TEST REPORT

SCOPE: EMISSIONS AND OUTPUT

FUEL: EPA TEST FUEL (CRIBS)

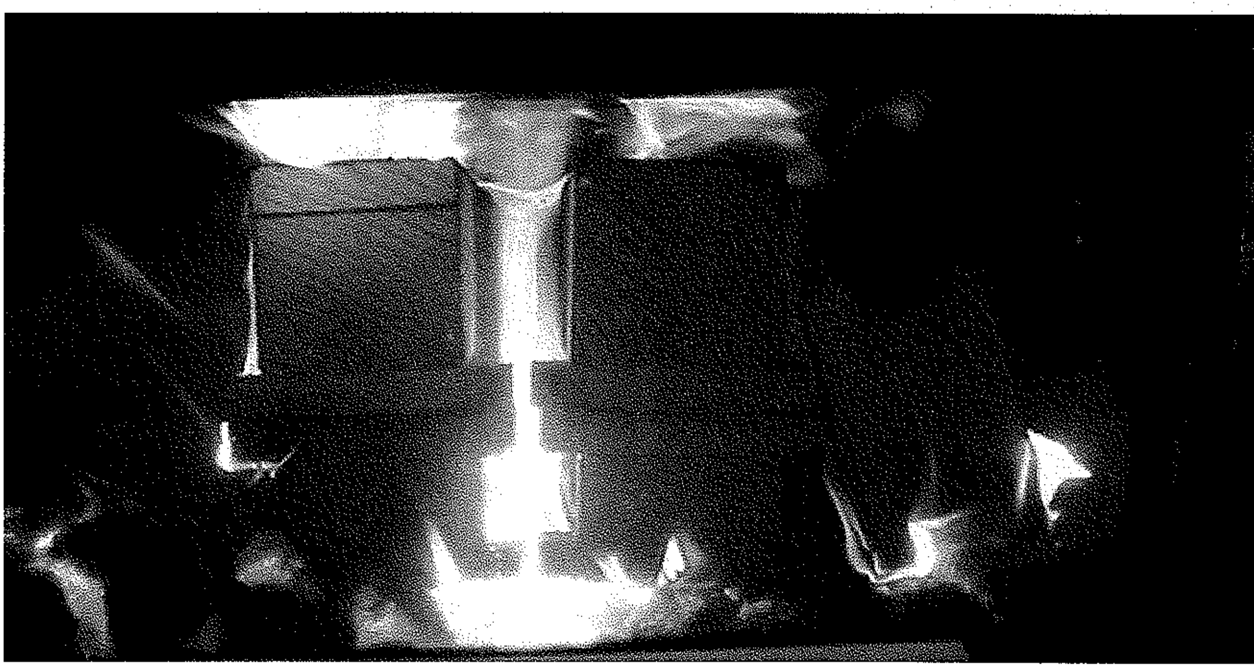
TEST STANDARD: EPA

MODEL: OSBURN 2200-I WOOD INSERT

US EPA WOOD HEATER CERTIFICATION TEST REPORT

OSBURN 2200 BAY/ 2000 NONCATALYTIC WOOD HEATER

SEPTEMBER 9, 2000



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* * * * * * * *

CONFIDENTIAL

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The data and information in this test report is confidential, proprietary information and is not to be released to and/or discussed with any party who is not authorized by the manufacturer or the testing laboratory to receive such data.

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Field Observation Checklist

Unit Name: OSBURN 2200 BAY / 2000 Date: 10/8/2000

Manufacturer Name: Osburn Manufacturing, INC

Manufacturer Address: 6670 Butler Crescent
Saanichton, B.C.
CANADA V8M 2G8

Manufacturer Phone: (250) 652-4200 Fax: (250) 652-4232

Observers & Affiliation: Phil Colby, Osburn

Myren Consulting's Field Team:

Supervisor: Ben Myren PAT GARVEY Thyer Myren

Other Members: John Palm Ilse Myren JEB Myren

Test Location: 501-C Williams Lake Road, Colville, WA 99114

Test Site Elevation: 1645 Feet

Lab:
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REPORT CERTIFICATION

The sampling and analysis for the woodstove described in this report was carried out under my direction and supervision.

Date 10/8/2000 Signature Albert J. Myren Jr.

Date ____________ Signature ____________

I have reviewed all of the testing data and results found in this test report and hereby certify that the test report is authentic and accurate.

Date 10/8/2000 Signature Albert J. Myren Jr.

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STATEMENT OF CONFIDENTIALITY

As a condition of being allowed to visit the woodstove testing facility and/or observe a woodstove test(s) at Myren Consulting, Inc.'s testing laboratory located at Suite 106, 12810 NE 178th St., Woodinville, WA 98072, I hereby agree not to release or divulge any information about the design engineering principals used at Myren Consulting, the testing facility, the testing personnel or the testing procedures (other than the information found in the Standard Method for Measuring the Emissions and Efficiencies of Residential Woodstoves promulgated by the Oregon Department of Environmental Quality (DEQ) and/or Methods 28, 28A, 5G and 5H promulgated by the United States Environmental Protection Agency (EPA) to any other individual or firm unless specifically authorized to do so by an authorized person from Myren Consulting.

SIGNED: ______________________________
Name

____
Title

____
Affiliation

____
Date

SIGNED: ______________________________
Name

____
Title

____
Affiliation

____
Date

Test Series Information and Discussion

Unit: Osburn 2200 Bay / 2000 Noncatalytic Woodheater

Model #: 2200 Bay / 2000

Manufacturer: Osburn Manufacturing, Inc.

Date Received: 8/21/2000 **Date(s) Aged:** 9/8-11/2000

Test Dates: 9/18, 19, 20, 21, 22, 23, 25 and 26/2000

Sampling Methods Used: M28, M5G-1 **Number of Test Runs:** 8

The Osburn 2200 Bay / 2000

manufactured by Osburn Manufacturing, Inc

of Saanichton, B.C., Canada **was tested by Myren Consulting, Inc. using the United States Environmental Protection Agency's (EPA) Method 28, "Certification and Auditing of Wood Heaters", Method 5G-1 "Determination of Particulate Emissions from Wood Heaters from a Dilution Tunnel Location." And, if applicable, Method 28A, "Measurement of Air to Fuel Ratio and Minimum Achievable Burn Rates for Wood Fired Appliances". (See the Federal Register/ Vol. 53, No. 38/ Friday, February 26, 1988/ pp. 5860-5926.) The Particulate Matter (PM) emission data, if present, was calculated as specified in the Wood Heater New Source Performance Standard (NSPS).**

If computed and reported, Oregon Overall Efficiency (%OE) for each run was calculated using the computer program supplied by the State of Oregon's Department of Environmental Quality (DEQ) as part of the "Standard Method for Measuring the Emissions and Efficiency of Residential Woodstoves". The weighted average overall efficiency was calculated using the overall efficiency data for each run and the EPA Burn Rate Probabilities for calculating weighted averages.

All events pertinent to the test data and test results are recorded on the data sheets in the individual test runs, particularly on pp. 9, 9A, 9A-1 and 12.

Any deviations made or noted from the promulgated methods other than those which were accepted and certified by the EPA and/or the DEQ during the laboratory accreditation process are listed and discussed below.

A brief note about how the particulate samples were processed is necessary to help the reviewer understand the net catch values. Experience has shown that the small portions of the filters that are left on the frits in the M5G-1 filter housing apparatus after the filters are removed are full of static electricity. When these small portions are removed to a plastic petri dish, they quickly adhere to the dish. Trying to recapture this material during weighing causes it to disintegrate into smaller and smaller pieces, making obtaining accurate catch weights difficult. Thus, it was decided to place this filter material in with the particulate captured with the acetone wash, where it shows up as catch. Some of the filter material was already following this pathway. Thus, there may be negative filter weight catches, particularly for the back half filter, that are used during the particulate emission rate calculation process. However, the filter material lost off the filters is accounted for in the acetone catch.

The following pages contain (1.) diagrams showing the height and location of the stack components and sampling ports for both the freestanding stove and the fireplace insert, (2.) a diagram of the EPA M5G-1 dilution tunnel components and (3.) copies of the letters sent to EPA requesting that the 30 day certification test scheduling requirement be waived for the Osburn 2200 Bay/ 2000 (4.) a discussion of results.

<u>DISCUSSION:</u>

(1.) The 2200 is a very difficult unit to test because it is prone to wood falls during both preburn and the test run. However, while these wood falls can dramatically affect dry burn rates, they do not seem to impact emissions very much because the wood falls tend to happen when the unit is in the charcoal phase. The report contains several runs where a wood fall during the test run significantly impacted the dry burn rate (DBR). The best example of this is Run 4, which was supposed to be a medium high, but due to a wood fall ended up being a medium low. Run 7 was another attempt at a high burn. The manufacturer elected for marketing reasons to do another high burn to try to increase the upper end BTU output of the stove. However, even though the test was started with a higher Delta T, a wood fall slowed the burn down enough to cause the run to break Delta T and be slower that the first high burn. A photograph of a wood fall that occurred in Run 5 is in the following pages. As is evident the top 4x4 (piece 3 in the loading sequence) has fallen off the underlying 2x4 and now is resting against the left wall of the firebox. The other type of wood fall that happened is that a piece of the test fuel would break off and fall down directly in front of the lower primary air orifice (LPAO). The bigger/ longer the piece the greater the impact.

While the impact of preburn wood falls were not as pronounced as those from wood falls that happened during a test run, preburn wood falls also would impact both the burn rate during preburn and the surface temperatures. If the third rick broke down during preburn the back of the stove would be much cooler than if the third rick did not fall down and block the LPAO air flow. Whether or not the wood fell during preburn also affected the bottom temperature. A classic example of a preburn wood fall is in Run 1. Here a wood fall after the start of preburn slowed the DBR so much that it was necessary to turn the stove around and start a whole new preburn.

While wood falls are a usual part of the testing experience, the wood falls that occurred during the testing of the Osburn 2200 were unusual because of the frequency of their occurrence and the magnitude of their impact(s). It is the opinion of the lab personnel that these wood falls are in some way related to the steep angle of the bay view in the door of the unit.

(2.) The unit is unusual in that it has a bay view front and door that has three pieces of glass in the door. To our knowledge, this is the second wood stove to be certified with this type of door. The first was the earlier model of the same stove. While the exterior appearance of the unit is approximately the same, the interior is significantly different. The curved front tube has been replaced with a straight tube and the unit has different material in the baffle. In addition, the firebox dimensions have changed so that the unit now loads north/ south (front to back) rather than east/west.

(3.) This report contains the data for both the freestanding and insert versions of this model line. At the end of the test series for the freestanding version,

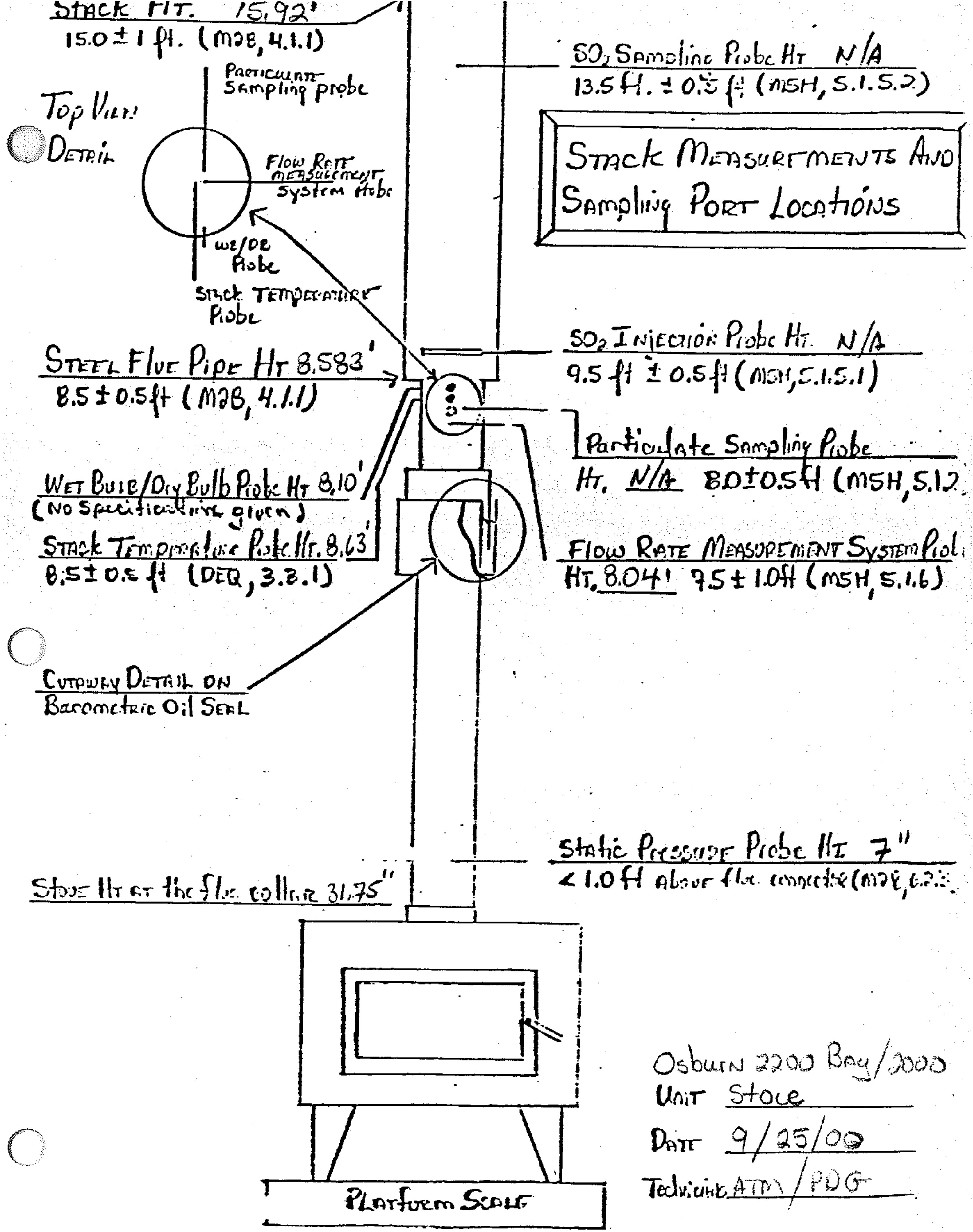

OSBURN

the unit was converted to a fireplace insert and the insert confirmation test was run on the unit. The only changes made were those to the exterior shielding and fan location. The firebox and firebox components remained intact. After the changes were made, the unit was set up for testing. However, because the pedestal had been removed, the installed insert had different heights for the stack components and sampling port locations. Thus, the second stack component diagram for the insert installation. EPA was advised of this procedure in the notification letter dated 26 August 2000.

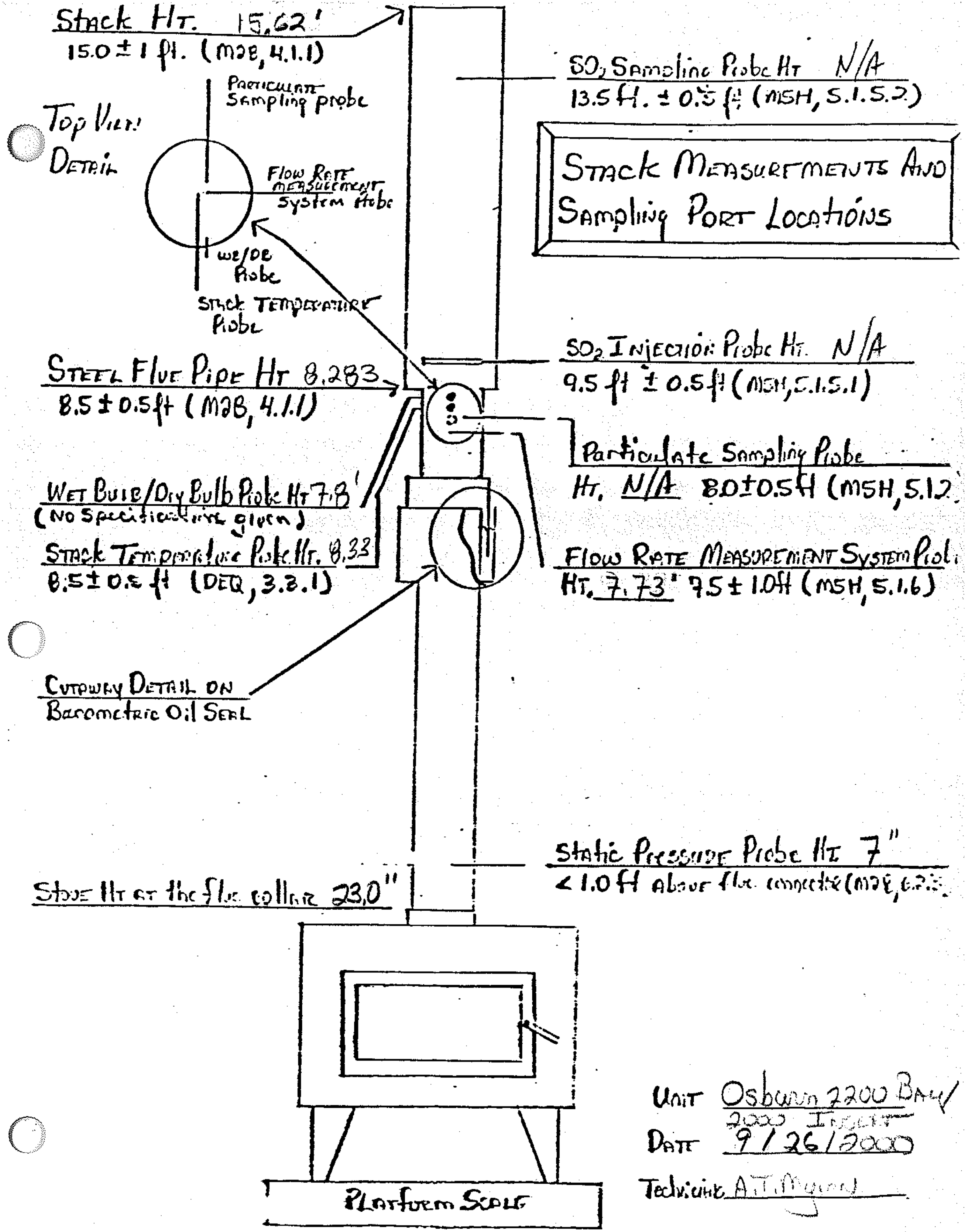
(4.) It is worth noting here that both the Fan Confirmation Test (FCT) and Insert Confirmation Test (ICT), while very close to the weighted average of the two medium low runs plus one gram limit, are both (barely) below the plus one grams limit. Thus, it is not necessary to calculate a weighted average for the two medium lows to determine if the two confirmation tests are within the plus one gram specification. The problem is not so much with the two confirmation tests, rather it is with the two medium lows. Both of these runs were better than expected. The manufacturer expected the medium low(s) to have emissions in the 3.0 gram range, which makes the two confirmation tests look reasonable.

(5.) There is another data sheet included in the temperature data. It contains the air temperatures inside the four secondary air tubes. The data is recorded for the first 150 minutes of each test. While this data is not required by EPA, it was decided to include it in the test report since it was recorded. Myren Consulting is now starting to record this information in an effort to gain a better understanding of how the secondary burn systems work in noncatalytic stoves.

Stack Measurements And Sampling Port Locations



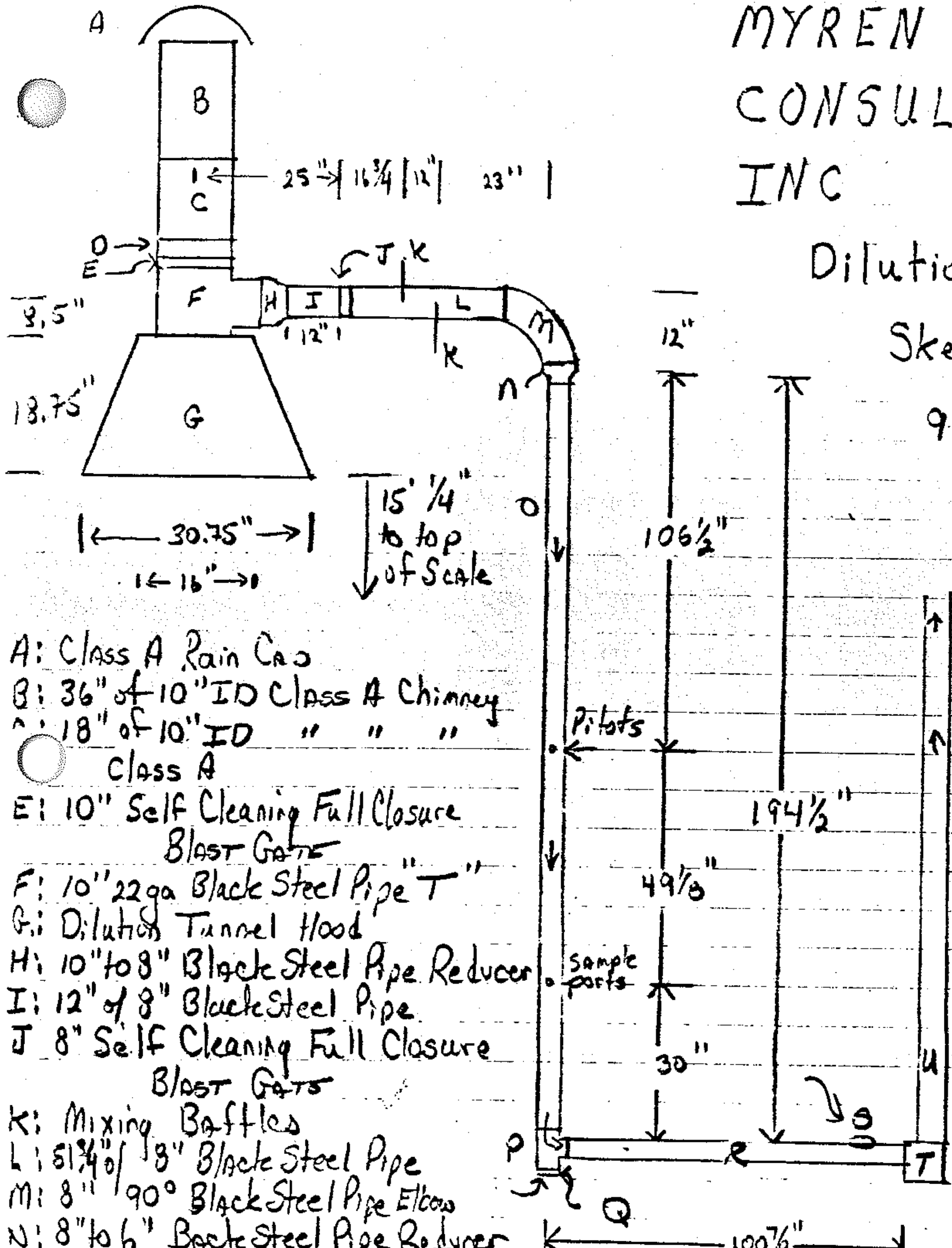
Osburn 2200 Bay/2000
Unit Stove
Date 9/25/00
Technician ATM / PDG


Stack Ht. 15.62'
15.0 ± 1 ft. (M28, 4.1.1)
Top View Detail
Particulate Sampling probe
Flow Rate Measurement System Probe
wet/dry Probe
Stack Temperature Probe
SO_2 Sampling Probe Ht N/A
13.5 ft. ± 0.5 ft (MSH, 5.1.5.2)
Stack Measurements And Sampling Port Locations
Steel Flue Pipe Ht 8.283
8.5 ± 0.5 ft (M28, 4.1.1)
SO_2 Injection Probe Ht. N/A
9.5 ft ± 0.5 ft (MSH, 5.1.5.1)
Particulate Sampling Probe Ht. N/A 8.0 ± 0.5 ft (MSH, 5.1.2)
Wet Bulb/Dry Bulb Probe Ht 7.8'
(No Specification given)
Stack Temperature Probe Ht. 8.33
8.5 ± 0.5 ft (DEQ, 3.2.1)
Flow Rate Measurement System Probe Ht. 7.73" 7.5 ± 1.0 ft (MSH, 5.1.6)
Cutaway Detail on Barometric Oil Seal
Static Pressure Probe Ht 7"
< 1.0 ft above flue connector (M28, 6.2.3)
Stove Ht at the flue collar 23.0"
Platform Scale
Unit Osburn 2200 Bay/ 2000 Insert
Date 9/26/2000
Technician A.T. Myers

MYREN CONSULTING INC

Dilution Tunnel Skematic

9/9/97



A: Class A Rain Cap
B: 36" of 10" ID Class A Chimney
C: 18" of 10" ID " " " Class A
E: 10" Self Cleaning Full Closure Blast Gate
F: 10" 22ga Black Steel Pipe "T"
G: Dilution Tunnel Hood
H: 10" to 8" Black Steel Pipe Reducer
I: 12" of 8" Black Steel Pipe
J 8" Self Cleaning Full Closure Blast Gate
K: Mixing Baffles
L: 51 3/4" of 8" Black Steel Pipe
M: 8" 90° Black Steel Pipe Elbow
N: 8" to 6" Black Steel Pipe Reducer
O: 194 1/2" of Black Steel Pipe
P: 6" Black Steel Pipe T Section
Q: 6" Self Cleaning Full Closure Blast Gate (for adjusting flows)
R: 100 7/8" 6" Black Steel Pipe
S: 2 1/4" diameter Bleed Hole
T: Dayton Blower
U: 6" Black Steel Pipe (Exhaust)

Not to Scale

Dimensions shown are actual

Total Tunnel Length - 22.635'
Hood Entrance to Sampling Port

Unit OSBURN 2200 [illegible] 2000
Date 9/8-11/2000
Technicians A. T. [illegible]
Page 1 of 1
WST5-Form3

CATALYTIC COMBUSTOR AGING DATA
OR
STOVE AGING DATA
WOODSTOVE TEST DATA SHEET #25

Hr. #	Date	Time	Firebox Temp	Secondary Burn Temp	Post Cat	In Cat	Comments
T/C#			9	10			
1	9/8/00	1425	1136	1498			
2	↓	1525	721	856			
3		1625	744	1333			
4		1725	711	958			
5		1825	532	690			
6		1925	528	665			
7	↓	2025	479	708			
8	9/11/00	1120	1049	1539			
9	↓	1220	646	832			
10		1320	752	1313			
11	↓	1420	731	1047			

EPA WEIGHTED AVERAGES CALCULATIONS
EPA WEIGHTED AVERAGE PARTICULATE EMISSION RATE

The weighted average particulate emission rate ($\overline{PM}$) for the Osburn 2200 Bay / 2000 Noncatalytic Woodheater manufactured by Osburn Manufacturing, Inc. of Saanichton, B.C., Canada is 2.74 g/hr.

EPA WEIGHTED AVERAGE OVERALL EFFICIENCY

The weighted average overall efficiency ($\overline{OE}$) for the Osburn 2200 Bay / 2000 is (default) 63 %.

II. EPA TEST RESULTS

* Denotes runs used in weighted average calculations

Run #	Dry Burn Rate/kg/hr	Grams/Hour	Overall Efficiency
* 1	0.972	2.737	
* 2	1.148	2.165	
* 4	1.227	2.157	
* 5	1.421	2.851	
* 6	2.524	3.417	
3 [1]	1.187	3.126	
8 [2]	1.168	3.079	
7 [3]	2.480	3.165	

Notes:
1 Run 3 = Fan Confirmation Test (FCT)
2 Run 8 = Insert Confirmation Test (ICT)
3 Run 7 - Broke Delta T

$K_1 = P_2 - P_0 =$	.4888	- .000	=	.4888
$K_2 = P_3 - P_1 =$	.5619	- .3509	=	.2110
$K_3 = P_4 - P_2 =$	.7063	- .4888	=	.2175
$K_4 = P_5 - P_3 =$	.9659	- .5619	=	.4040
$K_5 = P_6 - P_4 =$	1.0000	- .7063	=	.2937
$K_6 = P_7 - P_5 =$		-	=	
$K_7 = P_8 - P_6 =$		-	=	
$K_8 = P_9 - P_7 =$		-	=	
$K_9 = P_{10} - P_8 =$		-	=	
$K_{10} = P_{11} - P_9 =$		-	=	
$K_{11} = P_{12} - P_{10} =$		-	=	
$K_{12} = P_{13} - P_{11} =$		-	=	
$K_{13} = P_{14} - P_{12} =$		-	=	
$K_{14} = P_{15} - P_{13} =$		-	=	
$K_{15} = P_{16} - P_{14} =$		-	=	

IV. EPA WEIGHTED AVERAGES CALCULATIONS

The following formula is the one set out in Equation 28-1, Section 8.1, Method 28 and is to be used to calculate both the weighted average particulate emission rate (PM) and the weighted average overall efficiency (OE) as shown below. The formula uses interpolated probabilities for a given heat output demand calculated from the values listed in Table 28-1(2) in Method 28.

$$\overline{PM} = \frac{K_1PM_1 + K_2PM_2 + K_3PM_3 + \dots K_nPM_n}{K_1 + K_2 + K_3 \dots + K_n}$$

III. EPA CUMULATIVE PROBABILITY CALCULATIONS

$$P_n = \frac{[\text{Hi Prob.} - \text{Low Prob.}][\text{Act. Dry Burn Rate} - \text{Low Dry Burn Rate}]}{.05} + \text{Low Prob.} = P_n$$

P_n	Hi Prob.	Low Prob.	Act. Dry Burn Rate	Low Dry Burn Rate	÷	+ Low Prob.	= P_n
P_1	.380	.328	.972	.950	.05	.328	.3509
P_2	.490	.460	1.148	1.100	.05	.460	.4888
P_3	.572	.550	1.227	1.200	.05	.550	.5619
P_4	.722	.695	1.421	1.400	.05	.695	.7063
P_5	.968	.964	2.524	2.500	.05	.964	.9659
P_6					.05		
P_7					.05		
P_8					.05		
P_9					.05		
P_{10}					.05		
P_{11}					.05		
P_{12}					.05		
P_{13}					.05		
P_{14}					.05		
P_{15}					.05		

Where $\overline{PM}$ = The EPA weighted average particulate matter (PM) emission rate in grams per hour (g/hr).
$K_1, K_2, K_3, \ldots K_n$ = The weighting factors for the individual test runs as determined in III above.
$PM_1, PM_2, PM_3, \ldots PM_n$ = The particulate emission rates for the individual test runs as listed in II above.

And

$$\overline{OE} = \frac{K_1OE_1 + K_2OE_2 + K_3OE_3 + \ldots K_nOE_n}{K_1 + K_2 + K_3 + \ldots K_n}$$

Where $\overline{OE}$ = The EPA weighted average overall efficiency in percent (%).
$K_1, K_2, K_3, \ldots K_n$ = The weighting factors for the individual runs as determined in III above.
$OE_1, OE_2, OE_3, \ldots OE_n$ = The overall efficiencies for the individual test runs as listed in II above.

IV.A. EPA WEIGHTED AVERAGE PARTICULATE EMISSIONS CALCULATIONS

$\overline{PM}$ = .4888 (2.737) + .2110 (2.165) + .2175 (2.157) + .4040 (2.85) + (3.417) + ( ) + ( ) + ( ) + ( ) + ( ) + ( ) + ( ) + ( ) + ( ) =
.4888 + .2110 + .2175 + .4040 + .2937 + + + + + + + + +

$\overline{PM}$ = 1.3378 + .4568 + .4691 + 1.1518 + 1.0036 + + + + + + + + =
1.6150

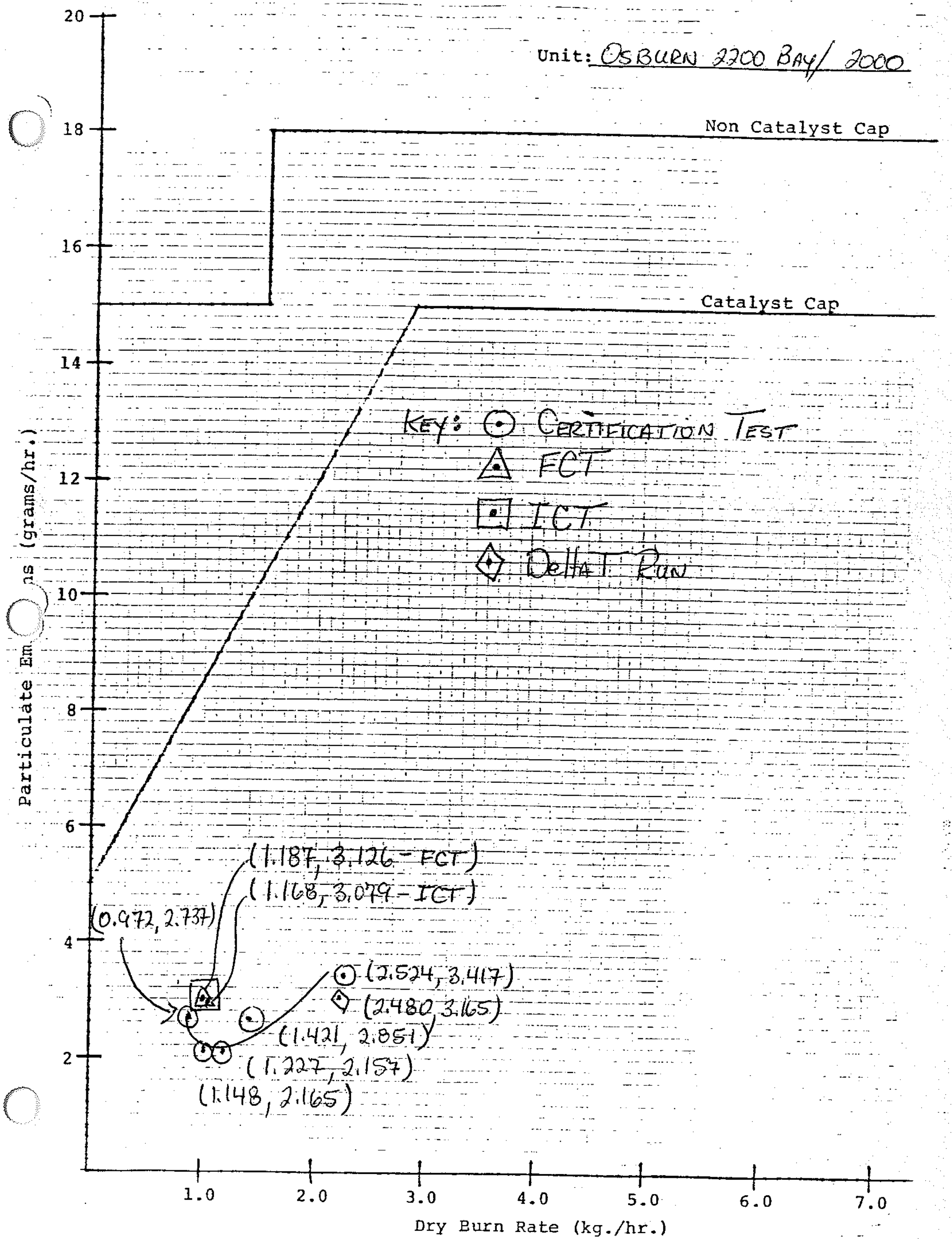
$\overline{PM}$ = 4.4191 / 1.6150 = 2.7363 = 2.74 g/hr

IV.B. EPA WEIGHTED AVERAGE OVERALL EFFICIENCY CALCULATIONS

$\overline{OE}$ = ( ) + ( ) + ( ) + ( ) + ( ) + ( ) + ( ) + ( ) + ( ) + ( ) + ( ) + ( ) + ( ) + ( ) =
+ + + + + + + + + + + + +

$\overline{OE}$ = + + + + + + + + + + + + + =

$\overline{OE}$ = ______ = ______ = ______ %



Unit: OSBURN 2200 BAY/ 2000
Non Catalyst Cap
Catalyst Cap
KEY: Certification Test
FCT
ICT
DeltaT Run
(1.187, 3.126 - FCT)
(1.168, 3.079 - ICT)
(0.972, 2.737)
(2.524, 3.417)
(2.480, 3.165)
(1.421, 2.851)
(1.227, 2.157)
(1.148, 2.165)
20
18
16
14
12
10
8
6
4
2
Particulate Emissions (grams/hr.)
1.0
2.0
3.0
4.0
5.0
6.0
7.0
Dry Burn Rate (kg./hr.)

Woodstove Data Summary

Run #	1	2	4	5	6	3 [1]	8 [2]	7 [3]	
Particulate Emissions:									
Concentration: grains/dscf:									
grams/m^3:									
Emission Rate: grams/hr:	2.737	2.165	2.157	2.851	3.417	3.126	3.079	3.165	
Emission Factor: gms/kg: (dry fuel weight basis)									
Front Half Catch: % of total									%
Total Mass Captured: Frt & Bck Halves:	30.4	20.1	17.8	21.2	15.1	29.9	29.1	14.1	mg
Efficiency Valves:									
Overall Appliance Efficiency									%
Combustion Efficiency									%
Heat Transfer Efficiency									%
Heat Output:									
Avg. BTU/hr for test cycle (EPA)	11,717	13,838	14,867	17,132	30,437	14,316	14,084	29,903	BTU/hr
Fuel Burn Rates:									
Avg Kg/hr for test cycle (Wet basis)	1.172	1.385	1.489	1.716	3.059	1.435	1.409	2.967	Kg/hr
Avg Kg/hr for test cycle (Dry basis)	0.972	1.148	1.227	1.421	2.524	1.187	1.168	2.480	Kg/hr

RUN #	1	2	4	5	6	3	8	7	
Average Temperatures:									
Stack Gas	252	289	311	335	508	323	295	517	°F
Primary Combustion Chamber Gas	619	691	694	743	929	715	697	940	°F
Secondary Combustion Chamber Gas	824	973	939	984	1157	969	881	1117	°F
Catalytic Combustor Exit Gas	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	°F
Stove Top	353	406	412	437	584	553	446	556	°F
Stove Left Sidewall	327	360	364	397	486	381	349	514	°F
Stove Back	316	363	365	364	442	396	374	457	°F
Stove Right Sidewall	340	388	392	403	499	401	368	530	°F
Stove Bottom	335	390	405	400	377	418	369	462	°F
Stove Temperature Change	-112.2	-84.0	-121	-98.8	-114.4	-78.4	-86.0	-151.6	°F
Test Chamber Environment:									
Avg. Barometric Pressure	28.56	28.623	28.553	28.619	28.723	28.46	28.624	28.675	in Hg
Avg. Temperature	82	81	74	76	70	77	74	76	°F
Avg. % Ambient Moisture	1.925	1.30	1.475	1.50	1.20	1.45	1.325	1.35	% H_2O
Avg. % Relative Humidity	62.0	44.5	47.5	46.5	42.5	52.5	43.5	44.0	%RH
Avg. Air Velocity	00.0	00.0	00.0	00.0	00.0	00.0	00.0	00.0	m/sec
Avg. Dilution Tunnel Draft (If Applicable)	.000	.000	.000	.000	.000	.000	.000	.000	in/H_2O
Test Fuel Weight and Burn Time:									
Density (Dry basis)	.5505	.4304	.4153	.3784	.5741	.4355	.3882	.4851	gm/cm³
Coal Bed Weight	3.4	3.6	3.4	3.3	3.6	3.1	3.3	3.1	lbs.
Pre Test Fuel Wt (Inc Kindling)	68.7	47.8	43.3	48.3	42.4	42.4	47.3	47.8	lbs.
Test Fuel Load Weight	14.0	14.5	14.5	14.5	14.5	14.5	14.5	14.5	lbs.
Total Test Cycle Burn Time	325	285	265	230	129	275	280	133	min.

RUN #	1	2	4	5	6	3	8	7	
Fuel Moisture Content:									
Kindling (Wet basis)	13.219	12.968	11.764	13.495	13.094	13.219	13.744	14.261	%
Pretest Fuel (Wet basis)	17.933	17.714	17.348	17.759	17.979	17.718	16.999	17.425	%
Test Fuel (Wet basis)	17.118	17.122	17.205	17.196	17.407	17.251	17.145	16.425	%
Air/Fuel Ratio:									
lbs air/lbs fuel									
Average Stack Gas Composition:									
Avg. % CO_2									%
Avg. % O_2									%
Avg. % CO									%
Avg. % Excess Air									%
Avg. % Moisture									%
Average Stack Gas Flow Rate:									
Stack flow rate - EPA CMB									dscfm
CHO balance									dscfm
Tracer Gas									dscfm
Draft (Static)	-.0365	-.0433	-.048	-.052	-.074	-.0508	-.0456	-.074	in. H_2O
Proportionality - Average	100.0	100.0	100.0	100.2	99.9	100.1	99.99	99.9	
Average Stack Gas Emission Factors:									
CO - g/Kg									
g/hr									