United States
Environmental Protection Agency
Wood Heater Certification Test Report

Jotul North America
3CBII

Volume 1 of 1

LoKee

Testing Laboratory

United States
Environmental Protection Agency
Wood Heater Certification Test Report

Jotul USA
400 Riverside Street
Portland, ME 04104
3CBII

Volume 1

Report By:

Chip Wadington
Cindy Kingman
Deborah Wadington

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AUTHORIZED PERSONNEL

July 20, 2000

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TEST SERIES INFORMATION

Unit name and model number: 3CBII

Type of unit: Wood Heater

Manufacturer: Jotul USA
Address: 400 Riverside Steet
Portland, ME 04104

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

Observers: N/A

Date Received: 12/15/99 Aged: 1 /4-5/2000 Dates Tested: 1/7-12/2000

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.

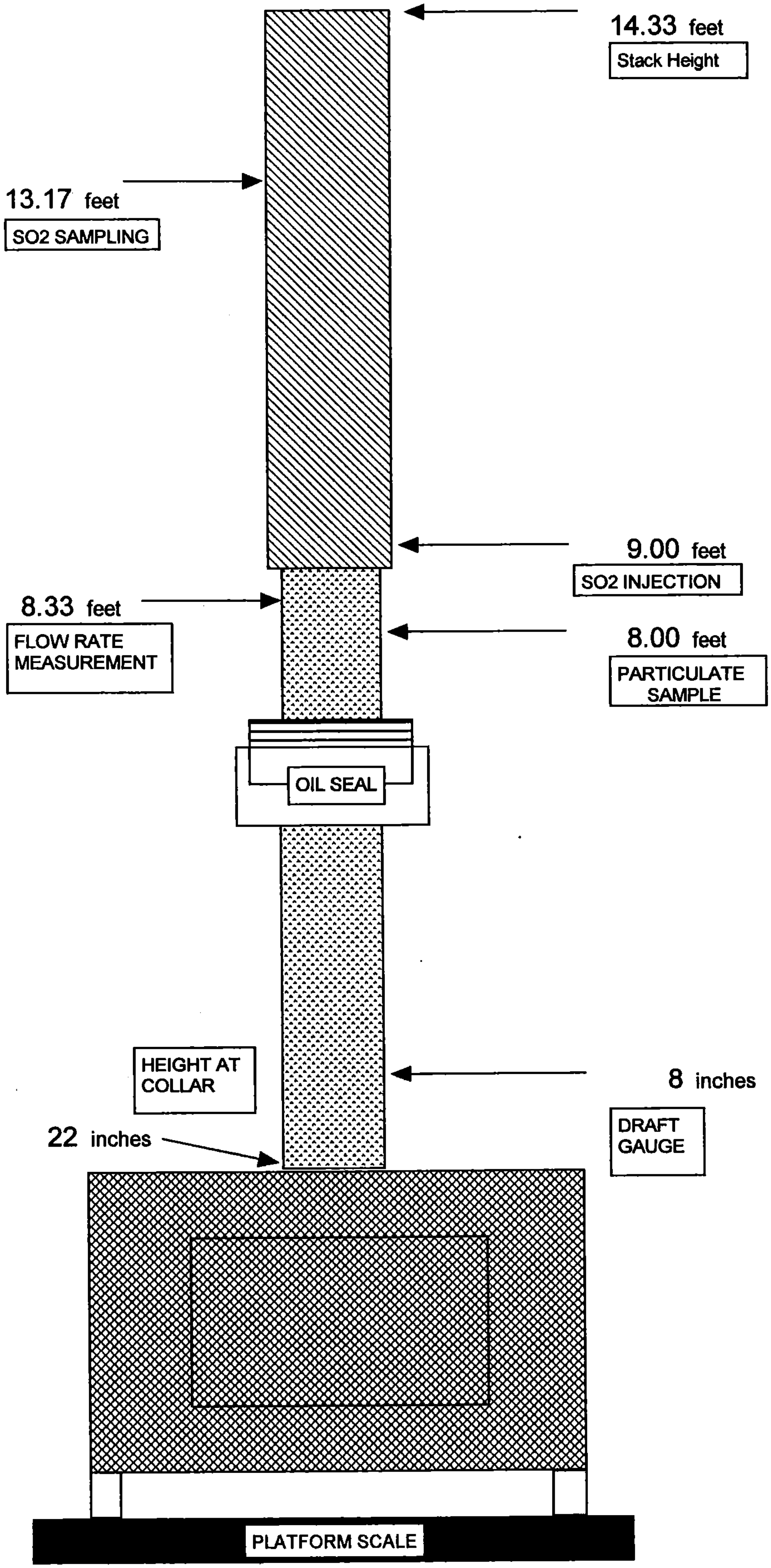
WARNING

SEALED EPA TEST UNIT

DO NOT TAMPER WITH SEALS
TO DO SO WILL VOID CERTIFICATION

JOTUL USA
3CBII

Model: **Jotul 3CBII** **Date:** **01/30/00**



AGING DATA SHEET

UNIT: Jotul 3CB11 DATE: 1-4-00

Hr #	DATE	TIME	TEMP TOP 1	TEMP SECONDARY 2
1	1-4-00	1250	611	1129
2	11	1350	201	510
3	11	1450	510	1308
4	11	1550	278	760
5	1-5-00	1225	736	1425
6	11	1325	252	713
7	11	1425	428	1191
8	11	1525	312	721
9	11	1625	262	603
10	1-6-00	1230	653	1400
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:

1-4-00 stove lit 1000
1-5-00 stove lit 0900
1-6-00 stove lit 0830

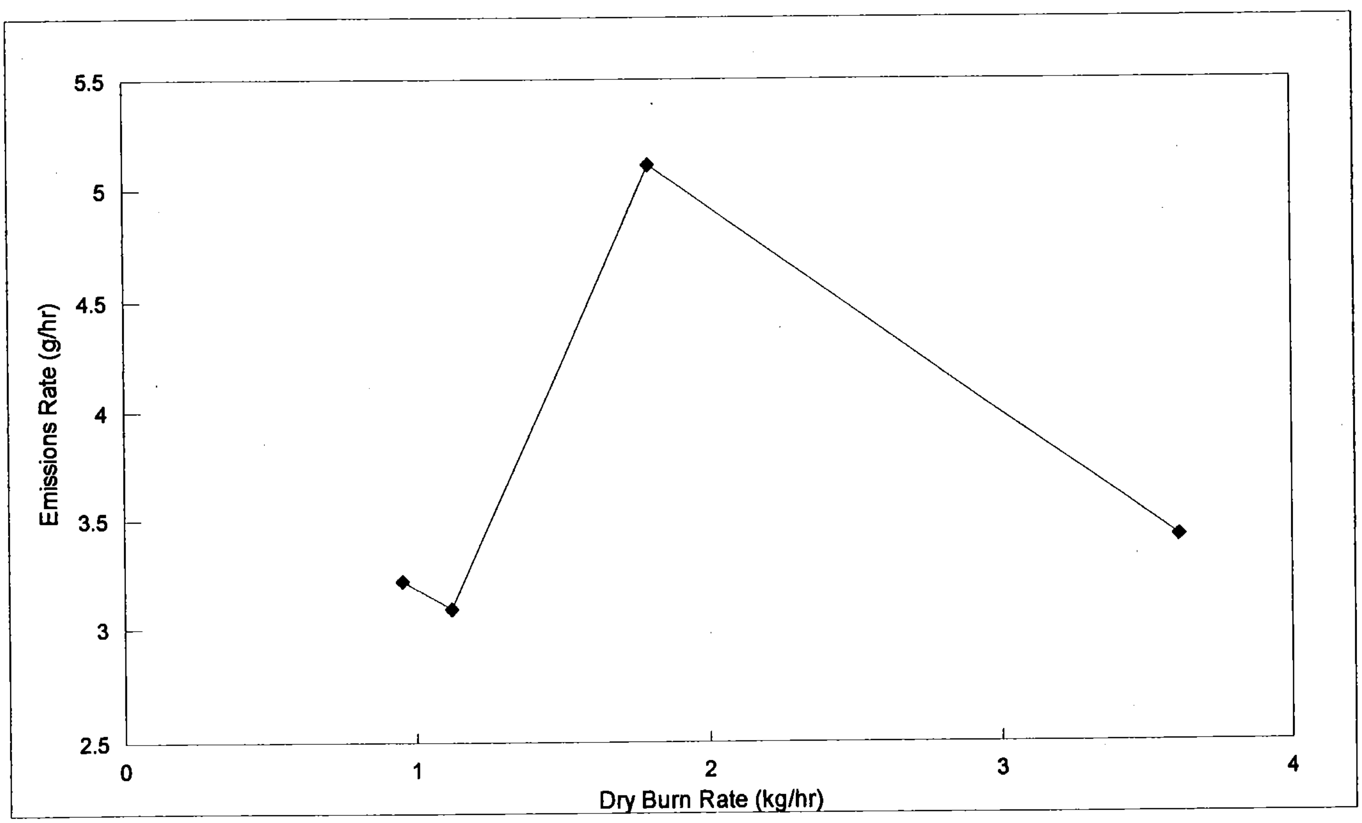
DATA
SUMMARY

Wood Heater Emission Test Summary

Laboratory/Wood Heater Information

Stove Manufacturer:	**Jotul**
Model Identification:	**3CBII**
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:	**1/25-27/2000**
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) 3.78
3	0.95	3.22	11455	
4	1.12	3.09	13505	
2	1.80	5.11	21705	
4	3.61	3.42	43530	



Unit: Jotul 3CBII

DATA SUMMARY

	RUN #	3	4	2	1				
Particulate Emissions:									
Concentration:	grains/dscf:	.1299	.1070	.1252	.0428				
Emissions Rate	grams/hr:	3.22	3.09	5.11	3.42				
Emissions Factor	grams/kg:	3.39	2.76	2.85	0.95				
Front Half Catch	% of total	38.03	39.53	31.25	72.33				
Total Mass Captured	total catch:	.4938	.3521	.3478	.0553				
Heat Output (EPA Default):	BTU/hr	11443.2	13481.1	21668.6	43481.9				
Fuel Burn Rates:									
Average kg/hr (dry)	Kg/hr	0.95	1.12	1.80	3.61				
Fuel Moisture Content:									
Kindling (wet basis)	%	8.953	8.815	9.118	11.190				
Pretest Fuel (wet basis)	%	17.740	19.109	19.571	18.897				
Test Fuel (wet basis)	%	18.228	17.876	18.506	18.223				
Air to Fuel Ratio		-	-	-	-				
Average Stack Gas									
Avg CO_2	%	6.59	6.58	8.42	9.05				
Avg O_2	%	-	-	-	-				
Avg CO	%	1.03	1.14	0.52	0.18				
Avg Moisture	%	6.40	6.80	8.59	9.12				
Avg Stack Gas Emissions:									
CO	g/Kg	138.42	152.72	60.95	20.39				
	g/hr	131.36	170.74	109.54	73.51				

Unit: Jotul 3CBII

	RUN #	3	4	2	1				
Avg Stack Gas Flow Rate									
EPA CMB	dscfm	06.37	07.42	10.51	20.53				
Tracer Gas	dscfm	06.469	07.261	10.337	12.631				
Draft (static)	in H_2O	-.037	-.039	-.051	-.064				
Proportionality Average	%	100	100	100	100				
Average Temperatures									
Stack Gas	°F	295	317	439	693				
Firebox	°F	747	760	884	1072				
Secondary	°F	906	893	1016	1275				
Catalytic Combustor	°F	-	-	-	-				
Top	°F	353	363	434	580				
Left Side	°F	283	288	331	396				
Back	°F	287	290	344	475				
Right Side	°F	304	308	365	495				
Bottom	°F	421	430	540	641				
Temperature Change	°F	-98.6	-55.2	+41.8	-18.4				
Test Chamber Enviroment									
Average Barometer	in. Hg	30.45	30.19	30.30	30.03				
Average Temperature	°F	76	75	81	82				
Ambient Moisture	% H_2O	1.10	1.05	1.20	1.15				
Relative Humidity	%RH	33.0	30.5	38.0	37.0				
Air Velocity	m/sec	0	0	0	0				
Fuel Weight and Burn Time									
Density (dry basis)	gm/cm^3	-	-	-	-				
Coal Bed Weight	lbs	2.0	1.9	2.0	1.9				
Pre Test Fuel (inc kindling)	lbs	40.5	35.7	36.8	42.6				
Test Fuel	lbs	8.1	8.0	8.1	8.1				
Burn Time	min	190	160	100	50				

MINIMUM
DBR

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.: 3 Date of Test: 1-27-00 Burn Rate: .949
Model No.: #3CBII

☒ min ☐ min-1.25 ☐ fan

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

Dry Gas Meter: Y Factor: .989 Post Leak Rate: .007 cfm Time: 190 min.
(0.000) (Data Sheet #2) (.000) (Data Sheet #2) (000) (Data Sheet #2)

Dry Gas Meter Volume: 60.601 cf
(00.000) (Data Sheet #2)

Stack Flow: 6.469 dscfm Δ H: .159 in. H_2O
(00.000) (Data Sheet #2) (.000) (Data Sheet #2)

Barometric Pressure: 30.45 in. Hg
(00.00) (Data Sheet #2)

H_2O Captured: 85.3 g
(00.0) (Data Sheet #3)

Total Particulate Catch: .4938 g
(0.0000) (Data Sheet #6)

Flue Gas Moisture: 6.4060 %
(00.000) (Data Sheet #7)

Particulate Emission: .1299 gr/dscf
(0.0000) (Data Sheet #7)

Ambient Moisture: 1.1 %
(0.00) (Data Sheet #8)

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

Total Fuel Consumed During Burn: 8.1 lbs
(00.0) (Data sheet #8)

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

Fuel % Moisture (dry): 22.292 % (wet): 18.228 %
(00.00) (Data Sheet #10)

Stack Static Pressure: -.037 in. H_2O
(0.000) (Data Sheet #12)

Temperature (Average Room) Combustion Air: 76 °F
(00) Data Sheet #14)

Stove Temperature Change: -98.6 °F
(00.0) (Data Sheet #14)

TABLE 1 ----- RAW DATA

CLIENT : Jotul TEST No. : 3

MODEL: 3CBII DATE: 27-Jan-00

TIME (MIN.)	METER READING (C F)	DELTA H (IN. H2O)	METER TEMP. (DEG. F)	PERCENT CO (%)	PERCENT CO2 (%)	SO2 COCENTR. PPM
0	988.000	0.150	84	0.70	6.40	550
5	989.500	0.600	85	0.33	7.80	275
10	992.537	0.140	87	0.71	3.50	575
15	994.004	0.120	87	0.92	3.20	625
20	995.353	0.120	87	0.88	4.10	625
25	996.703	0.150	87	0.67	9.90	550
30	998.236	0.150	87	0.76	8.60	550
35	999.769	0.160	87	0.51	9.60	525
40	1001.375	0.180	88	0.60	10.00	500
45	1003.068	0.200	89	0.17	10.50	475
50	1004.855	0.220	89	0.20	10.80	450
55	1006.742	0.200	90	0.57	10.60	475
60	1008.537	0.200	90	0.09	9.50	475
65	1010.334	0.200	90	0.11	9.20	475
70	1012.130	0.180	90	0.24	9.80	500
75	1013.837	0.180	90	0.30	9.20	500
80	1015.544	0.180	90	0.26	8.70	500
85	1017.251	0.160	90	0.54	7.30	525
90	1018.877	0.130	90	0.90	6.20	575
95	1020.362	0.130	90	0.87	6.20	575
100	1021.847	0.130	90	0.97	6.10	575
105	1023.331	0.130	90	0.97	6.20	575
110	1024.816	0.130	90	1.00	6.30	575
115	1026.301	0.130	90	1.14	6.10	575
120	1027.786	0.130	90	1.31	5.90	575
125	1029.272	0.130	90	1.57	5.60	575
130	1030.759	0.130	90	1.65	5.50	575
135	1032.246	0.130	90	1.51	5.50	575
140	1033.732	0.130	90	1.57	5.30	575
145	1035.219	0.130	90	1.60	5.20	575
150	1036.706	0.130	90	1.72	4.90	575
155	1038.193	0.130	90	1.59	4.90	575
160	1039.679	0.130	90	1.85	4.40	575
165	1041.166	0.130	90	1.83	4.30	575
170	1042.653	0.130	90	1.89	4.10	575
175	1044.139	0.130	90	1.84	4.00	575
180	1045.626	0.130	90	1.87	3.90	575
185	1047.144	0.130	90	1.90	3.90	575
190	1048.601	0.120	90	1.89	3.90	600
195						

TABLE 2---RAW DATA

CLIENT :	Jotul	TEST No.	3
MODEL:	3CBII	DATE:	27-Jan-00

****

METER CAL. FACTOR (Y)	------	0.989	Wt. WOOD BURNED(LB) -------	8.1	Lbs
BAROMETRIC PRESS.(Pb)	------	30.45 in Hg	WET,FUEL MOISTURE % -------	18.228	%
LEAK RATE POST (Lp)	------	0.007 cfm	Wt. PART. COLLECTED -------	0.4938	g
WATER VOL. (V1c)	------	85.3 Ml	METER VOLUME Vm -------	60.601	mcf
TEST TIME (MIN)	------	190 min	HC MOLE FRACTION -------	0.0132	

TABLE 3 -----FIELD DATA AVERAGES

CLIENT :Jotul TEST No. 3

MODEL: 3CBII DATE: 27-Jan-00

****

AVG DELTA H	-------	0.16 in H2O	AVG PRCNT CO	-------	1.03	%
AVG METER TEMP. Tm	-------	89 deg F	AVG PRCNT CO2	-------	6.59	%
AVG PPM SO2	-------	545 PPM	AVG BAL CO2/CO	-------	6.43	%

TABLE 4 ----- CALCULATIONS

CLIENT : Jotul TEST No. 3

MODEL: 3CBII DATE: 27-Jan-00

****

STD SAMPLE VOL. Vm(std) -----	58.68	dscf	STACK GAS FLOW Qsd -------	382.459	dscf/Hr
				&	
				6.37	dscf/min
VOL. WATER VAPOR Vw(std) ----	4.015	scf	PARTICULATE CONCTRT. Cs ------	0.0084	g/dscf
PRCNT MSTR Bws -------	6.40	%	PARTC.EMISS. RATE E -------	3.22	g/Hr
BURN RATE BR -------	0.95	Kg/Hr	MOLES OF GAS PER Lb WOOD Nt --	0.48	Lb-mole/Lb
CO EMISSION RATE -------	131.36	g/Hr	PART.EMISS. RATE ------	3.39	g/Kgdry fuel
	&				
	138.42	g/Kgdry fuel			

TABLE 5 ----- PROPORTIONAL RATE VARIATION

CLIENT : Jotul　　　　TEST No. : 3

MODEL: 3CBII　　　　DATE: 27-Jan-00

****

	TIME INTEVAL Ti	PPM * Vm	PROPRTN. RATE VAR. PR		PROPRTN RATE VAR. AVERAGE	
	5	805.6	98		100	
	10	814.2	99			
	15	819.9	100			
	20	819.5	99			
	25	820.1	100			
	30	819.6	100			
	35	819.6	100			
	40	818.9	99			
	45	820.7	100			
	50	822.2	100			
	55	821.8	100			
	60	824.4	100			
	65	825.3	100			
	70	824.9	100			
	75	825.2	100			
	80	825.2	100			
	85	825.2	100			
	90	825.3	100			
	95	825.5	100			
	100	825.5	100			
	105	824.9	100			
	110	825.5	100			
	115	825.5	100			
	120	825.5	100			
	125	826.0	100			
	130	826.6	100			
	135	826.6	100			
	140	826.0	100			
	145	826.6	100			
	150	826.6	100			
	155	826.6	100			
	160	826.0	100			
	165	826.6	100			
	170	826.6	100			
	175	826.0	100			
	180	826.6	100			
	185	843.8	102			
	190	809.9	98			
	195					
	200					

METER BOX DATA SHEET PAGE # 2

UNIT: JOTUL #3CBII RUN: 3 DATE: 1-27-00

Meter Box: 5H Y Factor: .989

Leak checks: 15 " Hg @ .004 cfm ______ " Hg @ ______ cfm

15 " Hg @ .007 cfm ______ " Hg @ ______ cfm

Inject SO² @ 100 cc/min. Nozzle: Probe @ 3/8 " od Initial Volume: 1.500

ROTO: PRESS: .18			SAMPLING RATIO: 21 : 1				BP: 30.50		
MIN	TIME	METER READING	SAMPLE MDCF	STACK DSCFM	DELTA H	METER TEMP	SO2 PPM	ROTO TEMP	PUMP VACC
0	1150	988.000	—	6.357	.15	84	550	84	1.0
5	55	989.500	—	12.690	.60	85	275	85	3.0
10	1200	992.537	992.537	6.047	.14	87	575	87	1.0
15	05	994.004	994.004	5.563	.12	87	625	87	1.0
20	10	995.353	995.353	5.563	.12	87	625	87	1.0
25	15	996.703	996.703	6.322	.15	87	550	87	1.0
30	20	998.236	998.236	6.322	.15	87	550	87	2.0
35	25	999.769	999.769	6.623	.16	87	525	87	2.0
40	30	1001.375	1001.375	6.941	.18	88	500	88	2.0
45	35	1003.068	1003.068	7.293	.20	89	475	89	2.0
50	40	1004.855	1004.855	7.698	.22	89	450	89	2.0
55	45	1006.742	1006.742	7.280	.20	90	475	90	2.0
ROTO PRESS: .18			TOTALS:	84.699	2.39	1047	BP.: 30.46		
60	1250	1008.537	1008.537	7.270	.20	90	475	90	2.0
65	55	1010.334	1010.334	7.270	.20	90	475	90	2.0
70	1300	1012.130	1012.130	6.907	.18	90	500	90	2.0
75	05	1013.837	1013.837	6.907	.18	90	500	90	2.0
80	10	1015.544	1015.544	6.907	.18	90	500	90	2.0
85	15	1017.251	1017.251	6.578	.16	90	525	90	2.0
90	20	1018.877	1018.877	6.006	.13	90	575	90	2.0
95	25	1020.362	1020.362	6.006	.13	90	575	90	2.0
100	30	1021.847	1021.847	6.006	.13	90	575	90	2.0
105	35	1023.331	1023.331	6.006	.13	90	575	90	2.0
110	40	1024.816	1024.816	6.006	.13	90	575	90	2.0
115	45	1026.301	1026.301	6.006	.13	90	575	90	2.0
			TOTALS:	77.875	1.88	1080	MAX VACC =		
TOTAL Cu Ft.			TOTALS:	162.574	4.27	2127	AVG. BP:		

METER BOX DATA SHEET PAGE # 2 Page: 2 of 2

UNIT: Jotul 3CB11 RUN: 3 DATE: 1-27-2000

Meter Box: 5H Y Factor: .989

Leak checks: 15 " Hg @ .004 cfm ______ " Hg @ ______ cfm

15 " Hg @ .007 cfm ______ " Hg @ ______ cfm

Inject SO² @ 100 cc/min. Nozzle : Probe @ 3/8 " od Initial Volume: 1,500

ROTO: PRESS:	.16		SAMPLING RATIO: 21		: 1		BP: 30.42		
MIN	TIME	METER READING	SAMPLE MDCF	STACK DSCFM	DELTA H	METER TEMP	SO2 PPM	ROTO TEMP	PUMP VACC
120	1350	1027.786	1027.786	5.998	.13	90	575	90	2.0
125	55	1029.272	1029.272	5.998	.13	90	575	90	2.0
130	1400	1030.759	1030.759	5.998	.13	90	575	90	2.0
135	05	1032.246	1032.246	5.998	.13	90	575	90	2.0
140	10	1033.732	1033.732	5.998	.13	90	575	90	2.0
* 145	15	1035.219	1035.219	5.998	.13	90	575	90	2.0
150	20	1036.706	1036.706	5.998	.13	90	575	90	2.0
155	25	1038.193	1038.193	5.998	.13	90	575	90	2.0
160	30	1039.679	1039.679	5.998	.13	90	575	90	2.0
165	35	1041.166	1041.166	5.998	.13	90	575	90	2.0
170	40	1042.653	1042.653	5.998	.13	90	575	90	2.0
175	45	1044.139	1044.139	5.998	.13	90	575	90	2.0
ROTO PRESS:	.16		TOTALS:	71.976	1.56	1080	BP.: 30.40		
180	1450	1045.626	1045.626	5.994	.13	90	575	90	2.0
* 185	55	1047.114	1047.114	5.994	.13	90	575	90	2.0
190	1500	1048.601	1048.601	5.744	.12	90	600	90	2.0
195				17.732	.38	270			
200									
205									
210									
215									
220									
225									
230						3477			
235				252.282	6.21	89	÷39		
			TOTALS:				MAX VACC =		3.0
TOTAL Cu Ft.	60.601		TOTALS:	6.469	.159	549	AVG. BP: 30.45		

PARTICULATE CATCH / MOISTURE DATA SHEET # 3

UNIT: Jotul3CB11 RUN: 3 DATE: 1-27-2000

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	661.7	597.3	515.6	847.4
INITIAL WT	595.0	592.3	513.7	835.7
NET WT GRAMS	66.7	+5.0	1.9	11.7

TOTAL CATCH: 85.3 GRAMS H_2O

FRONT HALF

FILTER #	14F	
FINAL WT g	.7996	
INITIAL WT g	.6722	
NET WT g	.1274	

BEAKER #	41
DESC.	ACETONE
FINAL WT g	105.5514
INITIAL WT g	105.4906
NET WT g	.0608
VOL. DESC. ml	90

BACK HALF

FILTER #	14B	
FINAL WT g	.4895	
INITIAL WT g	.4306	
NET WT g	.0589	

BEAKER #	42	43	44	45	
DESC.	ACETONE	METHCHLOR	H_2O	H_2O	
FINAL WT g	104.8149	107.3981	107.8313	94.9761	
INITIAL WT g	104.6712	107.3609	107.7966	94.9403	
NET WT g	.1437	.0372	.0347	.0358	.0705
VOL. DESC ml	200	75	150	150	300

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: 11 CM Lot No.: ZB921
Back Size: 8.2 CM Lot No.: ZB911

FILTER #	FIRST WEIGHT (DATE: 11-1, BY: [illegible])	TIME	SECOND WEIGHT (DATE: 11-4, BY: [illegible])	TIME	THIRD WEIGHT (DATE: , BY:)	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		
19B	.4288	1918	.4285	1825		
20B	.4340	1919	.4340	1826		
11F	.6660	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	.6654	1840		
18F	.6693	1935	.6690	1841		
19F	.6744	1935	.6745	1842		
20F	.6654	1936	.6655	1843		

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

BALANCE ROOM ENVIRONMENTAL CONDITIONS

DATE	TIME	BY	WB	DB	% RH
11-1	1815	[illegible]		73	46
11-4	1805	[illegible]		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		
53	105.7382	2131	105.7378	1229		
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		77	47
1-23	1210	DKW		73	44

Checked by : km

Date : 1-23-00

Time : 17:40

WOODSTOVE DATA SHEET # 4-3 : CONSTANT WEIGHTS

UNIT : Jotul 3CB11 RUN : 3 DATE : 1-27-2000

Beaker #	Date	Time	By	First Weight	Date	Time	By	Second Weight	Date	Time	By	Third Weight	Date	Time	By
41	1-28	1100	KW	105.5510	1-29	2114	KW	105.5514	1-30	2212	KW				
42	1-28	1740	KW	104.8147	1-29	2115	KW	104.8149	1-30	2213	KW				
43	1-28	1740	KW	107.3979	1-29	2116	KW	107.3981	1-30	2215	KW				
44	1-28	1740	KW	107.8318	1-29	2118	KW	107.8313	1-30	2216	KW				
45	1-28	1740	KW	94.9761	1-29	2119	KW	94.9761	1-30	2217	KW				

Filter #	Date	Time	By	First Weight	Date	Time	By	Second Weight	Date	Time	By	Third Weight	Date	Time	By
14F	1-27	1545	CJ	.8000	1-28	2142	KW	.7996	1-29	2120	KW				
14B	1-27	1545	CJ	.4910	1-28	2143	KW	.4899	1-29	2121	KW	.4895	1-30	2218	KW

SCALE ROOM ENVIRONMENTAL CONDITIONS

Weighing Session	Date	Time	By	WB	DB	%RH
1	1-28	2125	KW		77	43
2	1-29	2100	KW		77	39
3	1-30	2210	KW		77	39
4						

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

Dates: From 10-10-99
Through 1-15-2000

WOODSTOVE DATA SHEET #4-4
SCALE QA SHEET

Scale: Sartorius
Model: A1205
SN: 37010004

100g weight	10 g weight	1.0 g weight	100 mg weight	Tech	Date	Time	Dry Bulb	Wet Bulb	%.RH	
99.9998	10.0000	1.0000	.0999	DKW	10-10	1835	77		46	
100.0001	9.9999	.9999	.1000	DKW	10-11	1030	75		48	
100.0001	10.0000	1.0000	.1000	DKW	10-13	1640	77		47	
99.9999	9.9999	1.0001	.0998	DKW	10-13	2020	78		48	
99.9999	10.0001	1.0001	.1000	DKW	10-14	0805	77		44	
100.0001	10.0001	1.0000	.1001	DKW	10-14	1855	77		44	
100.0002	10.0002	1.001	.1001	DKW	10-15	0830	78		45	
100.0000	9.9999	.9996	.0998	CK	10/15	1545	76		48	
100.0001	10.0001	1.0000	.1001	CK	10/16	1140	76		47	
99.9997	9.9998	1.0000	.0999	DKW	10-28	1735	77		48	
100.0001	10.0000	.9998	.0999	DKW	11-1	1815	73		46	
99.9998	9.9998	.9998	.0997	DKW	11-4	1805	76		46	
99.9999	9.9999	.9999	.1000	DKW	11-23	1800	78		49	
99.9999	9.9997	.9998	.0999	DKW	11-24	1905	77		49	
100.0000	9.9997	1.0000	.0998	DKW	11-26	1735	75		43	
100.0000	9.9998	.9998	.0998	DKW	11-27	1555	78		48	
100.0000	9.9998	1.0001	.1002	DKW	11-28	1540	78		44	
100.0000	9.9999	1.0000	.0999	DKW	12-22	1935	77		47	
100.0001	10.0000	.9999	.0999	DKW	12-23	1945	75		48	
99.9999	9.9999	.9999	.0998	DKW	12-24	1945	76		45	
100.0002	10.0000	1.0000	.1000	DKW	12-25	1740	75		38	MERRY X-MAS
99.9999	10.0000	.9999	.0999	DKW	12-27	1210	76		46	
100.0000	9.9998	.9999	.1000	DKW	12-27	1900	77		47	
99.9998	9.9999	.9998	.0999	DKW	12-28	1750	78		46	
100.0001	9.9999	1.0000	.0997	DKW	12-29	1855	78		46	
100.0000	9.9999	1.0000	.0998	DKW	12-30	1940	78		47	
100.0000	9.9998	.9999	.1001	DKW	12-31	1410	75		37	HAPPY NEW YEAR!
99.9999	9.9999	1.0000	.0999	DKW	1-1	1850	78		39	
100.0000	9.9997	.9998	.1000	DKW	1-2	1335	75		39	
100.0000	9.9999	1.0000	.0998	DKW	1-2	2035	75		39	
100.0002	10.0000	.9998	.0999	DKW	1-8	1820	77		49	
100.0000	9.9998	1.0000	.1000	DKW	1-9	2125	72		44	
100.0001	10.0001	1.0000	.0998	DKW	1-10	1420	73		43	
100.0001	10.0000	.9998	.0999	DKW	1-11	1255	72		44	
100.0001	10.0002	.9999	.1000	DKW	1-11	1830	78		44	
100.0000	10.0002	.9999	.0999	DKW	1-12	1230	79		43	
100.0000	9.9999	.9999	.0999	DKW	1-13	2135	71		44	
100.0000	10.0000	.9999	.0997	DKW	1-15	1835	71		40	

Dates: From 1-17-2000
Through______________

WOODSTOVE DATA SHEET #4-4
SCALE QA SHEET

Scale: Sartorius
Model: A1205
SN : 37010004

100g weight	10 g weight	1.0 g weight	100 mg weight	Tech	Date	Time	Wet Bulb	Dry Bulb	% RH
100.0002	9.9999	1.0000	.0998	DKW	1-17	1850		72	38
100.0000	9.9997	.9999	.0999	DKW	1-21	2115		77	47
100.0001	10.0001	.9999	.0998	DKW	1-23	1210		73	44
100.0001	9.9998	1.0000	.0999	DKW	1-26	1805		78	49
100.0000	9.9999	1.0000	.1000	DKW	1-27	1545		78	48
99.9999	9.9998	1.0001	.1000	DKW	1-28	2125		77	43
100.0001	10.0000	.9999	.1000	DKW	1-29	2100		77	39
100.0000	9.9999	.9999	.1001	DKW	1-30	2210		77	39
99.9999	9.9998	1.0000	.1001	DKW	1-31	1550		77	43

BLANK PROCESSING DATA SHEET # 5

UNIT : Jotul #3CB II RUN : 3 DATE : 1-27-00

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 : NW DATE : 12-23 BY : NW 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 : NW DATE : 12-25 BY : NW DATE : 12-27 BY : NW

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	NW		77	47
12-23	1945	NW		75	48

FINAL QC

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

NET PARTICULATE CATCH CALCULATION DATA SHEET #6

UNIT: Jotul #3CB II RUN: 3 DATE: 1-27-00

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: .1274 (Total Catch) g - 1 (# of Filters) (.0000 g) (Blank Value / Filter) = .1274 g

BEAKERS: .0608 (Total Catch) g - 90 (ml Acetone) (.000004 g) (Blank Value / ml Acetone) = .0604 g

TOTAL FRONT HALF CATCH: .1878 g

BACK HALF CATCH

FILTERS: .0589 (Total Catch) g - 1 (# of Filters) (.0000 g) (Blank Value / Filter) = .0589 g

BEAKERS:

Acetone: .1437 (Total Catch) g - 200 (ml Acetone) (.000004 g) (Blank Value / ml Acetone) = .1429 g

Extract: .0372 (Total Catch) g - 75 (ml Dichloromethane) .0011 (.000015 g) (Blank Value / Dichloromethane) = .0361 g

Water: .0705 (Total Catch) g - 300 (ml Water) (.000008 g) (Blank Value / Water) = .0681 g

TOTAL BACK HALF CATCH: .3060 g

TOTAL CATCH: .4938 g

% FRONT HALF: 38.03 %

CALCULATIONS DATA SHEET # 7

UNIT : Jotul #3CB II RUN : 3 DATE : 1-27-00

1) Vm (std) = $\dfrac{(60.601 \text{ Vm})(17.64)(.989 \text{ mcf})\left(30.45\text{" Hg} + \dfrac{.159\text{" } H_2O}{13.6}\right)}{(549 \text{ TmA})} = \dfrac{58.6619}{000.0000}$ dscf

2) Vw (std) = (.04707) (85.3 ml H_2O) = $\dfrac{4.0151}{00.0000}$ scf

3) Asw = $\dfrac{(4.0151 \text{ scf})}{(4.0151 \text{ scf} + 58.6619 \text{ dscf})} = \dfrac{.0641}{.0000}$ Bws × 100 = $\dfrac{6.4060}{00.0000}$ % H_2O

4) Cs = $\dfrac{(.4938 \text{ g.})}{(58.6619 \text{ dscf})}$ (15.43) = $\dfrac{.1299}{0.0000}$ gr / dscf

5) Estimated g / hr = $\dfrac{(.4938 \text{ g.})}{(58.6619 \text{ dscf})}\left(\dfrac{6.469}{00.0000} \text{ dscfm}\right)(60) = \dfrac{3.2673}{00.0000}$ 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 : Jotul #3CB II RUN : 3 DATE : 1-27-00

Test Chamber Air Velocity Start : ϕ Stop : 0 Avg.: 0

Wet Bulb / Dry Bulb
Pre : WB : 60 DB : 78 = 33 % RH 1.1 % H_2O
Post : WB : 61 DB : 79 = 33 % RH 1.1 % H_2O

Average : 33 %RH 1.1 % H_2O

Empty Stove Weight (lbs) : — w/ stack & oil seal : Wet : — Dry : 356.8

Kindling Weight (lbs) : Paper : .2 Wood : 1.8

Preburn Fuel Weight : 9.5 + 10.2 + 8.6 + 10.4 Total : 38.7

Kindling & Preburn Fuel Weight (wood only) (lbs) : Total : 40.5

Coal Bed Wt Range (lbs) : 2.0 - 1.7 Scale : 358.8 - 358.5

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 : 2.0

Maximum Coal Bed Removal (lbs) : ((2.0 (Upper) + 1.7 (Lower)) ÷ 2) .25 = .4

Test Fuel (.75" x 1.5" x 5" spacers) = 16 pcs

Dimensions	Length in inches	No. Pcs	Weight in lbs	% of Load
2" x 4"	14.5	4	8.1	100.0
4" x 4"	—	—	—	—

Test Fuel Weight : 8.1 lbs

Estimated Dry Burn Rate :

$$\frac{8.1 - (8.1 \times .18228)}{2.2046} \times \frac{60}{190 \text{ (TIME)}} = .949 \text{ kg / hr}$$

1.476

Estimated BTU's/hr : $19{,}140 \times \frac{63}{100} \times \frac{.949}{\text{DBR}} = 11{,}443.23$ BTU's/hr

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

WOOD STOVE OPERATING DATA PAGE #9

Unit: JOTUL #3CB II Run: 3 Date: 1-27-00

FIRE STARTED: 0720

WARM UP AND PREBURN:

PRIMARY AIR : Set wide open for all warm-up / preburn fuel charges. Then set to (3.5") 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 25 sec.

TEST:

DOOR wide open during loading Ø min. 45 sec.

PRIMARY AIR : Opened full for first 5 min., then set to run setting of (3.5")

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 15 or 9 inches.

1st warm up / pre-burn fuel charge (9.5 lbs.) added at 0735

2nd warm up / pre-burn fuel charge (10.2 lbs.) added at 0815

3rd warm up / pre-burn fuel charge (8.6 lbs.) added at 0905

4th warm up / pre-burn fuel charge (10.4 lbs.) added at 1005

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

TEST DATA SHEET #10

Unit: Jotul #3CBII Run: 3 Date: 1-27-00

Room Temperature: 69 °F Correction Factor: Ø

Uncorrected Values are corrected for room temperature: Yes____ No ✓

Time Test Fuel moisture reading taken: 1015

Calibration Checks: X ✓ Y ✓ 12.0 12.1 22.0 22.1

pc #	Dimen.	Use	TOP Uncor	TOP Cor.	BOTTOM Uncor.	BOTTOM Cor.	SIDE Uncor.	SIDE Cor.	Avg Corrected
1	2"×4"×8'	K	8.5	8.9	9.0	9.5	10.5	11.1	9.833
2									
3									
4	2"×4"×8'	P	18.5	19.8	17.5	18.7	18.5	19.8	19.433
5	2"×4"×8'	P	22.0	23.7	22.5	21.4	22.0	23.7	22.933
6	2"×4"×8'	P	20.0	21.4	21.0	22.5	21.5	23.1	22.333
7	2"×4"×8'	P							64.699
8	2"×4"×8'	P							
9									
10									
11									
12	2"×4"×14½"	T	18.0	19.2	18.0	19.2	18.5	19.8	19.400
13	2"×4"×14½"	T	19.5	20.9	20.0	21.4	19.5	20.9	21.067
14	2"×4"×14½"	T	22.0	23.7	21.5	23.1	22.0	23.7	23.500
15	2"×4"×14½"	T	23.5	25.2	23.5	25.2	23.5	25.2	25.200
16									89.167
17									
18									
19									
20	Spacers	T	18.0	19.2	18.0	19.2	18.5	19.8	19.400

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

	KINDLING	PRETEST FUEL	TEST FUEL
Dry Moisture %:	9.833 %	21.566 %	22.292 %
Wet Moisture %:	8.953 %	17.740 %	18.228 %

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: 358

UNIT: JOTUL #3CB II

GAS DATA SHEET # 12

RUN: 3 DATE: 1-27-00 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	1150	366.9	8.1	—	.258	6.4	.539	13.5	.076	.70	9.3					298	-.038	550
5	55	366.7	7.9	.2	.314	7.8	.526	13.2	.034	.33	23.5					478	-.048	275
10	1200	366.0	7.2	.7	.139	3.5	.651	16.3	.071	.71	4.9					296	-.041	575
15	05	365.6	6.8	.4	.130	3.2	.637	15.9	.092	.92	3.5					264	-.037	625
20	10	365.4	6.6	.2	.163	4.1	.610	15.3	.088	.88	4.6					254	-.036	625
25	15	365.2	6.4	.2	.395	9.9	.437	10.9	.067	.67	14.8					337	-.044	550
30	20	364.7	5.9	.5	.346	8.6	.449	11.2	.076	.76	11.4					351	-.045	530
35	25	364.0	5.2	.7	.384	9.6	.424	10.6	.051	.51	19.0					377	-.047	525
40	30	363.5	4.7	.5	.400	10.0	.410	10.2	.060	.60	16.8					389	-.048	500
45	35	363.1	4.3	.4	.422	10.5	.399	10.0	.018	.17	60.6					399	-.049	475
50	40	362.6	3.8	.5	.433	10.8	.388	9.7	.021	.20	53.0					409	-.049	450
55	45	362.2	3.4	.4	.424	10.6	.388	9.7	.057	.57	18.8					405	-.049	475
TOTAL		*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	4257	-.531	*****
60	1250	361.8	3.0	.4	.382	9.5	.433	10.8	.010	.09	101.5					388	-.047	475
65	55	361.4	2.6	.4	.370	9.2	.429	10.7	.012	.11	81.1					370	-.046	475
70	1300	361.1	2.3	.3	.391	9.8	.412	10.3	.025	.24	40.0					358	-.045	500
75	05	360.8	2.0	.3	.370	9.2	.426	10.6	.031	.30	30.4					353	-.045	500
80	10	360.6	1.8	.2	.349	8.7	.437	10.9	.027	.26	33.0					345	-.044	500
85	15	360.5	1.7	.1	.292	7.3	.492	12.3	.054	.54	13.6					321	-.041	525
90	20	360.3	1.5	.2	.248	6.2	.527	13.2	.090	.90	6.9					294	-.038	575
95	25	360.2	1.4	.1	.249	6.2	.527	13.2	.087	.87	7.2					360	-.036	575
100	30	360.1	1.3	.1	.246	6.1	.529	13.2	.097	.97	6.4					272	-.035	575
105	35	360.0	1.2	.1	.247	6.2	.529	13.2	.097	.97	6.4					267	-.034	575
110	40	359.9	1.1	.1	.251	6.3	.525	13.1	.100	1.00	6.3					260	-.033	575
115	45	359.8	1.0	.1	.244	6.1	.529	13.2	.114	1.14	5.4					255	-.032	575
TOTAL		*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	3843	-.476	*****
TOTAL		*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	8100	-1.007	*****

WEIGHT : 358.0

UNIT : JOTUL # 3CBII

GAS DATA SHEET # 12

RUN : 3 DATE : 1-27-00 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 1350	359.8	1.0	Ø	.236	5.9	.532	13.3	.131	1.31	4.5					250	-.031	575
125 55	359.7	.9	.1	.225	5.6	.535	13.4	.157	1.57	3.6					247	-.031	575
130 1400	359.7	.9	Ø	.220	5.5	.536	13.4	.165	1.65	3.3					242	-.030	575
135 05	359.6	.8	.1	.222	5.5	.534	13.4	.151	1.51	3.7					239	-.030	575
140 10	359.5	.7	.1	.211	5.3	.535	13.4	.157	1.57	3.6					236	-.030	575
145 15	359.4	.6	.1	.207	5.2	.532	13.3	.160	1.60	3.2					233	-.029	575
150 20	359.3	.5	.1	.198	4.9	.528	13.2	.172	1.72	2.9					231	-.029	575
155 25	359.2	.4	.1	.195	4.9	.527	13.2	.159	1.59	3.1					228	-.029	575
160 30	359.1	.3	.1	.178	4.4	.525	13.1	.185	1.85	2.4					224	-.028	575
165 35	359.1	.3	Ø	.172	4.3	.522	13.1	.183	1.83	2.3					222	-.028	575
170 40	359.1	.3	Ø	.166	4.1	.521	13.0	.189	1.89	2.2					219	-.027	575
175 45	359.0	.2	.1	.161	4.0	.518	13.0	.184	1.84	2.2					217	-.027	575
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	2788	-.349	*****
180 1450	359.0	.2	Ø	.155	3.9	.514	12.9	.187	1.87	2.1					213	-.027	575
185 55	358.9	.1	.1	.157	3.9	.510	12.8	.190	1.90	2.1					212	-.026	575
190 1500	358.8	Ø	.1	.156	3.9	.507	12.7	.189	1.89	2.1					210	-.026	600
195 05																	
200 10																	
205 15																	
210 20																	
215 25																	
220 30																	
225 35																	
230 40															635	-.079	
235 45															3423	.428	÷39
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	11523	1.435	*****
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	295	-.037	*****

PREBURN DATA SHEET #13

UNIT: Jotul #3CB II RUN: 3 DATE: 1-27-00 PAGE: 1 of 1

TIME	SCALE	DROP	STACK	TOP	LF SIDE	BACK	RT SIDE	BOTTOM	FIREBOX	SEC/CAT	AMBIENT	STATIC	COMMENTS
0 / 1045	359.6	—	725	645	427	526	502	658	1146	1394	76	-.063	PREBURN START: # .8 UP
5 / 50	359.4	.2	476	607	430	499	501	660	1146	1271	78	.056	COAL BED SCALE RANGE:
10 / 55	359.2	.2	419	549	425	465	489	657	1132	1153	80	-.052	358.8 → 358.5
15 / 1100	359.0	.2	380	499	412	435	467	652	1095	1054	78	.048	PRIMARY AIR: (3.5")
20 / 05	358.9	.1	353	463	405	415	452	645	1068	972	78	.047	SECONDARY AIR: N/A
25 / 10	358.9	0	378	440	394	394	439	638	1045	950	78	-.046	FAN: N/A
30 / 15	360.3	.1	358	408	377	372	421	627	984	1155	79	-.043	PUMPS ON AT: 1125 -
35 / 20	360.0	.3	346	413	366	359	408	616	939	1124	76	-.045	CHECK WB/DB: N/A
40 / 25	359.7	.3	334	404	356	348	397	600	907	1112	77	-.043	~~ADDED~~ 1.5 @ 1113
45 / 30	359.4	.3	322	395	342	336	386	581	876	1067	76	.041	
50 / 35	359.2	.2	316	382	332	325	375	563	852	1075	76	-.041	
55 / 40	359.1	.1	312	379	326	320	367	549	838	1127	76	-.040	
*****	****	***	****	*****	*****	****	*****	*****	*****	*****	*****	****	
60 / 45	358.9	.2	304	372	318	315	362	537	825	959	76	-.039	
65 / 1150	358.8	.1	298	363	309	308	357	524	815	944	76	-.038	ΔT 372.2 -

UNIT: Jotul #3CB II

TEMPERATURE DATA SHEET # 14

RUN: 3 DATE: 1-27-00

TIME	TOP	LT SIDE	BACK	RT SIDE	BOTTOM	FIREBOX	SEC/CAT	AMBIENT	FURNACE	SAMPLE	SAMP IMP	C-GAS	GAS IMP	SO_2 IMP	372.2
0 / 1150	363	309	308	357	524	815	944	76	1270	257	56	254	36	37	
5 / 55	362	304	298	349	516	729	1222	76	1286	246	50	249	36	36	
10 / 1200	353	294	289	336	509	642	656	75	1311	246	49	247	35	36	
15 / 05	315	282	268	319	492	648	623	75	1334	247	45	246	36	38	
20 / 10	296	271	256	308	479	638	696	75	1336	247	44	245	36	37	
25 / 15	342	262	252	294	458	644	1130	75	1338	248	44	245	38	37	
30 / 20	385	260	261	286	445	682	1089	74	1341	250	44	245	37	35	
35 / 25	417	266	276	282	428	728	1207	75	1347	251	42	245	35	35	
40 / 30	442	277	295	283	412	771	1328	75	1352	251	42	244	36	34	
45 / 35	462	284	306	287	404	797	1289	75	1353	252	42	244	35	34	
50 / 40	481	293	319	293	396	820	1334	76	1343	250	42	246	36	35	
55 / 45	483	300	329	301	389	835	1356	76	1333	249	42	245	34	36	
TOTAL	4701	3402	3457	3695	5452	8799	12874	903	*****	*****	*****	*****	*****	*****	
60 / 1250	480	305	332	308	385	842	1335	76	1327	249	42	245	35	36	
65 / 55	473	312	339	316	382	852	1178	77	1323	248	42	246	34	36	
70 / 1300	461	313	343	323	381	866	1228	76	1324	248	43	246	34	36	
75 / 05	455	316	344	326	381	868	1145	77	1324	248	43	246	35	36	
80 / 10	446	315	348	328	383	870	1099	76	1326	248	43	245	35	36	
85 / 15	426	319	344	330	387	866	952	76	1329	247	43	245	35	36	
90 / 20	394	314	328	330	392	854	877	77	1332	247	43	245	34	35	
95 / 25	373	312	318	326	398	842	855	77	1333	247	43	244	34	35	
100 / 30	357	306	310	321	405	817	831	77	1335	247	44	245	36	35	
105 / 35	344	302	303	316	411	805	833	77	1335	246	44	244	36	35	
110 / 40	331	295	293	311	418	793	821	76	1332	245	44	243	37	36	
115 / 45	324	293	291	308	424	775	814	76	1331	245	44	243	37	35	
TOTAL	4864	3702	3893	3843	4747	10050	11968	918	*****	*****	*****	*****	*****	*****	
TOTAL	9565	7104	7350	7538	10199	18849	24842	1821	*****	*****	*****	*****	*****	*****	

TEMPERATURE DATA SHEET # 14

UNIT: JOTUL # 3CB II RUN: 3 DATE: 1-27-00 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	372.2
120 / 1350	315	287	285	304	430	759	797	76	1330	245	44	243	37	36	
125 / 55	309	283	281	302	433	748	778	76	1329	244	45	242	37	38	
130 / 1400	304	279	277	300	435	739	760	75	1328	244	45	242	36	37	
135 / 05	297	276	273	298	436	730	750	76	1327	244	45	242	36	38	
140 / 10	293	274	269	295	433	717	735	75	1330	244	45	242	36	37	
145 / 15	288	271	266	294	430	708	729	75	1331	243	45	241	36	37	
150 / 20	283	264	259	291	424	696	723	75	1332	243	46	242	37	37	
155 / 25	283	262	255	290	420	687	694	75	1332	243	46	241	36	37	
160 / 30	274	260	252	287	415	674	680	75	1333	243	46	241	37	37	
165 / 35	271	257	249	285	411	664	668	75	1334	243	46	241	37	36	
170 / 40	267	256	247	283	407	654	658	75	1335	243	46	241	36	36	
175 / 45	263	251	241	281	402	643	648	75	1336	243	47	241	35	36	
TOTAL	3447	3220	3154	3510	5076	8419	8620	903	*****	*****	*****	*****	*****	*****	
180 / 1450	257	244	235	276	392	627	628	74	1337	242	47	241	37	36	
185 / 55	253	243	233	273	385	620	626	74	1337	242	46	241	38	36	
190 / 1500	252	238	231	270	377	612	622	74	1336	242	47	241	38	37	
											372.2	–			
											273.6	–			
											-98.6	ΔT			
	762	725	699	819	1154	1859	1876	222							
	4209	3945	3853	4329	6230	10278	10496	1125	÷39						
TOTAL	13774	11049	11203	11867	16429	29127	35338	2946	*****	*****	*****	*****	*****	*****	
TOTAL	353	283	287	304	421	747	906	76	*****	*****	*****	*****	*****	*****	

ZERO / SPAN CHECK DATA SHEET #15-1

Date : 1-27-00 Analyte : CO_2 (15-1)

Source : JOTUL #3CB II Run # : 3

Zero Cyl. # : TX 79373 Conc. : 0.00 % CO_2 Cyl. Press. : 1350 PSI

Certified by : AIR LIQUIDE Date : 9/22/98

Span Cyl. # : CC 52549 Conc. : 12.4 % CO_2 Cyl. Press. : 490 PSI

Certified by : AIR LIQUIDE Date : 9/22/98

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 : 1055 Temp : 80 °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	-.201
SPAN	49.6	.496	12.4	49.4	.494	12.348	.052	.206

POST RUN Audit : by : D. Washington Time : 1525 Temp : 73 °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	.101
SPAN	49.6	.496	12.4	49.4	494	12.348	.052	.206

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

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

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

ZERO / SPAN CHECK DATA SHEET #15-2

Date : 1-27-00 Analyte : O_2 (15-2)

Source : JOTUL #3CB II Run # : 3

Zero Cyl. # : TX 79373 Conc. : 0.00 % O_2 Cyl. Press. : 1350 PSI

Certified by : AIR LIQUIDE Date : 9/22/98

Span Cyl. # : CC 52549 Conc. : 12.51 % O_2 Cyl. Press. : 490 PSI

Certified by : AIR LIQUIDE Date : 9/22/98

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 : 1055 Temp : 80 °F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.0	.002	.022	.022	.089
SPAN	12.5	.500	12.51	12.5	.501	12.524	.014	.057

POST RUN Audit : by : D Washington Time : 1525 Temp : 73 °F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.0	.001	-.003	-.003	-.011
SPAN	12.5	.500	12.51	12.5	.501	12.524	.014	.057

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

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

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

ZERO / SPAN CHECK DATA SHEET #15-3

Date : 1-27-00 Analyte : CO (15-3)

Source : JOTUL #3CB II Run # : 3

Zero Cyl. # : TX 79373 Conc. : 0.00 % CO Cyl. Press. : 1350 PSI

Certified by : AIR LIQUIDE Date : 9/22/98

Span Cyl. # : CC52549 Conc. : 5.08 % CO Cyl. Press. : 490 PSI

Certified by : AIR LIQUIDE Date : 9/22/98

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 : 1055 Temp : 80 °F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.0	.000	-.006	-.006	-.061
SPAN	50.8	.508	5.08	51.0	.510	5.102	.022	.219

POST RUN Audit : by : D. Washington Time : 1525 Temp : 73 °F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.0	.000	-.006	-.006	-.061
SPAN	50.8	.508	5.08	50.9	.509	5.092	.012	.119

± 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 : 1-27-00 Analyte : SO_2 (15-4)

Source : JOTUL #3CBII Run # : 3

Zero Cyl. # : TX 79373 Conc. : 0.00 ppm SO_2 Cyl. Press. : 1350 PSI

Certified by : AIR LIQUIDE Date : 9/22/98

Span Cyl. # : CC 67475 Conc. : 1260 ppm SO_2 Cyl. Press. : 750 PSI

Certified by : AIR LIQUIDE Date : 9/22/98

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 : 1100 Temp : 78 °F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	PPM	Meter	DVM	%		
ZERO	00.0	.000	00.0	.003	.003	12.006	12.006	.480
SPAN	50.4	.504	1260	50.8	.508	1269.271	9.271	.371

POST RUN Audit : by : D. Wadington Time : 1530 Temp : 73 °F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	PPM	Meter	DVM	%		
ZERO	00.0	.000	00.0	.004	.004	14.495	14.495	.580
SPAN	50.4	.504	1260	51.0	.510	1274.250	14.250	.570

± 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: Jotul #3CB II RUN: 3 DATE: 1-27-00

Thermocouple Check:

T/C # 1	°F	T/C # 13	61.0 °F
T/C # 2	— °F	T/C # 14	58.0 °F
T/C # 3	60.4 °F	T/C # 15	62.8 °F
T/C # 4	55.4 °F	T/C # 16	55.0 °F
T/C # 5	54.2 °F	T/C # 17	54.5 °F
T/C # 6	54.2 °F	T/C # 18	63.9 °F
T/C # 7	54.3 °F	T/C # 19	56.0 °F
T/C # 8	54.3 °F	T/C # 20	52.5 °F
T/C # 9	55.6 °F	T/C # 21	— °F
T/C # 10	55.1 °F	T/C # 22	— °F
T/C # 11	52.0 °F	T/C # 23	56.2 °F
T/C # 12	68.0 °F	T/C # 24	— °F

Thermocouple Readout:

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

ZERO: 1.2 °F Adj. to 0.0 °F — ZERO 1.0 °F Difference .050%

SPAN: 2001.4 °F Adj. to 2000.0 °F — SPAN 2001.6 °F Difference .080%

Thermocouple Readout Pretest Linearity Check

0	= 0.0 °F	200	= 201.8 °F	400	= 399.0 °F
600	= 601.3 °F	800	= 801.5 °F	1000	= 1000.5 °F
1200	= 1198.2 °F	1400	= 1399.2 °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 ✓	Post ✓

Scale Check Pre: 369.9 — 359.9

Post: 368.6 — 358.6

Stack Cleaned Prior to Test Run: YES ______ NO ✓

MINIMUM
TO 1.25

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: 1-28-00 Burn Rate: 1.118

Model No.: #3CBII

☐ 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: 160 min. (000) (Data Sheet #2)

Dry Gas Meter Volume: 52.729 cf
(00.000) (Data Sheet #2)

Stack Flow: 7.261 dscfm (00.000) (Data Sheet #2) Δ H: .169 in. H_2O (.000) (Data Sheet #2)

Barometric Pressure: 30.19 in. Hg
(00.00) (Data Sheet #2)

H_2O Captured: 78.8 g
(00.0) (Data Sheet #3)

Total Particulate Catch: .3521 g
(0.0000) (Data Sheet #6)

Flue Gas Moisture: 6.8055 %
(00.000) (Data Sheet #7)

Particulate Emission: .1070 gr/dscf
(0.0000) (Data Sheet #7)

Ambient Moisture: 1.05 %
(0.00) (Data Sheet #8)

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

Total Fuel Consumed During Burn: 8.0 lbs
(00.0) (Data sheet #8)

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

Fuel % Moisture (dry): 21.767 % (wet): 17.876 %
(00.00) (Data Sheet #10)

Stack Static Pressure: -.039 in. H_2O
(0.000) (Data Sheet #12)

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

Stove Temperature Change: -55.2 °F
(00.0) (Data Sheet #14)

TABLE 1 ----- RAW DATA

CLIENT : Jotul TEST No. : 4

MODEL: 3CBII DATE: 28-Jan-00

TIME (MIN.)	METER READING (C F)	DELTA H (IN. H2O)	METER TEMP. (DEG. F)	PERCENT CO (%)	PERCENT CO2 (%)	SO2 COCENTR. PPM
0	49.500	0.150	80	1.28	4.20	500
5	51.000	0.740	82	0.36	12.20	225
10	54.394	0.150	84	0.91	6.60	500
15	55.936	0.180	85	0.80	8.80	450
20	57.657	0.160	85	0.94	9.70	475
25	59.287	0.160	85	1.01	11.20	475
30	60.916	0.230	86	0.33	11.10	400
35	62.858	0.230	86	0.19	10.90	400
40	64.800	0.230	87	0.20	10.00	400
45	66.749	0.200	88	0.28	10.20	425
50	68.591	0.180	88	0.15	9.90	450
55	70.330	0.180	88	0.10	9.50	450
60	72.069	0.180	88	0.22	7.80	450
65	73.809	0.150	88	0.70	6.20	500
70	75.374	0.130	88	1.18	5.80	525
75	76.866	0.130	88	1.30	5.60	525
80	78.357	0.130	88	1.33	5.40	525
85	79.848	0.130	88	1.37	5.40	525
90	81.339	0.130	88	1.51	5.00	525
95	82.830	0.130	88	1.73	4.80	525
100	84.321	0.130	88	1.54	5.00	525
105	85.813	0.130	88	1.50	5.00	525
110	87.304	0.130	88	1.54	4.90	525
115	88.795	0.130	88	1.57	4.70	525
120	90.288	0.130	88	1.59	4.60	525
125	91.780	0.130	88	1.74	4.50	525
130	93.273	0.130	88	1.87	4.20	525
135	94.766	0.130	88	1.83	4.10	525
140	96.258	0.130	88	1.82	4.10	525
145	97.751	0.130	88	1.74	4.00	525
150	99.244	0.130	88	1.76	3.90	525
155	100.736	0.130	88	1.70	3.90	525
160	102.229	0.130	88	1.68	3.80	525
165						

TABLE 2---RAW DATA

CLIENT : Jotul TEST No. 4

MODEL: 3CBII DATE: 28-Jan-00

****

METER CAL. FACTOR (Y)	------ 0.989		Wt. WOOD BURNED(LB) -------	8.0	Lbs
BAROMETRIC PRESS.(Pb)	------ 30.19	in Hg	WET,FUEL MOISTURE % -------	17.876	%
LEAK RATE POST (Lp)	------ 0.011	cfm	Wt. PART. COLLECTED -------	0.3521	g
WATER VOL. (V1c)	------ 78.8	Ml	METER VOLUME Vm -------	52.729	mcf
TEST TIME (MIN)	------ 160	min	HC MOLE FRACTION -------	0.0132	

TABLE 3 -----FIELD DATA AVERAGES

CLIENT :Jotul TEST No. 4

MODEL: 3CBII DATE: 28-Jan-00

****

AVG DELTA H	-------	0.17 in H2O	AVG PRCNT CO	-------	1.14	%
AVG METER TEMP. Tm	-------	87 deg F	AVG PRCNT CO2	-------	6.58	%
AVG PPM SO2	-------	487 PPM	AVG BAL CO2/CO	-------	5.75	%

TABLE 4 ----- CALCULATIONS

CLIENT : Jotul TEST No. 4

MODEL: 3CBII DATE: 28-Jan-00

****

STD SAMPLE VOL. Vm(std) -----	50.82	dscf	STACK GAS FLOW Qsd -------	445.466	dscf/Hr
				&	
				7.42	dscf/min
VOL. WATER VAPOR Vw(std) ----	3.709	scf	PARTICULATE CONCTRT. Cs ------	0.0069	g/dscf
PRCNT MSTR Bws -------	6.80	%	PARTC.EMISS. RATE E -------	3.09	g/Hr
BURN RATE BR -------	1.12	Kg/Hr	MOLES OF GAS PER Lb WOOD Nt --	0.47	Lb-mole/Lb
CO EMISSION RATE -------	170.74	g/Hr	PART.EMISS. RATE ------	2.76	g/Kgdry fuel
	&				
	152.72	g/Kgdry fuel			

TABLE 5 ----- PROPORTIONAL RATE VARIATION

CLIENT : Jotul TEST No. : 4

MODEL: 3CBII DATE: 28-Jan-00

****

	TIME INTEVAL Ti	PPM * Vm	PROPRTN. RATE VAR. PR		PROPRTN RATE VAR. AVERAGE	
	5	730.8	97		100	
	10	742.5	99			
	15	746.5	99			
	20	749.2	100			
	25	749.0	100			
	30	747.8	100			
	35	750.2	100			
	40	749.5	100			
	45	750.8	100			
	50	753.2	100			
	55	752.9	100			
	60	752.9	100			
	65	753.3	100			
	70	752.8	100			
	75	753.5	100			
	80	753.0	100			
	85	753.0	100			
	90	753.0	100			
	95	753.0	100			
	100	753.0	100			
	105	753.5	100			
	110	753.0	100			
	115	753.0	100			
	120	754.0	100			
	125	753.5	100			
	130	754.0	100			
	135	754.0	100			
	140	753.5	100			
	145	754.0	100			
	150	754.0	100			
	155	753.5	100			
	160	754.0	100			
	165					
	170					

METER BOX DATA SHEET PAGE # 2

UNIT : JOTUL #3CBII RUN : 4 DATE : 1-28-00

Meter Box: 5H Y Factor: .989

Leak checks: 15 " Hg @ .013 cfm ______ " Hg @ ____ cfm

65 16 " Hg @ .011 cfm ______ " Hg @ ____ cfm

Inject SO² @ 100 cc/min. Nozzle: Probe @ 3/8 " od Initial Volume: 1.500

ROTO: PRESS: .17			SAMPLING RATIO: 23 : 1				BP: 30.20		
MIN	TIME	METER READING	SAMPLE MDCF	STACK DSCFM	DELTA H	METER TEMP	SO2 PPM	ROTO TEMP	PUMP VACC
0	1335	49.500	—	6.975	.15	80	500	80	1.0
5	40	51.000	—	15.442	.74	82	225	82	4.0
10	45	54.394	54.394	6.923	.15	84	500	84	1.0
15	50	55.936	55.936	7.679	.18	85	450	85	1.0
20	55	57.657	57.657	7.274	.16	85	475	85	1.0
25	1400	59.287	59.287	7.274	.16	85	475	85	1.0
30	05	60.916	60.916	8.623	.23	86	400	86	2.0
35	10	62.858	62.858	8.623	.23	86	400	86	2.0
40	15	64.800	64.800	8.607	.23	87	400	87	2.0
45	20	66.749	66.749	8.086	.20	88	425	88	2.0
50	25	68.591	68.591	7.636	.18	88	450	88	2.0
55	30	70.330	70.330	7.636	.18	88	450	88	2.0
ROTO PRESS: .17			TOTALS:	100.778	2.79	1024	BP.: 30.20		
60	1435	72.069	72.069	7.636	.18	88	450	88	2.0
65	40	73.809	73.809	6.873	.15	88	500	88	2.0
70	45	75.374	75.374	6.546	.13	88	525	88	2.0
75	50	76.866	76.866	6.546	.13	88	525	88	2.0
80	55	78.357	78.357	6.546	.13	88	525	88	2.0
85	1500	79.848	79.848	6.546	.13	88	525	88	2.0
90	05	81.339	81.339	6.546	.13	88	525	88	2.0
95	10	82.830	82.830	6.546	.13	88	525	88	2.0
100	15	84.321	84.321	6.546	.13	88	525	88	2.0
105	20	85.813	85.813	6.546	.13	88	525	88	2.0
110	25	87.304	87.304	6.546	.13	88	525	88	2.0
115	30	88.795	88.795	6.546	.13	88	525	88	2.0
			TOTALS:	79.969	1.63	1056	MAX VACC =		
TOTAL Cu Ft.			TOTALS:	180.747	4.42	2080	AVG. BP:		

METER BOX DATA SHEET PAGE # 2

UNIT: Jotul #3CBII RUN: 4 DATE: 1-28-00

Meter Box: 5H Y Factor: .989

Leak checks: 15 " Hg @ .013 cfm ______ " Hg @ ______ cfm

16 " Hg @ .011 cfm ______ " Hg @ ______ cfm

Inject SO² @ 100 cc/min. Nozzle : Probe @ 3/8 " od Initial Volume: 1.500

ROTO: PRESS: .16			SAMPLING RATIO: 23 : 1				BP: 30.17		
MIN	TIME	METER READING	SAMPLE MDCF	STACK DSCFM	DELTA H	METER TEMP	SO2 PPM	ROTO TEMP	PUMP VACC
120	1535	90.288	90.288	6.539	.13	88	525	88	2.0
125	40	91.780	91.780	6.539	.13	88	525	88	2.0
130	45	93.273	93.273	6.539	.13	88	525	88	2.0
135	50	94.766	94.766	6.539	.13	88	525	88	2.0
140	55	96.258	96.258	6.539	.13	88	525	88	2.0
* 145	1600	97.751	97.751	6.539	.13	88	525	88	2.0
150	05	99.244	99.244	6.539	.13	88	525	88	2.0
155	10	100.736	100.736	6.539	.13	88	525	88	2.0
160	15	102.229	102.229	6.539	.13	88	525	88	2.0
165									
170									
175				58.851	1.17	792			
ROTO PRESS:			TOTALS:				BP.:		
180									
185									
190									
195									
200									
205									
210			÷33						
215									
220									
225									
230									
235				239.598	5.59	2872			
			TOTALS:			87	MAX VACC =		4.0
TOTAL Cu Ft.	52.729		TOTALS:	7.261	.169	547	AVG. BP:	30.19	

PARTICULATE CATCH / MOISTURE DATA SHEET # 3

UNIT : Jotul 3CBII RUN : 4 DATE : 1-28-2000

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	654.4	601.4	515.3	856.8
INITIAL WT	601.3	597.3	503.8	846.7
NET WT GRAMS	53.1	4.1	11.5	10.1

TOTAL CATCH : 78.8 GRAMS H_2O

FRONT HALF

FILTER #	15F	
FINAL WT g	.7492	
INITIAL WT g	.6674	-
NET WT g	.0818	-

BEAKER #	46
DESC.	ACETONE
FINAL WT g	106.1090
INITIAL WT g	106.0513
NET WT g	.0577
VOL. DESC. ml	80

BACK HALF

FILTER #	15B	
FINAL WT g	.4604	
INITIAL WT g	.4313	-
NET WT g	.0291	-

BEAKER #	47	48	49	50	
DESC.	ACETONE	METHCHLOR	H_2O	H_2O	
FINAL WT g	107.1491	97.7885	108.3823	96.5571	
INITIAL WT g	107.0390	97.7534	108.3602	96.5364	
NET WT g	.1101	.0351	.0221	.0207	.0428
VOL. DESC ml	175	75	150	145	295

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: 11CM Lot No.: ZB921

Back Size: 8.2CM Lot No.: ZB911

FILTER #	FIRST WEIGHT (DATE: 11-1, BY: MG)	TIME	SECOND WEIGHT (DATE: 11-4, BY: MG)	TIME	THIRD WEIGHT (DATE: , BY:)	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		
19B	.4288	1918	.4285	1825		
20B	.4340	1919	.4340	1826		

11F	.6660	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	.6654	1840		
18F	.6693	1935	.6690	1841		
19F	.6744	1935	.6745	1842		
20F	.6654	1936	.6655	1843		

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

BALANCE ROOM ENVIRONMENTAL CONDITIONS

DATE	TIME	BY	WB	DB	% RH
11-1	1815	MG		73	46
11-4	1805	MG		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		
53	105.7382	2131	105.7378	1229		
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		77	47
1-23	1210	DKW		73	44

Checked by : TM
Date : 1-23-00
Time : 17:40

WOODSTOVE DATA SHEET # 4-3 : CONSTANT WEIGHTS

UNIT: Jotul #3CB1) RUN: 4 DATE: 1-28-2000

Beaker #	Date	Time	By	First Weight	Date	Time	By	Second Weight	Date	Time	By	Third Weight	Date	Time	By
46	1-29	1150	BW	106.1086	1-30	2220	BW	106.1090	1-31	1553	BW				
47	1-29	2044	BW	107.1488	1-30	2221	BW	107.1491	1-31	1554	BW				
48	1-29	2044	BW	97.7882	1-30	2222	BW	97.7885	1-31	1555	BW				
49	1-29	1150	BW	108.3820	1-30	2223	BW	108.3823	1-31	1556	BW				
50	1-29	1150	BW	96.5566	1-30	2225	BW	96.5571	1-31	1557	BW				

Filter #	Date	Time	By	First Weight	Date	Time	By	Second Weight	Date	Time	By	Third Weight	Date	Time	By
15F	1-28	1700	CP	.7493	1-29	2123	BW	.7492	1-30	2226	BW				
15B	1-28	1700	CP	.4609	1-29	2124	BW	.4604	1-30	2227	BW				

SCALE ROOM ENVIRONMENTAL CONDITIONS

Weighing Session	Date	Time	By	WB	DB	%RH
1	1-29	2100	BW		77	39
2	1-30	2210	BW		77	39
3	1-31	1550	BW		77	43
4						

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

Dates: From 10-10-99
Through 1-15-2000

WOODSTOVE DATA SHEET #4-4
SCALE QA SHEET

Scale: Sartorius
Model: A1205
SN : 37010004

100g weight	10 g weight	1.0 g weight	100 mg weight	Tech	Date	Time	Dry Bulb	Wet Bulb	%.RH
99.9998	10.0000	1.0000	.0999	DKW	10-10	1835	77		46
100.0001	9.9999	.9999	.1000	DKW	10-11	1030	75		48
100.0001	10.0000	1.0000	.1000	DKW	10-13	1640	77		47
99.9999	9.9999	1.0001	.0998	DKW	10-13	2020	78		48
99.9999	10.0001	1.0001	.1000	DKW	10-14	0805	77		44
100.0001	10.0001	1.0000	.1001	DKW	10-14	1855	77		44
100.0002	10.0002	1.001	.1001	DKW	10-15	0830	78		45
100.0000	9.9999	.9996	.0998	CK	10/15	1545	76		48
100.0001	10.0001	1.0000	.1001	CK	10/16	1140	76		47
99.9997	9.9998	1.0000	.0999	DKW	10-28	1735	77		48
100.0001	10.0000	.9998	.0999	DKW	11-1	1815	73		46
99.9998	9.9998	.9998	.0997	DKW	11-4	1805	76		46
99.9999	9.9999	.9999	.1000	DKW	11-23	1800	78		49
99.9999	9.9997	.9998	.0999	DKW	11-24	1905	77		49
100.0000	9.9997	1.0000	.0998	DKW	11-26	1735	75		43
100.0000	9.9998	.9998	.0998	DKW	11-27	1555	78		48
100.0000	9.9998	1.0001	.1002	DKW	11-28	1540	78		44
100.0000	9.9999	1.0000	.0999	DKW	12-22	1935	77		47
100.0001	10.0000	.9999	.0999	DKW	12-23	1945	75		48
99.9999	9.9999	.9999	.0998	DKW	12-24	1945	76		45
100.0002	10.0000	1.0000	.1000	DKW	12-25	1740	75		38
99.9999	10.0000	.9999	.0999	DKW	12-27	1210	76		46
100.0000	9.9998	.9999	.1000	DKW	12-27	1900	77		47
99.9998	9.9999	.9998	.0999	DKW	12-28	1750	78		46
100.0001	9.9999	1.0000	.0997	DKW	12-29	1855	78		46
100.0000	9.9999	1.0000	.0998	DKW	12-30	1940	78		47
100.0000	9.9998	.9999	.1001	DKW	12-31	1410	75		37
99.9999	9.9999	1.0000	.0999	DKW	1-1	1850	78		39
100.0000	9.9997	.9998	.1000	DKW	1-2	1335	75		39
100.0000	9.9999	1.0000	.0998	DKW	1-2	2035	75		39
100.0002	10.0000	.9998	.0999	DKW	1-8	1820	77		49
100.0000	9.9998	1.0000	.1000	DKW	1-9	2125	72		44
100.0001	10.0001	1.0000	.0998	DKW	1-10	1420	73		43
100.0001	10.0000	.9998	.0999	DKW	1-11	1255	72		44
100.0001	10.0002	.9999	.1000	DKW	1-11	1830	78		44
100.0000	10.0002	.9999	.0999	DKW	1-12	1230	79		43
100.0000	9.9999	.9999	.0999	DKW	1-13	2135	71		44
100.0000	10.0000	.9999	.0999	DKW	1-15	1835	71		40

MERRY X-MAS

HAPPY NEW YEAR!

Dates: From 1-17-2000
Through ____________

WOODSTOVE DATA SHEET #4-4
SCALE QA SHEET

Scale: Sartorius
Model: A1205
SN : 37010004

100g weight	10 g weight	1.0 g weight	100 mg weight	Tech	Date	Time	Wet Bulb	Dry Bulb	% RH
100.0002	9.9999	1.0000	.0998	DKW	1-17	1850		72	38
100.0000	9.9997	.9999	.0999	DKW	1-21	2115		77	47
100.0001	10.0001	.9999	.0998	DKW	1-23	1210		73	44
100.0001	9.9998	1.0000	.0999	DKW	1-26	1805		78	49
100.0000	9.9999	1.0000	.1000	DKW	1-27	1545		78	48
99.9999	9.9998	1.0001	.1000	DKW	1-28	2125		77	43
100.0001	10.0000	.9999	.1000	DKW	1-29	2100		77	39
100.0000	9.9999	.9999	.1001	DKW	1-30	2210		77	39
99.9999	9.9998	1.0000	.1001	DKW	1-31	1550		77	43

BLANK PROCESSING DATA SHEET # 5

UNIT : Jotul #3CB II RUN : 4 DATE : 1-28-00

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 : NW DATE : 12-23 BY : NW 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 : NW DATE : 12-25 BY : NW DATE : 12-27 BY : NW

BEAKER	1 ST WT	TIME	2 ND WT	TIME	3 RD WT	TIME
A	108.8999	2021	108.9016	1816	108.9011	1224 ✓
B	106.3066	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	NW		77	47
12-23	1945	NW		75	48

FINAL QC

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

NET PARTICULATE CATCH CALCULATION DATA SHEET #6

UNIT : Jotul #3CB II RUN : 4 DATE : 1-28-00

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 : .0818 g (Total Catch) - 1 (# of Filters) (.0000 g) (Blank Value / Filter) = .0818 g

BEAKERS : .0577 g (Total Catch) - 80 (ml Acetone) (.000004 g) (Blank Value / ml Acetone) = .0574 g

TOTAL FRONT HALF CATCH : .1392 g

BACK HALF CATCH

FILTERS : .0291 g (Total Catch) - 1 (# of Filters) (.0000 g) (Blank Value / Filter) = .0291 g

BEAKERS :

Acetone : .1101 g (Total Catch) - 175 (ml Acetone) (.000004 g) (Blank Value / ml Acetone) = .1094 g

Extract : .0351 g (Total Catch) - 75 (ml Dichloromethane) .0011 (.000015 g) (Blank Value / Dichloromethane) = .0340 g

Water : .0428 g (Total Catch) - 295 (ml Water) (.000008 g) (Blank Value / Water) = .0404 g

TOTAL BACK HALF CATCH : .2129 g

TOTAL CATCH : .3521 g

% FRONT HALF : 39.53 %

CALCULATIONS DATA SHEET # 7

UNIT : Jotul #3CB II RUN : 4 DATE : 1-28-00

1) Vm (std) = $\dfrac{(52.729\ \text{Vm})(17.64)(.989\ \text{mcf})\left(30.19\ \text{" Hg} + \dfrac{.169\ \text{" H}_2\text{O}}{13.6}\right)}{(547\ \text{TmA})}$ = $\dfrac{50.7924}{000.0000}$ dscf

30.2024

2) Vw (std) = (.04707) (78.8 ml H_2O) = $\dfrac{3.7091}{00.0000}$ scf

3) Asw = $\dfrac{(3.7091\ \text{scf})}{(3.7091\ \text{scf} + 50.7924\ \text{dscf})}$ = $\dfrac{.0681}{.0000}$ Bws × 100 = $\dfrac{6.8055}{00.0000}$ % H_2O

54.5015

4) Cs = $\dfrac{(.3521\ \text{g.})}{(50.7924\ \text{dscf})}$ (15.43) = $\dfrac{.1070}{0.0000}$ gr / dscf

5) Estimated g / hr = $\dfrac{(.3521\ \text{g.})}{(50.7924\ \text{dscf})}$ ($\dfrac{7.261}{00.0000}$ dscfm) (60) = $\dfrac{3.0201}{00.0000}$ 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 : Jotul #3CB II RUN : 4 DATE : 1-28-00

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

Wet Bulb / Dry Bulb
Pre : WB : 61 DB : 80 = 32 % RH 1.1 % H_2O
Post : WB : 60 DB : 80 = 29 % RH 1.0 % H_2O

Average : 30.5 %RH 1.05 % H_2O

Empty Stove Weight (lbs) : — w/ stack & oil seal : Wet : — Dry : 356.4

Kindling Weight (lbs) : Paper : .1 Wood : 1.3

Preburn Fuel Weight : 10.5 + 6.8 + 7.6 + 9.5 Total : 34.4

Kindling & Preburn Fuel Weight (wood only) (lbs) : Total : 35.7

Coal Bed Wt Range (lbs) : 2.0 - 1.6 Scale : 358.4 - 358.0

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 : 1.9

Maximum Coal Bed Removal (lbs) : ((2.0 (Upper) + 1.6 (Lower)) ÷ 2) .25 = .4

Test Fuel (.75" x 1.5" x 5" spacers) = 16 pcs

Dimensions	Length in inches	No. Pcs	Weight in lbs	% of Load
2" x 4"	14.5	4	8.0	100.0
4" x 4"	—	—	—	—

Test Fuel Weight : 8.0 lbs

Estimated Dry Burn Rate : 1,430

$$\frac{8.0 - (8.0 \times .17876)}{2.2046} \times \frac{60}{160 \text{ (TIME)}} = 1.118 \text{ kg / hr}$$

Estimated BTU's/hr : $19{,}140 \times \frac{63}{100} \times \frac{1.118}{\text{DBR}} = 13481.07$ BTU's/hr

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

WOOD STOVE OPERATING DATA PAGE #9

Unit: JOTUL #3CBII Run: 4 Date: 1-28-00

FIRE STARTED: 0845

WARM UP AND PREBURN:

PRIMARY AIR : Set wide open for all warm-up / preburn fuel charges. Then set to (3-7/16") 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 25 sec.

TEST:

DOOR wide open during loading 0 min. 40 sec.

PRIMARY AIR : Opened full for first 5 min., then set to run setting of (3 7/16")

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 15 or 9 inches.

1st warm up / pre-burn fuel charge (10.5 lbs.) added at 0855

2nd warm up / pre-burn fuel charge (6.8 lbs.) added at 0950

3rd warm up / pre-burn fuel charge (7.6 lbs.) added at 1055

4th warm up / pre-burn fuel charge (9.5 lbs.) added at ~1155

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

TEST DATA SHEET #10

Unit : Jotul #3CBII Run : 4 Date : 1-28-00

Room Temperature : 70 °F Correction Factor : ∅

Uncorrected Values are corrected for room temperature : Yes____ No Y

Time Test Fuel moisture reading taken : 1130

Calibration Checks : X ✓ Y ✓ 12.0 12.1 22.0 22.1

pc #	Dimen.	Use	TOP Uncor	TOP Cor.	BOTTOM Uncor.	BOTTOM Cor.	SIDE Uncor.	SIDE Cor.	Avg Corrected
1	2"×4"×8'	K	8.5	8.9	10.0	10.6	9.0	9.5	9.667
2									
3									
4	2"×4"×8'	P	22.0	23.7	21.0	22.5	21.0	22.5	22.900
5	2"×4"×8'	P	22.0	23.7	21.5	23.1	23.5	25.2	24.000
6	2"×4"×8'	P	23.0	24.7	21.5	23.1	22.5	24.1	23.967
7	2"×4"×8'	P							70.867
8	2"×4"×8'	P							
9									
10									
11									
12	2"×4"×14½"	T	17.5	18.7	18.0	19.2	18.0	19.2	19.033
13	2"×4"×14½"	T	19.5	20.9	20.0	21.4	19.5	20.9	21.067
14	2"×4"×14½"	T	20.0	21.4	21.0	22.5	20.0	21.4	21.767
15	2"×4"×14½"	T	23.5	25.2	23.5	25.2	23.5	25.2	25.200
16									87.067
17									
18									
19									
20	Spacers	T	18.5	19.8	19.0	20.3	17.5	18.7	19.600

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

	KINDLING	PRETEST FUEL	TEST FUEL
Dry Moisture % :	9.667 %	23.622 %	21.767 %
Wet Moisture % :	8.815 %	19.109 %	17.876 %

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: 300.3

GAS DATA SHEET # 12

UNIT: JOTUL #3CB II RUN: 4 DATE: 1-28-00 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 / 1335	366.3	8.0	—	.167	4.2	.611	15.3	.128	1.28	3.3					247	-.032	500
5 / 40	365.1	6.8	1.2	.487	12.2	.365	9.1	.037	.36	33.4					722	-.058	225
10 / 45	364.7	6.4	.4	.263	6.6	.535	13.4	.091	.91	7.3					343	-.045	500
15 / 50	364.1	5.8	.6	.353	8.8	.436	10.9	.080	.80	11.1					400	-.050	450
20 / 55	363.5	5.2	.6	.390	9.7	.408	10.2	.094	.94	10.4					419	-.051	475
25 / 1400	362.8	4.5	.7	.450	11.2	.360	9.0	.101	1.01	11.2					452	-.053	475
30 / 05	362.2	3.9	.6	.444	11.1	.372	9.3	.034	.33	33.2					461	-.054	400
35 / 10	361.7	3.4	.5	.437	10.9	.378	9.4	.020	.19	56.3					448	-.053	400
40 / 15	361.2	2.9	.5	.399	10.0	.404	10.1	.021	.20	48.9					424	-.051	400
45 / 20	360.8	2.5	.4	.407	10.2	.412	10.3	.029	.28	35.8					417	-.050	425
50 / 25	360.5	2.2	.3	.395	9.9	.429	10.7	.016	.15	64.1					395	-.049	450
55 / 30	360.1	1.8	.4	.382	9.5	.450	11.2	.011	.10	91.8					388	-.048	450
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	5116	-.594	*****
60 / 1435	359.9	1.6	.2	.313	7.8	.512	12.8	.023	.22	34.9					360	-.045	450
65 / 40	359.8	1.5	.1	.249	6.2	.556	13.9	.070	.70	8.9					322	-.042	500
70 / 45	359.7	1.4	.1	.233	5.8	.553	13.8	.118	1.18	4.9					303	-.040	525
75 / 50	359.6	1.3	.1	.223	5.6	.557	13.9	.130	1.30	4.3					286	-.037	525
80 / 55	359.5	1.2	.1	.218	5.4	.563	14.1	.133	1.33	4.1					276	-.036	525
85 / 1500	359.4	1.1	.1	.216	5.4	.561	14.0	.137	1.37	3.9					269	-.035	525
90 / 05	359.3	1.0	.1	.201	5.0	.570	14.3	.151	1.51	3.3					262	-.034	525
95 / 10	359.3	1.0	∅	.192	4.8	.572	14.3	.173	1.73	2.8					255	-.033	525
100 / 15	359.2	.9	.1	.199	5.0	.571	14.3	.154	1.54	3.1					251	-.032	525
105 / 20	359.2	.9	∅	.200	5.0	.572	14.3	.150	1.50	3.3					248	-.032	525
110 / 25	359.1	.8	.1	.195	4.9	.574	14.4	.154	1.54	3.2					245	-.031	525
115 / 30	359.0	.7	.1	.188	4.7	.572	14.3	.157	1.57	3.0					240	-.031	525
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	3317	-.428	*****
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	8433	1.022	*****

WEIGHT: 358.0

UNIT: JOTUL # 3CB II

GAS DATA SHEET # 12

RUN: 4 DATE: 1-28-00 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 / 1535	358.9	.6	.1	.183	4.6	.568	14.2	.159	1.59	2.9					236	-.031	525
125 / 40	358.8	.5	.1	.179	4.5	.566	14.2	.174	1.74	2.6					234	-.030	525
130 / 45	358.7	.4	.1	.167	4.2	.565	14.1	.187	1.87	2.2					231	-.030	525
135 / 50	358.7	.4	0	.165	4.1	.563	14.1	.183	1.83	2.2					229	-.029	525
140 / 55	358.6	.3	.1	.165	4.1	.561	14.0	.182	1.82	2.3					226	-.029	525
145 / 1600	358.5	.2	.1	.160	4.0	.589	14.7	.174	1.74	2.3					223	-.028	525
150 / 05	358.5	.2	0	.157	3.9	.588	14.7	.176	1.76	2.2					221	-.028	525
155 / 10	358.4	.1	.1	.156	3.9	.584	14.6	.170	1.70	2.3					218	-.027	525
160 / 15	358.3	0	.1	.154	3.8	.583	14.6	.168	1.68	2.3					217	-.028	525
165 / 20																	
170 / 25																	
175 / 30																	
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	2035	-.260	*****
																	÷33
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	10,468	-1.282	*****
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	317	-.039	*****

PREBURN DATA SHEET #13

UNIT: Jotul #3CB II RUN: 4 DATE: 1-28-00 PAGE: 1 of 1

TIME	SCALE	DROP	STACK	TOP	LF SIDE	BACK	RT SIDE	BOTTOM	FIREBOX	SEC/CAT	AMBIENT	STATIC	COMMENTS
0 / 1235	359.0	–	616	570	422	497	507	587	1134	1135	80	.060	PREBURN START : # .6 UP
5 / 40	3589	.1	380	511	418	453	497	600	1079	958	80	.049	COAL BED SCALE RANGE :
10 / 45	3589	∅	338	448	395	409	468	601	1009	879	81	.044	358.4 → 358.0
15 / 50	358.8	.1	323	414	380	383	449	597	973	843	81	.041	PRIMARY AIR : (3 7/16")
20 / 55	358.8	∅	307	386	366	357	426	589	934	816	79	.040	SECONDARY AIR : N/A
25 / 1300	358.7	.1	295	366	354	341	408	581	903	796	80	.038	FAN : N/A
30 / 05	358.7	∅	283	351	342	325	389	571	869	772	78	.037	PUMPS ON AT : 1315
35 / 10	358.6	.1	275	340	331	313	376	562	844	758	80	.036	CHECK WB/DB : N/A
40 / 15	358.5	.1	268	325	324	300	362	549	817	745	80	.035	
45 / 20	358.5	∅	261	317	313	290	349	537	797	724	79	.034	
50 / 25	358.4	.1	256	310	305	284	340	525	782	710	78	.033	
55 / 30	358.4	∅	251	302	296	278	329	511	763	686	78	.032	
*****	****	***	****	*****	*****	****	*****	*****	*****	*****	*****	****	
60 / 1335	3583	.1	247	295	293	245	323	503	744	640	78	.032	ΔT 331.8

TEMPERATURE DATA SHEET # 14

UNIT: Jotul #3CB II RUN: 4 DATE: 1-28-00 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	331.8
0 / 1335	295	293	245	323	503	744	640	78	1328	232	49	244	36	36	
5 / 40	390	282	280	313	489	694	1155	80	1333	238	45	247	37	36	
10 / 45	386	277	281	306	477	658	1159	78	1334	242	42	249	37	38	
15 / 50	421	274	286	300	465	652	1088	77	1335	244	44	251	37	37	
20 / 55	446	273	296	296	453	674	1169	77	1337	247	44	248	35	37	
25 / 1400	485	279	313	296	442	737	1244	78	1341	247	44	246	36	37	
30 / 05	506	289	334	300	431	806	1340	76	1339	249	43	247	37	36	
35 / 10	503	301	348	306	424	859	1315	76	1336	250	43	245	37	36	
40 / 15	500	313	355	313	417	883	1214	76	1335	248	43	245	38	36	
45 / 20	492	328	360	322	411	906	1190	76	1336	249	43	245	38	36	
50 / 25	479	331	364	329	409	921	1199	76	1337	250	44	246	38	37	
55 / 30	478	334	367	335	409	916	1279	75	1338	248	44	247	38	37	
TOTAL	5381	3574	3829	3739	5330	9450	13992	923	*****	*****	*****	*****	*****	*****	
60 / 1435	466	337	364	341	410	910	1113	76	1341	246	44	247	37	38	
65 / 40	428	330	346	343	414	883	892	75	1342	245	44	246	37	38	
70 / 45	396	325	329	342	419	859	849	75	1343	245	45	246	37	37	
75 / 50	370	318	316	338	427	832	824	75	1345	244	45	246	36	37	
80 / 55	350	308	302	334	433	809	814	75	1342	244	45	246	36	37	
85 / 1500	337	302	294	330	438	793	789	75	1341	244	45	246	38	37	
90 / 05	326	295	282	325	442	777	744	74	1340	243	45	246	38	36	
95 / 10	314	288	274	319	444	762	721	74	1338	242	45	246	37	36	
100 / 15	304	284	267	314	443	753	722	74	1337	242	46	246	37	37	
105 / 20	297	278	263	309	441	749	737	73	1336	242	46	246	37	36	
110 / 25	295	276	259	305	437	740	724	74	1334	241	47	245	37	35	
115 / 30	293	273	256	302	435	731	704	74	1333	241	48	245	37	36	
TOTAL	4176	3614	3552	3902	5183	9598	9633	894	*****	*****	*****	*****	*****	*****	
TOTAL	9557	7188	7381	7641	10,513	19,048	23625	1817	*****	*****	*****	*****	*****	*****	

TEMPERATURE DATA SHEET # 14

UNIT : JOTUL #3CBII RUN : 4 DATE : 1-28-00 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	331.8
120 / 1535	286	268	252	298	430	717	689	74	1333	241	48	245	37	35	
125 / 40	281	268	250	295	427	708	693	75	1332	241	48	245	36	35	
130 / 45	276	263	247	289	422	695	667	75	1330	240	48	244	34	35	
135 / 50	272	260	244	286	418	684	652	75	1329	239	48	244	35	35	
140 / 55	268	258	243	281	412	671	644	75	1327	240	47	244	34	35	
145 / 1600	264	255	241	277	406	660	638	74	1326	240	46	243	34	36	
150 / 05	261	250	239	274	401	649	632	75	1324	240	46	243	35	35	
155 / 10	256	244	235	268	391	633	622	73	1323	239	47	242	35	34	
160 / 15	253	243	236	265	386	626	616	73	1323	239	46	242	35	34	
165 / 20															
170 / 25															
175 / 30															
TOTAL	2417	2309	2187	2533	3693	6043	5853	669	*****	*****	*****	*****	*****	*****	
											331.8				
											276.6				
											-55.2	ΔT			
									1/33						
TOTAL	11974	9497	9566	10174	14206	25091	29478	2486	*****	*****	*****	*****	*****	*****	
TOTAL	363	288	290	308	430	760	893	75	*****	*****	*****	*****	*****	*****	

ZERO / SPAN CHECK DATA SHEET #15-1

Date : 1-28-00 Analyte : CO_2 (15-1)

Source : Jotul #3CB II Run # : 4

Zero Cyl. # : TX 79373 Conc. : 0.00 % CO_2 Cyl. Press. : 1350 PSI

Certified by : Air Liquide Date : 9/22/98

Span Cyl. # : CC 52549 Conc. : 12.4 % CO_2 Cyl. Press. : 490 PSI

Certified by : Air Liquide Date : 9/22/98

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 : 1200 Temp : 71 °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	-.301
SPAN	49.6	.496	12.4	49.5	.495	12.373	-.027	-.106

POST RUN Audit : by : D Washington Time : 1625 Temp : 73 °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	-.201
SPAN	49.6	.496	12.4	49.5	.495	12.373	-.027	-.106

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

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

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

ZERO / SPAN CHECK DATA SHEET #15-2

Date : 1-28-00 Analyte : O_2 (15-2)

Source : JOTUL #3CB II Run # : 4

Zero Cyl. # : TX 79373 Conc. : 0.00 % O_2 Cyl. Press. : 1350 PSI

Certified by : AIR LIQUIDE Date : 9/22/98

Span Cyl. # : CC 52549 Conc. : 12.51 % O_2 Cyl. Press. : 490 PSI

Certified by : AIR LIQUIDE Date : 9/22/98

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 : 1200 Temp : 71 °F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.0	.003	.047	.047	.190
SPAN	12.5	.500	12.51	12.5	.502	12.549	.039	.158

POST RUN Audit : by : A. Washington Time : 1625 Temp : 73 °F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.0	.002	.022	.022	.089
SPAN	12.5	.500	12.51	12.6	.503	12.574	.064	.258

± 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 : 1-28-00 Analyte : CO (15-3)

Source : JOTUL #3CB II Run # : 4

Zero Cyl. # : TX 79373 Conc. : 0.00 % CO Cyl. Press. : 1350 PSI

Certified by : AIR LIQUIDE Date : 9/22/98

Span Cyl. # : CC52549 Conc. : 5.08 % CO Cyl. Press. : 490 PSI

Certified by : AIR LIQUIDE Date : 9/22/98

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. Whedington Time : 1200 Temp : 71 °F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.0	.000	-.006	-.006	-.061
SPAN	50.8	.508	5.08	50.6	.506	5.062	-.018	-.182

POST RUN Audit : by : D. Whedington Time : 1625 Temp : 73 °F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.0	.000	-.006	-.006	-.061
SPAN	50.8	.508	5.08	50.7	.507	5.072	-.008	-.082

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

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

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

ZERO / SPAN CHECK DATA SHEET #15-4

Date : 1-28-00 Analyte : SO_2 (15-4)

Source : JOTUL #3CBII Run # : 4

Zero Cyl. # : TX 79373 Conc. : 0.00 ppm SO_2 Cyl. Press. : 1350 PSI

Certified by : AIR LIQUIDE Date : 9/22/98

Span Cyl. # : CC 67475 Conc. : 1260 ppm SO_2 Cyl. Press. : 750 PSI

Certified by : AIR LIQUIDE Date : 9/22/98

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 Washington Time : 1150 Temp : 72 °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	14.495	14.495	.580
SPAN	50.4	.504	1260	50.3	.503	1256.823	-3.177	-.127

POST RUN Audit : by : D Washington Time : 1630 Temp : 72 °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	14.495	14.495	.580
SPAN	50.4	.504	1260	50.1	.501	1251.843	-8.157	-.326

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

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

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

QUALITY CHECKS DATA SHEET # 16

UNIT : Jotul #3CB II RUN : 4 DATE : 1-28-00

Thermocouple Check :

T/C # 1	—	°F	T/C # 13	50.5	°F
T/C # 2	—	°F	T/C # 14	49.5	°F
T/C # 3	49.8	°F	T/C # 15	51.8	°F
T/C # 4	46.7	°F	T/C # 16	49.8	°F
T/C # 5	45.8	°F	T/C # 17	49.8	°F
T/C # 6	45.9	°F	T/C # 18	49.7	°F
T/C # 7	46.0	°F	T/C # 19	47.3	°F
T/C # 8	46.0	°F	T/C # 20	43.8	°F
T/C # 9	47.5	°F	T/C # 21	—	°F
T/C # 10	47.3	°F	T/C # 22	—	°F
T/C # 11	43.2	°F	T/C # 23	47.4	°F
T/C # 12	52.6	°F	T/C # 24	—	°F

Thermocouple Readout :

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

ZERO : -.7 °F Adj. to 0.0 °F — ZERO 1.5 °F Difference .075 %

SPAN : 1997.3 °F Adj. to 2000.0 °F — SPAN 2003.5 °F Difference .175 %

Thermocouple Readout Pretest Linearity Check

0	= 0.0 °F	200	= 201.8 °F	400	= 399.0 °F
600	= 601.3 °F	800	= 801.4 °F	1000	= 1000.5 °F
1200	= 1198.1 °F	1400	= 1399.0 °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 ✓	Post ✓

Scale Check Pre : 375.5 - 365.5

Post : 368.1 - 358.1

Stack Cleaned Prior to Test Run : YES ______ NO X

1.25
TO 1.90

TABLE 1 ----- RAW DATA

CLIENT : Jotul TEST No. : 2

MODEL: 3CBII DATE: 26-Jan-00

TIME (MIN.)	METER READING (C F)	DELTA H (IN. H2O)	METER TEMP. (DEG. F)	PERCENT CO (%)	PERCENT CO2 (%)	SO2 COCENTR. PPM
0	942.500	0.150	88	1.24	4.90	475
5	944.000	0.440	88	0.45	13.00	275
10	946.652	0.190	89	0.92	4.80	425
15	948.377	0.210	89	0.84	5.60	400
20	950.209	0.320	89	0.57	11.60	325
25	952.467	0.370	89	0.24	11.00	300
30	954.903	0.370	90	0.34	11.50	300
35	957.353	0.370	90	0.36	11.70	300
40	959.803	0.370	91	0.37	11.90	300
45	962.262	0.360	93	0.25	11.40	300
50	964.738	0.360	93	0.09	9.70	300
55	967.215	0.360	94	0.10	9.70	300
60	969.701	0.310	94	0.12	8.80	325
65	971.963	0.270	94	0.14	8.30	350
70	974.094	0.230	94	0.63	7.00	375
75	976.084	0.310	94	0.43	6.70	325
80	978.379	0.310	94	0.54	6.40	325
85	980.674	0.270	94	0.71	6.10	350
90	982.805	0.310	94	0.74	6.00	325
95	985.100	0.270	94	0.88	5.70	350
100	987.232	0.270	94	0.93	5.10	350
105						

TABLE 2---RAW DATA

CLIENT : Jotul   TEST No. 2

MODEL: 3CBII   DATE: 26-Jan-00

****

METER CAL. FACTOR (Y) ------	0.989	Wt. WOOD BURNED(LB) -------	8.1	Lbs
BAROMETRIC PRESS.(Pb) ------	30.3 in Hg	WET,FUEL MOISTURE % -------	18.506	%
LEAK RATE POST (Lp) ------	0.000 cfm	Wt. PART. COLLECTED -------	0.3478	g
WATER VOL. (V1c) ------	85.7 Ml	METER VOLUME Vm -------	44.732	mcf
TEST TIME (MIN) ------	100 min	HC MOLE FRACTION -------	0.0132	

TABLE 3 -----FIELD DATA AVERAGES

CLIENT :Jotul TEST No. 2

MODEL: 3CBII DATE: 26-Jan-00

****

AVG DELTA H	-------	0.31	in H_2O	AVG PRCNT CO	-------	0.52	%
AVG METER TEMP. Tm	-------	92	deg F	AVG PRCNT CO_2	-------	8.42	%
AVG PPM SO_2	-------	337	PPM	AVG BAL CO_2/CO	-------	16.24	%

TABLE 4 ----- CALCULATIONS

CLIENT : Jotul TEST No. 2

MODEL: 3CBII DATE: 26-Jan-00

****

STD SAMPLE VOL. Vm(std) -----	42.90	dscf	STACK GAS FLOW Qsd -------	630.748 & 10.51	dscf/Hr & dscf/min
VOL. WATER VAPOR Vw(std) ----	4.034	scf	PARTICULATE CONCTRT. Cs ------	0.0081	g/dscf
PRCNT MSTR Bws -------	8.59	%	PARTC.EMISS. RATE E -------	5.11	g/Hr
BURN RATE BR -------	1.80	Kg/Hr	MOLES OF GAS PER Lb WOOD Nt --	0.41	Lb-mole/Lb
CO EMISSION RATE -------	109.54 & 60.95	g/Hr & g/Kgdry fuel	PART.EMISS. RATE ------	2.85	g/Kgdry fuel

TABLE 5 ----- PROPORTIONAL RATE VARIATION

CLIENT : Jotul TEST No. : 2

MODEL: 3CBII DATE: 26-Jan-00

	TIME INTEVAL Ti	PPM * Vm	PROPRTN. RATE VAR. PR		PROPRTN RATE VAR. AVERAGE	
	5	687.9	97		100	
	10	704.0	99			
	15	706.6	100			
	20	706.3	100			
	25	707.5	100			
	30	704.1	99			
	35	707.5	100			
	40	706.8	100			
	45	707.5	100			
	50	711.1	100			
	55	710.7	100			
	60	712.6	101			
	65	702.4	99			
	70	712.5	101			
	75	712.9	101			
	80	712.6	101			
	85	712.6	101			
	90	712.5	101			
	95	712.6	101			
	100	712.9	101			
	105					
	110					

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.: 2 Date of Test: 1-26-00 Burn Rate: 1.797

Model No.: #3CBII ☐ 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: .000 cfm (.000) (Data Sheet #2) Time: 100 min. (000) (Data Sheet #2)

Dry Gas Meter Volume: 44.732 cf (00.000) (Data Sheet #2)

Stack Flow: 10.337 dscfm (00.000) (Data Sheet #2) Δ H: .306 in. H_2O (.000) (Data Sheet #2)

Barometric Pressure: 30.30 in. Hg (00.00) (Data Sheet #2)

H_2O Captured: 85.7 g (00.0) (Data Sheet #3)

Total Particulate Catch: .3478 g (0.0000) (Data Sheet #6)

Flue Gas Moisture: 8.6006 % (00.000) (Data Sheet #7)

Particulate Emission: .1252 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: 8.1 lbs (00.0) (Data sheet #8)

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

Fuel % Moisture (dry): 22.708 % (wet): 18.506 % (00.00) (Data Sheet #10)

Stack Static Pressure: -.051 in. H_2O (0.000) (Data Sheet #12)

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

Stove Temperature Change: +41.8 °F (00.0) (Data Sheet #14)

METER BOX DATA SHEET PAGE # 2

UNIT : JOTUL #3CBII RUN : 2 DATE : 1-26-00

Meter Box: 5H Y Factor: .989

58 Leak checks: 16 " Hg @ .002 cfm ______ " Hg @ ______ cfm

15 " Hg @ .000 cfm ______ " Hg @ ______ cfm

Inject SO² @ 100 cc/min. Nozzle: Probe @ 3/8 " od Initial Volume: 1.500

ROTO: PRESS:	.16		SAMPLING RATIO: 24 : 1				BP: 30.30		
MIN	TIME	METER READING	SAMPLE MDCF	STACK DSCFM	DELTA H	METER TEMP	SO2 PPM	ROTO TEMP	PUMP VACC
0	1430	942.500	—	7.258	.15	88	475	88	1.0
5	35	944.000	—	12.537	.44	88	275	88	2.0
10	40	946.652	946.652	8.097	.19	89	425	89	1.0
15	45	948.377	948.377	8.604	.21	89	400	89	1.0
20	50	950.209	950.209	10.589	.32	89	325	89	2.0
25	55	952.462	952.462	11.471	.37	89	300	89	2.0
30	1500	954.903	954.903	11.451	.37	90	300	90	2.0
35	05	957.353	957.353	11.451	.37	90	300	90	2.0
40	10	959.803	959.803	11.430	.37	91	300	91	2.0
45	15	962.262	962.262	11.388	.36	93	300	93	2.0
50	20	964.738	964.738	11.388	.36	93	300	93	2.0
55	25	967.215	967.215	11.368	.36	94	300	94	2.0
ROTO PRESS:	.16		TOTALS:	127.032	3.87	1083	BP.: 30.30		
60	1530	969.701	969.701	10.493	.31	94	325	94	2.0
65	35	971.963	971.963	9.744	.27	94	350	94	2.0
70	40	974.094	974.094	9.094	.23	94	375	94	2.0
75	45	976.084	976.084	10.493	.31	94	325	94	2.0
80	50	978.379	978.379	10.493	.31	94	325	94	2.0
85	55	980.674	980.674	9.744	.27	94	350	94	2.0
90	1600	982.805	982.805	10.493	.31	94	325	94	2.0
95	05	985.100	985.100	9.744	.27	94	350	94	2.0
100	10	987.232	987.232	9.744	.27	94	350	94	2.0
105				90.042	2.55	846			
110						1929			
115							1.21		
			TOTALS:	217.074	6.42	92	MAX VACC =		2.0
TOTAL Cu Ft.	44.732		TOTALS:	10.337	.306	552	AVG. BP: 30.30		

PARTICULATE CATCH / MOISTURE DATA SHEET # 3

UNIT : Jotul #3CB11 RUN : 2 DATE : 1-25-2000

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	663.0	599.0	515.1	836.5
INITIAL WT	595.3	593.1	513.4	826.1
NET WT GRAMS	67.7	5.9	1.7	10.4

TOTAL CATCH : 85.7 GRAMS H_2O

FRONT HALF

FILTER #	13F	
FINAL WT g	.7549	
INITIAL WT g	.6704	
NET WT g	.0845	

BEAKER #	36
DESC.	ACETONE
FINAL WT g	94.4862
INITIAL WT g	94.4616
NET WT g	.0246
VOL. DESC. ml	100

BACK HALF

FILTER #	13B	
FINAL WT g	.4835	
INITIAL WT g	.4298	
NET WT g	.0537	

BEAKER #	37	38	39	40	
DESC.	ACETONE	METHCHLOR	H_2O	H_2O	
FINAL WT g	106.7130	96.2813	97.1724	106.4977	
INITIAL WT g	106.6090	96.2538	97.1413	106.4708	
NET WT g	.1040	.0275	.0311	.0269	.0580
VOL. DESC ml	175	75	150	140	290

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: 11CM Lot No.: ZB921

Back Size: 8.2CM 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		
19B	.4288	1918	.4285	1825		
20B	.4340	1919	.4340	1826		

11F	.6660	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	.6654	1840		
18F	.6693	1935	.6690	1841		
19F	.6744	1935	.6745	1842		
20F	.6654	1936	.6655	1843		

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

BALANCE ROOM ENVIRONMENTAL CONDITIONS

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

BEAKER TARE WEIGHTS DATA SHEET #4-2

Into Dessicator: Date : 12-23-99 Time : 945 By : [illegible]

	DATE: 12-24	BY: [illegible]	DATE: 12-25	BY: [illegible]	DATE: 12-27	BY: [illegible]
BEAKER #	FIRST WEIGHT	TIME	SECOND WEIGHT	TIME	THIRD WEIGHT	TIME
26	101.0336	2006	101.0331	1802	JOTUL #3CB R#4	
27	106.3727	2007	106.3731	1803		
28	105.7471	2008	105.7483	1804	105.7488	1220
29	104.4534	2009	104.4530	1805		
30	107.3583	2010	107.3599	1805	107.3601	1221
31	95.5556	2011	95.5582	1806	95.5580	1222
32	107.8694	2011	107.8689	1807		
33	101.1780	2012	101.1785	1807	JOTUL #3CB II	
34	106.4707	2013	106.4712	1808		R#1
35	96.5626	2014	96.5624	1809		
36	94.4620	2015	94.4616	1810		
37	106.6076	2016	106.6088	1810	106.6090	1223
38	96.2542	2017	96.2538	1811		
39	97.1408	2018	97.1413	1812	JOTUL #3CB II	
40	106.4704	2018	106.4708	1813		R#2

BALANCE ROOM ENVIRONMENTAL CONDITIONS

DATE	TIME	BY	WB	DB	% RH
12-24	1945	[illegible]		76	45
12-25	1740	[illegible]		75	38
12-27	1210	[illegible]		76	46

Checked by : C. Waddington
Date : 12-27-99
Time : 1900

WOODSTOVE DATA SHEET # 4-3 : CONSTANT WEIGHTS

UNIT: Jotul #3 CB11 RUN: 2 DATE: 1-26-2000

Beaker #	Date	Time	By	First Weight	Date	Time	By	Second Weight	Date	Time	By	Third Weight	Date	Time	By
36	1-27	945	BKW	94.4857	1-28	2133	BKW	94.4862	1-29	2107	BKW	–			
37	1-27	1600	BKW	106.7127	1-28	2134	BKW	106.7130	1-29	2108	BKW	–			
38	1-27	1600	BKW	96.2809	1-28	2135	BKW	96.2813	1-29	2109	BKW	–			
39	1-27	945	BKW	97.1719	1-28	2137	BKW	97.1724	1-29	2110	BKW	–			
40	1-27	945	BKW	106.4972	1-28	2138	BKW	106.4977	1-29	2111	BKW	–			

Filter #	Date	Time	By	First Weight	Date	Time	By	Second Weight	Date	Time	By	Third Weight	Date	Time	By
13F	1-26	1700	Op	.7547	1-27	1555	BKW	.7549	1-28	2139	BKW				
13B	1-26	1700	Op	.4863	1-27	1556	BKW	.4840	1-28	2140	BKW	.4835	1-29	2113	BKW

SCALE ROOM ENVIRONMENTAL CONDITIONS

Weighing Session	Date	Time	By	WB	DB	%RH
1	1-27	1545	BKW		78	48
2	1-28	2125	BKW		77	43
3	1-29	2100	BKW		77	39
4						

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

Dates: From 10-10-99
Through 1-15-2000

WOODSTOVE DATA SHEET #4-4
SCALE QA SHEET

Scale: Sartorius
Model: A1205
SN : 37010004

100g weight	10 g weight	1.0 g weight	100 mg weight	Tech	Date	Time	Dry Bulb	Wet Bulb	%.RH	
99.9998	10.0000	1.0000	.0999	DKW	10-10	1835	77		46	
100.0001	9.9999	.9999	.1000	DKW	10-11	1030	75		48	
100.0001	10.0000	1.0000	.1000	DKW	10-13	1640	77		47	
99.9999	9.9999	1.0001	.0998	DKW	10-13	2020	78		48	
99.9999	10.0001	1.0001	.1000	DK	10-14	0805	77		44	
100.0001	10.0001	1.0000	.1001	DKW	10-14	1855	77		44	
100.0002	10.0002	1.001	.1001	DKW	10-15	0830	78		45	
100.0000	9.9999	.9996	.0998	CK	10/15	1545	76		48	
100.0001	10.0001	1.0000	.1001	CK	10/16	1140	76		47	
99.9997	9.9998	1.0000	.0999	DKW	10-28	1735	77		48	
100.0001	10.0000	.9998	.0999	DKW	11-1	1815	73		46	—
99.9998	9.9998	.9998	.0997	DKW	11-4	1805	76		46	—
99.9999	9.9999	.9999	.1000	DKW	11-23	1800	78		49	
99.9999	9.9997	.9998	.0999	DKW	11-24	1905	77		49	
100.0000	9.9997	1.0000	.0998	DKW	11-26	1735	75		43	
100.0000	9.9998	.9998	.0998	DKW	11-27	1555	78		48	
100.0000	9.9998	1.0001	.1002	DKW	11-28	1540	78		44	
100.0001	9.9999	1.0000	.0999	DKW	12-22	1935	77		47	—
100.0001	10.0000	.9999	.0999	DKW	12-23	1945	75		48	—
99.9999	9.9999	.9999	.0998	DKW	12-24	1945	76		45	—
100.0002	10.0000	1.0000	.1000	DKW	12-25	1740	75		38	MERRY X-MAS
99.9999	10.0000	.9999	.0999	DKW	12-27	1210	76		46	—
100.0000	9.9998	.9999	.1000	DKW	12-27	1900	77		47	
99.9998	9.9999	.9998	.0999	DKW	12-28	1750	78		46	
100.0001	9.9999	1.0000	.0997	DKW	12-29	1855	78		46	
100.0000	9.9999	1.0000	.0998	DKW	12-30	1940	78		47	
100.0000	9.9998	.9999	.1001	DKW	12-31	1410	75		37	HAPPY NEW YEAR!
99.9999	9.9999	1.0000	.0999	DKW	1-1	1850	78		39	
100.0000	9.9997	.9998	.1000	DKW	1-2	1335	75		39	
100.0000	9.9999	1.0000	.0998	DKW	1-2	2035	75		39	
100.0002	10.0000	.9998	.0999	DKW	1-8	1820	77		49	
100.0000	9.9998	1.0000	.1000	DKW	1-9	2125	72		44	
100.0001	10.0001	1.0000	.0998	DKW	1-10	1420	73		43	
100.0001	10.0000	.9998	.0999	DKW	1-11	1255	72		44	
100.0001	10.0002	.9999	.1000	DKW	1-11	1830	78		44	
100.0000	10.0002	.9999	.0999	DKW	1-12	1230	79		43	
100.0000	9.9999	.9999	.0999	DKW	1-13	2135	71		44	
100.0000	10.0000	.9999	.0997	DKW	1-15	1835	71		40	

Dates: From 1-17-2000
Through____________

WOODSTOVE DATA SHEET #4-4
SCALE QA SHEET

Scale: Sartorius
Model: A1205
SN : 37010004

100g weight	10 g weight	1.0 g weight	100 mg weight	Tech	Date	Time	Wet Bulb	Dry Bulb	% RH
100.0002	9.9999	1.0000	.0998	DKW	1-17	1850		72	38
100.0000	9.9997	.9999	.0999	DKW	1-21	2115		77	47
100.0001	10.0001	.9999	.0998	DKW	1-23	1210		73	44
100.0001	9.9998	1.0000	.0999	DKW	1-26	1805		78	49
100.0000	9.9999	1.0000	.1000	DKW	1-27	1545		78	48
99.9999	9.9998	1.0001	.1000	DKW	1-28	2125		77	43
100.0001	10.0000	.9999	.1000	DKW	1-29	2100		77	39
100.0000	9.9999	.9999	.1001	DKW	1-30	2210		77	39
99.9999	9.9998	1.0000	.1001	DKW	1-31	1550		77	43

BLANK PROCESSING DATA SHEET # 5

UNIT : JOTUL #3CB II RUN : 2 DATE : 1-26-00

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 : NW DATE : 12-23 BY : NW 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 : NW DATE : 12-25 BY : NW DATE : 12-27 BY : NW

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	NW		77	47
12-23	1945	NW		75	48

FINAL QC

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

NET PARTICULATE CATCH CALCULATION DATA SHEET #6

UNIT: Jotul #3CB II RUN: 2 DATE: 1-26-00

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: .0845 g (Total Catch) - 1 (# of Filters) (.0000 g) (Blank Value / Filter) = .0845 g

BEAKERS: .0246 g (Total Catch) - 100 (ml Acetone) (.000004 g) (Blank Value / ml Acetone) = .0242 g

TOTAL FRONT HALF CATCH: .1087 g

BACK HALF CATCH

FILTERS: .0537 g (Total Catch) - 1 (# of Filters) (.0000 g) (Blank Value / Filter) = .0537 g

BEAKERS:

Acetone: .1040 g (Total Catch) - 175 (ml Acetone) (.000004 g) (Blank Value / ml Acetone) = .1033 g
.0007

Extract: .0275 g (Total Catch) - 75 (ml Dichloromethane) (.000015 g) (Blank Value / Dichloromethane) = .0264 g
.0011

Water: .0580 g (Total Catch) - 290 (ml Water) (.000008 g) (Blank Value / Water) = .0557 g
.0023

TOTAL BACK HALF CATCH: .2391 g

TOTAL CATCH: .3478 g

% FRONT HALF: 31.25 %

CALCULATIONS DATA SHEET # 7

UNIT : Jotul #3CB II RUN : 2 DATE : 1-26-00

1) Vm (std) = $\dfrac{(44.732\ \text{Vm})(17.64)(.989\ \text{mcf})\left(30.30''\ \text{Hg} + \dfrac{.306''\ H_2O}{13.6}\right)}{(552\ \text{TmA})}$ = 42.8686 dscf (000.0000)

30.3225

2) Vw (std) = (.04707) (85.7 ml H_2O) = 4.0339 scf (00.0000)

3) Asw = $\dfrac{(4.0339\ \text{scf})}{(4.0339\ \text{scf} + 42.8686\ \text{dscf})}$ = .0860 (.0000) Bws × 100 = 8.6006 (00.0000) % H_2O

46.9025

4) Cs = $\dfrac{(.3478\ \text{g.})}{(42.8686\ \text{dscf})}$ (15.43) = .1252 (0.0000) gr / dscf

5) Estimated g / hr = $\dfrac{(.3478\ \text{g.})}{(42.8686\ \text{dscf})}$ (10.337 (00.0000) dscfm) (60) = 5.0319 (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 : Jotul #3CB II RUN : 2 DATE : 1-26-00

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

Wet Bulb / Dry Bulb
Pre : WB : 60 DB : 73 = 46 % RH 1.3 % H_2O
Post : WB : 60 DB : 79 = 30 % RH 1.1 % H_2O

Average : 38 %RH 1.2 % H_2O

Empty Stove Weight (lbs) : — w/ stack & oil seal : Wet : — Dry : 356.8

Kindling Weight (lbs) : Paper : .2 Wood : 1.8

Preburn Fuel Weight : 10.6 + 8.1 + 6.2 + 10.1 Total : 35.0

Kindling & Preburn Fuel Weight (wood only) (lbs) : Total : 36.8

Coal Bed Wt Range (lbs) : 2.0 - 1.7 Scale : 358.8 - 358.5

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 : 2.0

Maximum Coal Bed Removal (lbs) : ((2.0 (Upper) + 1.7 (Lower)) ÷ 2) .25 = .4

Test Fuel (.75" x 1.5" x 5" spacers) = 16 pcs

Dimensions	Length in inches	No. Pcs	Weight in lbs	% of Load
2" x 4"	14.5	4	8.1	100.0
4" x 4"	—	—	—	—

Test Fuel Weight : 8.1 lbs

Estimated Dry Burn Rate :

1.499

$$\frac{8.1 - (8.1 \times .18506)}{2.2046} \times \frac{60}{100 \ \text{(TIME)}} = 1.797 \text{ kg / hr}$$

$$\text{Estimated BTU's/hr} : 19{,}140 \times \frac{63}{100} \times \frac{1.797}{\text{DBR}} = 21{,}668.59 \text{ BTU's/hr}$$

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

WOOD STOVE OPERATING DATA PAGE #9

Unit : JOTUL #3CBII Run : 2 Date : 1-26-06

FIRE STARTED: 0930

WARM UP AND PREBURN:

PRIMARY AIR : Set wide open for all warm-up / preburn fuel charges. Then set to (3 3/16") at start of preburn.

SECONDARY AIR : CLOSED 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 25 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 (3 3/16")

SECONDARY AIR : CLOSED 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 15 or 9 inches.

1st warm up / pre-burn fuel charge (10.6 lbs.) added at 1000

2nd warm up / pre-burn fuel charge (8.1 lbs.) added at 1100

3rd warm up / pre-burn fuel charge (6.2 lbs.) added at 1135

4th warm up / pre-burn fuel charge (10.1 lbs.) added at 1230

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

TEST DATA SHEET #10

Unit : Jotul #3CB II Run : 2 Date : 1-26-00

Room Temperature : 71 °F Correction Factor : Ø

Uncorrected Values are corrected for room temperature : Yes____ No ✓

Time Test Fuel moisture reading taken : 1145

Calibration Checks : X ✓ Y ✓ 12.0 12.0 22.0 22.0

pc #	Dimen.	Use	TOP Uncor	TOP Cor.	BOTTOM Uncor.	BOTTOM Cor.	SIDE Uncor.	SIDE Cor.	Avg Corrected
1	2"×4"×8'	K	10.5	11.1	9.0	9.5	9.0	9.5	10.033
2									
3									
4	2"×4"×8'	P	23.5	25.2	23.0	24.7	23.0	24.7	24.867
5	2"×4"×8'	P	21.5	23.1	21.5	23.1	22.5	24.1	23.433
6	2"×4"×8'	P	23.0	24.7	23.0	24.7	23.0	24.7	24.700
7	2"×4"×8'	P							73.000
8	2"×4"×8'	P							
9									
10									
11									
12	2"x4"x14½"	T	18.0	19.2	17.5	18.7	18.0	19.2	19.033
13	2"x4"x14½"	T	21.5	23.1	21.0	22.5	22.0	23.7	23.100
14	2"x4"x14½"	T	22.0	23.7	21.5	23.1	22.0	23.7	23.500
15	2"x4"x14½"	T	23.5	25.2	23.5	25.2	23.5	25.2	25.200
16									90.833
17									
18									
19									
20	Spacers	T	18.0	19.2	19.0	20.3	18.5	19.8	19.767

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

	KINDLING	PRETEST FUEL	TEST FUEL
Dry Moisture % :	10.033 %	24.333 %	22.708 %
Wet Moisture % :	9.118 %	19.571 %	18.506 %

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: 058.0

GAS DATA SHEET # 12

UNIT: Jotul #3CB II

RUN: 2 DATE: 1-26-00 PAGE: 1 of 1

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 / 1430	366.9	8.1	0	.195	4.9	.589	14.7	.124	1.24	3.9					272	-.036	475
5 / 35	366.1	7.3	.8	.520	13.0	.296	7.4	.045	.45	29.2					567	-.051	275
10 / 40	365.7	6.9	.4	.152	4.8	.600	15.0	.092	.92	4.1					350	-.044	425
15 / 45	365.2	6.4	.5	.225	5.6	.565	14.4	.084	.84	6.7					348	-.045	400
20 / 50	364.2	5.4	1.0	.463	11.6	.366	9.1	.057	.57	20.5					523	-.057	325
25 / 55	363.3	4.5	.9	.442	11.0	.382	9.5	.025	.24	45.3					537	-.060	300
30 / 1500	362.6	3.8	.7	.461	11.5	.365	9.1	.035	.34	33.5					554	-.060	300
35 / 05	361.9	3.1	.7	.467	11.7	.359	9.0	.037	.36	32.1					552	-.061	300
40 / 10	361.2	2.4	.7	.475	11.9	.351	8.8	.038	.37	31.7					541	-.061	300
45 / 15	360.7	1.9	.5	.458	11.4	.365	9.1	.026	.25	45.1					509	-.058	300
50 / 20	360.2	1.4	.5	.387	9.7	.418	10.4	.010	.09	102.9					500	-.057	300
55 / 25	359.9	1.1	.3	.388	9.7	.418	10.4	.011	.10	93.2					485	-.056	300
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	5738	-.646	*****
60 / 1530	359.6	.8	.3	.351	8.8	.448	11.2	.013	.12	70.7					466	-.055	325
65 / 35	359.3	.5	.3	.333	8.3	.466	11.6	.015	.14	57.7					433	-.053	350
70 / 40	359.2	.4	.1	.282	7.0	.511	12.8	.063	.63	11.3					401	-.050	375
75 / 45	359.1	.3	.1	.268	6.7	.520	13.0	.043	.43	15.7					384	-.047	325
80 / 50	359.0	.2	.1	.256	6.4	.536	13.4	.054	.54	11.9					376	-.047	325
85 / 55	359.0	.2	0	.246	6.1	.545	13.6	.071	.71	8.7					367	-.046	350
90 / 1600	358.9	.1	.1	.241	6.0	.551	13.8	.074	.74	8.2					358	-.045	325
95 / 05	358.9	.1	0	.227	5.7	.562	14.1	.088	.88	6.5					350	-.045	350
100 / 10	358.8	0	.1	.205	5.1	.584	14.6	.093	.93	5.8					342	-.044	350
															3477	-.432	-.21
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	9215	-1.078	*****
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	439	-.051	*****

PREBURN DATA SHEET #13

UNIT: Jotul #3CB II RUN: 2 DATE: 1-26-00 PAGE: 1 of 1

TIME	SCALE	DROP	STACK	TOP	LF SIDE	BACK	RT SIDE	BOTTOM	FIREBOX	SEC/CAT	AMBIENT	STATIC	COMMENTS
0 / 1305	360.8	—	720	632	410	508	495	656	1294	1598	84	-.066	PREBURN START : # 2.0 UP
5 / 10	360.5	.3	436	596	413	481	491	641	1135	1255	87	-.057	COAL BED SCALE RANGE :
10 / 15	360.3	.2	415	519	403	441	468	621	1078	1206	86	-.054	358.8 → 358.5
15 / 20	360.1	.2	405	507	400	428	458	614	1061	1191	85	-.052	PRIMARY AIR : (3 3/16")
20 / 25	359.9	.2	394	483	389	407	443	603	1062	1094	84	-.051	SECONDARY AIR : CLOSED
25 / 30	359.7	.2	396	473	383	398	436	598	1033	1248	85	-.051	FAN : N/A
30 / 35	359.6	.1	384	469	379	385	428	591	1032	1065	83	-.049	PUMPS ON AT : 1340
35 / 40	359.5	.1	362	451	369	376	424	589	1010	959	84	-.046	CHECK WB/DB : N/A
40 / 45	359.4	.1	334	416	362	355	412	586	954	885	84	-.044	
45 / 50	359.4	0	321	384	352	339	396	584	914	850	83	-.042	
50 / 55	359.3	.1	312	367	345	329	385	582	910	832	82	-.041	
55 / 1400	359.3	0	304	353	336	316	371	577	899	815	81	-.040	
*****	****	***	****	*****	*****	****	*****	*****	*****	*****	*****	****	
60 / 05	359.2	.1	299	346	332	308	366	574	872	787	82	-.039	
65 / 10	359.1	.1	293	338	326	302	358	568	851	755	81	-.038	
70 / 15	359.1	0	283	324	318	295	349	559	825	740	80	-.037	
75 / 20	359.0	.1	279	315	311	291	342	553	816	733	80	-.036	
80 / 25	358.9	.1	275	310	308	286	336	547	791	722	79	-.036	
85 / 30	358.8	.1	272	306	303	282	332	542	781	714	79	-.036	353.0 ΔT -

TEMPERATURE DATA SHEET # 14

UNIT: Jotul #3CB II RUN: 2 DATE: 1-26-00 PAGE 1 of 1

TIME	TOP	LT SIDE	BACK	RT SIDE	BOTTOM	FIREBOX	SEC/CAT	AMBIENT	FURNACE	SAMPLE	SAMP IMP	C-GAS	GAS IMP	SO2 IMP	353.0
0 / 1430	306	303	282	332	542	781	714	79	1344	255	51	255	36	38	
5 / 35	381	294	289	326	536	691	890	77	1348	254	46	255	37	37	
10 / 40	357	287	283	321	536	637	612	78	1344	249	43	249	36	35	
15 / 45	325	276	265	311	523	600	982	78	1333	247	44	245	36	35	
20 / 50	416	266	281	307	508	705	1192	78	1326	247	46	243	35	36	
25 / 55	473	283	319	317	490	822	1305	78	1325	247	44	242	37	36	
30 / 1500	503	296	335	325	485	869	1339	79	1328	247	44	242	36	35	
35 / 05	526	315	360	344	480	931	1333	79	1333	248	44	241	37	34	
40 / 10	540	335	386	363	482	978	1231	81	1338	249	44	241	36	34	
45 / 15	526	354	396	380	492	1009	1188	81	1338	249	44	241	35	35	
50 / 20	518	364	403	392	508	1022	1199	82	1338	248	45	241	35	34	
55 / 25	511	372	403	399	525	1022	1180	82	1336	248	45	241	35	36	
TOTAL	5382	3745	4002	4117	6107	10067	13165	952	*****	*****	*****	*****	*****	*****	
60 / 1530	500	374	397	405	544	1024	1108	82	1334	247	46	240	35	36	
65 / 35	477	375	393	408	560	1007	967	83	1335	247	46	240	36	36	
70 / 40	443	372	375	407	572	990	950	83	1336	245	46	242	36	36	
75 / 45	416	362	360	401	584	961	908	83	1328	244	46	243	35	36	
80 / 50	404	359	355	398	589	946	893	83	1323	243	46	243	35	37	
85 / 55	387	350	347	390	595	923	874	83	1317	243	47	243	35	36	
90 / 1600	380	345	339	385	597	906	867	82	1313	243	47	243	36	36	
95 / 05	365	337	333	380	593	884	817	83	1310	243	46	244	35	35	
100 / 10	353	331	326	375	589	864	795	83	1308	242	46	244	36	37	
														START	353.0
														END	394.8
	3725	3205	3225	3549	5223	8505	8179	745	÷21					ΔT	+41.8
TOTAL	9107	6950	7227	7666	11330	18572	21344	1697	*****	*****	*****	*****	*****	*****	
TOTAL	434	331	344	365	540	884	1016	81	*****	*****	*****	*****	*****	*****	

ZERO / SPAN CHECK DATA SHEET #15-1

Date : 1-26-00 Analyte : CO_2 (15-1)

Source : JOTUL #3CB II Run # : 2

Zero Cyl. # : TX 79373 Conc. : 0.00 % CO_2 Cyl. Press. : 1350 PSI

Certified by : AIR LIQUIDE Date : 9/22/98

Span Cyl. # : CC 52549 Conc. : 12.4 % CO_2 Cyl. Press. : 490 PSI

Certified by : AIR LIQUIDE Date : 9/22/98

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 : 1235 Temp : 80 °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	-.301
SPAN	49.6	.496	12.4	49.4	.494	12.348	-.052	-.206

POST RUN Audit : by : D. Washington Time : 1635 Temp : 80 °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	-.201
SPAN	49.6	.496	12.4	49.6	.496	12.398	-.002	-.006

± 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 : 1-26-00 Analyte : O_2 (15-2)

Source : JOTUL #3CB II Run # : 2

Zero Cyl. # : TX 79373 Conc. : 0.00 % O_2 Cyl. Press. : 1350 PSI

Certified by : AIR LIQUIDE Date : 9/22/98

Span Cyl. # : CC 52549 Conc. : 12.51 % O_2 Cyl. Press. : 490 PSI

Certified by : AIR LIQUIDE Date : 9/22/98

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 : [signature] Time : 1735 Temp : 80 °F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.0	.002	.022	.022	.089
SPAN	12.5	.500	12.51	12.6	.503	12.574	.064	.258

POST RUN Audit : by : D. Wadlin Jr Time : 1635 Temp : 80 °F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.0	.002	.022	.022	.089
SPAN	12.5	.500	12.51	12.5	.501	12.524	.014	.057

± 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 : 1-26-00 Analyte : CO (15-3)

Source : JOTUL #3CBII Run # : 2

Zero Cyl. # : TX 79373 Conc. : 0.00 % CO Cyl. Press. : 1350 PSI

Certified by : AIR LIQUIDE Date : 9/22/98

Span Cyl. # : CC52549 Conc. : 5.08 % CO Cyl. Press. : 490 PSI

Certified by : AIR LIQUIDE Date : 9/22/98

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

Range : 0 - 10.0 % CO

Flow : 1.5 SCFH

Analyzer Output : 0 - 1.0 v.

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 : A Uhadington Time : 1235 Temp : 80 °F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.0	.000	-.006	-.006	-.061
SPAN	50.8	.508	5.08	50.6	.506	5.062	-.018	-.182

POST RUN Audit : by : A Uhadington Time : 1635 Temp : 80 °F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.1	.001	.004	.004	.039
SPAN	50.8	.508	5.08	50.8	.508	5.082	.002	.019

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

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

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

ZERO / SPAN CHECK DATA SHEET #15-4

Date : 1-26-00 Analyte : SO_2 (15-4)

Source : JOTUL #3CBII Run # : 2

Zero Cyl. # : TX 79373 Conc. : 0.00 ppm SO_2 Cyl. Press. : 1350 PSI

Certified by : AIR LIQUIDE Date : 9/22/98

Span Cyl. # : CC 67475 Conc. : 1260 ppm SO_2 Cyl. Press. : 750 PSI

Certified by : AIR LIQUIDE Date : 9/22/98

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. Waldorf Time : 1240 Temp : 79 °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	16.985	16.985	.679
SPAN	50.4	.504	1260	49.9	.499	1246.864	-13.136	-.525

POST RUN Audit : by : D. Waldorf Time : 1640 Temp : 79 °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	16.985	16.985	.679
SPAN	50.4	.504	1260	50.0	.500	1249.354	-10.646	-.426

± 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 : Jotul #3CB II RUN : 2 DATE : 1-26-00

Thermocouple Check :

T/C # 1	— °F	T/C # 13	54.8 °F
T/C # 2	— °F	T/C # 14	53.3 °F
T/C # 3	54.7 °F	T/C # 15	55.1 °F
T/C # 4	51.6 °F	T/C # 16	53.6 °F
T/C # 5	51.3 °F	T/C # 17	53.4 °F
T/C # 6	51.2 °F	T/C # 18	58.6 °F
T/C # 7	51.3 °F	T/C # 19	52.1 °F
T/C # 8	51.4 °F	T/C # 20	50.1 °F
T/C # 9	52.0 °F	T/C # 21	— °F
T/C # 10	51.7 °F	T/C # 22	— °F
T/C # 11	50.0 °F	T/C # 23	52.9 °F
T/C # 12	61.0 °F	T/C # 24	— °F

Thermocouple Readout :

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

ZERO : .4 °F Adj. to 0.0 °F — ZERO 2.2 °F Difference .110 %

SPAN : 1998.7 °F Adj. to 2000.0 °F — SPAN 2003.2 °F Difference .160 %

Thermocouple Readout Pretest Linearity Check

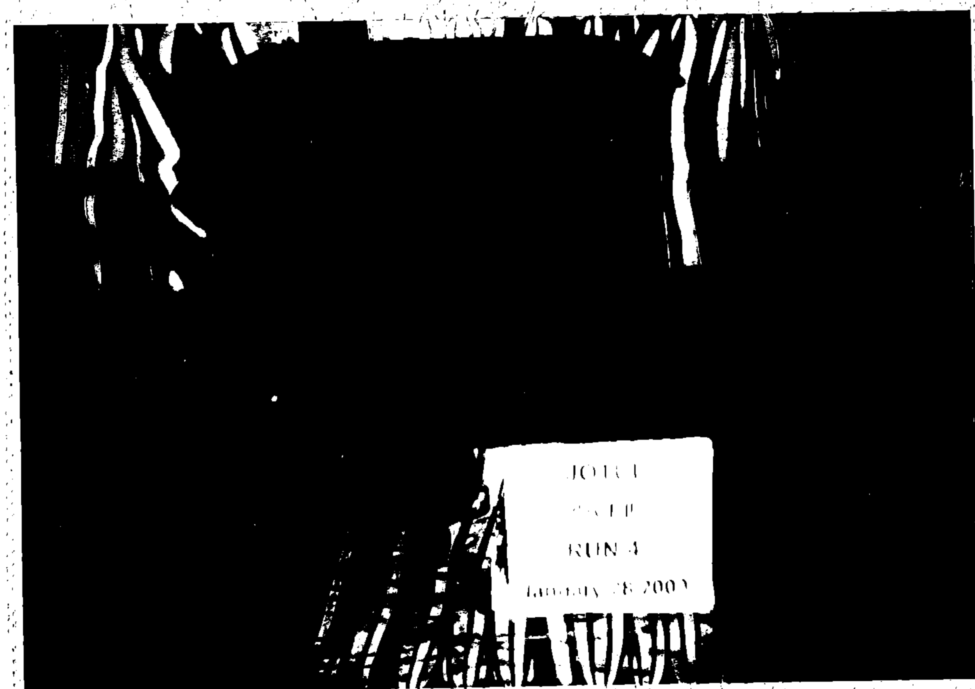
0	= 0.0 °F	200	= 201.8 °F	400	= 399.1 °F
600	= 601.4 °F	800	= 801.5 °F	1000	= 1000.5 °F
1200	= 1198.2 °F	1400	= 1399.1 °F	1600	= 1599.6 °F
1800	= 1800.0 °F	2000	= 2000.0 °F		

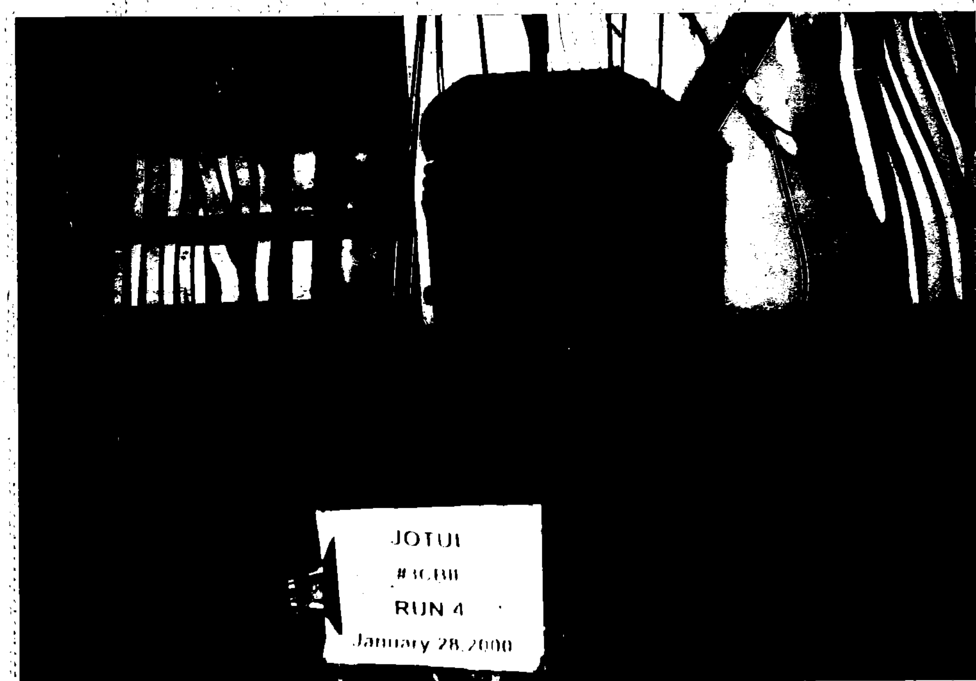
Sample Train Leak Check	Pre ✓	Post ✓
C-gas Train Leak Check	Pre ✓	Post ✓
SO_2 Train Leak Check	Pre ✓	Post ✓
Static Gauge Zero Check	Pre ✓	Post ✓

Scale Check Pre : 369.1 − 359.1

Post : 368.4 − 358.4

Stack Cleaned Prior to Test Run : YES ______ NO X


RUN 4


JOTUL
#3CBII
RUN 4
January 28,2000

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. : 1 Date of Test : 1-25-00 Burn Rate : 3.606

Model No.: #3CBII ☐ 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: .004 cfm
(.000) (Data Sheet #2)

Time: 50 min.
(000) (Data Sheet #2)

Dry Gas Meter Volume: 20.758 cf
(00.000) (Data Sheet #2)

Stack Flow: 12.631 dscfm
(00.000) (Data Sheet #2)

Δ H: .155 in. H_2O
(.000) (Data Sheet #2)

Barometric Pressure: 30.03 in. Hg
(00.00) (Data Sheet #2)

H_2O Captured: 42.5 g
(00.0) (Data Sheet #3)

Total Particulate Catch: .0553 g
(0.0000) (Data Sheet #6)

Flue Gas Moisture: 9.1239 %
(00.000) (Data Sheet #7)

Particulate Emission: .0428 gr/dscf
(0.0000) (Data Sheet #7)

Ambient Moisture: 1.15 %
(0.00) (Data Sheet #8)

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

Total Fuel Consumed During Burn: 8.1 lbs
(00.0) (Data sheet #8)

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

Fuel % Moisture (dry): 22.283 % (wet): 18.223 %
(00.00) (Data Sheet #10)

Stack Static Pressure: -.064 in. H_2O
(0.000) (Data Sheet #12)

Temperature (Average Room) Combustion Air: 82 °F
(00) Data Sheet #14)

Stove Temperature Change: -184 °F
(00.0) (Data Sheet #14)

TABLE 1 ----- RAW DATA

CLIENT : Jotul TEST No. : 1

MODEL: 3CBII DATE: 25-Jan-00

TIME (MIN.)	METER READING (C F)	DELTA H (IN. H2O)	METER TEMP. (DEG. F)	PERCENT CO (%)	PERCENT CO2 (%)	SO2 COCENTR. PPM
0	921.000	0.150	84	0.50	5.90	275
5	923.000	0.130	84	0.12	11.60	300
10	924.883	0.150	85	0.06	12.60	275
15	926.944	0.130	85	0.04	12.20	300
20	928.834	0.130	86	0.02	12.60	300
25	930.730	0.150	87	0.02	10.20	275
30	932.806	0.150	87	0.06	9.40	275
35	934.882	0.180	88	0.10	7.70	250
40	937.174	0.180	88	0.23	6.20	250
45	939.466	0.180	88	0.36	5.90	250
50	941.758	0.180	88	0.45	5.20	250
55						

TABLE 2---RAW DATA

CLIENT : Jotul TEST No. 1

MODEL: 3CBII DATE: 25-Jan-00

****

METER CAL. FACTOR (Y)	------ 0.989	Wt. WOOD BURNED(LB)	-------	8.1	Lbs
BAROMETRIC PRESS.(Pb)	------ 30.03 in Hg	WET,FUEL MOISTURE %	-------	18.223	%
LEAK RATE POST (Lp)	------ 0.004 cfm	Wt. PART. COLLECTED	-------	0.0553	g
WATER VOL. (V1c)	------ 42.5 Ml	METER VOLUME Vm	-------	20.758	mcf
TEST TIME (MIN)	------ 50 min	HC MOLE FRACTION	-------	0.0132	

TABLE 3 -----FIELD DATA AVERAGES

CLIENT :Jotul TEST No. 1

MODEL: 3CBII DATE: 25-Jan-00

****

AVG DELTA H	-------	0.16 in H2O	AVG PRCNT CO	-------	0.18	%
AVG METER TEMP. Tm	-------	86 deg F	AVG PRCNT CO2	-------	9.05	%
AVG PPM SO2	-------	273 PPM	AVG BAL CO2/CO	-------	50.77	%

TABLE 4 ----- CALCULATIONS

CLIENT : Jotul | TEST No. 1

MODEL: 3CBII | DATE: 25-Jan-00

****

STD SAMPLE VOL. Vm(std) -----	19.92	dscf	STACK GAS FLOW Qsd -------	1231.945	dscf/Hr
				&	
				20.53	dscf/min
VOL. WATER VAPOR Vw(std) ----	2.000	scf	PARTICULATE CONCTRT. Cs ------	0.0028	g/dscf
PRCNT MSTR Bws -------	9.12	%	PARTC.EMISS. RATE E -------	3.42	g/Hr
BURN RATE BR -------	3.61	Kg/Hr	MOLES OF GAS PER Lb WOOD Nt --	0.40	Lb-mole/Lb
CO EMISSION RATE -------	73.51	g/Hr	PART.EMISS. RATE ------	0.95	g/Kgdry fuel
	&				
	20.39	g/Kgdry fuel			

TABLE 5 ----- PROPORTIONAL RATE VARIATION

CLIENT : Jotul TEST No. : 1

MODEL: 3CBII DATE: 25-Jan-00

****

	TIME INTEVAL Ti	PPM * Vm	PROPRTN. RATE VAR. PR		PROPRTN RATE VAR. AVERAGE	
	5	530.2	97		100	
	10	544.0	100			
	15	545.3	100			
	20	545.0	100			
	25	545.8	100			
	30	547.3	100			
	35	546.8	100			
	40	548.4	101			
	45	548.4	101			
	50	548.4	101			
	55					
	60					

METER BOX DATA SHEET PAGE # 2

UNIT: JOTUL #3CBII RUN: 1 DATE: 1-25-00

Meter Box: 5H Y Factor: .989

Leak checks: 17 " Hg @ .003 cfm ______ " Hg @ ______ cfm

15 " Hg @ .004 cfm ______ " Hg @ ______ cfm

Inject SO² @ 100 cc/min. Nozzle: Probe @ 3/8 " od Initial Volume: 2.000

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ROTO: PRESS: .17			SAMPLING RATIO: 41 : 1				BP: 30.03		
MIN	TIME	METER READING	SAMPLE MDCF	STACK DSCFM	DELTA H	METER TEMP	SO2 PPM	ROTO TEMP	PUMP VACC
0	1450	921.000	—	12.517	.15	84	275	84	2.0
5	55	923.000	—	11.474	.13	84	300	84	2.0
10	1500	924.883	924.883	12.494	.15	85	275	85	2.0
15	05	926.944	926.944	11.453	.13	85	300	85	2.0
20	10	928.834	928.834	11.432	.13	86	300	86	2.0
25	15	930.730	930.730	12.448	.15	87	275	87	2.0
30	20	932.806	932.806	12.448	.15	87	275	87	2.0
35	25	934.882	934.882	13.668	.18	88	250	88	2.0
40	30	937.174	937.174	13.668	.18	88	250	88	2.0
45	35	939.466	939.466	13.668	.18	88	250	88	2.0
50	40	941.758	941.758	13.668	.18	88	250	88	2.0
55	45								
ROTO PRESS:			TOTALS:	138.938	1.71	950	BP.:		
60									
65									
70									
75									
80									
85									
90									
95									
100									
105									
110									
115						950	÷11		
			TOTALS:	138.938	1.710	86	MAX VACC =		2.0
TOTAL Cu Ft.		20.758	TOTALS:	12.631	.155	546	AVG. BP:	30.03	

PARTICULATE CATCH / MOISTURE DATA SHEET # 3

UNIT : Jotul 3CB11 RUN : 1 DATE : 1-25-2000

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	622.5	599.2	514.9	888.1
INITIAL WT	589.5	596.1	513.5	883.1
NET WT GRAMS	33.0	3.1	1.4	5.0

TOTAL CATCH : 42.5 GRAMS H_2O

FRONT HALF

FILTER #	12F	
FINAL WT g	.7015	
INITIAL WT g	.6833	
NET WT g	.0182	

BEAKER #	31
DESC.	ACETONE
FINAL WT g	95.5802
INITIAL WT g	95.5580
NET WT g	.0222
VOL. DESC. ml	100

BACK HALF

FILTER #	12B	
FINAL WT g	.4334	
INITIAL WT g	.4313	
NET WT g	.0021	

BEAKER #	32	33	34	35	
DESC.	ACETONE	METHCHLOR	H_2O	H_2O	
FINAL WT g	107.8782	101.1815	106.4728	96.5653	
INITIAL WT g	107.8689	101.1785	106.4712	96.5624	
NET WT g	.0093	.0030	.0016	.0029	.0045
VOL. DESC. ml	85	75	150	125	275

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: 11 CM Lot No.: ZB921
Back Size: 8.2 CM Lot No.: ZB911

FILTER #	FIRST WEIGHT (DATE: 11-1)	TIME (BY: [illegible])	SECOND WEIGHT (DATE: 11-4)	TIME (BY: [illegible])	THIRD WEIGHT (DATE:)	TIME (BY:)
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		
19B	.4288	1918	.4285	1825		
20B	.4340	1919	.4340	1826		

11F	.6660	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	.6654	1840		
18F	.6693	1935	.6690	1841		
19F	.6744	1935	.6745	1842		
20F	.6654	1936	.6655	1843		

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

BALANCE ROOM ENVIRONMENTAL CONDITIONS

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

BEAKER TARE WEIGHTS DATA SHEET #4-2

Into Dessicator: Date : 12-23-99 Time : 945 By : [illegible]

BEAKER #	FIRST WEIGHT (DATE: 12-24)	TIME (BY: [illegible])	SECOND WEIGHT (DATE: 12-25)	TIME (BY: [illegible])	THIRD WEIGHT (DATE: 12-27)	TIME (BY: [illegible])
26	101.0336	2006	101.0331	1802	JOTUL #3CB	R#4
27	106.3727	2007	106.3731	1803		
28	105.7471	2008	105.7483	1804	105.7488	1220
29	104.4534	2009	104.4530	1805		
30	107.3583	2010	107.3599	1805	107.3601	1221
31	95.5556	2011	95.5582	1806	95.5580	1222
32	107.8694	2011	107.8689	1807		
33	101.1780	2012	101.1785	1807	JOTUL #3CB II	
34	106.4707	2013	106.4712	1808		R#1
35	96.5626	2014	96.5624	1809		
36	94.4620	2015	94.4616	1810		
37	106.6076	2016	106.6088	1810	106.6090	1223
38	96.2542	2017	96.2538	1811		
39	97.1408	2018	97.1413	1812	JOTUL #3CB II	
40	106.4704	2018	106.4708	1813		R#2

BALANCE ROOM ENVIRONMENTAL CONDITIONS

DATE	TIME	BY	WB	DB	% RH
12-24	1945	[illegible]		76	45
12-25	1740	[illegible]		75	38
12-27	1210	[illegible]		76	46

Checked by : C. Waddington

Date : 12-27-99

Time : 1900

WOODSTOVE DATA SHEET # 4-3 : CONSTANT WEIGHTS

UNIT : Jotul 3CB11 RUN : 1 DATE : 1-25-2000

Beaker #	Date	Time	By	First Weight	Date	Time	By	Second Weight	Date	Time	By	Third Weight	Date	Time	By
31	1-26	1115	DKW	95.5797	1-27	1549	DKW	95.5802	1-28	2127	DKW				
32	1-26	1300	DKW	107.8778	1-27	1549	DKW	107.8782	1-28	2128	DKW				
33	1-26	1300	DKW	101.1795	1-27	1550	DKW	101.1811	1-28	2129	DKW	101.1815	1-29	2105	
34	1-26	1115	DKW	106.4725	1-27	1551	DKW	106.4728	1-28	2131	DKW				
35	1-26	1115	DKW	96.5648	1-27	1552	DKW	96.5653	1-28	2132	DKW				

Filter #	Date	Time	By	First Weight	Date	Time	By	Second Weight	Date	Time	By	Third Weight	Date	Time	By
12F	1-25	1620	Cp	.7020	1-26	1809	DKW	.7015	1-27	1553	DKW				
12B	1-25	1620	Cp	.4336	1-26	1810	DKW	.4334	1-27	1551	DKW				

SCALE ROOM ENVIRONMENTAL CONDITIONS

Weighing Session	Date	Time	By	WB	DB	%RH
1	1-26	1805	DKW		78	49
2	1-27	1545	DKW		78	48
3	1-28	2125	DKW		77	43
4	1-29	2100	DKW		77	39

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

Dates: From 10-10-99
Through 1-15-2000

WOODSTOVE DATA SHEET #4-4
SCALE QA SHEET

Scale: Sartorius
Model: A1205
SN : 37010004

100g weight	10 g weight	1.0 g weight	100 mg weight	Tech	Date	Time	Dry Bulb	Wet Bulb	%.RH	
99.9998	10.0000	1.0000	.0999	DKW	10-10	1835	77		46	
100.0001	9.9999	.9999	.1000	DKW	10-11	1030	75		48	
100.0001	10.0000	1.0000	.1000	DKW	10-13	1640	77		47	
99.9999	9.9999	1.0001	.0998	DKW	10-13	2020	78		48	
99.9999	10.0001	1.0001	.1000	DKW	10-14	0805	77		44	
100.0001	10.0001	1.0000	.1001	DKW	10-14	1855	77		44	
100.0002	10.0002	1.001	.1001	DKW	10-15	0830	78		45	
100.0000	9.9999	.9996	.0998	CK	10/15	1545	76		48	
100.0001	10.0001	1.0000	.1001	CK	10/16	1140	76		47	
99.9997	9.9998	1.0000	.0999	DKW	10-28	1735	77		48	
100.0001	10.0000	.9998	.0999	DKW	11-1	1815	73		46	
99.9998	9.9998	.9998	.0997	DKW	11-4	1805	76		46	
99.9999	9.9999	.9999	.1000	DKW	11-23	1800	78		49	
99.9999	9.9997	.9998	.0999	DKW	11-24	1905	77		49	
100.0000	9.9997	1.0000	.0998	DKW	11-26	1735	75		43	
100.0000	9.9998	.9998	.0998	DKW	11-27	1555	78		48	
100.0000	9.9998	1.0001	.1002	DKW	11-28	1540	78		44	
100.0001	9.9999	1.0000	.0999	DKW	12-22	1935	77		47	
100.0001	10.0000	.9999	.0999	DKW	12-23	1945	75		48	
99.9999	9.9999	.9999	.0998	DKW	12-24	1945	76		45	
100.0002	10.0000	1.0000	.1000	DKW	12-25	1740	75		38	MERRY X-MAS
99.9999	10.0000	.9999	.0999	DKW	12-27	1210	76		46	
100.0000	9.9998	.9999	.1000	DKW	12-27	1900	77		47	
99.9998	9.9999	.9998	.0999	DKW	12-28	1750	78		46	
100.0001	9.9999	1.0000	.0997	DKW	12-29	1855	78		46	
100.0000	9.9999	1.0000	.0998	DKW	12-30	1940	78		47	
100.0000	9.9998	.9999	.1001	DKW	12-31	1410	75		37	
99.9999	9.9999	1.0000	.0999	DKW	1-1	1850	78		39	HAPPY NEW YEAR!
100.0000	9.9997	.9998	.1000	DKW	1-2	1333	75		39	
100.0000	9.9999	1.0000	.0998	DKW	1-2	2035	75		39	
100.0002	10.0000	.9998	.0999	DKW	1-8	1820	77		49	
100.0000	9.9998	1.0000	.1000	DKW	1-9	2125	72		44	
100.0001	10.0001	1.0000	.0998	DKW	1-10	1420	73		43	
100.0001	10.0000	.9998	.0999	DKW	1-11	1255	72		44	
100.0001	10.0002	.9999	.1000	DKW	1-11	1830	78		44	
100.0000	10.0002	.9999	.0999	DKW	1-12	1230	79		43	
100.0000	9.9999	.9999	.0999	DKW	1-13	2135	71		44	
100.0000	10.0000	.9999	.0999	DKW	1-15	1835	71		40	

Dates: From 1-17-2000
Through___________

WOODSTOVE DATA SHEET #4-4
SCALE QA SHEET

Scale: Sartorius
Model: A1205
SN : 37010004

100g weight	10 g weight	1.0 g weight	100 mg weight	Tech	Date	Time	Wet Bulb	Dry Bulb	% RH
100.0002	9.9999	1.0000	.0998	DKW	1-17	1850		72	38
100.0000	9.9997	.9999	.0999	DKW	1-21	2115		77	47
100.0001	10.0001	.9999	.0998	DKW	1-23	1210		73	44
100.0001	9.9998	1.0000	.0999	DKW	1-26	1805		78	49
100.0000	9.9999	1.0000	.1000	DKW	1-27	1545		78	48
99.9999	9.9998	1.0001	.1000	DKW	1-28	2125		77	43
100.0001	10.0000	.9999	.1000	DKW	1-29	2100		77	39
100.0000	9.9999	.9999	.1001	DKW	1-30	2210		77	39
99.9999	9.9998	1.0000	.1001	DKW	1-31	1550		77	43

BLANK PROCESSING DATA SHEET # 5

UNIT : Jotul #3CB II RUN : 1 DATE : 1-25-00

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 : NW DATE : 12-23 BY : NW 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 : 12-21-99

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

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	NW		77	47
12-23	1945	NW		75	48

FINAL QC

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

NET PARTICULATE CATCH CALCULATION DATA SHEET #6

UNIT: Jotul #3CB II RUN: 1 DATE: 1-25-00

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: .0182 g - 1 (.0000 g) = .0182 g
(Total Catch) (# of Filters) (Blank Value / Filter)

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

TOTAL FRONT HALF CATCH: .0400 g

BACK HALF CATCH

FILTERS: .0021 g - 1 (.0000 g) = .0021 g
(Total Catch) (# of Filters) (Blank Value / Filter)

BEAKERS:

Acetone: .0093 g - 85 (.000004 g) = .0090 g
(Total Catch) (ml Acetone) (Blank Value / ml Acetone)

.0011

Extract: .0030 g - 75 (.000015 g) = .0019 g
(Total Catch) (ml Dichloromethane) (Blank Value / Dichloromethane)

Water: .0045 g - 275 (.000008 g) = .0023 g
(Total Catch) (ml Water) (Blank Value / Water)

TOTAL BACK HALF CATCH: .0153 g

TOTAL CATCH: .0553 g

% FRONT HALF: 72.33 %

CALCULATIONS DATA SHEET # 7

UNIT : Jotul #3CB II RUN : 1 DATE : 1-25-00

1) $V_m(std) = \dfrac{(20.758\ V_m)(17.64)(.989\ mcf)\left(30.03''\ Hg + \dfrac{.155''\ H_2O}{13.6}\right)}{(546\ TmA)} = \dfrac{19.9254}{000.0000}$ dscf

2) $V_w(std) = (.04707)(42.5\ ml\ H_2O) = \dfrac{2.0005}{00.0000}$ scf

3) $Asw = \dfrac{(2.0005\ scf)}{(2.0005\ scf + 19.9254\ dscf)} = \dfrac{.0912}{.0000}$ Bws $\times$ 100 = $\dfrac{9.1239}{00.0000}$ % H_2O

4) $Cs = \dfrac{(.0553\ g.)}{(19.9254\ dscf)}(15.43) = \dfrac{.0428}{0.0000}$ gr / dscf

5) Estimated g / hr = $\dfrac{(.0553\ g.)}{(19.9254\ dscf)}\left(\dfrac{12.631}{00.0000}\ dscfm\right)(60) = \dfrac{2.1033}{00.0000}$ 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 : Jotul #3CB II RUN : 1 DATE : 1-25-00

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

Wet Bulb / Dry Bulb
Pre : WB : 62 DB : 77 = 42 % RH 1.3 % H_2O
Post : WB : 59 DB : 77 = 32 % RH 1.0 % H_2O

Average : 37 %RH 1.15 % H_2O

Empty Stove Weight (lbs) : — w/ stack & oil seal : Wet : — Dry : 356.8

Kindling Weight (lbs) : Paper : .2 Wood : 1.8

Preburn Fuel Weight : 7.8 + 9.5 + 8.5 + 11.0 + 4.0 Total : 40.8

Kindling & Preburn Fuel Weight (wood only) (lbs) : Total : 42.6

Coal Bed Wt Range (lbs) : 2.0 - 1.7 Scale : 358.8 - 358.5

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 : 1.9

Maximum Coal Bed Removal (lbs) : ((2.0 (Upper) + 1.7 (Lower)) ÷ 2) .25 = .4

Test Fuel (.75" x 1.5" x 5" spacers) = 16 pcs

Dimensions	Length in inches	No. Pcs	Weight in lbs	% of Load
2" x 4"	14.5"	4	8.1	100.0
4" x 4"	—	—	—	—

Test Fuel Weight : 8.1 lbs

Estimated Dry Burn Rate :

$$\frac{8.1 - \overset{1.476}{(8.1 \times .18223)}}{2.2046} \times \frac{60}{\underset{\text{TIME}}{50}} = 3.606 \text{ kg / hr}$$

$$\text{Estimated BTU's/hr : } 19{,}140 \times \frac{63}{100} \times \frac{3.606}{\text{DBR}} = 43{,}481.87 \text{ BTU's/hr}$$

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

WOOD STOVE OPERATING DATA PAGE #9

Unit : JOTUL #3CBII Run : 1 Date : 1-25-00

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 : WIDE OPEN 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 25 sec.

TEST:

DOOR wide open during loading 0 min. 45 sec.

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

SECONDARY AIR : WIDEOPEN 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 15 or 9 inches.

1st warm up / pre-burn fuel charge (7.8 lbs.) added at 1010

2nd warm up / pre-burn fuel charge (9.5 lbs.) added at 1100

3rd warm up / pre-burn fuel charge (8.5 lbs.) added at 1220

4th warm up / pre-burn fuel charge (11.0 lbs.) added at 1330

5th warm up / pre-burn fuel charge (4.0 lbs.) added at 1408

TEST DATA SHEET #10

Unit : JOTUL #3CB II Run : 1 Date : 1-25-00

Room Temperature : 69 °F Correction Factor : Ø

Uncorrected Values are corrected for room temperature : Yes______ No Ø

Time Test Fuel moisture reading taken : 1220

Calibration Checks : X ✓ Y ✓ 12.0 12.1 22.0 22.1

pc #	Dimen.	Use	TOP Uncor	TOP Cor.	BOTTOM Uncor.	BOTTOM Cor.	SIDE Uncor.	SIDE Cor.	Avg Corrected
1	2"×4"×8'	K	11.5	12.2	12.0	12.8	12.0	12.8	12.600
2									
3									
4	2"×4"×8'	P	22.5	24.1	21.0	22.5	21.5	23.1	23.233
5	2"×4"×8'	P	20.0	21.4	20.5	22.0	20.5	22.0	21.800
6	2"×4"×8'	P	23.5	25.2	23.0	24.7	23.0	24.7	24.867
7	2"×4"×8'	P							69.900
8	2"×4"×8'	P							
9									
10									
11									
12	2"×4"×14½"	T	17.5	18.7	18.0	19.2	18.0	19.2	19.033
13	2"×4"×14½"	T	21.0	22.5	21.5	23.1	21.5	23.1	22.900
14	2"×4"×14½"	T	21.0	22.5	21.0	22.5	21.0	22.5	22.500
15	2"×4"×14½"	T	23.0	24.7	23.0	24.7	23.0	24.7	24.700
16									89.133
17									
18									
19									
20	Spacers	T	18.5	19.8	18.0	19.2	18.0	19.2	19.400

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

	KINDLING	PRETEST FUEL	TEST FUEL
Dry Moisture % :	12.600 %	23.300 %	22.283 %
Wet Moisture % :	11.190 %	18.897 %	18.223 %

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: 350.1

UNIT: Jotul #3CB II

GAS DATA SHEET # 12

RUN: 1 DATE: 1-25-00 PAGE: 1 of

TIME	SCALE	FUEL	DROP	V.	CO_2	V.	O_2	V.	CO	BAL	WB	DB	% H_2O	CAL WB	STACK	STATIC	SO_2PPM
0 / 1450	366.8	8.1	—	.237	5.9	.573	14.3	.050	.50	11.9					531	-.058	275
5 / 55	365.4	6.7	1.4	.465	11.6	.361	9.0	.013	.12	93.7					836	-.066	300
10 / 1500	363.9	5.2	1.5	.506	12.6	.332	8.3	.007	.06	197.6					812	-.068	275
15 / 05	362.6	3.9	1.3	.489	12.2	.341	8.5	.005	.04	277.8					806	-.069	300
20 / 10	361.4	2.7	1.2	.504	12.6	.328	8.2	.003	.02	525.0					811	-.070	300
25 / 15	360.4	1.7	1.0	.410	10.2	.403	10.1	.003	.02	426.8					770	-.068	275
30 / 20	359.7	1.0	.7	.378	9.4	.418	10.4	.007	.06	147.5					731	-.067	275
35 / 25	359.3	.6	.4	.310	7.7	.494	12.3	.011	.10	74.4					650	-.064	250
40 / 30	359.0	.3	.3	.250	6.2	.558	14.0	.024	.23	26.7					597	-.061	250
45 / 35	358.9	.2	.1	.235	5.9	.575	14.4	.037	.36	16.1					558	-.059	250
50 / 40	358.7	0	.2	.210	5.2	.601	15.0	.045	.45	11.8					523	-.056	250
55 / 45																	
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	7625	-.706	*****
																	÷11
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	7625	-.706	*****
TOTAL	*****	****	****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	693	-.064	*****

PREBURN DATA SHEET #13

UNIT: Jotul #3CB II　RUN: 1　DATE: 1-25-00　PAGE: 1 of 1

TIME	SCALE	DROP	STACK	TOP	LF SIDE	BACK	RT SIDE	BOTTOM	FIREBOX	SEC/CAT	AMBIENT	STATIC	COMMENTS
0 / 1330	368.6	—	612	408	343	332	381	653	808	750	71	-.058	PREBURN START : # UP
5 / 35	367.2	1.4	764	585	327	353	377	627	815	1268	71	-.067	COAL BED SCALE RANGE :
10 / 40	365.5	1.7	826	679	322	413	394	602	883	1469	73	-.070	358.8 - 358.5
15 / 1345	363.9	1.6	833	708	332	463	421	587	924	1521	73	-.070	PRIMARY AIR : Wide open
20 / 50	362.6	1.3	827	706	340	484	443	582	948	1564	75	-.069	SECONDARY AIR : Wide open
25 / 55	361.3	1.3	803	704	358	512	477	584	1016	1556	76	-.069	FAN : N/A
30 / 1400	360.4	.9	747	672	374	523	497	590	1087	1311	77	-.067	PUMPS ON AT : 1400 -
35 / 05	359.7	.7	669	628	401	515	518	601	1181	1208	78	-.064	CHECK WB/DB : N/A
40 / 10	362.9	.8	758	601	409	495	515	611	1162	1576	77	-.063	ADDED 4.0 @ 1408
45 / 15	361.8	1.1	780	708	420	524	508	622	1164	1580	79	-.067	
50 / 20	361.0	.8	746	687	418	514	510	629	1134	1533	81	-.066	
55 / 25	360.3	.7	713	655	418	508	516	640	1119	1481	82	-.065	
*****	****	***	****	*****	*****	****	*****	*****	*****	*****	*****	****	
60 / 1430	359.8	.5	681	635	416	502	524	657	1099	1354	83	-.064	
65 / 35	359.4	.5	637	595	409	484	524	674	1084	1302	82	-.063	
70 / 40	359.1	.3	581	545	404	463	516	683	1061	1120	82	-.061	
75 / 45	358.9	.2	543	502	394	439	503	689	1073	1062	83	-.058	
80 / 50	358.7	.2	531	486	394	429	498	691	1069	1034	83	-.058	ΔT 499.6 -

TEMPERATURE DATA SHEET # 14

UNIT: JOTUL #3CB II RUN: 1 DATE: 1-25-00 PAGE 1 of 1

TIME	TOP	LT SIDE	BACK	RT SIDE	BOTTOM	FIREBOX	SEC/CAT	AMBIENT	FURNACE	SAMPLE	SAMP IMP	C-GAS	GAS IMP	SO_2 IMP	499.6
0 / 1450	486	394	429	498	691	1069	1034	83	1329	243	54	237	36	37	
5 / 55	566	373	435	474	687	935	1582	80	1328	246	50	235	38	38	
10 / 1500	643	373	475	471	672	973	1602	81	1329	245	50	237	35	35	
15 / 05	668	379	499	476	642	1029	1584	81	1333	246	50	242	36	36	
20 / 10	672	387	516	486	623	1088	1526	82	1337	246	50	245	36	37	
25 / 15	655	399	532	501	608	1136	1316	82	1344	246	51	249	37	36	
30 / 20	628	414	518	513	604	1165	1222	85	1344	245	51	247	37	36	
35 / 25	578	420	496	520	616	1149	1201	82	1343	244	50	243	38	36	
40 / 30	531	413	465	515	628	1124	1041	83	1339	243	51	242	37	35	
45 / 35	493	408	442	505	637	1083	966	82	1333	242	51	240	37	35	
50 / 40	459	397	418	486	646	1036	950	81	1324	241	50	238	36	35	
55 / 45															
TOTAL	6379	4357	5225	5445	7054	11787	14024	902	*****	*****	*****	*****	*****	*****	
				499.6											
				481.2											
				-18.4	ΔT										
									÷11						
TOTAL	6379	4357	5225	5445	7054	11787	14024	902	*****	*****	*****	*****	*****	*****	
TOTAL	580	396	475	495	641	1072	1275	82	*****	*****	*****	*****	*****	*****	

ZERO / SPAN CHECK DATA SHEET #15-1

Date : 1-25-00 Analyte : CO_2 (15-1)

Source : JOTUL #3CB II Run # : 1

Zero Cyl. # : TX 79373 Conc. : 0.00 % CO_2 Cyl. Press. : 1350 PSI

Certified by : AIR LIQUIDE Date : 9/22/98

Span Cyl. # : CC 52549 Conc. : 12.4 % CO_2 Cyl. Press. : 490 PSI

Certified by : AIR LIQUIDE Date : 9/22/98

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 : 1255 Temp : 67 °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	-.301
SPAN	49.6	.496	12.4	49.7	.497	12.424	.024	.094

POST RUN Audit : by : D. Washington Time : 1615 Temp : 78 °F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.2	.002	.025	.025	.100
SPAN	49.6	.496	12.4	49.9	.499	12.474	.074	.294

± 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 : 1-25-00 Analyte : O_2 (15-2)

Source : JOTUL #3CB II Run # : 1

Zero Cyl. # : TX 79373 Conc. : 0.00 % O_2 Cyl. Press. : 1350 PSI

Certified by : AIR LIQUIDE Date : 9/22/98

Span Cyl. # : CC 52549 Conc. : 12.51 % O_2 Cyl. Press. : 490 PSI

Certified by : AIR LIQUIDE Date : 9/22/98

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 : 1255 Temp : 67 °F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.0	,003	,047	.047	.190
SPAN	12.5	.506	12.51	12.6	,503	12.574	,064	,258

POST RUN Audit : by : A. Washington Time : 1615 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	.002	,022	,022	,089
SPAN	12.5	.500	12.51	12.5	,501	12.524	,014	,057

± 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 : 1-25-00 Analyte : CO (15-3)

Source : JOTUL #3CB II Run # : 1

Zero Cyl. # : TX 19373 Conc. : 0.00 % CO Cyl. Press. : 1350 PSI

Certified by : AIR LIQUIDE Date : 9/22/98

Span Cyl. # : CC52549 Conc. : 5.08 % CO Cyl. Press. : 490 PSI

Certified by : AIR LIQUIDE Date : 9/22/98

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. Whitlingt Time : 1255 Temp : 67 °F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.0	.000	-.006	-.006	-.061
SPAN	50.8	.508	5.08	50.6	.506	5.062	-.018	-.182

POST RUN Audit : by : D. Whitlingt Time : 1615 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	-.006	-.006	-.061
SPAN	50.8	.508	5.08	50.7	.507	5.072	-.008	-.082

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

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

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

ZERO / SPAN CHECK DATA SHEET #15-4

Date : 1-25-00 Analyte : SO_2 (15-4)

Source : JOTUL #3CBII Run # : 1

Zero Cyl. # : TX 79373 Conc. : 0.00 ppm SO_2 Cyl. Press. : 1350 PSI

Certified by : AIR LIQUIDE Date : 9/22/98

Span Cyl. # : CC 67475 Conc. : 1260 ppm SO_2 Cyl. Press. : 750 PSI

Certified by : AIR LIQUIDE Date : 9/22/98

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 : 1300 Temp : 68 °F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	PPM	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.6	.006	19.474	19.474	.779
SPAN	50.4	.504	1260	49.7	.497	1241.885	-18.115	-.725

POST RUN Audit : by : D. Wadington Time : 1620 Temp : 77 °F

AUDIT RESULTS

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	PPM	Meter	DVM	%		
ZERO	00.0	.000	00.0	00.6	.006	19.474	19.474	.779
SPAN	50.4	.504	1260	49.7	.497	1241.885	-18.115	-.725

± 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 : Jotul #3CB II RUN : 1 DATE : 1-25-00

Thermocouple Check :

T/C # 1	—	°F	T/C # 13	46.4	°F
T/C # 2	—	°F	T/C # 14	46.5	°F
T/C # 3	46.6	°F	T/C # 15	46.4	°F
T/C # 4	45.4	°F	T/C # 16	47.4	°F
T/C # 5	45.0	°F	T/C # 17	47.4	°F
T/C # 6	45.0	°F	T/C # 18	46.8	°F
T/C # 7	45.1	°F	T/C # 19	46.5	°F
T/C # 8	44.8	°F	T/C # 20	45.2	°F
T/C # 9	45.0	°F	T/C # 21	—	°F
T/C # 10	45.1	°F	T/C # 22	—	°F
T/C # 11	44.8	°F	T/C # 23	47.5	°F
T/C # 12	46.4	°F	T/C # 24	—	°F

Thermocouple Readout :

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

ZERO : -2.0 °F Adj. to 0.0 °F — ZERO 2.2 °F Difference .110 %

SPAN : 2001.9 °F Adj. to 2000.0 °F — SPAN 2003.4 °F Difference .170 %

Thermocouple Readout Pretest Linearity Check

0	= 0.0 °F	200	= 201.7 °F	400	= 399.0 °F
600	= 601.3 °F	800	= 801.5 °F	1000	= 1000.5 °F
1200	= 1198.8 °F	1400	= 1399.1 °F	1600	= 1599.7 °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 ✓	Post ✓

Scale Check Pre : 368.5 - 358.5

Post : 367.8 - 357.8

Stack Cleaned Prior to Test Run : YES ✓ NO ______

CALIBRATION
DATA

INSPECTION CERTIFICATE

Phillips Morris Scale Company
Partners in Weighing Systems
934 Elliott Avenue W.
Seattle, WA 98119
Ph#(206)284-6090
Fax#(206)282-6612

CUSTOMER: LOKEE TESTING
ADDRESS: 13235 Prarie 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

CONSUMER & PRODUCER PROTECTION DIVISION
WEIGHTS & MEASURES SECTION
METROLOGY LABORATORY
2747 29TH AVENUE SOUTHWEST
TUMWATER 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

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. Deleasa

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

Customer and Contact

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°	Ø
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	Ø

[a] Every 50°F for each reference point
[b] Type of Calibration System Used
[c] $\frac{\text{(reference temperature)} - \text{(thermocouple temperature)}}{\text{reference temperature}} * 100$

c:\winword\report\cal.doc

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

SO² 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: Jotul 3CB11 DATE : 1-29-2000

TEST DATA

RUN #	1	2	3	4	5	6	7	8	9	10
AVG. Δ H	.115	.173	.131	4.0						
MAX VAC	2.0	3.0	2.0	.243						

Avg. Test Series Δ H : .178 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		30.21	30.21	30.21
VAC		4.0	4.0	4.0
AUDIT METER :				
VOL.	Final	938.907	943.792	948.667
(Vw)	Initial	934.000	938.907	943.792
	Vol.	4.907	4.885	4.875
TEMP (°F)	Initial	69	71	75
(Tw)	Mid	70	73	77
	Final	71	75	78
(°F / °A)	Avg.	70 530	73 533	77 537
Δ H	Initial	.178	.178	.178
	Mid	.178	.178	.178
	Final	.178	.178	.178
	Avg.	.178	.178	.178
DRY GAS METER :				
VOL.	Final	925.000	930.000	935.000
(Vd)	Initial	920.000	925.000	930.000
	Vol.	5.000	5.000	5.000
TEMP (°F)	Initial	81	85	87
(Tm)	Mid	83	86	88
	Final	85	87	89
(°F / °A)	Avg.	83 543	86 546	88 548

$$Y = \frac{(Vw)(mcf)(BP)(Tm)}{(Vd)\left(BP + \frac{DH}{13.6}\right)(Tw)}$$

$$\text{Y Factor \% Diff.} = \frac{\text{Act} - \text{Exp}}{\text{Exp}} \times 100$$

NOTE : mcf = meter correction (Y) factor for Dry Gas Meter used as a transfer standard

RUN 1

4.937

$$Y = \frac{(4.907)(.989)(30.21)(543)}{(5.000)\left(30.21 + \frac{.178}{13.6}\right)(530)} = \frac{79609.1}{80091.2} = \underline{.994}$$

$$\Delta\% = \frac{(.994 - .985)}{.985} \times 100 = \underline{.912}\ \%$$

RUN 2

$$Y = \frac{(4.885)(.989)(30.21)(546)}{(5.000)\left(30.21 + \frac{.178}{13.6}\right)(533)} = \frac{79690.7}{80544.5} = \underline{.989}$$

30.223

$$\Delta\% = \frac{(.989 - .985)}{.985} \times 100 = \underline{.406}\ \%$$

RUN 3

$$Y = \frac{(4.875)(.989)(30.21)(548)}{(5.000)\left(30.21 + \frac{.178}{13.6}\right)(537)} = \frac{79818.2}{81149.0} = \underline{.984}$$

$$\Delta\% = \frac{(.984 - .985)}{.985} \times 100 = \underline{-.102}\ \%$$

NOTE : The Y factor % difference must be < ± 5.0 % to be acceptable

INTERPOLATED Y FACTOR

.1 (A) inch H_2O ΔH = .993 (C) Calculated calibration Y factor from calibrations

.2 (B) inch H_2O ΔH = .983 (D) Calculated calibration Y factor from calibrations

.2 (B) - .1 (A) = .1 X 100 = 10 (E)

.993 (D) - .983 (C) = -.010 ÷ 10 (E) = -.0010 (F)

.178 (Avg ΔH) - .1 (A) = .078 X 100 = 7.8 (G)

[-.0010 (F) X 7.8 (G)] + .993 (C) = .985 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	78	79 539
$Y = \dfrac{(W_{mcf})(Vw)(Pb)(tm)}{Vd\left[Pb + \dfrac{\Delta H}{13.6}\right](tw)}$		.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 CALIBRATION LOG

Wet Test Meter Serial Number AA455 Date 4/16/99

Range of Wet Test Meter Flow Rate 0 - 0.25

Volume of Test Flask Vs= 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 (Vs), 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 - Vs)/Vs = $\frac{(100)(3.012-3.000)}{3.000}$ (±1%) = 0.40%

WET TEST METER CALIBRATION LOG

SO_2 ROTAMETER CALIBRATION

Last Cal. : 4-10-99 By : C.W. Date : 11-20-99 By : C. Wadlington

Manufacturer : SKC-WEST
SKC ACCUFLOW Digital Flow Calibrator: Model 712 SN : 311325

Barometric Pressure : 30.48 " Hg Temperature : 69

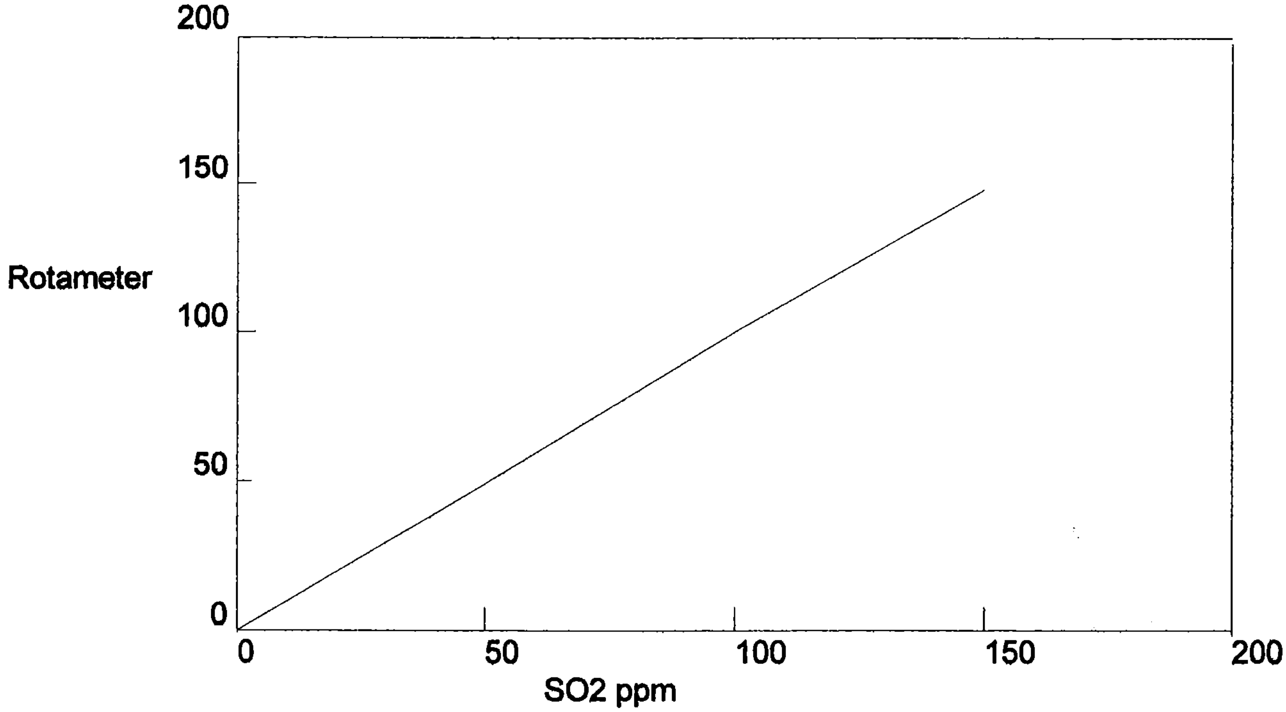
RUN #	50 CC/MINUTE DIGICAL VOLUME	100 CC/MINUTE DIGICAL VOLUME	150 CC/MINUTE DIGICAL VOLUME
1	55.0	128.0	185.0
2	55.2	127.8	185.1
3	54.9	128.1	185.3
4	55.2	127.9	185.0
5	55.0	128.1	185.3
6	55.1	128.4	185.6
7	55.2	128.5	185.5
8	55.4	128.3	185.4
9	55.1	128.1	185.6
10	55.2	128.4	185.3
AVERAGE	55.1 cc/min	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	.502
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						

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

GASES FOR RESEARCH AND DEVELOPMENT

CYL # CC-52549 CGA 590

PRES 1650 VOL 112CF

TEST # 06598 DATE 03-6-98

Analytical Method GC/Paramagnetic

	Requested	Analyzed
Hydrogen		
Nitrogen	Bal.	Bal.
Argon		
Air		
Carbon Monoxide	5%.	5.08%.
Methane		
Oxygen	12.5%.	12.51%.
Helium		
Carbon Dioxide	12.5%.	12.40%.

SIGNED

AIR LIQUIDE

1451 THORNE RD.
TACOMA, WA 98421
TEL: (206) 383-3637

THE ONLY LIABILITY OF THIS COMPANY FOR GAS WHICH FAILS TO COMPLY WITH THIS ANALYSIS SHALL BE REPLACEMENT THEREOF BY THE COMPANY WITHOUT EXTRA COST.

DO NOT REMOVE
THIS TAG

Scott Specialty Gases

Shipped From: 500 WEAVER PARK RD
LONGMONT CO 80501
Phone: 303-442-4700 Fax: 303-772-7673

C E R T I F I C A T E   O F   A N A L Y S I S

ENERGY & ENV MEASUREMENT

C/O ED WADINGTON
3730 N. PELLEGRINO DR.
TUCSON AZ 85749

PROJECT #: 08-34135-007
PO#: VERBAL
ITEM #: 0802C4015014AL
DATE: 4/24/97

CYLINDER #: AAL7152
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	21.	%	21.0	%
CARBON MONOXIDE	8.5	%	8.51	%
OXYGEN	21.	%	21.0	%
NITROGEN		BALANCE		BALANCE

CGA 590 2015 PSIA

ANALYST: Diana Beehler
DIANA BEEHLER

Scott Specialty Gases

500 WEAVER PARK RD,LONGMONT,CO 80501 Phone: 303-442-4700 Fax: 303-772-7673

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)

SULFUR DIOXIDE *

First Triad Analysis

Date: 04/14/97	Response Unit: PPM	
Z1=0.3947	R1=487.72	T1=505.77
R2=488.79	Z2=1.8201	T2=505.89
Z3=1.8425	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=488.69
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:
WR	WR	WR

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)

SULFUR DIOXIDE *

First Triad Analysis

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 #3CB II

CO_2 ANALYZER
MULTIPOINT CALIBRATION REPORT FORM

Date: 1-6-2000

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

Calibration by: C. Wadington

Cal Gas Flow: 1.5 SCFH Measured by: Rotameter

BP: 30.30 Instrument ID: PRINCO

Temp: 69 Instrument ID: TR

Analyzer last calibrated: 11-20-99 By: C. Wadington

Cylinders:

1. #TX 79373 Concentration: 00.00 % CO_2 Cyl. Press.: 1350 PSI
   Certified by: AIR LIQUIDE Date: 9/22/98
2. #CC 52549 Concentration: 12.4 % CO_2 Cyl. Press.: 490 PSI
   Certified by: AIR LIQUIDE Date: 9/22/98
3. #AAL 7152 Concentration: 21.0 % CO_2 Cyl. Press.: 480 PSI
   Certified by: SCOTT SPECIALTY GASES Date: 5/15/97
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		ACTUAL		ADJ.		% DIF.	POTENTIOMETER	
			METER	DVM	METER	DVM	METER	DVM		UNADJ.	ADJ.
1	1	00.00	00.0	.000	0.20	.002	0.00	.000			
2	2	12.4	49.6	.496	49.5	.495	49.6	.496			
3	3	21.0	84.0	.840	83.9	.839	—	—			
4	4	6.25	25.0	.250	25.2	.252	—	—			
5	1	00.00	00.0	.000	00.0	.000	—	—			

.5 = 12.499

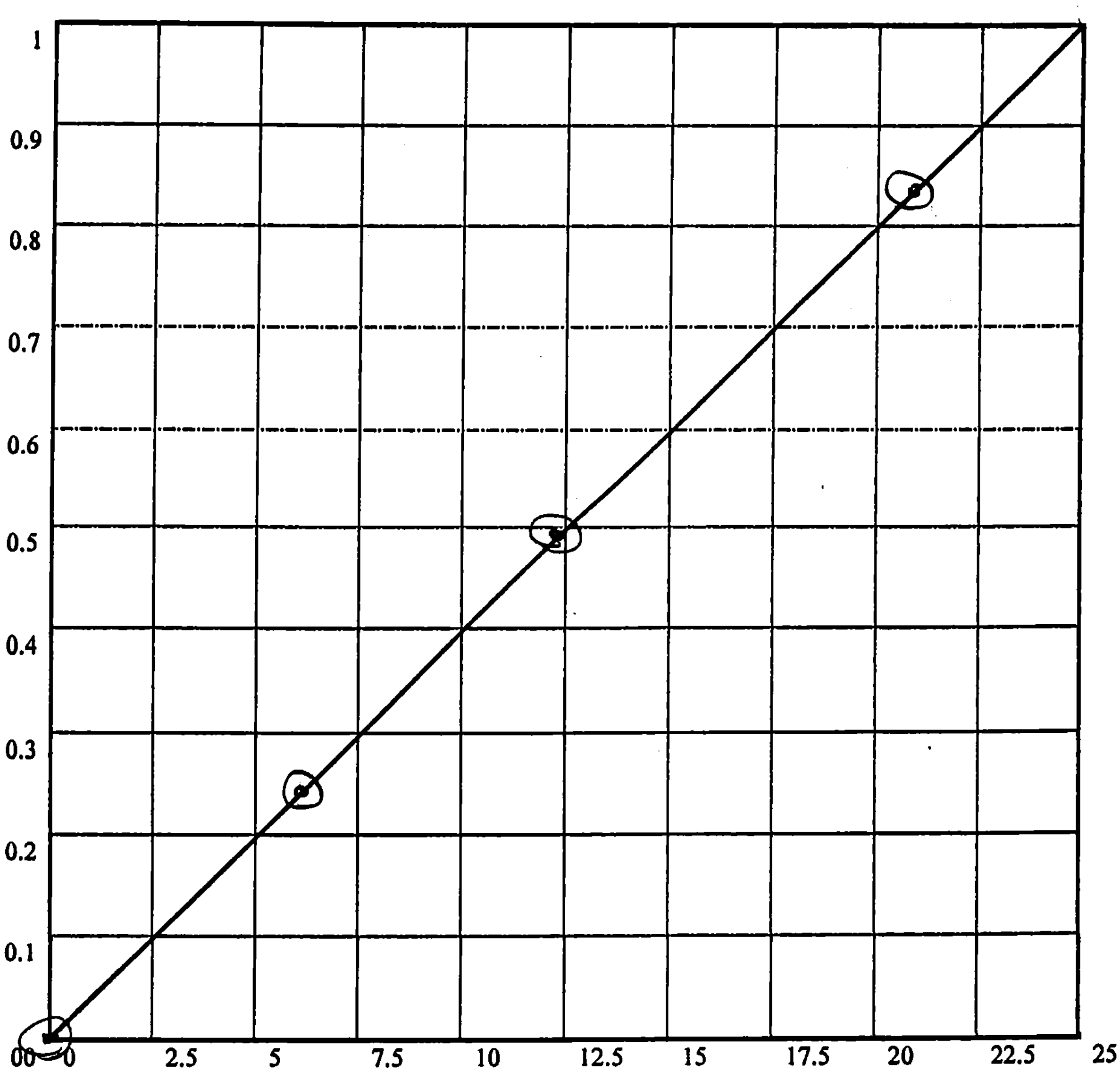
CO_2 Linear Regression Results:

Y = MX +B
Slope (M) = .0399235

Y Intercept (B) = .0010080

Correlation Coefficient (r) = .9999956

r^2 = .9999913

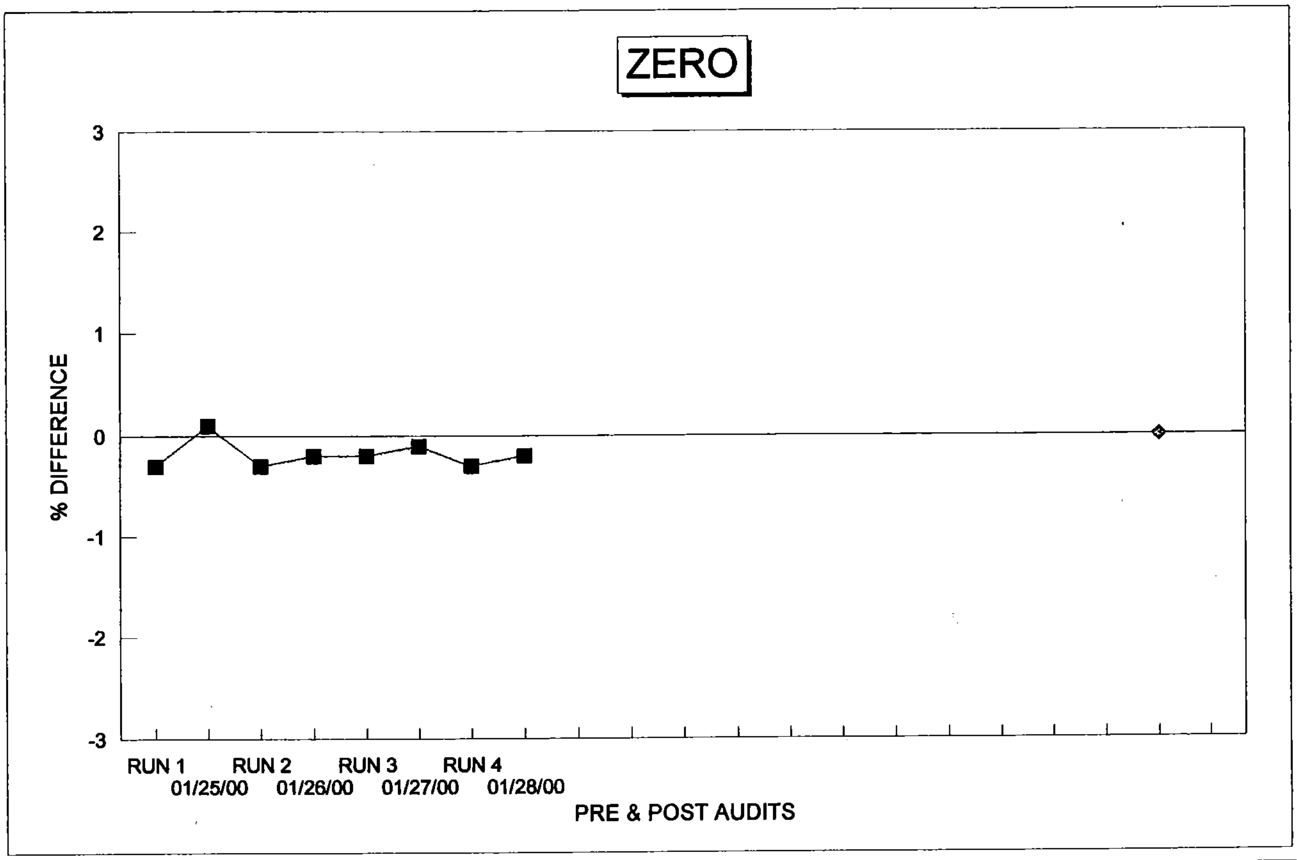


EPA Span Value = ± 2.0% of 25% CO_2 = ± .5%

Cal Volts = Cal Volt Conc - Std Conc = ± Conc Diff = ± Δ %

.839 = 20.975 - 21.0 = -.025 = -.100

.252 = 6.300 - 6.25 = .050 = .200


ZERO
3
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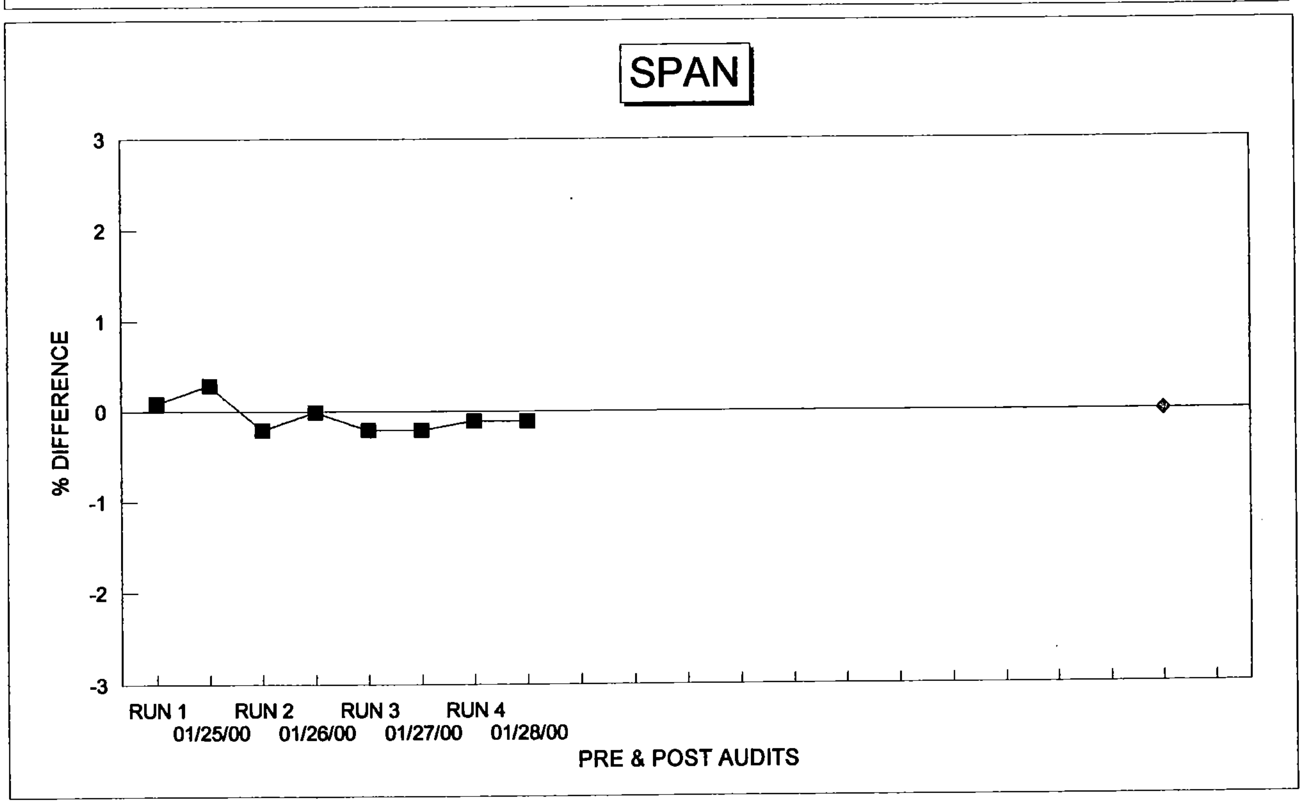
-1
-2
-3
% DIFFERENCE
RUN 1
RUN 2
RUN 3
RUN 4
01/25/00
01/26/00
01/27/00
01/28/00
PRE & POST AUDITS


SPAN
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-1
-2
-3
% DIFFERENCE
RUN 1
RUN 2
RUN 3
RUN 4
01/25/00
01/26/00
01/27/00
01/28/00
PRE & POST AUDITS

O_2 ANALYZER
MULTIPOINT CALIBRATION REPORT FORM

Date: 1-6-2000

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

Calibration by: C. Wadington

Cal Gas Flow: 1.5 SCFH Measured by: Rotameter

BP: 30.30 Instrument ID: PRINCO

Temp: 69 Instrument ID: TR

Analyzer last calibrated: 11-20-99 By: C. Wadington

Cylinders:

1. # TX 79373 Concentration: 00.00 % O_2 Cyl. Press.: 1350 PSI
   Certified by: AIR LIQUIDE Date: 9/22/98
2. # CC52549 Concentration: 12.51 % O_2 Cyl. Press.: 490 PSI
   Certified by: AIR LIQUIDE Date: 9/22/98
3. # AAL 7152 Concentration: 21.0 % O_2 Cyl. Press.: 480 PSI
   Certified by: SCOTT SPECIALTY GASES Date: 5/15/97
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	00.00	00.0	.000	00.0	.000	—	—			
2	2	12.51	12.5	.500	12.5	.500	—	—			
3	3	21.0	21.0	.840	21.0	.839	—	—			
4	4	6.24	6.2	.250	6.2	.252	—	—			
5	1	00.00	00.0	.000	00.0	.000	—	—			

.5 = 12.499

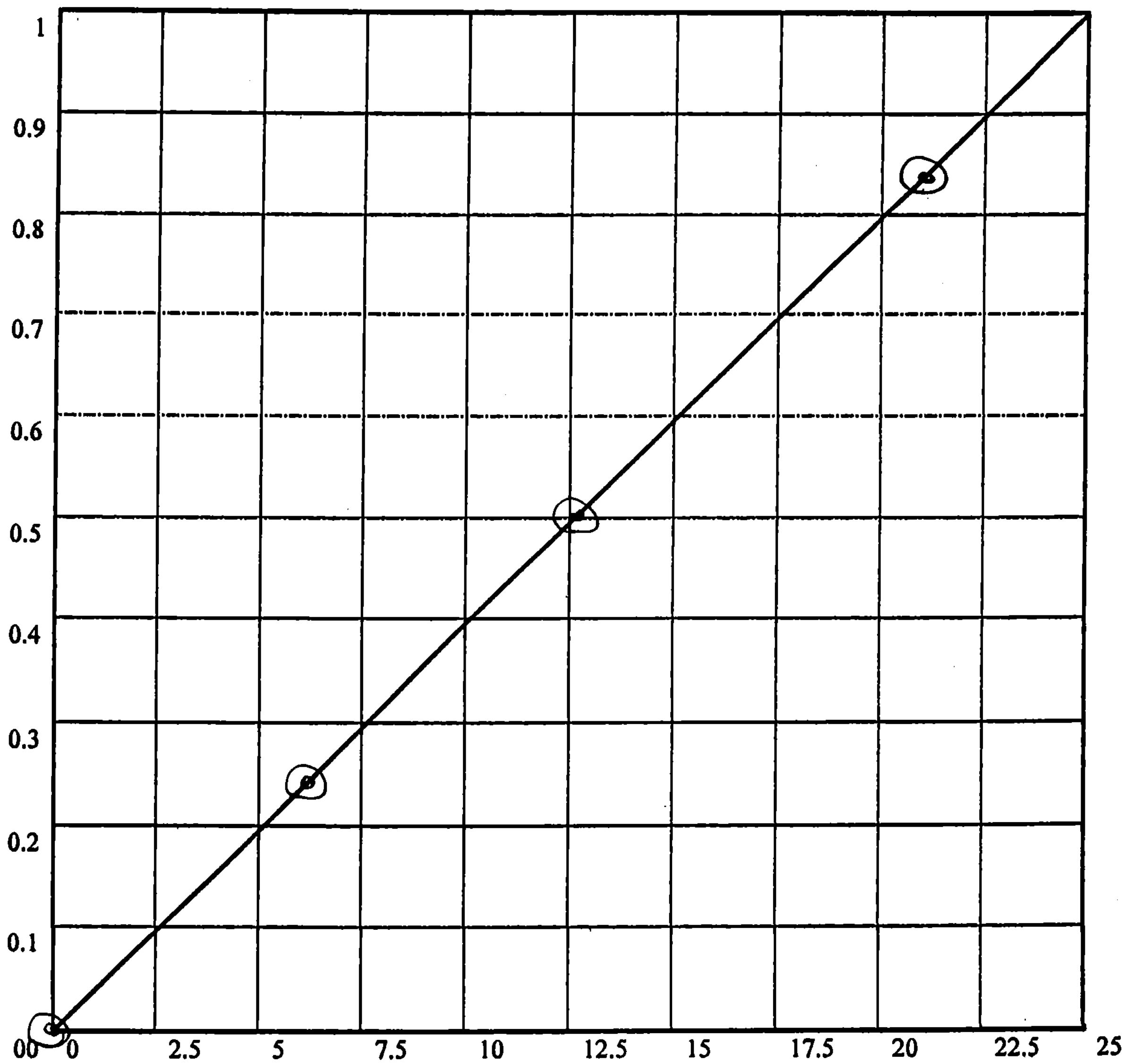
O_2 Linear Regression Results:

Y = MX +B
Slope (M) = .0399132

Y Intercept (B) = .0011130

Correlation Coefficient (r) = .9999937

r^2 = .9999874

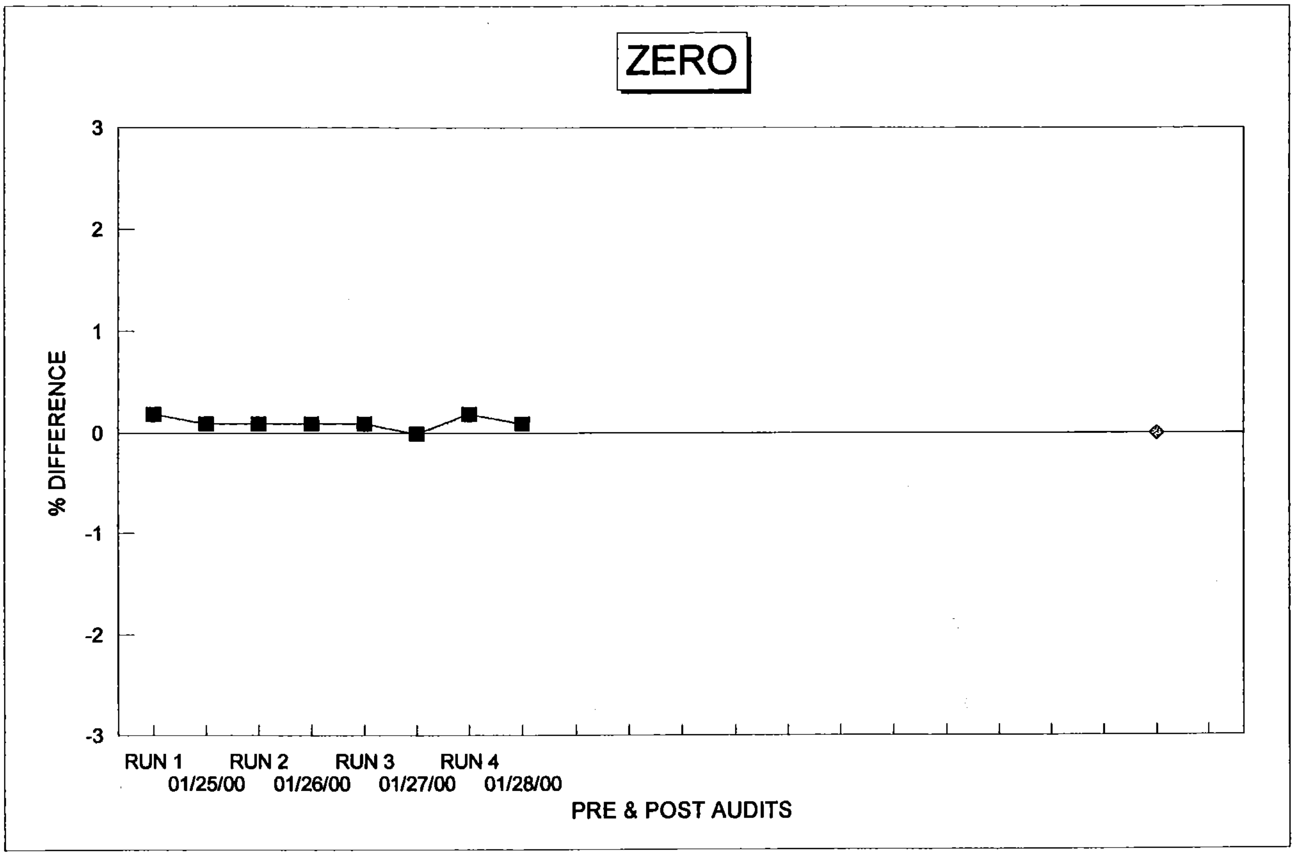


EPA Span Value = ± 2.0% of 25% CO_2 = ± .5%

Cal Volts = Cal Volt Conc - Std Conc = ± Conc Diff = ± Δ %

.839 = 20.992 - 21.0 = -.008 = -.033

.252 = 6.305 - 6.24 = .065 = .260


ZERO
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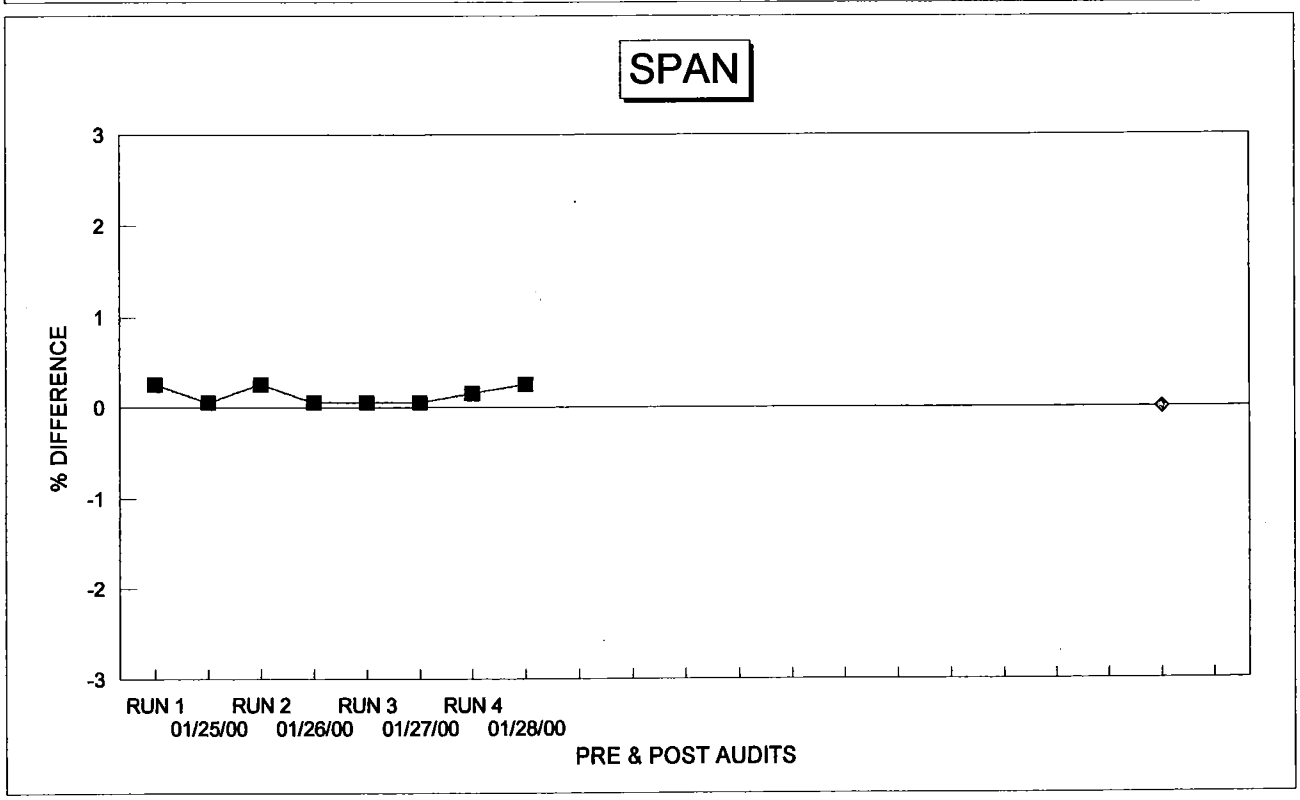
-3
% DIFFERENCE
RUN 1
RUN 2
RUN 3
RUN 4
01/25/00
01/26/00
01/27/00
01/28/00
PRE & POST AUDITS


SPAN
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-1
-2
-3
% DIFFERENCE
RUN 1
RUN 2
RUN 3
RUN 4
01/25/00
01/26/00
01/27/00
01/28/00
PRE & POST AUDITS

CO ANALYZER
MULTIPOINT CALIBRATION REPORT FORM

Date: 1-6-2000

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

Calibration by: C. Waddington

Cal Gas Flow: 1.5 SCFH Measured by: Rotameter

BP: 30.30 Instrument ID: PRINCO

Temp: 69 Instrument ID: TR

Analyzer last calibrated: 11-20-99 By: C. Waddington

Cylinders:

1. # TX 79373 Concentration: 00.00 % **CO** Cyl. Press.: 1350 PSI
   Certified by: AIR LIQUIDE Date: 9/22/98
2. # CC 52549 Concentration: 5.08 % **CO** Cyl. Press.: 490 PSI
   Certified by: AIR LIQUIDE Date: 9/22/98
3. # AAL 7152 Concentration: 8.51 % **CO** Cyl. Press.: 480 PSI
   Certified by: SCOTT SPECIALTY GASES Date: 5/15/97
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	00.00	00.0	.000	0.10	.001	0.00	.000			
2	2	5.08	50.8	.508	50.9	.509	50.8	.508			
3	3	8.51	85.1	.851	85.0	.850	—	—			
4	4	2.01	20.1	.201	20.2	.202	—	—			
5	1	00.00	00.0	.000	00.0	.000	—	—			

.5 = 5.002

CO Linear Regression Results:

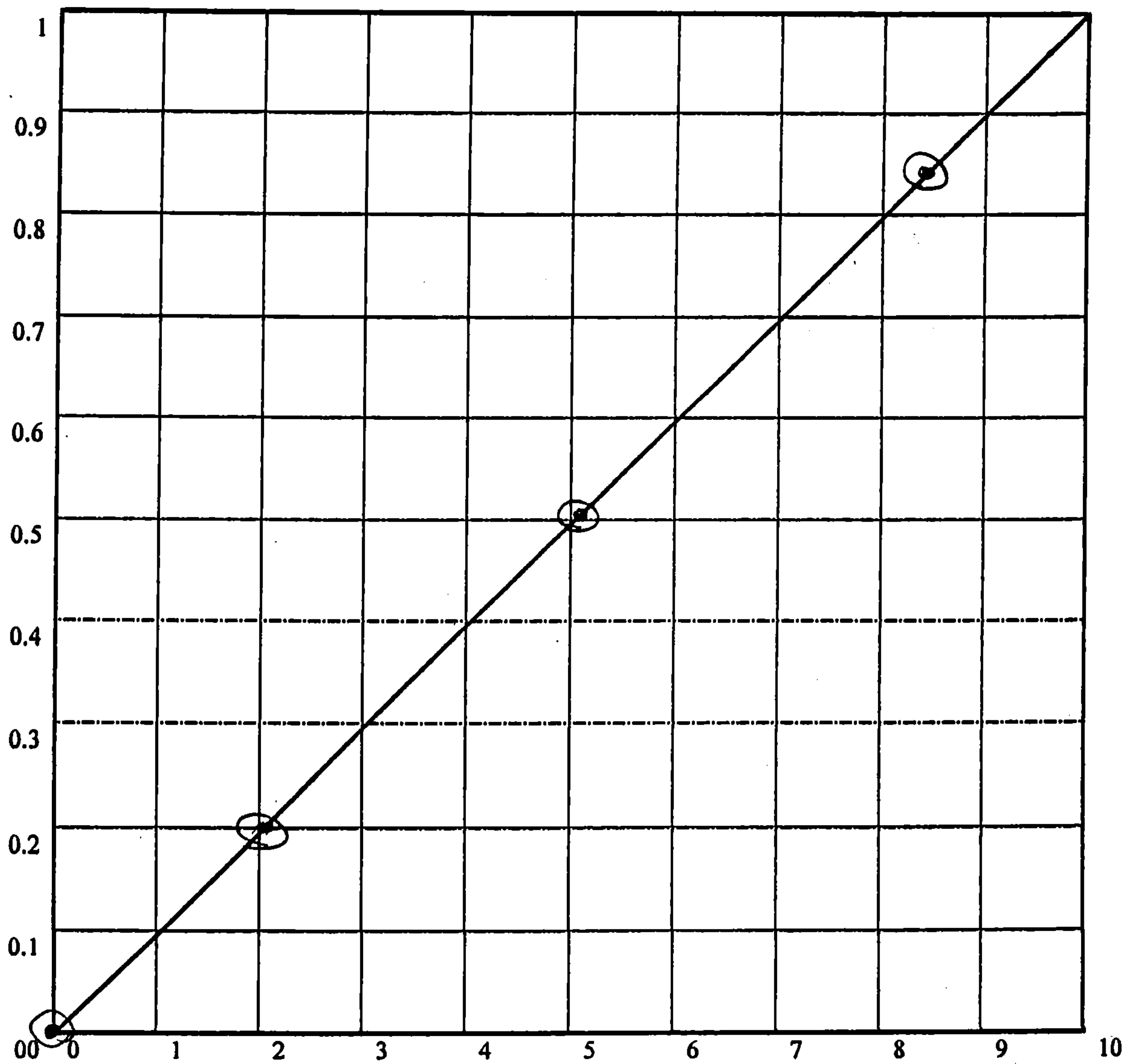
Y = MX +B

Slope (M) = .0998431

Y Intercept (B) = .0006119

Correlation Coefficient (r) = .999988

r^2 = .9999976

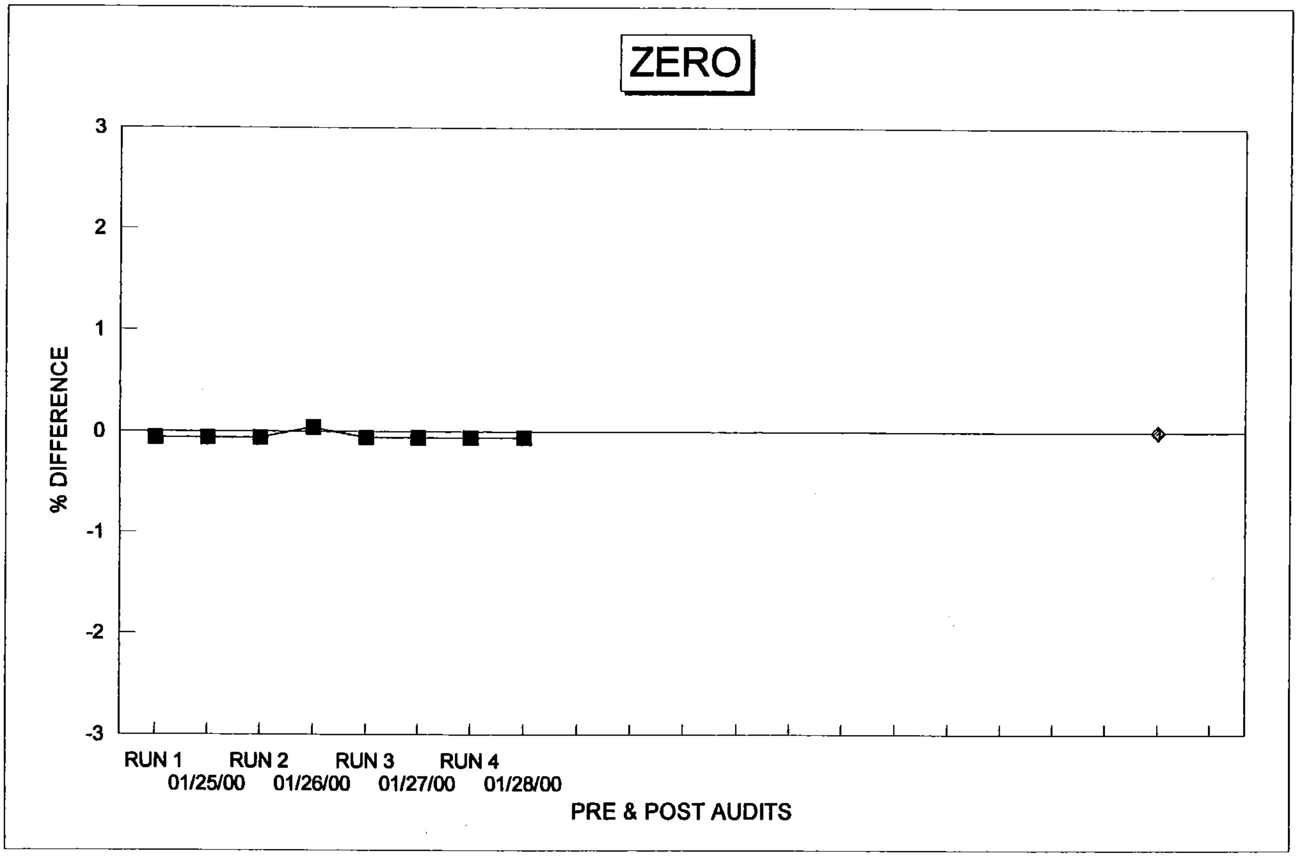


EPA Span Value = ± 2.0% of 10% CO = ± .2%

Cal Volts = Cal Volt Conc - Std Conc = ± Conc Diff = ± Δ %

.850 = 8.50 - 8.51 = -.010 = -.100

.202 = 2.020 - 2.010 = .010 = .100


ZERO
% DIFFERENCE
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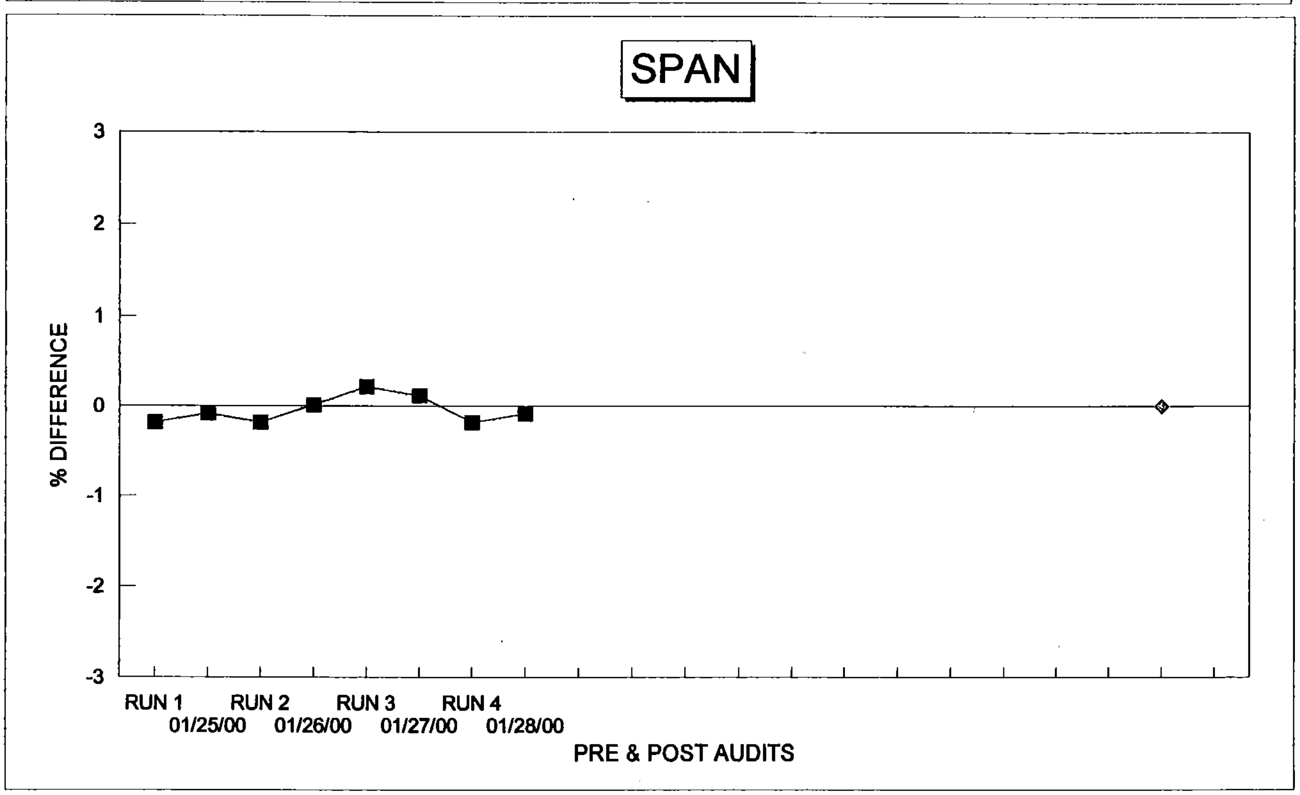
-3
RUN 1
RUN 2
RUN 3
RUN 4
01/25/00
01/26/00
01/27/00
01/28/00
PRE & POST AUDITS


SPAN
% DIFFERENCE
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0
-1
-2
-3
RUN 1
RUN 2
RUN 3
RUN 4
01/25/00
01/26/00
01/27/00
01/28/00
PRE & POST AUDITS

SO_2 ANALYZER
MULTIPOINT CALIBRATION REPORT FORM

Date: 1-6-2000

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

Calibration by: C. Wadington

Cal Gas Flow: 1.5 SCFH Measured by: Rotameter

BP: 30.30 Instrument ID: PRINCO

Temp: 69 Instrument ID: TR

Analyzer last calibrated: 11-20-99 By: C. Wadington

Cylinders:

1. # TX 79373 Concentration: 00.00 % SO_2 Cyl. Press.: 1350 PSI
   Certified by: AIR LIQUIDE Date: 9/22/98
2. # CC 67475 Concentration: 1260 % SO_2 Cyl. Press.: 750 PSI
   Certified by: AIR LIQUIDE Date: 9/22/98
3. # ALMO 49127 Concentration: 1770 % SO_2 Cyl. Press.: 1190 PSI
   Certified by: SCOTT SPECIALTY GASES Date: 5/15/97
4. # ALMO 52285 Concentration: 506 % SO_2 Cyl. Press.: 1050 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	00.00	00.0	.000	00.0	.000	—	—			
2	2	1260	50.4	.504	51.1	.511	50.4	.504			
3	3	1770	70.8	.708	71.0	.710	—	—			
4	4	506	20.2	.202	19.9	.199	—	—			
5	1	00.00	00.0	.000	00.0	00.0	—	—			

.5 = 1249.354

SO_2 Linear Regression Results:

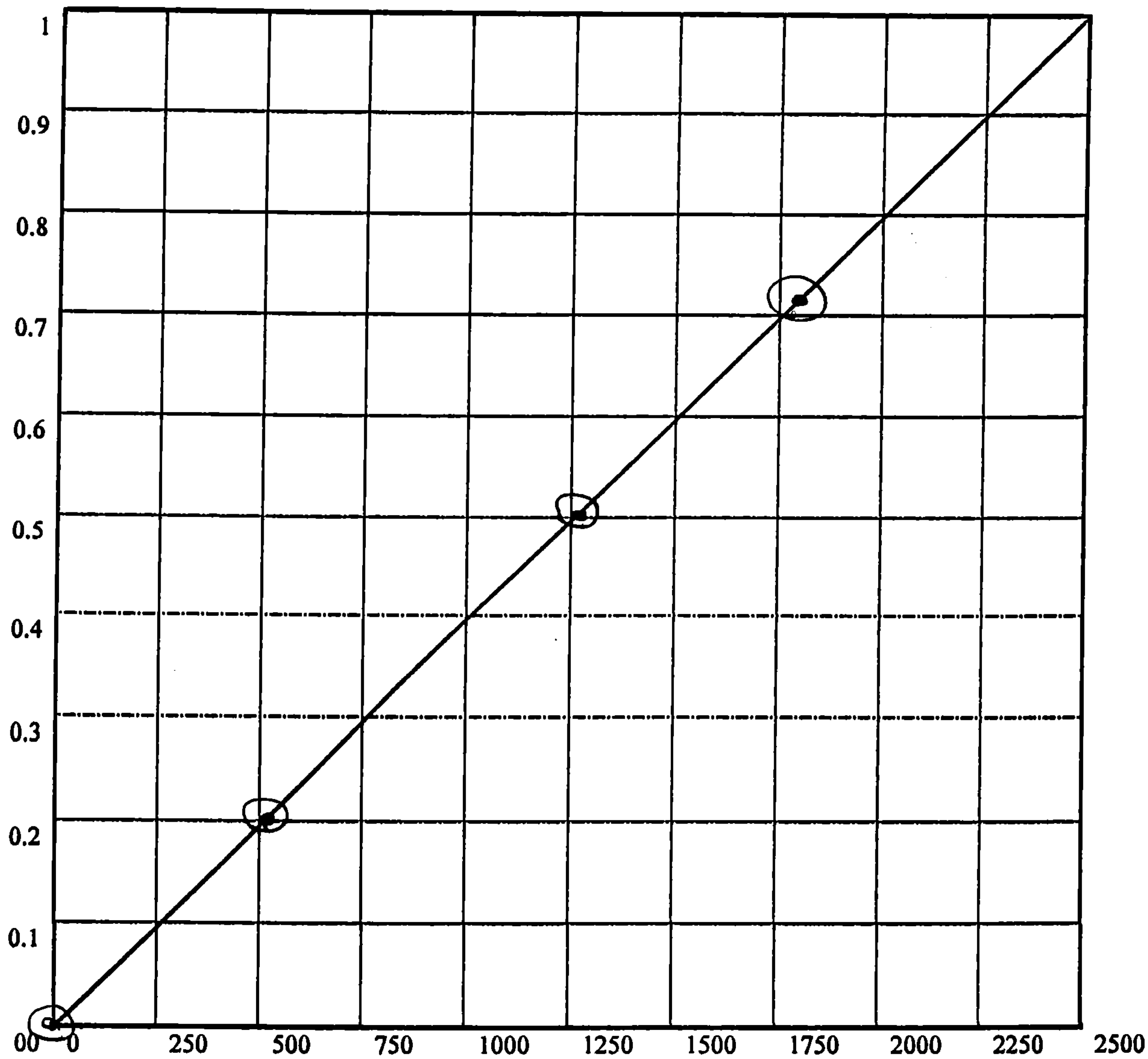
Y = MX +B

Slope (M) = .0004017

Y Intercept (B) = -.0018103

Correlation Coefficient (r) = .9999832

r^2 = .9999664

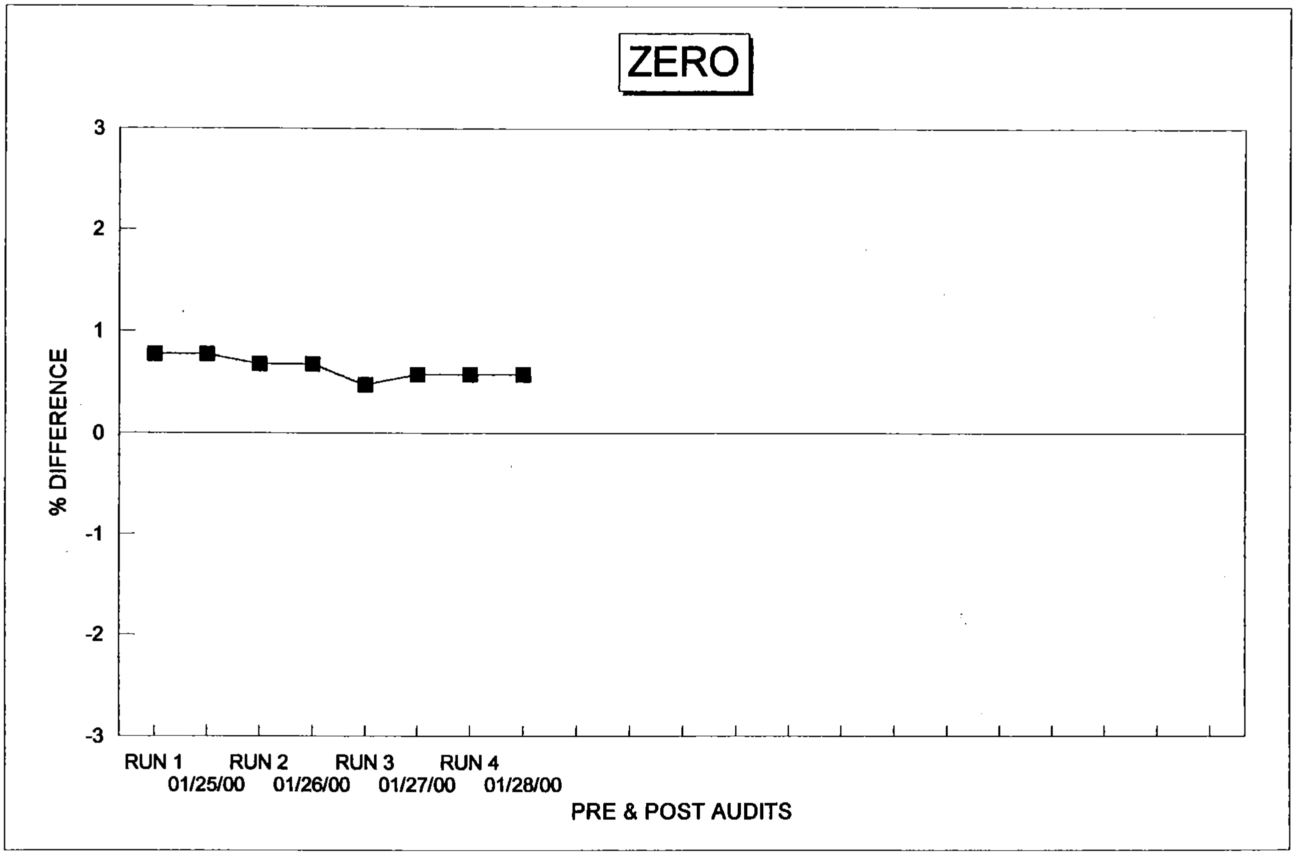


EPA Span Value = ± 2.0% of 2500 PPM SO2 = ± 50 PPM

Cal Volts = Cal Volt Conc - Std Conc = ± Conc Diff = ± Δ %

.710 = 1775.000 - 1770.000 = 5.000 = .200

.199 = 497.500 - 506.000 = -8.500 = -.340


ZERO
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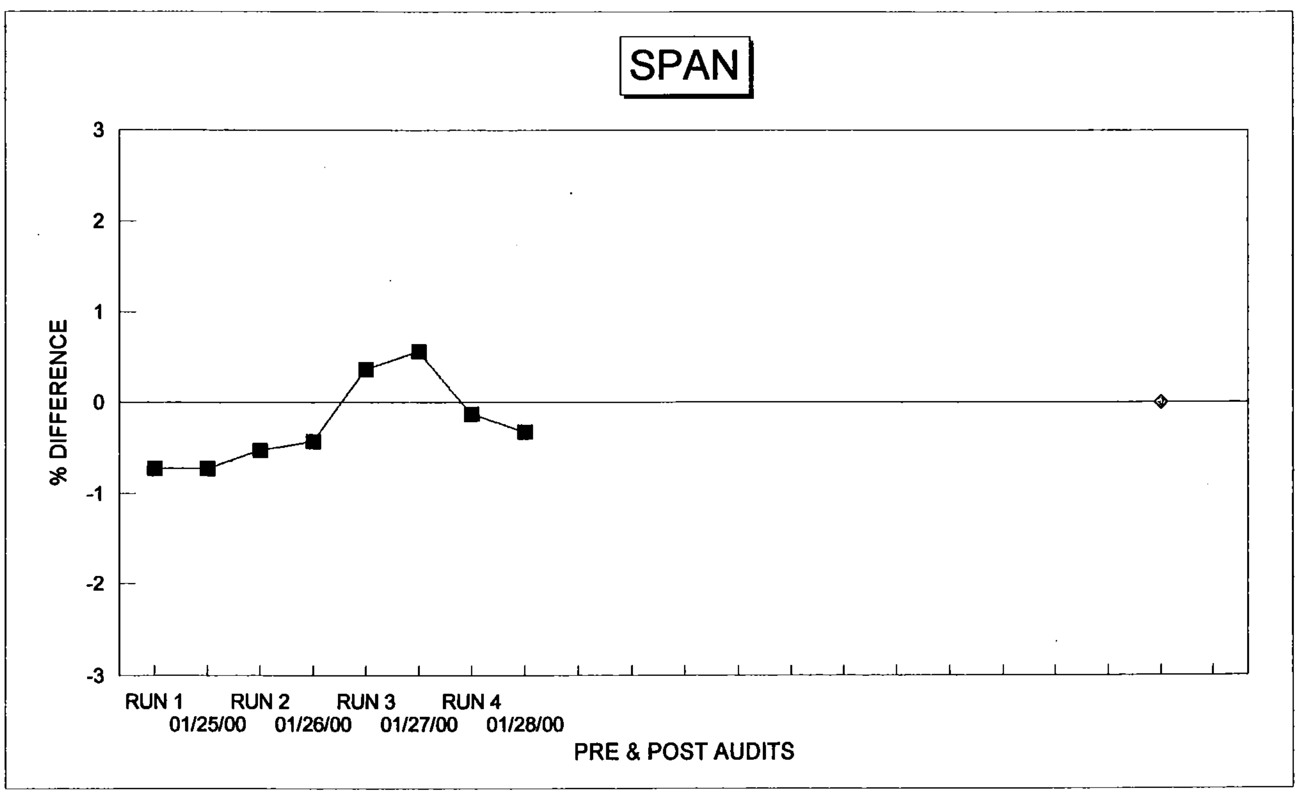
-3
% DIFFERENCE
RUN 1
RUN 2
RUN 3
RUN 4
01/25/00
01/26/00
01/27/00
01/28/00
PRE & POST AUDITS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-3
% DIFFERENCE
RUN 1
RUN 2
RUN 3
RUN 4
01/25/00
01/26/00
01/27/00
01/28/00
PRE & POST AUDITS

MANUAL

8.25

+1.125

9.375 = 238.125
241.30

9.45

$19\frac{22}{32}$ 19.6875 500.0625

$19\frac{3}{8}$ 19.375 492.125

(480 −6 486 +6 = 492)

500

486 = 19.15

Aksjonsliste/Action List, F3 USA. Oppdatert 11.4.07/MK & RJ.

	Item #	Issue	Sak
FUEL TO VOLUME RELATION	1	Burn chamber width is outside tolerances. Jøtul N.A to propose action. **Action taken**: Oddmund has revised ITS Approval Drawing 4-4238 from P00 to P01, now showing burnchamber width 486 mm. **Next action: Jøtul NA to implement revised drawing with ITS/EPA.**	Brennkammer er for bredt. Jøtul N.A. foreslår tiltak. Tiltak utført: Oddmund har revidert ITS godkjenningstegning 4-4238 fra P00 til P01, tegningen viser nå brennkammer bredde 486 mm. **Neste tiltak: Jøtul NA må implementere revidert tegning i godkjenning fra ITS/EPA.**
238 NOM	2	Burn chamber height, HB2 is very marginal. Action resommended. **Action taken**: Oddmund has revised ITS Approval Drawing 4-4238 from P00 to P01, now showing HB2 = 240 mm. **Next action: Jøtul NA to implement revised drawing with ITS/EPA.**	Brennkammer er for høyt. HB2 har for liten toleranse. Tiltak anbefales. Tiltak utført: Oddmund har revidert ITS godkjenningstegning 4-4238 fra P00 til P01, tegningen viser nå HB2 =240 mm. **Neste tiltak: Jøtul NA må implementere revidert tegning i godkjenning fra ITS/EPA.**
OK	3	Heat shield under stove is larger than shown on approval drawing. Revice drawing) **Action taken:** Oddmund has revised ITS Approval Drawing 4-4238 from P00 to P01, now showing Bottom Heat Shield to be 316 mm x 238 mm.. **Next action: Jøtul NA to implement revised drawing with ITS/EPA.**	Varmeskjold under ovnen er større enn på godkjenningspapirene. Revidere tegning. **Tiltak utført:** Oddmund har revidert ITS godkjenningstegning 4-4238 fra P00 til P01. Tegningen viser nå varmeskjoldet som 316 mm x 238 mm. **Neste tiltak: Jøtul NA må implementere revidert tegning i godkjenning fra ITS/EPA.**
OK BETTER SEAL	4	Cover Plate Gasket is LD 250, not LD 187. Drawing revision needed. **Action taken:** Oddmund has revised ITS Approval Drawing 4-4244 from P00 to P01, now specifying LD 250 for Cover Plate.. **Next action: Jøtul NA to implement revised drawing with ITS/EPA.**	Pakning for røkhullsdeksel stemmer ikke med tegning. Benytter LD250, ikke LD187. Trenger ny revisjon av tegning. **Tiltak utført:** Oddmund har revidert ITS godkjenningstegning 4-4244 fra P00 til P01. Tegningen angir nå LD 250 for røkhullsdeksel.. **Neste tiltak: Jøtul NA må implementere revidert tegning i godkjenning fra ITS/EPA.**
	5	**Primary air valve area tends to be smaller than the lower limit of 2660 mm^2 resulting from the nominal area of 2800 mm2 stated by ITS approval drawing 4-4238 P01.**	**Ventil for primærluft tenderer til å ha areal underminimum = 2660 mm^2 basert på nominelle 2800 mm^2 spesifisert av ITS godkjenningstegning 4-4238 P01.**
	6		

Roger Purinton

From: Magne Kilebu
Sent: Thursday, April 19, 2007 12:36 PM
To: Roger Purinton
Cc: Skjønsholt Oddmund
Subject: SV: F 3 USA.xls

Roger,

Further to the F 3 valve issue:
a) Our drawing 3-2498 P00 is attached. The previous FAM approval drawing was based on the valve dimensions and calculations shown therein, yielding nominally 2800 mm^2.

b) The 35 mm x 24 mm openings (A2) dimensions appear to be taken from our drawing 2-99-0619. This drawing shows the said dimensions to include 7° slip angle thru the thickness of the valve (102457). The A2 dimensions used do therefore not reflect the actual opening dimension at the parting line side (which is smaller).
The nominal area of 2800 mm2 was therefore calculated from incorrect input and should be corrected. The correct A2 dimensions would be 33mm x 22 mm, which is also what we actually find.
A corrected total valve opening area would be

New nominal area calculation, mm^2	
New A total	**2457,5**
Same A1	687,5
New A2	590

The actual A1 area is approximately 10% larger than the nominal, but total actual valve area would be within the revised ±5% limits.

This way to solve the valve area issue will require revision of the approval drawing 4-4238 P01 that Oddmund recently sent you and we would probably need to support the change as outlined above.

Your comments please.

Best regards,

Magne

-----Opprinnelig melding-----
Fra: Roger Purinton [mailto:RPurinton@jotulnoamer.com]
Sendt: 18. april 2007 20:37
Til: Kilebu Magne
Kopi: Paul Andrews; Holliday Jim; Skjønsholt Oddmund
Emne: RE: F 3 USA.xls

Hello Magne,

My responses to the issues.

1. Upon reviewing the test data from the certification report, I find that all the fuel loads are nearly the exact nominal weight. The fuel loads are based on 7 lbs of fuel per cubic foot of firebox volume. By recalculating the firebox volume based on the adjusted dimension it is likely that the tested fuel loads will still be applicable to the revised volume. I recall getting EPA to agree to this proposal for a Vermont casting stove, so in my mind they established a precedent.

At the moment I am quite tied up with the Board Meeting, presentations, etc. I will recalculate the volume and get back to you by the end of the week .I don't expect a problem.

The only other option would be obtaining permission from EPA to un-seal the test unit and confirm the measurement. I really don't want to go that route.

2. Same response as to #1

3. Larger heat shield is OK

4. In strict technicality the new gasket should be run by EPA for approval. Considering the size is greater, it should provide an improved seal. In addition this is past the point of combustion so it would be considered to have minor relevance.

Regards,

Roger

PS Which stove do you want to concentrate on next?

-----Original Message-----
From: Magne Kilebu
Sent: Monday, April 16, 2007 10:23 AM
To: Roger Purinton
Cc: Paul Andrews; Jim Holliday; Skjønsholt Oddmund
Subject: F 3 USA.xls

Hello Roger,

Please find attached updated version of our updated EPA QC records for F 3 USA.
Oddmund recently sent you a revised approwal drawing package for this product.
We have now become aware that the real maximum opening area of the primary air valve is below the minimum of 2660 mm2 following from the nominal of 2800 mm2 shown on drawing 4-4838 P01.
The valve is difficult to measure, but we have now found a method we think is sufficiently accurate.

We seam to have two alternatives:
a) Revise approval drawing 4-4238 again to show smaller nominal valve opening (which is probably what it has always been).
b) Modify actual valve parts to comply with drawing.

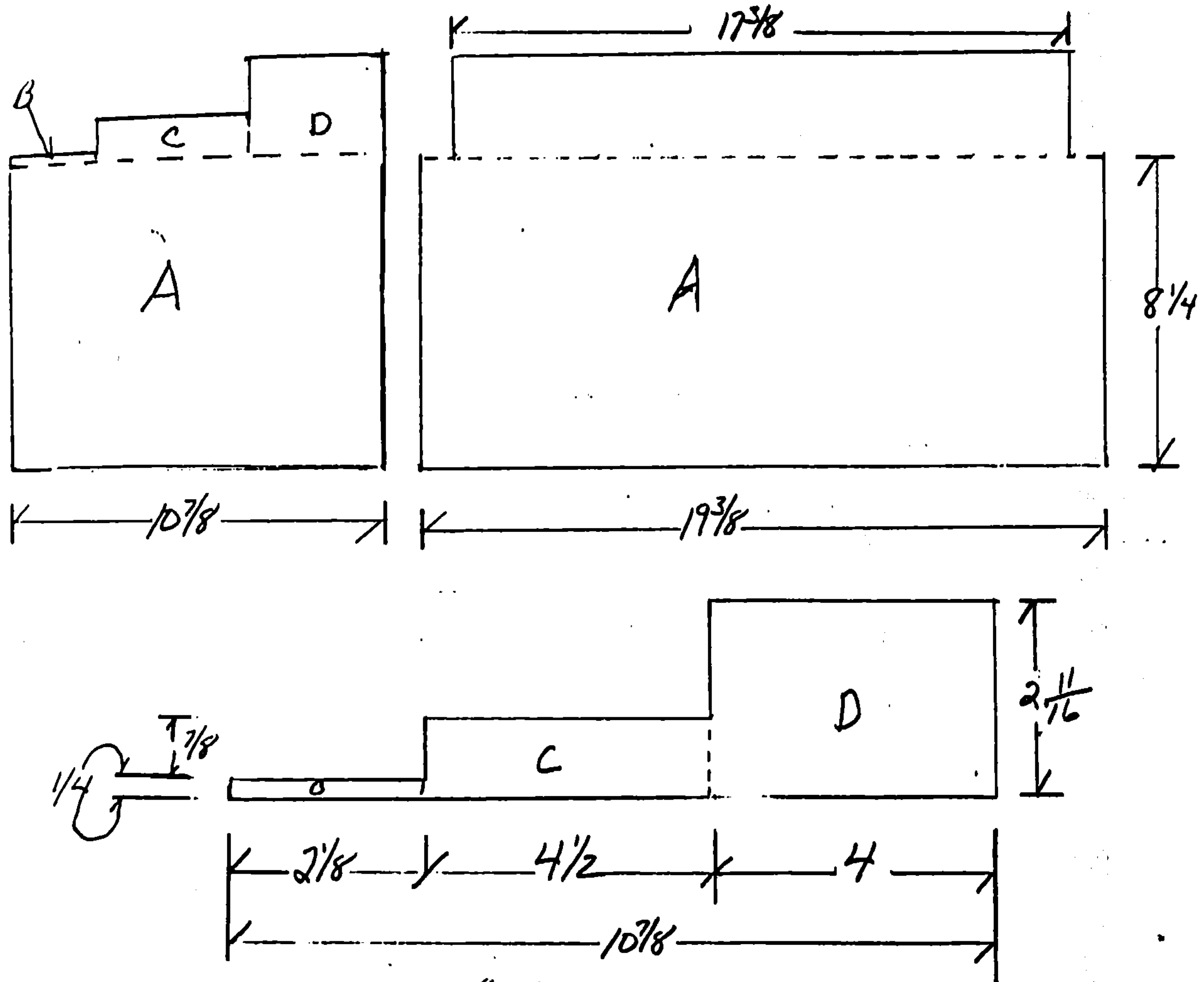
We regret this discovery this late; we realize that you may have submitted the revised 4-4238 to the authoroties already.
Please let us know what you think should be the next step.

Magne

##

##

FIRE BOX VOLUME CALCULATION



19,15

A = 10.875 × 8.25 × 19.375 = 1738.300781   1718.114063

B = 2.125 × .25 × 17.375 = 9.23046875

C = 4.5 × 1.2 1.125 × 17.375 = 87.9609375   93.825

D = 4.0 × 2.6875 × 17.375 = 186.78125

2022.273437 IN^3 2007.950782

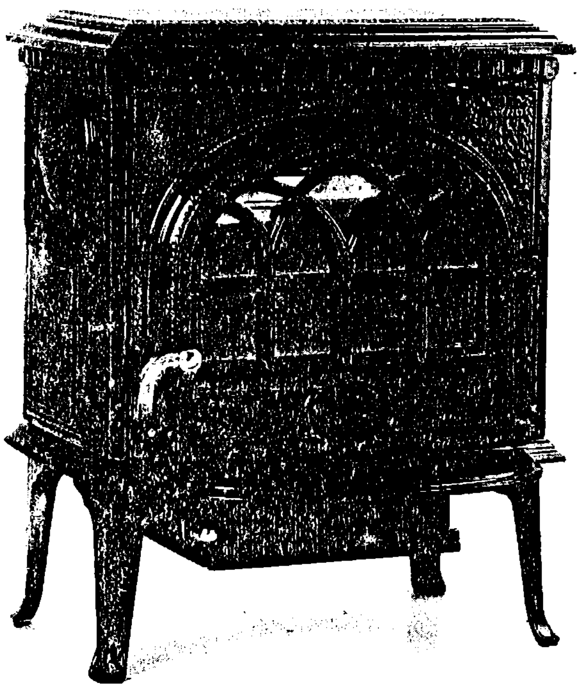
= 1.170 FT^3 1.162008554

7.4 – 8.2 – 9.0

Low   Ideal   High   7.317-8.13-8.94

Fuel load range

JØTUL®



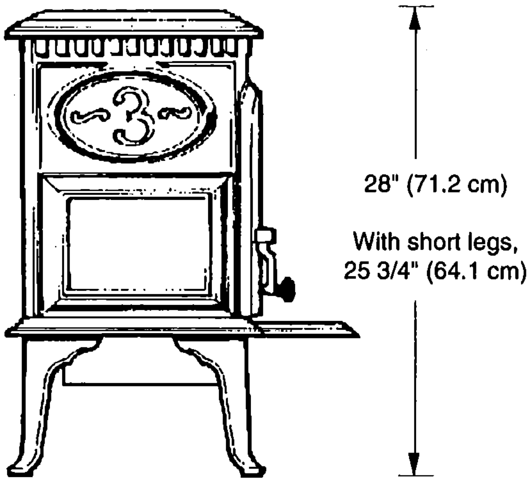
Jøtul 3 CB

04 MAI 1999

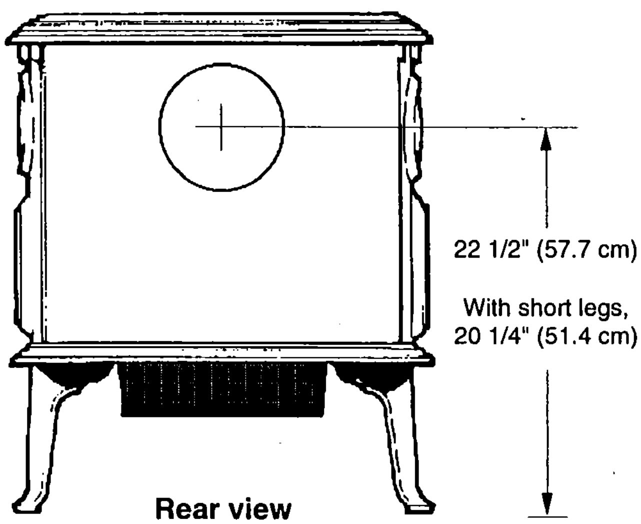
Safety notice: If this solid fuel room heater is not properly installed, a house fire may result. For your safety, follow the installation directions. Contact local building or fire officials about restrictions and installation inspection requirements in your area. Kindly save these instructions for future references.

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

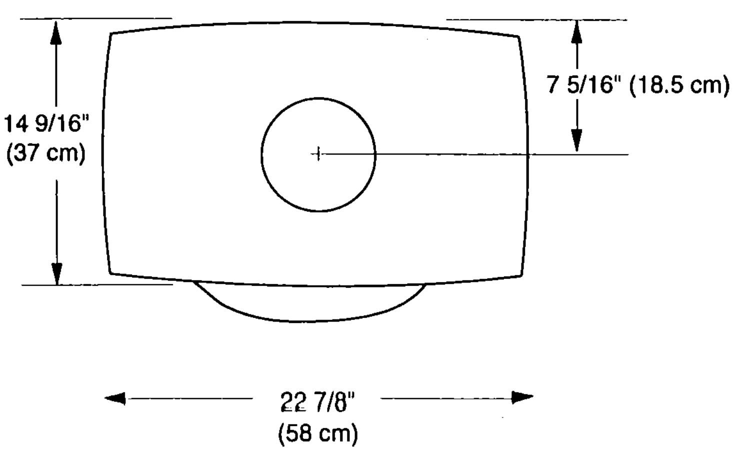
Tested and listed by Intertek Testing Services–Warnock Hersey of Middleton, Wisconsin.
Tested to UL 737, UL 1482, ULC S627, December, 1995. Report No. 13321–764



Side view



Rear view



Top view

TABLE OF CONTENTS

1. General Information

The Owner's Manual describes the installation and operation of the Jøtul 3 CB non-catalytic wood heater. This heater meets the U.S. Environmental Protection Agency's emission limits for wood heaters sold after July 1,1990. Under specific test conditions, this heater has shown heat output at rates ranging from **13,095** to **58,553** BTU's per hour.

When installing, operating, and maintaining your Jøtul 3 CB, follow the guidelines given in these instructions. Save these instructions, and make them available to anyone using the stove.

A number of areas of the U.S. and Canada require a building permit to install a solid-fuel burning appliance. NFPA 211 (National Fire Protection Association, *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel Burning Appliances*) or CAN/CSA B-365 (Installation Code for Solid-Fuel Burning Appliances and Equipment) may apply to the installation of solid fuel burning appliances in your area. Your Jøtul dealer has knowledge of your local codes and can provide assistance in making sure your installation is safe and legal. Also contact your insurance representative, building inspector, or fire officials to determine what regulations apply in your area.

The Jøtul 3 CB has been tested and listed to ANSI-UL 737, ANSI-UL 1482, and ULC S627 by Inchcape Testing Services-Warnock Hersey of Middleton, Wisconsin.

2. Possible Hazards to Avoid When Using the Jøtul 3 CB Woodstove

Any use of fire in a house represents a certain danger. With intense overfiring, temperatures on the surface of the 3 CB can exceed 1000 degrees F. (536 degrees C).

Comply with the following guidelines:

• 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.

• Teach children that the stove is hot and must not be touched.

• Never use gasoline, gasoline-type lantern fuel, kerosene, charcoal lighter fluid or similar liquids to start or "freshen up" a fire in this heater. They can ignite with explosive force, causing bodily injury or death. Keep all such liquids far away from the heater while it is in use.

• Never use the stove if there are combustible gases in the house. Certain cleaning fluids, adhesives, and paints are a few examples of household products that can produce combustible gases. Remember, the operating woodstove is a source of "open flame".

• Avoid creating a "low pressure" condition in the room where the stove is operating, such as by operating an exhaust fan or a clothes dryer. A low pressure condition could cause poisonous gases to be drawn out of the stove into the room. You can prevent a low pressure condition by providing adequate outside combustion air within 24" of the stove.

• Never operate the Jøtul 3 CB if it has cracked or broken glass. Replace damaged glass only with the proper 3 CB glass panel available from your Jøtul dealer.

• Never burn trash of any kind in the stove.

• Keep combustible materials far away from the stove.

• Never modify the stove in any way.

• Do not dry clothes over the stove, since they could fall and ignite.

• Use only seasoned wood in your stove. Never use fireplace coal or synthetic logs that have not been approved for use in a wood stove.

• Always wear protective gloves when adding fuel to the fire.

• This stove is not approved for use in mobile homes.

3. Assembly

The 3 CB must have the four legs, ash lip, and door handle knob installed before it can be used. These items are packed inside the stove, along with a detachable multi-purpose handle, a complementary container of touch-up paint, and a plastic bag of screws for component asembly. (**Figure 1**)

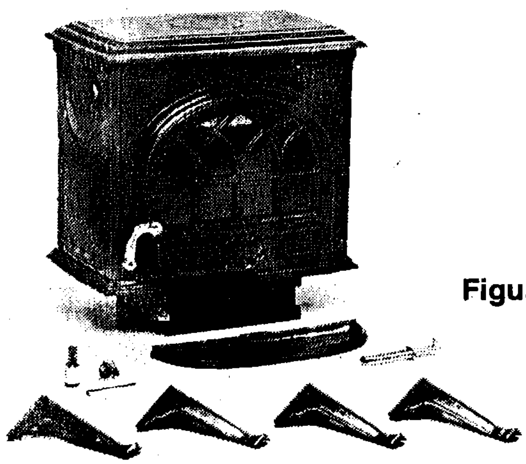


Figure 1

1. Carefully tip the stove onto its side.

2. Position a leg in a corner of the stove bottom and secure it by threading the 6 x 20 mm bolts provided into the bolt hole. Repeat this procedure for the remaining three bolts. Firmly tighten all four bolts.

3. Carefully tip the stove back up onto its legs.

4. Install the ash lip by hooking it onto the stove front, just below the front door. Secure it by threading the 6 x 16 mm bolt provided into the ash lip bolt hole.

5. Screw the handle knob onto the front door handle. See assmbly sequence in **Figure 1A**.

NOTE: Optional short legs that reduce the height of the 3 CB by 2 1/4" are available from authorized Jøtul dealers.

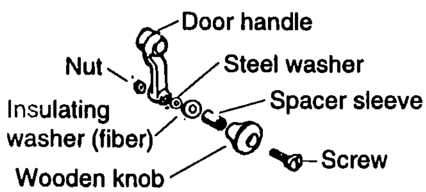


Figure 1A

4. Installation

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.

Please read this entire manual before you install and use your new stove. Failure to follow instructions may result in property damage, bodily injury, or even death.

We recommend that you have your 3 CB installed by a professional installer of solid fuel room heaters.

Choose A Flue Exit Position

The 3 CB may be vented from the top, from the rear, or from either the right or left side. Whichever flue exit location is selected, a cast "knockout" must be removed in order to install the chimney connector. The 3 CB-Ivory may be vented from the rear only—the cast knockout has already been removed.

You may remove the top or rear knockout by striking it with a rubber mallet, or by holding a block of wood against it and striking the wood with a hammer.

The Jøtul 3 CB comes equipped with a double rear heat shield as standard equipment.

If the stove is to be installed in a rear-exiting configuration, remove the cover plates on the heat shield using sheet metal sheers. Touch up any remaining sharp edges with a file.

Then, remove the knockout from the rear stove panel.

For a top-exiting stove, simply remove the knockout from the top plate.

If you will be side venting, first remove the screws that secure the top and remove the top. Break out the appropriate knockout by striking on the **INSIDE**.

CAUTION: REMOVE THE DOOR PRIOR TO STRIKING THE KNOCKOUT TO AVOID BREAKING THE GLASS.

Plan Ahead

A safe stove installation involves several elements, including: (A) the chimney connector, (B) the chimney itself, (C) the connection between the chimney connector and chimney, and (D) protection of combustible materials in the vicinity of the stove. Each of these elements is equally important for a safe stove installation.**For some stove installation you have to use a flue adapter to connect the flue pipe to the stove. See installation instructions on page 17.*

A. Chimney Connector (Stove Pipe)

Chimney connector is also sometimes called stove pipe or flue pipe, and it is used to connect the stove to the chimney. The chimney connector should be 6" diameter black steel, with a minimum 24 gauge thickness.

Do not use aluminum or galvanized steel pipe as a chimney connector. These materials cannot withstand the extreme temperatures of a wood fire and can give off toxic fumes when heated.

Matching enamel pipe is available for your 3 CB. Contact you Authorized Jøtul Dealer for more information.

Do not use chimney connector pipe as a chimney.

Chimney connector sections must be attached to the stove's flue exit and to each other with the crimped end toward the stove (**Figure 2**).

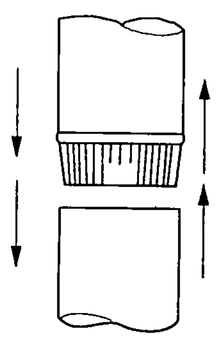


Figure 2

All joints should be secured with three sheet metal screws to ensure that the sections will not separate.

In the rear flue-exit configuration, the stove's flue exit and any attached connector pipe must be supported by either wall pass-through brackets or ceiling pass-through support brackets.

For proper operation, the chimney connector should be as short as possible. Horizontal lengths should have an upward slope from the stove of 1/4" per foot. Avoid using more than two 90-degree elbows or total runs of pipe greater than 10'.

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. Whenever possible, avoid passing the chimney connector through a combustible wall.

Wall Pass-Throughs

When your installation unavoidably requires that the chimney connector pass through a combustible wall to reach the chimney, extreme care must be taken. 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. In Canada, refer to CAN/CGA B365. Before beginning the installation, contact local building officials to make sure the proposed pass-through method meets local building code requirements.

A commonly used method to pass through a wall directly to a masonry chimney requires removal of all combustible material from at least 12" around the entire chimney connector. The space is then filled with at least 12" of brick around a fireclay liner. Be sure to locate it so that the top of the chimney connector will be at least 18" below the ceiling. To construct the brick pass-through, you will need an opening of 30" x 30" minimum. It will be necessary to cut wall studs, install headers, and construct a sill frame to maintain proper dimensions and to hold the weight of the brick. Minimum 3-1/2" (4" nominal) thick solid bricks are to be used. The fireclay liner (ASTM C35 or equivalent), minimum 5/8" wall thickness, must not penetrate into the chimney beyond the inner surface of the chimney flue liner and must be firmly cemented in place. If it is necessary to cut a hole in the chimney liner, use extreme care to keep it from shattering. Refractory mortar must be used at the junction to the chimney liner. See **Figure 3.**

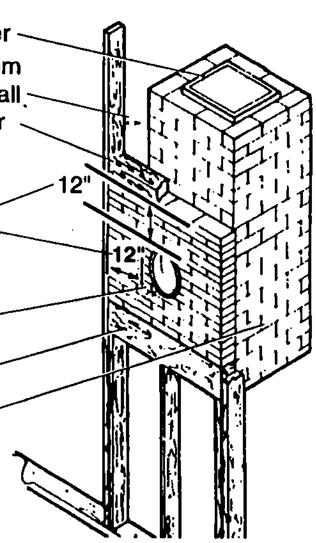


Figure 3

Figure 4 shows an approved installation that uses a section of listed solid fuel insulated factory-built chimney as a pass-through for the chimney connector.

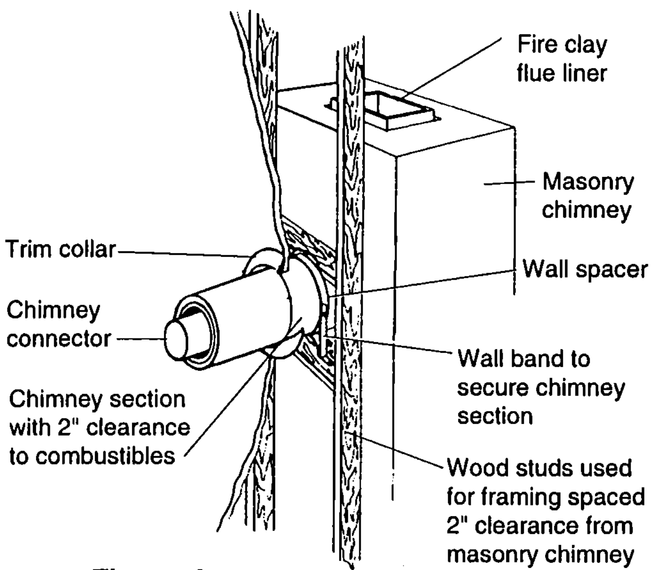


Figure 4

The chimney section must have an inside diameter which is 2" larger than the chimney connector, have a minimum length of 12" and must have at least 1" of insulation thickness. The chimney section is installed with at least 2" of air space between the outer chimney wall and adjacent combustible materials.

Sheet steel support plates are used on both ends of the chimney section to keep the connector centered. The opening around the chimney section is closed on both sides of the wall with sheet steel plates and the chimney section is securely fastened to the plates. Fasteners used to support the chimney section should never penetrate the inner flue liner.

See NFPA-211 for other approved wall pass-through methods.

B. Chimneys

There are two types of chimneys suitable for the 3 CB: An approved masonry chimney, or a safety-listed residential-type building heating appliance chimney.

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: the height, cross-sectional area, and temperature of the chimney, as well as the proximity of surrounding trees or buildings.

In general, 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 up, and in extremely cold northern areas it may not work at all.

A tall masonry chimney inside the house is easier to keep warm and will work the best.

This guideline gives the necessary chimney requirements based on the U.S. national code (NFPA 211). However, many local codes differ from the national code to take into account climate, altitude, or other factors. It is important that you check with your local building officials to find out what codes apply in your area before constructing a chimney.

Masonry Chimneys

The minimum requirements for a properly constructed masonry chimney include the following:

- The foundation must be large enough to support the intended chimney without settling.
- 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.
- The chimney must have a fireclay flue liner (or equivalent) with a minimum thickness of 5/8" and must be installed with refractory mortar. There must be at least 1/2" air space between the flue liner and chimney wall.
- The preferred fireclay flue liner size has a nominal size of 8" x 8", and should not be larger than 8" x 12". If round fireclay liners are used, the inside diameter should be 6" and not larger than 8". If an existing chimney with larger tiles is used, it should be relined with an appropriate liner.
- No other appliance can be vented into the same flue.
- An airtight cleanout door should be located at the base of the chimney.
- A chimney inside the house must have at least 2" of clearance to the combustible structure. A chimney outside the house must have at least 1" clearance to the combustible structure. Fire stops must be installed at the spaces where the chimney passes through floors and/or ceilings (**Figure 5**).

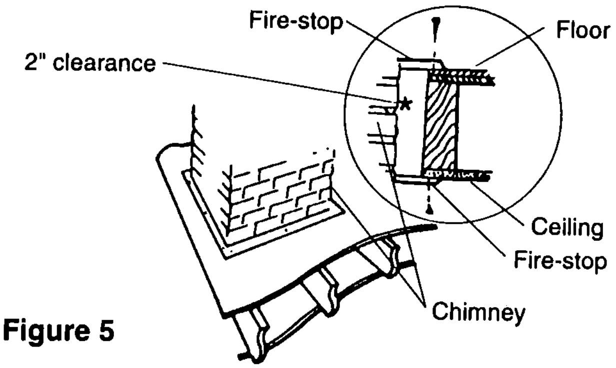


Figure 5

Remember that there must be air space around the chimney, and that insulation must be 2" or more from the chimney (**Figure 6**).

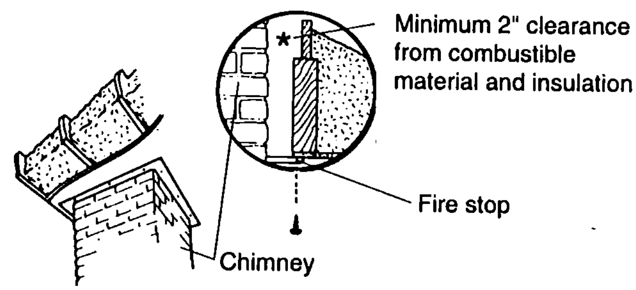


Figure 6

A chimney, whether masonry or prefabricated metal, must be the required height above the roof or other obstruction for safety and for proper draft operation. The requirement is that the chimney must be at least 3' higher than the highest point where it passes through the roof and at least 2' higher than the highest part of the roof or structure that is within 10' of the chimney, measured horizontally (**Figure 7**).

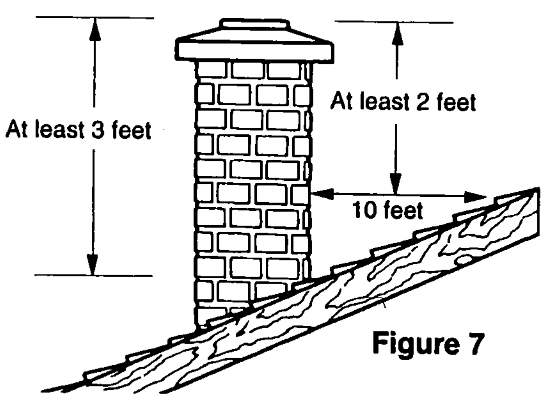


Figure 7

Chimneys shorter than 14' may not provide adequate draft. This could result in smoke spilling into the room from the door or joints in the stove or pipe. In addition, inadequate draft can cause backpuffing. A too-strong draft, on the other hand, can cause excessive temperatures and can shorten burn times. Excessive drafts can be corrected by having your dealer install a barometric damper set at 0.1" of water column. If you suspect you have a draft problem, consult your dealer.

Listed Metal Prefabricated Chimneys

When a metal prefabricated chimney is used, the manufacturer's installation instructions must be followed precisely. You must also purchase (from the same manufacturer) and install the ceiling support package or wall pass through, the "T" section package, the firestops (when needed), the insulation shield, the roof flashing, the chimney cap, etc. Maintain the proper clearance to the structure as recommended by the manufacturer. This clearance is usually a minimum of 2", although it may vary by manufacturer or for certain components.

There are basically two methods of metal chimney installation. One method is to install the chimney inside the residence through the ceiling and the roof (**Figures 8, 9**).

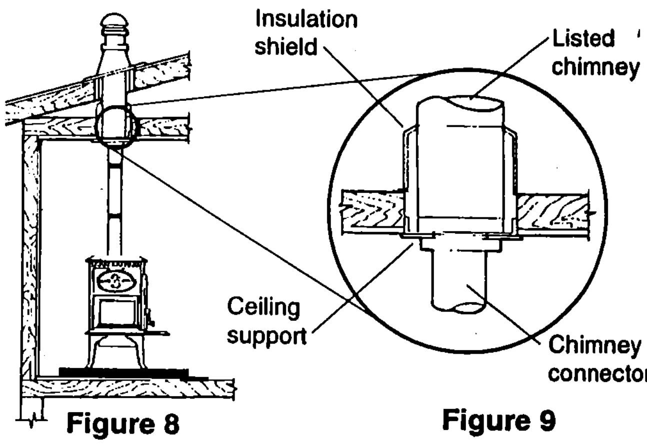


Figure 8 Figure 9

The other method is to install an exterior chimney that runs up the outside of the residence (**Figures 10,11**). The components illustrated may not look exactly like the system you purchase, but they demonstrate the basic components you will need for a proper and safe installation.

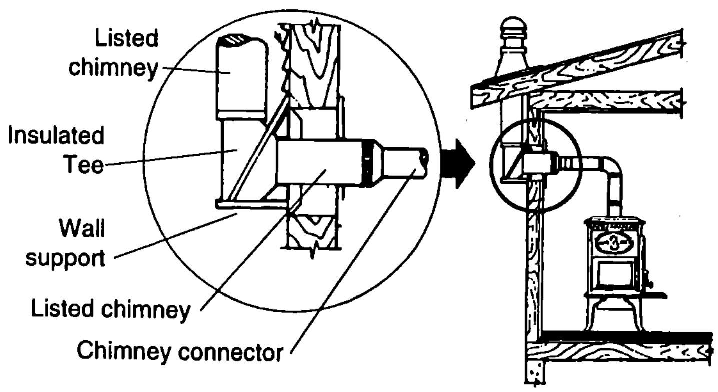


Figure 10 Figure 11

C. Connection to the Chimney

Masonry Chimneys

When connecting to a masonry chimney, the chimney connector must slide completely inside the chimney thimble (or breach) to the inner surface of flue liner. Make sure the connector does not protrude past the inside of the flue liner as that will reduce the flow area available for the smoke and ultimately cause problems with your chimney system. The chimney connector should be sealed into the thimble with refractory cement and the connector should also be mechanically fastened to the chimney. See **Figure 12.**

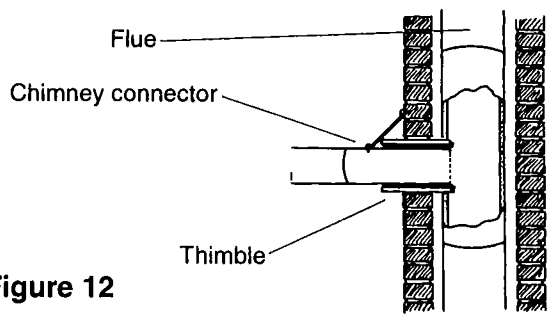


Figure 12

Prefabricated Chimneys

Always follow the chimney manufacturer's instructions and use all the components required by the manufacturer. Do not take shortcuts or use makeshift methods for securing the chimney connector to the chimney.

Through a Masonry Fireplace

The 3 CB may be vented through a masonry firelace. With the standard legs installed, the fireplace opening height must be at least 25 1/2". With the short legs installed, the height must be at least 23 1/4".

The damper plate must be either removed or securely fixed in the open position, and the damper opening around the connector sealed with sheetmetal and sealant. The connector must extend above the tile liner. See **Figure 13**

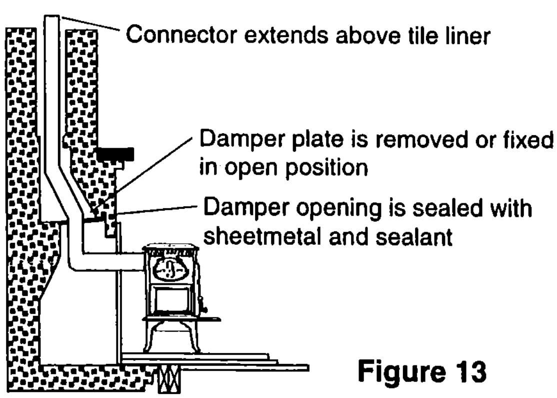


Figure 13

The chimney flue size must not exceed three times the cross sectional area of the stove's flue. If the flue is larger than this, an approved chimney relining system should be installed to downsize the flue.

Fireplace installations must observe special clearance requirements to surrounding trim and the mantel as illustrated in **Figure 14**:

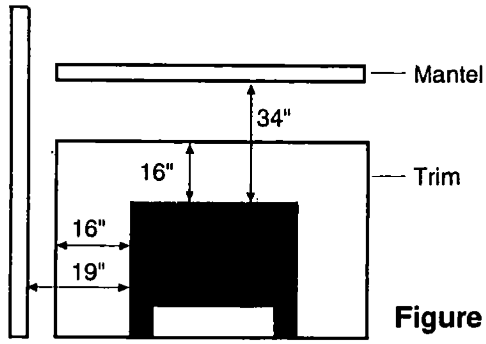


Figure 14

In addition, fireplace installations must satisfy the floor protection guidelines specified in the following section.

D. Clearances to Combustibles

Floor Protection

The stove must be placed on a non-combustible floor protector with a minimum R value of 1.1 that extends at least 8" beyond the sides and back of the stove and 16" in front of it. This will result in a minimum floor protector size of 39" wide X 39" deep (**Figure 15a**). The floor protector must also cover the area under any horizontal sections of chimney connector (stove pipe) and must extend at least 2" beyond either side of the pipe (**Figure 15b, 15c**).

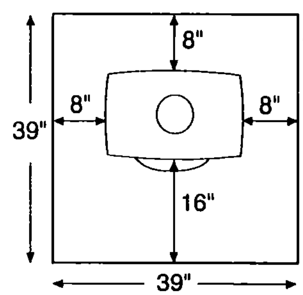


Figure 15a

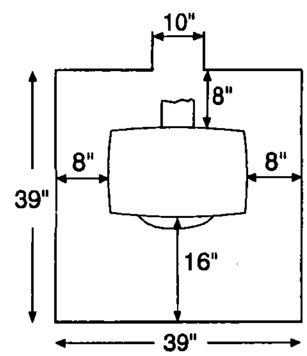


Figure 15b

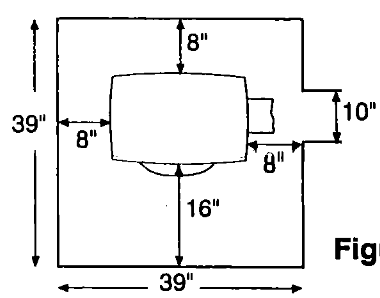


Figure 15c

Never put any type of floor protection on top of carpeting.

Alternate Floor Protection

All floor protection materials must be non-combustible (i.e., metals, brick, stone, mineral fiber boards, etc.). Any organic materials (i.e., plastics, wood, paper products, etc.) are combustible and must not be used.

The floor protector specified may include some form of thermal designation such as R-value (thermal resistance), k-factor (thermal conductivity, or C-factor (thermal conductance).

The easiest means of determining if a proposed alternate floor material meets requirements listed in the appliance manual is to follow this procedure:

1. Convert the specification to R-value.
   a. If R-value is given, no conversion is needed.
   b. k-factor is given with a required thickness (T) in inches: R=1/k X T.
   c. C-factor 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 system is greater than the R-value of the specified floor protector, the alternate is acceptable.

EXAMPLE:
The specified floor protector should be 3/4 inch thick material with a k-factor of .84. The proposed alternate is 4" brick with a C-factor of 1.25 over 1/8" mineral board with a k-factor of .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 Rbrick = 1/C = 1/1.25 =.80.
1/8" mineral board of k = .29,
therefore Rmin.bd.=1/.29 X .125 = .431.
Total R Rbrick Rmineral board = .8 + .431 = 1.231

Step C. *Compare proposed system R of 1.231 to specified R of .893.* Since R is greater than required, the system is acceptable.

Definitions:

$$\text{Thermal conductance} = C = \frac{\text{Btu}}{(\text{hr})(\text{ft}^2)(^\circ\text{F})} = \frac{\text{W}}{(\text{m}^2)(^\circ\text{K})}$$

$$\text{Thermal conductivity} = k = \frac{(\text{Btu})(\text{inch})}{(\text{hr})(\text{ft}^2)(^\circ\text{F})} = \frac{\text{W}}{(\text{m})(^\circ\text{K})} = \frac{(\text{Btu})}{(\text{hr})(\text{ft})(^\circ\text{F})}$$

$$\text{Thermal resistance} = R = \frac{(\text{ft}^2)(\text{hr})(^\circ\text{F})}{\text{Btu}} = \frac{(\text{m}^2)(^\circ\text{K})}{\text{W}} = \frac{(\text{Btu})(\text{inch})}{(\text{hr})(\text{ft}^2)(^\circ\text{F})}$$

Clearances to Adjacent Combustible Materials

Figures 16a-n on pages 10-12 give the required clearances you must maintain from unprotected combustible materials or objects.

A combustible is anything that can burn, and in the case of stove installations, these combustibles may not be visible. If you are not sure of the combustible nature of any material in the vicinity of your planned stove installation, you should check with your local fire officials. Remember that "fire resistant" materials are considered combustible; they are difficult to ignite, but they will burn.

If you have recently purchased a home that has a stove hearth in it that you plan to use, it is extremely important that the entire system be examined for safety. Many older homes may have faulty chimneys, or previous owners may have covered combustible walls or studs with brick veneers. Heat is conducted readily through brick and could ignite unseen combustibles behind it.

Contact local building or fire officials about restrictions and installation requirements in your area.

Using Heat Shields to Reduce Clearances

When utilizing a chimney connector heat shield to reduce connector pipe clearace, it must start 1" above the lowest exposed point on the connector pipe and extend vertically to a point 25" above the top surface of the stove.

Double wall pipe is an acceptable substitute for a pipe heat shield.

When utilizing wall protecting heat shields (wall protectors), refer ro NFPA 211 for proper construction and sizing guidelines. **Figures 16c, 16f, 16g, 16j** show clearances related to wall protectors.

NOTE: THE CLEARANCES EXPRESSED IN INCHES ARE THOSE APPROVED FOR INSTALLATIONS IN THE UNITED STATES. THE CLEARANCES IN PARENTHESES THAT ARE EXPRESSED IN CENTIMETERS ARE THOSE APPROVED FOR INSTALLATIONS IN CANADA. DIFFERENT TEST STANDARDS FOR THE RESPECTIVE COUNTRIES MAY RESULT IN DIFFERENCES IN THE CLEARANCE REQUIREMENTS.

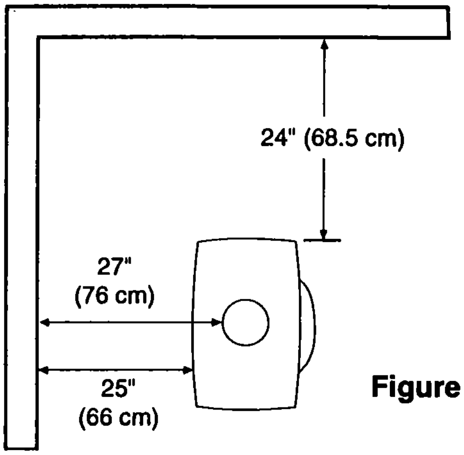


Figure 16a

Parallel Installation, single wall connector, top vent.
No connector pipe heat shield, no wall protection.

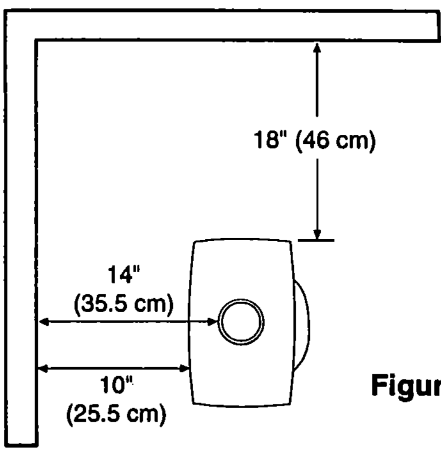


Figure 16b

Parallel Installation, double wall connector, top vent.
No wall protection.

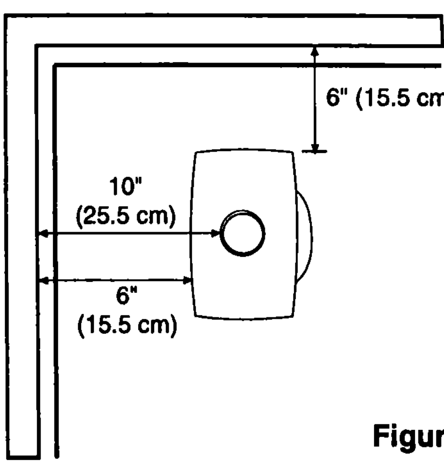


Figure 16c

Parallel Installation, double wall connector, top vent.
With wall protection.

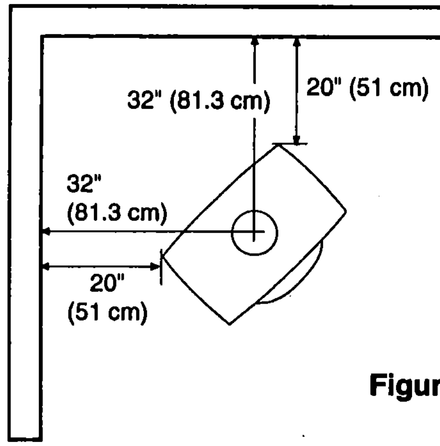


Figure 16d

Corner Installation, single wall connector, top vent.
No connector pipe heat shield, no wall protection.

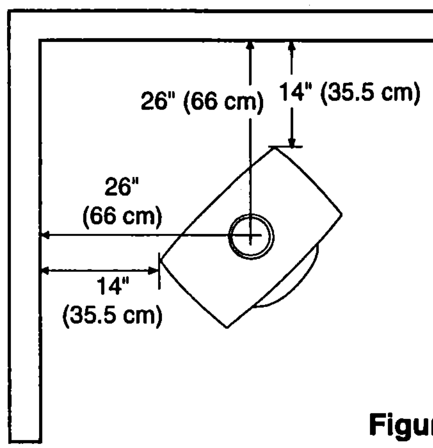


Figure 16e

Corner Installation, double wall connector, top vent.
No wall protection.

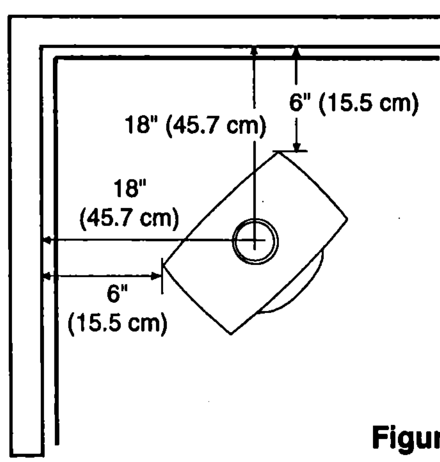


Figure 16f

Corner Installation, double wall connector, top vent.
With wall protection.

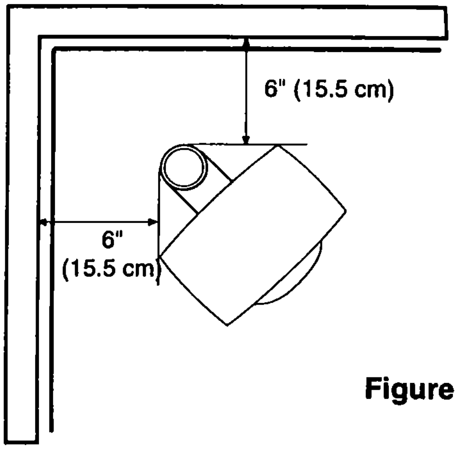


Figure 16g

Corner Installation, double wall connector, rear vent to vertical connector.
With wall protection.

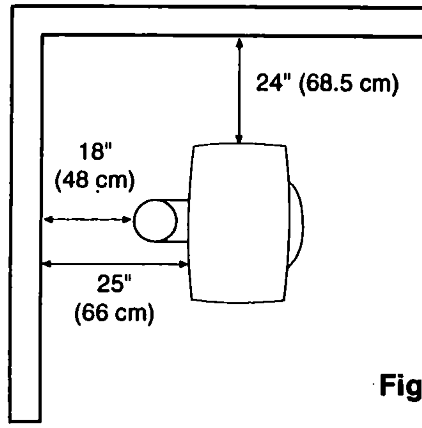


Figure 16h

Parallel Installation, single wall connector, rear vent to vertical connector. *No connector pipe heat shield, no wall protection.*

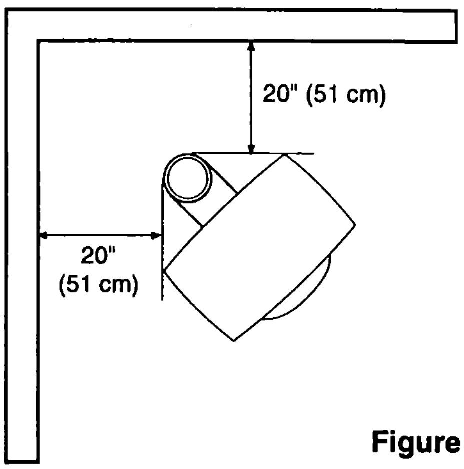


Figure 16i

Corner Installation, single or double wall connector, rear vent to vertical connector. *No wall protection.*

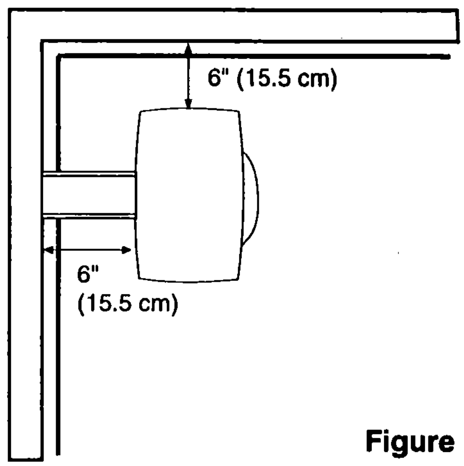


Figure 16j

Parallel Installation, double wall connector, rear vent. *With wall protection.*

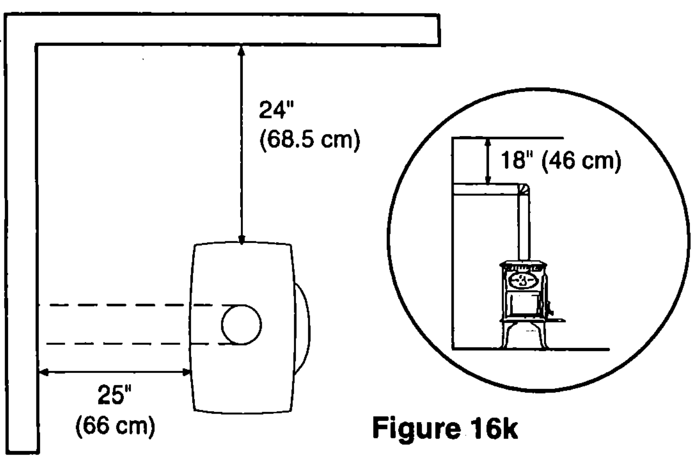


Figure 16k

Parallel Installation, single wall connector, top venting through wall. *No connector heat shields, no wall protection.*

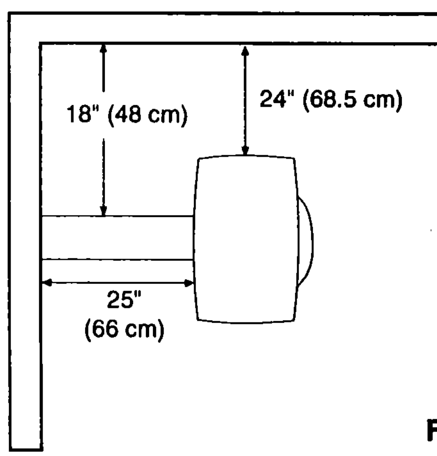


Figure 16l

Parallel Installation, single wall connector, rear venting through wall. *No connector heat shields, no wall protection.*

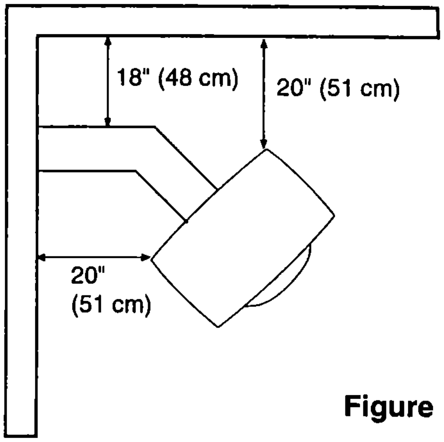


Figure 16m

Corner Installation, single wall connector, rear venting through wall. *No connector heat shields, no wall protection.*

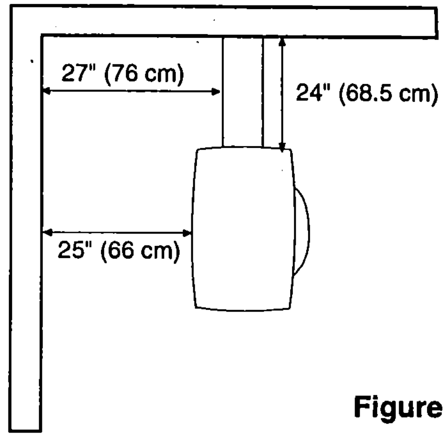


Figure 16n

Parallel Installation, single wall connector, side venting through wall. *No connector heat shields, no wall protection.*

Alcove Installations

When installed with double wall connector pipe and with wall protection, the Jøtul 3 CB can be placed in an alcove that has a minimum height of 40" [1] from the ceiling to the top of the stove and a maximum depth of 24" (Figure 17a), and that has a minimum width of 35" (Figure 17b).

(Note: [1]See NFPA 211 for ceiling clearance reductions with protection.)

Wall Protection for Alcove Installations

The wall protector for an alcove must be noncombustible, such as a minimum 24 gauge galvanized steel or its equivalent, and must protect the rear wall and both side walls of the alcove. The wall protector must be elevated 1" from the floor to provide an air space and must be mounted to allow an air space of at least 1" between the shield and the combustible wall.

The rear wall must be protected to within 1" of the ceiling. The height of the side wall protector, including the air space at the bottom, must be at least 43" and at least 15" above the stove top. (Figure 17a)

Both side walls and the rear wall must be protected by the wall protector. (Figure 17b) The side wall protection must extend the full depth of the alcove.

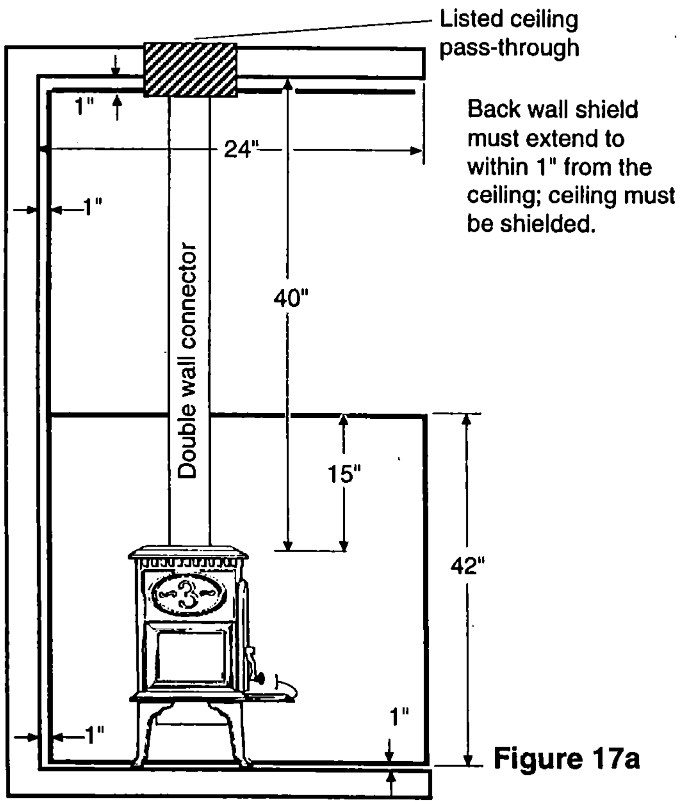


Figure 17a

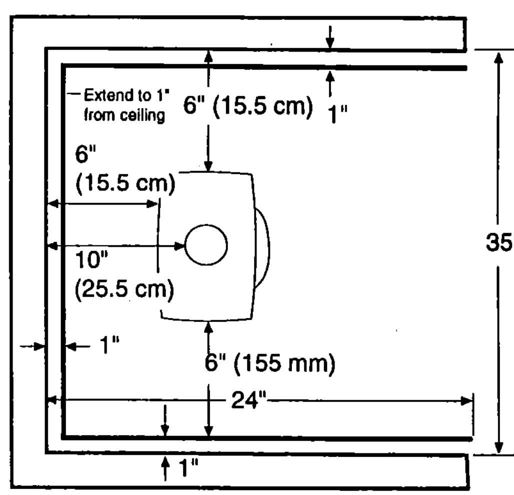


Figure 17b

Figures 17a and 17b: **Alcove Installation, double wall connector, top vent.**
With double wall connector pipe, with wall and ceiling protection.

5. Operation

Before building a fire in your new stove, please read the following section carefully.

This stove is designed to burn natural wood only. Higher efficiencies and lower emissions generally result when burning air-dried seasoned hardwoods, as compared to softwoods or to green or freshly-cut hardwoods.

Do not burn:

• Coal	• Treated or Painted Wood
• Garbage	• Chemical Chimney Cleaners
• Cardboard	• Colored Paper
• Solvents	• Trash
	• Any synthetic fuel or logs that have not been approved for wood stoves.

Burning treated wood, garbage, solvents, colored paper, chemical chimney cleaners, or trash may result in release of toxic fumes.

Never use gasoline, gasoline-type lantern fuel, kerosene, charcoal lighter fluid, or similar liquids to start or "freshen up" a fire in this heater. Keep all such liquids far away from the heater while it is in use.

Wood Storage

When storing wood outside, it should be covered and stored off the ground to protect it from the elements. Make certain that the woodpile has good air circulation through it in order to promote drying to aid in the seasoning process.

To obtain the best performance from your stove, we recommend using seasoned hardwood that has been dried and stored under cover for at least one year. Burning unseasoned or wet wood causes the rapid development of creosote and reduces the heat value of the wood being burned.

Creosote and Soot Formation and the Need for Removal

When wood is burned slowly, it produces tar and other organic vapors which combine with expelled moisture to form creosote. These creosote vapors condense in the relatively cool chimney flue of a slow burning fire. The creosote that accumulates in the flue is highly flammable and is the fuel of chimney fires. To prevent a chimney fire, the creosote needs to be removed by sweeping the chimney and flue connector. The frequency of sweeping will depend on how you operate your stove, but it is important to inspect the flue after every two weeks of use. An accumulation of 1/4" or more on the sides of the flue or connector is considered hazardous and should be removed.

In the event that creosote in your chimney or flue connector ignites, the resulting fire is often accompanied by a roaring noise and a crackling sound as flakes of burned creosote break loose. If you suspect you are having a chimney fire, immediately close the draft regulator and make sure the stove door is closed. Call the fire department and get everyone safely out of the house.

Trying to extinguish the fire in the stove will not help. In fact, it can make the matter worse by allowing oxygen through the door, which then supports the fire in the chimney. When the roaring and crackling have stopped, you should resist the temptation to open the door and look at the fire. The fire may have suffocated, but could rekindle when you open the door. After a chimney fire, do not use your stove until the chimney and the flue connector have been cleaned and inspected to ensure that no damage has been sustained.

Breaking in Your Stove

A cast iron stove should be "broken in" gradually. Five consecutive small fires must be built in the stove prior to operating the stove continuously. Each fire should be a little larger than the previous one, and the last fire should be a full-sized load. Allow the stove to cool completely between fires.

It is normal for new painted stoves to emit a smell or even some smoke during the first few fires. This is caused by the seasoning of the high temperature paint, and the odor will diminish with each fire and eventually disappear. Opening a window or door near the stove will help provide additional ventilation and reduce the odor.

HOT WHILE IN OPERATION. KEEP CHILDREN, CLOTHING, AND FURNITURE AWAY. DO NOT STORE FUEL WITHIN THE CLEARANCES LISTED PREVIOUSLY.

Controls

This stove is equipped wih a permanent latch to operate the door.

In addition it comes with a detachable handle to operate the air controls, open and close the door for the ashpan, and for removing the ashpan.

Front Door Latch

The latch for the front door is conveniently located to the left of the door's center.

Never operate the door handle without using a protective stove glove to prevent burning your hand.

To open the door, turn the latch a quarter-turn counter-clockwise to the 3:00 o'clock position.

Door is closed when handle is vertical (6:00 o'clock position) To open, turn counter-clockwise to the 3:00 o'clock position.

To close the door, press it firmly against the stove front and rotate the handle a quarter-turn clockwise to the 6:00 o'clock position. See **Figure 18.**

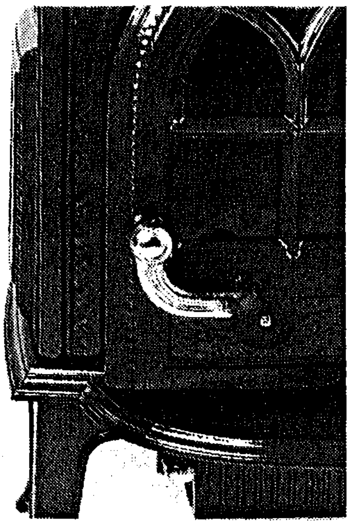


Figure 18
(*Latch in open position*)

Primary Air Control

The sliding primary combustion air control (See **Figure 19**) is located on the front panel above the fuel loading door.

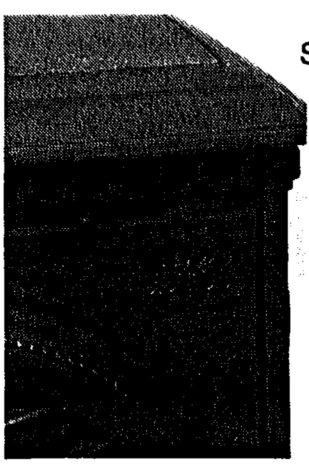


Figure 19

Sliding the control to the right increases the air supply and the heat.

Cooler ⟵⟶ Hotter

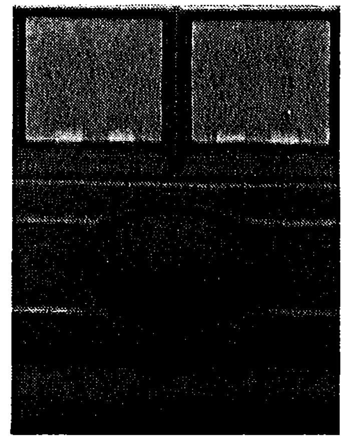
Sliding it to the left diminishes the air supply and the heat.

Slide the control fully to the right when first starting or reviving a fire, or when maximum heat is required. Position the control in the middle or left of the middle when less heat is needed and when longer burn times are desired. You will determine the best settings for your particular needs as you gain experience with your stove.

Start-Up Air Control

There is a special air supply for use during start-up. The control is located below the glass in the center of the front door. (**Figure 20**).

WARNING: This control is to be used only during the initial lighting and kindling of a fire, and only for a maximum of five minutes.



Closed ⟵⟶ Open

Figure 20

Do not open this control to freshen or accelerate the fire or during refueling. Opening this control can result in a dangerous overfiring condition which can damage the appliance or ignite surrounding combustible materials. Never leave the stove unattended while the control is open.

Building a Fire

Build the fire directly on the grate. Do not use andirons to elevate the fire.

A good fire will efficiently utilize your fuel, keep the glass in the door clean, keep emissions and creosote to an absolute minimum, require less work, and be very predictable.

A Good Foundation

Make sure that the primary combustion air control handle is fully to the right and that the start-up air control is in the open position. Open the front door and cover the bottom of the stove with tightly crumpled newspaper. Criss-cross a generous double handful of dry kindling, such as split pieces of scrap lumber, on top of the paper. If you don't have scrap lumber, split some of your best dry wood down to finger-sized pieces and use that. Place three or four 1" - 2" split pieces of dry wood on top of the kindling.

Light the paper evenly across the front and close the door.

Continue to add 1" - 2" pieces of split dry wood until a healthy bed of glowing coals has formed.

You can now add three or four small-to-medium pieces of wood. Allow this wood to burn for several minutes. Once you are sure that the wood is burning well, close the start-up air and adjust the primary air control to set your desired heat output level and to maintain safe operating temperatures. Moving it to the right increases the heat; moving it too the left decreases the heat. Avoid operating the stove with the air control closed completely.

In order for secondary combustion to occur, the fire must be well established with temperatures above 1,000° F. (600° C.) in the fire box.

If the fire dies out, the cause is most likely either an insufficient bed of coals, reducing the air supply too soon, or using wood that is either too large or not sufficiently dry.

Reloading

Reload the stove while it is still hot and there are plenty of hot coals to ignite the fresh fuel load. It is a good idea to include a smaller piece or two of wood at the base of the new load to help the stove recover more quickly to its operating temperature

Reloading Procedure

- •Always wear stove gloves when tending your stove.
- •Push the air control to the right to the full open position.
- •Wait a few seconds and open the door.
- •Use a stove shovel or similar tool to break up any remaining charcoal and to drag some live embers toward the front where combustion air enters.
- •Load the fuel (Smaller pieces first).
- •Close the door.
- •Wait 5-10 minutes and adjust the air control to desired setting.

Note: If the charcoal bed present at reloading time is relatively deep (2" - 3") and your wood is well seasoned, it is possible to add the fresh fuel load, close the door and reset the air control for the desired heat output rate within 5 minutes.

Open-Door Operation

Always use the optional 3 CB spark screen (Part no. 350168) when operating your stove with the doors open.

WARNING: OPERATE YOUR 3 CB ONLY WITH THE FRONT DOOR FULLY CLOSED OR FULLY OPEN WITH SPARK SCREEN IN PLACE. A PARTIALLY OPEN DOOR MAY RESULT IN OVERFIRING.

Ash Removal

Ash removal will be required every day or two during normal operation, and is most easily done when the fire has burned down to coals.

First, use a stove shovel or a similar tool to move ashes in the bottom of the stove so that they fall down into the ashpan.

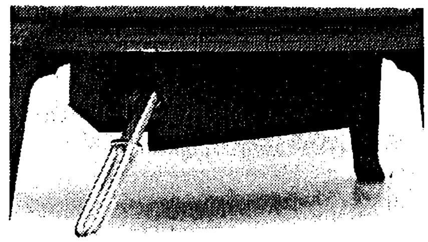


Figure 21

To remove the ashpan, locate the ashdoor under the ash lip. **(Figure 21)**

Use the multi-purpose handle and rotate the ashdoor lock clockwise to open the door.

Then, insert the pin on the multi-purpose handle into the socket on the ashpan and slide the ashpan carefully from the stove. **(Figure 22)**

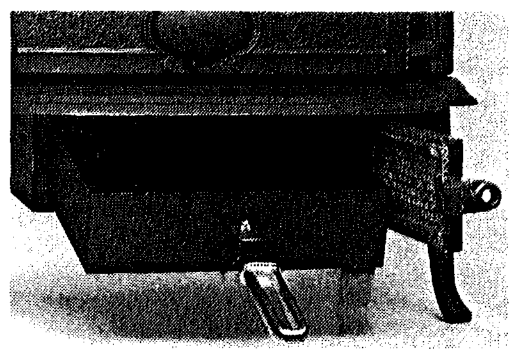


Figure 22

When removing ash from a stove that is in operation, close and latch the door before taking the ashes outside for safe disposal. It is always a good idea to wear heavy protective gloves while removing and disposing of the ashes from your stove.

Ashes should be placed in a metal container used exclusively for ashes, with a tight fitting lid. The closed container of ashes should be placed outdoors, well away from all combustible materials, pending final disposal. If the ashes are disposed of by burial in soil or otherwise dispersed, they should be retained in the closed container until all cinders have thoroughly cooled.

WARNING: LEAVING THE ASH DOOR OPEN CAN RESULT IN A DANGEROUS OVERFIRING CONDITION WHICH CAN DAMAGE THE APPLIANCE OR IGNITE SURROUNDING COMBUSTIBLE MATERIALS.

6. Maintenance

General

At least once a year, perform a routine maintenance check. A good time to do this is when you are cleaning the chimney and the connector. You should clean the chimney and connector whenever accumulations of soot and creosote reach 1/4" thick, which may be several times a year, depending on how the stove is operated. Make sure the fire is out and the stove is cool before starting any maintenance procedure.

1. Thoroughly clean the entire stove. Brush all ash and soot out of the stove. It is better to brush out the ash and soot than to vacuum it out because soot particles are small enough to pass through most vacuum bags.

2. In a dark room, use a strong light to inspect the stove inside and out for cracks or leaks at corners and joints. Cracked parts should be replaced. Leaks at joints can be patched with stove furnace cement.

3. Check the door and window gaskets for tightness. To check the front door gasket, put a dollar bill halfway into the stove, close and latch the door, and try pulling the dollar out. If it can be removed easily , the seal is too loose. Check several spots around the door. To replace the gasket, lift off the door and bring it outdoors or place it on a protected surface. Scrape out all old gasket material and gasket cement.

Spread a 1/8" bead of gasket cement into the bottom of the groove and press in new gasket. Trim off any excess gasket length. The ends of the gasket should meet but not overlap.

The door requires approximately 58" (144 cm) of 3/8" (8.6 mm) diameter low density fiberglass woodstove gasket. The gasket between the glass panel and the door receives very little wear. The best indication that it needs to be replaced is streaks on the glass caused by air leaking around the gasket.

The top plate uses approximately 66" (168 cm) of 3/8" (9.5 mm) diameter low density fiberglass gasket. The ash compartment door uses approximately 32" (80 cm) of 1/4" (7 mm) diameter low density fiberglass gasket.

Glass Replacement

Do not abuse the glass door such as by striking or slamming shut.

If the stove's glass is cracked or broken, you must replace it before operating your stove. Carefully remove any broken pieces. Replace the panel only with the correct Jøtul replacement glass, and do not use substitutes.

•Lift the door off and bring it outside. NOTE: Don't lose the washer that is under the lower hinge pin. It must be used again when the door is reinstalled.

•Remove all broken glass.

•Unscrew the two glass retainers, one from each side. **Figure 23**

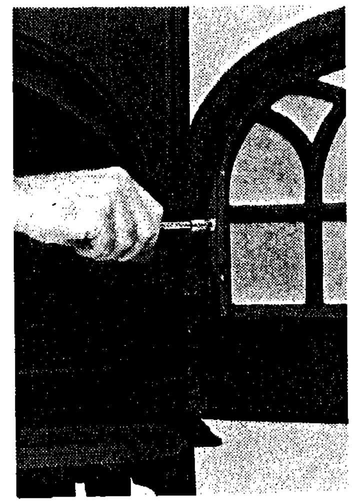


Figure 23

•Clean off the residual gasket material from the door using a wire brush if necessary.

•The replacement gasket length is approximately 41" (104 cm) of 3/16" (4.5 mm) diameter high density fiberglass gasket and is self-adhesive. Measure enough gasket to go from the upper right corner of the glass, down the right side, across the bottom and back up to the upper left corner and then back across to the starting point and then add about 2".

•Peel off about 12" of the self-adhesive backing strip. Starting in a corner, apply the gasket to the groove on the door, making sure that the adhesive is facing the door. Press the gasket firmly in place. Repeat peeling off more backing and applying until you reach your starting corner.

•Trim off any excess gasket length. It is important that the ends meet closely but not overlap.

•Center the replacement glass panel on the gasket and reinstall the glass retainers and screws.

It is extremely important that the retainers be tightened a small amount at a time and following a pattern similar to tightening the lug bolts on an automobile wheel. They should end up equally tightened and **not over-tightened.** Make sure that the glass panel stays centered in the opening and does not slip down. It may be necessary to re-tighten once again after the stove has been burned and the new gasket has been seated.

Glass Cleaning

From time to time, clean off the accumulated ash from the inside surfaces of the glass panels. If this fly ash is allowed to remain on the surface for extended periods, it could eventually cause the glass to become permanently etched and somewhat cloudy. Any creosote which might deposit on the glass will burn off during the next hot fire.

Never clean the glass while it is hot and never use any abrasive materials to clean the glass. Warm water and a soft cloth or paper towel are usually all that is required. Rinse thoroughly with clean water after washing and dry completely before burning your stove.

Special stove glass cleaners are also available from your Jotul dealer.

Replacing Baffle Plate and Burn Plates

It is not uncommon for baffle and burn plates to need replacement after years of use. Whether they need to be replaced, and with what frequency, depends on how the stove has been used. To replace them, follow this procedure:

1. Clean the stove (see maintenance section).

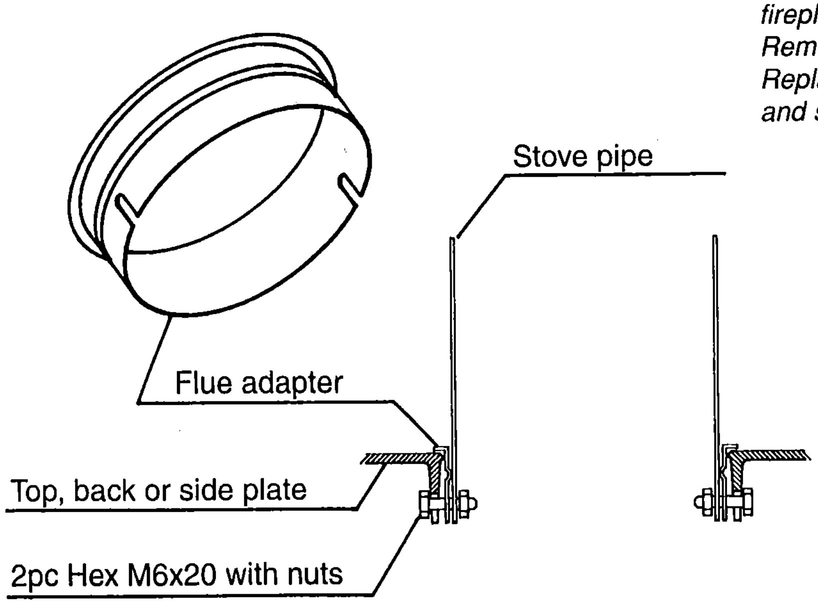
2. Remove the door to avoid damaging it and for a better view of the interior.

3. If the burn plates have to be changed, loosen the two screws that fasten the baffle plate to the rear of the stove. Do not remove them. Lift the front of the baffle plate, and use a screwdriver to remove the burn plates. Install the new burn plates, and tighten the two screws to secure the baffle.

4. To replace the baffle plate, remove the two screws that secure it to the rear of the stove. Slide the baffle plate out gently. Install the replacement baffle plate and secure it with the two screws.

5. Replace the door.

NOTE: A technical bulletin to help with this procedure is available upon request.



** Put the flue adapter into the hole you have made in your 3 CB. Align slots in the adapter with those in the fireplace. Insert the stove pipe, and mark the slots on it. Remove stove pipe and drill 1/4" holes where marked. Replace stove pipe aligning holes with slots in adapter and stove. Insert bolts and tighten with nuts.*

APPENDIX
A

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. <u>Probe</u>

   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. <u>Filter Holder</u>

   A 3" or 4" standard M5 filter holder. A SS filter support with gasket.

3. <u>Filters</u>

   3" or 4" fiber glass (#25 glass) manufactured by Schleicher and Schuell.

4. <u>Front Half Filter Heater</u>

   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. <u>Desiccant</u>

   Indicating silica gel, 6-20 mesh. The silica gel is changed as needed.

6. <u>Filter (Back Half) Holder</u>

   Same as front half 3" or 4" filter.

7. <u>Impinger Gas</u>

   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. <u>Meterbox</u>

   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.

APPENDIX
B

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. <u>Determination of the Combustion Gas Train's Response Time</u>

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. <u>Calibration and Audit Procedures for the Combustion Gas Analyzers</u>

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. <u>SO_2 Injection Probe</u>
   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. <u>Rotameter</u>
   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. <u>Temperature</u>
   The temperature at the injection rotameter is measured with a type K thermocouple.
4. <u>Injection Gas</u>
   Pure SO_2, 99.999% pure, released from the cylinder through a SS regulator and shut off valve.
5. <u>Calibration Gases</u>

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. <u>Calibration and Audit Procedures for the Tracer Gas (SO_2) Analyzer</u>

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.

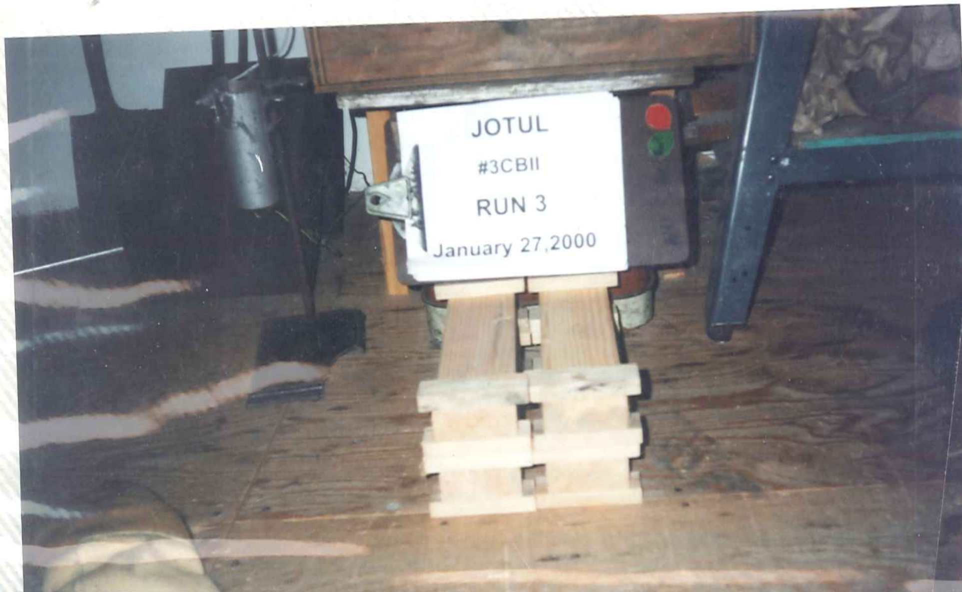
G. Continue to add pretest fuel until the stove has thoroughly warmed up. As necessary, rake the coal bed prior to adding additional pretest fuel charges.

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,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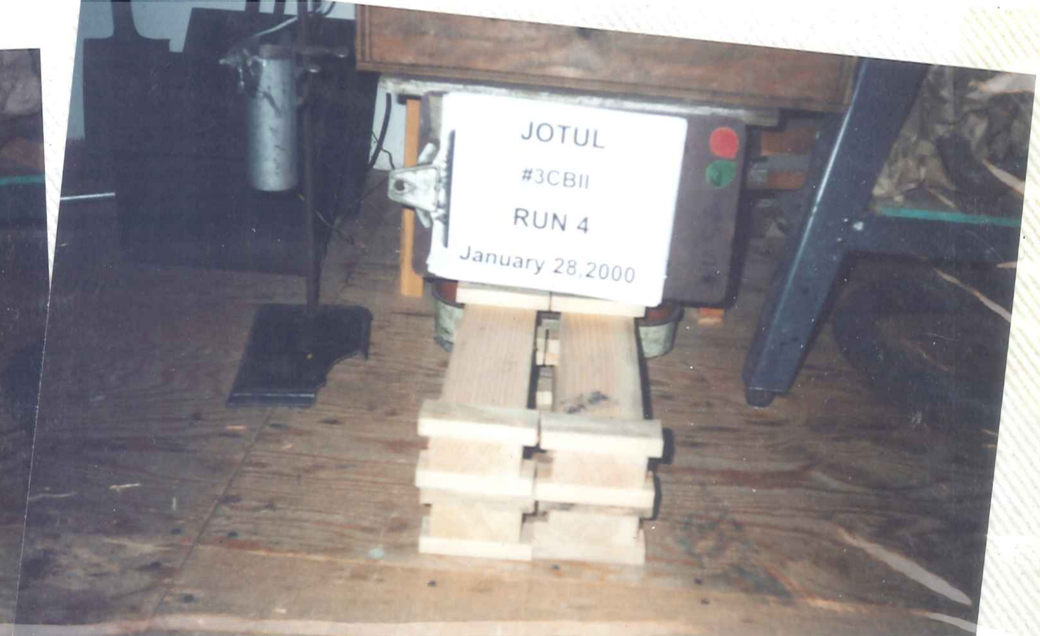
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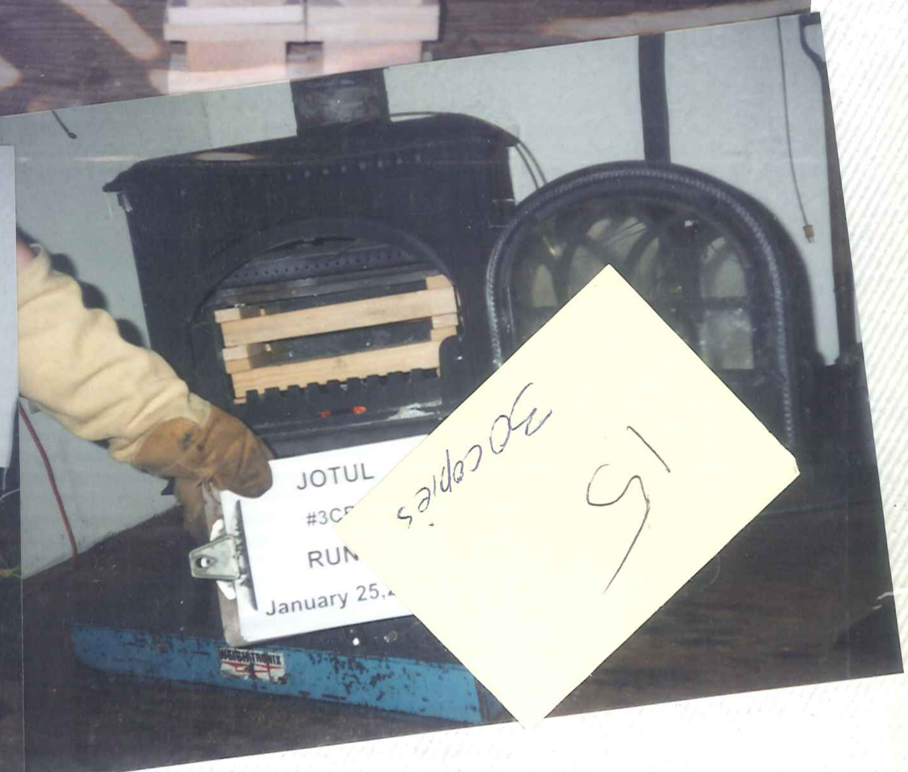
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