT INSTALL IN A BEDROOM/SLEEPING ROOM. THE STRUCTURAL INTEGRITY OF THE MOBILE HOME'S FLOOR, WALL, CEILING/ROOF MUST BE MAINTAINED.

OPERATION

Before building a fire in your new F 400 Castine, please read the following section carefully and completely.

Do Not Burn

First this stove is designed to burn natural wood ONLY, wood that has been air-dried for a period of 6 to 14 months will provide the cleanest most efficient heat.

Do not burn:

*Coal	*Treated or painted wood
*Garbage	*Chemical Chimney cleaners
*Cardboard	*Colored paper
*Solvents	*Any synthetic fuel or logs

The burning of any of these materials can result in the release of toxic fumes. Never use gasoline, gasoline-type lantern fuel, kerosene, charcoal lighter fluid, or similar liquids to start or "freshen-up" the fire. Always keep such liquids away from the heater at all times.

IMPORTANT

NEVER BUILD OR ALLOW THE FIRE TO REST DIRECTLY ON THE GLASS. THE LOGS SHOULD ALWAYS BE SPACED AT LEAST ONE INCH FROM THE GLASS TO ALLOW FOR PROPER AIR FLOW WITHIN THE STOVE.

Controls on the F 400 Castine

A single air control lever controls the burn time and heat output of the stove. This primary air control lever is located on the front of the stove directly above the ashlip. The primary air lever, controls the amount of air that enters the stove for combustion.

When first starting or reviving the fire: the primary control lever should be at the **far right position**, which allows the maximum amount of air into the stove. The more air entering the stove the hotter the fire the shorter the burn time. Moving the lever to the left reduces the air-flow into the stove which prolongs the fire at a lower heat output. See figure 11.

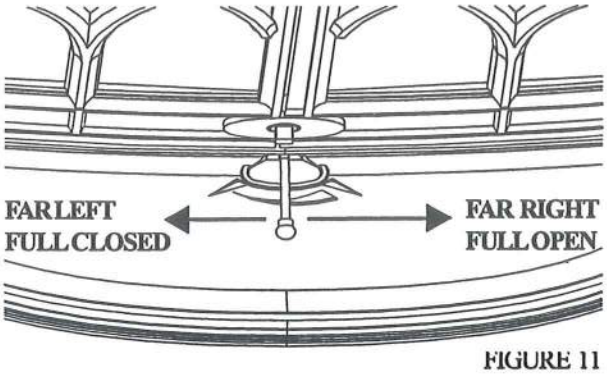


FIGURE 11

Breaking in your new stove

Your new F 400 Castine is constructed of cast iron and stove furnace cement. This type of construction requires the stove to be "broken-in" gradually so that heat expansion does not occur too quickly and cause damage.

Complete the following steps for the proper break-in procedure for the F 400 Castine:

To monitor the stove's temperature, Jøtul recommends the use of a magnetic stove-top thermometer, placed directly on the corner of the stove's top plate.

1. Light a small fire, newspaper and kindling only, only allow the stove to reach a maximum surface temperature of 200°. Burn for approximately 1 hour.
2. Allow stove to cool to room temperature.
3. Light a second fire, allowing the stove to reach a maximum temperature of 300° for 1 hour.
4. Cool the stove to room temperature.
5. Light a third fire and gradually allow the stove to reach a surface temperature of 400°
6. Cool stove to room temperature. This completes the "break-in" procedure.

Never allow the stove to exceed a 400° surface temperature during any "break-in fire" with the exception of the last "break-in" fire.

Note: IT IS NORMAL for a new painted stove to emit an odor and even smoke during its first several fires. This is caused by the seasoning of the high temperature paint and will diminish with each fire and will eventually disappear. Opening a window or door to provide additional ventilation will reduce the odor as this process takes its course.

F 400 CASTINE WOODSTOVE CLEARANCES*

STOVE CLEARANCES	UNPROTECTED SURFACE INSTALLATION			PROTECTED SURFACE INSTALLATION PER NFPA211 OR CAN/CSA -B365-M93		
	SIDE	REAR	CORNER*	SIDE	REAR	CORNER*
Stove -no heatshield single wall pipe	19" **A** 485mm	25" **B** 635mm	18" **C** 460mm	11" **D** 280mm	7" **E** 180mm	8" **F** 205mm
Stove -with rear heatshield single wall pipe	18" **G** 460mm	18" **H** 460mm	13" **I** 330mm	11" **J** 280mm	7" **K** 180mm	8" **L** 205mm
Stove -no heatshields double wall pipe	16" 405mm	19" 485mm	13" 330mm	8" 205mm	7" 180mm	6" 150mm
Stove -with rear heatshield with connector shield	15" **M** 380mm	7" **N** 180mm	11" **O** 280mm	8" **P** 205mm	7" **Q** 180mm	6" **R** 150mm
Stove -rear heatshield with double wall pipe	15" **S** 380mm	7" **T** 180mm	11" **U** 280mm	8" **V** 205mm	7" **W** 180mm	6" **X** 150mm

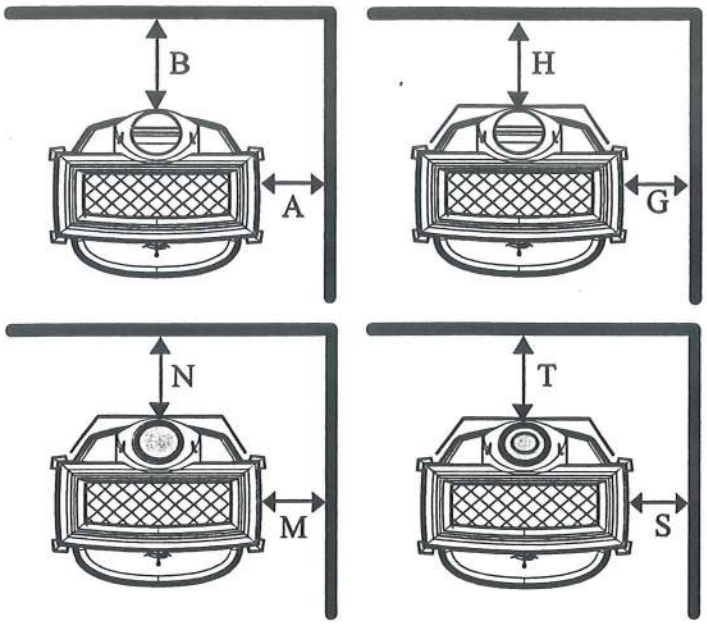
CONNECTOR CLEARANCES (pipe)	UNPROTECTED SURFACE VERTICAL INSTALLATION	PROTECTED SURFACE VERTICAL INATALLATION per NFPA211 OR CAN/CSA-B365-M93
Single wall pipe	25" 460mm	12" 300mm
Single wall pipe with rear heatshield	18" 460mm	7" 180mm
Single wall pipe with connector shields	7" 180mm	7" 180mm
Double wall pipe	7" 180mm	7" 180mm

CONNECTOR CLEARANCES (pipe)	UNPROTECTED SURFACE HORIZONTAL INSTALLATION	PROTECTED SURFACE HORIZONTAL INSTALLATION per NFPA211 OR CAN/CSA-B365-M93
Single wall connector	18" 460mm	7" 180mm
Double wall Pipe	6" 150mm	6" 150mm

MANTEL AND TRIM CLEARANCES	Stove to 1" thick or less, **side trim**	13" 300mm
	Stove to 1" thick or less, **top trim**	23" 585mm
	Stove to **mantel**- maximum mantel depth 12"	25" 635mm

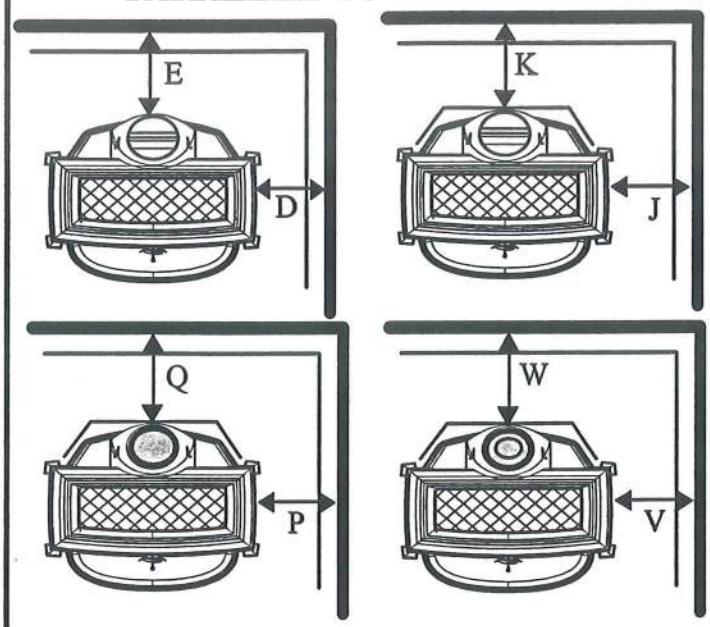
F 400 CASTINE WOODSTOVE CLEARANCES

UNPROTECTED SURFACE PARALLEL TO THE WALL



PROTECTED SURFACE PARALLEL TO THE WALL

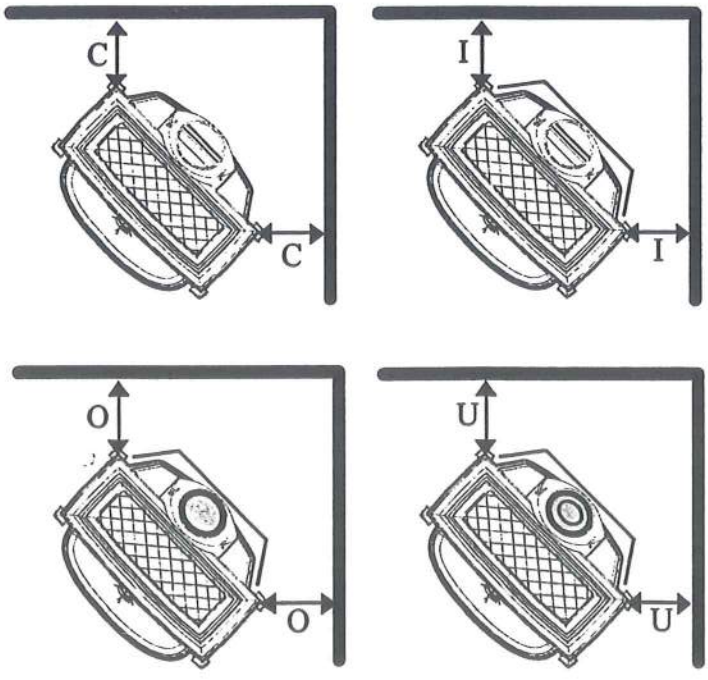
PER NFPA 211 or CAN/CSA-B365



IMPORTANT:
CONNECTOR HEATSHIELDS AND DOUBLE WALL PIPE MUST BE A ISTEDPRODUCT.
ALWAYS FOLLOW THE MANUFACTURE'S INSTRUCTIONS.

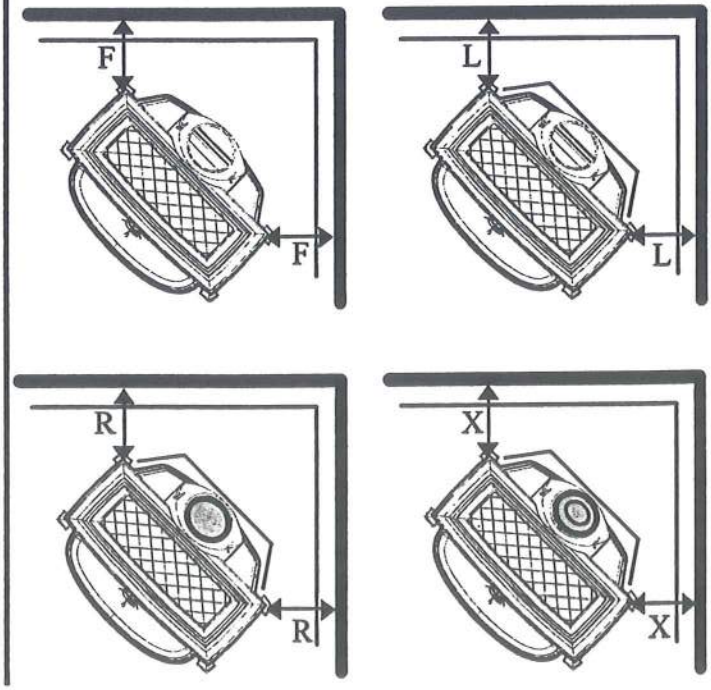
= SINGLE WALL PIPE WITH CONNECTOR SHIELDS = DOUBLE WALL PIPE

UNPROTECTED SURFACE CORNER INSTALLATION



PROTECTED SURFACE CORNER INSTALLATION

PER NFPA 211 or CAN/CSA-B365



In Canada, refer to CAN/CSA-B365, *Installation Code for Solid-Fuel Burning Appliances and Equipment*, also for acceptable materials, proper sizing and construction guidelines.

Stove Mounted Heatshield: A stove rear heatshield has been specifically designed for the F 400 Castine.

In the U.S. and Canada the rear heatshield part number is # 154911.

NO OTHER HEAT SHIELD MAY BE USED.

NOTICE

Accessories for woodstoves for clearance reduction have been developed by many manufacturers. If not following the methods of the installation codes, be sure that any accessory you choose has been tested by an independent laboratory and carries the laboratory's testing mark. Make sure to follow all of the manufacturer's instructions.

Always contact your local building inspector or fire officials about restriction and requirements in your area. Reminder, it is the local officials who have final authority in the installations approval.

ALCOVE

The F 400 Castine can be installed in an ALCOVE situation provided: See figures 9 and 10.

1. The stove must be installed with listed double wall pipe.
2. In a PROTECTED alcove installation both side walls and rear wall must be protected per NFPA 211 or CAN/CSA-B365. The wall protection must be elevated 1" from the floor and at least 1" off the combustible wall to allow for an air-flow.
3. The height of the wall protection including the bottom air space must be 48".
4. The Bottom heatshield is required in all Alcove installations.
5. ALCOVE floor protection must be: a UL/ULC or WHI listed hearth pad or a non combustible material with a minimum R value of 2.0.
6. Minimum ceiling height in an unprotected installation, off the top of the stove is 58"(1475mm). The minimum ceiling height off the top of the stove in a protected ceiling installation is 36 (915mm).

MOBILE HOME INSTALLATIONS

The F 400 Castine has been approved for use in mobile homes in the U.S. and Canada, provided:

1. The stove is secured to the floor or the mobile home. Floor mounting kit #750304
2. The stove is provided outside air for combustion. Outside Air kit #154335(see page 16 for more details)
3. Must be installed in accordance to 24CRR, Part 3280 (HUD).

As always consult with your local building inspector or fire officials about restrictions and requirements in your area, prior to installing the stove.

UNPROTECTED ALCOVE INSTALLATION*

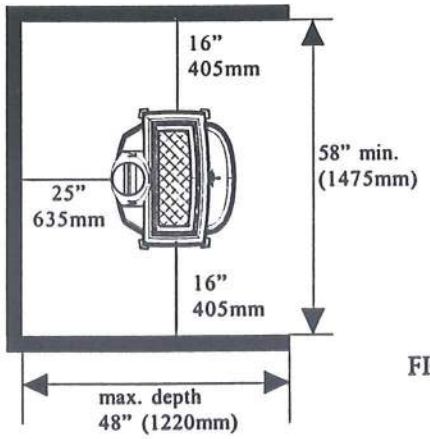


FIGURE 9

PROTECTED ALCOVE INSTALLATION*

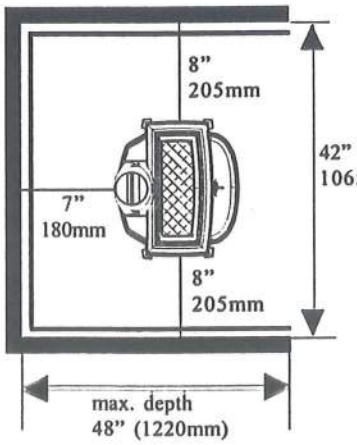


FIGURE 10

PROTECTION AND AIR SPACE MUST COMPLY WITH NFPA 211OR CAN/CSA-B365.

CLEARANCES TO COMBUSTIBLES

Floor Protection (In the U.S.and Canada)

The F 400 Castine requires any one of the following three forms of hearth protection:

1. Any UL, ULC or WH listed hearth board. (No bottom heatshield required).
2. Any non-combustible material that has a minimum R- value of 2.0. (No bottom heatshield required.)
3. Any non-combustible material WITH THE USE OF THE STOVE'S BOTTOM HEATSHIELD.

ALL FORMS OF PROTECTION MUST be a non-combustible surface extending a minimum of 18" (460mm) in front of the stove. And 8" (200mm) from the sides and back of the stove (measured from side and back panels).

This will result in a minimum floor protection of 42"W X 44"D. See figure 8.

In a rear vent installation the floor protection must also extend under the stove pipe a minimum of 2" (50mm) beyond either side of the pipe. See figure 8.

WHEN CONSTRUCTING A NEW HEARTH OR FLOOR PAD, CONSULT APPENDIX A AT THE BACK OF THIS MANUAL FOR ALTERNATE MATERIALS AND METHODS.

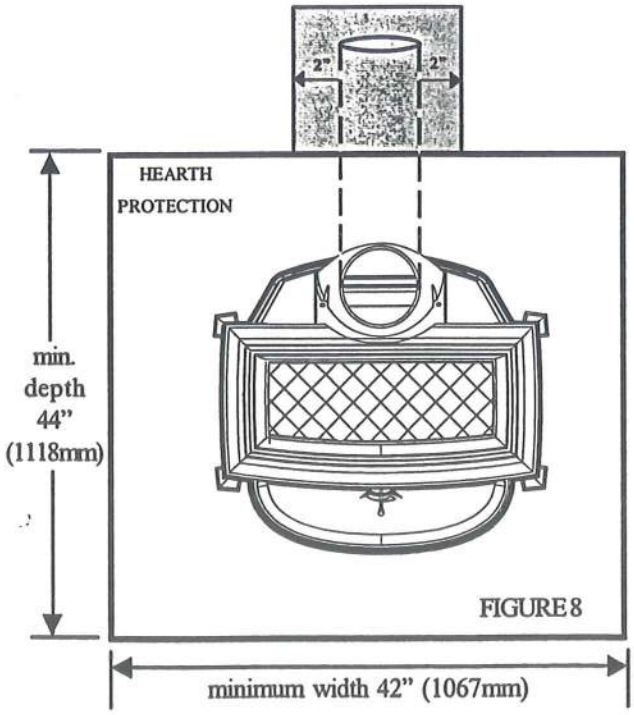


FIGURE 8

Clearances to walls and ceilings

The following clearances have been tested to UL and ULC standards and are the minimum clearances specifically established for the Jøtul F 400 Castine.

The following diagrams give the required clearances you must maintain when installing the F 400 Castine near combustible surfaces.

A combustible surface is anything that can burn (i.e. sheet rock, wall paper, wood, fabrics etc.). These surfaces are not limited to those that are visible and also include materials that are behind non-combustible materials.

If you are not sure of the combustible nature of a material, consult your local fire officials.

Remember: "Fire Resistant" materials are considered combustible; they are difficult to ignite, but will burn. Also "Fire-rated" sheet rock is also considered combustible.

Contact your local building officials about restrictions and installation requirements in your area.

SEE PAGES 10-12 FOR COMPLETE CLEARANCE REQUIREMENTS AND DIAGRAMS.

Using Shields to Reduce Clearances

Pipe shields: When using listed pipe shields to reduce the connector clearance to combustibles, it must start 1" above the lowest exposed point of the connect pipe and extend vertically a minimum of 25" above the top surface of the stove.

Double wall pipe: Listed double wall pipe is an acceptable alternative to connector pipe heatshields.

Wall-Mounted Protection: When reducing clearances through the use of wall mounted protection:

In the U.S. refer to NFPA 211, *Standard for Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances*, for acceptable materials, proper sizing and construction guidelines.

Hearth-mount into a Masonry Fireplace

The F 400 Castine may be installed into a masonry fireplace provided the height of the opening is a minimum of 29 1/2". If necessary, the short leg package reduces the stove's height by 2 1/4".

When installing the F 400 Castine into a masonry fireplace, code requires that the fireplace damper plate be removed or securely fixed in the open position. A connector pipe must then extend from the stove's flue exit through the damper area of the fireplace and into the chimney tile liner. See figure 5.

The inside area of the flue liner must not be less than the area of the stove's flue exit, and cannot be more than three times greater than the cross sectional area of the stove's flue exit.

If the chimney liner is too large to accommodate the stove, an approved relining system must be installed to resize the flue.

A new sheet metal damper block-off plate must be installed around the connector pipe at the damper frame and sealed with the proper sealant (usually High-Temp Silicone).

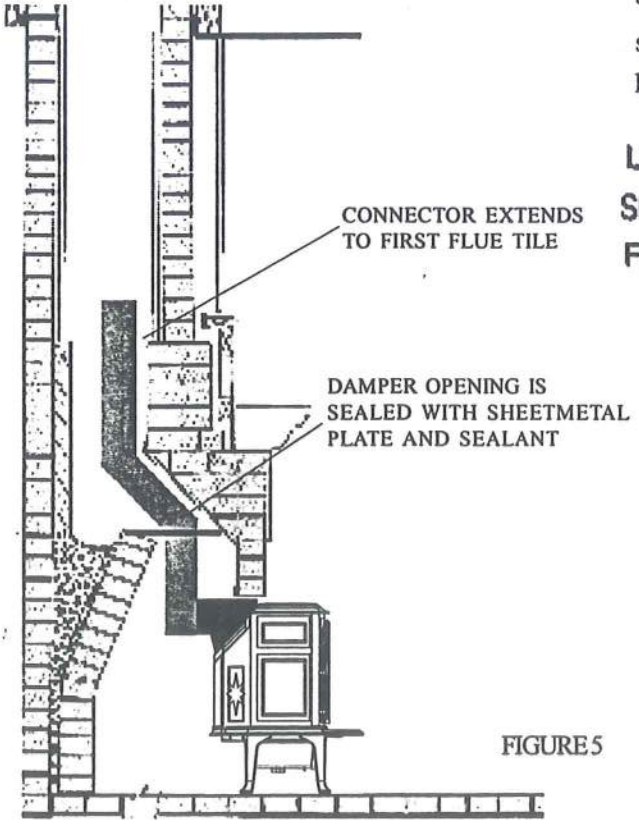


FIGURE 5

Fireplace installation must also observe the proper clearances to surrounding trim and mantels (addressed in clearance section of this manual). In addition, fireplace installations must also adhere to the floor protection guidelines specified in the following section.

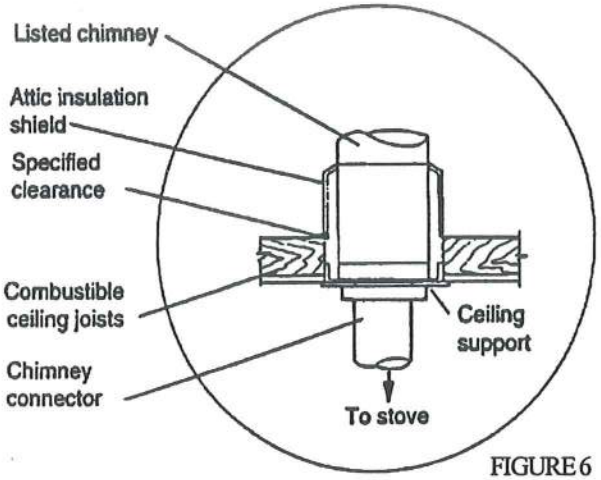


FIGURE 6

Prefabricated Chimneys

When installing the F 400 Castine to a prefabricated metal chimney always follow the pipe manufacture's instructions and be sure to use the components that are required. This usually includes some type of "smoke pipe adapter" that is secured to the bottom section of the metal chimney and allows the chimney pipe to be secured to it with three sheet metal screws. See figures 6 and 7.

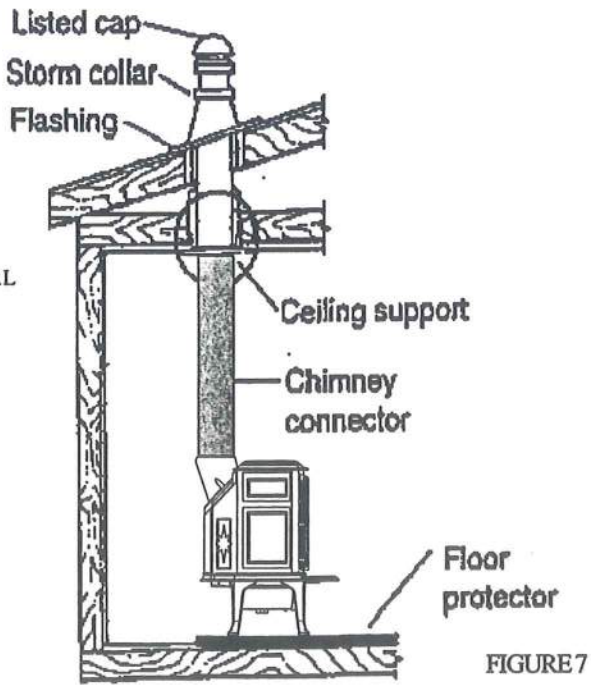


FIGURE 7

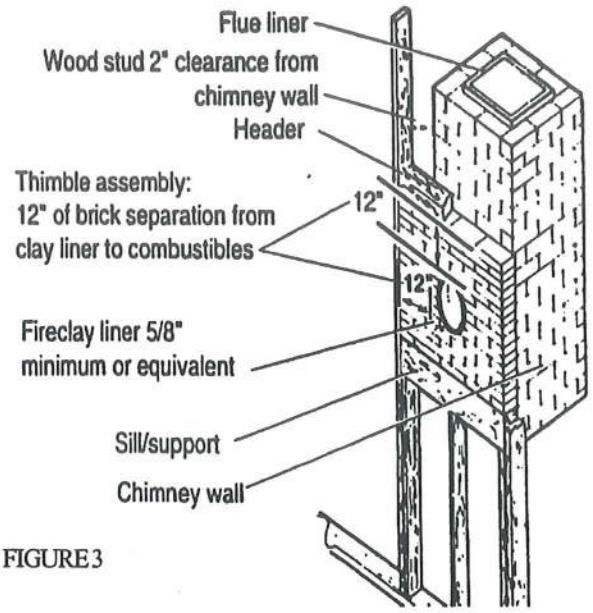


FIGURE 3

In Canada

The Canada the standard has been established by the Canadian Standard Association. The installation must conform to CAN/CSA-B365, *Installation Code for Solid Fuel Burning Appliances and Equipment.* Before proceeding be sure to consult your local building inspector.

Common Method

This method requires the removal of all combustible materials from at least 18" (457mm) around the chimney connector's proposed location. With a 6" round liner the minimum area required would be 43" x 43" square.

It is important to remember to locate the pass-through at least 18" from the ceiling to maintain the proper clearance to combustibles.

The space that is cleared of combustible materials must then remain empty. Sheet metal panels can then be used to cover the area. However, when using a panel on both sides of the wall each cover must be installed on noncombustible spacers at least 1" from the wall. If one panel of sheet metal is to be used it may be installed flush to the wall.

SEE SECTION 5.3.1 and 5.3.2 of CAN/CSA - B365-M91.

Consult your local building inspector, authorized Jøtul Dealer, NFPA 211 in the U.S. or CAN/CSA-B635 in Canada for other approved wall pass-through methods.

CONNECTING TO THE CHIMNEY

Masonry Chimney

When installing a Jøtul F 400 Castine into a masonry chimney through a "thimble"(the opening through the chimney wall to the flue), the thimble must be lined with ceramic tile or metal and be securely cemented in place.

The chimney connector/stove pipe must slide completely inside the thimble to the inner surface or the flue liner. It may be necessary to make use of a thimble sleeve (a pipe with a slightly smaller diameter than standard stove pipe). This special pipe can be easily installed into a thimble. See figure 4.

Make sure the connector pipe or thimble sleeve does not protrude into the flue liner, thereby restricting the area the smoke has to flow through. This bottle-neck will have a negative affect on the chimney system.

The chimney connector should be sealed at the thimble with refractory cement and the stove pipe leading to the stove should have a minimum of three screws.

DO NOT CONNECT THIS STOVE TO A CHIMNEY FLUE SERVICING ANOTHER APPLIANCE OF ANY KIND.

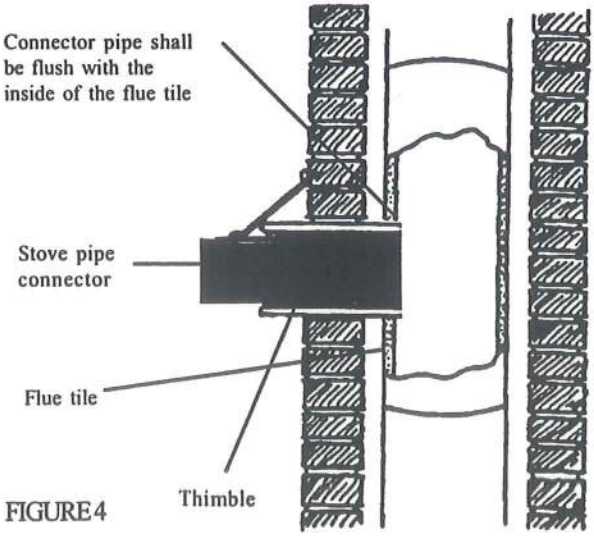


FIGURE 4

The manufacturer's installation instructions must be followed precisely. Always maintain the proper clearance to combustibles as established by the pipe manufacturer. This clearance is usually a minimum of 2", although it may vary by manufacturer or for certain chimney components.

Chimney Height

Whether a masonry chimney or prefabricated metal chimney is used it must be the required height above the roof line.

The requirement is:

The chimney must be at least 3 feet higher than the highest point where it passes through the roof and at least 2 feet higher than the highest part of the roof or structure that is within 10 feet of the chimney, measured horizontally. See figure 2.

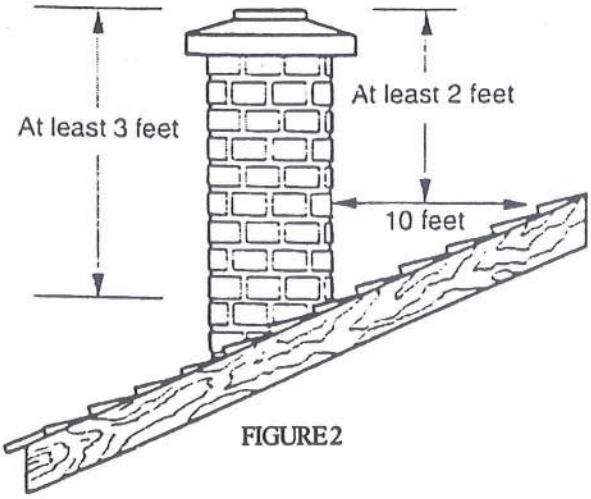


FIGURE 2

Chimneys shorter than 14 feet may not provide adequate draft. This could result is smoke spilling into the room from the stove when loading the stove, or when the door is open. In addition, inadequate draft can cause back puffing, which is a build up of gases inside the firebox.

Other times, chimney height can create excessive draft which can cause high stove temperatures and short burn times. Excessive drafts can be corrected by installing a butterfly damper.If you suspect you have a draft problem, consult your dealer.

WALL PASS-THROUGHS

When your installation unavoidably requires the chimney connector to pass through a combustible wall to reach the chimney, always consult your local building officials, and be sure any materials to be used have been tested and listed for wall pass-throughs.

In the U.S.

The National Fire Protection Association's publication, NFPA 211, *Standard for Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances* permits four methods for passing through a combustible wall. Before proceeding with any method be sure to consult with your local building officials to discuss any local code requirements.

Common Method

When passing through a combustible wall to a masonry chimney this method requires the removal of all combustible materials from at least 12" around the chimney connectors proposed location. With a 6" round liner the minimum area required would be 31" x 31" square.

The space is then filled with at least 12" of brick around a fireclay liner. Remember, the liner must be ASTM C35 or equivalent, with a minimum wall thickness of 5/8".

It is important to remember to locate the pass-through at least 18" from the ceiling for proper clearance to combustibles.

It will be necessary to cut wall studs, install headers, and construct a sill frame to maintain the proper dimensions and to support the weight of the brick.

The bricks must be solid brick with a minimum of 3 ½ " thick (4" nominal).

Refractory mortar must be used at the junction of the chimney and the pass-through liner. The pass-through liner must not penetrate the chimney liner beyond the inner surface of the chimney liner. Use extreme care when constructing the hole in the chimney liner, the tiles can shatter easily. See figure 3.

The chimney size should not be less than the cross-sectional area of the flue collar, and not more than three times greater than the cross-sectional area of the flue collar.

When selecting a chimney type and the location for the chimney in the house, keep this in mind: it is the chimney that makes the stove work, NOT the stove that makes the chimney work. This is because a chimney actually creates a suction, called "draft" which pulls air through the stove.

Several factors affect draft: chimney height, cross-sectional area (size), and temperature of the chimney, as well as the proximity of surrounding trees or buildings.

As a result, a short masonry chimney on the exterior of a house will give the poorest performance. This is because it can be very difficult to warm the chimney thereby creating inadequate draft. In extremely cold northern areas it may be necessary to reline the chimney or extend its height to help establish draft.

Oppositely, a tall masonry chimney inside the house is easier to keep warm and will perform the best.

The following guidelines give the necessary chimney requirements based on the national code (ANSI-NFPA 211for the US. And CSA CAN-B365 for Canada). However, many local codes differ from the national code to take into account climate, altitude, or other factors.

NOTICE:
It is important that you check with your local building officials to find out what codes apply in your area before installing your new F 400 Castine.

REMEMBER:
Your local inspector(s) have the final authority in approving your installation. It is always best to cnsult them prior to the installation.

DO NOT CONNECT THIS STOVE TO ANY AIR DISTRIBUTION DUCT OR SYSTEM.

Masonry Chimneys

When installing the F 400 Castine into a masonry chimney you must conform to all of the following guidelines:

- The masonry chimney must have a fireclay liner or equivalent, with a minimum thickness of 5/8" and must be installed with refractory mortar. There must be at least ½" air space between the flue liner and chimney wall.
- The fireclay flue liner must have a nominal size of 8" X 8", and should not be larger than 8"X 12". If a round fireclay liner is to be used it must have a minimum inside diameter of 6" and not larger than 8" in diameter. If a chimney with larger dimensions is to be used, it should be relined with an appropriate liner that is code approved.
- The masonry wall of the chimney, if brick or modular block, must be a minimum of 4" nominal thickness. A mountain or rubble stone wall must be at least 12" thick.
- A newly-built chimney must conform to local codes and in their absence must recognize national regulations.
- When using an existing chimney, it must be inspected by a professional licensed chimney sweep, fire official, or code officer, to ensure that the chimney is in proper working order.
- No other appliance can be vented into the same flue.
- An airtight clean-out door should be located at the base of the chimney.

Prefabricated Chimneys

If a prefabricated metal chimney is to be used it must be a chimney type that is tested and listed for use with solid fuel burning appliances. High Temperature (HT) Chimney Standard UL 103 for the U.S. and High Temperature Standard ULC S-629 for Canada.

INSTALLATION

IF THIS SOLID FUEL ROOM HEATER IS NOT PROPERLY INSTALLED A HOUSE FIRE MAY RESULT. FOR YOUR SAFETY, FOLLOW THE INSTALLATION DIRECTIONS. CONTACT THE LOCAL BUILDING OR FIRE OFFICIALS ABOUT RESTRICTIONS AND INSTALLATION INSPECTION REQUIREMENTS IN YOUR AREA.

Reminder:
Your local officials have final authority in determining if a proposed installation is acceptable. Any requirement, that is requested by the local authority having jurisdiction, that is not specifically addressed in THIS manual, defaults to NFPA 211, and local codes in the U.S. or in Canada, CAN/CSA-B365-M and local codes.

TOP OR REAR EXIT FLUE

The F 400 Castine is shipped with the flue collar, gasketing and hardware inside the stove. To install the flue collar in the top or rear exit position remove the tape from the gasketing and adhere to the groove on the back of the stove around the flue opening. Place the flue collar on the stove in the top or rear exit position and secure with the nut, bolt and washer. The nut and washer are placed on the inside of the stove.

STOVE PIPE
CHIMNEY CONNECTOR

The chimney connector is a single walled pipe used to connect the stove to the chimney. For use with the F 400 Castine the chimney connector MUST be 6" in diameter, with a minimum thickness of 24 gauge black steel.

Aluminum and Galvanized steel pipe is not acceptable for use with the F400 Castine. These materials cannot withstand the extreme temperatures of a wood fire and can give off toxic fumes when heated.

Do not use the connector pipe as a chimney.

Each chimney connector or stove pipe section must be installed to the stove flue collar and to each other with the male (crimped) end toward the stove.
See figure 1.

This prevents any amount of condensed or liquid creosote from running down the outside of the pipe or the stove top. All joints, including the flue collar connection must be secured with three sheet metal screws to ensure that the sections do not separate.

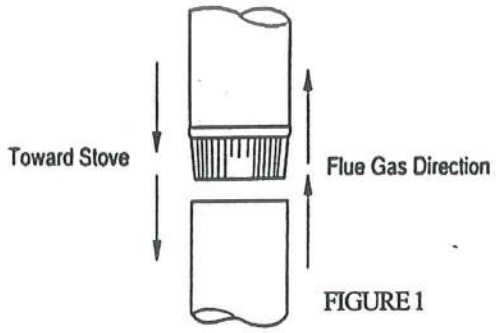


FIGURE 1

For the best performance the chimney connector should be as short and direct as possible, with no more than two 90° elbows. The maximum horizontal run is 36" and a recommended total length of stove pipe should not exceed 10 feet. Always slope horizontal runs upward ¼" per foot toward the chimney.

No part of the chimney connector may pass through an attic or roof space, closet or other concealed space, or through a floor or ceiling. All sections of the chimney connectors must be accessible for cleaning. Where passage through a wall or partition of combustible construction is desired, the installation must conform with NFPA 211 or CAN/CSA-B365, and is also addressed in this manual.

DO NOT CONNECT THIS UNIT TO A CHIMNEY FLUE SERVICING ANOTHER APPLIANCE.

CHIMNEY REQUIREMENTS

There are two types of chimneys suitable for the F 400 Castine:

1. A code-approved masonry chimney with a flue liner.
2. A prefabricated chimney complying with the requirements for Type HT (2100°F) chimneys per UL 103 or ULC S629.

STANDARDS

The F 400 Castine woodstove has been tested and listed to;

U.S. Standards: ANSI/UL 737 and ANSI/UL 1482.
Canadian Standards: CAN/ULC-S627-M93

Tests performed by ITS, Intertek Testing Services, Middleton, WI

Manufactured by Jøtul A.S.A., P.O. Box 135
Fredrikstad, Norway
Distributed by Jøtul North America, P.O. Box 1157
400 Riverside Street
Portland, ME 04104

This heater meets the U.S. Environment Protection Agency's Emissions limits for wood heaters manufactured and sold after July 1, 1990.

Under specific test conditions, this heater has shown heat output at rates ranging from 12,000 to 35,000 BTU's per hour.

The Jøtul F 400 Castine woodstove is ONLY listed to burn wood . Do not burn any other fuels.

JØTUL F 400 CASTINE WOODSTOVE

When installing, operating and maintaining your Jøtul F 400 Castine woodstove, follow the guidelines presented in these instructions, and make them available to anyone using or servicing the stove.

A number of areas require a building permit to install a solid fuel burning appliance. In the U.S., the National Fire Protection Association's Code, NFPA 211, *Standards for Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances*, or similar regulations, may apply to the installation of a solid fuel burning appliance in your area.

In Canada, the guideline is established by the CSA Standard, CAN/CSA-B365-M93, *Installation Code for Solid-Fuel-Burning Appliances and Equipment*. Always consult your local building inspector or authority having jurisdiction to determine what regulations apply in your area.

DO NOT CONNECT TO ANY AIR DISTRIBUTION DUCT OR SYSTEM.

NOTICES

- DO NOT: USE CHEMICALS OR FLUIDS TO START THE FIRE. DO NOT BURN GARBAFE OR FLAMMABLE FLUIDS.

- IF THIS ROOM HEATER IS NOT PROPERLY INSTALLED, A HOUSE FIRE MAY RESULT. TO REDUCE THE RISK OF FIRE, FOLLOW THE INSTALLATION INSTRUCTIONS. FAILURE TO FOLLOW THESE INSTRUCTIONS MAY RESULT IN PROPERTY DAMAGE, BODILY INJURY, OR EVEN DEATH.

- Jøtul recommends that you have your new Jøtul F 400 Castine installed by a professional installer of solid fuel burning appliances.

- EXTREMELY HOT WHILE IN OPERATION! KEEP CHILDREN, CLOTHING AND FURNITURE AWAY. CONTACT MAY CAUSE SKIN BURNS.

- Avoid creating a low pressure condition in the room where the stove is operating. Operating an exhaust fan or a clothes dryer could create a low pressure area, causing poisonous gases to come out of the stove into the room.

  You can prevent low pressure conditions by providing adequate combustion air within 24" but not closer than 12" from the stove. Or, simply install the optional outside air manifold system, which allows the direct connection of air from outside the house to the stove.

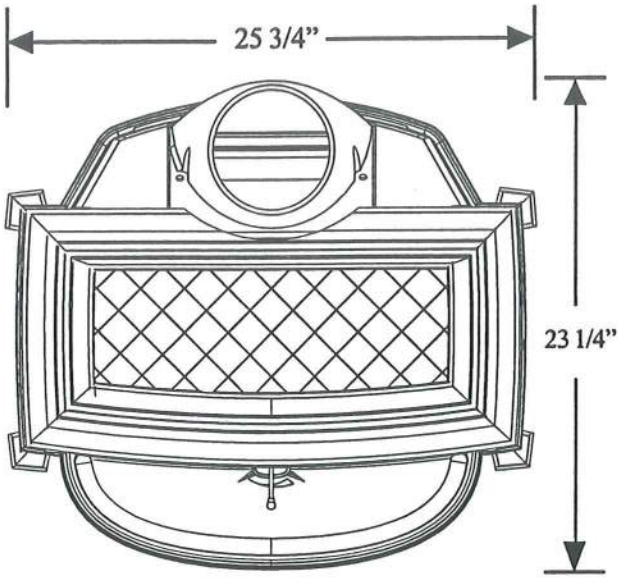
- Do not use chemicals or fluids to start the fire. Some fuels will, during combustion, separate carbon monoxide and generate it in the burn chamber. Carbon monoxide is toxic, so please follow the guidelines in this manual for proper operation of your Jøtul F 400 Castine.

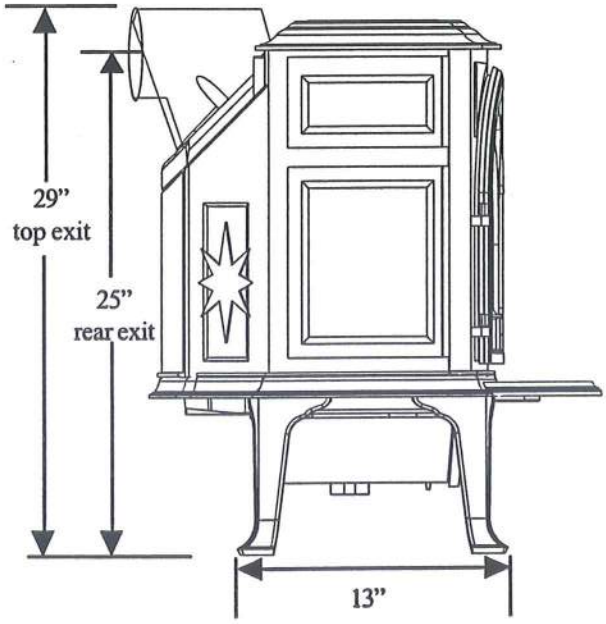
- If you for some reason experience smoke "roll-out" from the stove, it may activate smoke detectors if installed in the house.

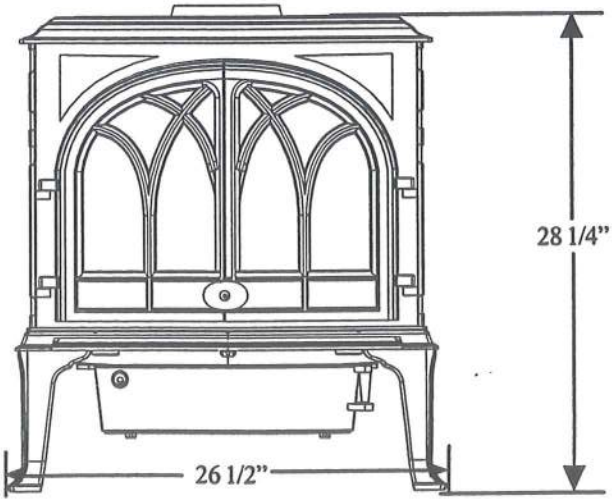
TABLE OF CONTENTS:

READ THIS ENTIRE MANUAL BEFORE YOU INSTALL AND USE YOUR NEW ROOM HEATER.

SAVE THESE INSTRUCTIONS AND MAKE THEM AVAILABLE TO ANYONE USING OR SERVICING THE STOVE.







JØTUL

Jøtul F 400
Castine Woodstove

Installation and Operating Instructions for USA
Installation et fonctionnement pour Canada

Safety notice: If this solid fuel room heater is not properly installed, a house fire may result. For your safety, follow the installation directions. Contact local building or fire officials about restrictions and installation inspection requirements in your area. Kindly save these instructions for future reference.

Avis de sécurité: Une installation non appropriée de ce poêle de chauffage risque de provoquer un incendie. Assurez votre sécurité en respectant les directives d'installation suivantes. Consultez les autorités locales du bâtiment ou de la prévention des incendies au sujet des restrictions et exigences relatives aux inspections d'installations dans votre région.

Tested and listed by ITS Intertek Testing Services, Middleton, Wisconsin.
Tested to U.S. Standards: ANSI/UL 1482, Canadian Standards: CAN/ULC-S627-M93

EXAMPLE CALIBRATION/DATA FLOW

All individual test run raw data sheets are organized in a manner that would allow a data reviewer to follow the data as it is being calculated in a step by step fashion. In many cases, the equations used to calculate a specific required data are given on the raw data sheets themselves.

For example, the particulate emission rate in g/dscf is calculated on Data Sheet #7. However, the data used to derive this data begins on Data Sheet #2 (Meterbox Data Sheet) where the meter volume (cubic feet), average meter temperature (°F), average ΔH (in. H_2O), and average Barometric pressure (in. Hg) are recorded and averaged. Each of the averages for these parameters are used in equation 1 on P. 7 where the volume (MCF) is converted to dscf.

The moisture catch sheet (p. 3) total (g. H_2O) is transferred to P. 7 and the percent stack moisture is calculated in equations 2 and 3.

The gross and net gravimetric (g) particulate catches are determined and calculated on PP. 4-6. Pages 4-1, 4-2 and 4-3 show the initial (tare) constant weights for filters (p. 4-1) and beakers (p. 4-2) and the final constant weights (p. 4-3) for those filters and beakers used for each run. Final and tare weight data is transferred to P. 5-1 (front half catch) and P. 5-2 (back half catch) and the gross gravimetric (g) catch for each filter and beaker is calculated. On P. 5-3 the gravimetric catch for each blank is calculated. The gross gravimetric catch for each filter and beaker is transferred to P. 6 and the net gravimetric catch (g) is calculated, as well as front half and back half catch totals. The net gravimetric catch (g) is transferred to P. 7 and the grain loading/dscf is calculated in equation 4.

Some data sheet specific information is listed below on a page by page basis.

P. 8 The % ambient moisture is determined by interpolating from psychrometric charts which are contained in the State of Oregon Department of Environmental Quality's "Standard Method for Measuring the Emissions and Efficiencies of Woodstoves".

The % relative humidity is determined from the wet bulb/dry bulb temperature readings using the tables found in Section 3.1.2.4 of the State of Montana Air Quality Bureau's Quality Assurance Manual.

P. 10 The uncorrected moisture meter readings are corrected for pin insulation and may or may not be corrected for ambient (wood) temperatures. All corrections are based upon the correction equations or tables supplied by the moisture meter manufacturer. (These are standard, known corrections.)

P. 11 The moisture meter readings are corrected as discussed above.

P. 12 The gas concentrations shown for each gas monitored (CO_2, O_2, CO and SO_2) are determined by converting the analyzer's voltage output recorded on P. 12 to the concentration shown using the analyzer's current calibration curve. The SO_2 concentration is determined using the manufacturer's calibration curve and the current calibration curve.

The cal. W/B (calculated wet bulb) temperature is obtained by first determining the % moisture in the extracted flue gas stream using the temperature data from thermocouples 1 (Wet Bulb) and 2 (Dry Bulb). Then based upon the stack temperature (thermocouple 3) and the % moisture in the extracted gas stream, a calculated wet bulb temperature is determined. All data is derived from the psychrometric tables found in the State of Oregon's "Standard Method for Measuring the Emissions and Efficiencies of Woodstoves".

The following pages contain the equations used to generate the data on Tables 3-5 on the computer printouts:

Dry Gas Volume (standard):

$$V_{m(std)} = \frac{V_m * 17.65 * mcf * \left(P_{bar} + \frac{\Delta H}{13.6} \right)}{T_m}$$

Volume of Water:

$$V_{w(std)} = (0.04707)(ml\ H_2O)$$

Moisture Content:

$$B_{ws} = \left(\frac{V_w}{V_w + V_{m(std)}} \right) * 100$$

Dry Burn Rate:

$$Br = \left(\frac{Wwt - (Wwt * \%\ H_2O)}{2.2046} \right) * \frac{60}{\theta}$$

Carbon Balance (N_t):

$$Nt = \frac{K_3 Nc}{(YCO_2 + YCO + YHC)}$$

Stack Flow Rate (Q_{sd}):

$$Q_{sd} = K_4 N_t Br$$

Particulate Concentration (C_s):

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

Particulate Emission Rate (E):

$$E = C_s Q_{sd}$$

Proportional Rate Variation (Pr):

$$Pr = \left(\frac{\theta S_i * V_{mi(std)}}{10 \sum_{i=1}^{n} [S_i * V_{mi(std)}]} \right) * 100$$

Where:

Br = dry wood burn rate, kg/hr.

B_{ws} = Water vapor in the gas stream, proportion by volume.

c_s = Concentration of particulate matter in stack gas, dry basis, corrected to standard conditions, g/dscm (g/dscf).

E =Particulate Emission Rate, g/hr.

ΔH = Average pressure differential across the orifice meter (see Figure 5-2), mm H_20 (in. H_20).

K_3 = 1.0 lb/lb (English)
1000 g/kg (metric)

K_4 = 0.02406 dsm^3/g-mole(metric)
384.8 dscf/lb-mole (English)

m_n = Total amount of particulate matter collected, mg.

mcf = Dry gas meter correction factor.

N_c = Gram atoms of carbon/gram of dry fuel (lb/lb), equal to 0.0425.

N_t = Total dry moles of exhaust gas/Kg of dry wood burned.

P_r = Percent of proportional sampling rate.

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

Q_{sd} = Total gas flow rate, dscf/hr.

S_i = Concentration measured at the SO_2 analyzer for the "i^{th}" 5 minute interval, ppm.

S_1 = Concentration measured at the SO_2 analyzer for the first 5 minute interval ppm

T_m = Absolute average DGM temperature (see Figure 5-2), °K (°R).

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

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

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

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

W_{wt} = Wet wood weight.

Y = Dry gas meter calibration factor.

Y_{CO} = Measured mole fraction of CO (dry).

Y_{CO2} = Measured mole fraction of CO_2 (dry).

Y_{HC} = Assumed mole fraction of HC (dry);
=0.0088 for catalytic woodheaters
=0.0132 for noncatalytic woodheaters
=0.0080 for pellet fired woodheaters

θ = Total sampling time, min.

13.6 = Specific gravity of mercury.

60 = Sec/min.

100 = Conversion to percent.

M5H PARTICULATE SAMPLING TRAIN

1. Probe

   3/8" seamless SS-20" long. Outlet end of probe is attached to a SS outlet fitting with a Sweglock SS union. The probe is unheated except for the portion that is in the stack and the heated filter box. The probe is sealed to the stack with a washer.

2. Filter Holder

   A 3" or 4" standard M5 filter holder. A SS filter support with gasket.

3. Filters

   3" or 4" fiber glass (#25 glass) manufactured by Schleicher and Schuell.

4. Front Half Filter Heater

   A box containing a fan for air circulation and a cone heater. The temperature in the box is monitored with a type K thermocouple and adjusted with a voltage regulator to maintain a temperature below 248 °F.

5. Desiccant

   Indicating silica gel, 6-20 mesh. The silica gel is changed as needed.

6. Filter (Back Half) Holder

   Same as front half 3" or 4" filter.

7. Impinger Gas

   Type K thermocouple threaded into the exit "arm" of the impinger. Ice is added to the cooler whenever necessary to maintain an exit gas temperature less than 68 °F.

8. Meterbox

   RAC Stack Sampler modified by EEMC

   Ranges: 0-1.0" inclined water manometer

   0-10.0" vertical water manometer

   Accuracy: Dry gas Meter 0-999.999 cu ft ±1.0%

   Temperatures are monitored using two type K thermocouples.

SAMPLING PROCEDURES AND INSTALLATION DESCRIPTION

This section is broken into two major parts. The first contains a brief description of the sampling and procedures used by LoKee when performing a test using EPA Methods 28, 28A and 5H. The second section contains a complete listing of all equipment in each of the major sampling trains and a diagram of each major train.

LoKee uses EPA M5H for the particulate sampling procedure and collects the required data so that efficiency of a unit can be calculated using the Oregon Method.

TEST FACILITY AND WOOD HEATER EQUIPMENT LIST

1. Flue Pipe

   The diameter of the 24 gauge black steel flue pipe used for each stove varies with the size of the stove's flue collar, e.g., 6" flue pipe is used with a 6" flue collar. The joint at the flue collar is sealed with mortar. The pipe is attached to the stove at the flue collar with three sheet metal screws. All sampling ports are sized for the sampling probes and sealed using washers.

2. Insulated Flue Pipe

   The diameter of the insulated flue pipe matches the diameter of the flue collar on the stove. The 6", 7" and 8" pipe meet the requirements of UL 103 HT. The SO_2 injection loop port is sealed with high temperature silicone sealant.

3. Liquid Seal

   The liquid (oil) seal used by LoKee varies in size with the flue pipe. The seals are made of 12 gauge steel. The liquid sealant is mineral oil. The cooler consists of 3/8" copper tubing which is coiled in the bottom of the lower half of the seal. Ambient air is pumped through this line when necessary to cool the seal.

4. Supports

   The lower half of the seal and the 24 gauge steel black flue pipe is supported by the stove. The upper half of the seal and the insulated flue pipe are hung from wooden supports.

5. Platform Scale

   Platform (30" X 30" deck)

   Manufacturer: Weightronics

   Model: platform: DS-014/SN 4479 readout: W1-110/SN 016409

   Type: Electronic

   Range: 0-1000 lb.

Capacity: 1000 lb.

Resolution: ±0.1 lb.

Accuracy: ±0.1%

6. Fuel Balance Scale

LoKee uses the platform scale listed above to weigh the fuel charges.

7. Fuel Storage Area

LoKee stores the fuel in a humidity and temperature regulated room.

8. Moisture Meter

LoKee has two moisture meters which it uses to determine wood moisture levels.

The primary meter is:

Manufacturer: Delmhorst Instrument Co.

Model: RC-1C/SN 16152 with 26-E probe and #496 insulated pins.

Type: Electrical Resistance

Resolution: ±0.1% moisture

Ranges: 6-11%, 11-25%, 25-80%

Accuracy:	Moisture	Content Accuracy
	6-12%	±0.5%
	12-20%	±1.0%
	20%-saturation point	±2.0%

Type of Calibration: The RC-1C is equipped with two potentiometers (Zero and Span) which are checked and adjusted on a daily basis. The unit is also checked with a calibration block.

Electrode and Pin Type: 26-E probe and #496 insulated pins

The backup moisture meter:

Manufacturer: Delmhorst Instrument Co.

Model: G-30SN/2477 with 26-E probe and #496 insulated pins

Type: Electrical Resistance

Resolution: ±0.1% moisture

Accuracy:	Moisture	Content Accuracy
	6-12%	±0.5%
	12-20%	±1.0%
	20%-saturation point	±2.0%

Type of Calibration: Calibration is accomplished with an internal calibration point and a potentiometer. The calibration can also be checked against a calibration block.

Description of Operation: The pins are pounded into the wood to be sampled. The meter reading is recorded on Data Sheet #10 (Wood Moisture) or Data Sheet #11 (Density Determination). This is the uncorrected reading which is then corrected for pin insulation and, as needed, temperature using the correction tables for each parameter supplied by the manufacturer.

9. Temperature Monitors

The temperatures are monitored with Type K thermocouples. Each thermocouple's calibration is checked prior to use.

The thermocouple readout is an Omega Model 410B-K/SN 05/4475, with a range of -58 °F to 1999 °F (type K) and an accuracy of ±0.9 °C, which can be read at ±0.1 °F. EEMC reads and rounds to 1.0 °F. The single channel readout is interfaced with a manually operated selector switch that allows 24 channels to be monitored with the same readout. The thermocouples are attached to the test unit with sheet metal screws. The thermocouples monitoring internal stove temperature are sealed at the point of entry with sealant.

10. Draft Gauge

Manufacturer:	Dwyer
Model:	
Type:	Inclined Water Manometer
Range:	0-0.25" water
Resolution:	0.001" water
Accuracy:	±0.001" water (readability)

11. Anemometer

Manufacturer:	Dwyer
Model:	480 Vaneometer/SN S 222 D
Range:	0-400 FPM
Accuracy:	±5% of full scale from 0-1 FPM

12. Humidity Gauge

Manufacturer:	Bacharach
Model:	SAC
Type:	Sling Psychrometer
Range:	Wet Bulb: 30-110 °F
Dry Bulb:	30-110 °F
Resolution:	±1 °F
Accuracy:	±1 °F

13. Barometer

Manufacturer:	Princo Instruments, Inc.
Model:	NOVA 469

Type:	Mercury Barometer
Range:	20-32" Hg
Resolution:	0.01" Hg
Accuracy:	±0.01" when calibrated and installed as per the manufacturer's written operating instructions.

Equation 6.3.1a of the "Standard Methods for Measuring the Emissions and Efficiencies of Residential Wood Stoves" and equation #1 are programmed into a Hewlett Packard 15C calculator which first calculates stack gas flow rate and then the ΔH. The stack gas flow rate and ΔH are both recorded on Data sheet #2. The ΔH is used to set the flow rate through the dry gas meter at 5 minute intervals during the test.

In order to successfully maintain the correct sampling ratio, the following data is recorded on Data Sheet #2 (Meter Box Data Sheet): temperature (°F) at the SO_2 injection rotameter (Tr), pressure (inches H_2O) at the SO_2 injection rotameter (Pr), SO_2 injection rate (cc/min), barometric pressure (BP) (inches Hg), stack gas SO_2 concentration (ppm SO_2), sampling ratio (Sr), and the average dry gas meter temperature (°F). This data is entered into the HP15C, which is used to first calculate a stack gas flow rate (dscf) and then a ΔH for every sampling interval. The flow rate through the dry gas meter is adjusted and maintained by maintaining the appropriate ΔH.

CEM MONITORS

1. Calibration Gases

   LoKee uses vendor certified (±2.0%) calibration gases for each CEM. The concentrations purchased coincide with ranges specified in M5H. Upon receipt of the cylinder, the concentrations are verified with Method 3 (ORSAT) analysis.

2. Flow Regulators

   LoKee uses a variety of standard gas flow regulators to meter the flow of calibration gases from the cylinders.

3. Point of Injection

   Calibration gases are injected directly into the end of the probe. The line carrying the calibration gases from the cylinders is connected to the probe with a short piece of rubber tubing.

4. Sample Gas Conditioning System

   The combustion gas is conditioned with a train that is a duplicate of a M5H train. It contains the following components:

   SS probe

   Glass 4" M5H filter and holder in a heated box

4 1000 ml glass impingers

Glass 4" M5H filter and holder

Indicating silica gel

Type K thermocouple to monitor exit gas temperature

Thomas pump

5. Filters

The filters used are the same as EPA M5H filters.

6. Manifold and Exhaust

The gas stream is delivered to each analyzer through a manifold and flowmeter with the excess gases being routed to an exhaust.

7. CO Analyzer

Horiba PIR 2000/SN 408005

Nondispersive infrared (NDIR)

The gas stream flow is controlled by a SS flowmeter downstream of the analyzer. The calibrated range used is 0-10.0% by volume. The resolution is 0.01% CO. The manufacturer's specification given for linearity is ±1.0%.

8. CO_2 Analyzer

Horiba PIR 2000/SN 407069

The CO_2 analyzer is also a NDIR and is operated in exactly the same manner as the CO analyzer. The range of the CO_2 analyzer is 0-25.0% CO_2.

COMBUSTION GAS ANALYZER TRAIN OPERATING INSTRUCTIONS

A. Pretest Preparation, Checks and Audit Procedures

1. Clean the probe with acetone and a brush. Seal the end of the probe for a leak check.
2. Remove the filter holder from the sample box and change the filter.
3. Empty water from all the impingers in the train. Clean all impingers and fill the first 2 with 100 ml of water.
4. Remove the second filter holder from the train and change the filter.
5. Visually check the indicating silica gel in the fourth impinger. If it is visibly impacted by water, replace the silica gel with dry silica gel.
6. Turn on the pump and perform a leak check on the entire train. This is done by placing the exhaust line in water. A successful leak check is accomplished when no bubbles are detected.
7. Slowly release the plug from the probe to prevent any back flushing.
8. Turn off the pump.

9. Turn on the heat in the sample box. Adjust Variac voltage controller so that temperature in the sample box does not exceed 248 °F.
10. Open the bypass valve on the pump.
11. Connect the probe to the zero/span gas delivery line.
12. Turn on the zero gas and adjust the flow rate to 1.5 SCFH.
13. Wait until the zero gas has completely flushed the train and a stable reading is obtained.
14. Record the zero gas readings of the DVM on Data Sheets #15.
15. Turn off the zero gas at the cylinder.
16. Disconnect the zero/span gas delivery line from the zero gas cylinder.
17. Connect the zero/span gas delivery line to the span gas source for each analyzer.
18. Turn on the span gas and adjust the flow rate to 1.5 SCFH. Wait until a stable reading is obtained on each analyzer. Repeat until all three analyzers are spanned properly.
19. Record the span gas readings of the DVM. Record the analyzer's output and all other pertinent information Data Sheets #15.
20. Turn off the span gas at the cylinder.
21. Disconnect the probe from the zero/span gas delivery line.
22. Insert the probe in the stack.
23. Close the bypass valve on the pumps.
24. Approximately 15-20 minutes before the actual start of the test, turn on the pump and adjust the flow through each analyzer until the flow rate is 1.5 SCFH.

B. <u>Operation During Testing</u>

1. Monitor the flow rate to the analyzers periodically to maintain a flow rate of 1.5 SCFH. Make any necessary adjustments.
2. Record data as follows:

   a. At the start of each 5 minute data cycle, record the scale weight, wet bulb/dry bulb, stack gas temperature and static pressure on Data Sheet #12 (Gas Data).

   b. Record the combustion gas (CO_2, O_2 and CO) analyzer data and the SO_2 analyzer data on Data Sheet #12.

   c. Record the remainder of the temperature data.

C. <u>Post Test Checks and Audit Procedures</u>

1. Remove the probe from the stack. (Be careful when handling the probe as it can be quite hot.)
2. Seal the end of the probe.
3. Perform a leak check on the entire train.
4. Slowly release the plug from the end of the probe to prevent any back flushing.
5. Turn off the pump.

6. Open the bypass valve on the pump.

7. Connect the probe to the zero/span gas delivery line.

8. Turn on the zero gas and adjust the flow rate through each analyzer to 1.5 SCFH.

9. Wait until the zero gas has completely flushed the train and a stable reading is obtained from each analyzer.

10. Record the zero gas reading. Record each analyzer's output and all other pertinent information on Data Sheets #15.

11. Turn off the zero gas at the cylinder.

12. Disconnect the zero/span gas delivery line from the zero gas cylinder.

13. Connect the zero/span gas delivery line to the span gas source for each analyzer.

14. Turn on the span gas and adjust until the flow rate through each analyzer to 1.5 SCFH. Wait until the span gas has completely flushed the train and a stable reading is obtained on each analyzer.

15. Record the span gas reading. Record each analyzer's output and all other pertinent information on Data Sheets #15.

16. Turn off the span gas at the cylinder.

17. Disconnect the probe from the zero/span gas delivery line.

D. Determination of the Combustion Gas Train's Response Time

1. The response time of the combustion gas analyzer train is to be determined using the following procedures. It is best to determine the combustion gas analyzer train response time during the "charcoal phase" of a test burn so that CO levels are relatively stable.

   a. Leak check the combustion gas (CEM) analyzer train.

   b. Zero the CO analyzer using ambient air.

   c. Calibrate the CO analyzer.

   d. Insert the probe for the combustion gas analyzer train in the stack.

   e. Sample flue gas until a stable reading is obtained.

   f. Remove the probe from the stack, note the exact CO concentration as measured on the DVM and start a stop watch at the exact time of removal.

   g. Observe the stop watch and DVM. Record the length of time to initial response, i.e., when the CO levels begin to decline.

   h. Continue observing the stop watch and DVM. Record the time when the analyzer's output equals zero (0.000 v).

   i. Repeat steps d-h 2 or 3 times to verify results.

E. Calibration and Audit Procedures for the Combustion Gas Analyzers

1. Calibrate by presenting zero and span gases to each analyzer at the probe and through the entire sampling train. (See Sections 6.7.2 and 6.9 [M5H].) Record the responses on the appropriate calibration forms.
2. Immediately prior to and after each test run, present the zero and span gases to the analyzers through the entire sampling train as is discussed in section C. Record each analyzer's response on Data Sheets #15.
3. Calculate the ± concentration difference and the actual percent difference as follows using the zero and span gas values obtained in #2 above. All calculations are to be based upon the actual gas concentrations involved.

$$\pm \text{ Concentration Difference} = \text{Actual Conc (\%)} - \text{Std Conc (\%)}$$

$$\text{Zero \% Difference} = \frac{\text{Act Conc (\% or ppm)} - \text{Std Conc (\% or ppm)}}{\text{Full Scale Value (\% or ppm)}} * 100$$

$$\text{Span Act \% Difference} = \frac{\text{Act Response (\% or ppm)} - \text{Exp Response (\% or ppm)}}{\text{Full Scale Value (\% or ppm)}} * 100$$

Then refer to Section 4.2 and 4.3 (M5H) to determine whether the audits are acceptable or not.

TRACER GAS (SO_2) EQUIPMENT

1. SO_2 Injection Probe

   A circular SS loop about 4" in diameter is positioned in the center of the stack. The loop extends outside the stack and is connected to the line leading from the SO_2 injection rotameter with Sweglock fittings. The loop is inserted in the stack at 9.5 ±0.5 ft above the top of the scale.
2. Rotameter

   A rotameter that has been calibrated with a bubble tube. The rotameter is all glass, stainless steel and Teflon. The rotameter has a flow control mechanism which is set to the calibrated flow.
3. Temperature

   The temperature at the injection rotameter is measured with a type K thermocouple.
4. Injection Gas

   Pure SO_2, 99.999% pure, released from the cylinder through a SS regulator and shut off valve.
5. Calibration Gases

LoKee uses vendor certified calibration gases with traceability established in accordance with EPA Protocol #1 as specified in Section 3.3.1 and verified using EPA Method 6.

6. Sample Probe

3/8" SS tubing inserted at 13.5 ±0.5 feet above the platform scale. No obstructions are in the stack between the injection and sample probes.

7. Combustor

Lindberg tube furnace, Model 55035/SN 800125, range 0-2000 °F. The temperature in the tube furnace is monitored with a type K thermocouple and controlled with a Variac voltage regulator. Power adjustments are made as necessary to maintain temperature at 1425 °F ±25 °F.

8. Sample Condenser

The sample condenser consists of 3 modified M5 impingers immersed in a freezer.

A filter assembly

The exit gas temperature is monitored with a type K thermocouple.

9. Filter

A standard EPA M5H 3" or 4" filter.

10. SO_2 Analyzer

Horiba, PIR 2000/SN 403019

Nondispersive infrared (NDIR)

The analyzer is operated as per the manufacturer's instructions at a flow rate of 1.5 SCFH. The calibration range is 0-2500 ppm SO_2 at a resolution of ±25.0 ppm. The manufacturer's specification for linearity is ±1.0%. The voltage response is displayed on a DVM which is converted to ppm using the manufacturer's calibration curves.

11. Flow Control

Flow through the tracer gas sampling train is controlled by a SS flowmeter.

TRACER GAS TRAIN OPERATING INSTRUCTIONS

A. Pretest Preparation and Checks and Audit Procedures

1. Clean the probe with a brush. After cleaning, seal the end of the probe. **Note: Do Not Use Acetone Or Other Organic Solvents To Clean The Probe Immediately Prior To Running A Test Or Conducting A Leak Check.**
2. Turn on the tube furnace in order to insure that the unit is at the correct operating temperature (1425 °F) at the start of the test.
3. Remove all water and clean the impingers.
4. Change the filter.
5. Turn on the pump.

6. Perform a leak check on the entire tracer gas train. This is done by placing the SO_2 exhaust line in water. A successful leak check is accomplished when no bubbles are detected.
7. Slowly remove the plug from the end of the probe to prevent any back flushing.
8. Turn off the pump.
9. Bypass the pump.
10. Connect the probe to the zero/span delivery gas line.
11. Connect the zero/span gas delivery line to the zero gas cylinder and turn on the zero gas and adjust the flow until the flow rate through the SO_2 analyzer is 1.5 SCFH.
12. Wait until the zero gas has completely flushed the train.
13. Record the zero gas reading. Record the SO_2 analyzer's DVM output on Data Sheets #15.
14. Turn off zero gas at the cylinder.
15. Disconnect the zero/span gas delivery line from the zero gas cylinder.
16. Connect the zero/span gas delivery line to the span gas cylinder.
17. Turn on the span gas and adjust the flow until the flow rate through the SO_2 analyzer is 1.5 SCFH. Wait until the span gas has completely flushed the train and a stable reading is obtained on the analyzer.
18. Record the span gas reading. Record the analyzer's output and all other pertinent information on Data Sheets #15.
19. Turn off the span gas at the cylinder.
20. Disconnect the zero/span gas delivery line from the probe.
21. Insert the probe in the stack.
22. Close the bypass on the pump.
23. Approximately 15 to 20 minutes before the actual start of the test, turn on the SO_2 injection train and the pump for the tracer gas train.

B. <u>Operation</u>

1. Turn on the tube furnace to insure furnace is at approximately 1425 °F when the test begins.
2. Approximately 15-20 minutes before the actual start of the test, turn on the cylinder of pure SO_2.
3. Using the rotameter's current calibration, adjust the SO_2 flow rate to the calibrated level.
4. Turn on the pump in the tracer gas train. Adjust the flow rate through the SO_2 analyzer so that it remains at 1.5 SCFH.
5. Monitor the SO_2 concentrations in the stack and stack gas flow rates in order to establish a sampling ratio for the test and a correct ΔH at the start of the test.

6. At the start of the test and every 5 minutes thereafter, record the SO_2 analyzer output in volts and the stack gas SO_2 concentration in order to calculate the stack gas flow rate and determine the correct ΔH for the meter box.

   Also monitor and record the temperature at the Rotameter (Tr), pressure at the Rotameter (Pr), barometric pressure (BP) SO_2 injection rate (cc/min) and static pressure on Data Sheets #2 and #12.

C. Post Test Checks and Audit (Zero/Span) Procedures

1. Remove the probe from the stack. (Be careful when removing the probe from the stack as it can be quite hot.)
2. Plug the end of the probe.
3. Perform a leak check.
4. Slowly remove the plug from the end of the probe to prevent any back flushing.
5. Turn off the pump.
6. Bypass the pump.
7. Connect the probe to the zero/span gas delivery line.
8. Connect the zero/span gas delivery line to the zero gas cylinder. Turn on and adjust until the flow rate through the SO_2 analyzer is 1.5 SCFH.
9. Wait until the zero gas has completely flushed the train.
10. Record the zero gas reading. Record the SO_2 analyzer's DVM output on Data Sheet #15.
11. Turn off zero gas at the cylinder.
12. Disconnect the zero/span gas delivery line from the zero gas cylinder.
13. Connect the zero/span gas delivery line to the span gas cylinder.
14. Turn on the span gas and adjust the flow until the flow rate through the SO_2 analyzer is 1.5 SCFH. Wait until the span gas has completely flushed the train and a stable reading is obtained.
15. Record the span gas reading. Record the analyzer's output and all other pertinent information on Data Sheet #15.
16. Turn off the span gas at the cylinder.
17. Disconnect the zero/span gas delivery line from the probe.

D. Determination of Tracer Gas Train's Response Time

1. Zero and calibrate the SO_2 analyzer.
2. Prepare and leak check the tracer gas train as per A above.
3. Insert the probe in the stack which contains flue gas and SO_2 concentrations in the ranges normally encountered during wood stove testing.

4. Sample flue gas with SO_2 concentrations until a stable reading is obtained. It is best to determine the tracer gas train's response time during the "charcoal phase" of a test burn so that the SO_2 concentrations are as stable as possible.
5. Remove the probe from the stack, noting the exact SO_2 concentration as measured by the DVM and starting a stop watch at the exact time of removal.
6. Observe the stop watch and DVM. Record the length of time to the initial response, i.e., when the SO_2 levels begin to decline.
7. Continue observing the stop watch and DVM. Record the time when the SO_2 analyzer's output equals zero (0.000 v.).
8. Repeat steps 3-7 two or three times to verify results.

E. Calibration and Audit Procedures for the Tracer Gas (SO_2) Analyzer

1. Calibrate by presenting zero and span gases to the analyzer at the probe and through the entire sampling train. Record the responses on the appropriate calibration form.
2. Immediately prior to and after each test run, present the zero and span gases to the analyzer through the entire sampling train as is discussed in Sections A and C. Record the analyzer's response on Data Sheet #15.
3. Calculate the ± concentration differences and actual percent difference as follows using values obtained in #2 above as the expected response. All calculations are to be based upon the actual gas concentration involved.

$$\pm \text{ Concentration Difference} = \text{Actual Conc (\%)} - \text{Std Conc (\%)}$$

$$\text{Zero \% Difference} = \frac{\text{Act Conc (\% or ppm)} - \text{Std Conc (\% or ppm)}}{\text{Full Scale Value (\% or ppm)}} * 100$$

$$\text{Span Act \% Difference} = \frac{\text{Act Response (\% or ppm)} - \text{Exp Response (\% or ppm)}}{\text{Full Scale Value (\% or ppm)}} * 100$$

Then refer to Section 4.2 and 4.3 (M5H) to determine whether the audits are acceptable or not.

TEMPERATURE SENSING OPERATING INSTRUCTIONS

A. Operate the thermocouple readout selector switch and record the temperature for each thermocouple. All the temperature in the test facility should be approximately the same. Repair as necessary.

B. Check the operation and output of the thermocouple readout using the Omega NBS Traceable Thermocouple Simulator. The simulator is hooked up to thermocouple readout #23. Check the readout over its full range at 200 °F intervals. Record the data on Data Sheet #16.

C. One hour before the actual test start record stove temperatures (thermocouple readout #'s 4, 5, 6, 7 and 8), firebox (readout #9), post catalytic combustor or secondary burn chamber (readout #10), and room temperature (readout #11). Record the temperatures every 5 minutes until the start of the test on Data Sheet #13 (Preburn).

D. During the test record the temperatures every 5 minutes for each of the thermocouples on Data Sheets #12 and 14.

FUEL PREPARATION

A. No more than 4 hours prior to use, obtain 3 moisture readings from each piece of wood. Record all moisture readings on Data Sheet #10.

B. Obtain kindling by finely splitting pieces that otherwise cannot be used as test fuel. Weigh the kindling and record the weight on Data Sheet #8.

C. Obtain the pretest fuel by using 2 x 4's. The length of the pretest fuel can be no less than 1/3 the length of the test fuel. Weigh the pretest fuel prior to its being loaded in the stove. Record weights on Data Sheets #8 and #9.

D. Obtain the test fuel by cutting dimensional lumber (either 2 x 4's or 4 x 4's) so that the length is 5/6's the length of the longest usable dimension of the firebox. Use the mix of 2 x 4's and 4 x 4's specified in Section 4.3 M28. The test fuel shall be essentially free of knots, sap seams or rotten areas.

E. The spacers shall measure 1 x 5 x 1" (nominally). The spacers shall be free of knots, sap seams or rotten areas. Nail the spacers to the 2 x 4's and 4 x 4's as described in the regulations.

F. Take a photograph of the assembled fuel charge at a 90° angle from the photograph that will be take when the fuel charge is loaded in the stove.

WOOD DENSITY DETERMINATION

A. When cutting the test fuel, cut a representative piece of 2 x 4 or 4 x 4 that is approximately 3 to 5-inches in length.

B. Take a moisture reading from the top, bottom and side of the piece. Record readings on Data Sheet #11. Determine the % moisture on a wet and dry basis.

C. Weight the piece on a balance.

D. Take measurements of width, depth and length at the four corners with a micrometer. Determine the volume of the piece. (Length x width x depth = Volume in cubic centimeters)

E. Dry the piece in an oven at 95-100 °C for a minimum of 24 hours.

F. Reweigh the piece on the balance.

G. Calculate % moisture on a dried basis.

$$\% \text{ moisture (dry basis)} = 1 - \frac{\text{dried weight}}{\text{wet weight}} * 100$$

H. Calculate the density.

$$\text{Density (g / cc)} = \frac{\text{dried weight (g)}}{\text{volume (cc)}}$$

BTU'S/LB DETERMINATION

A. When cutting the test fuel (only the test fuel, not the kindling, pretest fuel or spacers), collect a sawdust sample. Place in a clearly marked plastic bag.

B. Forward sample to a commercial laboratory for BTU contents analysis.

STOVE PREPARATION

A. Clean the stove.

B. Weigh the stove, record the weight on Data Sheet #8.

C. Add approximately 0.3 lb. of wadded newspaper to the stove. Record weight of newspaper on Data Sheet #8. Add 4-8 lb. of kindling to the stove, and record the weight of the kindling on Data Sheet #8.

D. Light the paper and kindling, leaving the stove's air draft control(s) wide open and the door cracked until well ignited.

E. Close door.

F. When between 50% - 75% of the weight of the kindling has been burned add the first pretest fuel charge.

G. Continue to add pretest fuel until the stove has thoroughly warmed up. As necessary, rake the coal bed prior to adding additional pretest fuel charges.

H. Remove all material from the firebox after two or more hours of burning on high. Obtain the dry empty stove weight and record on Data Sheet #8.

I. Set the stove's air draft control(s) at the desired setting a minimum of 1 hour before the test run is to begin.

J. As necessary set the heat exchange blower(s) at the specified setting a minimum of one hour before the test is to begin.

K. Record the stove surface temperatures, firebox and post catalytic or secondary burn temperatures and scale weigh for a minimum of one hour before the test run begins. As necessary add fuel,

rake the coal bed, level the coal bed and/or remove coals during the first 45 minutes of the hour immediately preceding the start of the test. Record all information concerning raking, fuel additions, etc. on Data Sheet #13.

L. If necessary, sometime during the last 15 minutes before the start of the test, open the door and brake up all large pieces and then rake and level the pretest fuel in the stove. At this time, level the coal bed as necessary to accommodate loading the fuel charge into the stove. Close the door. Total time door can be open during the last 15 minutes is 1 minute. No further manipulation of the stove is allowed during the 15 minutes immediately preceding the start of the test.

M. When the weight of the coal bed equals 20-25% of the weight of the test fuel charge, load the test fuel. Take a photograph of the fuel load in the stove immediately after loading the fuel. Leave the door open as per the manufacturer's instruction, but no longer than 5 minutes.

N. Document all stove operating data from ignition through loading and test start up on Data Sheet #9.