Non-Confidential Business Information (Non-CBI)

Certification Test Report

509 Fabrications, Inc.
Densified Fuel-Fired Freestanding Room Heater

Model: 509-1 Optimum

Prepared for:	509 Fabrications, Inc. 6512 W Seltice Way Post Falls, ID 83854
Prepared by:	OMNI-Test Laboratories, Inc. 13327 NE Airport Way Portland, OR 97230 (503) 643-3788
Test Period:	January 9, 2017 - September 5, 2017
Report Date:	September 2017
Report Number:	0559WS001E

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AUTHORIZED SIGNATORIES

This report has been reviewed and approved by the following authorized signatories:

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Jared Sorenson, Technical Services Director
OMNI-Test Laboratories, Inc.

Evaluation Decision:

Sebastian Button, Testing Supervisor
OMNI-Test Laboratories, Inc.

September 29, 2017
Issue Date

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Section 1
Appliance, Testing, & Results

1.1 - Appliance Description

Appliance Manufacturer: 509 Fabrications, Inc.

Model Designation: 509-1 Optimum

Type: Freestanding, densified fuel burning stove

Materials of Construction: The firebox and heat exchanger are constructed primarily of mild steel. The fire chamber is lined with ceramic firebrick. The fire viewing door features 3/16-inch Neoceram glass and is sealed with a 3/4-inch fiberglass rope gasket. Flat gasketing is provided by 1/4-inch adhesive-backed fiberglass.

Fuel Feed: Densified fuel logs are loaded into the appliance via a feed tube on the top of the appliance. As the log in the fire chamber burns down, the logs in the feed tube slide down the tube to maintain a continuous, even burn. This system is designed for densified fuel logs only and is not for use with other fuel type, including cordwood.

Air Introduction System: The 509-1 Optimum features primary only a primary air intake system.

- **Primary air** is introduced beneath the fire chamber via a 3" diameter tube, the opening of which is adjusted via the damper discussed below. Combustion air is then routed around to the side and enters the fire chamber through a 0.90" ID tube. **Secondary Air -** N/A The stove design does not utilize secondary air.
- **Tertiary Air** – N/A The stove design does not utilize tertiary air.

Combustion Control Mechanisms: All combustion air settings are manually controlled via a damper plate, manipulated by a handle on the front of the appliance. The damper plate acts to restrict the opening of the 3" air feed tube described above. The range of the damper plate adjustment is such that the 3" intake tube can be completely blocked or open to a total inlet area of 5.29 in^2.

Internal Baffles: The main firebox baffle is located at the top of the firebox, where the combustion air passes over the convection heat exchanger tubes, the combustion air then passes through two sets of chevroned baffles located on the back of the stove before exhausting out of the combustion blower.

Other Features: The appliance features an ignitor switch for automatic lighting of the fuel, as well as a standard feature convection blower, which forces air through the 26, 1" diameter heat exchanger tubes, and out into the room above the fire chamber door. Combustion air is pulled through the fire chamber and pushed out of the flue collar via a Fasco blower.

Flue Outlet: The 3-inch diameter flue outlet is located on the bottom/rear of the unit.

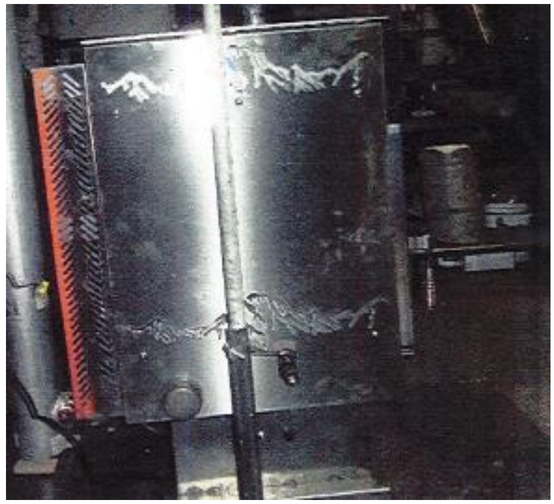
Specific Written Instructions: See Appendix A of this report. All markings and instruction materials were reviewed for content prior to printing.

Appliance Photographs

Model: 509-1 Optimum

Test Dates: January 9, 2017, September 5, 2017

Appliance Right Side



Appliance Left Side

Appliance Front

Appliance Back

1.2 - Procedures and Results Summary

INTRODUCTION

509 Fabrications, Inc. retained *OMNI* to provide EPA certification services on the 509-1 Optimum Densified Fuel Fired Freestanding Room Heater. Testing was performed by Myren Consulting, Inc., an EPA accredited laboratory. Upon completion of testing, Myren Consulting submitted a report and all relevant data to OMNI for review. This report serves as acceptance of the test report in meeting all the technical testing and reporting requirements. A copy of the Myren Consulting report can be found in Appendix D and E of this report.

The testing was performed at Myren Consulting's testing facility in Colville, Washington. The altitude of the laboratory is 1650 feet above sea level. Myren Consulting representative Ben Myren supervised the certification testing and all testing was completed by September 5, 2017.

This report is organized in accordance with the EPA-recommended outline and is summarized in the Table of Contents immediately preceding this report. The results in this report are limited to the items submitted.

TESTING AND SAMPLING PROCEDURE

The 509-1 Optimum was tested in accordance with an alternate test method as approved by EPA. The first test, conducted on January 9, 2017, was a single integrated test run performed in accordance ASTM E2779-10, *Standard Test Method for Determining Particulate Matter Emissions from Pellet Heaters.* Upon completion of the test, it was determined that the medium burn rate, which is required to be less than 50% of the high burn rate, was too high, and thus did not satisfactorily meet the operational requirements of test standard. Upon review of the issues with involved with the unique design of the stove, which is not a pellet stove, the EPA approved an alternate test method for a second test, which was performed on September 5, 2017. Again, this test was conducted in accordance with ASTM E2779, except for the order of the burn rates. Instead of the standard, high, medium, low, sequence, the appliance was tested from low, to medium, then high. Approval of these alternate test methods and an in-depth discussion of the unique nature of this appliance can be found in the Myren Consulting Report located in Appendix D and E of this report.

Particulate sampling was conducted in accordance with ASTM E2515-11, *Standard Test Method for Determination of Particulate Matter Emissions Collected in a Dilution Tunnel*. No other methods were used and no deviations were made from the method.

SUMMARY OF RESULTS

A total of two test runs were performed on the 509-1 Optimum stove. The results from the two integrated test runs were arithmetically averaged to determine compliance with the 2020 particulate emission standard for wood heaters of 2.0 g/hr.

The average particulate emission rate was measured to be **1.5 g/hr**.

The overall thermal (HHV) efficiency was measured to be **78.8%.**

The average CO emissions was measured to be **1.59 g/hr.**

1.3 - Summary Tables

Table 1 – Particulate Emissions

	One-Hour Filter Emissions Rate (g/hr)	Integrated Total Emissions Rate (g/hr)
Run 1	1.50	1.89
Run 2	1.54	1.10
Average	1.52	1.50

Table 2 – Efficiency and CO

Run #	Setting	Time (minutes)	Dry Burn Rate (kg/hr)	Heat Output Rate (BTU/hr)	Efficiency (%, HHV)	CO Emission (g/min)
1	**High**	60	2.32	33,114	78.3	1.18
1	**Medium**	120	2.90	42,099	79.6	1.61
1	**Low**	180	1.76	25,198	79.5	1.75
Integrated Total		360	2.23	32,183	79.0	1.58
2	**High**	60	1.98	27,834	77.2	1.97
2	**Medium**	120	1.55	22,368	79.3	1.70
2	**Low**	180	1.05	14,856	77.9	1.42
Integrated Total		360	1.37	19,573	78.5	1.59
				Average of Integrated Totals:	78.8	1.59

Table 3 – Test Facility Conditions

Run	Room Temperature (°F)		Barometric Pressure (in Hg)		Air Velocity (ft/min)	
	Before	**After**	**Before**	**After**	**Before**	**After**
1	62	73	28.17	28.17	<50	<50
2	66	75	28.52	28.47	<10	<10

Section 2
Laboratory Quality Assurance

2.1 - Quality Assurance/Quality Control

2.1 - Quality Assurance/Quality Control

OMNI follows the guidelines of ISO/IEC 17025, "General Requirements for the Competence of Testing and Calibration Laboratories," and the quality assurance/quality control (QA/QC) procedures found in *OMNI*'s Quality Assurance Manual.

OMNI's scope of accreditation includes, but is not limited to, the following:

- ANSI (American National Standards Institute) for certification of product to safety standards.
- To perform product safety testing by the International Accreditation Service, Inc. (formerly ICBO ES) under accreditation as a testing laboratory designated TL-130.
- To perform product safety testing as a "Certification Organization" by the Standards Council of Canada (SCC).
- Serving as a testing laboratory for the certification of wood heaters by the U.S. Environmental Protection Agency.

This report is issued within the scope of *OMNI*'s accreditation. Accreditation certificates are available upon request.

The manufacturing facilities and quality control system for the production of the 509-1 Optimum stove at 509 Fabrications, Inc. were evaluated to determine if sufficient to maintain conformance with OMNI's requirements for product certification. OMNI has concluded that the manufacturing facilities, processes, and quality control system are adequate to produce the appliance congruous with the standards and model codes to which it was evaluated.

This report shall not be reproduced, except in full, without the written approval of OMNI-Test Laboratories, Inc.

Appendix A

Labeling & Owner's Manual

CAUTION:

HOT WHILE IN OPERATION DO NOT TOUCH,
KEEP CHILDREN AND CLOTHING AWAY.
CONTACT MAY CAUSE SKIN BURNS.
KEEP FURNISHINGS AND OTHER COMBUSTIBLE
MATERIAL FAR AWAY FROM THE APPLIANCE.
SEE NAMEPLATE AND INSTRUCTIONS

Tested & Listed By O-TL C US Portland Oregon USA

OMNI-Test Laboratories, Inc.

0559WS001E

SERIAL

Model 509-1 OPTIMUM

PREVENT HOUSE FIRES

Install and use only in accordance with manufacturer's installation and operating instructions. Contact local building or fire officials about restrictions and installation inspections in your area.
Do not obstruct the space beneath heater.

NOT SUITABLE FOR MOBILE HOME INSTALLATION WARNING -

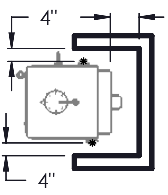
Inspect and clean chimney frequently - Under Certain Conditions of Use, Creosote Buildup May Occur Rapidly. Do not connect this unit to a chimney serving another appliance.

Electrical Rating: 115 VAC, 1.2 Amps, 60 Hz. Route power cord away from unit. Do not route cord under or in front of appliance.
DANGER: Risk of electrical shock. Disconnect power supply before servicing.
Replace glass only with 1/4" in Neo-Ceram available from your dealer.
Do not overfire - if heater or chimney connector glows, you are overfiring.
OPERATE ONLY WITH DOORS CLOSED
Open lid only to add fuel to the fire.

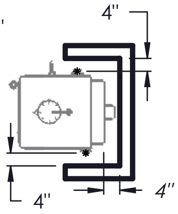
Do **NOT** operate before fully assembling components.
WARNING: Only use approved fuel listed in owners manual. Burning any other fuel will void warranty.
Only open one door at a time.
Follow cleaning procedures in the manual carefully.

VENT SPECIFICATIONS:

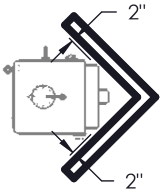
SINGLE WALL: 3 in (3 inches) (76mm) diameter, minimum 24 MSG black or blued steel connector pipe, with a listed factory-built UL103HT* Class "A" chimney, suitable for use with solid fuels, or a masonry chimney, and the referenced clearances.
DOUBLE WALL: 3 inch (3 inches) (76mm) diameter, Listed double wall air insulated connector pipe with listed factory-built MH8381 & MH14420) to UL 641 Type L Low Temperature Venting Systems Class "A" chimney, or a masonry chimney and the referenced clearances.



VERTICAL INSTALL-EXHAUST
Rear Wall or Alcove



HORIZONTAL INSTALL-EXHAUST
Rear Wall or Alcove



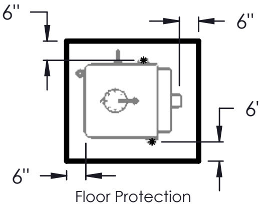
Corner Wall

MIN CLEARANCES TO COMBUSTIBLE MATERIALS: Inches & (Millimeters)
NOTE: All "A" , "C" and "F" Dimensions are to the center diameter of flue collar.

INSTALLATION: FULL VERTICAL										
	A	B	C	D	E	F	G	H	I	J
SINGLE WALL PIPE										
DOUBLE WALL PIPE										
INSTALLATION: HORIZONTAL WITH MINIMUM 2 FT VERTICAL OFF STOVE TOP										
SINGLE WALL PIPE										
DOUBLE WALL PIPE										

INSTALLATION: ALCOVE - Three inch (3 inches) (76mm) diameter Listed DOUBLE WALL pipe with MH8381 & MH14420) to UL 641 Type L Low Temperature Venting Systems** Listed factory-built Class "A" chimney, or a masonry chimney. (Mobile Home must be equipped with a spark arrestor.) Maximum depth of Alcove shall be no more than 48 inches (1219mm) with a minimum height of 84.0 inches (2134mm) from floor to bottom of ceiling and the referenced clearances.
(**In Canada must comply with Standard CAN/ULC-S629-M87 for the 650oC Factory-built chimney.)

FLOOR PROTECTION:
Floor protector must be 1/2 in. minimum non-combustible material extending beneath heater and to front/sides/rear as indicated on the diagram below.
Exception: Non-combustible floor protections must extend beneath the flue pipe when installed with horizontal venting and extend 2 inches (51mm) beyond each side.



Floor Protection

This wood heater needs periodic inspection and repair for proper operation. Consult the owner's manual for further information. It is against federal regulations to operate this wood heater in a manner inconsistent with the operating instructions in the owner's manual.
U.S. ENVIRONMENTAL PROTECTION AGENCY - Certified to comply with 2020 particulate emission standards using densified fuel logs. This wood heater was found to have an average emissions rate of 1.9 g/hr using ASTM E2779

Manufactured by:
509 Fabrications, Inc.
Post Falls, ID.
www.509Fab.com

2017 2018 2019 2020 2021 2022 JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

DO NOT REMOVE THIS LABEL

509 Stoves
Owner's Operation Manual
Model 5091

UL 1482 STANDARD FOR SOLID-FUEL TYPE ROOM HEATERS- Edition 7 - Revision Date 2015/08/19
ULC S627 SPACE HEATERS FOR USE WITH SOLID FUELS- Edition 3 - Issue Date 2000/06/01
ASTM E1509 STANDARD SPECIFICATION FOR ROOM HEATERS, PELLET FUEL-BURNING TYPE - Issue Date 2012/10/01

OMNI PROJECT NUMBER: 0559WS001E

Tested & Listed By O-TL C US Portland Oregon USA
OMNI-Test Laboratories, Inc.

MADE IN U. S. A.

MODEL 509-1

CAUTION!!!

IMPORTANT OPERATING AND MAINTENANCE INSTRUCTIONS INCLUDED.

DO NOT DISCARD.

LEAVE THIS MANUAL WITH THE HOMEOWNER.

Failure to follow the information in this manual may result in a fire; causing property damage, personal injury, or death. Read this booklet completely before installing or operating this appliance.

Do not modify this appliance in any way. Operation of the appliance in a manner inconsistent with this owner's manual will void the warranty.

This wood heater needs periodic inspection and repair for proper operation. It is against federal regulations to operate this wood heater in a manner inconsistent with operating instructions in this manual.

Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.

Comply with all minimum clearances to combustibles as specified. Failure to comply may cause a house fire.

Certified to comply with 2020 particulate emission standards using densified fuel logs. This wood heater was found to have an average emissions rate of 1.9 g/hr using ASTM E2779

This wood heater has a manufacturer-set minimum low burn rate that must not be altered. It is against federal regulations to alter this setting or otherwise operate this wood heater in a manner inconsistent with operating instructions in this manual.

Glass and other surfaces are hot during operation and for some time after the fire has gone out. Supervise children around this appliance. Warn children and adults about high temperatures. High temperatures may ignite clothing or other flammable materials. Keep clothing, furniture, draperies and other combustible materials away.

DO NOT OPERATE WITH THE DOOR OPEN.

CALIFORNIA PROP 65 WARNING:
Use of this product may produce smoke which contains chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm.

IMPORTANT WARNINGS

CAUTION: Read this manual thoroughly before starting installation. For your safety, follow the installation, operation and maintenance instructions exactly without deviation. Failure to follow these instructions may result in a possible fire hazard and will void the warranty. If this appliance is not properly installed, a house fire may result. Contact local building or fire officials about requirements and installation inspection in your area.

1. DO NOT CONNECT THIS UNIT TO A CHIMNEY FLUE CONNECTED TO ANOTHER APPLIANCE.
2. Do not connect this appliance to air ducts or any air distribution system.
3. Do not install a flue damper in the exhaust venting system of this appliance.
4. Do not use class B venting intended for gas appliances as a chimney or connector pipe on this appliance.
5. The minimum clearances must be maintained for all combustible surfaces and materials including; furniture, carpet, drapes, clothing, wood, papers, etc. Do not store firewood next to or touching the appliance.

6. INSTALLATION DISCLAIMER - This stoves exhaust system works with negative combustion chamber pressure and a slightly positive chimney pressure. Therefore, it is imperative that the exhaust system is gas tight and installed correctly. Since 509 Fabrications, Inc. has no control over the installation of your stove, 509 Fabrications, Inc. grants no warranty, implied or stated for the installation or maintenance of your stove, and assumes no responsibility for any consequential damage(s).
7. Burning any kind of fuel consumes oxygen. If outside air is not ducted to the appliance, ensure that there is an adequate source of fresh air available to the room where the appliance is installed. WE HIGHLY RECOMMEND USING OUTSIDE AIR SOURCE IN CASE OF APPLIANCE SHUT DOWN, NO SMOKE WILL FILL THE ROOM.
8. The stove will not operate using natural draft, nor without a power source for the blower and fuel feeding systems.
9. 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 well away from the heater while it is in use.
10. CONTINUOUS OPERATION: When operated correctly, this appliance cannot be overfired. Continuous operation at a maximum burn can, however, shorten the life of the electrical components (blowers, motors, and electronic controls), and is not recommended. Typical approved operation would include running at the low to mid-range setting with occasional running on the maximum setting during the coldest periods of the winter. The blower speed control should be turned to HIGH when operating the stove on the high heat setting.
11. CAUTION: HOT IN OPERATION. An appliance hot enough to warm your home can severely burn anyone touching it. Keep children, clothing and furniture away. Contact may cause skin burns. Do not let children touch the appliance. Train them to stay a safe distance from the unit.
12. APPROVED FUEL: This appliance is designed specifically for densified wood fuels only. This appliance is NOT approved to burn cardboard, nut hulls, cherry pits, corn, etc. regardless if it js in log form. Failure to comply with this restriction will void all warranties and the safety listing of the stove. Consult with your authorized 509 Fabrications, Inc. dealer for more information on approved densified log fuels.
13. FLY ASH BUILD-UP: For all densified fuel heaters, the combustion gases will contain small particles of fly ash. This will vary due to the ash content of the fuel being burned. Over time, the fly ash will collect in the exhaust venting system and restrict the flow of the flue gases. The exhaust venting system should be inspected regularly and cleaned as necessary.
14. SOOT FORMATION Incomplete combustion, such as occurs during startup, shutdown, or incorrect operation of the room heater will lead to some soot formation which will collect in the exhaust venting system. A precautionary inspection on a regular basis is advisable to determine the necessity of cleaning. The exhaust venting system should be inspected regularly and cleaned as necessary.
15. DISPOSING OF ASHES: Any ashes removed from the stove must be deposited in a metal container with a tight-fitting lid. The closed container of ashes should be placed on a noncombustible floor or on the ground, well away from ail combustible materials, outside of the dwelling pending final disposal. If the ashes are disposed of by burial in soil or otherwise locally dispersed, they should be retained in the closed container until all cinders have been thoroughly cooled.
16. SAVE THESE INSTRUCTIONS.
17. See the listing label on the appliance or see Safety / Listing Label

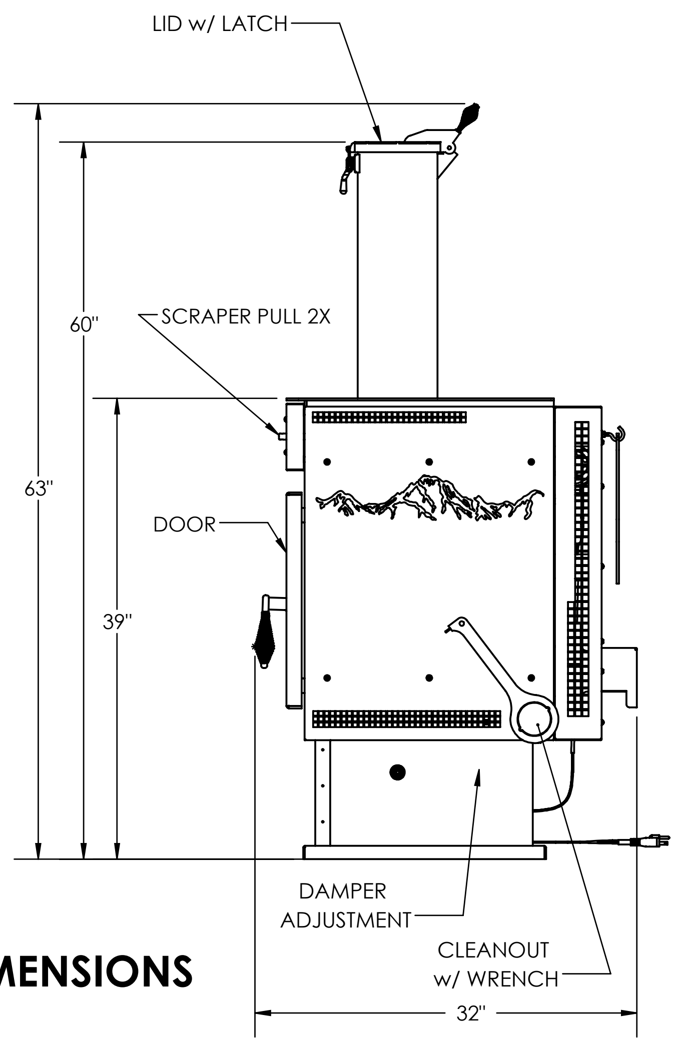
509 Fabrication

Thank you for purchasing our 509 Fabrications, Inc Densified Fuel Log Stove.
This manual is designed to be simple. After reading through it if you have any questions, please feel free to email me anytime at Dusty@509Fab.com <mailto:Dusty@509Fab.com>. I will respond to you as soon as possible.

Very Important: In the unlikely event if your electricity goes out, do not open the door or the lid on the top of the stove. The stove is designed to be air tight. Let the fire go out naturally.
Do not have the lid and the door open at the same time while the fire is burning. You will get smoke in the room. Only open one at a time.
Do not burn wood or any other substance in this stove except natural densified fuel logs with no additives. Burning these types of fuel will void your warranty and heavily damage the inner workings of the stove and exhaust motor.

This manual will cover:

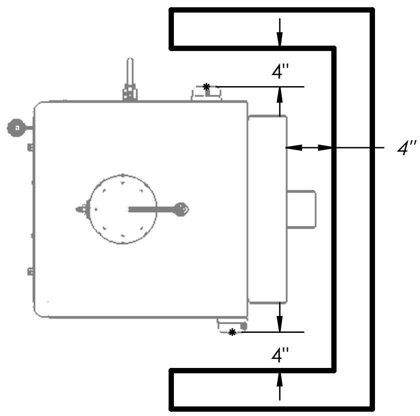
1. Where and How to Install the stove including air intake and exhaust
2. How to Power the stove
3. Types of fuel you "Can and Cannot Burn"
4. How to Light the stove
5. How to Operate the stove and problem solving
6. How to Clean the stove
7. Maintenance
8. Clearance to combustibles
9. Limited Warranty
10. Important Warnings



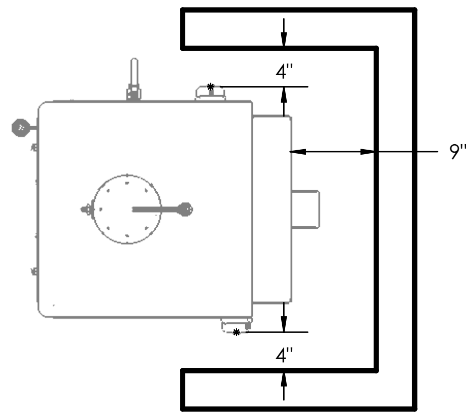
DIMENSIONS

How to Install the stove

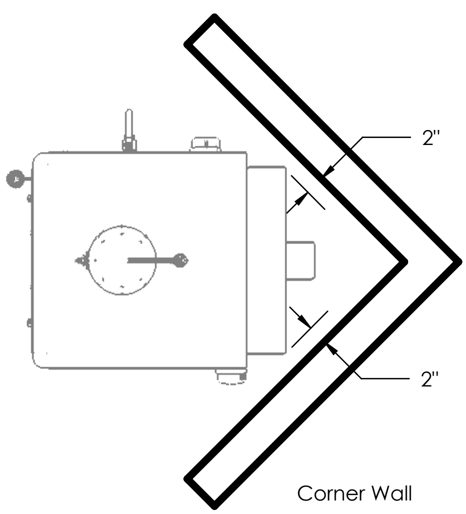
The stove should be installed by a licensed stove company or a licensed HVAC Technician. Some states and counties require permits be obtained before you install your stove.
The outlet on the bottom combustion blower motor is 3” in diameter. Double wall pipe with stainless steel for the inner liner must be used in all installs. It is most commonly called Pellet Pipe. Your installer will know clearances for pipes through the walls and if you choose to run the pipe up instead of out the wall, you will more likely need to use 4” double wall pipe.
The intake pipe fitting located on the bottom center of the stove is 3”. A single wall pipe can be used for the intake air to the outside of the home.
Place the stove on an approved fire pad. Check with your installer in the state you are in to determine clearances on the size of pad. Some can be even with the base of the stove and others need to be one foot or more in size than the outer dimensions of the stove.
The stove is designed to be pushed back to within inches of the back wall and to be at least one foot from any sidewalls or any other surface. Check with your local permit inspector to verify your clearance from combustibles in your state. We have UL specifications on the stove for clearance to combustibles. (see #8)



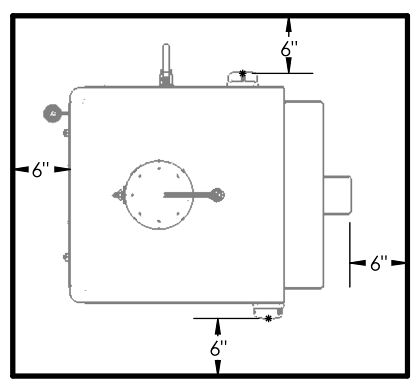
HORIZONTAL INSTALL-EXHAUST
Rear Wall or Alcove



VERTICAL INSTALL-EXHAUST
Rear Wall or Alcove



Corner Wall



Floor Protection

DuraVent - PelletVent Pro - Pipe

Building structure and Air intake and output, The following pages show requirments per UL testing of this stove
509 FAB suggest the DuraVent products and Specifactions (*See Attached Manual*) As an Industerial leader in Pellet Stove Pipe products

How to Power the stove

The stove has one plug-in, 3 prong 6 Ft. cord. Plug it into a 3-prong outlet. **The stove should be plugged into its own outlet for safety and power surges.**

The Fan and Igniter switches are on the left side of the stove on the base. The upper convection fan is plugged into to outlet under the stove.

The round knob is your first switch on the side of the stove and it is on the far left. This switch controls the upper air that will flow into the room. It has a variable speed and can be set to your needs.

The second switch is for your combustion blower. This switch will need to be turned to the up position and be on at all times that the stove is in operation.

The third switch is for your Hot Air Igniter. It is "ON" when the switch is located in the up position. The normal time for ignition is 1 to 3 minutes. **It is very important to not leave this on after you are done lighting the stove. You could damage the igniter.**

What you "Can and Cannot Burn" in your stove.

1. The stove **is not** designed to burn cord wood or wood round logs. **DO NOT BURN WOOD!**

2. The stove **is not** designed to burn any log that has additives in the log to help it burn. These types of logs will void your warranty if burned in your stove. The materials in these logs will also "clog up" the way the stove breathes to be able to operate efficiently and it will also plug up the fan blades on the motor that takes the exhaust out of the stove. Most of these logs that **are not** designed to be burned in your stove will have a wrapper on the log. Some examples of these types of logs are:

A. Duraflame

B. Java Log

C. Pine Mountain

D. Enviro Log

3. You can use the little fire starters that have wax additives in them to light your fire if needed. **One per starting operation.**

Log Fuel for the Stove .

Some logs over time will become "scaley" or rough feeling. This means that they have taken on moisture, just like a pellet will, over time, for a pellet stove. You cannot burn old pellets in a pellet stove but you can still burn your logs in your new stove, they just tend to create moisture inside the tube and water will be on the inside of the lid, so be careful opening the lid to keep the drops from spilling onto the top of the stove.

Be careful when selecting your new logs. They should be smooth and glossy felling to the touch, and have a slight dark color on the outside. Some older logs will start taking shape like a banana, they are not the ones to buy, they are too old to burn well. If you have logs left over from the previous season, it is best to mix them in with the new logs as you burn the stove, and use them to chop into kindling for starting the stove.

If a log sticks in the feed tube then you need to take the scraper tool provided and push it down the tube. Normally a couple of taps with the scraper tool will loosen the log and it will fall down to be burned in the fire.

How to Light the stove

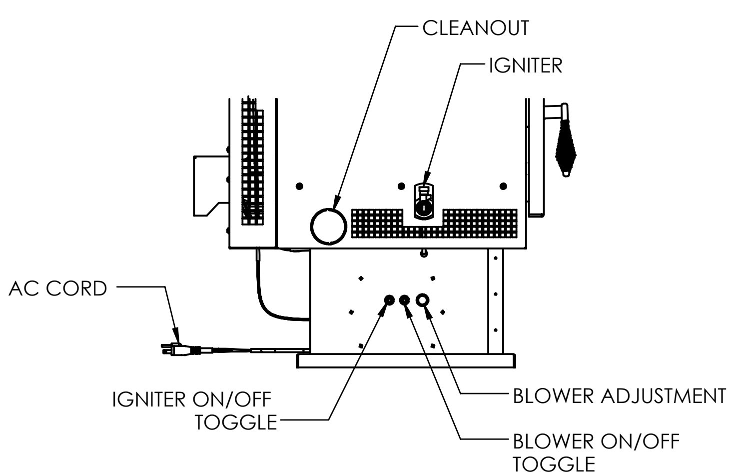
DO NOT USE ANY TYPE OF FIRE STARTING LIQUIDS LIKE CHARCOAL LIGHTER FLUID, GAS, OR ANY OTHER COMBUSTIBLE FOR ANY REASON.

1. Open the door and make sure there is not a log left in the firebox. You can do this by looking at the bottom of the feed tube and down inside the square box. If you cannot clearly see in the fire box, slide the brick in the front over and look in with a flashlight. Slide the brick back into place when finished. **If there is a log in there then follow this procedure**

A. Move the log over to the right.

B. Drop in several little chunks of new log on the left-hand side, as many as can be fit in there without packing them in. Then proceed to # 8.

2. Close the door and latch it.
3. Open up the top lid on the stove
4. Slide the damper handle (located on the right side of the stove on the base) all the way to the front part of the base.
5. Break off some small ends of the logs using a hatchet or our log chipper found on our website. These pieces should be small chunks not full round discs from the logs. Drop about 3 cups of these pieces down the open lid.
6. Chop or break off 3 round discs about ½ inch thick from a log and drop those down the tube.
7. Grab a North Idaho Energy Log, a Presto Log, or a Home Fire Prest-Log or any natural style log and drop it down the tube. **Try and hang onto it as you initially slide it down the tube**
8. Close the top lid and latch it.
9. Open up the ball valve on the left side of the stove. In the closed position the handle will be alongside the stove. In the open position, it will be out 90 degrees from the stove.
10. Turn on the round knob to full speed
11. Turn on the Combustion blower motor, the second middle switch to the up position.
12. Turn the Igniter toggle switch, the 3rd switch to the far left on the base of the stove, to the up position.
13. When you see flames inside the stove, then slide the damper handle towards the back of the stove.
14. Turn off the igniter toggle switch, the 3rd switch to the far left on the base of the stove.
15. Turn the ball valve back to the closed position so it is in-line with the side of the stove.
16. Load the stove with extra logs.
17. Let the stove burn on high for at least 25 minutes before turning the damper down to low or medium burn. There is an indicator on the side of the base to determine your setting. On high you will go through a log every 2 hours or so. On low you will get from 4 to 6 hours out of a log. These figures are based on North Idaho Energy Logs. Other logs that are smaller will burn shorter periods. (Some logs will burn cooler as well in the amount of heat the stove produces, so find the logs that are right for you and your home and use them.) Different brands of logs are available in different parts of the country, just make sure they are a natural log with no additives.



OPERATION - START UP

How to Operate the stove and Problem Solving

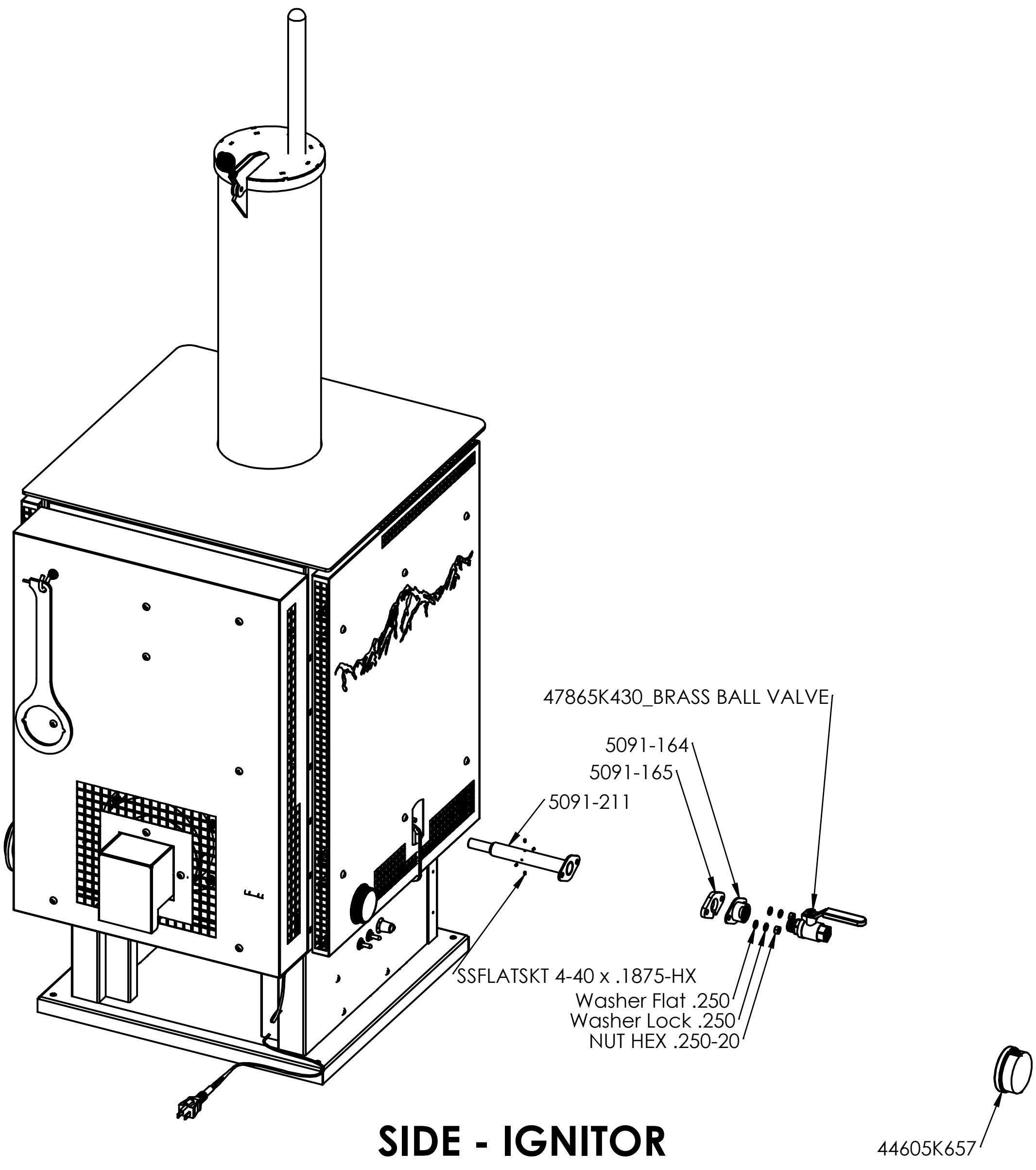
The stove is very easy to operate as it does not have moving parts, and only the 2 fan motors. The biggest mistake to be made on this stove is to not let it burn for at least 25 minutes on high after lighting it. This is crucial to how the stove performs.

1. **I can't get my fire to light with the igniter.** Solutions: The igniter may be covered by a piece of fuel in the fire box. Slide the front brick over and look down in the fire box. Slide the log chunks over to the right of the left edge of the firebox. This will uncover the hole in the brick where the hot air is introduced to light the kindling in the firebox.
2. **My stove is not putting out any heat.** Inspect the fire through the door and make sure that the combustion blower is running and the upper convection blower is blowing air. If you can see a log in the firebox that is not glowing red or flaming, you may need to turn it up. Open up the damper by sliding the lever handle towards the rear of the stove. Let the stove burn for at least half an hour and then turn down to the setting you desire.
3. **My stove is not putting out any heat.** Inspect the fire through the door and make sure the combustion blower is running and the upper convection blower is blowing air. If you do not see glowing or burning in the firebox, then you may have a log stuck in the feed tube. Open up the top lid and look down the feed tube. If you can see a log in the feed tube, then follow this procedure: First, close the lid on top and then open the door. Feel for heat without touching anything on or inside the stove. If it is very hot when you open the door, then close the door and open the feed tube lid. Using a suitable tool, like a round rod, tap the log from the lid side down the feed tube. It will fall into the firebox. Open up the damper by sliding it towards the rear of the stove and let it burn on high for ½ hour and then reset to your desired setting.
4. **My stove is not putting out any heat.** Check the combustion blower and make sure it is on. It is powered "ON" by the middle toggle switch on the base of the stove. Make sure you have power to the plug where the stove is plugged in. You can do this by plugging another appliance into the wall and see if it comes on. If the appliance comes on you will need to call a repair company to replace the blower motor. (I have the blower motors available on my website and I will get you one out right away.)
5. **My stove is not blowing any heat from the convection blower out the front of the stove.** Make sure the blower is plugged in and the switch is turned on. Try unplugging the blower motor from the plug in on the backside of the stove under the base and plugging it into an extension cord. Then plug that cord directly into the wall. If the blower motor does not come on, then the switch or the blower motor is bad. Have a repair company come and fix it and order a blower off of our website.

How to Clean the stove

FOR YOUR SAFETY, IT IS IMPERATIVE TO MAKE SURE THE STOVE IS OFF AND COLD FOR ANY CLEANING PROCEDURE.

1. The glass is NORMALLY easy to clean. The best way to clean the glass is to take a razor blade with a built in safety handle and scrape the glass and then clean it with a product like “Simple Green” or glass cleaner and a paper towel.
2. The inside around the firebox needs to be vacuumed out about every 2 to 3 weeks or longer depending on how often you burn. **Use an “ash vacuum” only to do this. It is what they are made for and then the dust will not blow in the house.** The ash vacuums are available on my website.
3. Inspect the firebox by sliding the front brick to the side or removing the brick. Use a flash light to look in the firebox. If needed, vacuum the firebox out completely.
4. **VERY IMPORTANT!! Every 3 to 4 days take the special wrench provided and using the pin end slide it into the hole on the rod sticking out by the tubes on the top front of the stove. Use wrench to pull the rod from front to back completely 5 or 6 times. This will clean off the radiant tubes so they transfer heat better.**
5. **Every Time you clean the stove…** Use the special wrench provided to loosen the caps on each side of the stove. Unscrew them and use the ash vacuum to vacuum out those tubes. You can slide the end of the hose all the way in until it hits the other side of the stove. Look inside the tube with a light to make sure you have that area clean.
6. The body of the stove itself can be cleaned with glass cleaner, **ONLY WHEN COLD**.

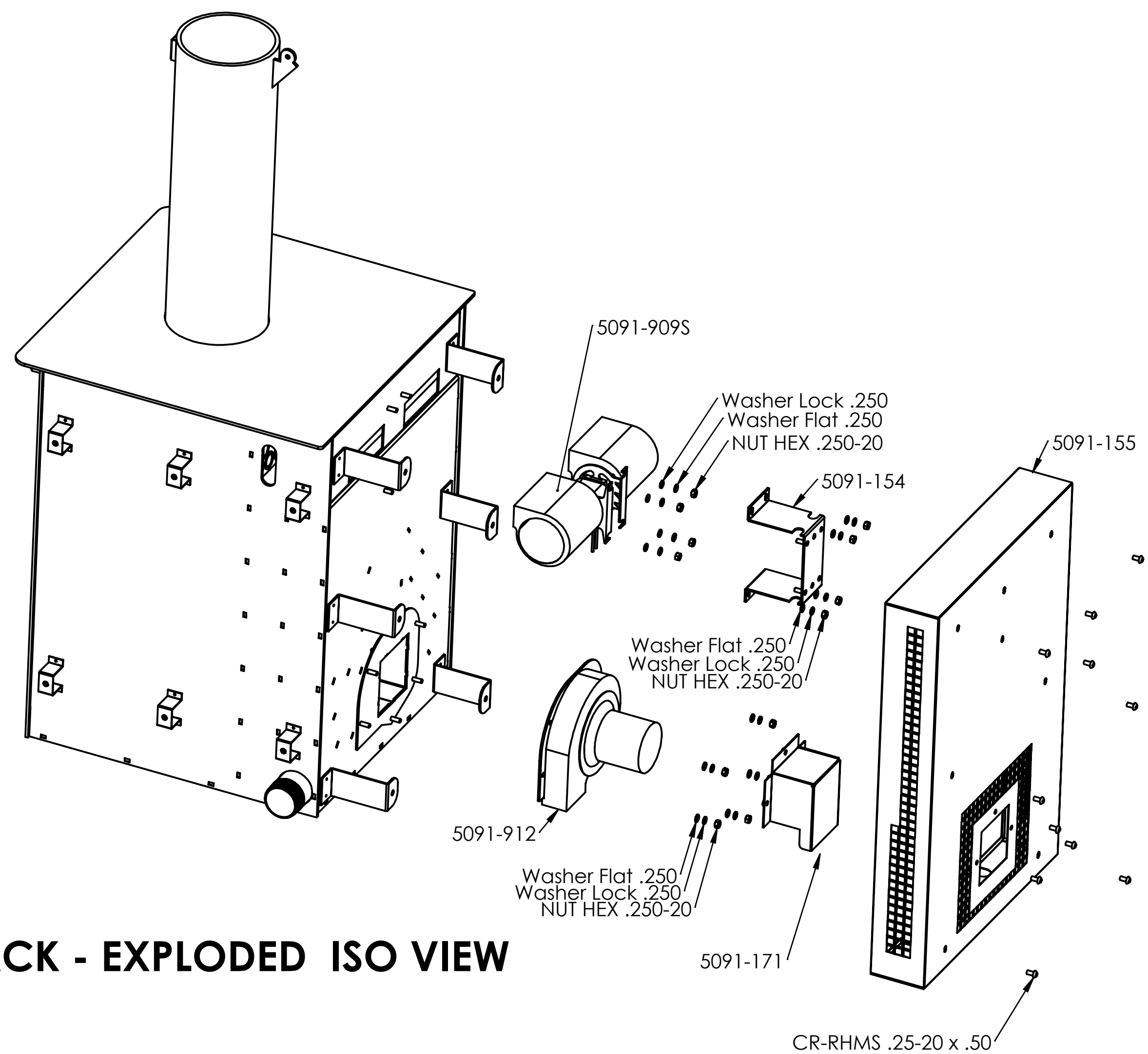


SIDE - IGNITOR

Maintenance

1. Normal cleaning should be all that is necessary. Make sure to clean the radiant heat tubes with the scraper rod and wrench handle every day. This is a 30 second procedure.

One time a year the Lower Combustion motor should be removed and cleaned. The blades will have buildup on them from regular burning. This buildup needs to be removed and cleaned by a professional and the motor re-installed, making sure all nut fasteners and lock washers are used for re-install and tightened down securely. Do not over-tighten the nuts. If the gasket is damaged, it should be replaced to prevent air leaks.
With the combustion motor removed, inspect your chimney pipe inspected for debris, and have it cleaned by a professional at this time if needed. When it is re-installed make sure that all connections are re-sealed and secure.

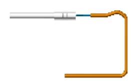


BACK - EXPLODED ISO VIEW

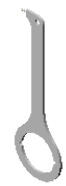
Replacement Parts and Accessories

Call 509 Fabrication for Price and Aviability

GLASS, DOOR MAIN

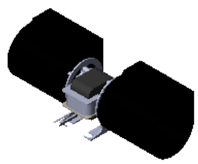


IGNITOR

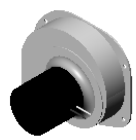


WRENCH-PULLER

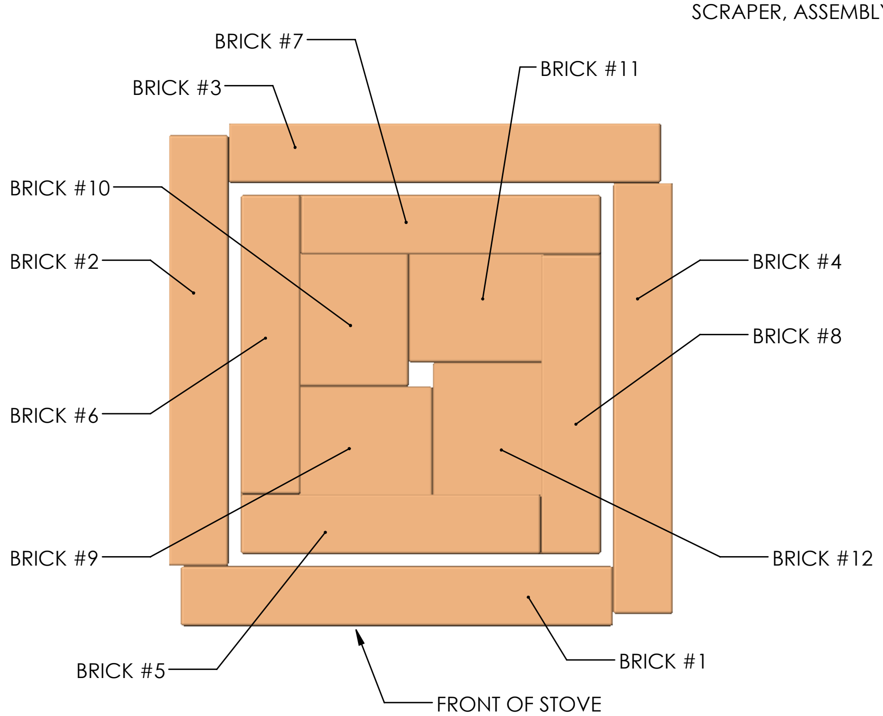
SCRAPER, ASSEMBLY



BLOWER



DRAFT FAN

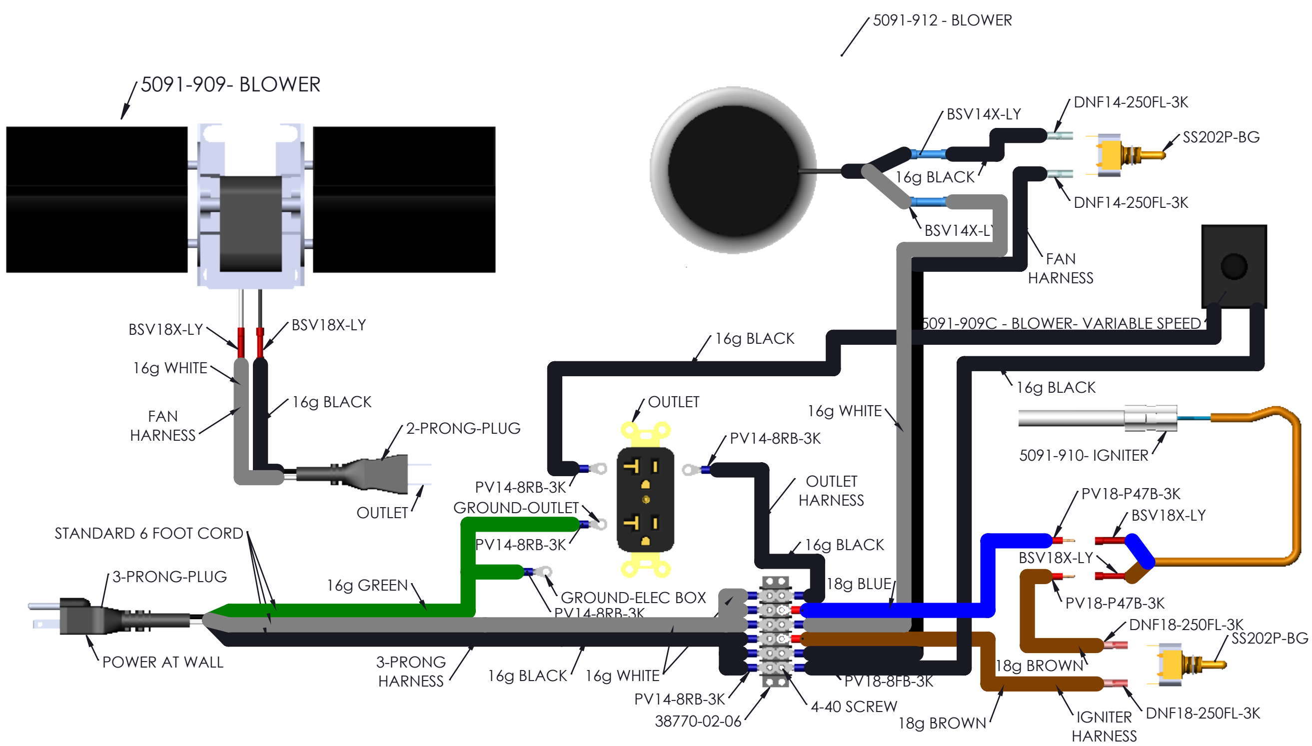


BRICK-FIREBOX

Brick replacement

The upper row of bricks are standard fire bricks except for the front facing brick. It has been cut down for air flow. The bricks can be obtained on the website or a home improvement store.
The inside row of bricks are identified and counted from the front facing brick that stands on its side. Front brick is #1 brick. #2 is to the left, brick #3 is in the back and brick #4 is the one on the right. These bricks are all special to their designated placement, and how they are cut and shaped. The bricks in the bottom of the firebox, if needing replaced, will all have to be replaced at the same time. They are available on the website.

Wiring Diagram



Warranty

These stoves are all built by hand and Made in America by 509 Fabrications, Inc. Post Falls, ID. They have been made with the finest parts and materials available and metal thicknesses that will last a lifetime.

1. The stove body itself, minus the finish paint, is warranted for life by the original purchaser.
2. The convection blower is warranted for 1 year from date of purchase.
3. The Combustion blower motor is warranted for 1 year from date of purchase.
4. The glass is warranted for 1 year from date of purchase.
5. The fire bricks do not have any warranty.

509 Fabrications, Inc.
Post Falls, ID.
www.509Fab.com <http://www.509Fab.com>
Dusty@509Fab.com <mailto:Dusty@509Fab.com>
https://www.facebook.com/509Fab/

Appendix B

Manufacturer's Quality Assurance Plan
(Confidential Business Information)

The following quality assurance plan has been developed to ensure all that all units within the model line are similar in all material respects that would affect emissions to the sample tested under this report, in accordance with § 60.533 (m).

Appendix C

Manufacturer Design Information
(Confidential Business Information)

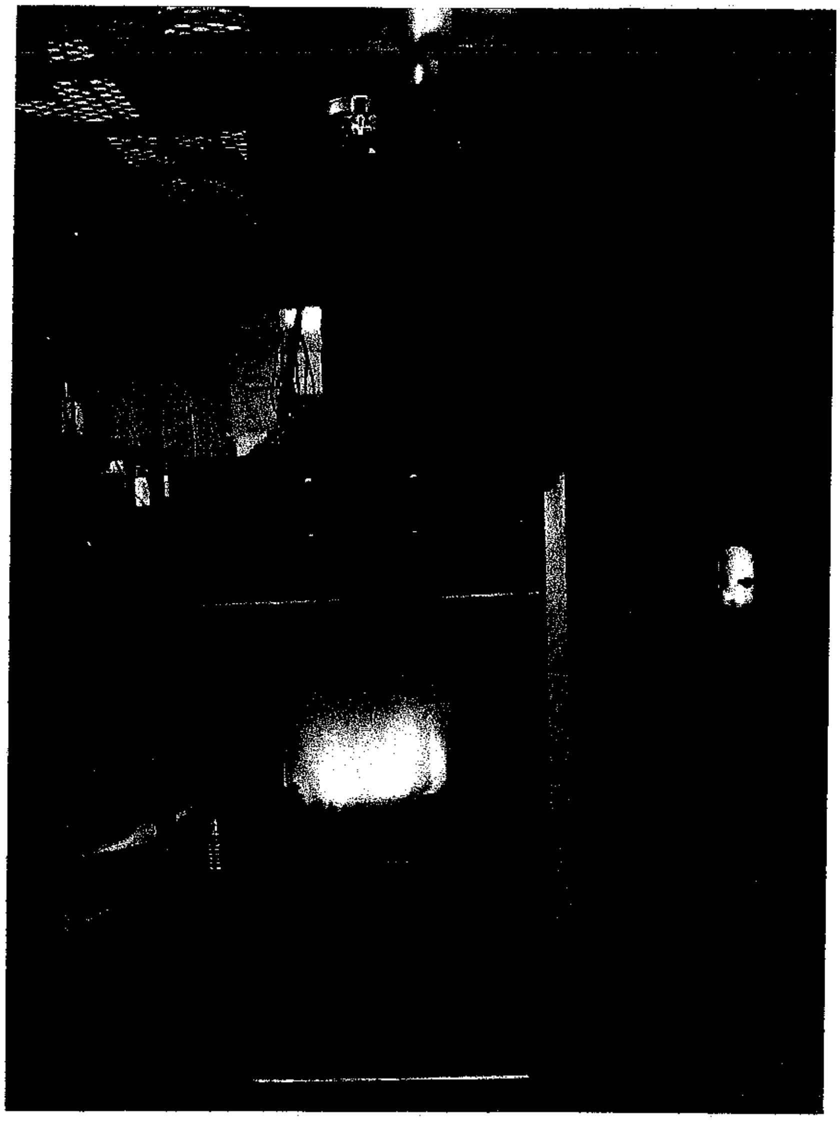
Appendix D

Myren Consulting Test Report Dated April 24, 2017

US EPA WOOD HEATER CERTIFICATION TEST REPORT

509 FABRICATORS, INC.
OPTIMUM DENSIFIED FUEL LOG STOVE

APRIL 24, 2017



MYREN CONSULTING, INC.

OFFICE
512 WILLIAMS LAKE ROAD
COLVILLE, WA 99114
PHONE 509-684-1154
FAX 509-684-3987

LABORATORY
501 C WILLIAMS LAKE ROAD
COLVILLE, WA 99114
PHONE 509-685-9458
EMAIL myren.ben@gmail.com

Myren Consulting, Inc.

512 Williams Lake Road

Colville, WA 99114

Office: (509) 684-1154 Lab: (509) 685-9458

email:myren.ben@gmail.com

509 FAB Optimum Sanchez Letter

24 April 2017

Dr. Rafael Sanchez, PhD.
U.S.EPA
Office of Enforcement and Compliance Assurance
Office of Compliance
William Jefferson Clinton Building, South
Room 7419D
1200 Pennsylvania Ave., N.W.
Washington, DC 20003

Dear Dr. Sanchez:

Myren Consulting, Inc. has prepared a certification test report for the Optimum densified fuel log stove and sent it to the manufacturer's certifying third party entity, Omni Test lab. As the test results indicate, the unit's emissions are below both the 2015 EPA standard of 4.5 g/h and 2020 EPA standard of 2.0 g/h.

Our report format has been revised to comply with EPA's specified format for pellet stoves and is organized in basically the same way as the previous pellet stove test reports Myren Consulting, Inc. has submitted to EPA. While the report is basically organized like the reports submitted under the old NSPS, some parts of the report have been reorganized/ revised to insure compliance with the rules in the new NSPS. Thus look at the relevant pages, e.g., Individual Test Run Page Index, in the Introduction Section to find the required information.

A comment is warranted here. This unit is the first unit that burns densified fuel logs to be certification tested. How it operates is very differently from both wood stoves and pellet stoves. It is truly an "outside the box hybrid" that combines operational features from both wood and pellet stoves, so the way it operates and was tested reflects this.

If you or anyone else has any questions about the information or data in this test report, please contact me immediately.

Sincerely,

Alben T. Myren Jr.
President
ATM/im

****

Confidential

****

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.

****

Confidential

****

Report Certification

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

Date: April 20, 2017 Signature: Albert T. Myren Jr.
Title: President

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

Date: April 20, 2017 Signature: Albert T. Myren Jr.
Title: President

PELLET STOVE
TABLE OF CONTENTS

TESTING LOCATION AND PERSONNELL INFORMATION

Unit Name: OPTIMUM DENSIFIED FUEL LOG STOVE

Manufacturer Name: 509 FABRICATORS, INC.

**Manufacturer Address: 14823N. Peone Pines Drive
Mead, WA 99201**

Manufacturer Phone: 509 993 3767

**Manufacturer Contact Person: Dusty Henderson
email: Dusty@509fab.com**

Observers & Affiliation: Dusty Henderson & Gary Henderson, both from 509 Fabricators

SUPERVISOR: Ben Myren

MYREN CONSULTING'S LAB TEAM: Ilse Myren, Ben Myren, Eric Schaefer

LAB LOCATION: Myren Consulting's lab in Colville, WA 99114

ELEVATION: ~ 1650 FEET

MYREN CONSULTING, INC.

LABORATORY
501-C WILLIAMS LAKE ROAD
COLVILLE, WA 99114
509 685 9458

OFFICE
512 WILLIAMS LAKE ROAD
COLVILLE, WA 99114
509 684 1154
email: <myren.ben@gmail.com>

Pellet Stove Test Report Page Number Index

Pellet Stove Page Number Index

ASTM E2515/ EPA M5G-1 Individual Test Run Page Index (Pellet Stove)

The data sheets in the individual test runs are organized in the following sequence.

Page Description	# of Pages
Filters photo	1
CSA B415.1-10 "Report" computer spreadsheet printout	Variable
CSA B415.1-10 "Data Input" computer spreadsheet printout	Variable
Dilution Tunnel Traverse data	1
Dilution Tunnel Gas Velocity and Volumetric Flow Rate Calculations	1
Train 1 Emission Rate/ Dilution Tunnel Calculations computer spreadsheet printout	Variable
Train 1 0-60 Minute Emission Rate/ Dilution Tunnel Calculations computer spreadsheet printout	Variable
Train 1 0-60 Minute Particulate Sampling data (Meter Box data)	Variable
Train 1 60 Minute Plus Particulate Sampling data (Meter Box data)	Variable
Filter Constant Tare Weight data	Variable
Beaker Constant Tare Weight data	Variable
Acetone Blank Beaker Constant Final Weight data	1
Train 1 0-60 Minute PM Sample Constant Final Weight data	1
Train 1 60 Minute Plus Constant Final Weight data	1
Train 1 Particulate Matter Catch Calculations	Variable
Train 2 Emission Rate/ Dilution Tunnel Calculations computer spreadsheet printout	Variable
Train 2 Particulate Sampling data (Meter Box data)	Variable
Train 2 PM Sample Constant Final Weight data	1
Train 2 Particulate Matter Catch Calculations	1
Train 3 Room Blank Sampling Rate and PM Concentration Calculations computer spreadsheet printout	Variable
Train 3 Particulate Sampling data (Meter Box data)	Variable
Train 3 PM Sample Constant Final Weight data	1
Train 3 Particulate Matter Catch Calculations	1
Analytical Balance QA/ QC data	Variable
Woodstove Data Sheet #8 Miscellaneous data	1
Woodstove Data Sheet #9 Pellet Stove Operating data	1
Woodstove Data Sheet #10 Preburn and Fuel Load Moisture Determination data	1
Woodstove Data Sheet #11 ASTM E2780 Fuel Load Calculations	1
Woodstove Data Sheet #13 Pre Burn Data	Variable
Woodstove Data Sheet #14 Burn Rate, Flue Gas and Temperature Data	Variable
Woodstove Data Sheet #15-1 CO_2 Pre and Post Test Zero/Span Audits	1
Woodstove Data Sheet #15-3 CO Pre and Post Test Zero/Span Audits	1
Woodstove Data Sheet #16 Quality Checks	1

TEST SERIES INFORMATION AND DISCUSSION

MODEL LINE: OPTIMUM DENSIFIED FUEL LOG STOVE MODEL 1

TEST UNIT: OPTIMUM DENSIFIED FUEL LOG STOVE MODEL 1

Manufacturer: 509 FABRICATORS INC.

Date Received: 12/28/16

Date(s) Aged: 12/27/2016 - 1/1/2017. See AGING Section

Test Date(s): 1/9/2017

PM Sampling Method(s): ASTM E2515 using 4″ fiber glass filters (EPA M5G-1)

Operating and Fueling Protocol: EPA M28R, ASTM E2779 Revised. See letters to EPA (Rafael Sanchez, OEC, D.C. and Mike Toney, OAQPS, RTP) and their email responses.

Number of Test Runs: 1

The OPTIMUM Densified Fuel Log stove manufactured by 509 FABRICATORS, INC. located in Mead, WA was tested by Myren Consulting, Inc. using the Environmental Protection Agency's (EPA) Test Method 28R, "*Certification and Auditing of Wood Heaters*", ASTM E2515-11, "*Standard Test Method for Determination of Particulate Emissions Collected in a Dilution Tunnel*" and ASTM E2779-10, *Standard Test Method for Determining Particulate Matter Emissions from Pellet Heaters*". (See the Federal Register/ Vol.80, No.50/ Monday, March 16, 2015. [pp.13672-13753]). On March 28, 2015 Myren Consulting, Inc. requested approval from EPA to use four-inch filters when conducting all PM emission certification tests and received the approval to do so on April 7, 2015. Thus the PM sampling and PM sample processing procedures used during the certification tests found in this test report are what are found in EPA M5G-1 in the previous NSPS. (See the Federal Register/ Vol.53,No.38/ Friday, February 26, 1988/ pp.5860-54926, especially in Method 5G in Appendix A on pp. 5884-5892.) The particulate matter (PM) emission data was calculated as specified in the Wood Heater New Source Performance Standard (NSPS) dated March 16, 2015. The percent overall efficiency (%OE) for the overall test run and for each test segment (High, Medium and Low) was calculated using the %OE algorithm found in CSA's B415.1-10.

All events and information pertinent to the test data are recorded on the data sheets for the test run, particularly on pp. 13 and 14.

Any deviations made or noted from the promulgated methods other than those that were accepted and certified by EPA during the laboratory accreditation process are listed and discussed below. The OPTIMUM densified fuel log stove was tested at Myren Consulting's lab in Colville, WA using Myren Consulting laboratory's lab accreditation. A copy of the letter from EPA (Johnson) granting Myren Consulting, Inc. accreditation under the 2015 NSPS and a copy of Myren Consulting's new Laboratory Accreditation Certificate (#2) are included in the following pages.

A brief note about how the four-inch (EPA M5G-1) particulate samples were processed is necessary to help the reviewer understand the net catch values. First, filters are weighed in pairs to reduce weighing errors. Second, experience has shown that the small portions of the filters that are left on the frits (filter supports) 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 petri dish. Because trying to recapture these small pieces of filter material during weighing causes them to disintegrate into smaller and smaller pieces, which makes obtaining accurate catch weights difficult, 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 catch weights that are used during the particulate emission rate calculation process. However, the filter material lost off the filters is accounted for in the acetone wash catch.

ASTM E2779-10 Equation 1 calls for a dry moisture content for the test fuel used during testing. There is no way to measure the moisture content of pellets on a dry basis. Instead one can determine the wet basis moisture content by drying a sample. This is what done and the data for this is on Data Sheet 11 in the test run. Once the wet basis moisture content is known, it is then possible to calculate the fuel burnt on a dry basis, which again is what was done. The dry burn rate (DBR) determination is the same. The revised procedures and equations used to determine the actual DBR are to be found on the page after Data Sheet 11 in the Section titled TEST RUN.

The following pages contain: (1.) A discussion of test results. (2.) A diagram showing the height of the appliance and chimney used during testing (4" ICC EXCEL Pellet Pipe) and the location of the sampling ports in the chimney. (3.) A diagram of the EPA 6" diameter dilution tunnel used by Myren Consulting during EPA Certification testing, (4.) 3 pages with photos showing the front, back and right and left sides of the test unit. Note that the back photo shows how the venting system was attached to the stove along with the static pressure probe and the stack temperature at 1 foot. And there is also a full page photo of the testing installation configuration, i.e., the stove with attached flue pipe venting into the dilution tunnel hood, (5.) photos of an North Idaho Energy log, the densified fuel log that was used during testing, (6.) A copy of the letter from EPA granting Myren Consulting, Inc accreditation under the 2015 NSPS, (7.) a copy of the new EPA Laboratory Accreditation Certificates (#2) for Myren Consulting's Colville lab, (8.) a copy of the 30 day advance certification test notification sent to EPA for the week the unit was tested, (9.) three pages with information that is pertinent to the test run and (10.) copies of the following information:

(1.) A memo dated 26 November 2013 sent to Dr. Sanchez at EPA that initiated the development of a testing protocol for a stove that burns densified fuel logs.

(2.) A memo dated 30 April 2016 sent to Mike Toney and Stef Johnson at EPA (OAQPS, RTP) that provided additional information about the stove, the fuel it burns and what the test protocol might be.

(3.) A letter dated 6 December 2016 sent to Mike Toney (EPA, OAQPS, RTP) about whether (or not) Myren Consulting, Inc. could test the unit.

(4.) Emails from Toney and Sanchez granting Myren consulting, Inc. approval to test the unit with the agreed upon protocol, which is basically a variant of ASTM E 2779 except that fuel had to be added during the test run and the primary air control (PAC) was adjusted manually to change the dry burn rate (DBR).

Note: You can see by the photos that the unit has undergone substantial revision since development began. The manufacturer's personnel listed in the memo addresses also reflect the ownership changes (3X) that have occurred during the product development process.

DISCUSSION:

(1.) The test series was done at Myren Consulting's lab in Colville, WA.
(2.) The test series required 1 test run.
(3.) Because the whole testing format for pellet stoves has changed in the new NSPS, there are several revisions to the report format. Specifically the following changes have been made:
   a. The first page in the Data Summary section is titled Summary Results which reports the test data in the format requested by EPA.
   b. Because the pellet stove test is now an integrated sample test, there is no weighted average calculations because collecting the integrated sample "automatically" generates an "integrated weighted average". Instead of the pages used to calculate a weighted average, there is now a single page titled *Integrated Average Test Results,* which reports the PM emission rate (g/h and lbs./MM Btu output), the overall efficiency (%OE)(HHV and LHV) and CO (g/h and g/lb. of dry fuel) for the unit.
   c. A new page has been added to the Data Summary Section (p. 3) which summarizes the PM Sampling Train Performance information and addresses the *Dual Train Comparison* criteria found in ASTM E2515 Section 11.7. The average emission rate calculated and reported on this new page using the data from the 2 PM sampling trains is then also reported on the page titled *Integrated Test Results*. Also reported on this page are the performance data for the "Room Blank" train and the PM emission rate (g/h) and dry burn rate (DBR) (kg/h) data for the 0-60 minute filter set from Train 1.
   d. Section 60.534(d) requires that filter sets be changed (switched) at 1 h into a test run on one of the PM sampling trains. This was done on Train 1 during the test run. Thus there are additional data sheets in each test run for the 2 filter sets used in Train 1 to accomplish this requirement. As noted above, the PM emission rate for the first hour is reported on the computer spreadsheet for that PM sample and again in the Data Summary section itself.
   d. ASTM E2515 requires 2 PM sampling trains and a third "Room Blank" train. That means there are also additional data sheets for Trains 2 and 3 in the

section with the Raw Data sheets for the test run and in the Cal Data Section where the calibration and post test audit data is presented for the equipment used in all 3 of these trains.

Please look at the Table of Contents (p. iv), the Pellet Stove Test Report Page Number Index (pp. vi-vii) and the Individual Test Run Page Index (p. ix) to find any pages of interest. Or call Myren Consulting, Inc. at either 509 685 9458 (Lab)or 509 684 1154 (Office) if further assistance is needed.

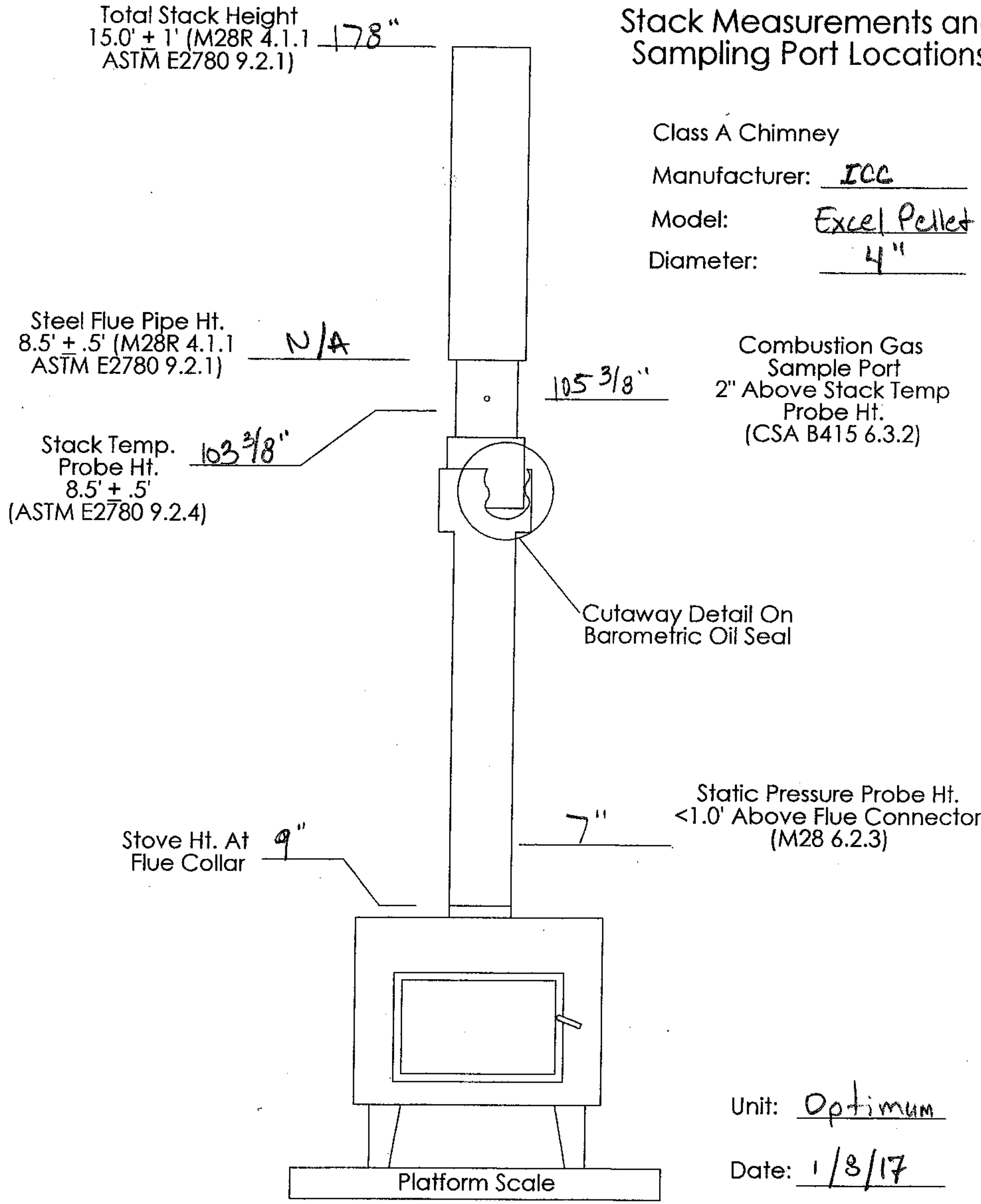
Stack Measurements and Sampling Port Locations

Class A Chimney

Manufacturer: ICC

Model: Excel Pellet

Diameter: 4"



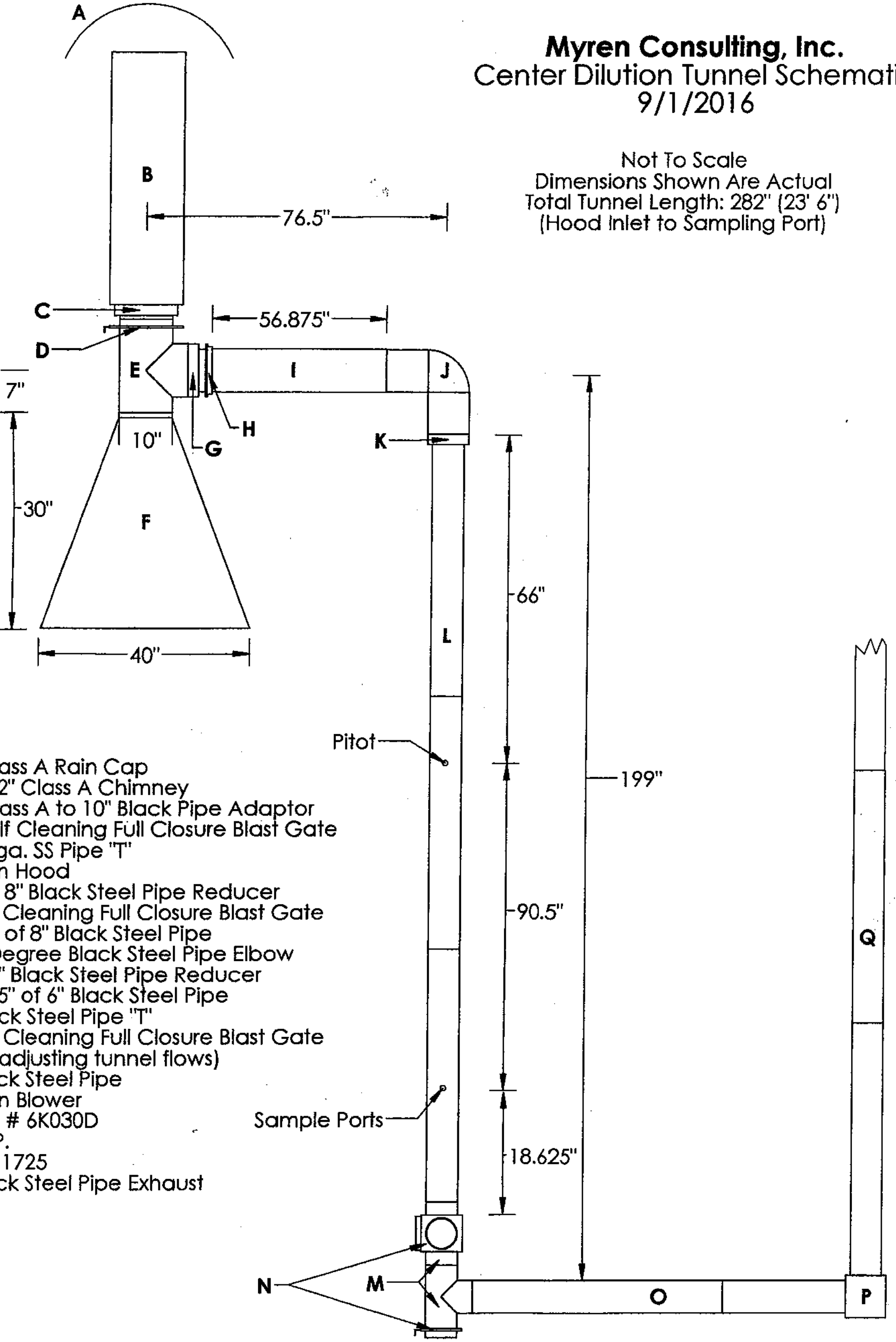
Unit: Optimum

Date: 1/8/17

Technician(s):
ESS ATM

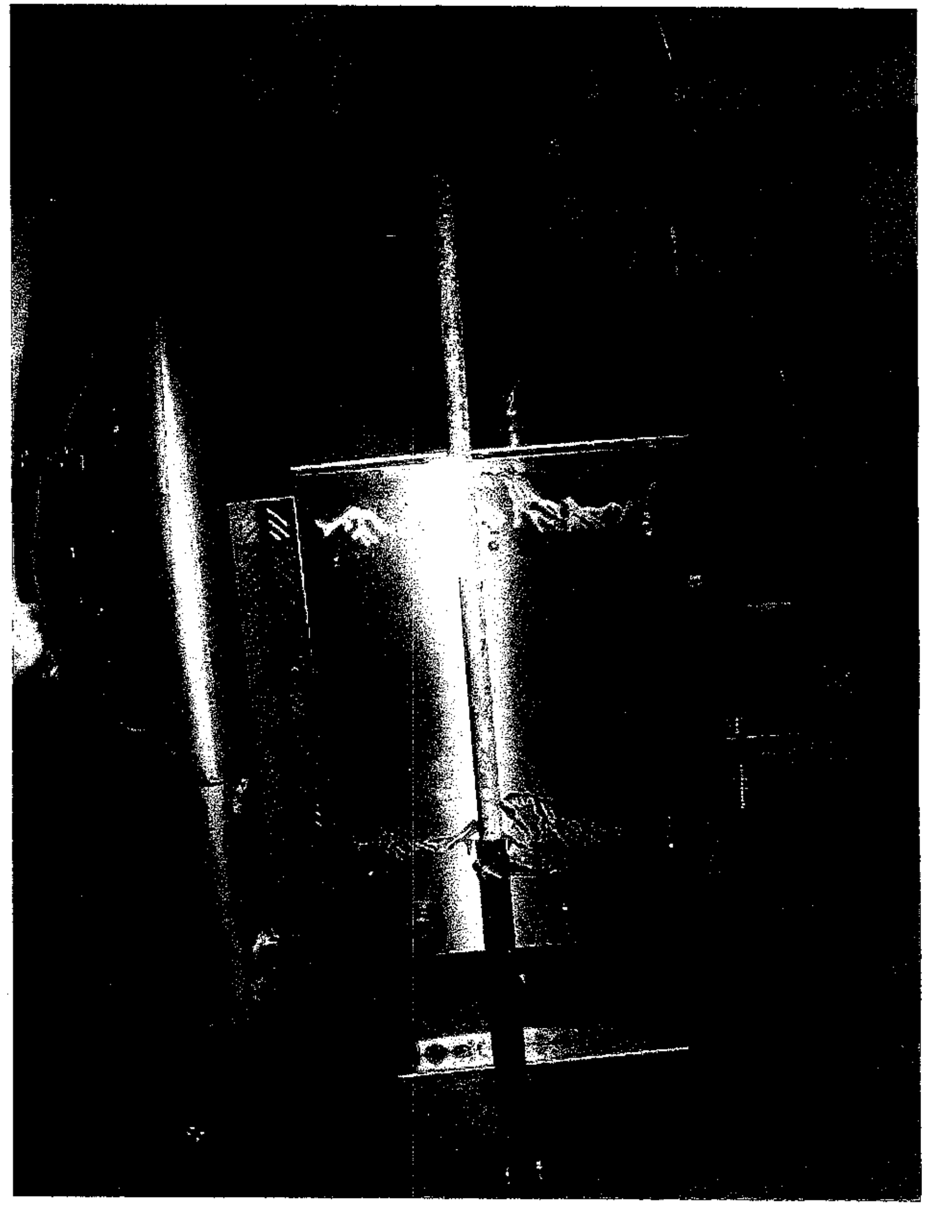
Myren Consulting, Inc.
Center Dilution Tunnel Schematic
9/1/2016

Not To Scale
Dimensions Shown Are Actual
Total Tunnel Length: 282" (23' 6")
(Hood Inlet to Sampling Port)

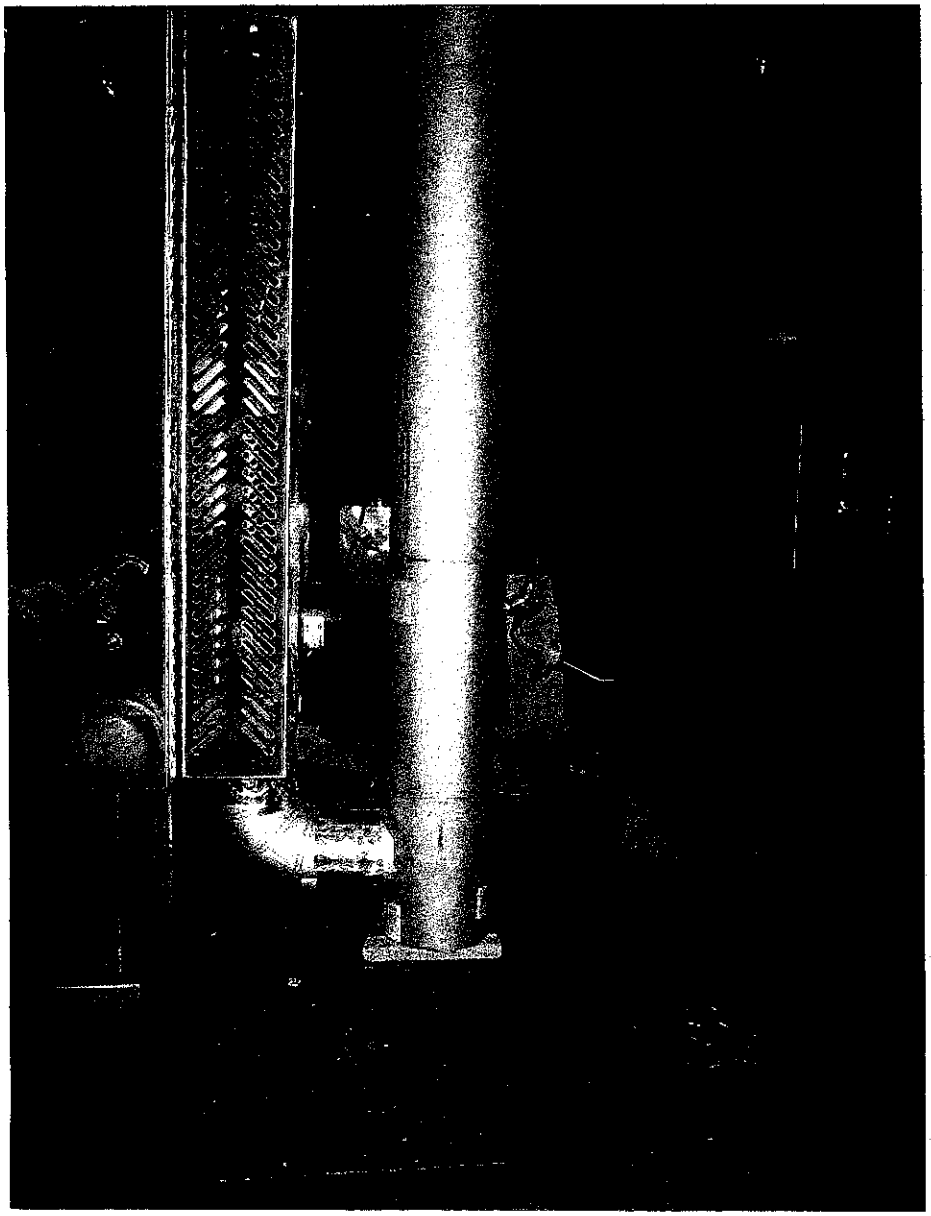


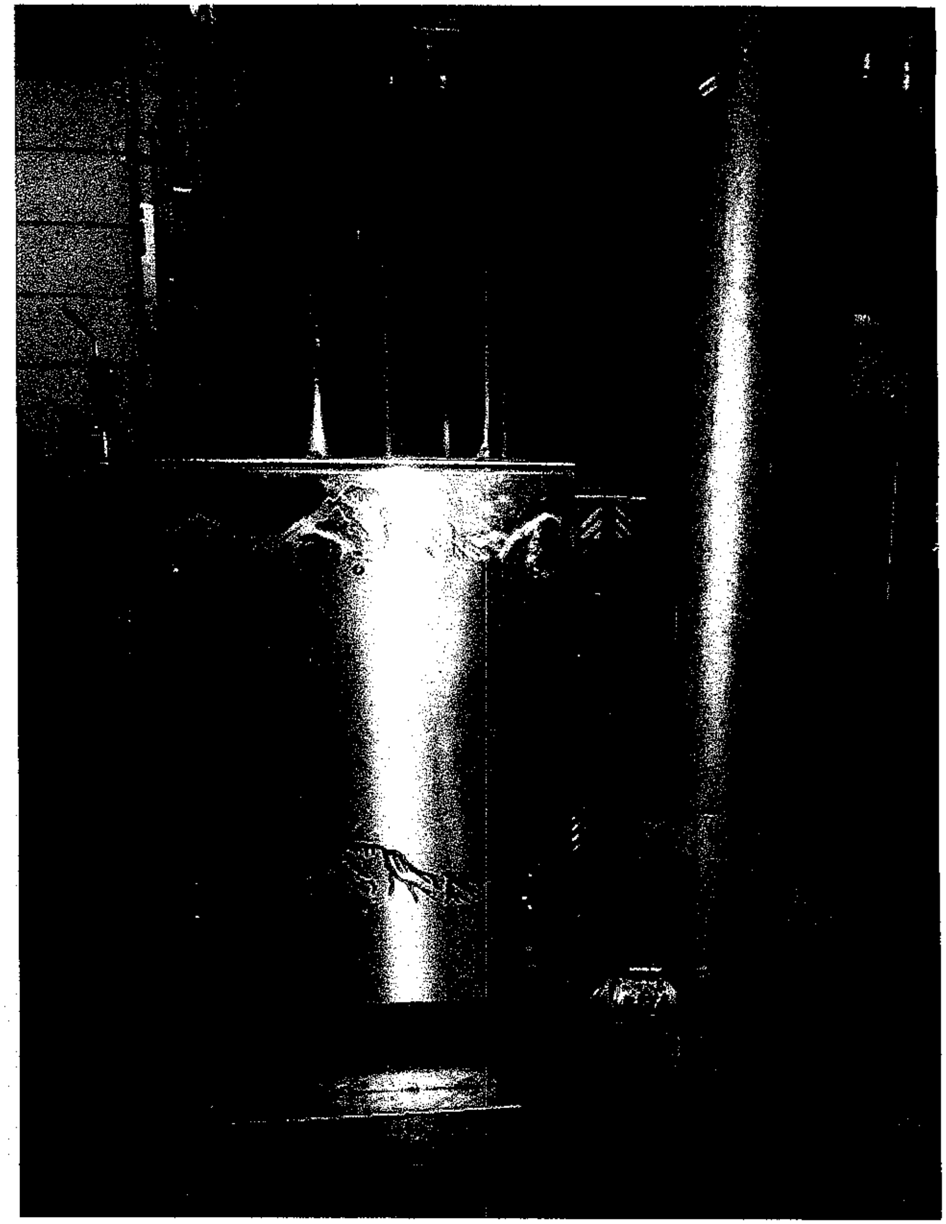
A: 12" Class A Rain Cap
B: 48" - 12" Class A Chimney
C: 12" Class A to 10" Black Pipe Adaptor
D: 10" Self Cleaning Full Closure Blast Gate
E: 10" 22ga. SS Pipe "T"
F: Dilution Hood
G: 10" to 8" Black Steel Pipe Reducer
H: 8" Self Cleaning Full Closure Blast Gate
I: 56.875" of 8" Black Steel Pipe
J: 8" 90 Degree Black Steel Pipe Elbow
K: 8" to 6" Black Steel Pipe Reducer
L: 175.125" of 6" Black Steel Pipe
M: 6" Black Steel Pipe "T"
N: 6" Self Cleaning Full Closure Blast Gate
(for adjusting tunnel flows)
O: 6" Black Steel Pipe
P: Dayton Blower
Model # 6K030D
1/3 H.P.
R.P.M. 1725
Q: 6" Black Steel Pipe Exhaust

FRONT VIEW



LEFT SIDE

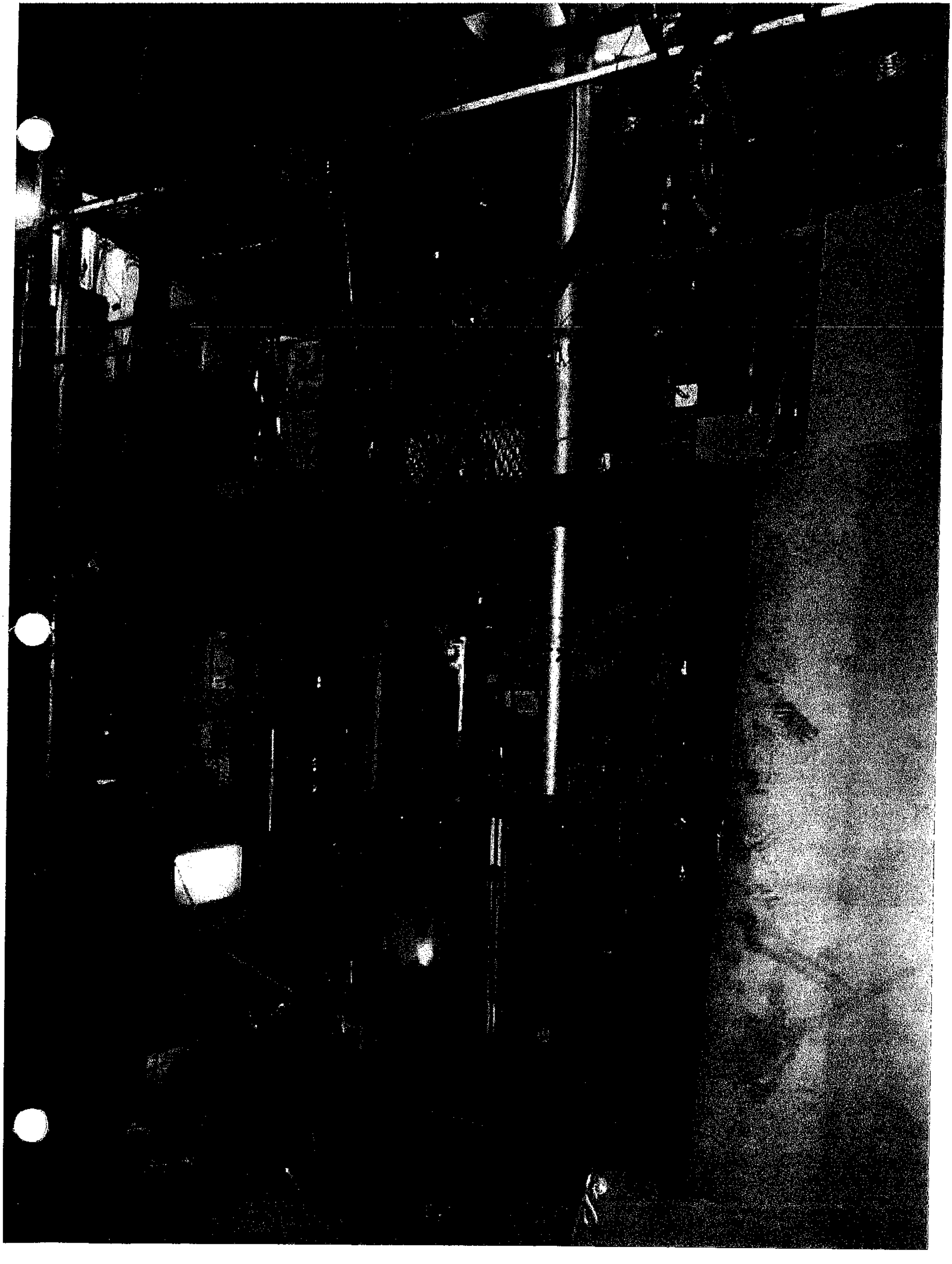


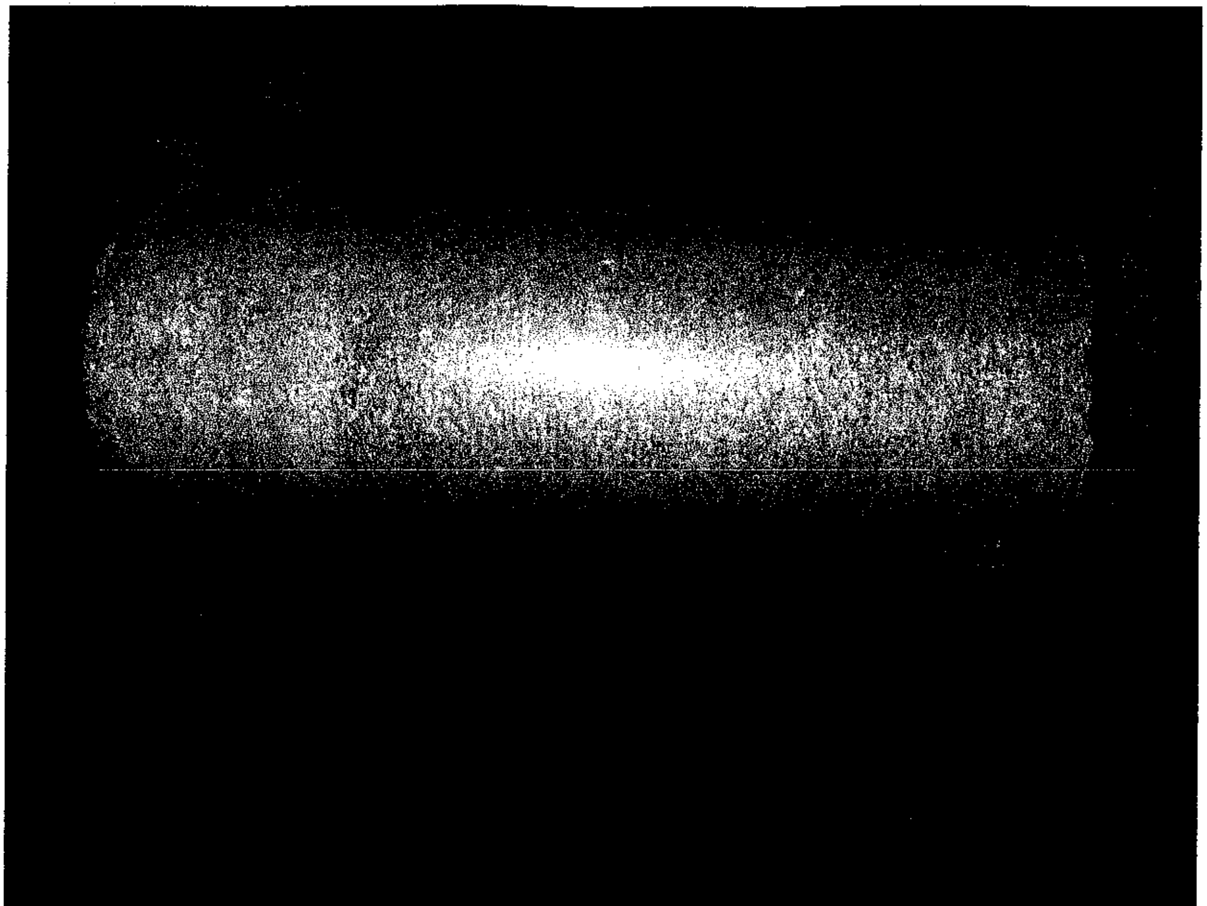


REAR VIEW

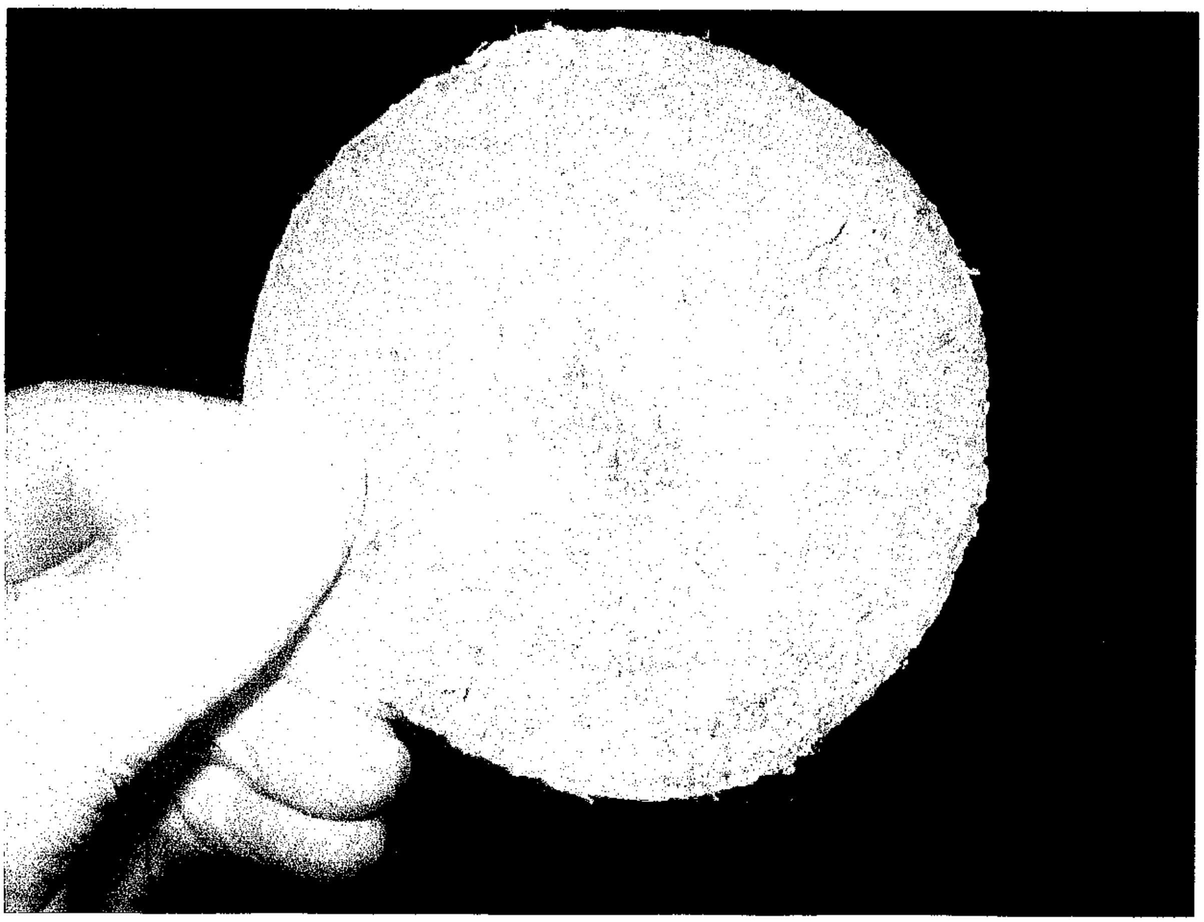
SHOWING CHIMNEY INSTALLATION

RIGHT SIDE





NORTH IDAHO ENERGY LOG ~ 8.0 LBS./ LOG



CROSS SECTION OF NORTH IDAHO ENERGY LOG

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

NOV 12 2015

OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

Ben Myren
Myren Consulting, Inc.
512 Williams Lake Road
Coleville, WA 99114

Dear Mr. Myren:

Thank you for your recent inquiry regarding the United States Environmental Protection Agency (EPA) wood heater laboratory accreditation program. The review of your reaccreditation letter that you submitted November 10, 2015 is complete and acceptable. Enclosed is your current certificate of accreditation. Myren Consulting, Inc. is accredited under Subpart AAA 40 CFR Standards of Performance for New Residential Wood Heaters Sections (60.534, 60.535) and Subpart QQQQ 40 CFR Standards of Performance for New Residential Hydronic Heaters and Forced-Air Furnaces Sections (60.5476, 60.5477). Please follow the requirements for EPA Test Method 28R Certification and Auditing of Wood Heaters in Appendix A-8 to Part 60-Test Methods 26 through 30B. This approval expires on March 16, 2018, unless renewed by Myren Consulting, Inc.

As a condition of your lab accreditation, Myren Consulting, Inc. must abide by the following provisions:
(i) Agree to participate biennially in an independently operated proficiency testing program with no direct ties to the laboratories participating;
(ii) Agree to allow the EPA, regulatory agencies and certifying bodies access to observe certification testing;
(iii) Agree to comply with calibration, reporting and recordkeeping requirements that affect testing laboratories; and
(iv) Agree to perform a compliance audit test at the manufacturer's expense at the testing cost normally charged to such manufacturer if the laboratory is selected by the EPA to conduct a compliance audit test of the manufacturer's model line;
(v) Have no conflict of interest and receive no financial benefit from the outcome of certification testing conducted pursuant to §60.5475;
(vi) Agree to not perform initial certification tests on any models manufactured by a manufacturer for which the laboratory has conducted research and development design services within the last 5 years;
(vii) Agree to seal any wood heater on which it performed certification tests, immediately upon completion or suspension of certification testing, by using a laboratory-specific seal.
(viii) Agree to immediately notify the EPA of any suspended tests through email and in writing, giving the date suspended, the reason(s) why, and the projected date for restarting.

Emission test reports should be submitted to EPA's Office of Enforcement and Compliance Assurance, at one of the following addresses:

U.S. Postal Service
U.S. EPA
Office of Enforcement and Compliance
Assurance, Office of Compliance
William Jefferson Clinton Building, South
Mail Code 2227A
1200 Pennsylvania Ave, NW
Washington, DC 20003

Attn: Wood heater Certification Lead

Private Courier
U.S. EPA
Office of Enforcement and Compliance
Assurance, Office of Compliance
William Jefferson Clinton Building, South
Room 7419D
1200 Pennsylvania Ave, NW
Washington, DC 20003

Attn: Woodheater Certification Lead

I would like to thank you for your cooperation in the wood heater certification program.

Sincerely,

Steffan Johnson
Measurement Technology Group

Enclosure (2)

cc.

Julius Banks, OECA (2227A)
Rafael Sanchez, OECA (2227A)
Adam Baumgart-Getz, OID (C304-05)
Amanda Aldridge, OID (C304-05)
David Cole, OID (C304-05)

CERTIFICATE OF ACCREDITATION

This certifies that:

Myren Consulting, Inc

Has satisfied the requirements for laboratory accreditation for the certification of wood heaters pursuant to subpart AAA of 40 CFR Part 60, New Source Performance Standards For Residential Wood Heaters and subpart QQQQ of 40 CFR Part 60, Standards of Performance for New Hydronic Heaters and Forced Air Furnaces.

November 12, 2015 - March 16, 2018
EFFECTIVE DATE

MEASUREMENT TECHNOLOGY GROUP
GROUP LEADER

Methods 28R, 28 WHH, 28 WHH-PTS,
All Methods listed in Sections 60.534 and 60.5476
METHODS

2
CERTIFICATE NUMBER

Myren Consulting, Inc.
512 Williams Lake Road
Colville, WA 99114

Office: (509)684-1154 Lab: (509)685-9458
Fax: (509)684-3987 email:myren.ben@gmail.com

DATE: 25 November 2016

TO: Dr. Rafael Sanchez, PhD., EPA

CC: Dusty Henderson, 509 Fabricators
Dan Shoman, PFS; Wayne Terpstra, PFS

FROM: Ben Myren

RE: Wood Heater 30 Day Advance Certification Test Notification

Section 60.534(e)(1) of the Wood Heater NSPS requires that EPA be notified at least 30 days in advance of the start or resumption of EPA Certification Testing for each specific model line. To comply with the above requirement, Myren Consulting, Inc. hereby notifies EPA that Myren Consulting, Inc., 512 Williams Lake Road, Colville, WA 99114 plans to start an EPA Certification Test series on the unit identified below.

UNIT: 509 FABRICATORS DENSIFIED FUEL LOG STOVE

Manufactured by:

509 FABRICATORS
14821 N. Peone Pines Dr.
Mead, WA 99201

Contact Person: Dusty Henderson
Phone: 509 993 3767
F:
email: unlimitedpower59@yahoo.com

Starting sometime the week beginning on Monday, January 9, 2017.

The testing will be conducted at:

Myren Consulting, Inc.
512 Williams Lake Road
Colville, WA 99114

Contact Person: Ben Myren
Lab: 509 685 9458 F: 509 684 3987
email: myren.ben@gmail.com

The 3rd Party Certifying Entity will be

PFS
1420 Lizzy Court
Keller, TX 76248

Contact Person; Dan Shoman
P: 975 489 6017 F: 817 742 0007
email: dshoman@pfscorporation.com

If you have any questions about this notification, contact me immediately.

NOTE: The Densified Fuel Log stove is a new appliance type and testing details based upon ASTM E2779 are still being worked out with the Emission Measurement Branch of OAQPS in RTP.

Room Blank Probe Location

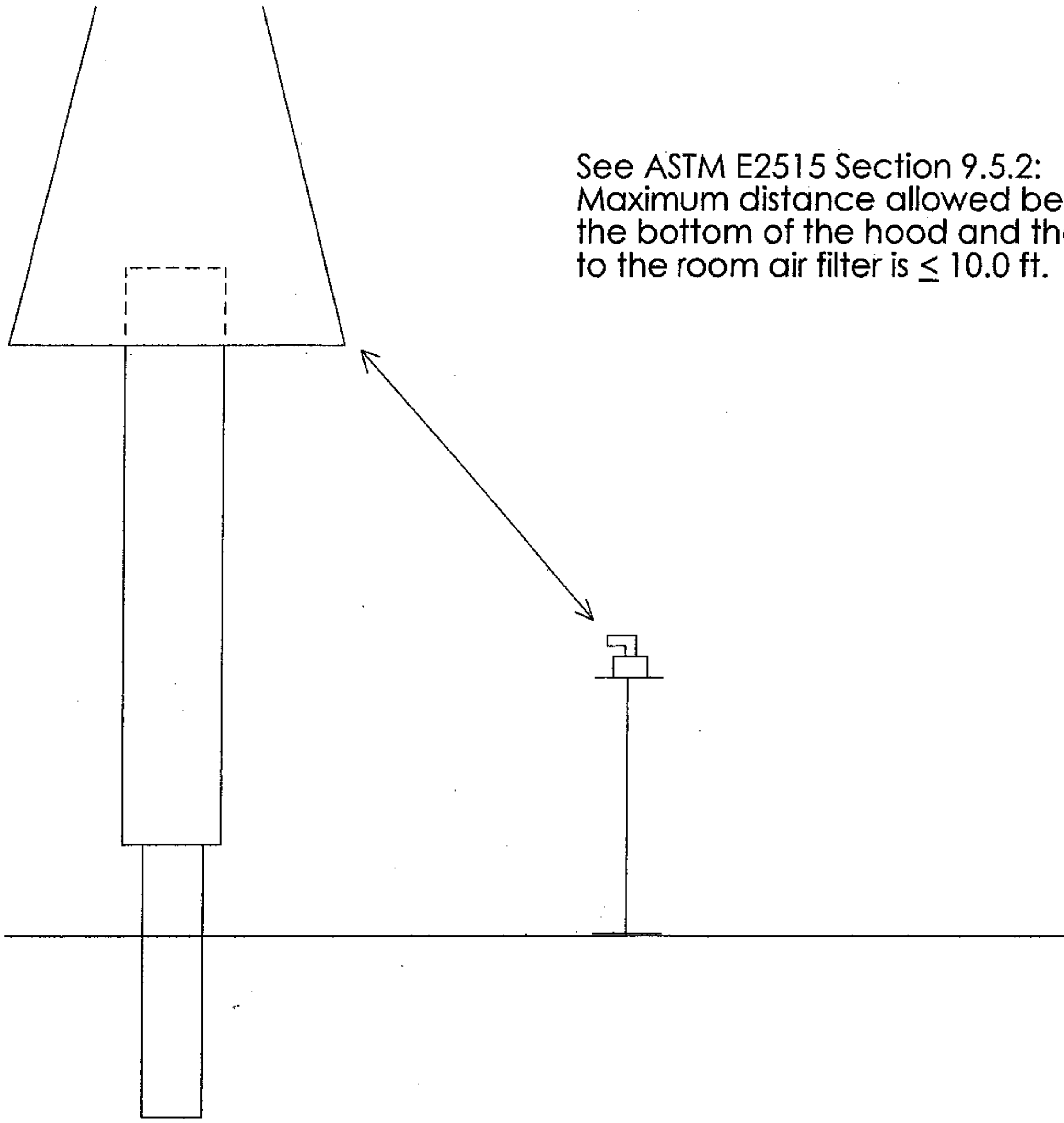
Myren Consulting Inc.

Unit: Optimum
Date: 1/8/17
Tech: ATM FSS
Run: EPA 1

The room blank probe inlet was located 41 1/4 "

from the bottom of the dilution tunnel hood.

See ASTM E2515 Section 9.5.2: Maximum distance allowed between the bottom of the hood and the inlet to the room air filter is ≤ 10.0 ft.



MYREN CONSULTING, INC.

Unit: Optimum

Date: 1/8/17

Tech: NJM ESS

Rev 0 5.21.2016

INDUCED DRAFT CHECK

Depending upon the unit being tested, once the appliance was installed on the platform scale or in the test facility and the tunnel flow was determined for 100% smoke capture (See ASTN E 2515, Section 9.2.4), an induced draft check was performed as per EPA M28/ M28R Section 4.1.2/ ASTM E2515 Section 9.2.3 to verify that the dilution tunnel was not inducing a draft of >0.005″ H_2O on the unit.

The static pressure probe located ≤1.0 foot above the flue collar (EPA M28/ M28R Section 6.2.3/ ASTM E2515 Section 9.2.3) that was connected to a 0.05-0-0.25 inch H_2O manometer was used to make the induced draft determination. The reading resolution on the 0.05-0-0.25 inch H_2O manometer is 0.001 inch H_2O, which is greater than the 0.002 inch H_2O resolution stipulated in EPA M28/ M28R Section 3.9 for the instruments used to measure static pressure.

The results of the induced draft check are as follows:

Flue Damper:		n/a
Door Open:	Primary Air Control Closed*:	.000 ″ H_2O
	Primary Air Control Open:	.000 ″ H_2O
Door Closed:	Primary Air Control Closed*:	.000 ″ H_2O
	Primary Air Control Open:	.000 ″ H_2O

*Note: In units with a "stop" in the primary air control, the primary air "closed" induced draft check was conducted with the primary air control set at the "stop". In units that had no "stop", the induced draft check was conducted with the primary air control either fully closed or set so that the amount the primary air orifice was open was at the minimum amount possible.

DETERMINATION OF TUNNEL FLOW FOR 100% SMOKE CAPTURE

Rev 2 - 10/2/16

UNIT: Optimum DATE: 1/8/17 TECHNICIAN(S): Jim ESS

Δp @ 100% Smoke Capture: .030* Tunnel Temperature: 117 °F = 577 °A BP: 28.71 in. Hg

Tunnel Diameter: (6″ tunnel = 0.1963 ft², 12″ tunnel = 0.7854 ft²)

Gas Velocity in the Center of the Dilution Tunnel (Vscent) (EPA M2 EQN 2-9, ASTM E 2515-07 EQN 7)

(9) Vstrav = (85.49) (0.99 cp) {2} (.030 $\sqrt{\Delta P}$ ″H_2O) {2} $\sqrt{\dfrac{577 \text{ Ts °A } \{0\}}{(28.71 \text{ Ps ″Hg}) \{2\} (28.78 \text{ lb./ lb. mole})}}$ = 12.25003 fps {5}

Estimated Pitot Correction Factor (Fp): 0.96 {3}

Stack Gas Dry Volumetric Flow Rate - Qsd (EPA M2 EQN 2-10, ASTM E 2515-07 EQN 3)

(10) Qsd = 3600(1 - 0.02 Bws) (12.25003 fps) {2} (.1963 ft²) {4} (.96 [Fp]) {3} [(528 °A) (28.71 Ps ″Hg) {2} /

(577 T_s °A) {0} (29.92″ Hg) = 7151.133 {1} dscfhr (or dscfh)

(10A) 7151.133 {1} dscfhr ÷ 60 = 119.189 {1} dscfmin (or dscfm) X 5 = 595.944 {1} dscfm - Maximum Allowed Qsd

Note: Number in { } under blank lines denotes number of decimals to be used. If a blank calls for an answer already calculated, use the number of decimals previously specified for that answer.

* This is a forced air combustion unit, so ΔP for 100% smoke capture will be higher due to the forced draft

Myren Consulting, Inc.

512 Williams Lake Road
Colville, WA 99114

Office: (509)684-1154 Lab: (509)685-9458
Fax: (509)684-3987 email: myren.ben@gmail.com

DATE: 26 November 2013

TO: Dr. Rafael Sanchez, PhD., EPA

CC: Reyn Smith, Presto Log Stove; Mike Toney, EPA; Gil Wood EPA

FROM: Ben Myren

RE: Certification Testing Protocol for a Densified Fuel Log Stove

What follows is a proposed EPA Certification Testing protocol for an appliance that burns densified fuel logs (Presto Logs).

Densified Fuel Logs:

Densified fuel logs are nothing more than big pellets with a diameter of 5 inches, a (nominal) length of 12 inches and an average weight of 7-8 lbs. These numbers vary from manufacturer to manufacturer. The advertised moisture content is 2.0%, probably taken immediately after production. We have checked the moisture in 1 log and found it to be 6.7%. The increase in moisture content is probably due to the log being exposed to ambient air and moisture after production.

Densified Fuel Log Burner:

Unlike most pellet stoves, there are no electronic controls on the unit other than two on/off toggle switches which turn the combustion and convection air fans on and off. The stove has an angled feed tube that holds at least 3 logs that are gravity fed into the burn area in the firebox. Like a woodstove the burn rate is controlled by the amount of combustion air entering the unit. The combustion air is pulled through the unit by a 178 cfm fan located downstream of the firebox. The amount of combustion air is controlled by a "butterfly damper" in the combustion air inlet and is adjusted by a control rod on the lower right front of the unit. The exhaust gasses leave the firebox through a slot in the top of the burn chamber into a heat exchange chamber that has 20-27" long 1.0"ID tubes with convection air from a 273 cfm fan flowing through them.

2 photos of the unit are attached.

Test Protocol:

We propose the following set up and procedures for testing the unit:

1. Use 14-16' of 4" pellet vent as the stack.
2. Eliminate the use of the 5 surface thermocouples used to calculate "Delta T". The unit operates in basically a "steady state" mode, so the one hour of preburn before each test should insure a fairly uniform temperature profile start to finish.
3. Use the procedures specified in EPA M28, Section 6.7. This includes a 1 one hour preburn and a 2 hour PM emissions test for each possible burn category. Tests will be run with the air control at:
   A. The maximum possible air setting
   B. The minimum possible air setting
   C. With the air control set to produce dry burn rates in any of the required burn categories between what is produced by A. and B.

Note: At present the maximum dry burn rate (DBR) is about 2.35 kg/hr and the minimum DBR is about 1.4 kg/hr. The manufacturer hopes to reduce the minimum DBR to something below 1.25 kg/hr, hopefully to about 1.0 kg/hr. So depending upon what they can accomplish, tests may be needed in all 4 burn categories.

Because the fuel is a densified fuel log, a two hour test should produce viable, accurate test results. However there is one issue that needs to be addressed, that being the amount of sample catch. One of the most recent 2 hour R&D runs using EPA M5G-1 to collect a PM sample had a front filter catch of 2.0 mg. The back half filter catch was 0 and the acetone wash catch was about 0.2mg with an average sampling rate of 0.4913 cfm. Using ASTM E 2515 (EPA M5G-3) as an alternative not an option because the nominal sampling rate of 0.15 cfm is about 1/3 of the sampling rate used in M5G-1 tests, so the catch would be about 1/3 of the M%G-1 catch, or roughly 0.7 mg. The constant weight tolerance criteria of ±0.5 mg and ±0.2 mg for M5G-1 and ASTM E 2515 respectively yields a potential error of ±22.7% for M5G-1 ((1.7 - 2.2)/2.2) and 28.5% for ASTM E2515 ((.5-.7)/.7). To try to reduce this error as much as possible, we propose to increase the sampling rate to at least 1 cfm - as much as possible (1.4 cfm ?) without exceeding the filter face velocity criteria set of 30 ft/min set forth in M5G section 7.2.1. (See attached memo about face velocities and sampling flows.)

We look forward to your reply. Let me know if you have any questions.

Have a Happy Thanksgiving!

Regards,
Ben

Myren Consulting, Inc.
512 Williams Lake Road
Colville, WA 99114
Office: (509)684-1154 Lab: (509)685-9458
Fax: (509)684-3987 email: myren.ben@gmail.com

DATE: 30 April 2016

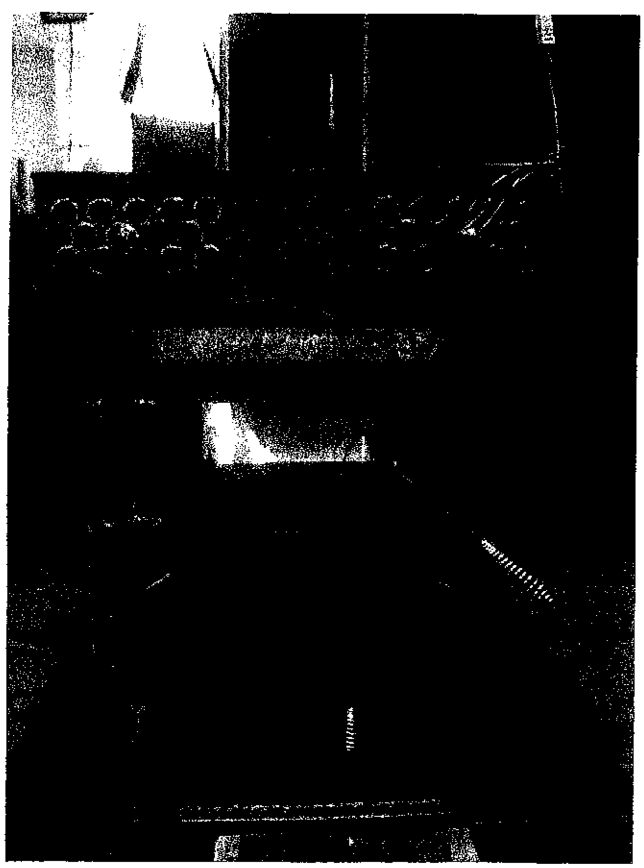
TO: Mike Toney, EPA; Stef Johnson, EPA

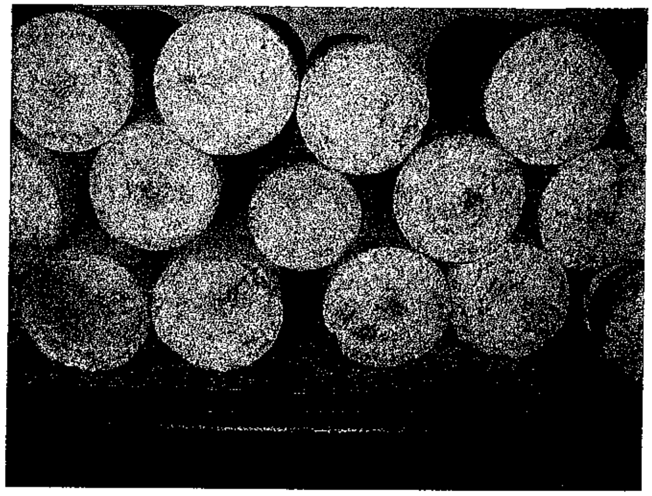
CC: Adam Baumgart-Getz, EPA; Amanda Aldridge, EPA, Rafael Sanchez, EPA; David Cole, EPA, Larry Brockman, EPA; Dusty Henderson, 509 Fabricators

FROM: Ben Myren

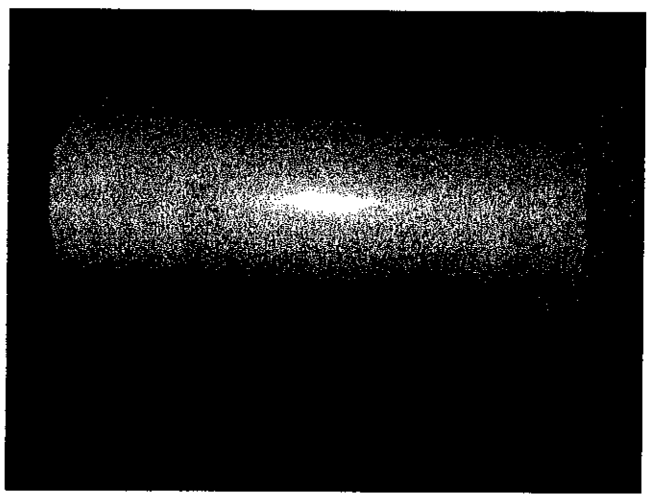
RE: DENSIFIED FUEL LOG WOOD HEATER

I have been working with a client that is developing a wood heater that burns densified fuel logs, a.k.a., Presto logs. The photos below show the most recent prototype burning in my lab on 4/26/16 and some densified fuel logs.

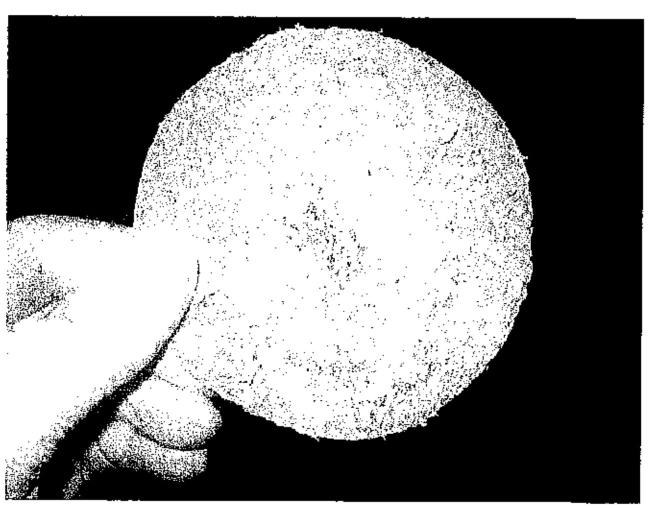




Note the 2 different sizes (diameters). The larger diameter log is a North Idaho Energy Log and the smaller diameter log is an actual Presto log.



This is a close up of a North Idaho Energy Log. It weighs about 8 lbs.



This is a close up of the end of a North Idaho Energy Log. You can see the compacted wood particles.

STOVE OPERATION:

The fuel is gravity fed into the combustion chamber via a 6" ID vertical feed tube that holds 3.5 logs. You can see part of the feed tube in the photo of the stove. The part of the feed tube inside the stove is glowing red hot. The dry burn rate (DBR) is controlled by the combustion air fed into the burn chamber. The unit has 4 combustion air settings: High, Medium, Low and Off. When set on Off, no air enters the firebox. The unit has 2 fans, one for combustion air and the other for convection air.

Since densified fuel logs are nothing more than a "big pellet", I am suggesting that we use ASTM E2779 as the basis for testing the unit. We could easily fill up the tube with logs and run an integrated 6 h test with 1 h on High, 2 h on Medium and 3 h on Low to determine PM emissions and use CSA B415.1-10 to determine the overall efficiency (%OE).

My intent with this letter is to start a dialogue with EPA with the end result of the dialogue being an agreed upon alternative testing protocol that can be used to test the stove so that the unit can be certified. I am certain that EPA will have a number of questions about this unit, but at least this memo should get the process started.

I look forward to your comments, questions and answers.

Regards,

Ben Myren
President

Myren Consulting, Inc.

512 Williams Lake Road
Colville, WA 99114

Office: (509) 684-1154 Lab: (509) 685-9458
Fax: (509) 684-3987 email: myren.ben@gmail.com

Date: 6 December 2016

To: Mike Toney, EPA

CC: Adam Baumgart-Getz, EPA; Amanda Aldridge, EPA; David Cole, EPA; Rafael Sanchez, EPA, Steffan Johnson, EPA; Dusty Henderson, 509 Fabricators

From: Ben Myren

RE: Section 60.535(a)(2)(vi)

Section 60.535(a)(2)(vi) states

"…Agree to not perform initial certification tests on any models manufactured by a manufacturer for which the laboratory has conducted research and design services within the past 5 years…".

Myren Consulting, Inc. has done some evaluation testing on at least 2 stove prototypes of a stove designed to burn densified fuel logs during the past 3 years for 2 different firms - same stove, but with a change in ownership. This evaluation testing included both PM emissions and overall efficiency (%OE) measurements. During this testing the manufacturer would make design changes and Myren Consulting, Inc. would conduct the PM and %OE measurements and report the results. The manufacturer would then use that data to make a decision about the next design change. The manufacturer then used all of that information to design and build a new prototype that has many different "k-list" design changes. These changes include a different combustion blower (less CFMs), a different feed tube, a completely redesigned firebox (larger) and a different convection air pathway. Myren Consulting, Inc. had no input in the decisions that led to these design changes and the construction of the latest prototype.

To provide and insure total transparency, Myren Consulting, Inc. has performed 2 PM and %OE evaluation tests (Hi and Low) on this new prototype to verify its performance. The data indicated that the unit was ready for certification testing, so at the manufacturer's request Myren Consulting (1.) submitted some 30 day advance certification test notifications to EPA and (2.) resent a memo to EPA about a proposed test protocol for the unit that was based upon ASTM E2779.

My question is, "Since Myren Consulting, Inc. did not have any input in the development of the design of the most recent prototype other than to supply the manufacturer with test data, can Myren Consulting, Inc. conduct the certification test on this unit?"

I want to be totally upfront on this because I do not want to jeopardize the manufacturer's certification or Myren Consulting, Inc.'s laboratory accreditation. When Myren Consulting, Inc. has done R&D work on a unit, I have referred the manufacturer to a different Lab for the actual certification testing. Case in point, the Kiwi 2.1 VcV stove. I look forward to your reply.

Regards,

Ben Myren

Gmail

Alben T. Myren Jr <myren.ben@gmail.com>

Test Protocol for the Densified Fuel Log Stove

5 messages

Alben T. Myren Jr <myren.ben@gmail.com> Tue, Dec 27, 2016 at 6:51 PM
To: Mike Toney <toney.mike@epamail.epa.gov>, Dusty Henderson <unlimitedpower59@yahoo.com>

Mike,

Received the OK from Sanchez to test the stove that burns densified fuel logs. The manufacturer is bringing the stove to Colville tomorrow so we can start aging it. So by 1.3.17 we will be ready to test. I have turned in 30 day certification test advance notices for the unit for the weeks starting on 1.2.17 and 1.9.17. I know the manufacturer wants to test so he can have numbers for the trade show. So where are we on the protocol? Do I need to turn in some more 30 day advance notices for this stove?

Ben

Toney, Mike <Toney.Mike@epa.gov> Wed, Dec 28, 2016 at 6:55 AM
To: "Alben T. Myren Jr" <myren.ben@gmail.com>, Dusty Henderson <unlimitedpower59@yahoo.com>
Cc: "Johnson, Steffan" <johnson.steffan@epa.gov>

Hi Ben,

Please call me regarding the protocol if you need to. I looked in my email but did not see one. I know what we talked about regarding the densified pellet heater using ASTM 2779 for the test method. Since Rafael gave you approval you can test using ASTM 2779 for the pellet heater and ASTM 2515 for particulates. Remember to take the first hour filter pull as required in the rule and to measure the CO during testing and to conduct CSA B415 for efficiency. We also need a preburn before testing just like regular wood heater testing, so more than one pellet maybe required during testing but this will be your call. Have a great test.

From: Alben T. Myren Jr [mailto:myren.ben@gmail.com]
Sent: Tuesday, December 27, 2016 9:51 PM
To: Toney, Mike <Toney.Mike@epa.gov>; Dusty Henderson <unlimitedpower59@yahoo.com>
Subject: Test Protocol for the Densified Fuel Log Stove

Mike,

Received the OK from Sanchez to test the stove that burns densified fuel logs. The manufacturer is bringing the stove to Colville tomorrow so we can start aging it. So by 1.3.17 we will be ready to test. I have turned in 30 day certification test advance notices for the unit for the weeks starting on 1.2.17 and 1.9.17. I know the manufacturer wants to test so he can have numbers for the trade show. So where are we on the protocol? Do I need to turn in some more 30 day advance notices for this stove?

Ben

Alben T. Myren Jr <myren.ben@gmail.com> Wed, Dec 28, 2016 at 8:43 AM
To: "Toney, Mike" <Toney.Mike@epa.gov>, "Sanchez, Rafael" <sanchez.rafael@epa.gov>
Cc: Dusty Henderson <unlimitedpower59@yahoo.com>, "Johnson, Steffan" <johnson.steffan@epa.gov>

Mike, Attached is the memo I sent earlier about testing the densified fuel log stove. And, yes, we are planning to do (1.) a 1 hour preburn on "High" before the start of the high burn test, (2.) a filter set change at 60 minutes in Train 1 at the end of the high burn test segment, (3.) collect all of the necessary data for B415 for CO and %OE, (4.) and reload the stove (add a log or logs) sometime during the test. We will try to sort out when to add the extra logs during aging. My thought is to add the log(s) at the end of the 2 h Med burn segment. It only takes about 15-30 seconds to add a log, so the impact on the data should be minimal So if you would add the logs at 176 minutes, the stove would have a chance to recover by the next reading (180 minutes). (Remember that the added logs will be on top of the logs that are actually burning at the bottom of the feed tube, so it will be a while before the added logs actually start to burn.) At which time you would take the necessary readings and turn the stove to Low. That would make it easy to do the B415 entries.

Rafael, Dusty is bring the stove up to the lab today. We plan to set it up and start aging it as soon as it arrives. As noted above we will try to sort out when to add the logs during aging.. If all goes as planned we will do the integrated test series next week, probably on Wed.

Any thoughts or input from either DC or RTP is welcome.

REGARDS. Ben
[Quoted text hidden]

TONEY DENSIFIED FUEL LOG TESTING PROTOCOL MEMO 4.30.16.doc
439K

Toney, Mike <Toney.Mike@epa.gov> Wed, Dec 28, 2016 at 8:48 AM
To: "Alben T. Myren Jr" <myren.ben@gmail.com>, "Sanchez, Rafael" <Sanchez.Rafael@epa.gov>
Cc: Dusty Henderson <unlimitedpower59@yahoo.com>, "Johnson, Steffan" <johnson.steffan@epa.gov>

Hi Ben,

I remember the email now. You are good to go.

From: Alben T. Myren Jr [mailto:myren.ben@gmail.com]
Sent: Wednesday, December 28, 2016 11:44 AM
To: Toney, Mike <Toney.Mike@epa.gov>; Sanchez, Rafael <Sanchez.Rafael@epa.gov>
Cc: Dusty Henderson <unlimitedpower59@yahoo.com>; Johnson, Steffan <johnson.steffan@epa.gov>
Subject: Re: Test Protocol for the Densified Fuel Log Stove

[Quoted text hidden]

Alben T. Myren Jr <myren.ben@gmail.com> Wed, Dec 28, 2016 at 1:48 PM
To: "Toney, Mike" <Toney.Mike@epa.gov>

Thank You! We will run the test on Wed of next week. Ben
[Quoted text hidden]

Had to delay testing due to technical issues and weather (cold). Tested unit on 1.9.17

WOOD BURNING HEATERS UNIT:509 OPTIMUM Densified Fuel Log Stove P.1 of 2

Test Method 28R for Certification and Auditing of Wood Heaters

SUMMARY RESULTS-DENSIFIED FUEL LOG HEATERS

Run #	Date	Setting	Dry Burn Rate (kg/h)	Run Time (minutes)	Heat Output Btu/h	PM Emissions (g/h) 1st h	PM Emissions (g/h) Int. Avg.	CO Emissions (g/h) Segment	CO Emissions (g/h) Int. Avg.	%OE(%)(B415)(HHV) Segment	%OE(%)(B415)(HHV) Int. Avg.
1	1.9.17	High	2.319	60	33,114	1.503		70.51		78.3	
1	1.9.17	Medium	2.899	120	42,099			96.32		79.6	
1	1.9.17	Low	1.761[1]	180	25,198			104.79		78.4	
Integrated Averages:			2.226	360	32,183		1.890		94.68		79.0

Note: (1.) There are no test runs in Dry Burn Rate (BDR) Categories 1 (<0.80 kg/h) and 2 (0.80-1.25 kg/h) because the unit's dry burn rate is controlled by its primary air control and combustion air fan, the density and size of the fuel logs themselves, the amount of fuel remaining in the feed tube at any given time and how the fuel logs "settle" in the feed tube. The logs are gravity fed and logs can "warp" and hang up in the feed tube which slows the DBR. The weight of the logs left in the feed tube affects the feed rate because the weight pressing down from above is what causes the burning end of a log to disintegrate into smaller pieces, i.e., the more weight, the faster the disintegration, which allows more unburnt fuel to drop into the combustion chamber. The DBR data reflects this operating scenario. When the "High" burn test segment was started, the unit had been burning for a little over 75 minutes (~15 minutes for ignition and 60 minutes for Preburn). A fuel log was added at approximately 5 minutes into preburn, so at the end of the "High" burn segment there was enough room in the feed tube to add 2 logs (15.2 lbs.). The DBR for the 60 minute "High" burn segment was 2.319 kg/h with a partially full fee tube. The DBR for the 120 minute "Medium" burn segment was which was started with a full feed tube was 2.899 kg/h. Even though the Primary Air Control (PAC) setting had been reduced to the "Medium" setting, the DBR increased. That clearly shows how the amount of fuel in the feed tube can impact the DBR and that the amount of primary air being pulled through the unit really does not impact the DBR. The unit burned 13.5 lbs. in the 120 minute "Medium" burn test segment. At the end of the Medium burn segment, the PAC was adjusted to the Low burn setting and 1 fuel log (8 lbs.) was added at 20 minutes into the "Low" burn test segment. The DBR immediately increased due to the extra weight in the feed tube and then slowed as the amount of fuel in the feed tube decreased. (See Data Sheet #14, pages 4 of 7 and 5 of 7.) Additional fuel (3.4 lbs, approximately ½ a log, was added at 312 minutes because the DBR had dropped down to 0.1 lb./ 5 minutes and we were worried that the fire might go out. Again, as soon as fuel was added the DBR increased, but the increase in the burn rate was not as great as when 2 logs were added, again showing how the amount of fuel in the feed tube impacts the burn rate. (See Data Sheet #14, page 6 of 7.) The wild swings in combustion gas (CO_2, O_2 and CO) concentrations also confirm that the amount of fuel in the feed tube is what really controls how this stove performs. See Data Sheet #14, p4 of 7, at 205 and 210 minutes and look at the DBR and CO_2 and CO concentrations. At 205 minutes the DBR was 0.1 lb and the CO_2 and CO concentrations were 11.21 and 0.71% respectively. At 210 minutes the DBR was 0.6 lbs. and the CO_2 and CO concentrations were 11.76 and 0.85% respectively. When fuel is added the CO_2

concentration doesn't change much. So this unit is really a Single Burn Rate Appliance (SBR) with a burn rate that varies due to the amount of fuel remaining in the feed tube. Adjusting the PAC really has little or no affect on the burn rate because the unit uses a combustion air fan to pull the combustion air through the unit and closing the PAC creates a smaller orifice, but the fan just pulls the air through the orifice faster. Unlike most pellet stoves where the speed of the combustion air fan is reduced as the fuel feed rate is reduced, the combustion air fan speed on the Optimum remains the same.

509 OPTIMUM DENSIFIED FUEL LOG STOVE INTEGRATED AVERAGE TEST RESULTS

Integrated averages are different from weighted averages which are based upon the probability factors listed in EPA M28/ M28R, Table 1 and the calculation procedures shown in M28/ M28R Figure 28-5. Integrated averages are based on the test data generated by the test method itself (ASTM E2779) which requires that a pellet heater be operated at three different settings, each for a specific period of time, i.e., 1 h on High, 2 h on Medium and 3 h on Low. Since the sampling is continuous for the 6 h test period stipulated in ASTM E2779, the testing process "automatically" generates the Integrated Average.

The integrated average particulate matter (PM) emission rate (g/h) is

1.890 g/h.

The integrated average particulate matter (PM) emissions (lbs./ MM Btu output) is

0.13 lb./MM Btu output

The integrated average overall HHV efficiency (%OE) is

79.0%.

The integrated average overall LHV efficiency (%OE) for the is

85.6%.

The integrated average CO emissions (g/h) is

94.68 g/h

The integrated average CO emissions (g/ kg dry fuel) is

42.52 g/ dry kg of fuel

SUMMARY OF ASTM E2515 PARTICULATE EMISSIONS SAMPLING TRAIN PERFORMANCE

		T1					T2						
RUN #	DBR (kg/hr)	CATCH (mg)	SAMPLE RATE (cfm)	SAMPLE VOl (dscf)	AVG.% PROP	EMISSIONS (g/h)	CATCH (mg)	SAMPLE RATE (cfm)	SAMPLE VOL (dscf)	AVG. % PROP	EMISSIONS g/h	Avg. g/h.	% DIFF
EPA 1	2.226	43.2	.539	173.086	99.973	1.975	39.6	.526	172.942	99.966	1.805	1.890	4.50

SUMMARY OF ASTM E2515 AMBIENT AIR (ROOM BLANK) SAMPLING TRAIN PERFORMANCE

RUN #	CATCH (mg)	SAMPLE RATE (cfm)	SAMPLE VOL. (dscf)	AMBIENT PM CONCENTRATION (mg/dscf)
EPA 1	1.8	0.5245	174.665	0.010305

TRAIN 1 0-60 MINUTE DBR and PM EMISSIONS

Run #	DBR (kg/h)	CATCH mg	EMISSIONS g/h
EPA 1	2.312	5.7	1.503

Woodstove Data Summary

Run #	1	Units
Particulate Emissions:		
Emission Rate:	1.89	g/hr
Emission Factor: (Dry fuel weight basis)	0.85	g/kg
Efficiency Values: (CSA B415.10-1)		
Combustion Efficiency:	97.0	%
Heat Transfer Efficiency: HHV:	81.0	%
Heat Transfer Efficiency: LHV:	88.2	%
Overall Efficiency: HHV:	79.0	%
Overall Efficiency: LHV:	85.6	%
Heat Output:		
Avg. EPA Btu/hr. for test cycle	33,231	Btu/hr.
Avg. B415 Btu/hr. for test cycle	32,183	Btu/hr.
Fuel Burn Rates:		
Avg. Dry Burn Rate (Wet Basis)	2.359	kg/hr.
Avg. Dry Burn Rate (Dry Basis)	2.226	kg/hr.
PM Sampling Parameters:		
Avg. Tunnel Flow(Qsd):	137.562	dscfm
Avg. Tunnel Velocity(Vs):	809.431	ft./min.
Pitot Correction Factor:	.95663	
Total Sample Volume:	See page titled "Summary of ASTM E2515 Particulate Emission Sampling Train Performance"	dscf
Avg. Sampling Flow Rate:		cfm
Avg. % Proportionality:		%
Total Particulate Catch:		mg

Woodstove Data Summary

Run #	1								Units
Fuel Moisture Content:									
Kindling (Wet basis):	–								%
Pre Test Fuel (Wet basis):	–								%
Test Fuel (Wet basis):	5.629								%
Air/Fuel Ratio:									
lbs. air/lbs. fuel:	12.14								
Average Stack Gas Composition:									
Avg. % CO_2:	9.66								%
Avg. % O_2: (stochiometrically)	11.08								%
Avg. % CO:	0.40								%
Average Stack Gas Flow Rate:									
Stack Flow Rate- EPA CMB									dscfm
Draft (static):	-.0910								in. H_2O
Average Stack Gas Emission Factors:									
CO:	42.52								g/Kg
	94.68								g/hr.

Woodstove Data Summary

	Run # 1								
Average Temperatures:									
Stack Gas:	304.0								°F
Stove Top:	N/A								°F
Stove Left Sidewall:									°F
Stove Back:									°F
Stove Right Sidewall:									°F
Stove Bottom:									°F
Primary Combustion Chamber Gas:									°F
Secondary Combustion Chamber Gas:									°F
Catalytic Combustor Exit Gas:									°F
Stove Temperature Change:									°F
Test Chamber Environment:									
Avg. Barometric Pressure:	28.179								in. Hg
Avg. Temperature:	72.5								°F
Avg. % Ambient Moisture:	0.90								% H_2O
Avg. % Relative Humidity:	40.25								% RH
Avg. Air Velocity:	>0.450								ft/sec
Avg. Dilution Tunnel Draft: (If Applicable)	.000								in/H_2O
Test Fuel Weight and Burn Time:									
Density (Dry basis):	N/A								g/cm^3
Coal Bed Weight:	N/A								lbs.
Pre Test Fuel Weight (Inc. Kindling):	6.1								lbs.
Test Fuel Load Weight:	31.2								lbs.
Total Test Cycle Burn Time:	360								min.

AGING DATA

The Optimum Densified Fuel Log stove was aged by Myren Consulting, Inc. The Aging installation configuration was the same as the installation used during certification testing. During Aging the stove was run on the Medium setting used during certification testing and the temperature and the (wet) burn rate data were collected using a Data Acquisition System (DAS). The Aging data was then transferred from the DAS spreadsheet to the Aging data pages in this section. The dry burn rate (DBR) varies during the aging process because the densified fuel logs sometimes warp (bend) and then stick in the feed tube, slowing the DBR. When the log(s) finally drop, the DBR will speed up for a while.

Unit: Optimum

PELLET STOVE AGING DATA
Woodstove Test Data Sheet #25P
WST5-Form 3A, Rev 12/15

Date(s): 12/
Technicians: ESS AIM
Page: 1 of 2

T/C# 1

HOUR #	2016 DATE	TIME	POUNDS BURNT	STACK TEMP	COMMENTS
1	12/28	1200	7.5	249	Fire Started @ 11:00 AM
2	↓	1300	7.2	328	
3		1400	6.7	345	1412 Added 20.2 lbs. (3 logs)
4		1500	4.8	346	
5		1600	7.3	352	
6		1700	4.5	293	
7		1800	3.9	278	23 114 lbs of logs, 2.9 lbs K
8	12/29	1100	7.2	290	Fire Started @ 1000
9	↓	1200	4.5	263	7.852 lbs added @ 10:34
10		1300	5.9	309	
11		1400	3.5	257	
12		1500	4.5	308	1507 added 23.208 lbs
13		1600	5.2	284	
14		1700	5.0	311	
15		1800	4.6	276	
16		1900	3.3	296	1905 added 15.625 lbs.
17		2000	4.7	311	
18		2100	6.9	320	
19		2200	3.1	256	
20		2300	3.8	298	
21	12/30	1050	6.1	240	Fire Started @ 9:50
22	↓	1150	5.7	299	23 470 lbs of Logs + 2.7 lbs K
23		1250	5.9	313	1310 Added 15.886 lbs.
24		1350	5.5	301	
25		1450	3.9	276	
26		1550	8.7	356	
27		1650	6.2	339	
28		1750	3.9	276	Added 8.018 lbs @ 1545
29		1850	8.7	356	

Unit: Optimum
Date(s): 12/28, 29, 30, 31 2016 1/1/2017
Technicians: ESS ATR
Page: 2 of 2

PELLET STOVE AGING DATA
Woodstove Test Data Sheet #25P
WST5-Form 3A, Rev 12/15

T/C# 1

HOUR #	2016 DATE	TIME	POUNDS BURNT	STACK TEMP	COMMENTS
30	12/30	1950	6.2	339	
31	↓	2050	6.6	349	
32	↓	2150	2.8	282	15.864 lbs of logs +2.4 lbs K
33	12/31	1030	5.4	242	Fire Started @ 930
34		1130	5.1	274	945 Added 15.864 lbs
35		1230	7.1	317	1208 Added 7.926 lbs.
36		1330	5.1	320	
37		1430	3.9	264	1456 Added 15.458 lbs.
38		1530	6.4	312	
39		1630	7.3	350	
40		1730	5.8	336	
41	↓	1830	3.0	275	
42	1/1/17	1205	6.8	253	Fire Started @ 1105
43		1305	6.7	326	23.766 lbs logs + 3.2 lbs kindling
44		1405	8.2	369	1312 added 1 log - 7.882 lbs
45		1505	5.8	318	1532 Added 2 logs - 15.266 lbs.
46		1605	5.0	343	
47		1705	6.5	349	1736 Added 2 logs 16.340 lbs.
48		1805	6.5	346	
49		1905	5.6	323	
50		2005	9.4	303	2006 Added 2 logs 15.246 lbs.
51	↓	2105	6.4	331	

MYREN CONSULTING, INC

Manufacturer: 509 FAB
Model: PRESTO LOG
Date: 1.9.17
Run: EPA 1
Control #:
Test Duration: 360
Output Category: INTEGRATED

Technicians: ATMYREN

Test Results in Accordance with CSA B415.1-09

	HHV Basis	LHV Basis
Overall Efficiency	79.0%	85.6%
Combustion Efficiency	97.0%	97.0%
Heat Transfer Efficiency	81%	88.2%

Output Rate (kJ/h)	33,927	32,183	**(Btu/h)**
Burn Rate (kg/h)	2.23	4.91	**(lb/h)**
Input (kJ/h)	42,945	40,738	**(Btu/h)**

Test Load Weight (dry kg)	13.36	29.44	**dry lb**
MC wet (%)	5.63		
MC dry (%)	5.97		
Particulate (g)	11.33945		
CO (g)	568		
Test Duration (h)	6.00		

Emissions	**Particulate**	**CO**
g/MJ Output	0.06	2.79
g/kg Dry Fuel	0.85	42.52
g/h	1.89	94.68
lb/MM Btu Output	0.13	6.49

Air/Fuel Ratio (A/F)	12.14

VERSION: **2.2** **12/14/2009**

VERSION: 2.2 12/14/2009

Manufacturer: 509 FAB
Model: PRESTO LOG
Date: 1.9.17
Run: EPA 1
Control #:
Test Duration: 360
Output Category: INTEGRATED

Appliance Type: NON CAT (Cat, Non-Cat, Pellet)

Temp. Units	F	(F or C)
Weight Units	lb	(kg or lb)

Default Fuel Values

	D. Fir	Oak
HHV (kJ/kg)	19,810	19,887
%C	48.73	50
%H	6.87	6.6
%O	43.9	42.9
%Ash	0.5	0.5

Wood Moisture (% wet):	5.63
Load Weight (lb wet):	31.20
Burn Rate (dry kg/h):	2.23
Total Particulate Emissions:	11.33945 g

Fuel Data

	D. Fir	
HHV	19,288	kJ/kg
%C	50.81	
%H	6.9	
%O	41.88	
%Ash	0.41	

Note 1: For other fuels, use the heating value and fuel composition determined by analysis of fuel sample in accordance with Clause 9.2.

Note 2: In cases where the "Fuel Weight Remaining" is the same for three or more readings in a row, a "divide by zero error" will occur in the calculation sheet. In such cases, adjust the weight values by interpolation between the first occurence and the next reading showing a decrease in weight.

	Averages	0.40	9.66	11.06	304.04	72.45
					Temp. (°F)	
Elapsed	Fuel Weight	Flue Gas Composition (%)			Flue	Room
Time (min)	Remaining (lb)	CO	CO_2	O_2	Gas	Temp
0	31.20	0.11	10.89	10.00	327.0	62.0
5	30.60	0.43	12.72	8.01	336.0	64.0
10	29.90	0.43	11.63	9.10	340.0	65.0
15	29.40	0.11	10.91	9.98	342.0	65.0
20	28.80	0.09	10.46	10.44	342.0	66.0
25	28.30	0.08	9.92	10.98	342.0	67.0
30	27.70	0.10	9.77	11.12	341.0	68.0
35	27.10	0.17	10.71	10.15	340.0	68.0
40	26.80	0.12	9.24	11.64	338.0	69.0
45	26.50	0.20	9.00	11.84	336.0	70.0
50	26.20	0.36	6.83	13.93	332.0	71.0
55	26.00	0.55	6.93	13.74	326.0	70.0
60	25.80	0.98	6.06	14.39	321.0	70.0
65	25.30	0.87	14.17	6.34	318.0	71.0
70	24.70	0.06	12.67	8.24	320.0	73.0
75	24.10	0.05	11.41	9.51	320.0	73.0
80	23.40	0.33	10.74	10.04	321.0	73.0
85	22.80	0.08	9.62	11.28	322.0	73.0
90	22.20	0.10	9.57	11.32	323.0	74.0
95	21.60	0.08	9.92	10.98	322.0	74.0
100	20.90	0.13	11.85	9.03	321.0	74.0
105	20.40	0.18	11.36	9.49	322.0	74.0
110	19.90	0.10	10.94	9.95	323.0	74.0
115	19.40	0.11	9.77	11.12	323.0	74.0
120	18.80	0.16	10.41	10.45	323.0	74.0
125	18.30	1.03	10.98	9.45	323.0	74.0
130	17.70	0.22	11.11	9.72	325.0	74.0
135	17.00	0.85	13.69	6.83	327.0	74.0
140	16.30	0.86	12.72	7.79	331.0	74.0
145	15.80	0.25	10.91	9.91	334.0	74.0
150	15.30	1.20	12.00	8.34	337.0	74.0
155	14.70	0.25	10.74	10.08	338.0	73.0
160	14.30	0.57	10.46	10.20	339.0	74.0
165	13.80	0.12	10.19	10.69	339.0	73.0
170	13.20	0.11	10.11	10.78	338.0	73.0
175	12.50	0.13	8.03	12.85	335.0	73.0
180	12.30	0.15	5.86	15.01	329.0	73.0

185	12.10	0.28	7.23	13.57	311.0	73.0
190	11.90	0.12	9.77	11.11	300.0	73.0
195	11.70	0.28	7.73	13.07	291.0	73.0
200	11.50	0.56	4.52	16.14	283.0	73.0
205	11.40	0.71	11.21	9.38	282.0	73.0
210	10.80	0.85	11.76	8.76	279.0	74.0
215	10.50	1.10	11.33	9.06	280.0	74.0
220	9.90	2.34	12.18	7.59	282.0	73.0
225	9.40	2.42	13.12	6.61	287.0	74.0
230	8.90	1.20	10.84	9.50	289.0	74.0
235	8.40	0.10	10.66	10.23	289.0	74.0
240	8.00	1.64	12.35	7.77	291.0	75.0
245	7.30	0.2	12.3	8.54	294	74
250	6.80	0.29	10.86	9.935	295	74
255	6.40	0.1	8.87	12.02	295	75
260	5.90	0.12	8.52	12.36	293	75
265	5.60	0.15	7.85	13.015	290	75
270	5.20	0.16	7.46	13.4	287	74
275	4.80	0.19	6.96	13.885	283	75
280	4.50	0.19	6.46	14.385	278	74
285	4.30	0.21	7.68	13.155	273	74
290	4.00	0.22	7.06	13.77	269	74
295	3.70	0.43	10.31	10.415	267	74
300	3.50	0.19	9.52	11.325	265	74
305	3.40	0.38	7.53	13.22	263	73
310	3.30	0.59	5.74	14.905	261	73
315	3.00	0.22	9.49	11.34	262	73
320	2.50	0.26	8.13	12.68	261	73
325	2.10	0.37	10.02	10.735	259	73
330	1.70	0.73	9.2	11.375	259	72
335	1.50	0.31	10.26	10.525	260	73
340	1.20	0.14	9.97	10.9	261	73
345	0.90	0.11	7.75	13.135	262	73
350	0.40	0.14	6.36	14.51	262	73
355	0.10	0.18	5.52	15.33	260	73
360	0.00	0.23	4.27	16.555	256	73

Er Calc Sheet

Unit: Optimum

Run: EPA 1 0-360

Date: 1/9/17

Cs = K2 x (Mn/ Vstd)

= .001 (________ / __________) = ________________

Er = (Cs-Cr) x Qsd X θ

= ______ x __________ x_____ = __________________

T1 11.8499 g

T2 10.8290 g

11.33945

From Spreadsheets

MYREN CONSULTING, INC

Manufacturer:	509 FAB	**Technicians:**	ATMYREN
Model:	PRESTO LOG		
Date:	1.9.17		
Run:	EPA 1		
Control #:			
Test Duration:	60		
Output Category:	HIGH BURN		

Test Results in Accordance with CSA B415.1-09

	HHV Basis	LHV Basis
Overall Efficiency	78.3%	84.8%
Combustion Efficiency	98.0%	98.0%
Heat Transfer Efficiency	80%	86.6%

Output Rate (kJ/h)	34,908	33,114	**(Btu/h)**
Burn Rate (kg/h)	2.31	5.10	**(lb/h)**
Input (kJ/h)	44,597	42,305	**(Btu/h)**

Test Load Weight (dry kg)	2.31	5.10	**dry lb**
MC wet (%)	5.629		
MC dry (%)	5.96		
Particulate (g)	1.5026		
CO (g)	71		
Test Duration (h)	1.00		

Emissions	Particulate	CO
g/MJ Output	0.04	2.02
g/kg Dry Fuel	0.65	30.49
g/h	1.50	70.51
lb/MM Btu Output	0.10	4.69

Air/Fuel Ratio (A/F)	12.34

VERSION: **2.2** **12/14/2009**

VERSION: 2.2 12/14/2009

Manufacturer: 509 FAB
Model: PRESTO LOG
Date: 1.9.17
Run: EPA 1
Control #:
Test Duration: 60
Output Category: HIGH BURN

Appliance Type: NON CAT (Cat, Non-Cat, Pellet)

Temp. Units F (F or C)
Weight Units lb (kg or lb)

Default Fuel Values

	D. Fir	Oak
HHV (kJ/kg)	19,810	19,887
%C	48.73	50
%H	6.87	6.6
%O	43.9	42.9
%Ash	0.5	0.5

Wood Moisture (% wet): 5.63
Load Weight (lb wet): 5.40
Burn Rate (dry kg/h): 2.31
Total Particulate Emissions: 1.5026 g

Fuel Data

	D. Fir	
HHV	19,288	kJ/kg
%C	50.81	
%H	6.9	
%O	41.88	
%Ash	0.41	

Note 1: For other fuels, use the heating value and fuel composition determined by analysis of fuel sample in accordance with Clause 9.2.

Note 2: In cases where the "Fuel Weight Remaining" is the same for three or more readings in a row, a "divide by zero error" will occur in the calculation sheet. In such cases, adjust the weight values by interpolation between the first occurence and the next reading showing a decrease in weight.

Elapsed Time (min)	Fuel Weight Remaining (lb)	Flue Gas Composition (%) CO	CO_2	O_2	Temp. (°F) Flue Gas	Room Temp
Averages		0.29	9.62	11.18	335.62	67.31
0	5.40	0.11	10.89	10.00	327.0	62.0
5	4.80	0.43	12.72	8.01	336.0	64.0
10	4.10	0.43	11.63	9.10	340.0	65.0
15	3.60	0.11	10.91	9.98	342.0	65.0
20	3.00	0.09	10.46	10.44	342.0	66.0
25	2.50	0.08	9.92	10.98	342.0	67.0
30	1.90	0.10	9.77	11.12	341.0	68.0
35	1.30	0.17	10.71	10.15	340.0	68.0
40	1.00	0.12	9.24	11.64	338.0	69.0
45	0.70	0.20	9.00	11.84	336.0	70.0
50	0.40	0.36	6.83	13.93	332.0	71.0
55	0.20	0.55	6.93	13.74	326.0	70.0
60	0.00	0.98	6.06	14.39	321.0	70.0

Er Calc Sheet

Unit: Optimum

Run: EPA 1 0-60 (High Burn Segment

Date: 1/9/17

Cs = K2 x (Mn/ Vstd)

= .001 (5.7 / 29.260) = .0001948 g/dscf

Er = (Cs-Cr) x Qsd X θ

= ____ x 135,735 x 60 = 1.5026

Rm Blk .010305 X .001

.0001948 g/dscf

.0000103 "

.0001845 g/dscf

MYREN CONSULTING, INC

Manufacturer:)9 FABRICATORS
Model: MODEL 1
Date: 1.9.17
Run: EPA 1
Control #:
Test Duration: 120
Output Category: MEDIUM

Technicians: ATMYREN

Test Results in Accordance with CSA B415.1-09

	HHV Basis	LHV Basis
Overall Efficiency	79.6%	86.3%
Combustion Efficiency	97.7%	97.7%
Heat Transfer Efficiency	81%	88.3%

Output Rate (kJ/h)	44,379	42,099	**(Btu/h)**
Burn Rate (kg/h)	2.89	6.37	**(lb/h)**
Input (kJ/h)	55,747	52,882	**(Btu/h)**

Test Load Weight (dry kg)	5.78	12.74	**dry lb**
MC wet (%)	5.629		
MC dry (%)	5.96		
Particulate (g)	N/A		
CO (g)	193		
Test Duration (h)	2.00		

Emissions	Particulate	CO
g/MJ Output	#VALUE!	2.17
g/kg Dry Fuel	#VALUE!	33.33
g/h	#VALUE!	96.32
lb/MM Btu Output	#VALUE!	5.04

Air/Fuel Ratio (A/F)	11.14

VERSION: **2.2** **12/14/2009**

VERSION: 2.2 12/14/2009

Manufacturer:	509 FABRICATORS	**Appliance Type:**	NON CAT	(Cat, Non-Cat, Pellet)
Model:	MODEL 1			
Date:	1.9.17	**Temp. Units**	F	(F or C)
Run:	EPA 1	**Weight Units**	lb	(kg or lb)
Control #:				
Test Duration:	120			
Output Category:	MEDIUM			

Default Fuel Values

	D. Fir	Oak
HHV (kJ/kg)	19,810	19,887
%C	48.73	50
%H	6.87	6.6
%O	43.9	42.9
%Ash	0.5	0.5

Wood Moisture (% wet):	5.63	
Load Weight (lb wet):	13.50	
Burn Rate (dry kg/h):	2.89	
Total Particulate Emissions:	N/A	g

Fuel Data

	D. Fir	
HHV	19,288	kJ/kg
%C	50.81	
%H	6.9	
%O	41.88	
%Ash	0.41	

Note 1: For other fuels, use the heating value and fuel composition determined by analysis of fuel sample in accordance with Clause 9.2.

Note 2: In cases where the "Fuel Weight Remaining" is the same for three or more readings in a row, a "divide by zero error" will occur in the calculation sheet. In such cases, adjust the weight values by interpolation between the first occurence and the next reading showing a decrease in weight.

	Averages	**0.36**	**10.61**	**10.15**	**326.96**	**73.36**
					Temp. (°F)	
Elapsed	**Fuel Weight**	**Flue Gas Composition (%)**			**Flue**	**Room**
Time (min)	**Remaining (lb)**	**CO**	**CO_2**	**O_2**	**Gas**	**Temp**
0	13.50	0.98	6.06	14.39	321.0	70.0
5	13.00	0.87	14.17	6.34	318.0	71.0
10	12.40	0.06	12.67	8.24	320.0	73.0
15	11.80	0.05	11.41	9.51	320.0	73.0
20	11.10	0.33	10.74	10.04	321.0	73.0
25	10.50	0.08	9.62	11.28	322.0	73.0
30	9.90	0.10	9.57	11.32	323.0	74.0
35	9.30	0.08	9.92	10.98	322.0	74.0
40	8.60	0.13	11.85	9.03	321.0	74.0
45	8.10	0.18	11.36	9.49	322.0	74.0
50	7.60	0.10	10.94	9.95	323.0	74.0
55	7.10	0.11	9.77	11.11	323.0	74.0
60	6.50	0.16	10.41	10.45	323.0	74.0
65	6.00	1.03	10.98	9.45	323.0	74.0
70	5.40	0.22	11.11	9.72	325.0	74.0
75	4.70	0.85	13.69	6.83	327.0	74.0
80	4.00	0.86	12.72	7.79	331.0	74.0
85	3.50	0.25	10.91	9.91	334.0	74.0
90	3.00	1.20	12.00	8.34	337.0	74.0
95	2.40	0.25	10.74	10.08	338.0	73.0
100	2.00	0.57	10.46	10.20	339.0	74.0
105	1.50	0.12	10.19	10.69	339.0	73.0
110	0.90	0.11	10.11	10.78	338.0	73.0
115	0.20	0.13	8.03	12.85	335.0	73.0
120	0.00	0.15	5.86	15.01	329.0	73.0

MYREN CONSULTING, INC

Manufacturer: 509 FAB
Model: MODEL 1
Date: 1.9.17
Run: EPA 1
Control #:
Test Duration: 180
Output Category: LOW

Technicians: ATMYREN

Test Results in Accordance with CSA B415.1-09

	HHV Basis	LHV Basis
Overall Efficiency	78.4%	85.0%
Combustion Efficiency	95.8%	95.8%
Heat Transfer Efficiency	82%	88.7%

Output Rate (kJ/h)	26,563	25,198	**(Btu/h)**
Burn Rate (kg/h)	1.76	3.87	**(lb/h)**
Input (kJ/h)	33,861	32,121	**(Btu/h)**

Test Load Weight (dry kg)	5.27	11.61	**dry lb**
MC wet (%)	5.629		
MC dry (%)	5.96		
Particulate (g)	N/A		
CO (g)	314		
Test Duration (h)	3.00		

Emissions	Particulate	CO
g/MJ Output	#VALUE!	3.95
g/kg Dry Fuel	#VALUE!	59.69
g/h	#VALUE!	104.79
lb/MM Btu Output	#VALUE!	9.17

Air/Fuel Ratio (A/F)	13.12

VERSION: **2.2** **12/14/2009**

VERSION: 2.2 12/14/2009

Manufacturer: 509 FAB
Model: MODEL 1
Date: 1.9.17
Run: EPA 1
Control #:
Test Duration: 180
Output Category: LOW

Appliance Type: NON CAT (Cat, Non-Cat, Pellet)

Temp. Units: F (F or C)
Weight Units: lb (kg or lb)

Wood Moisture (% wet): 5.63
Load Weight (lb wet): 12.30
Burn Rate (dry kg/h): 1.76
Total Particulate Emissions: N/A g

Fuel Data

	D. Fir	
HHV	19,288	kJ/kg
%C	50.81	
%H	6.9	
%O	41.88	
%Ash	0.41	

Default Fuel Values

	D. Fir	Oak
HHV (kJ/kg)	19,810	19,887
%C	48.73	50
%H	6.87	6.6
%O	43.9	42.9
%Ash	0.5	0.5

Note 1: For other fuels, use the heating value and fuel composition determined by analysis of fuel sample in accordance with Clause 9.2.

Note 2: In cases where the "Fuel Weight Remaining" is the same for three or more readings in a row, a "divide by zero error" will occur in the calculation sheet. In such cases, adjust the weight values by interpolation between the first occurence and the next reading showing a decrease in weight.

Elapsed Time (min)	Fuel Weight Remaining (lb)	Flue Gas Composition (%) CO	CO_2	O_2	Temp. (°F) Flue Gas	Room Temp
	Averages	0.48	8.83	11.87	278.59	73.62
0	12.30	0.15	5.86	15.01	329.0	73.0
5	12.10	0.28	7.23	13.57	311.0	73.0
10	11.90	0.12	9.77	11.11	300.0	73.0
15	11.70	0.28	7.73	13.07	291.0	73.0
20	11.50	0.56	4.52	16.14	283.0	73.0
25	11.40	0.71	11.21	9.38	282.0	73.0
30	10.80	0.85	11.76	8.76	279.0	74.0
35	10.50	1.10	11.33	9.06	280.0	74.0
40	9.90	2.34	12.18	7.59	282.0	73.0
45	9.40	2.42	13.12	6.61	287.0	74.0
50	8.90	1.20	10.84	9.50	289.0	74.0
55	8.40	0.10	10.66	10.23	289.0	74.0
60	8.00	1.64	12.35	7.77	291.0	75.0
65	7.30	0.20	12.30	8.54	294.0	74.0
70	6.80	0.29	10.86	9.94	295.0	74.0
75	6.40	0.10	8.87	12.02	295.0	75.0
80	5.90	0.12	8.52	12.36	293.0	75.0
85	5.60	0.15	7.85	13.02	290.0	75.0
90	5.20	0.16	7.46	13.40	287.0	74.0
95	4.80	0.19	6.96	13.89	283.0	75.0
100	4.50	0.19	6.46	14.39	278.0	74.0
105	4.30	0.21	7.68	13.16	273.0	74.0
110	4.00	0.22	7.06	13.77	269.0	74.0
115	3.70	0.43	10.31	10.42	267.0	74.0
120	3.50	0.19	9.52	11.33	265.0	74.0
125	3.40	0.38	7.53	13.22	263.0	73.0
130	3.30	0.59	5.74	14.91	261.0	73.0
135	3.00	0.22	9.49	11.34	262.0	73.0
140	2.50	0.26	8.13	12.68	261.0	73.0
145	2.10	0.37	10.02	10.74	259.0	73.0
150	1.70	0.73	9.20	11.38	259.0	73.0
155	1.50	0.31	10.26	10.53	260.0	73.0
160	1.20	0.14	9.97	10.90	261.0	73.0
165	0.90	0.11	7.75	13.14	262.0	73.0
170	0.40	0.14	6.36	14.51	262.0	73.0
175	0.10	0.18	5.52	15.33	260.0	73.0
180	0.00	0.23	4.27	16.56	256.0	73.0

MYREN CONSULTING, INC.
Dilution Tunnel Traverse Data with 8 Traverse Points Rev: 1.7.12

Unit: Optimum
Run #: EPA 1
Date: 1/9/17
Technicians: ATM, ESS
TIME: 11:00

Point	Location	Δp	$\sqrt{\Delta p_{trav}}$	Δp	$\sqrt{\Delta p_{cent}}$	T_{trav}	T_{cent}	Pg
W-1	0.5"	.035	.187			99		
2	1.5	.039	.197			101		
Center	Center			.041	.202		102	—
3	4.5	.041	.202			102		
4	5.5	.032	.179			101		
S-1	0.5	.040	.200			102		
2	1.5	.040	.200			103		
Center	Center			.039	.197		102	—
3	4.5	.036	.190			101		
4	5.5	.030	.173			100		
	Totals		1.528		.399	809	204	—
	Average		.1910		.1995	101.1	102	—
	°R = (°F + 460)					561.1	562	

BP = 28.17 "Hg Ps = BP + (-Pg/13.6) = 28.17 + (— /13.6) = 28.17 " Hg

LEAK CHECKS: Manometer Level: OK ✓ Zeroed: OK ✓ Tech: ESS

Pg Leg: Pre Test: Pressure: 5.690 " H_2O Movement: .000 " H_2O Tech: ESS

Post Test: Pressure: 7.490 " H_2O Movement: .000 " H_2O Tech: ESS

Velocity Head Leg: Pre Test: Pressure: 7.020 " H_2O Movement: .000 " H_2O Tech: ESS

Post Test: Pressure: 7.910 " H_2O Movement: .000 " H_2O Tech: ESS

MYREN CONSULTING, INC. ASTM E2515 DATA SHEET # 5-2 PAGE 2 OF 2

DILUTION TUNNEL GAS VELOCITY & VOLUMETRIC FLOW RATE CALCULATIONS

Rev 6/6/11

UNIT: Optimum DATE: 1/9/17 RUN #: EPA 1 TECHNICIAN(S): ATM / ESS

Average Gas Velocity in the Dilution Tunnel Vstrav (EPA M2 EQN 2-9, ASTM E 2515 EQN 7)

(9) Vstrav = (85.49) (0.99 cp) (.1910 {4} x $\sqrt{\Delta P}$ "H_2O) $\sqrt{\dfrac{561.1 \text{ {1} Ts °A}}{(28.17 \text{ {3} Ps "Hg}) (28.78 \text{ lb./ lb. mole})}}$ = 13.44823 {5} fps

(9A) Vs = (13.44823 {5} fps) (60) = 806.894 {3} fpm

Gas Velocity in the Center of the Dilution Tunnel - Vscent (EPA M2 EQN 2-9, ASTM E 2515 EQN 7)

(9) Vscent = (85.49) (0.99 cp) (.1995 {4} x $\sqrt{\Delta P}$ "H_2O) $\sqrt{\dfrac{562 \text{ {1} Ts °A}}{(28.17 \text{ {3} Ps "Hg}) (28.78 \text{ lb./ lb. mole})}}$ = 14.05797 {5} fps

(9A) Vs = (14.05797 {5} fps) (60) = 843.478 {3} fpm

EPA M5G1 Section 4.2.2, ASTM E 2515 EQN 1 Adjustment Factor for Center of Tunnel Pitot Tube Location

Fp = Vstrav/ Vscent = 13.44823 {5} ÷ 14.05797 {5} = .95663 {5}

Average Stack Gas Dry Volumetric Flow Rate - Qsd (EPA M2 EQN 2-10, ASTM E 2515 EQN 3)

(10) Qsd = 3600 (1 - 0.02 Bws) (13.44823 {5} fps) (.1963 {4} ft²) [(528 °A) (28.17 {3} Ps "Hg) / (561.1 {1} T_s °A) (29.92" Hg) = 8251.501 {3} dscfhr (or dscfh)

(10A) 8251.501 {3} dscfhr ÷ 60 = 137.525 {2} dscfmin (or dscfm)

Note: Number in { } under blank lines denotes number of decimals to be used. If a blank calls for an answer already calculated, use the number of decimals previously specified for that answer.

EPA 1 T 1

DILUTION TUNNEL CALCULATIONS

MYREN CONSULTING CERTIFICATION TEST DATA

4/15/10, Ms=28.78, Bws=2.0% 6"Tunnel

File Name:	EPA 1 T 1
Manufacturer:	509 FAB
Model Number:	OPTIMUM
Lab Name:	MYREN
Test Date:	1.9.17
Run Number:	EPA 1 T 1
Meter Box Y Factor:	0.9743
Barometric Pressure (in Hg):	28.179
Dry Gas Meter Temp(avg.)(F):	**84**
Delta H(Avg.)(in H2)):	**0.900**
Gas meter initial reading:	415.1000
Gas meter final reading:	609.0750
Total Particulate Catch(mg):	43.2
Sampling Flow Rate(cfm):	0.539
Tunnel Flow (Qsd) (dscfm)	**137.562**
Emission Rate(g/hr):	**1.975**
Emission Factor(g/kg)	**0.887**
Avg. of Delta P Sq. Roots:	**0.2000**
Vs (Avg.)(ft/min):	**809.431**
Tunnel Avg. Temperature (F):	**102.892**
Test time(min):	360
Fuel Load: (lbs. Dry):	29.4430
Wood moisture(%wet):	5.630
Burn rate(dry kg/hr):	**2.226**
Sample Volume (dscf)	**173.086**
Avg. Tunnel Static (-inch H2O):	**0.0000**
Room Blank Catch (mg/dscf):	0.010305
Total PM Emissions(Er))(g):	**11.8499**
Pitot Correction Factor:	0.95663
Front Filter Number:	365, 367
Back Filter Number:	364, 366
Beaker number:	57, 56
PRELIMINARY RESULTS	
FINAL RESULTS:	AUDITED

DATA SUMMARY

MODEL:	OPTIMUM
RUN:	EPA 1 T 1
DATE:	1.9.17
DBR:	2.226
EMISSION RATE (g/hr)(unadj):	1.9750
EMISSION FACTOR (g/kg):	0.8873
AVG. % PROPORTIONALITY :	99.973

RUN TIME (min)	PITOT DELTAP (in H2O)	TNL TEMP (°F)	GAS METER RDG (ft3)	GAS METER TEMP (°F)	GAS METER DELTA H (in.H2O)	TUNNEL VELOCITY (ft/min)	PROP RATE (%)	dDGM vol std (ft3)	Tunnel Static (- Inch H2O)	SQUARE ROOT DELTA P	DRY GAS METER READING (M3)
0	0.040	102	415.100	60	0.90	808.79			0.000	0.20000	
10	0.040	104	420.387	65	0.90	809.51	106.4	4.912	0.000	0.20000	
20	0.040	107	425.719	69	0.90	811.30	105.8	4.912	0.000	0.20000	
30	0.040	107	431.043	73	0.90	812.38	104.2	4.867	0.000	0.20000	
40	0.040	107	436.398	76	0.90	812.38	103.3	4.863	0.000	0.20000	
50	0.040	105	441.778	79	0.90	811.66	102.5	4.859	0.000	0.20000	
60	0.040	105	447.174	81	0.90	810.95	101.8	4.851	0.000	0.20000	
70	0.040	106	452.570	83	0.90	811.30	101.2	4.833	0.000	0.20000	
80	0.040	106	458.000	83	0.90	811.66	101.5	4.854	0.000	0.20000	
90	0.040	106	463.391	84	0.90	811.66	100.7	4.820	0.000	0.20000	
100	0.040	106	468.795	84	0.90	811.66	100.8	4.827	0.000	0.20000	
110	0.040	106	474.186	84	0.90	811.66	100.3	4.811	0.000	0.20000	
120	0.040	106	479.577	85	0.90	811.66	100.3	4.811	0.000	0.20000	
130	0.040	105	484.960	85	0.90	811.30	99.9	4.799	0.000	0.20000	
140	0.040	107	490.315	85	0.90	811.66	99.3	4.770	0.000	0.20000	
150	0.040	107	495.675	86	0.90	812.38	99.5	4.774	0.000	0.20000	
160	0.040	108	500.976	86	0.90	812.74	98.3	4.717	0.000	0.20000	
170	0.040	107	506.254	87	0.90	812.74	97.6	4.693	0.000	0.20000	
180	0.040	106	511.677	87	0.90	812.02	100.0	4.817	0.000	0.20000	
190	0.040	100	517.084	87	0.90	809.51	99.1	4.798	0.000	0.20000	
200	0.040	99	522.509	87	0.90	806.99	99.1	4.814	0.000	0.20000	
210	0.040	99	527.968	87	0.90	806.63	99.8	4.845	0.000	0.20000	
220	0.040	100	533.370	87	0.90	806.99	98.9	4.794	0.000	0.20000	
230	0.040	102	538.737	88	0.90	808.07	98.2	4.759	0.000	0.20000	
240	0.040	103	544.197	88	0.90	809.15	99.9	4.837	0.000	0.20000	
250	0.040	103	549.616	88	0.90	809.51	99.2	4.800	0.000	0.20000	
260	0.040	102	555.018	89	0.90	809.15	98.6	4.781	0.000	0.20000	
270	0.040	102	560.417	89	0.90	808.79	98.3	4.774	0.000	0.20000	
280	0.040	101	565.813	89	0.90	808.43	98.2	4.771	0.000	0.20000	
290	0.040	100	571.222	89	0.90	807.71	98.3	4.783	0.000	0.20000	
300	0.040	98	576.637	89	0.90	806.63	98.3	4.788	0.000	0.20000	
310	0.040	98	582.031	89	0.90	805.91	97.8	4.770	0.000	0.20000	
320	0.040	97	587.441	89	0.90	805.55	98.1	4.784	0.000	0.20000	
330	0.040	97	592.858	88	0.90	805.18	98.4	4.794	0.000	0.20000	
340	0.040	98	598.255	88	0.90	805.55	98.3	4.781	0.000	0.20000	
350	0.040	98	603.665	88	0.90	805.91	98.5	4.792	0.000	0.20000	
360	0.040	97	609.075	88	0.90	805.55	98.5	4.792	0.000	0.20000	
370											
380											

EPA 1 T 1 0-60 1.9.17

DILUTION TUNNEL CALCULATIONS

MYREN CONSULTING CERTIFICATION TEST DATA

1\25\09, Md=28.56, Bws=4% 6" Tunnel

File Name:	EPA 1 T 1 0-60
Manufacturer:	509 FAB
Model Number:	OPTIMUM
Lab Name:	MYREN
Test Date:	1.9.17
Run Number:	EPA 1 T 1 0-60
Meter Box Y Factor:	0.9743
Barometric pressure (in):	28.165
Gas meter temp (ave):	**72**
delta H(avg):	**0.900**
Gas meter initial reading:	415.1000
Gas meter final reading:	447.1740
Front catch (acetone) mg:	7.1
first filter catch (mg):	-1.4
second filter catch (mg):	0
Tunnel Flow (Qsd) (dscfm)	**135.735**
Emission Rate(g/hr):	**1.503**
Emission Rate(M5H) :	**2.552**
Avg. of Delta P Sq. Roots:	**0.2000**
Vs (Avg.)(ft/min):	**819.196**
Tunnel Avg. Temperature (F):	**105.286**
Test time(min):	60
Fuel Load(lb. wet):	5.400
Wood moisture(%wet):	5.630
Burn rate(dry kg/hr):	**2.312**
Sample Volume (dscf)	**29.260**
Avg. Tunnel Static (-inch H2O):	**0.0000**
Room Blank Catch (mg/dscf):	0.010305
Emission Factor (g/kg):	**0.6500**
Pitot Correction Factor:	0.95663
front filter number	365
back filter number	364
Beaker Number:	57
PRELIMINARY RESULTS	
FINAL RESULTS:	AUDITED
DATA SUMMARY	
MODEL:	OPTIMUM
RUN:	EPA 1 T 1 0-60
DATE:	1.9.17
DBR:	2.312
EMISSION RATE (g/hr)(M5H)	2.5518
EMISSION FACTOR (g/kg):	0.6500
AVG. % PROPORTIONALITY :	99.928

RUN TIME (min)	PITOT DELTAP (- INCH H20)	TNL TEMP (°F)	GAS METER RDG (ft3)	GAS METER TEMP (°F)	GAS METER DELTA H (in.H2O)	TUNNEL VELOCITY (ft/min)	PROP RATE (%)	dDGM vol std (ft3)	Tunnel Static (- Inch H2O)	SQUARE ROOT DELTA P	DRY GAS METER RDG (m3)
0	0.040	102	415.100	60	0.90	812.10			0.000	0.20000	
10	0.040	104	420.387	65	0.90	818.50	102.5	4.910	0.000	0.20000	
20	0.040	107	425.719	69	0.90	820.32	101.6	4.909	0.000	0.20000	
30	0.040	107	431.043	73	0.90	821.41	100.0	4.865	0.000	0.20000	
40	0.040	107	436.398	76	0.90	821.41	99.2	4.861	0.000	0.20000	
50	0.040	105	441.778	79	0.90	820.68	98.4	4.857	0.000	0.20000	
60	0.040	105	447.174	81	0.90	819.96	97.7	4.848	0.000	0.20000	
80											
90											
100											
110											
120											
130											
140											
150											
160											
170											
180											
190											
200											
210											
220											
230											
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270											
280											
290											
300											
310											
320											
330											
340											
350											
360											
370											
380											

TI 0-60

Method 5G Particulate Sampling Data

Unit: Optimum
Run: EPA 1
Date: 1/9/18
 Rev 12/15

Meter Box 45G-P Meter Y 0.9743 Filter #'s: (F) 365 (R) 364

Filter/O-Ring ID #: —

.952/.953
Pre Test Leak Check: .001 CFM@ -16.0 in Hg Filter Size: Reg 110 mm

Probe ID #: —

.1565/.157
Post Test Leak Check: .0005 CFM@ -10.25 in Hg Probe Length: 24 in glass

Time		Meter Reading (ft³)	Pitot		Tunnel Temp (°F)	Meter Temp (°F)	Gas Meter Δh	Vac (in Hg)
Clock	Elapsed		ΔP	Pg				
1120	00	415.100	.040		102	60	.90	0
30	10	420.387	.040		104	65	.90	0
40	20	425.719	.040		107	69	.90	0
50	30	431.043	.040		107	73	.90	0
1200	40	436.398	.040		107	76	.90	0
10	50	441.778	.040		105	79	.90	0
20	60	447.174	.040		105	81	.90	0
	70							
	80							
	90							
	00							
	10							
	20							
	30							
	40							
	50							
	60							
	70							
	80							
	90							

BP
00 28.17
60 28.16
Avg. = 28.165 in Hg"

Pre Test Filter Tare Weight Check
F 1.3385
R

End of Test Weight
F 1.3400 R
1.3385
.0015

TI 60r

Method 5G Particulate Sampling Data

Unit: Optimum
Run: EPA 1
Date: 1/9/17
Page: 1 of 2 Rev 12/15

Meter Box 45G-P Meter Y .9743 Filter #'s: (F) 367 (R) 366

.876/.877

Filter/O-Ring ID #: —

Pre Test Leak Check: .001 CFM@ – 16.0 in Hg Filter Size: Reg 110 mm

.101/.101

Probe ID #: —

Post Test Leak Check: .000 CFM@ – 10.75 in Hg Probe Length: 21 in Glass

Time		Meter Reading [redacted] (ft^3)	Pitot		Tunnel Temp (°F)	Meter Temp (°F)	Gas Meter Δh	Vac (in Hg)
Clock	Elapsed		ΔP	Pg				
	00							
	10							
	20							
	30							
	40							
	50							
1220	60	447.174	.040		105	81	.90	0
30	70	452.570	.040		106	83	.90	0
40	80	458.000	.040		106	83	.90	0
50	90	463.391	.040		106	84	.90	0
1300	100	468.795	.040		106	84	.90	0
10	110	474.186	.040		106	84	.90	0
20	120	479.577	.040		106	85	.90	0
30	130	484.960	.040		105	85	.90	0
40	140	490.315	.040		107	85	.90	0
50	150	495.675	.040		107	86	.90	0
1400	160	500.976	.040		108	86	.90	0
10	170	506.254	.040		107	87	.90	0
20	180	511.677	.040		106	87	.90	0
30	190	517.084	.040		100	87	.90	0

BP

00	28.17	300	28.20
60	28.16	360	28.20
120	28.16		
180	28.17		
240	28.19		

Avg. = 28.1786 in Hg"

Pre Test Filter Tare Weight Check

F

R 1.3398

End of Test Weight

F 1.3660 R

1.3399

.0261

TI 60+

Method 5G Particulate Sampling Data

Unit: Optimum
Run: EPA 1
Date: 1/9/17
Page: 2 of 2 Rev 12/15

Meter Box 45G-P Meter Y .9743 Filter #'s: (F) 367 (R) 366

.876/.877
Filter/O-Ring ID #: ——

Pre Test Leak Check: .001 CFM@ -16.0 in Hg Filter Size: Reg 110 mm

.101/.101
Probe ID #: ——

Post Test Leak Check: .000 CFM@ -10.25 in Hg Probe Length: 21 in Glass

Time		Meter Reading (ft³)	Pitot		Tunnel Temp (°F)	Meter Temp (°F)	Gas Meter Δh	Vac (in Hg)
Clock	Elapsed		ΔP	Pg				
1440	200	522.509	.040		99	87	.90	0
50	210	527.968	.040		99	87	.90	0
1500	220	533.370	.040		100	87	.90	0
10	230	538.737	.040		102	88	.90	0
20	240	544.197	.040		103	88	.90	0
30	250	549.616	.040		103	88	.90	0
40	260	555.018	.040		102	89	.90	0
50	270	560.417	.040		102	89	.90	0
1600	280	565.813	.040		101	89	.90	0
10	290	571.222	.040		100	89	.90	0
20	300	576.637	.040		98	89	.90	0
30	310	582.031	.040		98	89	.90	0
40	320	587.441	.040		97	89	.90	0
50	330	592.858	.040		97	88	.90	0
1700	340	598.255	.040		98	88	.90	0
10	350	603.665	.040		98	88	.90	0
20	360	609.075	.040		97	88	.90	0
	70							
	80							
	90							

BP

00	28.17	300	28.20
60	28.16	360	28.20
120	28.16		
180	28.17		
240	28.19		

Avg. = 28.1786 in Hg"

Pre Test Filter Tare Weight Check
F ______
R 1.3398

End of Test Weight
F 1.3660 R ______
1.3399
.0261

Woodstove Data Sheet #4-1: Initial Filter Pair Tare Weights

Into Desiccator: Date: 6/24/16 Time: 1730 By: ATM Front Half X Back Half X

Manufacturer: Pall Size: 110 mm Lot. No.: T-42414 Grade: AE Glass 1.0 μm

Balance Used: Sartorius Model: CP224S SN: 24850860

Filter #'s	First Wt.	2016 Date	Time	By	Second Wt.	2016 Date	Time	By	Third Wt.	Date	Time	By
350/351	1.2596	8/2	1414	ESS	1.2595	8/18	1324	ATM				
352/353	1.2611	8/2	1415	ESS	1.2611	8/18	1325	ATM				
354/355	1.2612	8/2	1416	ESS	1.2611	8/18	1326	ATM				
356/357	1.3008	8/2	1417	ESS	1.3008	8/18	1326	ATM	1.3003	12/30	1348	[illegible]
	1.3002	1/1/17	1504	ATM								
358/359	1.3369	8/2	1418	ESS	1.3370	8/18	1330	ATM	1.3363	12/30	1351	[illegible]
	1.3362	1/1/17	1506	ATM								
360/361	1.3472	8/2	1419	ESS	1.3473	8/18	1331	ATM	1.3467	12/30	1352	[illegible]
	1.3468	1/1/17	1508									
362/363	1.3418	8/2	1421	ESS	1.3417	8/18	1332	ATM	1.3412	12/30	1353	[illegible]
	1.3411	1/1/17	1510	ATM	EPA 1	T2						
364/365	1.3393	8/2	1422	ESS	1.3393	8/18	1334	ATM	1.3387	12/30	1354	[illegible]
	1.3385	1/1/17	1515	ATM	EPA 1	T1	0-60					
366/367	1.3405	8/2	1423	ESS	1.3404	8/18	1335	ATM	1.3398	12/30	1355	[illegible]
	1.3399	1/1/17	1517	ATM	EPA 1	T1	60+					
368/369	1.3219	8/2	1425	ESS	1.3220	8/18	1336	ATM	1.3215	12/30	1356	[illegible]
	1.3213	1/1/17	1519	ATM								
370/371	1.3113	8/2	1426	ESS	1.3114	8/18	1337	ATM	1.3104	12/30	1357	[illegible]
	1.3106	1/1/17	1522	ATM								
372/373	1.3131	8/2	1427	ESS	1.3130	8/18	1339	ATM	1.3125	12/30	1358	[illegible]
	1.3124	1/1/17	1524	ATM								
						1/2/17						

Checked by A.T. Myren Date: 8/18/16 Time: 1558 / 1500

QA Reweigh

Filter #	WT	Date	Time	By
356/357	1.3001	1/3/17	1210	ESS
360/361	1.3466	1/3/17	1208	ESS
364/365	1.3383	1/3/17	1206	ESS
370/371	1.3104	1/3/17	1203	ESS

Balance Room Environmental Conditions

WB	DB	%RH	Date 2016	Time	By
55	66	48	8/2	1345	ESS
54	65	48	8/18	1244	ATM
49	61	40	12/30	1207	ATM
50	65	31	1/3/17	1200	ESS

	1st	2nd	3rd	4th	5th
Date	8/2/16	8/18/16	12/30/16	1/3/17	
Post Weighing 0.0000g	0.0000	0.0000	0.0000	0.0000	
Scale Check 100.0000g	99.9993	99.9991	99.9992	99.9992	

Woodstove Data Sheet #4-2: Initial Beaker Weights (Tare Weights)

Into Dessicator: Date 10/21/16 Time 1645 By ATM
Balance Used: Sartorius Model: CP224S SN:24850860

Bkr #	First Wt	2016 Date	Time	By	Second Wt	2016 Date	Time	By	Third Wt	Date	Time	By
50	70.4391	11/3	1103	ATM	(70.4392)	12/30	1503	JM				
50												
51	68.1985	11/3	1036	ATM	68.1979	12/30	1435	JM	68.1986	1/1/17	1501	AT
51	68.1974	1/10	1144	JM								
52	67.8121	11/3	1106	ATM	(67.8122)	12/30	1512	JM				
52												
53	67.9774	11/3	1047	ATM	(67.9774)	12/30	1437	JM	67.9769	1/1/17	1127	ATM
53												
54	70.5415	11/3	1110	ATM	(70.5414)	12/30	1457	JM				
54												
55	67.2797	11/3	1056	ATM	(67.2796)	12/30	1442	JM	EPA 1 T3			
55												
56	70.2612	11/3	1054	ATM	(70.2612)	12/30	1440	JM	70.2604	1/9	1802	ATM
56	(70.2604)	1/10	1146	JM	★ EPA 1 T1 60+							
57	70.0069	11/3	1101	ATM	(70.0069)	12/30	1447	JM	70.0062	1/9	1800	ATM
57	(70.0060)	1/10	1140	JM	★ EPA 1 T1 0-60							
58	70.0416	11/3	1112	ATM	(70.0416)	12/30	1444	JM	70.0416	1/9	1804	ATM
58									★ EPA 1 T2			
59	70.6472	11/3	1044	ATM	(70.6472)	12/30	1521	JM				
59												

Checked by________ **Date:**______ **Time:**______

QA Reweigh

Beaker #	WT	Date	Time	By

Balance Room Environmental Conditions

WB	DB	%RH	Date 2016	Time	By
58	70	48	11/3	1028	ATM
49	61	40	12/30	1207	ATM
53	65	44	1/1/17	1441	ATM
50	64	34	1/9/17	936	ESS
53	65	44	1/10/17	1053	ATM

	1st	2nd	3rd	4th	5th
Date	11/3/16	12/30/16	1/1/17	1/9/17	1/10/17
Post Weighing 0.0000g	0.0000	0.0000	.0000	.0000	
Scale Check 100.0000g	99.9992	99.9992	99.9992	99.9992	

Woodstove Data Sheet #4-1: Initial Filter Pair Tare Weights

Room Blank

Into Desiccator: Date: 6/24/16 Time: 1730 By: ATM Front Half X Back Half ____

Manufacturer: Pall Size: 110 mm Lot. No.: 742414 Grade: AE Glass 1 μm (Reg 110 Filter

Balance Used: Sartorius Model: CP224S SN: 24850860

Filter #'s	First Wt.	2017 Date	Time	By	Second Wt.	2017 Date	Time	By	Third Wt.	Date	Time	By
312	.6286	1/8	1946	ATM	.6285	1/9	939	ESS	X			
313	.6273	1/8	1948	ATM	.6271	1/9	938	ESS				
314	.6292	1/9	1306	ATM								
315	.6326	↓	1307	ATM								
316	.6325		1309	ATM								
317	.6322		1310	ATM								
318	.6332		1311	ATM								
319	.6357		1312	ATM								
320	.6316		1313	ATM								
321	.6349	↓	1314	ATM								

Checked by ____ Date: ____ Time: ____

QA Reweigh

Filter #	WT	Date	Time	By

Balance Room Environmental Conditions

WB	DB	%RH	Date	Time	By
50	64	34	1/8/17	1903	ATM
50	64	34	1/9/17	936	ESS

		1st	2nd 1st	3rd 2nd	4th	5th
Date		1/8/17	1/9/17	1/9/17		
Post Weighing	0.0000g	.0000	0.0000	0.0000		
Scale Check	100.0000g	99.9992	99.9991	99.9993		

Woodstove Data Sheet #4-2: Initial Beaker Weights (Tare Weights)

Into Dessicator: Date 10/21/16 Time 1700 By ATM

Balance Used: Sartorius Model: CP224S SN:24850860

Bkr #	First Wt	2016 Date	Time	By	Second Wt	2016 Date	Time	By	Third Wt	Date	Time	By
60	70.5364	11/3	11:23	ATM	70.5370	11/22	0922	Jm	(70.5368)	11/23	1820	ATM
60												
61	70.8354	11/3	1121	ATM	70.8363	11/22	0920	Jm	70.8356	11/23	1805	ATM
61	70.8353	11/25	0824	Jm	(70.8353)	11/26	949	ATM	(Blank)			
62	68.7331	11/3	1116	AM	(68.7330)	11/22	0924	Jm	Thelin T-4000	EPA 6	T	
62												
No # 63	70.6252	11/3	1119	ATM	(70.6253)	11/22	0921	Jm	Thelin T-4000	EPA6	T	
63												

Checked by________ Date:______ Time:______

QA Reweigh

Beaker #	WT	Date	Time	By

Balance Room Environmental Conditions

WB	DB	%RH	Date 2016	Time	By
58	70	48	11/3	1028	ATM
			11/22		
			11/23		
			11/25		
			11/26		

	1st	2nd	3rd	4th	5th
Date	11/3/16	11/22/16	11/23/16	11/25/16	11/26/16
Post Weighing 0.0000g	0.0000	0.0000	0.0000	0.0000	0.0000
Scale Check 100.0000g	99.9992	99.9992	99.9992	99.9992	99.9993

50 ml

Fisher Optima Lot No. 158570

Acetone Blank 12/19/16

Woodstove Data Sheet #4-3: Constant Final Weights

Unit Optimus
Run # EPA-1
Date: 1/9/17

WST5-Form 9, Pg 1, Rev 10/10

Final Beaker Weights

Beaker	Into	Date	Time	By	First	Date	Time	By	Second	Date	Time	By	Third	Date	Time	By
61	70.8444	12/23	1412	ATM	70.8354	12/29	1135	ATM	70.8352	12/30	1430	[illegible]				

Final Filter Weights

	Filter #	Into Dessic	Date	Time	By	First	Date	Time	By	Second	Date	Time	By	Third	Date	Time	By
F																	
R																	

QA Reweigh: Final Weight

Date	Beaker #	Final Wt	By

Date	Filter #	Final Wt	By

Scale Room Environmental Conditions

Weighing Session	2016 Date	Time	By	WB	DB	%RH
1	12/29	1125	ATM	54	68	39
2	12/30	1207	ATM	49	61	40
3						
4						
5						
6						
7						

Scale Room Environmental Conditions

8						
9						
10						
11						
12						

Comment
Beaker ✓ wt. 70.8353 (12/19/16)
" Tare wt. 70.8353 (11/26/16)

Woodstove Data Sheet #4-3: Constant Final Weights

T1 0-60

Unit Optimum
Run # EPA 1
Date: 1/9/17
WST5-Form 9, Pg 1, Rev 10/10

60 ml.

Final Beaker Weights

Beaker	Into	Date	Time	By	First	Date	Time	By	Second	Date	Time	By	Third	Date	Time	By
57	70.0198	1/10	2007	ATM	70.0132	1/11	1546	ESS	70.0130	1/12	1317	ATM	70.0131	1/16	1535	ESS

Final Filter Weights

	Filter #	Into Dessic	Date	Time	By	First	Date	Time	By	Second	Date	Time	By	Third	Date	Time	By
F	364, 365	1.3400	1/10	1044	ATM	1.3393	1/10	2027	Jm	1.3389	1/11	1548	ESS	1.3374	1/12	1337	ATM
						1.3369	1/16	1538	ESS	1.3371	1/20	1130	ATM				
R																	

QA Reweigh: Final Weight

Date	Beaker #	Final Wt	By
Date	**Filter #**	**Final Wt**	**By**

Scale Room Environmental Conditions

Weighing Session	2017 Date	Time	By	WB	DB	%RH
1	1/10	1950	AM	52	66	55
2	1/11	1539	ESS	46	60	30
3	1/12	1234	ATM	50	64	34
4	1/16	1531	ESS	50	65	32
5	1/20	1116	ATM	53	65	44
6						
7						

Scale Room Environmental Conditions

8						
9						
10						
11						
12						

Comment

Woodstove Data Sheet #4-3: Constant Final Weights (T1 60+)

Unit: Optimum
Run #: EPA 1
Date: 1/9/17
WST5-Form 9, Pg 1, Rev 10/10

70 ml

Final Beaker Weights

Beaker	Into	Date	Time	By	First	Date	Time	By	Second	Date	Time	By	Third	Date	Time	By
56	70.2770	1/11	1553	ESS	70.2746	1/12	1306	ATM	70.2737	1/16	1540	ESS	70.2737	1/20	1137	ATM

Final Filter Weights

	Filter #	Into Dessic	Date	Time	By	First	Date	Time	By	Second	Date	Time	By	Third	Date	Time	By
F	366,367	1.3660	1/10	1222	ATM	1.3652	1/10	2034	Sm	1.3648	1/11	1555	ESS	1.3644	1/12	1327	ATM
						1.3639	1/16	1542	ESS	1.3641	1/20	1147	ATM				
R																	

QA Reweigh: Final Weight

Date	Beaker #	Final Wt	By

Date	Filter #	Final Wt	By

Scale Room Environmental Conditions

Weighing Session	2017 Date	Time	By	WB	DB	%RH
1	1/10	1950	ATM	52	66	35
2	1/11	1539	ESS	46	60	30
3	1/12	1234	ATM	50	64	34
4	1/16	1531	ESS	50	65	32
5	1/20	1110	ATM	53	65	44
6						
7						

Scale Room Environmental Conditions

8						
9						
10						
11						
12						

Comment

Train 1 Woodstove Particulate Catch Processing Sheet
Woodstove Data Sheet #5
ASTM E 2515/ EPA M5G-1

T1
0-60
60+

Unit: Optimum
Run: EPA 1 **Train** T1
Date: 1/9/17
Technicians: DTM ESS
Revised 11/15 - Data Sheet #5

0-60 Minutes:

Filters:

Filter # (Front): 363, 364 **Beaker #:** 57 **Final Wt.:** 70.0131 g

Tare Wt.: 1.3385 g **ml** 60 **Tare Wt.:** 70.0060 g

Filter # (Rear): ______ **Desiccant: Acetone** **Net Wt.:** .0071 g

Tare Wt.: ______ g **Beaker Tare Wt,. Check:** 70.0060 g

0-60 Minute Combined Filter Final Weight: 1.3371 g

0-60 Minute Combined Filter Tare Weight: 1.3385 g

0-60 Minute Combined Net Catch Weight: -.0014 g

60 Minutes Plus:

Filter # (Front): 366, 367 **Beaker #:** 56 **Final Wt.:** 70.2737 g

Tare Wt.: 1.3399 g **ml** 70 **Tare Wt.:** 70.2604 g

Filter # (Rear): ______ **Desiccant: Acetone** **Net Wt.:** .0133 g

Tare Wt.: ______ g **Beaker Tare Wt. Check:** 70.2605 g

60 Minute Plus Combined Filter Final Weight: 1.3641 g

60 Minute Plus Combined Filter Tare Weight: 1.3399 g

60 Minute Plus Combined Net Catch Weight: .0242 g

Acetone Blank Calculation: **Blank Date:** 12/19/16 **Blank Beaker #:** 61 **Desiccant: 50 ml Acetone**

Final Wt.: 70.8352 g - **Tare Wt.:** 70.8353 g = **Net Catch Wt.:** -0.0001 ≈ 0.0000 g

Net Catch Weight: .0000 g / 50 ml Acetone = .0000 g/ml Acetone Blank Residual Value

0-60 Minute Acetone Residue Value Calculation:

(.0000 g/ml Acetone)(60 ml Acetone) = .0000 g Residue Value

60 Minute Plus Acetone Residue Value Calculation:

(.0000 g/ml Acetone)(70 ml Acetone) = .0000 g Residue Value

Total Particulate Catch Calculations:	**0-60 Minute**	**60 Minute Plus**
Combined Filter Net Catch Weight:	-.0014 g	.0242 g
Acetone Wash Catch Weight:	.0071 g	.0133 g
Less Acetone Residual Value:	- .0000 g	- .0000 g
Equals Net Acetone Wash Catch:	.0071 g	.0133 g
Total Net Catch (Combined Filter + Acetone Catch):	.0057 g	.0375 g
	5.7 mg	37.5 mg

Total Train 1 Net Catch (0-60 Minute + 60 Minute Plus Catches): 43.2 mg

EPA 1 T 2 1.9.17

MYREN CONSULTING CERTIFICATION TEST DATA

DILUTION TUNNEL CALCULATIONS

4/15/10, Ms=28.78, Bws=2.0% 6"Tunnel

File Name:	EPA 1 T 2
Manufacturer:	509 FAB
Model Number:	OPTIMUM
Lab Name:	MYREN
Test Date:	1.9.17
Run Number:	EPA 1 T 2
Meter Box Y Factor:	0.9656
Barometric Pressure (in Hg):	28.179
Dry Gas Meter Temp(avg.)(F):	**67**
Delta H(Avg.)(in H2)):	**0.800**
Gas meter initial reading:	182.925
Gas meter final reading:	372.443
Total Particulate Catch(mg):	39.6
Sampling Flow Rate(cfm):	0.526
Tunnel Flow (Qsd) (dscfm)	**137.559**
Emission Rate(g/hr):	**1.805**
Emission Factor(g/kg)	**0.811**
Avg. of Delta P Sq. Roots:	**0.2000**
Vs (Avg.)(ft/min):	**809.451**
Tunnel Avg. Temperature (F):	**102.919**
Test time(min):	360
Fuel Load: (lbs. Dry):	29.4430
Wood moisture(%wet):	5.630
Burn rate(dry kg/hr):	**2.226**
Sample Volume (dscf)	**172.942**
Avg. Tunnel Static (-inch H2O):	**0.0000**
Room Blank Catch (mg/dscf):	0.010305
Total PM Emissions(Er))(g):	**10.8290**
Pitot Correction Factor:	0.95663
Front Filter Number:	363
Back Filter Number:	362
Beaker number:	58
PRELIMINARY RESULTS	
FINAL RESULTS:	AUDITED

DATA SUMMARY

MODEL:	OPTIMUM
RUN:	EPA 1 T 2
DATE:	1.9.17
DBR:	2.226
EMISSION RATE (g/hr)(unadj):	1.8048
EMISSION FACTOR (g/kg):	0.8108
AVG. % PROPORTIONALITY :	99.966

RUN TIME (min)	PITOT DELTAP (in H2O)	TNL TEMP (°F)	GAS METER RDG (ft3)	GAS METER TEMP (°F)	GAS METER DELTA H (in.H2O)	TUNNEL VELOCITY (ft/min)	PROP RATE (%)	dDGM vol std (ft3)	Tunnel Static (- Inch H2O)	SQUARE ROOT DELTA P	DRY GAS METER READING (M3)
0	0.040	102	182.925	53.0	0.800	808.79			0.000	0.20000	
10	0.040	104	188.199	57.0	0.800	809.51	105.0	4.926	0.000	0.20000	
20	0.040	107	193.399	58.0	0.800	811.30	102.8	4.833	0.000	0.20000	
30	0.040	107	198.631	59.5	0.800	812.38	103.0	4.851	0.000	0.20000	
40	0.040	107	203.854	61.5	0.800	812.38	102.1	4.826	0.000	0.20000	
50	0.040	105	209.113	62.5	0.800	811.66	102.1	4.846	0.000	0.20000	
60	0.040	105	214.367	63.0	0.800	810.95	101.6	4.834	0.000	0.20000	
70	0.040	106	219.598	64.5	0.800	811.30	100.9	4.804	0.000	0.20000	
80	0.040	106	224.829	64.5	0.800	811.66	100.6	4.797	0.000	0.20000	
90	0.040	106	230.077	66.0	0.800	811.66	100.7	4.806	0.000	0.20000	
100	0.040	106	235.363	66.0	0.800	811.66	101.1	4.834	0.000	0.20000	
110	0.040	106	240.605	66.0	0.800	811.66	100.3	4.793	0.000	0.20000	
120	0.040	106	245.888	66.0	0.800	811.66	101.0	4.831	0.000	0.20000	
130	0.040	105	251.166	67.0	0.800	811.30	100.7	4.822	0.000	0.20000	
140	0.040	107	256.420	67.0	0.800	811.66	100.1	4.795	0.000	0.20000	
150	0.040	107	261.636	67.0	0.800	812.38	99.5	4.761	0.000	0.20000	
160	0.040	108	266.899	68.0	0.800	812.74	100.2	4.799	0.000	0.20000	
170	0.040	107	272.177	68.0	0.800	812.74	100.3	4.808	0.000	0.20000	
180	0.040	106	277.469	69.0	0.800	812.02	100.3	4.816	0.000	0.20000	
190	0.040	100	282.748	69.0	0.800	809.51	99.4	4.800	0.000	0.20000	
200	0.040	99	288.039	69.0	0.800	806.99	99.3	4.811	0.000	0.20000	
210	0.040	99	293.329	69.0	0.800	806.63	99.4	4.810	0.000	0.20000	
220	0.040	100	298.611	69.5	0.800	806.99	99.2	4.800	0.000	0.20000	
230	0.040	102	303.883	69.0	0.800	808.07	99.2	4.791	0.000	0.20000	
240	0.040	103	309.178	70.0	0.800	809.15	99.7	4.810	0.000	0.20000	
250	0.040	103	314.430	70.0	0.800	809.51	98.7	4.766	0.000	0.20000	
260	0.040	102	319.687	70.5	0.800	809.15	98.6	4.769	0.000	0.20000	
270	0.040	102	324.950	71.0	0.800	808.79	98.5	4.769	0.000	0.20000	
280	0.040	101	330.211	71.0	0.800	808.43	98.3	4.765	0.000	0.20000	
290	0.040	100	335.485	71.0	0.800	807.71	98.5	4.777	0.000	0.20000	
300	0.040	98	340.750	71.5	0.800	806.63	98.0	4.767	0.000	0.20000	
310	0.040	98	346.019	71.5	0.800	805.91	98.0	4.768	0.000	0.20000	
320	0.040	97	351.298	71.5	0.800	805.55	98.1	4.777	0.000	0.20000	
330	0.040	97	356.571	71.5	0.800	805.18	98.0	4.772	0.000	0.20000	
340	0.040	98	361.863	71.5	0.800	805.55	98.4	4.789	0.000	0.20000	
350	0.040	98	367.152	71.0	0.800	805.91	98.5	4.789	0.000	0.20000	
360	0.040	98	372.443	71.0	0.800	805.91	98.6	4.793	0.000	0.20000	
370											
380											

T2

Method 5G Particulate Sampling Data

Unit: Optimum
Run: EPA 1
Date: 1 / 9 / 17
Page: 1 of 2 Rev 12/15

Meter Box 511-M Meter Y .9656 Filter #'s: (F) 363 (R) 362

.095 / .6975

Filter/O-Ring ID #: —

Pre Test Leak Check: .0025 CFM@ -22.25 in Hg Filter Size: Reg 110 mm

.492 /

Probe ID #: —

Post Test Leak Check: ______ CFM@ -13.0 in Hg Probe Length: 21.5 in glass

Time		Meter Reading (ft³)	Pitot		Tunnel Temp (°F)	Meter Temp (°F)	Gas Meter Δh	Vac (in Hg)
Clock	Elapsed		ΔP	Pg				
1120	00	182.925	.040	—	102	53	.80	-2.25
30	10	188.199	.040		104	57	.80	-2.25
40	20	193.399	.040		107	58	.80	-2.25
50	30	198.631	.040		107	59.5	.80	-2.25
1200	40	203.854	.040		107	61.5	.80	-2.25
10	50	209.113	.040		105	62.5	.80	-2.25
20	60	214.367	.040		105	63	.80	-2.25
30	70	219.598	.040		106	64.5	.80	-2.25
40	80	224.929	.040		106	64.5	.80	-2.25
50	90	230.077	.040		104	66	.80	-2.25
1300	100	235.363	.040		106	66	.80	-2.25
10	110	240.605	.040		106	66	.80	-2.25
20	120	245.888	.040		106	66	.80	-2.25
30	130	251.166	.040		105	67	.80	-2.25
40	140	256.420	.040		107	67	.80	-2.25
50	150	261.636	.040		107	67	.80	-2.25
1400	160	266.899	.040		108	68	.80	-2.25
10	170	272.177	.040		107	68	.80	-2.25
20	180	277.469	.040		106	69	.80	-2.25
30	190	282.748	.040		100	69	.80	-2.25

BP

00	28.17	300	28.20
60	28.16	360	28.20
120	28.16		
180	28.17		
240	28.19	Avg. = 28.1786 in Hg"	

Pre Test Filter Tare Weight Check
F ______
R 1.3409

End of Test Weight
F 1.3707 R ______

1.3411
296

T2

Method 5G Particulate Sampling Data

Unit: Optimum
Run: EPA 1
Date: 1/9/17
Page: 2 of 2 Rev 12/15

Meter Box 511-M Meter Y .9656 Filter #'s: (F) 363 (R) 362

.095/.0975

Filter/O-Ring ID #: —

Pre Test Leak Check: .0025 CFM@ -22.25 in Hg Filter Size: Reg 110 mm

.492/.492

Probe ID #: —

Post Test Leak Check: .000 CFM@ -13.0 in Hg Probe Length: 21.5 in glass

Time		Meter Reading [redacted](ft³)	Pitot		Tunnel Temp (°F)	Meter Temp (°F)	Gas Meter Δh	Vac (in Hg)
Clock	Elapsed		ΔP	Pg				
1440	200	288.039	.040		99	69	.80	-2.25
50	210	293.329	.040		99	69	.80	-2.25
1500	220	298.611	.040		100	69.5	.80	-2.25
10	230	303.883	.040		102	69	.80	-2.25
20	240	309.178	.040		103	70	.80	-2.25
30	250	314.430	.040		103	70	.80	-2.25
40	260	319.687	.040		102	70.5	.80	-2.25
50	270	324.950	.040		102	71	.80	-2.25
1600	280	330.211	.040		101	71	.80	-2.25
10	290	335.485	.040		100	71	.80	-2.25
20	300	340.750	.040		98	71.5	.80	-2.25
30	310	346.019	.040		98	71.5	.80	-2.25
40	320	351.298	.040		97	71.5	.80	-2.25
50	330	356.571	.040		97	71.5	.80	-2.25
1700	340	361.863	.040		98	71.5	.80	-2.25
10	350	367.152	.040		98	71	.80	-2.25
20	360	372.443	.040		98	71	.80	-2.25
	70							
	80							
	90							

BP

00	28.17	300	28.20
60	28.16	360	28.20
120	28.16		
180	28.17		
240	28.19		

Avg. = 28.1786 in Hg"

Pre Test Filter Tare Weight Check
F ________
R ________

End of Test Weight
F ________ R ________

Unit Optiv [illegible]
Run # EPA 1
Date: 1/9/17
WST5-Form 9, Pg 1, Rev 10/10

T2

Woodstove Data Sheet #4-3: Constant Final Weights

65 ml

Final Beaker Weights

Beaker	Into	Date	Time	By	First	Date	Time	By	Second	Date	Time	By	Third	Date	Time	By
58	70.0559	1/10	1005	ATM	70.0538	1/10	2011	Jm	70.0535	1/11	1541	ESS	70.0538	1/12	1257	ATM
					70.0527	1/16	1544	ESS	70.0526	1/20	1133	ATM				

Final Filter Weights

	Filter #	Into Dessic	Date	Time	By	First	Date	Time	By	Second	Date	Time	By	Third	Date	Time	By
F	362,363	1.3707	1/9	1815	ATM	1.3701	1/10	2021	Jm	1.3698	1/11	1543	ESS	1.3697	1/12	1324	ATM
						1.3693	1/16	1546	ESS	1.3697	1/20	1139	ATM	1.3697	1/22	0939	Jm
R																	

QA Reweigh: Final Weight

Date	Beaker #	Final Wt	By

Date	Filter #	Final Wt	By

Scale Room Environmental Conditions

Weighing Session	2017 Date	Time	By	WB	DB	%RH
1	1/10	1950	ATM	52	66	35
2	1/11	1539	ESS	46	60	30
3	1/12	1234	ATM	50	64	34
4	1/16	1531	ESS	50	65	32
5	1/20	1110	ATM	53	65	44
6	1/21	924	ATM	52	64	43
7						

Scale Room Environmental Conditions

8						
9						
10						
11						
12						

Comment

Train 2/ Room Blank Woodstove
Particulate Catch Processing Sheet
Woodstove Data Sheet #5
ASTM E 2515/ EPA M5G-1

T2

Unit: Optimum
Run: EPA 1 **Train** T2
Date: 1/9/17
Technicians: ATM
Revised 11/15 - Data Sheet #5A

Filters:

Filter # (Front): 362, 363 **Beaker #:** 58 **Final Wt.:** 70.0526 g

Tare Wt.: 1.3411 g **ml** 65 **Tare Wt.:** 70.0416 g

Filter # (Rear): ______ **Desiccant: Acetone** **Net Wt.:** .0110 g

Tare Wt.: ______ g **Beaker Tare Wt,. Check:** 70.0416 g

Combined Filter Final Weight: 1.3697 g

Combined Filter Tare Weight: 1.3411 g 28.6

Combined Net Catch Weight: .0286 g

Acetone Blank Calculation: **Blank Date:** 12/19/16 **Blank Beaker #:** 61 **Desiccant: 50 ml Acetone**

Final Wt.: 70.8352 g - **Tare Wt.:** 70.8353 g = **Net Catch Wt.:** -0.0001 = 0.0000 g

Net Catch Weight: .0000 g / **50 ml Acetone =** .0000 **g/ml Acetone Blank Residual Value**

Acetone Residue Value Calculation:

(.0000 g/ml Acetone)(65 ml Acetone) = .0000 g **Residue Value**

Total Particulate Catch Calculations:

Combined Filter Net Catch Weight: .0286 g

Acetone Wash Catch Weight: .0110 g

Less Acetone Residual Value: - .0000 g

Equals Net Acetone Wash Catch: .0110 g

Total Net Catch (Combined Filter + Acetone Catch): .0396 g

39.6 mg

EPA 1 T 3 1.9.17

ROOM BLANK SAMPLE FLOW PROPORTIONALITY

5/1/2008

MYREN CONSULTING CERTIFICATION TEST DATA

File Name:	EPA 1 T 3
Manufacturer:	509 FAB
Model Number:	OPTIMUM
Lab Name:	MYREN
Test Date:	1.9.17
Run Number:	EPA 1 T 3
Initial Meter Reading (cf):	11165.0004
Final Meter Reading (cf):	11353.8350
Test Time (Min):	360.0
Average Sample Rate (cfm):	0.5245
Preliminary Results:	
Final results:	AUDITED
BP:	28.1786
Average Δ_h:	0.120
Avg. Dry Gas Meter Temp (F):	66.9
Sample Volume (dscf):	174.665
Dry Gas Meter Y:	0.9802
Total Room Blank Catch (mg):	1.800
Room Blank mg/dscf	0.010305
Avg. Sampling Rate $\Delta_{\theta(\%)}$:	-1.241

RUN TIME (min)	GAS METER READING (Cu, Ft,)	INTERVAL SAMPLE VOLUME (Cu. Ft.)	SAMPLING RATE % DIFFERENCE	INTERVAL SAMPLING RATE (cfm)	DRY GAS METER READING (M3)	DRY GAS METER Δ_h	DRY GAS TEMP F
0	11165.0004				316.1576	0.120	53.5
10	11170.3117	5.3113	0.0000	0.53113	316.3080	0.120	57.0
20	11175.5665	5.2548	-1.0638	0.52548	316.4568	0.120	58.5
30	11180.8249	5.2584	-0.9973	0.52584	316.6057	0.120	60.0
40	11186.0620	5.2372	-1.3963	0.52372	316.7540	0.120	62.0
50	11191.3169	5.2548	-1.0638	0.52548	316.9028	0.120	63.0
60	11196.5823	5.2654	-0.8644	0.52654	317.0519	0.120	63.5
70	11201.8336	5.2513	-1.1303	0.52513	317.2006	0.120	65.5
80	11207.0849	5.2513	-1.1303	0.52513	317.3493	0.120	65.5
90	11212.6822	5.5974	5.3856	0.55974	317.5078	0.120	65.5
100	11217.5698	4.8875	-7.9787	0.48875	317.6462	0.120	66.5
110	11222.8281	5.2584	-0.9973	0.52584	317.7951	0.120	66.5
120	11228.0794	5.2513	-1.1303	0.52513	317.9438	0.120	66.5
130	11233.3413	5.2619	-0.9309	0.52619	318.0928	0.120	66.5
140	11238.5997	5.2584	-0.9973	0.52584	318.2417	0.120	67.0
150	11243.8615	5.2619	-0.9309	0.52619	318.3907	0.120	67.5
160	11249.1234	5.2619	-0.9309	0.52619	318.5397	0.120	67.5
170	11254.3853	5.2619	-0.9309	0.52619	318.6887	0.120	68.5
180	11259.6507	5.2654	-0.8644	0.52654	318.8378	0.120	68.5
190	11264.9091	5.2584	-0.9973	0.52584	318.9867	0.120	69.0
200	11270.1463	5.2372	-1.3963	0.52372	319.1350	0.120	68.5
210	11275.3975	5.2513	-1.1303	0.52513	319.2837	0.120	69.0
220	11280.6524	5.2548	-1.0638	0.52548	319.4325	0.120	69.5
230	11285.8966	5.2442	-1.2633	0.52442	319.5810	0.120	69.0
240	11291.1196	5.2230	-1.6622	0.52230	319.7289	0.120	69.5
250	11296.3391	5.2195	-1.7287	0.52195	319.8767	0.120	69.5
260	11301.5692	5.2301	-1.5293	0.52301	320.0248	0.120	70.5
270	11306.8064	5.2372	-1.3963	0.52372	320.1731	0.120	70.5
280	11312.0294	5.2230	-1.6622	0.52230	320.3210	0.120	70.5
290	11317.2560	5.2266	-1.5957	0.52266	320.4690	0.120	70.5
300	11322.4755	5.2195	-1.7287	0.52195	320.6168	0.120	70.5
310	11327.6986	5.2230	-1.6622	0.52230	320.7647	0.120	70.5
320	11332.9357	5.2372	-1.3963	0.52372	320.9130	0.120	70.0
330	11338.1552	5.2195	-1.7287	0.52195	321.0608	0.120	70.0
340	11343.3889	5.2336	-1.4628	0.52336	321.2090	0.120	70.0
350	11348.6084	5.2195	-1.7287	0.52195	321.3568	0.120	70.0
360	11353.8350	5.2266	-1.5957	0.52266	321.5048	0.120	70.0

T3

Method 5G Particulate Sampling Data

Unit: Optimum
Run: EPA 1
Date: 1/9/17
Page: 1 of 2 Rev 12/15

Meter Box Train 3 Meter Y .9902 Filter #'s: (F) 312 (R) —

.1470/.1472 = .0002 Filter/O-Ring ID #: —

Pre Test Leak Check: .07 CFM@ -18.75 in Hg Filter Size: Reg 110 mm

.5063/.5064 = .0001 cmm z Probe ID #: —

Post Test Leak Check: .0035 CFM@ -11.8 in Hg Probe Length: — in N/A

Time		Meter Reading (m^3)	Pitot		Tunnel Temp (°F)	Meter Temp (°F)	Gas Meter Δh	Vac (in Hg)
Clock	Elapsed		ΔP	Pg				
1120	00	316.1576	—	—	—	53.5	.120	-1.5
30	10	316.3080				57	.120	-2.0
40	20	316.4568				58.5	.120	-2.0
50	30	316.6057				60	.120	-2.0
1200	40	316.7540				62	.120	-2.0
10	50	316.9028				63	.120	-2.0
20	60	317.0519				63.5	.120	-2.0
30	70	317.2006				65.5	.120	-2.0
40	80	317.3493				65.5	.120	-2.0
50	90	317.5078				65.5	.120	-2.0
1300	100	317.6462				66.5	.120	-2.0
10	110	317.7951				66.5	.120	-2.0
20	120	317.9438				66.5	.120	-2.0
30	130	318.0928				66.5	.120	-2.0
40	140	318.2417				67	.120	-2.0
50	150	318.3907				67.5	.120	-2.0
1400	160	318.5397				67.5	.120	-2.0
10	170	318.6887				68.5	.120	-2.0
20	180	318.8378				68.5	.120	-2.0
30	190	318.9867				69	.120	-2.0

BP

00	28.17	300	28.20
60	28.16	360	28.20
120	28.16		
180	28.17		
240	28.19		

Avg. = 28.1786 in Hg"

Pre Test Filter Tare Weight Check
F
R .6286

End of Test Weight
F .6282 R

.6285
-.0003

T3

Method 5G Particulate Sampling Data

Unit: Optimum
Run: EPA 1
Date: 1/9/17
Page: 2 of 2 Rev 12/15

Meter Box: Train 3 Meter Y: .9802 Filter #'s: (F) 312 (R) —

.1470/.1472 = .0002 =

Filter/O-Ring ID #: —

Pre Test Leak Check: .0071 CFM@ -18.75 in Hg Filter Size: Reg 110 mm

.5063/.5064 .0001 cm

Probe ID #: —

Post Test Leak Check: .0035 CFM@ -11.8 in Hg Probe Length: — in N/A

Time		Meter Reading (m^3)	Pitot		Tunnel Temp (°F)	Meter Temp (°F)	Gas Meter Δh	Vac (in Hg)
Clock	Elapsed		ΔP	Pg				
1440	200	319.1350				68.5	.120	-2.0
50	210	319.2837				69	.120	-2.0
1500	220	319.4325				69.5	.120	-2.0
10	230	319.5810				69	.120	-2.0
20	(240)	319.7289				69.5	.120	-2.0
30	250	319.8767				69.5	.120	-2.0
40	260	320.0248				70.5	.120	-2.0
50	270	320.1731				70.5	.120	-2.0
1600	280	320.3210				70.5	.120	-2.0
10	290	320.4690				70.5	.120	-2.0
20	(300)	320.6168				70.5	.120	-2.0
30	310	320.7647				70.5	.120	-2.0
40	320	320.9130				70	.120	-2.0
50	330	321.0608				70	.120	-2.0
1700	340	321.2090				70	.120	-2.0
10	350	321.3568				70	.120	-2.0
20	(360)	321.5048				70	.120	-2.0
	70							
	80							
	90							

BP

00	28.17	300	28.20
60	28.16	360	28.20
120	28.16		
180	28.17		
240	28.19		

Avg. = 28.1786 in Hg"

Pre Test Filter Tare Weight Check
F
R .6286

End of Test Weight
F .6282 R
.6285
- .0003

Unit Opti, Jm
Run # EPR 1
Date: 1/9/17
WST5-Form 9, Pg 1, Rev 10/10

Woodstove Data Sheet #4-3: Constant Final Weights

T3

40 ml

Final Beaker Weights

Beaker	Into	Date	Time	By	First	Date	Time	By	Second	Date	Time	By	Third	Date	Time	By
55	67.2920	1/10	2007	ATM	67.2839	1/11	1602	ESS	67.2844	1/12	1303	ATM	67.2835	1/16	1548	ESS
					67.2836 ✓	1/20	1123	ATM								

Final Filter Weights

	Filter #	Into Dessic	Date	Time	By	First	Date	Time	By	Second	Date	Time	By	Third	Date	Time	By
F	312	.6282	1/10	1010	ATM	.6276	1/10	2030	Jm	.6266	1/11	1605	ESS	.6265	1/12	1347	ATM
						.6263 ✓	1/16	1549	ESS								
R																	

QA Reweigh: Final Weight

Date	Beaker #	Final Wt	By

Date	Filter #	Final Wt	By

Scale Room Environmental Conditions

Weighing Session	2017 Date	Time	By	WB	DB	%RH
1	1/10	1950	ATM	52	66	55
2	1/11	1539	ESS	46	60	30
3	1/12	1234	ATM	50	64	34
4	1/16	1531	ESS	50	65	32
5	1/20	1110	ATM	53	65	44
6						
7						

Scale Room Environmental Conditions

Weighing Session						
8						
9						
10						
11						
12						

Comment: Tare = 67.2796

Train 2/ Room Blank Woodstove
Particulate Catch Processing Sheet
Woodstove Data Sheet #5
ASTM E 2515/ EPA M5G-1

T3

Unit: Optimum
Run: EPA 1 Train T3
Date: 1/9/17
Technicians: ATM LSS
Revised 11/15 - Data Sheet #5A

Filters:

Filter # (Front): 312 Beaker #: 55 Final Wt.: 67.2836 g

Tare Wt.: .6285 g ml 40 Tare Wt.: 67.2796 g

Filter # (Rear): ______ Desiccant: Acetone Net Wt.: .0040 g

Tare Wt.: ______ g Beaker Tare Wt. Check: 67.2794 g

Combined Filter Final Weight: .6263 g

Combined Filter Tare Weight: .6285 g

Combined Net Catch Weight: -.0022 g

Acetone Blank Calculation: Blank Date: 12/19/16 Blank Beaker #: 61 Desiccant: 50 ml Acetone

Final Wt.: 70.8352 g - Tare Wt.: 70.8353 g = Net Catch Wt.: -0.0001 ≈ 0.0000 g

Net Catch Weight: .0000 g / 50 ml Acetone = .0000 g/ml Acetone Blank Residual Value

Acetone Residue Value Calculation:

(.0000 g/ml Acetone)(40 ml Acetone) = .0000 g Residue Value

Total Particulate Catch Calculations:

Combined Filter Net Catch Weight: -.0022 g

Acetone Wash Catch Weight: .0040 g

Less Acetone Residual Value: -.0000 g

Equals Net Acetone Wash Catch: .0040 g

Total Net Catch (Combined Filter + Acetone Catch): .0018 g

1.8 mg

From: 11/5/16
Through:

Woodstove Data Sheet 4-4 Scale QC Record Sheet
Scale 2

Scale: Sartorius
Model: CPA 2245
SN: 24850860
Rev: 5/10

Level	Recali-brated	100g Weight	10g Weight	1g Weight	100mg Weight	10mg Weight	DATE	TIME	TECH	BP	LINE VOLTS	WET BULB	DRY BULB	% RH
Yes	No	99.9992	9.9999	1.0000	0.1000	0.0100	11/22/16	848	ATM	28.53	121	54	66	45
Yes	No	99.9992	9.9999	1.0000	0.1000	0.0100	11/23/16	1740	ATM	28.44	120	53	64	47
Yes	No	99.9993	10.0000	1.0000	0.1000	0.0100	11/24/16	1005	ATM	28.52	120	53	64	47
Yes	No	99.9993	9.9999	0.9999	0.1000	0.0099	11/25/16	740	ATM	28.32	118	52	63	46
Yes	No	99.9992	9.9999	1.0000	0.1000	0.0100	11/26/16	833	ATM	28.22	121	54	65	48
Yes	No	99.9992	9.9999	1.0000	0.1000	0.0100	11/27/16	1413	ATM	28.11	119	51	63	42
Yes	No	99.9992	9.9999	1.0000	0.1000	0.0100	12/29/16	1125	ATM	28.63	119	54	68	39
Yes	No	99.9992	9.9999	1.0000	0.1000	0.0100	12/30/16	1207	ATM	28.56	121	49	61	40
Yes	Yes	99.9992	9.9999	0.9999	0.0999	0.0100	1/1/17	1441	ATM	28.28	120	53	65	44
Yes	NO	99.9992	9.9999	1.0000	0.0999	0.0100	1/3/17	1200	ESS	28.71	121	50	65	31
Yes	No	99.9993	9.9999	1.0000	0.0999	0.0100	1/4/17	1246	ATM	28.71	118	48	61	32
Yes	No	99.9993	9.9999	1.0000	0.1000	0.0100	1/5/17	1654	ATM	28.63	120	51	66	32
Yes	No	99.9992	9.9999	1.0000	0.1000	0.0100	1/6/17	1930	ATM	28.62	121	50	64	34
Yes	No	99.9993	9.9999	1.0000	0.0999	0.0100	1/7/17	1007	ATM	28.65	120	49	63	33
Yes	No	99.9992	9.9999	1.0000	0.1000	0.0100	1/8/17	1903	ATM	28.18	120	50	64	34
Yes	No	99.9991	9.9999	1.0000	0.1000	0.0099	1/9/17	936	ESS	28.19	119	50	64	34
Yes	No	99.9992	9.9999	0.9999	0.0999	0.0100	1/10/17	1053	ATM	28.24	120	53	65	44
Yes	No	99.9993	9.9999	1.0000	0.1000	0.0100	1/10/17	1950	ATM	28.25	120	52	66	35
Yes	Yes	99.9992	9.9999	1.0001	0.1000	0.0099	1/11/17	1539	ESS	28.38	119	46	60	30
Yes	Yes	99.9992	9.9999	1.0000	0.1000	0.0100	1/12/17	1234	ATM	28.66	121	50	64	34
Yes	NO	99.9993	9.9999	1.0000	0.1000	0.0100	1/16/17	1531	ESS	28.69	119	50	65	32
Yes	No	99.9992	9.9999	.9999	0.1000	0.0100	1/20/17	1110	ATM	27.74	118	53	65	44
Yes	No	99.9993	9.9999	1.0000	0.1000	0.0100	1/22/17	924	ATM	28.72	120	[illegible]	64	43

From: 9/16/16
Through: 11/4/16

Woodstove Data Sheet 4-4 Scale QC Record Sheet
Scale 2

Scale: Sartorius
Model: CPA 2245
SN: 24850860
Rev: 5/10

Level	Recali-brated	100g Weight	10g Weight	1g Weight	100mg Weight	10mg Weight	2016 DATE	TIME	TECH	BP	LINE VOLTS	WET BULB	DRY BULB	% RH
Yes	No	99.9992	10.0000	1.0000	.1000	.0100	9/16	2145	ATM	28.	119	60	72	48
Yes	No	99.9992	10.0000	1.0000	.1000	.0100	9/17	1417	ATM	28.30	116	58	70	48
Yes	No	99.9991	9.9999	1.0000	.1000	.0101	9/18	1200	ATM	28.43	118	54	67	41
Yes	No	99.9992	9.9999	.9999	.1000	.0100	9/19	1048	ATM	28.50	120	56	67	49
Yes	No	99.9992	9.9999	1.0000	.1000	.0100	9/19	2220	ATM	28.53	120	53	65	44
Yes	NO	99.9991	9.9999	1.0000	0.1000	.0100	9/28	1413	ESS	28.44	120	54	65	47
Yes	NO	99.9990	9.9999	1.0000	0.1000	0.0099	9/30	1457	ESS	28.33	118	60	72	48
Yes	No	99.9993	10.0000	1.0000	0.1000	0.0100	10/2	910	ATM	28.49	120	53	64	47
Yes	No	99.9992	9.9999	1.0000	0.1000	0.0100	10/3	929	ATM	28.35	120	52	63	46
Yes	No	99.9992	9.9999	1.0000	0.1000	0.0100	10/8	1915	ATM	28.32	120	56	67	49
Yes	No	99.9993	10.0000	1.0000	0.1000	0.0100	10/9	1057	ATM	28.49	120	56	68	46
Yes	No	99.9992	10.0000	0.9999	0.1000	0.0099	10/15	1002	ATM	28.19	120	56	67	49
Yes	No	99.9992	9.9999	1.0000	0.1000	0.0101	10/17	1523	ATM	28.22	120	55	66	48
Yes	No	99.9992	10.0000	0.9999	0.1000	0.0100	10/18	1938	ATM	28.55	120	56	68	46
Yes	No	99.9992	9.9999	1.0000	0.1000	0.0100	10/19	1548	ATM	28.72	119	57	69	46
Yes	Yes	QC Services Here - Post Visit Weight ✓					10/20	1640	ATM	28.43	120	—	—	—
Yes	Yes	99.9992	9.9999	1.0000	0.1000	0.0100	10/20	1705	ATM	28.43	120			—
Yes	Yes	99.9993	9.9999	1.0000	0.1000	0.0100	10/22	1846	ATM	28.46	119	56	67	49
Yes	No	99.9993	10.0000	1.0000	0.1000	0.0100	10/23	1400	ATM	28.48	120	56	67	49
Yes	No	99.9993	9.9999	1.0000	0.1000	0.0100	10/24	1742	ATM	28.28	119	58	70	48
Yes	No	99.9992	9.9999	1.0000	0.1000	0.0100	10/25	1712	ATM	28.49	119	58	70	48
Yes	No	99.9992	10.0000	1.0000	0.1000	0.0100	10/26	1444	ATM	28.42	119	55	66	48
Yes	NO	99.9992	10.0000	1.0000	0.1000	0.0100	11/1	1132	ESS	28.35	120	57	69	46
Yes	No	99.9991	9.9999	1.0000	0.1000	0.0100	11/2	1803	ATM	28.43	119	57	69	46
Yes	No	99.9992	9.9999	0.9999	0.0999	0.0100	11/3	1028	ATM	28.58	120	58	70	48
Yes	Yes	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

From: 7/17/2016

Through: 9/15/2016

Woodstove Data Sheet 4-4 Scale QC Record Sheet
Scale 2

Scale: Sartorius
Model: CPA 2245
SN: 24850860
Rev: 7.15

Level	Recali-brated	100g Weight	10g Weight	1g Weight	100mg Weight	10mg Weight	(2016) DATE	TIME	TECH	BP	LINE VOLTS	WET BULB	DRY BULB	% RH
Yes	No	99.9993	10.0000	1.0000	.1000	.0100	7/17	1600	ATM	28.51	119	54	65	48
Yes	Yes	99.9992	9.9999	1.0000	.1000	.0100	7/18	1757	ATM	28.49	118	56	67	49
Yes	No	99.9992	9.9999	.9999	.0999	.0100	7/19	1506	ATM	28.48	117	58	71	45
Yes	No	99.9993	[illegible]	0.9999	.0999	.0100	7/20	1110	ATM	28.50	119	57	69	46
Yes	Yes	99.9993	10.0000	1.0000	0.0999	.0100	7/21	836	ATM	28.59	119	55	66	48
Yes	Yes	99.9991	9.9999	1.0000	0.1000	.0100	7/23	1200	ATM	28.59	120	56	68	46
Yes	No	99.9992	9.9999	1.0000	0.1000	.0100	7/24	734	ATM	28.58	118	58	70	48
Yes	NO	99.9991	10.0000	0.9999	0.1000	0.0100	7/25	1324	ESS	28.42	118	56	68	46
Yes	No	99.9992	9.9999	0.9999	0.1001	0.0101	8/2	1345	ESS	28.33	117	55	66	48
Yes	No	99.9991	9.9999	1.0000	0.1000	0.0100	8/4	1344	ATM	28.47	116	56	67	49
Yes	No	99.9991	9.9999	1.0000	0.1000	0.0101	8/6	1117	ATM	28.40	120	56	67	49
Yes	No	99.9991	9.9999	1.0000	0.1000	0.0100	8/7	1100	ATM	28.37	121	54	65	48
Yes	NO	99.9992	10.0000	0.9999	0.1000	0.0101	8/9	1045	ESS	28.42	120	53	64	47
Yes	No	99.9992	9.9999	0.9999	0.1000	0.0101	8/14	1618	ATM	28.34	120	56	67	49
Yes	No	99.9993	9.9999	1.0000	0.1000	0.0100	8/17	1336	ATM	28.40	117	58	70	48
Yes	No	99.9993	9.9999	1.0000	0.1000	0.0100	8/18	1244	ATM	28.45	119	54	65	48
Yes	No	99.9992	9.9999	0.9999	0.1000	0.0100	8/19	1652	ATM	28.49	117	58	70	48
Yes	No	99.9992	9.9999	1.0000	0.1000	0.0100	8/24	851	ATM	28.47	120	55	67	45
Yes	No	99.9992	9.9999	0.9999	0.1000	0.0100	8/31	545	ATM	28.42	119	58	70	48
Yes	No	99.9993	9.9999	0.9999	0.1000	0.0100	9/3	1036	ATM	28.46	118	54	65	48
Yes	No	99.9992	10.0000	0.9999	0.1000	0.0100	9/4	0730	ATM	28.42	120	54	66	45
Yes	No	99.9992	9.9999	1.0000	0.1000	0.0100	9/7	1721	ATM	28.40	118	57	69	46
Yes	No	99.9992	9.9999	1.0000	0.1000	0.0100	9/8	612	ATM	28.50	118	58	70	48
Yes	No	99.9993	10.0000	1.0000	0.1000	0.0100	9/13	554	ATM	28.61	120	53	64	47
Yes	No	99.9992	9.9999	1.0000	0.1000	0.0100	9/15	2058	ATM	28.47	120	54	65	48

Unit: Optimum
Run # EPA 1
Date: 1/9/17
Technician: ATM, ESS
WST6-Form1, Rev 6/11

Miscellaneous Test Data
Woodstove Data Sheet #8

Useable Firebox Dimensions: See QC Section Useable Volume: N/A ft³

Dilution Tunnel Draft (If Applicable): Start: .000 Stop: .000 Avg: .000 in. H_2O

Test Chamber Air Velocity: Start: >0, <5 Stop: >0, <5 Avg: >0, <5.0 ft./m.

Wet Bulb/ Start: WB: 49 °F DB: 60 °F % Amb Moisture: 0.80 %RH: 43.5

Dry Bulb Stop: WB: 54 °F DB: 69 °F % Amb Moisture: 0.90 %RH: 37.0

$\bar{X}$ Ambient Moisture(%Vol.) = 0.85 % $\bar{X}$ Relative Humidty (%RH) = 40.25%

Empty Stove Wt: 522.6 w/o C Gas Probe lbs. 523.2 w/ C Gas Probe

Empty Stove Wt with Stack (inc oil seal) Wet: 494.1 lbs. Dry: — lbs.

Empty Stove Wt with Stack and Ash Ash: ____ lbs. Total: ____ lbs.

Kindling Wt. Paper: ____ lbs. Wood: ____ lbs. Total: ____ lbs.

Pre Burn Fuel Wt. ____ Total: ____ lbs.

Total Kindling and Pre Burn Fuel Wt. ____ lbs.

Coal Bed Wt.: Range(____ - ____) ____ lbs. Actual: ____ lbs.

Allowable Amount of Charcoal That Can Be Removed:

Coal Bed Wt. Range (____ + ____ /2) .25 = ____ lbs.
Upper Wt. Lower Wt.

Test Fuel Wt.: Ideal ____ lbs. Range: ____ lbs. Actual: ____ lbs.

Test Fuel Size (pcs.) (.75 x 1.5 x 5" Spacers): ____ Pcs. ____ lbs.

2 x 4's x ____ " ____ Pcs. ____ lbs. ____ %

4 x 4's x ____ " ____ Pcs. ____ lbs. ____ %

13.3555 dkg

Est. Dry Burn Rate(Kg/Hr.) $\frac{31.2 - (31.2 \times .0563)}{2.2046} \times \frac{60}{360}$ = 2.2259 Dry Burn Rate (Kg/Hr)

Est EPA Heat Output (HO_E)(Avg BTU's/Hr)(19,140) X $\frac{2.2259 \times .78}{100}$ = 33,231 EPA Heat Output (HO_E)BTU's/Hr

From Pellet Stove

OPERATION OF THE OPTIMUM DENSIFIED FUEL LOG STOVE.

The Optimum was operated according to the manufacturer's written instructions. (See the second page in the Manual Section.) While the primary air control (PAC) was adjusted for each test segment as per the written instructions, the adjustments had little impact on the dry burn rate (DBR).

COMMENT:

As noted in the cover letter to Dr Sanchez in the front of this report, this unit is the first unit that burns densified fuel logs to be EPA certification tested and that it combines features found in both wood and pellet stoves, making the unit an "outside of the box" hybrid". That in and of itself creates some issues for those conducting the tests because the unit is batch, gravity fed with a combustion air fan that has only 1 speed.

What follows is basically a repeat of the information provided under Note 1 on the first page in the Data Summary Section that is titled

WOOD BURNING HEATERS UNIT:509 OPTIMUM Densified Fuel Log Stove

Test Method 28R for Certification and Auditing of Wood Heaters

SUMMARY RESULTS-DENSIFIED FUEL LOG HEATERS

There are no test runs in Dry Burn Rate (BDR) Categories 1 (<0.80 kg/h) and 2 (0.80-1.25 kg/h) because the unit's dry burn rate is controlled by its primary air control and combustion air fan, the density and size (diameter) of the fuel logs themselves, the amount of fuel remaining in the feed tube at any given time and how the fuel logs "settle" in the feed tube. The logs are gravity fed and logs can "warp" due to heat and moisture content and hang up in the feed tube which slows the DBR. The weight of the logs left in the feed tube affects the feed rate because the weight pressing down from above is what causes the burning end of a log to disintegrate into smaller pieces, i.e., the more weight, the faster the disintegration, which allows more unburnt fuel to drop into the combustion chamber. The DBR data reflects this operating scenario. When the "High" burn test segment was started, the unit had been burning for a little over 75 minutes (~15 minutes for ignition and 60 minutes for Preburn). A fuel log was added at approximately 5 minutes into preburn, so at the end of the

"High" burn segment there was enough room in the feed tube to add 2 logs (15.2 lbs.). The DBR for the 60 minute "High" burn segment was 2.319 kg/h with a partially full fee tube. The DBR for the 120 minute "Medium" burn segment was which was started with a full feed tube was 2.899 kg/h. Even though the Primary Air Control (PAC) setting had been reduced from the "High" to the "Medium" setting, the DBR increased. That clearly shows how the amount of fuel in the feed tube can impact the DBR and that the amount of primary air being pulled through the unit really does not impact the DBR. The unit burned 13.5 lbs. in the 120 minute "Medium" burn test segment. At the end of the Medium burn segment, the PAC was adjusted to the Low burn setting and 1 fuel log (8 lbs.) was added at 20 minutes into the "Low" burn test segment. The DBR immediately increased due to the extra weight in the feed tube and then slowed as the amount of fuel in the feed tube decreased. (See Data Sheet #14, pages 4 of 7 and 5 of 7.) Additional fuel (3.4 lbs, approximately ½ a log, was added at 312 minutes because the DBR had dropped down to 0.1 lb./ 5 minutes and we were worried that the fire might go out. Again, as soon as fuel was added the DBR increased, but the increase in the burn rate was not as great as when 2 logs were added, again showing how the amount of fuel in the feed tube impacts the burn rate. (See Data Sheet #14, page 6 of 7.) The wild swings in combustion gas (CO_2, O_2 and CO) concentrations also confirm that the amount of fuel in the feed tube is what really controls how this stove performs. See Data Sheet #14, p4 of 7, at 205 and 210 minutes and look at the DBR and CO_2 and CO concentrations. At 205 minutes the DBR was 0.1 lb and the CO_2 and CO concentrations were 11.21 and 0.71% respectively. At 210 minutes the DBR was 0.6 lbs. and the CO_2 and CO concentrations were 11.76 and 0.85% respectively. Huge change in burn rate, but no change in gas concentrations, due to no change in fan speed. In both instances, the unit was burning the crumbled up portions of a fuel log. The only difference was in the amount of crumbled up fuel log that was available for combustion. Dropping a new fuel log into the feed tube caused the bottom of the burning fuel log to really crumble. When fuel is added the CO_2 and CO concentrations initially doesn't change much. Yet later at 215 minutes when there is still a substantial amount of crumbled up fuel log burning plus some new unburnt fuel now available for combustion, the CO went up because now there was not enough O_2 present in the right location for clean combustion. You do not see these kind of wild swings in DBR or gas concentrations in a typical pellet stove because the controls simultaneously and automatically adjust both the combustion fan speed and the feed rate.

So this unit is really a Single Burn Rate Appliance (SBR) with a burn rate that varies due to the amount of fuel remaining in the feed tube. Adjusting the PAC really has little or no affect on the burn rate because the unit uses a combustion air fan to pull the combustion air through the unit and closing the PAC creates a smaller orifice, but the fan just pulls the air through the orifice faster. Unlike most pellet stoves where the speed of the combustion air fan is reduced as the fuel feed rate is reduced, the combustion air fan speed on the Optimum remains the same no mater where the PAC is set.

Wood Density Determination
Woodstove Test Data Sheet #11

Unit: Optimum
Run#: EPA 1
Date: 1/9/17
Technician: ATM

Rev 5/10

Wood Piece: Nominal Dimensions: ______ X ______ X ______

Depth (D): ______ cm

Width (W): ______ cm

Length(L): ______ cm

______ cm Length $\overline{X}$ = ______ cm

______ cm

______ cm Volume: ______ cm^3

(D x W x L)

Room Temperature: ______ °F Correction Factor: ______

Meter Readings Corrected for temperature: Yes ______ No ______

Note: Record Moisture Meter readings to the nearest 0.5% or 0.1%

	Uncor	Cor	Avg % Moisture (Dry) ______ %
Top:		%	
Bottom:		%	Avg % Moisture (Wet) ______ %
Side:		%	Scale: Leveled In ______ Out ______
$\overline{X}$:		%	Zeroed: In ______ Out ______

Wet Weight: ______ g Dry Weight: ______ g

% Moisture Dried Basis: ______ %

([1 – (Dry Wt/Wet Wt)] X 100)

Density = ______ g/ ______ cm^3 = ______ g/cm^3

(dry wt) (volume)

dried crumbled up, chopped up pcs of a test fuel log.

	Date	Time	Temp	
Into Dryer	1/9/17	1200	147	°F
Out of Dryer	1/19/17	1430	146	°F

(Minimum Time in Dryer: 24 hrs.)

Pellet Fuel Moisture Content Determintation

Tare Beaker Wt. 15.7 g

Log ~~Pellet~~ Name: N. Idaho Energy Log

Log ~~Pellet~~ Manufacturer: N. Idaho Energy

Pellet Grade: N/A

Wet Wt: [illegible] g - 15.7 g = 204.3 g

Gross Wet Wt. Tare Beaker Wt. Net Wet Wt.

Dry Wt: 208.5 g - 15.7 g = 192.8 g

Gross Dry Wt. Tare Beaker Wt. Net Dry Wt.

% Moisture Wet Basis: 5.629 %

[1 – (Net Dry Wt./Net Wet Wt.)] X 100

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MYREN CONSULTING, INC.
ASTM E2779 Densified Fuel Heater Eqns
Forms/ Densified Fuel Stoves/ Eqns.
Rev 6. 4.20.17 P. 1 of 2

Unit: Optimum
Run #: EPA 1
Date: 1/9/17
Tech: A.T. Myren

ASTM E2779 EQN 1: Kilograms/ Pounds of dry fuel burnt, db (Revised)

Note: EQN 1 assumes that no fuel will be added to the unit while it is being tested. That was not possible with the Optimum because of the unit's dry burn rate, i.e., the stove will run out of fuel and go out if one does not add fuel to the unit sometime during the 6 hour integrated test. So the M_{Bbd} (the dry mass of the fuel burnt) equals the total of the pounds of fuel burnt during each 5 minute sampling interval, in this case 31.2 lbs. , minus the moisture content, in this case 5.629%

M_{Bdb} = (31.2)(100)/(100 + FM)

FM = average fuel moisture content of test fuel, % wet basis, 5.629%

M_{Bdb} = weight of the fuel burned during the test run, dry basis, kg(lb).

M_{Bdb} = (31.2 lbs)(100)/(100+5.629) = 29.5373 lbs / 2.2046 lbs/ kg = 13.398 kg

ASTM EQN2: Kilograms/ Pounds of Dry Fuel Burnt During a Test Segment (S_1), db

Note: Again, do to the way this stove burns and the need to add fuel at some point (or points) during a test run, so the M_{Bbdi} (the dry mass of the fuel burnt during each sampling interval) equals the total of the pounds of fuel burnt during each 5 minute sampling interval for each test segment minus the moisture content, in this case 5.629%

M_{BSidb} = (M_{SSiwb} – M_{SESiwb})(100)/(100+FM) (Revised)

***i* = test run segment in Accordance with 9.4 Table 1.**

Test Segment 1: 0-60 minutes:
M_{BS1db} =(5.4 lbs.)(100)/(100+.5629) = 5.112 lbs/ 2.2046 lbs/kg = 2.319 kg
Test Segment 2: 60-180 minutes:
M_{BS2db} =(13.5 lbs.)(100)/(100+5.629) = 12.781 lbs/ 2.2046 lbs/kg = 5.797 kg
Test Segment 3: 180-360 minutes:
M_{BS3db} = (12.3 lbs.)(100)/(100+5.629) = 11.645 lbs/ 2.2046 lbs/kg = 5.282 kg

MYREN CONSULTING, INC.
ASTM E2779 Densified Fuel Heater Eqns
Forms/ Densified Fuel Stoves/ Eqns.
Rev 6 4.20.17 P. 2 of 2

Unit: Optimum
Run #: EPA, 1
Date: 1/9/18
Tech: A. T. Myren

ASTM EQN 3: Average Dry Burn Rate BR (DBR)

BR (DBR) = (60(M_{Bdb}))/θ

BR (DBR) = Average dry burn rate over the full integrated test run, kg/h (lb/h), and
Θ = total length of full integrated test run, min.

BR (DBR) = (60(13.398 **kg)/** 360 **=** 2.233 **kg/h** ✓

ASTM EQN 4: Average Dry Burn Rate (DBR) over a Test Segment *i*, kg/h(lb/h)

BR $(DBR)_{Si}$ = (60(M_{Bidb}))/θ

BR $(DBR)_{Si}$ = Average dry burn rate over test run segment *i*, kg/h (lb/h), and
$Θ_{Si}$ = total length of test segment *i*, min.

Test Segment 1: 0-60 minutes
BR $(DBR)_{S1}$ = (60(2.319 **kg)/** 60 **=** 2.319 **kg/h** ✓
Test Segment 2: 60-180 minutes
BR $(DBR)_{S2}$ = (60(5.797 **kg)/** 120 **=** 2.8985 **kg/h** ✓
Test Segment 3 : 180-360 minutes
BR $(DBR)_{S3}$ = (60(5.282 **kg)/** 180 **=** 1.7607 **kg/h** ✓

Preburn Start Wt. — Lbs. Up — lbs.
Test Start Wt Range — lbs.
Baro. Pressure 28.18 "Hg

Pre Burn Data
Record Sheet #13

Unit: Optimum Date: 1/9/17
Run: EPA 1 Technician(s): ATM, ESS
Page: 1 of 1 WST2-Form 16, Rev 6/11

Hot Box On ✓

Minute	⏱	Scale Weight	Burn Rate	Stack (T/C# 1)	Stove Top (2)	Left Side (3)	Back (4)	Right Side (5)	Bottom (6)	Firebox (7)	2nd Burn Catalytic (8)	Room Temp (9)	Static	Stack @ 1' (20)	Comments
0	1020	526.7	0.0	263								61	-.047	301	Primary Air Set At ON HI
5	25	534.2	*.5	264	Added 7.8 lbs @ 4 mins. into							61	-.048	301	Secondary Air Set At N/A
10	30	533.8	.4	269	preburn							61	-.048	307	Fan: On
15	35	533.0	.8	276								61	-.049	318	Tunnel on at: 1041
20	40	532.4	.6	286								61	-.050	332	Buckets Iced ✓
25	45	531.9	.5	292								61	-.051	340	Analyzers Spanned ✓
30	50	531.6	.3	296								62	-.052	345	Pumps Turned on at: 1110
35	55	530.9	.7	302								62	-.053	352	ΔT ΔΔT
40	1100	530.4	.5	307								62	-.054	359	
45	05	529.9	.5	311								62	-.054	364	
50	10	529.4	.5	316								62	-.054	370	
55	15	528.7	.7	322								62	-.055	379	Tunnel ΔP
X	X	—		—		—			—		—		—	X	Probe In Tunnel —
60	1120	528.2	.5	327								62	-.056	382	
65															
70															
75															*Added Log 526.4 - 534.2 = 7.8 lbs
80															
85															
90															
95															
100															
105															
110															
115															

Myren Consulting Inc Data Sheet #14 P 1 **of** 7 **Unit** Optimum **Date** 1 / 9 / 17 **Run** EPA 1

Test End Wt. 523.7 **ΔT** N/A **Barometric Pressure** 28.17 **"Hg Gas Flow @ 1.5" Technician(s)** ATM, ESS

	Time E/T Min	Time ⏲	Scale WT.	Lbs. Left	Burn Rate	CO_2 V.	CO_2 %	O_2 %	CO V.	CO %	Gas Bal	Stack Temp #1	Stack Static Pressure	Opacity	T3 Cond #18	Stack C1 #20	Gas Train VAC
5.4	0	1120	528.2	31.2	0.0	.434	10.89	10.00	.11	.11	99.0	327	-.056		50	382	-10.2
4.8	05	25	527.6	30.6	.6	.508	12.72	8.00	.43	.43	29.6	336	-.057	C	40	396	-10.5
4.1	10	30	526.9	29.9	.7	.464	11.63	9.09	.43	.43	27.0	340	-.057	"	39	401	-10.5
3.6	15	35	526.4	29.4	.5	.435	10.91	9.97	.11	.11	99.2	342	-.057	"	38	403	-10.5
3.0	20	40	525.8	28.8	.6	.417	10.46	10.43	.09	.09	116.3	342	-.057	"	38	402	-10.5
2.5	25	45	525.3	28.3	.5	.395	9.92	10.98	.08	.08	123.9	342	-.056	"	38	401	-10.5
[illegible]	30	50	524.7	27.7	.6	.389	9.77	11.12	.10	.10	97.7	341	-.056	"	38	400	-10.5
3	35	55	524.1	27.1	.6	.427	10.71	10.14	.17	.17	63.0	340	-.055	"	38	399	-10.5
1.0	40	1200	523.8	26.8	.3	.368	9.24	11.64	.12	.12	77.0	338	-.055	"	38	398	-10.5
.7	45	05	523.5	26.5	.3	.358	9.00	11.84	.20	.20	45.0	336	-.054	"	38	395	-10.5
[illegible]	50	10	523.2	26.2	.3	.271	6.83	13.93	.36	.36	19.0	332	-.054	"	38	389	-10.5
.2	55	15	523.0	26.0	.2	.275	6.93	13.73	.55	.55	12.6	326	-.053	"	38	381	-10.5
	Total											4047	-.667				

Time E/T Min	Time ⏲	Top #2	Left #3	Back #4	Right #5	Bottom #6	Firebox #7	Fr. 2nd #8	Amb #9	Tnl. #10	C Gas Box #11	C Gas Impin #12	T1 Part. Filt. #13	T1 Part. Cond. #14	T2 Part. Filter #15	T2 Part. Cond. #16	T3 Part. Filter #17
0	1120								62	102	226	30	76	47	74	52	70
05	25								64	105	220	31	77	36	74	43	70
10	30								65	104	219	30	78	37	75	42	71
15	35								65	106	219	30	78	38	78	41	72
20	40								66	107	220	31	79	38	79	40	73
25	45								67	108	221	31	79	38	80	40	74
30	50								68	107	222	31	80	38	81	40	75
35	55								68	106	223	32	80	38	81	40	77
40	1200								69	107	224	32	80	38	81	41	78
45	05								70	107	224	32	80	38	82	40	79
50	10								71	105	223	32	80	37	82	40	79
55	15								70	105	223	32	80	37	82	40	79
Total									805								

0

Myren Consulting Inc Data Sheet #14 P 2 of 7 Unit Optimum Date 1/9/17 Run EPA 1

Test End Wt. 523.7 ΔT N/A Barometric Pressure 28.16 "Hg Gas Flow @ 1.5" Technician(s) ATM, ESS

Time E/T Min	Time ⏱	Scale Wt. 522.8	Lbs. Left	Burn Rate	CO_2 V.	CO_2 %	O_2 %	CO V.	CO %	Gas Bal	Stack Temp #1	Stack Static Pressure	Opacity	Turned to MED. Slapper T/F.	T3 Cond. #18	Stack @1' #20	Gas Train Vac
60	1220	538.1	25.8	—	.240	6.06	14.39	.98	.98	(6.2)	321	-.051	C *	Added Fuel	38	374	-10.1
65	25	537.6	25.3	.5	.566	14.17	6.39	.87	.87	(16.3)	318	-.054	"	2 Logs. 522.9-538.1	38	373	-11.0
70	30	537.0	24.7	.6	.506	12.67	8.24	.06	.06	211.2	320	-.054	"	15.2 lbs.	38	374	-11.0
75	35	536.4	24.1	.6	.455	11.41	9.51	.05	.05	228.1	320	-.054	"	@61 mins	38	375	-11.0
80	40	535.7	23.4	.7	.428	10.74	10.04	.33	.33	32.5	321	-.054	"		38	377	-11.0
85	45	535.1	22.8	.6	.383	9.62	11.28	.08	.08	120.2	322	-.054	"		38	378	-11.0
90	50	534.5	22.2	.6	.381	9.57	11.32	.10	.10	95.7	323	-.054	"		38	378	-11.0
95	55	533.9	21.6	.6	.395	9.92	10.98	.08	.08	123.9	322	-.054	"		38	377	-11.0
100	1300	533.2	20.9	.7	.473	11.85	9.02	.13	.13	91.2	321	-.054	"		38	377	-11.0
105	05	532.7	20.4	.5	.453	11.36	9.49	.18	.18	63.1	322	-.055	"		38	378	-11.0
110	10	532.2	19.9	.5	.436	10.94	9.95	.10	.10	109.4	323	-.054	"		38	380	-11.0
115	15	531.7	19.4	.5	.389	9.77	11.12	.11	.11	88.8	323	-.055	"		38	379	-11.0
Total											(3856)	(-.647)					

Time E/T Min	Time ⏱	Top #2	Left #3	Back #4	Right #5	Bottom #6	Firebox #7	Fr. 2nd #8	Amb #9	Tnl. #10	C Gas Box #11	C Gas Impin #12	T1 Part. Filt. #13	T1 Part. Cond. #14	T2 Part. Filter #15	T2 Part. Cond. #16	T3 Part. Filter #17
60	1220								70	105	222	32	81	37	82	40	79
65	25								71	106	222	33	79	37	82	40	79
70	30								73	106	221	33	78	39	82	41	80
75	35								73	106	221	33	78	39	82	41	80
80	40								73	106	221	32	77	39	82	41	81
85	45								73	106	221	32	77	39	82	41	81
90	50								74	106	222	32	77	39	83	41	81
95	55								74	105	222	33	78	39	83	41	81
100	1300								74	106	222	33	78	39	82	41	81
105	05								74	106	223	33	78	39	82	41	81
110	10								74	106	224	33	78	39	82	41	80
115	15								74	106	224	33	78	39	82	41	80
Total									(877)								

Myren Consulting Inc Data Sheet #14 P 3 of 7 Unit Optimum Date 1/9/17 Run EPA 1

Test End Wt. 523.7 **ΔT** N/A **Barometric Pressure** 28.16 **"Hg Gas Flow @ 1.5" Technician(s)** ATM, ESS

Time		Scale	Lbs.	Burn	CO_2	CO_2	O_2	CO	CO	Gas	Stack		Opacity	T3 Cond. #18	~~Notes~~ stack @ 1' #20	GAS TRAIN VAC
E/T Min	⏲	WT.	Left	Rate	V.	%	%	V.	%	Bal	Temp #1	Static Pressure				
120	1320	531.1	18.8	.6	.415	10.41	10.45	.16	.16	65.1	323	-.054	C	38	379	-11.0
125	25	530.6	18.3	.5	.438	10.98	9.44	1.03	1.03	10.7	323	-.054	"	38	381	-11.0
130	30	530.0	17.7	.6	.443	11.11	9.72	.22	.22	50.5	325	-.055	W	38	383	-11.0
135	35	529.3	17.0	.7	.547	13.69	6.82	.85	.85	16.1	327	-.054	wisps-C	38	388	-11.0
140	40	528.6	16.3	.7	.508	12.72	7.79	.86	.86	14.8	331	-.055	C	38	392	-11.0
145	45	528.1	15.8	.5	.435	10.91	9.90	.25	.25	43.6	334	-.056	"	38	396	-11.0
150	50	527.6	15.3	.5	.479	12.00	8.34	1.20	1.20	10.0	337	-.055	"	38	400	-11.0
155	55	527.0	14.7	.6	.428	10.74	10.08	.25	.25	42.9	338	-.055	wisps	38	402	-11.5
160	1400	526.6	14.3	.4	.417	10.46	10.19	.57	.57	18.4	339	-.056	C	38	404	-11.5
165	05	526.1	13.8	.5	.381	10.19	10.69	.12	.12	84.9	339	-.056	"	38	402	-11.5
170	10	525.5	13.2	.6	.403	10.11	10.77	.11	.11	92.0	338	-.056	"	38	400	-11.5
175	15	524.8	12.5	.7	.319	8.03	12.85	.13	.13	61.7	335	-.056	"	38	395	-11.5
Total											3989	-.662				

Time		Top	Left	Back	Right	Bottom	Firebox	Fr. 2nd	Amb	Tnl.	C Gas Box	C Gas Impin	T1 Part. Filt.	T1 Part. Cond.	T2 Part. Filter	T2 Part. Cond.	T3 Part. Filter
E/T Min	⏲	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14	#15	#16	#17
120	1320								74	106	224	33	78	39	82	42	80
125	25								74	106	224	33	78	39	82	42	81
130	30								74	105	225	33	78	39	82	42	81
135	35								74	107	225	33	78	39	82	42	81
140	40								74	107	226	33	78	40	82	42	81
145	45								74	107	227	33	78	40	82	42	81
150	50								74	107	227	33	78	39	82	42	81
155	55								73	107	228	33	78	39	82	42	81
160	1400								74	108	228	33	78	39	82	42	81
165	05								73	107	229	33	78	39	82	42	81
170	10								73	107	229	33	78	39	82	42	81
175	15								73	106	228	33	78	39	82	42	81
Total									884								

Myren Consulting Inc Data Sheet #14 P 4 **of** 7 **Unit** Optimum **Date** 1 / 9 / 17 **Run** EPA1

Test End Wt. 523.7 **ΔT** N/A **Barometric Pressure** 28.17 **"Hg Gas Flow @ 1.5" Technician(s)** ATM, ESS

Time E/T Min	Time ⌚	Scale WT.	Lbs. Left	Burn Rate	CO_2 V.	CO_2 %	O_2 %	CO V.	CO %	Gas Bal	Stack Temp #1	Stack Static Pressure	Opacity	Turned (~~Notes~~)	T3 Cond. #18	Stack @1' #20	GAS TRAIN VAC
180	1420	524.6	12.3	.2	.232	5.86	15.00	.15	.15	39.1	329	-.055	C	To Low	38	386	-11.5
185	25	524.4	12.1	.2	.287	7.23	13.57	.28	.28	25.8	311	-.051	"		38	365	-11.5
190	30	524.2	11.9	.2	.389	9.77	11.11	.12	.12	81.4	300	-.049	"		38	354	-11.5
195	35	524.0	11.7	.2	.307	7.73	13.07	.28	.28	27.6	291	-.049	"		38	344	-11.1
200	40	531.8	11.5 *	.2	.178	4.52	16.14	.56	.56	(8.1)	283	-.048	"	*ADDED COAL 524.0-532.0	38	335	-11.1
205	45	531.7	11.4	.1	.447	11.21	9.38	.71	.71	(15.8)	282	-.048	"	8 lbs.	38	333	-11.5
210	50	531.1	10.8	.6	.469	11.76	8.76	.85	.85	13.8	279	-.046	W	@200 mins	38	330	-11.5
215	55	530.8	10.5	.3	.452	11.33	9.06	1.10	1.10	10.3	280	-.046	C		38	331	-11.5
220	1500	530.2	9.9	.6	.486	12.18	7.59	2.34	2.34	(5.2)	282	-.049	L		38	335	-12.0
225	05	529.7	9.4	.5	.524	13.12	6.61	2.42	2.42	5.4	287	-.049	L-W		39	340	-12.0
230	10	529.2	8.9	.5	.432	10.84	9.50	1.20	1.20	9.0	289	-.049	C		39	343	-12.0
235	15	528.7	8.4	.5	.425	10.66	10.23	.10	.10	106.6	289	-.049	"		39	343	
Total											(3502)	(-.588)					

Time E/T Min	Time ⌚	Top #2	Left #3	Back #4	Right #5	Bottom #6	Firebox #7	Fr. 2nd #8	Amb #9	Tnl. #10	C Gas Box #11	C Gas Impin #12	T1 Part. Filt. #13	T1 Part. Cond. #14	T2 Part. Filter #15	T2 Part. Cond. #16	T3 Part. Filter #17
180	1420	|	|	|	|	|	|	|	73	106	228	33	78	39	82	42	81
185	25	|	|	|	|	|	|	|	73	102	227	33	78	39	81	42	81
190	30	|	|	|	|	|	|	|	73	100	226	34	78	39	81	42	81
195	35	|	|	|	|	|	|	|	73	99	224	34	78	39	81	42	81
200	40	|	|	|	|	|	|	|	73	99	223	33	78	38	80	41	80
205	45	|	|	|	|	|	|	|	73	98	222	34	78	38	80	42	80
210	50	|	|	|	|	|	|	|	74	99	221	34	78	39	80	42	80
215	55	|	|	|	|	|	|	|	74	99	220	34	78	39	80	42	80
220	1500	|	|	|	|	|	|	|	73	100	220	34	78	39	81	42	81
225	05	|	|	|	|	|	|	|	74	101	220	34	78	39	81	42	81
230	10	|	|	|	|	|			74	102	221	34	78	40	81	42	81
235	15								74	102	222	34	79	40	82	42	82
Total									(881)								

Myren Consulting Inc Data Sheet #14 P 5 of 7 Unit Optimum Date 1/9/17 Run EPA 1

Test End Wt. 523.7 ΔT N/A Barometric Pressure 28.19 "Hg Gas Flow @ 1.5" Technician(s) ATM, ESS

Time E/T Min	Time ⏱	Scale WT.	Lbs. Left	Burn Rate	CO_2 V.	CO_2 %	O_2 %	CO V.	CO %	Gas Bal	Stack Temp #1	Stack Static Pressure	Opacity	T3 Cond. #18	~~Notes~~ Stack Cl #20	GAS TRAIN VAC
240	1520	528.3	8.0	.4	.493	12.35	7.77	1.64	1.64	7.5	291	-.049	wisps	39	347	-12.5
245	25	527.6	7.3	.7	.491	12.30	8.54	.20	.20	61.5	294	-.050	ow	39	349	-12.5
250	30	527.1	6.8	.5	.433	10.86	9.93	.29	.29	37.4	295	-.050	C	39	351	-12.5
255	35	526.7	6.4	.4	.353	8.87	12.02	.10	.10	88.7	295	-.050	"	39	350	-13.0
260	40	526.2	5.9	.5	.339	8.52	12.36	.12	.12	71.0	293	-.050	"	39	348	-12.5
265	45	525.9	5.6	.3	.312	7.85	13.01	.15	.15	52.4	290	-.049	"	39	344	-12.5
270	50	525.5	5.2	.4	.296	7.46	13.40	.16	.16	46.6	287	-.049	"	39	338	-12.5
275	55	525.1	4.8	.4	.276	6.96	13.89	.19	.19	36.6	283	-.048	"	39	333	-12.5
280	1600	524.8	4.5	.3	.256	6.46	14.38	.19	.19	34.0	278	-.047	"	40	326	-12.5
285	05	524.6	4.3	.2	.305	7.68	13.16	.21	.21	36.6	273	-.046	"	39	321	-12.5
290	10	524.3	4.0	.3	.280	7.06	13.77	.22	.22	32.1	269	-.045	"	39	316	-12.5
295	15	524.0	3.7	.3	.411	10.31	10.41	.43	.43	24.0	267	-.045	"	39	313	-12.5
Total											3415	-.578				

Time E/T Min	Time ⏱	Top #2	Left #3	Back #4	Right #5	Bottom #6	Firebox #7	Fr. 2nd #8	Amb #9	Tnl. #10	C Gas Box #11	C Gas Impin #12	T1 Part. Filt. #13	T1 Part. Cond. #14	T2 Part. Filter #15	T2 Part. Cond. #16	T3 Part. Filter #17
240	1520								75	103	223	34	79	40	82	43	82
245	25								74	103	225	34	79	40	83	43	83
250	30								74	103	226	34	79	40	83	43	83
255	35								75	103	228	33	79	40	83	43	83
260	40								75	102	228	33	80	40	83	43	83
265	45								75	102	228	34	80	40	83	43	83
270	50								74	102	228	34	80	40	83	43	83
275	55								75	101	228	34	79	40	83	43	83
280	1600								74	101	227	34	79	40	83	43	82
285	05								74	100	227	34	79	39	82	43	82
290	10								74	100	226	34	79	39	82	43	82
295	15								74	99	225	34	78	39	82	43	82
Total									893								

Myren Consulting Inc Data Sheet #14 P. 6 of 7 Unit Optimum **Date** 1/9/17 **Run** EPA 1

Test End Wt. 523.7 **ΔT** N/A **Barometric Pressure** 28.20 **"Hg Gas Flow @ 1.5" Technician(s)** ATM, ESS

Time E/T Min	Time ⏱	Scale WT.	Lbs. Left	Burn Rate	CO_2 V.	CO_2 %	O_2 %	CO V.	CO %	Gas Bal	Stack Temp #1	Stack Static Pressure	Opacity	T3 Cond. #18	~~Notes~~ Stack e1	Gas Train VAC
300	1620	523.8	3.5	.2	.379	9.52	11.33	.19	.19	50.1	265	-.045	C	39	311	-12.5
305	25	523.7	3.4	.1	.299	7.53	13.22	.38	.38	19.8	263	-.044	"	39	310	-12.5
310	30	523.6	3.3	.1	.227	5.71	14.90	.59	.59	(9.7)	261	-.044	"	39	308	-12.5
315	35	526.7	3.0	* .3	.378	9.49	11.34	.22	.22	(43.2)	262	-.045	" *	Added Fuel 523.6 39	309	-12.5
320	40	526.2	2.5	.5	.323	8.13	12.68	.26	.26	31.3	261	-.045	"	527.0 3.4 lbs. 39	306	-12.5
325	45	525.8	2.1	.4	.399	10.02	10.74	.37	.37	27.1	259	-.045	"	@312 mins 39	304	-12.5
330	50	525.4	1.7	.4	.366	9.20	11.38	.73	.73	12.6	259	-.045	"	39	304	-13.0
335	55	525.2	1.5	.2	.409	10.26	10.52	.31	.31	33.1	260	-.045	"	39	305	-13.0
340	1700	524.9	1.2	.3	.397	9.97	10.90	.14	.14	71.2	261	-.045	"	39	307	-13.0
345	05	524.6	.9	.3	.308	7.75	13.13	.11	.11	70.5	262	-.045	"	39	308	-13.0
350	10	524.1	.4	.5	.259	6.36	14.33	.14	.14	46.7	262	-.045	"	39	308	-13.0
355	15	523.8	.1	.3	.218	5.52	15.33	.18	.18	30.6	260	-.045	"	39	305	-13.0
Total											(3135)	(-.538)				

Time E/T Min	Time ⏱	Top #2	Left #3	Back #4	Right #5	Bottom #6	Firebox #7	Fr. 2nd #8	Amb #9	Tnl. #10	C Gas Box #11	C Gas Impin #12	T1 Part. Filt. #13	T1 Part. Cond. #14	T2 Part. Filter #15	T2 Part. Cond. #16	T3 Part. Filter #17
300	1620								74	98	224	34	78	39	81	42	81
305	25								73	98	224	34	78	39	81	42	81
310	30								73	98	224	34	78	39	81	42	81
315	35								73	98	223	34	78	39	81	42	81
320	40								73	97	222	34	77	39	80	42	81
325	45								73	97	222	34	77	39	80	42	80
330	50								72	97	222	34	77	40	80	43	80
335	55								73	97	222	34	77	40	80	43	80
340	1700								73	98	221	34	77	40	80	43	80
345	05								73	97	222	34	77	40	80	43	80
350	10								73	98	222	34	77	40	80	43	80
355	15								73	97	222	34	77	39	80	42	80
Total									(876)								

Myren Consulting Inc Data Sheet #14 P 7 of 7 Unit Optimum Date 1/9/17 Run EPA1

Test End Wt. 523.7 **ΔT** N/A **Barometric Pressure** 28.20 **"Hg Gas Flow @ 1.5" Technician(s)** ATM, ESS

Time E/T Min	Time	Scale WT.	Lbs. Left	Burn Rate	CO_2 V.	CO_2 %	O_2 %	CO V.	CO %	Gas Bal	Stack Temp #1	Stack Static Pressure	Opacity	T3 Cond. #18	~~Notes~~ Stack @ #20	GAS TRAIN VAC
360	1720	523.7	0	.1	.168	4.27	16.55	.23	.23	18.6	256	-.045		39	299	-12.5
365											(22195)	(3.725)	Total			
370											(304.0)	(-.0510)	÷73			
375																
380																
385																
390																
395																
400																
405																
410																
415																
Total																

Time E/T Min	Time	Top #2	Left #3	Back #4	Right #5	Bottom #6	Firebox #7	Fr. 2nd #8	Amb #9	Tnl. #10	C Gas Box #11	C Gas Impin #12	T1 Part. Filt. #13	T1 Part. Cond. #14	T2 Part. Filter #15	T2 Part. Cond. #16	T3 Part. Filter #17
360	1720								73	97	222	34	77	39	80	42	80
365									(5289)		Total						
370									(72.5)		÷73						
375																	
380																	
385																	
390																	
395																	
400																	
405																	
410																	
415																	
Total																	

Pre and Post Test Zero/Span Check
Woodstove Data Sheet # 15-1

Site: Myren Consulting, Colville, WA Date: 1/9/17 Analyte: CO_2

Source: Optimum Run #: EPA 1

Zero Cyl #: DOT 3AA 2265 Conc. 00.0 % CO_2 Cyl Press: 1810 psi

Certified By: OXARC Date: 2/25/16

Span Cyl #: EB-0041761 Conc. 12.45 % CO_2 Cyl Press: 1000 psi

Certified By: Liquid Technology Corp. Date: 4/15/15

Analyzer: Make: Horiba Model: PIR-2000 SN: 607024

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

Flow: 1.5 SCFH Measured By: Rotameter: X Flowmeter: ______

EPA Span Values= 25.0% CO_2

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

Pre Run Audit: By: [signature] Time: 1032 Temp: 60 °F

Audit Results

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
Zero	00.0	00.0	00.0	00.0	.000	.09822	+0.09822	+0.39
Span	49.8	.498	12.45	49.0	.498	12.4761	+0.02607	+0.21

Comments:

Post Run Audit: By: [signature] Time: 1749 Temp: 73 °F

Audit Results

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
Zero	00.0	00.0	00.0	00.0	.003	.17279	+0.17279	+0.69
Span	49.8	.498	12.45	50.2	.515	12.8986	+0.4486	+3.60

Comments:

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

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

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

Pre and Post Test Zero/Span Check
Woodstove Data Sheet # 15-3

Site: Myren Consulting, Inc. Lab, Colville, WA **Date:** 1/9/17 **Analyte:** CO

Source: Optimum **Run #:** EPA 1

Zero Cyl #: DOT 3AA2265 **Conc.** 00.0 % CO **Cyl Press:** 1810 psi

Certified By: OXARC **Date:** 2/25/16

Span Cyl #: EB-0041761 **Conc.** 2.61 % CO **Cyl Press:** 1000 psi

Certified By: Liquid Technology Corp **Date:** 4/15/15

Analyzer: Make: California Analytical Instruments **Model:** 200 **SN:** 1M12002

Range: 0 – 10.0 % CO **Analyzer Output:** 0 – 10.0 v.

Flow: 1.5 scfh **Measured By: Rotameter:** X **Flowmeter:** ______

EPA Span Values = 0 - 5.0 % CO or 0 - 10.0 % CO
EPA Control Limits = ± 2.5% of 5.0 % CO = ± 0.125 % CO, ± 2.5% of 10.0 % CO = ± 0.250 % CO

Pre Run Audit: By: SSB **Time:** 1033 **Temp:** 60 °F

Pre Test Audit Results

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
Zero	00.0	.000	00.0	0.00	0.00	.00566	+.00566	+0.11
Span	2.61	2.61	2.61	2.63	2.61	2.5758	-0.0342	-1.31

Comments:

Post Run Audit: By: SSB **Time:** 1749 **Temp:** 73 °F

Post Test Audit Results

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
Zero	00.0	.000	00.0	0.07	0.08	.0844	+0.0844	+1.69
Span	2.61	2.61	2.61	2.62	2.61	2.5758	-0.0342	-1.31

Comments:

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

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

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

Quality Checks
Woodstove Data Sheet #16

Unit: Optimum
Run: EPA 1
Date: 1/9/17
Technicians: ATM, ESS
WS DS 16, Rev 1/12

Thermocouple Check (at ambient): T/C # 1: 265 °F; T/C # 2: — °F

T/C # 3: — °F; T/C # 4: — °F; T/C # 5: — °F;

T/C # 6: — °F; T/C # 7: — °F; T/C # 8: — °F;

T/C # 9: 61 °F; T/C # 10: 69 °F; T/C # 11: 74 °F;

T/C # 12: 30 °F; T/C # 13: 69 °F; T/C # 14: 50 °F;

T/C # 15: 74 °F; T/C # 16: 52 °F; T/C # 17: 69 °F;

T/C # 18: 51 °F; T/C # 19: — °F; T/C # 20: 303 °F;

T/C # 21: — °F; T/C # 22: — °F; T/C # 23: — °F;

T/C # 24: — °F; T/C # 25: — °F; T/C # 26: — °F;

Comments: Stove was running when T/C Check was done.

Thermocouple Readout: Pretest Zero/Span Check and Calibration:

Zero (0°F): -1 °F Adj to: — °F Post Test Check Zero (0°F): 0 °F %Difference 0

Span (2000°F): 2001 °F Adj to: — °F Span (2000°F): 2004 °F +0.04

(Allowable % Difference [Δ%] = 1.5%. Δ% = [(Actual Response-Expected Response)/Expected Response]. Δ% calculated in degrees absolute (°A). [°A= °F + 460])

Thermocouple Readout Pretest Linearity Check

0°F = -1 °F; 200°F = 200 °F; 400°F = 398 °F

600°F = 601 °F; 800°F = 801 °F; 1000°F = 1000 °F

1200°F = 1199 °F; 1400°F = 1400 °F; 1600°F = 1601 °F

1800°F = 1801 °F; 2000°F = 2001 °F

Combustion Gas (CO_2, O_2, CO) Train Leak Check: Pre OK ✓ ESS Post OK ✓ ESS

Draft (Static) Gauge Level/ Zero Check: Pre OK ✓ ESS

Post OK ✓ ESS

Scale Check Pre (Wt, #'s): 532.5 - 527.5 = 5.0 lbs. / 5.0 lbs. OK ✓ ESS

Post (Wt, #'s): 528.3 - 523.3 = 5.0 lbs. / 5.0 lbs. OK ✓ ESS

Stack Cleaned Prior to the Run: Yes____ No ✓

Tunnel Cleaned Prior to the Run: Yes____ No ✓

Becherini Scale Center, Inc.
317 E. Sprague
Spokane, WA 99202

SCALE CALIBRATION RECORD

Customer: MYREN
Date: 3/30/16
Work Order Number: 49901
PO Number:

Equipment Mfg.	Serial Number	Specifications	Weight used	Initial Readings	Final Readings
1. PANTHER	4466459	1000 x .1	Ø	Ø	Ø
	(Pass)..Fail		50	49.9	50.0
Notes: Square - Calibrated Cinder Block = 27.1 Lbs			100	99.9	100.0
			200	199.9	200.0
			300	299.9	300.0
			Ø	Ø	Ø

Equipment Mfg.	Serial Number	Specifications	Weight used	Initial Readings	Final Readings
2. PANTHER	0015555 6CA	5K x 1	Ø		
	Pass...Fail		50		
Notes: Did not Check			100		
			300		
			650		
			Ø		

Equipment Mfg.	Serial Number	Specifications	Weight used	Initial Readings	Final Readings
3. PANTHER	00025736AJ	1000 x .1	Ø	Ø	
	(Pass)..Fail		50	50.0	
Notes: South			100	100.0	
			200	200.0	
			300	300.0	
			Ø	Ø	

Equipment Mfg.	Serial Number	Specifications	Weight used	Initial Readings	Final Readings
4. PANTHER	00926516KL	1000 x .1	Ø	Ø	Ø
	(Pass)..Fail		50	50.0	50.0
Notes: Center Calibrated			100	99.9	100.0
			200	199.9	200.0
			300	299.8	300.0
			Ø	Ø	Ø

Additional Comments:

Last Checked: 9/15
Next Check Due: 9/16
Weights Certified: 10/14
Technician:

Calibration checked IAW NIST handbook 44

Becherini Scale Center, Inc.
317 E. Sprague
Spokane, WA 99202

SCALE CALIBRATION RECORD

Customer: MYREN	Date: 3/30/16
Work Order Number: 48901	PO Number:

Equipment Mfg.	Serial Number	Specifications	Weight used	Initial Readings	Final Readings
1. SARTORIUS	25359106	15K x .5	Φ	Φ	
CISL1-4	(Pass) ...Fail		50	50.0	
Notes:			100	100.0	
			500	500.0	
			1000	1000.0	
			Φ	Φ	

Equipment Mfg.	Serial Number	Specifications	Weight used	Initial Readings	Final Readings
2. OHAUS	2350003	24 x .002	Φ	Φ	Φ
RANGER	(Pass) ...Fail		4	4.000	4.000
Notes: Calibrated			10	10.000	10.000
			20	19.998	20.000
			24	23.998	24.000
			Φ	Φ	Φ

Equipment Mfg.	Serial Number	Specifications	Weight used	Initial Readings	Final Readings
3.					
	Pass...Fail	Did not check			
Notes:					

Equipment Mfg.	Serial Number	Specifications	Weight used	Initial Readings	Final Readings
4.					
	Pass...Fail				
Notes:					

Additional Comments:

Last Checked: 9/15	Next Check Due: 9/16
Weights Certified: 10/14	Technician: TCC/DM

Calibration checked IAW NIST handbook 44.

DENSITY STANDARD USED FOR TROEMNER PRECISION WEIGHTS

Troemner Inc. adjusts all new weights and all weights received for recalibration on the basis of apparent mass versus material of density 8.0g/cm³ at 20°C. This action is in accordance with the recommendations of the American Society for Testing and Materials specification ANSI/ASTM E 617 and the International Organization of Legal Metrology (OIML) International Recommendation No. 20.

Previously, all weights had usually been adjusted on the basis of apparent mass versus "brass," a hypothetic material of defined density 8.4g/cm³ at 0°C and 8.3909g/cm³ at 20°C. This practice originated in the early 1800's and was adopted in all of the English speaking countries as well as a number of other countries. Now most mass standards and test weights are made from stainless steel (density ranges from 7.77g/cm³ to 8.0g/cm³). A number of countries have adopted the recommendations of OIML and the foremost balance manufacturers are adjusting the built-in weights in their balances on the basis of apparent mass versus 8.0g/cm³. In order to smooth the transition in this country, the Reports of Calibration of the National Bureau of Standards are reporting the corrections to calibrated mass standards on both bases.

In terms of normal weighing procedures the change is very small. For a given weight, the mass value assigned on the basis of apparent mass versus density 8.0g/cm³ material will be 7 parts per million higher than the value assigned on the basis of apparent mass versus "density 8.4g/cm³" material. In many cases the allowed weight adjustment tolerances are so large that this change is immaterial although closely adjusted weights often have a smaller tolerance than the correction change. For example at the 1 kilogram level the change is 7 mg. For comparison the ANSI/ASTM E 617 Class 6 tolerance for 1 kilogram is 100 mg while the Class 1 tolerance is 2.5 mg. A detailed discussion of mass and mass values is given in Reference 3.

Precision Weights manufactured by Troemner Inc. to ASTM Class 1, 1.1, 2, 3, 4, 5, and 6 tolerances and the equivalent OIML and NBS tolerances are of the following materials:

Designation	*Base Material*	*Density*	*Weight Range*
Stainless Steel	18-8	7.84g/cm³ at 20°C	1 g & larger
Stainless Steel	18-8	8.0g/cm³ at 20°C	50 mg to 500 mg
Aluminum	1100	2.7g/cm³ at 20°C	30 mg & smaller

References:

1. ANSI/ASTM E 617
   Available from: Troemner Inc. 6825 Greenway Ave., Phila. Pa. 19142
   215-724-0800 or American Society for Testing and Materials, 1916 Race Street, Phila., Pa. 19103

2. OIML INTERNATIONAL RECOMMENDATION No. 20
   Available from: Organisation Internationale De Metrologie Legale
   11 Rue Trugot - 75009 Paris, France

3. NBS MONOGRAPH 133, MASS AND MASS VALUES
   Available from: Superintendent of Documents, U.S. Government Printing Office
   Washington, D.C. 20402
   Order by SD Catalog No. C13,44:1331 Stock Number 0303-01178

TROEMNER INC.

Manufacturers of Precision Weights...
Mass Standards • Balances • Laboratory Apparatus
6825 Greenway Avenue - Philadelphia, Pa. 19142
215/724-0800

Wts. used for Scale QC Checks, P. 4-4.

QUALITY CONTROL SERVICES

Established 1974

LABORATORY EQUIPMENT • SALES • SERVICE • CALIBRATION • REPAIRS
2340 SE 11TH Ave. Portland, Oregon 97214 • Box 14831 Portland, Oregon 97293
(503) 236-2712 • FAX (503) 235-2535 • www.qc-services.com

ACCREDITED
Calibration Services
Certificate Number: 1550.01
Laboratory code: 115953

Myren Consulting
512 Williams Lake Road
Colville, WA 99114

Report Number: MYRC0224850860161020

A2LA ACCREDITED
CERTIFICATE OF CALIBRATION WITH DATA

INSTRUMENT INFORMATION

Item	Make	Model	Serial Number	Customer ID	Location
Balance	Sartorius	CPA224S	24850860	N/A	Lab
Units	**Readability**	**SOP**	**Cal Date**	**Last Cal Date**	**Cal Due Date**
g	0.0001	QC012	10/20/16	4/13/16	4/2017

FUNCTIONAL CHECKS

ECCENTRICITY
Test Wt: 100 Tol: 0.0003
As-Found: Pass: ☑ Fail: ☐
As-Left: Pass: ☑ Fail: ☐

LINEARITY
Test Wt: 50 x 4 Tol: 0.0002
As-Found: Pass: ☑ Fail: ☐
As-Left: Pass: ☑ Fail: ☐

STANDARD DEVIATION
Test Wt: 100 Tol: 0.0001

1. 100.0000	5. 100.0000	9. 100.0000
2. 100.0000	6. 100.0000	10. 100.0000
3. 99.9999	7. 99.9999	**Result**
4. 100.0000	8. 100.0000	0.00004

ENVIRONMENTAL CONDITIONS
☐ Good ☑ Fair ☐ Poor
Temperature: 19.8°C

A2LA ACCREDITED SECTION OF REPORT

Standard	As-Found	As-Left	Expanded Uncertainty
200	199.9997	200.0000	0.00014
100	99.9998	100.0000	0.00014
50	49.9999	49.9999	0.00014
10	10.0000	9.9999	0.00014
1	1.0000	1.0000	0.00014
0.1	0.1000	0.1000	0.00014

CALIBRATION STANDARDS

Item	Make	Model	Serial Number	Cal Date	Cal Due Date	NIST ID
Weight Set	Rice Lake	30 kg-1mg	S751	1/4/16	1/2017	20160003

Permanent Information Concerning this Equipment:

Comments/Info Concerning this Calibration:

Report prepared/reviewed by: [signature] **Date:** 10-2016

Technician: R. Hintz
Signature: [signature]

THIS CERTIFICATE SHALL NOT BE REPRODUCED WITHOUT THE APPROVAL OF QUALITY CONTROL SERVICES, INC.

The uncertainty is calculated according to the ISO Guide to the Expression of Uncertainty in Measurement and includes the uncertainty of standards used combined with the observed standard deviation and readability of the unit under test. The uncertainty is expanded with a k factor of 2 for an approximate 95% level of confidence. Instruments listed above were calibrated using standards traceable to the National Institute of Standards and Technology (NIST). Calibration data reflect results at the time and location of calibration. Calibration data should be reviewed to insure that the instrument is performing to its required accuracy. Calibrations comply with ISO/IEC 17025 and ANSI/Z540-1-1994 quality standards.

Member: National Conference of Standards Laboratories and Weights & Measures

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(503) 236-2712 • FAX (503) 235-2535 • www.qc-services.com

ACCREDITED
Calibration Services
Certificate Number: 1550.01
Laboratory code: 115953

Myren Consulting
512 Williams Lake Road
Colville, WA 99114

Report Number: MYRC0224850860160413

A2LA ACCREDITED
CERTIFICATE OF CALIBRATION WITH DATA

INSTRUMENT INFORMATION

Item	Make	Model	Serial Number	Customer ID	Location
Balance	Sartorius	CPA224S	24850860	N/A	Lab
Units	**Readability**	**SOP**	**Cal Date**	**Last Cal Date**	**Cal Due Date**
g	0.0001	QC012	4/13/16	11/4/15	10/2016

FUNCTIONAL CHECKS

ECCENTRICITY
Test Wt: 100 Tol: 0.0003
As-Found: Pass: ☑ Fail: ☐
As-Left: Pass: ☑ Fail: ☐

LINEARITY
Test Wt: 50 x 4 Tol: 0.0002
As-Found: Pass: ☑ Fail: ☐
As-Left: Pass: ☑ Fail: ☐

STANDARD DEVIATION
Test Wt: 100 Tol: 0.0001

1. 100.0000	5. 100.0000	9. 100.0001
2. 100.0001	6. 100.0000	10. 100.0001
3. 100.0000	7. 100.0001	**Result**
4. 100.0001	8. 100.0001	0.00005

ENVIRONMENTAL CONDITIONS
☐ Good ☑ Fair ☐ Poor
Temperature: 19.8°C

A2LA ACCREDITED SECTION OF REPORT

Standard	As-Found	As-Left	Expanded Uncertainty
200	200.0004	200.0000	0.00015
100	100.0001	100.0000	0.00015
50	50.0000	49.9999	0.00015
10	10.0000	9.9999	0.00015
1	0.9999	1.0000	0.00015
0.1	0.0999	0.1000	0.00015

CALIBRATION STANDARDS

Item	Make	Model	Serial Number	Cal Date	Cal Due Date	NIST ID
Weight Set	Rice Lake	30 kg-1mg	S751	1/4/16	1/2017	20160003

Permanent Information Concerning this Equipment:

Comments/Info Concerning this Calibration:
4/16 Performed internal span overwrite adjustment.

Report prepared/reviewed by: [signature] **Date:** 4.13.2016

Technician: R. Hintz
Signature: [signature]

THIS CERTIFICATE SHALL NOT BE REPRODUCED WITHOUT THE APPROVAL OF QUALITY CONTROL SERVICES, INC.

The uncertainty is calculated according to the ISO Guide to the Expression of Uncertainty in Measurement and includes the uncertainty of standards used combined with he observed standard deviation and readability of the unit under test. The uncertainty is expanded with a k factor of 2 for an approximate 95% level of confidence. Instruments listed above were calibrated using standards traceable to the National Institute of Standards and Technology (NIST). Calibration data reflect results at the time and location of calibration. Calibration data should be reviewed to insure that the instrument is performing to its required accuracy. Calibrations comply with ISO/IEC 17025 and ANSI/Z540-1-1994 quality standards.

Member: National Conference of Standards Laboratories and Weights & Measures

ALTEK

CERTIFICATE OF CALIBRATION

This is to Certify that your Altek Unit has been calibrated using standards whose accuracies are traceable to the National Institute of Standards and Technology (formerly NBS) within the limits of the NIST Calibration Services. Actual records pertaining to these standards are on file and are available for examination.

Certified by: Altek Industries Corp.
Recommend Recalibration: Annually

In service date 4/11/96

Serial # 177533

Model K2100F Serial No. ____

T. Kruech
Calibration Technician

31 AUG 95
Factory Calibration Date

ALTEK INDUSTRIES CORP
210 Commerce Drive, Rochester, NY 14623 U.S.A.
(716) 334-3720 FAX: (716) 334-6673
800-32-ALTEK
800-322-5835
Anywhere in USA

MYREN CONSULTING, INC.
512 Williams Lake Road
Colville, WA 99114
Office: 509 684 1154
Lab: 509 685 9458

Calibration Data Sheet # 65
Revision 1 3/3/04

THERMOCOUPLE READOUT CALIBRATION

DATE: 5/19/16
TECHNICIAN: ATM ESS

Thermocouple Readout Manufacturer: Omega

Model #: 400 B-TC Serial #: 11020109 Type: K Range: 0-2100°F

Location: Center Dial Station - Dial Station # 2

Calibrated with: Altec SN 177553 0-2100°F

As found: 0° F = 1 Adjusted to: 0
2100° F = 2100 Adjusted to: —

		% Dif			% Dif			% Dif
0 =	0	0 ✓	800 =	802	-.0016 ✓	1600 =	1601	-.00049 ✓
100 =	97	+.0054 ✓	900 =	898	+.0015 ✓	1700 =	1700	0 ✓
200 =	201	-.0015 ✓	1000 =	1001	-.00068 ✓	1800 =	1801	-.00044 ✓
300 =	297	+.0039 ✓	1100 =	1099	+.00064 ✓	1900 =	1900	0 ✓
400 =	399	+.0012 ✓	1200 =	1199	+.00060 ✓	2000 =	2001	-.00041 ✓
500 =	498	+.0021 ✓	1300 =	1299	+.00057 ✓	2100 =	2100	0 ✓
600 =	602	-.0019 ✓	1400 =	1400	0 ✓			
700 =	698	+.0017 ✓	1500 =	1500	0 ✓			

$$\% \text{ Dif} = \frac{(\text{Reference Temperature } ^\circ F + 460) - (\text{Readout Temperature } ^\circ F + 460)}{\text{Reference Temperature } ^\circ F + 460}$$

Or

$$\% \text{ Dif} = \frac{(\text{Reference Temperature } ^\circ C + 273) - (\text{Readout Temperature } ^\circ C + 273)}{\text{Reference Temperature } ^\circ C + 273}$$

MYREN CONSULTING, INC.
512 Williams Lake Road
Colville, WA 99114
Office: 509 684 1154
Lab: 509 685 9458

Calibration Data Sheet # 65
Revision 1 3/3/04

THERMOCOUPLE READOUT CALIBRATION

DATE: 5/19/16
TECHNICIAN: AVM ESS

Thermocouple Readout Manufacturer: Omega

Model #: 115 KF Serial #: 004487KF Type: K Range: 0-1900°F

Location: Apex 45G-P Meter Box

Calibrated with: Altec SN 177533 0-2100°F

As found: 0° F = 0 Adjusted to: —
1900° F = 1901 Adjusted to: 1900

		% Dif			% Dif			% Dif
0 =	0	0 ✓	800 =	800	0 ✓	1600 =	1600	0 ✓
100 =	96	+.0071 ✓	900 =	897	+.0022 ✓	1700 =	1699	+.00046 ✓
200 =	203	-.0045 ✓	1000 =	1001	-.00068 ✓	1800 =	1800	0 ✓
300 =	299	+.0013 ✓	1100 =	1099	+.00064 ✓	1900 =	1900	0 ✓
400 =	400	0 ✓	1200 =	1199	+.00060 ✓	2000 =	—	—
500 =	498	+.0021 ✓	1300 =	1297	+.0017 ✓	=		
600 =	600	0 ✓	1400 =	1399	+.00054 ✓			
700 =	696	+.0034 ✓	1500 =	1498	+.0010 ✓			

$$\% \text{ Dif} = \frac{(\text{Reference Temperature } ^\circ F + 460) - (\text{Readout Temperature } ^\circ F + 460)}{\text{Reference Temperature } ^\circ F + 460}$$

Or

$$\% \text{ Dif} = \frac{(\text{Reference Temperature } ^\circ C + 273) - (\text{Readout Temperature } ^\circ C + 273)}{\text{Reference Temperature } ^\circ C + 273}$$

MYREN CONSULTING, INC.
512 Williams Lake Road
Colville, WA 99114
Office: 509 684 1154
Lab: 509 685 9458

Calibration Data Sheet # 65
Revision 1 3/3/04

THERMOCOUPLE READOUT CALIBRATION

DATE: 5/19/16
TECHNICIAN: ATM ESS

Thermocouple Readout Manufacturer: JENCO

Model #: 768-KF-02 Serial #: 900167 Type: K Range: 0-1999 °F

Location: Apex 511-M Meter Box

Calibrated with: Altec SN 177533 0-2100°F

As found: 0° F = 2 Adjusted to: 0
1900° F = 1900 Adjusted to: —

		% Dif			% Dif			% Dif
0 =	0	0 ✓	800 =	800	0 ✓	1600 =	1614	-.0068 ✓
100 =	94	+.0107 ✓	900 =	899	+.00074 ✓	1700 =	1710	-.0046 ✓
200 =	199	+.0015 ✓	1000 =	1006	-.0041 ✓	1800 =	1806	-.0027 ✓
300 =	295	+.0066 ✓	1100 =	1107	-.0045 ✓	1900 =	1900	0 ✓
400 =	394	+.0070 ✓	1200 =	1210	-.0060 ✓	2000 =	—	—
500 =	491	+.0094 ✓	1300 =	1312	-.0068 ✓	___ =		
600 =	595	+.0047 ✓	1400 =	1415	-.0081 ✓			
700 =	693	+.0060 ✓	1500 =	1514	-.0071 ✓			

$$\% \text{ Dif} = \frac{(\text{Reference Temperature } ^\circ F + 460) - (\text{Readout Temperature } ^\circ F + 460)}{\text{Reference Temperature } ^\circ F + 460}$$

Or

$$\% \text{ Dif} = \frac{(\text{Reference Temperature } ^\circ C + 273) - (\text{Readout Temperature } ^\circ C + 273)}{\text{Reference Temperature } ^\circ C + 273}$$

Woodstove Data Sheet # 55
Revision 0 12/18/01

THERMOMETER CALIBRATION DATE: 11/16/16 TECHNICIAN: A.T. Myren

MANUFACTURER:	Ertco	Ertco	Fisher	Taylor	Taylor	Premium	
CAT #.	1003 FG	E 17	ASTM59F	1330 N/A	1330 N/A	—	
SERIAL NO.	1697	K35473	AD4544	—	—	—	
RANGE:	-1 to 100°C	0-260°C	0-180°F	20-120°F	20-120°F	0-220°F	
GRADUATIONS:	0.1C	1°C	1°F	1°F	1°F	2°F	
TYPE:	Tube	Tube	Tube	Tube	Tube	Dial	
TEMP. POINT 1	.4	1.0	32	33	34	34	
2	6.9	7	45	46	46	48	
3	14.6	15	59	59	60	60	
4	22.9	23	74	75	75	75	

COMMENTS:

$°F = (°C \times 9/5) + 32$
$°C = (5/9)(°F - 32)$

EVER READY THERMOMETER CO., INC.
228 LACKAWANNA AVENUE
WEST PATTERSON, NJ 07424
(201) 812-7474

REPORT OF CALIBRATION

LIQUID-IN-GLASS-THERMOMETER

CALIBRATED BY EVER READY THERMOMETER CO.

MARKED: ERTCO CAT 1005-3FC S/N-1697
RANGE: -1 TO +101 DEGREES C IN 0.1 DEGREE GRADUATIONS.

THERMOMETER READING	CORRECTION (ITS-90)**
0.00 C	0.00 C
10.00	0.00
20.00	0.00
30.00	0.00
37.00	0.00
40.00	0.00
50.00	0.00
56.00	0.00
60.00	0.02
70.00	0.00
80.00	0.00
90.00	0.00
100.00	0.00

** ALL TEMPERATURES IN THIS REPORT ARE BASED ON THE INTERNATIONAL TEMPERATURE SCALE OF 1990 (ITS-90) PUBLISHED IN THE METROLGIA 27, NO. 1, 3/10/90.

THIS THERMOMETER WAS CALIBRATED AGAINST A STANDARD CALIBRATED AT THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST) FORMERLY THE NATIONAL BUREAU OF STANDARDS (NBS) IN ACCORDANCE WITH ASTM METHOD E 77, AND NBS MONOGRAPH 174.

FOR A DISCUSSION OF ACCURACIES ATTAINABLE WITH SUCH THERMOMETERS SEE NBS MONOGRAPH 250-23.

IF NO SIGN IS GIVEN ON THE CORRECTION, THE TRUE TEMPERATURE IS HIGHER THAN THE INDICATED TEMPERATURE; IF THE SIGN GIVEN IS NEGATIVE, THE TRUE TEMPERATURE IS LOWER THAN THE INDICATED TEMPERATURE. TO USE THE CORRECTIONS PROPERLY, REFERENCE SHOULD BE MADE TO THE NOTES GIVEN BELOW.

CONTINUED

TEST NUMBER: 152439
DATE: 07/16/96
STANDARD SERIAL NO. 128239
NIST IDENTIFICATION NO. 88024

REPORT OF CALIBRATION

LIQUID-IN-GLASS-THERMOMETER

THE THERMOMETER WAS TESTED IN A LARGE, CLOSED-TOP, ELECTRICALLY HEATED, LIQUID BATH, BEING "IMMERSED" 76MM. THE TEMPERATURE OF THE ROOM WAS ABOUT 25 DEGREES C (77 DEGREES F). IF THE THERMOMETER IS USED UNDER CONDITIONS WHICH WOULD CAUSE THE AVERAGE TEMPERATURE OF THE EMERGENT LIQUID COLUMN TO DIFFER MARKEDLY FROM THAT PREVAILING IN THE TEST, APPRECIABLE DIFFERENCES IN THE INDICATIONS OF THE THERMOMETER WOULD RESULT.

THE TABULATED CORRECTIONS APPLY PROVIDED THE ICE-POINT READING, TAKEN AFTER EXPOSURE FOR NOT LESS THAN 3 DAYS TO A TEMPERATURE OF ABOUT 20 DEGREES C (70 DEGREES F) IS 0.00 DEGREES C. IF THE ICE-POINT READING IS FOUND TO BE HIGHER (OR LOWER) THAN STATED, ALL OTHER READINGS WILL BE HIGHER (OR LOWER) TO THE SAME EXTENT. IF THE THERMOMETER IS USED AT A GIVEN TEMPERATURE SHORTLY AFTER BEING HEATED TO A HIGHER TEMPERATURE. AN ERROR OF 0.01 DEGREES OR LESS, FOR EACH 10 DEGREE DIFFERENCE BETWEEN THE TWO TEMPERATURES, MAY BE INTRODUCED. THE TABULATED CORRECTIONS APPLY IF THE THERMOMETER IS USED IN THE UPRIGHT POSITION; IF USED IN A HORIZONTAL POSITION, THE INDICATIONS MAY BE A FEW HUNDREDTHS OF A DEGREE HIGHER.

TEST NUMBER: 152439
DATE: 07/16/96
STANDARD SERIAL NO. 128239
NIST IDENTIFICATION NO. 88024

Charles Tang-Nian
QUALITY CONTROL MANAGER

T1

Revised 7/11

Dry Gas Meter Calibration Data

Date: 11/16/16 Technician: ESS

Calibration Meter Mfr: Rockwell SN: 1052202 Y: 0.9963

Meter Box ID 456-P Meter Mfr: Rockwell SN: 265561

Electrical Check OK ✓ Pitot Leak Check OK ✓

Leak Check Front Half OK ✓ Back Half OK ✓

BP = 28.32 in. Hg

Orifice (Δh) in. H_2O	Gas Volume	Cal. Meter (Vc), (cu.ft.)	Dry Gas Meter (Vm), $(m^3)(ft^3)$	Temperature	Cal. Meter (Tc), °F	Dry Gas Meter Inlet (Tmi), (°F) (°C)	Dry Gas Meter Outlet (Tmo), (°F)(°C)	Time (Θ), Min.
.80	initial	835.908	236.200	initial	58	60	60	
.80	final	840.959	241.402	mid	58	64	64	10:17
.80				final	58	65	65	(10.28) ✓
	total	5.051 ✗	5.202 ✗	avg.	58 ✗	63 ✓	63 ✓	
			.506 cfm		518	523	523	523
.90	initial	841.439	241.900	initial	58	64	64	
.90	final	846.461	247.102	mid	58	67	67	9:32
.90				final	58	70	70	(9.53) ✓
	total	5.022 ✗	5.202 ✗	avg.	58 ✗	67 ✗	67 ✓	
			.546 cfm		518	527	527	527
1.00	initial	846.850	247.500	initial	58	68	68	
1.00	final	852.006	252.904	mid	58	72	72	9:17
1.00				final	58	73	73	(9.28) ✓
	total	5.156 ✗	5.404 ✗	avg.	58 ✗	71 ✗	71 ✗	
			.582 cfm		518	531	531	531
	initial			initial				
	final			mid				
				final				
	total			avg.				
	initial			initial				
	final			mid				
				final				
	total			avg.				

$$Y = \frac{(Y)(Vc)(Pb)(Tm + 460)}{(Vm)(Pb + \Delta h/13.6)(Tc + 460)}$$

$$\Delta h@ = \frac{(0.0317)(\Delta h)}{Pb(Tmo + 460)} \left[(Tc + 460)(\Theta)\right] / \left[(Vc)(Yc)\right]^2$$

Back Half Leak Check

	Start	Stop	Δ
Leg 1	7.78" H_2O	7.78" H_2O	0.00" H_2O
Leg 2	6.86"	6.86	0.00

Front Half Leak Check

	Vac in Hg	Meter Reading Start	Meter Reading Stop	Leak Rate cmm	Leak Rate cfm
DGm	-16.75	.502	.503	—	.001
Tm	-16.75	.785	.786	—	.001

Meter Box Calibration Page 2

$$Y = \frac{(Y_c)(V_c)(BP)(T_m + 460)}{(V_m)(BP + \Delta H/13.6)(T_c + 460)} =$$

$$Y = \frac{(.9963)(5.051)(28.32)(63 + 460)}{(5.202)(28.32 + .80/13.6)(58 + 460)} = \frac{74,535.374}{76,470.600} = 0.9747$$

(523) (518)

$$Y = \frac{(.9963)(5.022)(28.32)(67 + 460)}{(5.202)(28.32 + .90/13.6)(58 + 460)} = \frac{74,674.221}{76,490.413} = 0.9763$$

(527) (518)

$$Y = \frac{(.9963)(5.156)(28.32)(71 + 460)}{(5.404)(28.32 + 1.00/13.6)(58 + 460)} = \frac{77,248.634}{79,481.212} = 0.9719$$

(531) (518)

$$Y = \frac{(\quad)(\quad)(\quad)(\quad + 460)}{(\quad)(\quad + \quad/13.6)(\quad + 460)} = \underline{\qquad} = \underline{\qquad}$$

$$Y = \frac{(\quad)(\quad)(\quad)(\quad + 460)}{(\quad)(\quad + \quad/13.6)(\quad + 460)} = \underline{\qquad} = \underline{\qquad}$$

Y Factor	Variation (± 0.02 Allowed From Average Y)
0.9747	+.0004
0.9763	+.0020
0.9719	-.0024

Avg Y 0.9743

$$\Delta H@ = \frac{(0.0317)(\Delta H)}{(Pb)(T_{mo} + 460)} \cdot \left[\frac{(T_w + 460)(\Theta)}{(Y_c)(V_c)}\right]^2 =$$

$$\Delta H@ = \frac{(0.0317)(.80)}{(28.32)(63 + 460)} \cdot \left[\frac{(58 + 460)(10.28)}{(.9963)(5.051)}\right]^2 = 1.9172$$

(523) (518)

$$\Delta H@ = \frac{(0.0317)(.90)}{(28.32)(67 + 460)} \cdot \left[\frac{(58 + 460)(9.53)}{(.9963)(5.022)}\right]^2 = 1.8608$$

(527) (518)

$$\Delta H@ = \frac{(0.0317)(1.00)}{(28.32)(71 + 460)} \cdot \left[\frac{(58 + 460)(9.28)}{(.9963)(5.156)}\right]^2 = 1.8460$$

(531) (518)

$$\Delta H@ = \frac{(0.0317)(\quad)}{(\quad)(\quad + 460)} \cdot \left[\frac{(\quad + 460)(\quad)}{(\quad)(\quad)}\right]^2 = \_\_\_\_$$

$$\Delta H@ = \frac{(0.0317)(\quad)}{(\quad)(\quad + 460)} \cdot \left[\frac{(\quad + 460)(\quad)}{(\quad)(\quad)}\right]^2 = \_\_\_\_$$

ΔH@	VARIATION (± 0.20 ALLOWED)
1.9172	+0.0425
1.8608	-0.0139
1.8460	-0.0287

AVG ΔH@ 1.8747

Post Test
Meter Box Audit
Woodstove Data Sheet #32

T1

Unit: Optimum
Date: 1/30/17
Technician: ATM ESS
WST9-Form2, Rev 6/11

Meter Box Calibration Audit
Test Data

Run #	1	2	3	4	5	6	7	8	9	10
Avg.Δh	.90									
Max Vac	0									

Avg. Test Series Δh: .90 in H_2O. Test Series Max Vac: 0 in Hg
Audit Dry Gas Meter Mfr: Rockwell SN: 1052202 Correction Factor (Y): .9963
Test Dry Gas Meter Mfr: Rockwell SN: 3039270 Correction Factor (Y): .9743

Audit Data

		Audit #1	Audit #2	Audit #3
BP ("Hg):		28.72	28.71	28.71
Vac("Hg):		0	0	0
Audit Meter:	Final Vol	66.047	71.283	76.926
	Initial Vol	60.874	66.261	71.545
	Vol (V_c, Ft^3)	5.173 ✗	5.022 ✗	5.381 ✗
Audit Meter Temp (°F) (Tc)	Initial	57	57	57
	Mid	57	57	57.5
	Final	58	57	58
	Avg (°F/°A)	57.3 (517.3)	57 (517)	57.5 (517.5)
Δh("H_2O)	Initial	.90	.90	.90
	Mid	.90	.90	.90
	Final	.90	.90	.90
	Avg	.90 ✗	.90 ✗	.90 ✗
Dry Gas Meter:	Final Vol	636.566	642.124	648.134
	Initial Vol	631.100	636.800	642.400
	Vol(V_d)(ft^3)(m^3)	5.466 ✗	5.324 ✗	5.734 ✗
Dry Gas Meter Temp (°F) : Inlet (T_m)	Initial	72	77	78
	Mid	76	78	80
	Final	78	80	81
	Avg(°F/°A)	75.3 (535.3)	78.3 (538.3)	79.7 (539.7)
Dry Gas Meter Temp (°F) : Outlet (T_m)	Initial	72	77	78
	Mid	76	78	80
	Final	78	80	81
	Avg(°F/°A)	75.3 (535.3)	78.3 (538.3)	79.7 (539.7)
Avg Dry Gas Meter Temp (T_m - °F/°A)		75.3 (535.3)	78.3 (538.3)	79.7 (539.7)
Time (minutes)		10:03	9:46	10:30

Note: If volume is in m^3, multiply by 35.314667 to obtain ft^3.
Note: Add 460° to all temperatures for degrees Absolute.

$$Y = \frac{(V_c)(MCF)(BP)(T_m)}{(V_d)(BP + \Delta h/13.6)(T_c)}$$

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

T1 optimum

Note: MCF = Meter Correction Factor (Y) for Dry Gas Meter used as a Transfer Standard

Run 1

Y = (5.173)(.9963)(28.72)(539.3) / (5.466)(28.72 + .90/13.6)(517.3) = 79,234.494 / 81,394.693 = 0.9735

Δ% = (.9735 - .9692) / .9692 X 100 = +0.414 %

Run 2

Y = (5.022)(.9963)(28.71)(538.3) / (5.324)(28.71 + .90/13.6)(517.0) = 77,352.798 / 79,206.656 = 0.9766

Δ% = (.9766 - .9692) / .9692 X 100 = +0.76 %

Run 3

Y = (5.381)(.9963)(28.71)(539.7) / (5.734)(28.71 + .90/13.6)(517.5) = 83,068.952 / 85,388.843 = 0.9728

Δ% = (.9728 - .9692) / .9692 X 100 = +0.37 %

Note: The Y Factor % Difference must be < ±5.0% to be acceptable. Avg. Δ%= +0.52

Determination of Interpolated Y Factor for Average Certification Test Series Δ H from Dry Gas Meter Calibration Data:

.90 (A) inch H_2O Δh= .9692 (C) Calculated Calibration Y Factor (from Calibration)

____ (B) inch H_2O Δ h = ____ (D) Calculated Calibration Y Factor (from Calibration)

____ (B) - ____ (A) = ____ X100 = ____ (E)   ____ (D) - ____ (C) = ____ / ____ (E) = ____ (F)

____ Avg Δ h - ____ (A) = ____ X 100 = ____ (G)

(____ F X ____ G) + ____ C = ____ Interpolated Y Factor For Avg. Test Series Δ h

Back Half Leak Check

	Start	Stop	Δ
Leg 1	9.42	9.42	0.00
Leg 2	8.70	8.70	0.00

Dry Gas Meter Back Half Leak Check: ____ **inch H_2O in One Minute**

Front Half Leak Check

Meter	Vac In. Hg	Meter Reading Start	Meter Reading Stop	Leak Rate cmm	Leak Rate cfm
DGM	-16.25	.787	.790	—	.003
TM	-16.25	.274	.274	—	.000

T 2

Revised 7/11

Dry Gas Meter Calibration Data

Date: 11/17/16 Technician: ESS

Calibration Meter Mfr: Rockwell SN: 1052202 Y: 0.9963

Meter Box ID 511-M Meter Mfr: Rockwell SN: 322914

Electrical Check OK✓ Pitot Leak Check OK✓

Leak Check Front Half OK✓ Back Half OK✓

BP = 28.59 in. Hg

Orifice (Δh) in. H_2O		Gas Volume: Cal. Meter (Vc), (cu.ft.)	Gas Volume: Dry Gas Meter (Vm), $(m^3)(ft^3)$		Temperature: Cal. Meter (Tc), °F	Dry Gas Meter: Inlet (Tmi), (°F) (°C)	Dry Gas Meter: Outlet (Tmo), (°F)(°C)	Time (Θ), Min.	
.70	initial	955.887	880.100	initial	51.5	53	53	13:30	✓
.70	final	962.139	886.631	mid	51.5	54	53	(13.5)	.484
.70				final	52	55	53		
	total	6.252 ✗	6.531 ✗	avg.	51.7 ✗	54 ✗	53 ✗	53.5 ✓	
					511.7	514	513	513.5	
.75	initial	962.590	887.100	initial	52	55	54	11:15	
.75	final	968.036	892.700	mid	52	56	54	(11.25)	.498
.75				final	52	57	55		
	total	5.446 ✗	5.600 ✗	avg.	52 ✗	56 ✓	54.3 ✗	55.2 ✗	
					512	516	514.3	515.2	
.80	initial	968.581	893.300	initial	52	56	54	10:15	
.80	final	973.726	898.612	mid	52	57	55	(10.25)	.518
.80				final	52	57	55		
	total	5.145 ✗	5.312 ✗	avg.	52 ✓	56.7 ✗	54.7 ✗	55.7 ✗	
					512	516.7	514.7	515.7	
.85	initial	5.981	899.400	initial	55	57	56	10:00	
.85	final	11.180	904.789	mid	54.5	58	57	(10.0)	.539
.85				final	54.5	58	57		
	total	5.199 ✗	5.389 ✗	avg.	54.7 ✗	57.7 ✗	56.7 ✗	57.2 ✗	
					514.7	517.6	516.7	517.2	
	initial			initial					
	final			mid					
				final					
	total			avg.					

$$Y = \frac{(Y)(Vc)(Pb)(Tm + 460)}{(Vm)(Pb + \Delta h/13.6)(Tc + 460)}$$

$$\Delta h@ = \frac{(0.0317)(\Delta h)}{Pb(Tmo + 460)} [(Tc + 460)(\Theta)] / [(Vc)(Yc)]^2$$

Back Half Leak Check 11/16/16

	Start	Stop	Δ
Leg 1	6.96	6.96	0.00
Leg 2	7.45	7.45	0.00

2nd ✓

11/17/16 Front Half Leak Check

	VAC	START	STOP	CFM
DGM	-16.1	.7355	.7355	.000
TM	-16.1	.315	.315	.000

Meter Box Calibration Page 2

$$Y = \frac{(Y_c)(V_c)(BP)(T_m + 460)}{(V_m)(BP + \Delta H/13.6)(T_c + 460)} =$$

$$Y = \frac{(.9963)(6.252)(28.59)(53.5 + 460)}{(6.531)(28.59 + .70/13.6)(51.7 + 460)} = \frac{91,445.787}{95,717.294} = 0.9554$$

(513.5) (511.7)

$$Y = \frac{(.9963)(5.446)(28.59)(55.2 + 460)}{(5.600)(28.59 + .75/13.6)(52 + 460)} = \frac{79,920.424}{82,131.366} = 0.9731$$

(515.2) (512)

$$Y = \frac{(.9963)(5.145)(28.59)(55.7 + 460)}{(5.312)(28.59 + .80/13.6)(52 + 460)} = \frac{75,576.504}{77,917.466} = 0.9700$$

(515.7) (512)

$$Y = \frac{(.9963)(5.199)(28.59)(57.2 + 460)}{(5.389)(28.59 + .85/13.6)(54.7 + 460)} = \frac{76,591.861}{79,473.964} = 0.9637$$

(517.2) (514.7)

$$Y = \frac{(\quad)(\quad)(\quad)(\quad + 460)}{(\quad)(\quad + \quad/13.6)(\quad + 460)} = \_\_\_\_ = \_\_\_\_$$

Y Factor	Variation (± 0.02 Allowed From Average Y)
0.9554	-0.0102
0.9731	+0.0075
0.9700	+0.0044
0.9637	-0.0019

Avg Y 0.9656

$$\Delta H@ = \frac{(0.0317)(\Delta H)}{(Pb)(T_{mo} + 460)} \cdot \left[\frac{(T_w + 460)(\Theta)}{(Y_c)(V_c)}\right]^2 =$$

$$\Delta H@ = \frac{(0.0317)(.70)}{(28.59)(53 + 460)} \cdot \left[\frac{(51.7 + 460)(13.5)}{(.9963)(6.252)}\right]^2 = 1.8608$$

(513) (511.7)

$$\Delta H@ = \frac{(0.0317)(.75)}{(28.59)(54.3 + 460)} \cdot \left[\frac{(52 + 460)(11.25)}{(.9963)(5.446)}\right]^2 = 1.8222$$

(514.3) (512)

$$\Delta H@ = \frac{(0.0317)(.80)}{(28.59)(54.7 + 460)} \cdot \left[\frac{(52 + 460)(10.25)}{(.9963)(5.145)}\right]^2 = 1.8064$$

(514.7) (512)

$$\Delta H@ = \frac{(0.0317)(.85)}{(28.59)(56.7 + 460)} \cdot \left[\frac{(54.7 + 460)(10.0)}{(.9963)(5.199)}\right]^2 = 1.8010$$

(516.7) (514.7)

$$\Delta H@ = \frac{(0.0317)(\quad)}{(\quad)(\quad + 460)} \cdot \left[\frac{(\quad + 460)(\quad)}{(\quad)(\quad)}\right]^2 = \_\_\_\_$$

ΔH@	VARIATION (± 0.20 ALLOWED)
1.8608	+0.0382
1.8222	-0.0004
1.8064	-0.0162
1.8010	-0.0216

AVG ΔH@ 1.8226

Post Test
Meter Box Audit
Woodstove Data Sheet #32

T2

Unit: Optimum
Date: 1/30/17
Technician: ATM ESS
WST9-Form2, Rev 6/11

Meter Box Calibration Audit
Test Data

Run #	1	2	3	4	5	6	7	8	9	10
Avg.Δh	.80									
Max Vac	-2.25									

Avg. Test Series Δh: .80 in H_2O. Test Series Max Vac: -2.25 in Hg

Audit Dry Gas Meter Mfr: Rockwell SN: 1052202 Correction Factor (Y): .9963
Test Dry Gas Meter Mfr: Rockwell SN: 322914 Correction Factor (Y): .9656

Audit Data

		Audit #1	Audit #2	Audit #3
BP ("Hg):		28.69	28.68	28.68
Vac("Hg):		-2.25	-2.25	-2.25
Audit Meter:	Final Vol	120.919	126.373	131.780
	Initial Vol	115.827	121.296	126.679
	Vol (V_c, Ft^3)	5.092 ✓	5.077 ✓	5.101 ✓
Audit Meter Temp (°F) (Tc)	Initial	61	60	61
	Mid	60.5	60	60.5
	Final	60.5	60.5	61
	Avg (°F/°A)	60.7 ✓ (520.7) ✓	60.2 ✓ (520.2) ✓	60.8 ✓ (520.8) ✓
Δh("H_2O)	Initial	.80	.80	.80
	Mid	.80	.80	.80
	Final	.80	.80	.80
	Avg	.80 ✓	.80 ✓	.80 ✓
Dry Gas Meter:	Final Vol	388.610	394.282	399.899
	Initial Vol	383.300	389.000	394.600
	Vol(V_d)(ft^3)(m^3)	5.310 ✓	5.282 ✓	5.299 ✓
Dry Gas Meter Temp (°F) : Inlet (T_m)	Initial	64	64	65
	Mid	64	65	66
	Final	65	66	66
	Avg(°F/°A)	64.3 ✓ (524.3) ✓	65 ✓ (525) ✓	65.7 ✓ (525.7)
Dry Gas Meter Temp (°F) : Outlet (T_m)	Initial	63	64	64
	Mid	63	64	64
	Final	64	64	65
	Avg(°F/°A)	63.3 ✓ (523.3) ✓	64 ✓ (524) ✓	64.3 ✓ (524.3) ✓
Avg Dry Gas Meter Temp (T_m - °F/°A)		63.8 ✓ (523.8) ✓	64.5 ✓ (524.5) ✓	65 ✓ (525) ✓
Time (minutes)		10:00	10:00	10:00

Note: If volume is in m^3, multiply by 35.314667 to obtain ft^3.
Note: Add 460° to all temperatures for degrees Absolute.

$$Y = \frac{(V_c)(MCF)(BP)(T_m)}{(V_d)(BP + \Delta h/13.6)(T_c)}$$

Y Factor % Difference = $\frac{Act - Exp}{Exp}$ X 100

optimum T2

Note: MCF = Meter Correction Factor (Y) for Dry Gas Meter used as a Transfer Standard

Run 1

Y = (5.092)(.9963)(28.69)(523.8) / (5.310)(28.69 + .80/13.6)(520.7) = 76,238.539 / 79,488.111 = 0.9591

Δ% = (.9591 - .9666) / .9666 X 100 = -0.77 %

Run 2

Y = (5.077)(.9963)(28.68)(524.5) / (5.282)(28.68 + .80/13.6)(520.2) = 76,089.010 / 78,965.562 = 0.96036

Δ% = (.96036 - .9666) / .9666 X 100 = -0.31 %

Run 3

Y = (5.101)(.9963)(28.68)(525) / (5.299)(28.68 + .80/13.6)(520.8) = 76,521.576 / 79,311.083 = 0.9648

Δ% = (.9648 - .9666) / .9666 X 100 = -0.18 %

Note: The Y Factor % Difference must be < ±5.0% to be acceptable. Avg. Δ% = -0.42

Determination of Interpolated Y Factor for Average Certification Test Series Δ H from Dry Gas Meter Calibration Data:

.80 inch H_2O Δh = .9666 Calculated Calibration Y Factor
(A) (C) (from Calibration)

____ inch H_2O Δ h = ____ Calculated Calibration Y Factor
(B) (D) (from Calibration)

____ - ____ = ____ X100 = ____   ____ - ____ = ____ / ____ = ____
(B) (A) (E) (D) (C) (E) (F)

____ - ____ = ____ X 100 = ____
Avg Δ h (A) (G)

(____ X ____) + ____ = ____
F G C Interpolated Y Factor For Avg. Test Series Δ h

Dry Gas Meter Back Half Leak Check: .000 inch H_2O in One Minute

Front Half Leak Check — Meter Reading — Leak Rate

Meter	Vac In. Hg	Start	Stop	cmm	cfm
DGM	-16.4	.246	.248	—	.002
TM	-16.4	.752	.7525	—	.0005

T3

Dry Gas Meter Calibration Data

Date: 11/16/16 Technician: ESS

Calibration Meter Mfr: Rockwell SN: 1052202 Y: 0.9963

Meter Box ID: Train 3 Meter Mfr: Kimmon SN: 8000571

Electrical Check: OK ✓ Pitot Leak Check: OK ✓

Leak Check Front Half: OK ✓ Back Half: OK ✓

BP = 28.33 in. Hg

Orifice (Δh) in. H_2O	Gas Volume	Cal. Meter (Vc), (cu.ft.)	Dry Gas Meter (Vm), (m^3)	Temperature	Cal. Meter (Tc), °F	Dry Gas Meter Inlet (Tmi), (°F)	Dry Gas Meter Outlet (Tmo), (°F)	Time (Θ), Min.	
.100	initial	896.670	308.4400	initial	61	65	64	(11.20)	
.100	final	901.684	308.5858	mid	61	67	64	11.33	
			.1458 m^3 ✓	final	61	67	65		
.100	total	5.014 ✓	5.149 ✓	avg.	61 ✓	66.3 ✓	64.3 ✓	65.3 ✓	52[illegible]
			.454 cfm		521				
.110	initial	903.211	308.6300	initial	61	66	64	11.15	
.110	final	908.552	308.7851	mid	61	67	64	(11.25)	
.110			.1551 m^3	final	61.5	68	65		
	total	5.341 ✓	5.447 ✓	avg.	61.2 ✓	67 ✓	64.3 ✓	65.7 ✓	52[illegible]
			.484 cfm		521.2				
.120	initial	909.241	308.8050	initial	60.5	63	63	10:30	
.120	final	914.496	308.9576	mid	60	64	63	(10.5)	
			.1526 m^3	final	60	65	63		
.120	total	5.255 ✓	5.389 ✓	avg.	60.2 ✓	64 ✓	63 ✓	63.5 ✓	523
			.5132 cfm		520.2				
.135	initial	915.483	308.9860	initial	60.5	64	63	9:45	
.135	final	920.669	309.1364	mid	60	66	63	(9.75)	
.135			.1504 m^3 ✓	final	60.5	67	64		
	total	5.186 ✓	5.311 ✓	avg.	60.3 ✓	65.7 ✓	63.3 ✓	64.5 ✓	52[illegible]
			.545 cfm		520.3				
	initial			initial					
	final			mid					
				final					
	total			avg.					

$$Y = \frac{(Y)(Vc)(Pb)(Tm+460)}{(Vm)(Pb+\Delta h/13.6)(Tc+460)}$$

$$\Delta h@ = \frac{(0.0317)(\Delta h)}{Pb(Tmo+460)} \left[(Tc+460)(\Theta)\right] / \left[(Vc)(Yc)\right]^2$$

Back Half Leak Check

Start	Stop	Δ
8.16 " H_2O	8.16 " H_2O	0.00 " H_2O

Front Half Leak Check

	Vac	Meter Reading		Leak Rate	
	in. Hg	Start	Stop	cmm	cfm
OGM	-17.9	.4321	.4322	.0001	.004
TM	-17.9	.401	.404	—	.003

Meter Box Calibration Page 2

$$Y = \frac{(Y_c)(V_c)(BP)(T_m + 460)}{(V_m)(BP + \Delta H/13.6)(T_c + 460)} =$$

$$Y = \frac{(.9963)(5.014)(28.33)(65.3 + 460)}{(5.149)(28.33 + .100/13.6)(61 + 460)} = \frac{74,341.006}{76,018.605} = 0.9779$$

(525.3) / (521)

$$Y = \frac{(.9963)(5.341)(28.33)(65.7 + 460)}{(5.447)(28.33 + .110/13.6)(61.2 + 460)} = \frac{79,249.633}{80,451.164} = 0.9851$$

(525.7) / (521.2)

$$Y = \frac{(.9963)(5.255)(28.33)(63.5 + 460)}{(5.389)(28.33 + .120/13.6)(60.2 + 460)} = \frac{77,647.256}{79,443.862} = 0.9774$$

(523.5) / (520.2)

$$Y = \frac{(.9963)(5.186)(28.33)(64.5 + 460)}{(5.311)(28.33 + .135/13.6)(60.3 + 460)} = \frac{76,774.096}{78,312.096} = 0.9804$$

(524.5) / (520.3)

$$Y = \frac{(\quad)(\quad)(\quad)(\quad + 460)}{(\quad)(\quad + \quad/13.6)(\quad + 460)} = \underline{\qquad} = \underline{\qquad}$$

Y Factor	Variation (± 0.02 Allowed From Average Y)
0.9779	-.0023
0.9851	+.0049
0.9774	-.0028
0.9804	+.0002

Avg Y 0.9802

$$\Delta H@ = \frac{(0.0317)(\Delta H)}{(Pb)(T_{mo} + 460)} \cdot \left[\frac{(T_w + 460)(\Theta)}{(Y_c)(V_c)}\right]^2 =$$

$$\Delta H@ = \frac{(0.0317)(.100)}{(28.33)(64.3 + 460)} \cdot \left[\frac{(61 + 460)(11.33)}{(.9963)(5.014)}\right]^2 = 0.2980$$

(524.3) (521)

$$\Delta H@ = \frac{(0.0317)(.110)}{(28.33)(64.3 + 460)} \cdot \left[\frac{(61.2 + 460)(11.25)}{(.9963)(5.341)}\right]^2 = 0.2850$$

(524.3) (521.2)

$$\Delta H@ = \frac{(0.0317)(.120)}{(28.33)(63 + 460)} \cdot \left[\frac{(60.2 + 460)(10.5)}{(.9963)(5.255)}\right]^2 = 0.2794$$

(523) (520.2)

$$\Delta H@ = \frac{(0.0317)(.135)}{(28.33)(63.3 + 460)} \cdot \left[\frac{(60.3 + 460)(9.75)}{(.9963)(5.186)}\right]^2 = 0.2783$$

(523.3) 520.3

$$\Delta H@ = \frac{(0.0317)(\quad)}{(\quad)(\quad + 460)} \cdot \left[\frac{(\quad + 460)(\quad)}{(\quad)(\quad)}\right]^2 = \_\_\_\_$$

ΔH@	VARIATION (± 0.20 ALLOWED)
0.2980	+.0128
0.2850	-0.0002
0.2794	-0.0058
0.2783	-.0069

AVG ΔH@ 0.2852

Post Test
Meter Box Audit
Woodstove Data Sheet #32

T3

Unit: Optimum
Date: 1/30/17
Technician: ATM ESS
WST9-Form2, Rev 6/11

Meter Box Calibration Audit
Test Data

Run #	1	2	3	4	5	6	7	8	9	10
Avg.Δh	.12									
Max Vac	-2.0									

Avg. Test Series Δh: 0.12 in H_2O. Test Series Max Vac: -2.0 in Hg

Audit Dry Gas Meter Mfr: Rockwell SN: 1052202 Correction Factor (Y): .9963
Test Dry Gas Meter Mfr: Kimmon SN: B000555 Correction Factor (Y): .9802

Audit Data

		Audit #1	Audit #2	Audit #3
BP ("Hg):		28.70	28.70	28.69
Vac("Hg):		-2.0	-2.0	-2.0
Audit Meter:	Final Vol	102.231	108.489	114.549
	Initial Vol	97.175	103.378	109.421
	Vol (V_c, Ft^3)	5.056	5.111	5.128
Audit Meter Temp (°F) (Tc)	Initial	59.5	60	60.5
	Mid	60	60	60.5
	Final	60	60	60.5
	Avg (°F/°A)	59.8 (519.8)	60 (520)	60.5 (520.5)
Δh("H_2O)	Initial	.12	.12	.12
	Mid	.12	.12	.12
	Final	.12	.12	.12
	Avg	.12	.12	.12
Dry Gas Meter:	Final Vol	322.2466	322.4282	322.6038
	Initial Vol	322.1000	322.2800	322.4550
	Vol(V_d) [redacted] (m^3)	.1466 (5.177)	.1482 (5.234)	.1488 (5.255)
Dry Gas Meter Temp (°F) : Inlet (T_m)	Initial	65	64	65
	Mid	66	66	66
	Final	66	66	67
	Avg(°F/°A)	65.7 (525.7)	65.3 (525.3)	66 (526)
Dry Gas Meter Temp (°F) : Outlet (T_m)	Initial	63	63	64
	Mid	63	63	64
	Final	63	64	64
	Avg(°F/°A)	63 (523)	63.3 (523.3)	64 (524)
Avg Dry Gas Meter Temp (T_m - °F/°A)		64.3 (524.3)	64.3 (524.3)	65 (525)
Time (minutes)		10:00	10:00	10:01

Note: If volume is in m^3, multiply by 35.314667 to obtain ft^3.
Note: Add 460° to all temperatures for degrees Absolute.

$$Y = \frac{(V_c)(MCF)(BP)(T_m)}{(V_d)(BP + \Delta h/13.6)(T_c)}$$

Y Factor % Difference = $\frac{Act - Exp}{Exp}$ X 100

Optimum T3

Note: MCF = Meter Correction Factor (Y) for Dry Gas Meter used as a Transfer Standard

Run 1

Y = (5.056)(.9963)(28.70)(524.3) / (5.177)(28.70 + .120 /13.6)(519.8) = 75,798,210 / 77,255,576 = 0.9811

Δ% = (.9811 - .9781) / .9781 X 100 = +0.31 %

Run 2

Y = (5.111)(.9963)(28.70)(524.3) / (5.234)(28.70 + .12 /13.6)(520.) = 76,622.755 / 78,136.231 = 0.9806

Δ% = (.9806 - .9781) / .9781 X 100 = +0.26 %

Run 3

Y = (5.128)(.9963)(28.69)(525) / (5.255)(28.69 + .12 /13.6)(520.5) = 76,953.433 / 78,497.811 = 0.9803

Δ% = (.9803 - .9781) / .9781 X 100 = +0.22 %

Note: The Y Factor % Difference must be < ±5.0% to be acceptable. Avg. Δ%= +0.26

Determination of Interpolated Y Factor for Average Certification Test Series Δ H from Dry Gas Meter Calibration Data:

.120 (A) inch H_2O Δh= .9781 (C) Calculated Calibration Y Factor (from Calibration)

______ (B) inch H_2O Δ h = ______ (D) Calculated Calibration Y Factor (from Calibration)

______ (B) - ______ (A) = ______ X100 = ______ (E)   ______ (D) - ______ (C) = ______ / ______ (E) = ______ (F)

______ Avg Δ h - ______ (A) = ______ X 100 = ______ (G)

Back Half Leak Check
Start 5.30" H_2O
Stop 5.30" H_2O

(______ F X ______ G) + ______ C = ______ Interpolated Y Factor For Avg. Test Series Δ h

Dry Gas Meter Back Half Leak Check: .000 **inch H_2O in One Minute**

Front Half Leak Check — **Meter Reading** — **Leak Rate**

Meter	Vac In. Hg	Start	Stop	cmm	cfm
DGM	-16.5	.5185	.5815	.0000	.000
TM	-16.5	.001	.002	—	.001

APEX INSTRUMENTS REFERENCE METER VERIFICATION
USING WET-TEST METER #11AE6
Myren Consulting

Calibration Meter Information	
WTM Model #	AL20
WTM Serial #	11AE6
WTM Gamma	0.9999
Original 15Pt Gamma	**0.9963**

Calibration Conditions			
Date	Time	4-Apr-16	8:30
Barometric Pressure		29.69	in Hg
Calibration Tech		EW	
DGM Serial Number		S-110-1052202	

Factors/Conversions		
Std Temp	528	°R
Std Press	29.92	in Hg
K_1	17.647	°R/in Hg

Calibration Data													Results		
Run Time	Metering Console						Calibration Meter						Dry Gas Meter		
					Outlet Temp					Outlet Temp			Calibration Factor		Flowrate
Elapsed	DGM Input Pressure	Volume Initial	Volume Final	Volume Sample	Initial	Final	Volume Initial	Volume Final	Volume Sample	Initial	Final		Previous	Current	Std & Corr
(Θ)	(P_m)	(V_{mi})	(V_{mf})	(V_m)	(t_{mi})	(t_{mf})	(Vw_i)	(Vw_f)	(V_m)	(t_{wi})	(t_{wf})		(Y)	(Y)	($Q_{m(std)(corr)}$)
min	in H_2O	cubic feet	cubic feet	cubic feet	°F	°F	cubic feet	cubic feet	cubic feet	°F	°F				cfm
6.00	-3.6	508.805	514.920	6.115	69.8	71.6	380.520	386.540	6.020	70	70		0.9955	0.9946	0.992
											Variation		0.09%	must be less than 1.5%	
10.00	-2.2	514.920	520.503	5.583	71.6	71.6	386.540	392.140	5.600	70	70		0.9988	1.0116	0.554
											Variation		1.28%	must be less than 1.5%	

I certify that the above Dry Gas Meter was calibrated in accordance with USEPA Methods, CFR 40 Part 60, App A, Method 5, Paragraph 7.1.2.2, using the Precision Wet Test Meter # 11AE6, which in turn was calibrated using the American Bell Prover # 3785, certificate # F107, which is traceable to the National Bureau of Standards (N.I.S.T.).

Signature [signature] Date 4/4/16

APEX INSTRUMENTS REFERENCE METER CALIBRATION
USING WET-TEST METER #11AE6
15-POINT ENGLISH UNITS

Calibration Meter Information	
WTM Model #	AL-20
WTM Serial #	11AE6
WTM Gamma	0.9999

Calibration Conditions			
Date	Time	18-Feb-14	9:15
Barometric Pressure		29.8	in Hg
Calibration Technician		EW	
DGM Serial Number		S-110-1052202	

Factors/Conversions		
Std Temp	528	°R
Std Press	29.92	in Hg
K_1	17.647	°R/in Hg

Run Time	Dry Gas Meter						Calibration Meter					Results: Dry Gas Meter		
Elapsed (Θ) min	Meter Pressure (P_m) in H_2O	Volume Initial (V_{mi}) cubic feet	Volume Final (V_{mf}) cubic feet	Sample Volume (V_m) cubic feet	Outlet Temp Initial (t_{mi}) °F	Outlet Temp Final (t_{mf}) °F	Volume Initial (Vw) cubic feet	Volume Final (Vw) cubic feet	Sample Volume (V_m) cubic feet	Outlet Temp Initial (t_{wi}) °F	Outlet Temp Final (t_{wf}) °F	Calibration Factor Value (Y)	Calibration Factor Variation (ΔY)	Flowrate Std & Corr ($Q_{m(std)(corr)}$) cfm
5	-5.1	657.117	663.335	6.218	73.4	73.4	677.080	683.140	6.060	68.0	68.0	0.9970	0.00149	1.21
5	-5.1	663.335	669.550	6.215	73.4	73.4	683.140	689.180	6.040	68.0	68.0	0.9942	-0.00133	1.20
5	-5.1	669.550	675.768	6.218	73.4	73.4	689.180	695.230	6.050	68.0	68.0	0.9954	-0.00016	1.21
										Passed Calibration Fa		0.9955	Averages	1.21
6	-3.7	694.023	699.987	5.964	75.2	75.2	713.145	718.970	5.825	68.0	68.0	0.9990	0.00269	0.97
6	-3.7	699.987	705.997	6.010	75.2	75.2	718.970	724.820	5.850	68.0	68.0	0.9956	-0.00071	0.97
6	-3.7	705.997	712.025	6.028	75.2	75.2	724.820	730.680	5.860	68.0	68.0	0.9944	-0.00198	0.97
										Passed Calibration Fa		0.9963	Averages	0.97
7	-2.8	712.025	717.674	5.649	75.2	75.2	730.680	736.190	5.510	68.0	68.0	0.9955	0.00082	0.78
7	-2.8	717.674	723.317	5.643	75.2	75.2	736.190	741.690	5.500	68.0	68.0	0.9947	0.00007	0.78
7	-2.8	723.317	728.975	5.658	75.2	77.0	741.690	747.190	5.500	68.0	68.0	0.9938	-0.00090	0.78
										Passed Calibration Fa		0.9947	Averages	0.78
10	-2.0	728.975	734.645	5.670	77.0	77.0	747.190	752.730	5.540	68.0	68.0	0.9986	0.00215	0.55
10	-2.0	734.645	740.312	5.667	77.0	77.0	752.730	758.260	5.530	68.0	68.0	0.9973	0.00088	0.55
10	-2.0	740.312	745.991	5.679	77.0	77.0	758.260	763.780	5.520	68.0	68.0	0.9934	-0.00303	0.55
										Passed Calibration Fa		0.9964	Averages	0.55
15	-1.9	675.768	681.868	6.100	73.4	75.2	695.230	701.215	5.985	68.0	68.0	0.9974	-0.00135	0.40
15	-1.9	681.868	687.947	6.079	75.2	75.2	701.215	707.180	5.965	68.0	68.0	0.9992	0.00043	0.40
15	-1.9	687.947	694.023	6.076	75.2	75.2	707.180	713.145	5.965	68.0	68.0	0.9997	0.00092	0.40
										Passed Calibration Fa		0.9988	Averages	0.40
										Overall Average Y		0.9963		

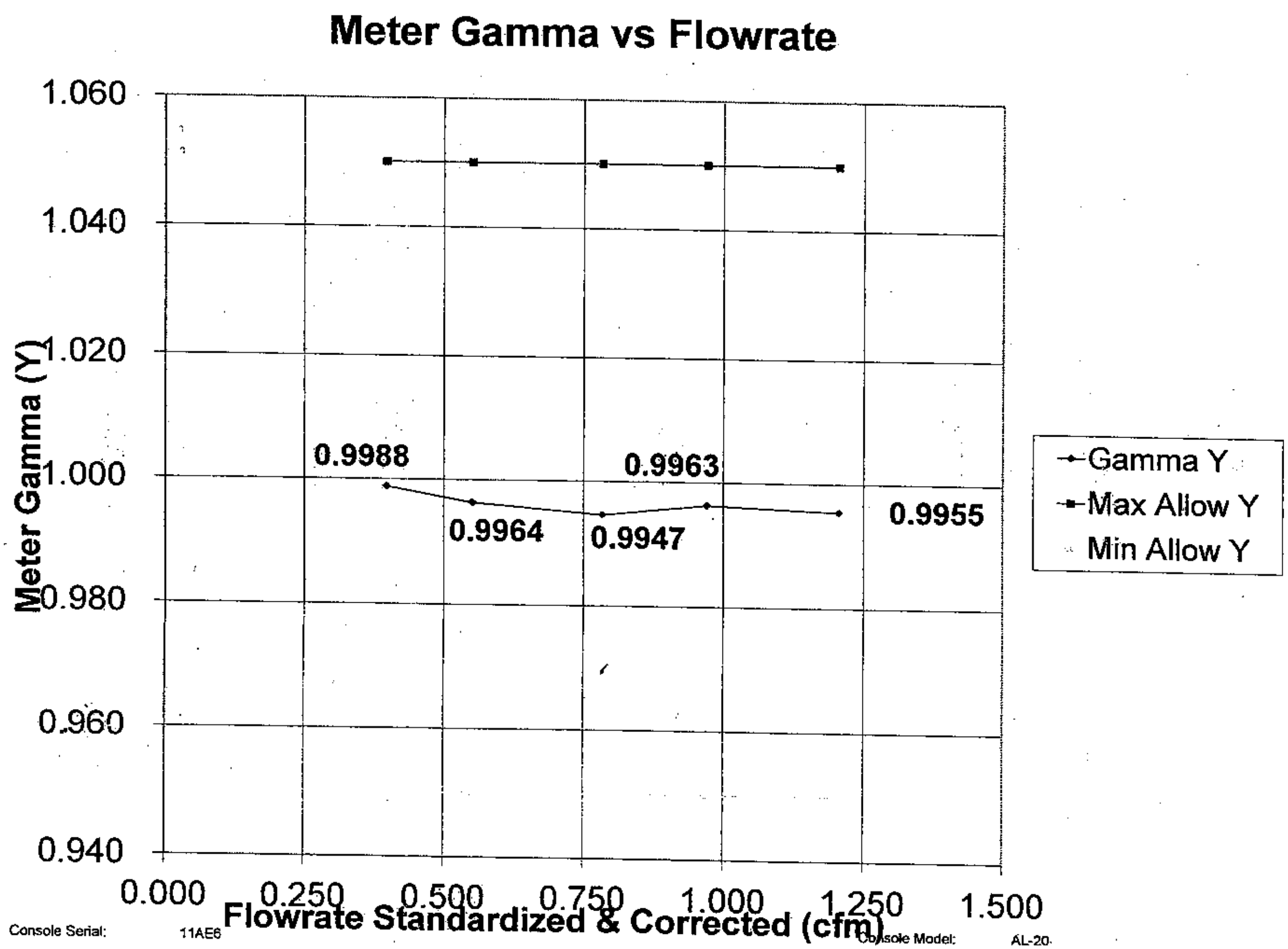
Note: For Calibration Factor Y, the ratio of the reading of the calibration meter to the dry gas meter, acceptable tolerance of individual values from the average is +-0.02.

I certify that the above Dry Gas Meter was calibrated in accordance with USEPA Methods, CFR 40 Part 60, using the Precision Wet Test Meter # 11AE6, which in turn was calibrated using the American Bell Prover # 3785, certificate # F107, which is traceable to the National Bureau of Standards (N.I.S.T.).

Signature [signature] Date 2/18/14

Calibration Date: 2-18-2014

Calibration Technician: EW

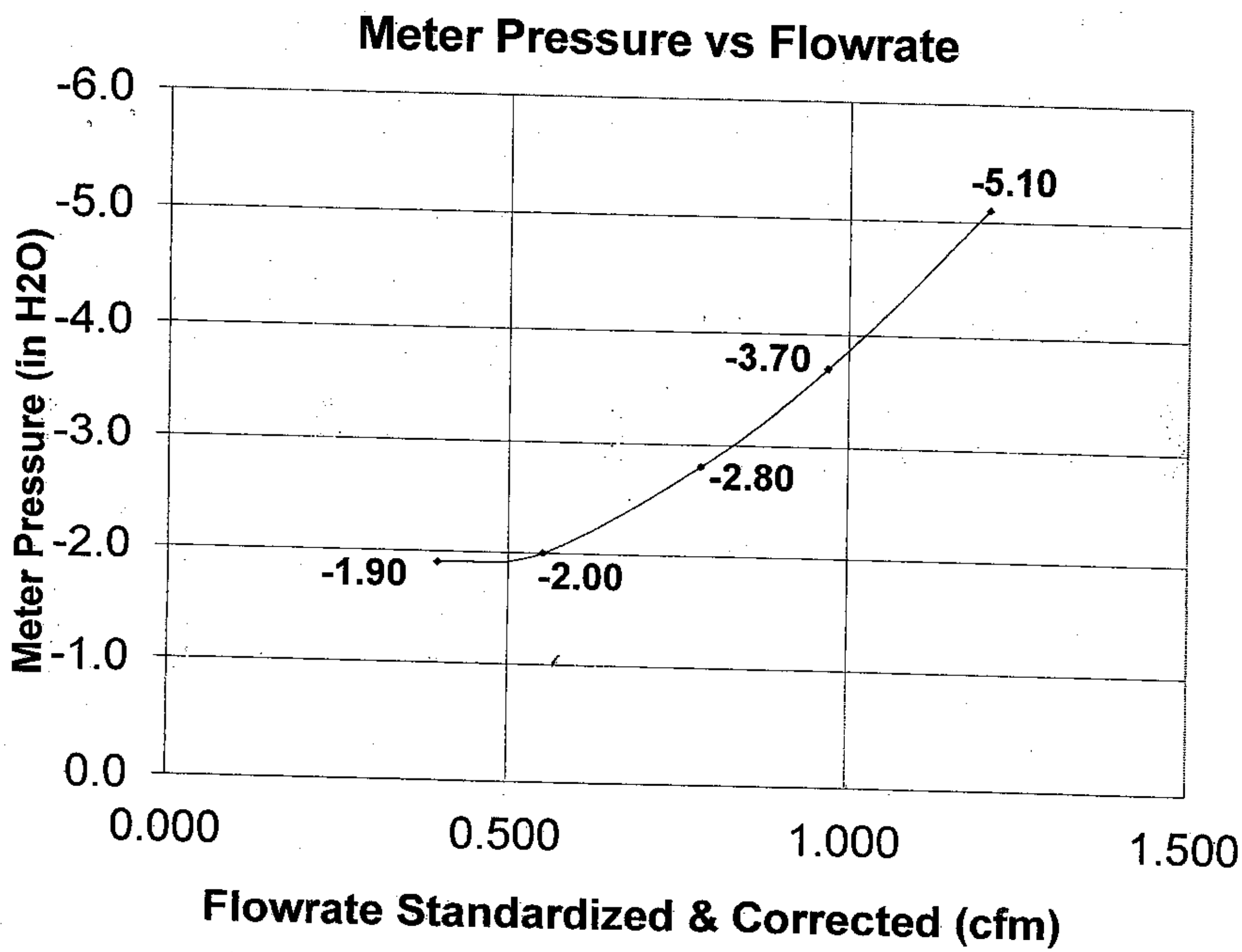


Console Serial: 11AE6

Console Model: AL-20

Calibration Date: 2-18-2014

Calibration Technician:



Console Serial: 11AE6

Console Model: AL-20

VANEOMETER CALIBRATION

Myren Consulting used a Dwyer Model 3480 Vaneometer to measure test chamber air velocity. The manufacturer's specifications for accuracy are ± 5.0% from 0 to 100 fpm and ± 10% from 100 to the top of the scale. Myren Consulting insures that the instrument is level and clean prior taking each reading. According to EPA personnel (Westlin, RTP) no further calibration is necessary.

DRAFT GUAGE CALIBRATION

Myren Consulting used a Dwyer Model 115 AV, a -0.05 - 0.0 - 0.25" inclined red oil manometer (readability resolution ± 0.001" H_2O) 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 needs no further calibration.

The manometer is leveled and zeroed at the start of each test, checked as necessary during a run to verify that the settings have not changed and again at the end of each test run. The results of these checks are recorded on Woodstove Data Sheet #16 in each individual test.

BAROMETER CALIBRATION

Myren Consulting used a Princo Model 453 SN W14275 Mercury barometer and a Weems and Plath aneroid barometer to measure the barometric pressure (BP). The Weems and Plath barometer was calibrated daily by comparing it to the Princo and adjusting it as necessary. The Princo when calibrated following the manufacturer's instructions is a primary standard and needs no further calibration.

MOISTURE METER CALIBRATION

Myren Consulting uses a Delmhorst J-2000 which was calibrated daily using the "Check" feature. Then the operation of the moisture meter was checked with a Delmhorst Moisture Content Standard Model MCS-1 at 12.6 and 23.8%. The results of these checks are recorded on Data Sheet #10.

The readings obtained with the moisture meter are then corrected as per the manufacturer's written instructions for temperature. If Delmhorst #496 insulated pins are used, the meter is set at 222 using the Set Pin Calibration instructions. The meter is set at 1 for the Species correction. 1 is the setting for D. Fir

Woodstove Data Sheet #26-A
CEM Gas Train Response Time
Semi Annual Check

Date	11/17/16	→	→	→	→	→					
Technicians	ATM	→	→	→	→	→					
Elapsed Time	CO_2 Conc.(V)	CO_2 Conc.(V)	CO_2 Conc.(V)	CO Conc.(V)	CO Conc.(V)	CO Conc.(V)	O_2 Conc.(V)	O_2 Conc.(V)	O_2 Conc.(V)	Conc.(V)	Conc.(V)
0 Seconds	.321	.319	.320	1.75	179	1.800					
15	.320	.319	.319	1.74	1.76	1.76					
30	.175	.174	.174	1.62	1.63	1.64					
45	.098	.098	.099	.88	.89	.90					
60	.031	.030	.031	.51	.52	.53					
75	.005	.005	.006	.34	.34	.36					
90	.004	.004	.004	.12	.13	.14					
105	.003	.004	.004	.06	.07	.07					
12	.002	.003	.003	.05	.06	.07					
135	.002	.002	.002	.04	.05	.06					
150	.002	.001	.002	.04	.04	.05					
165	.001	.001	.001	.03	.03	.05					
180	.001	.000	.001	.03	.03	.03					
Initial Response Time (seconds)	~29 Sec	→	→	~40 Sec	~40 Sec	~40 Sec					
95% Response Time (seconds)	>60 <75	→	→	>90 <105	→	→					
Analyser Flow Rate	1.5scfh	→	→	→	→	→					

Comments: 95% = .016V .016V .016 .09 .09 .09

Myren Consulting Inc.

512 Williams Lake Rd; Colville, WA 99114; (509)685-9458

QA WS, REV 1/10

CO_2 Analyzer

Multipoint Calibration Report Form

Site: Myren Lab, Colville, WA Date: 1/3/2017

Analyzer: Make: Horiba Model: PIR 2000 SN: 607204

Calibration by: A.T. Myren

Cal Gas Flow: 1.5 scfh Measured by: Rotameter: X Mass Flowmeter: ______

BP: 28.71 "Hg Instrument ID: Princo

Temp: 59 °F Instrument ID: Omega Digicator Center Stand

Analyzer Last Calibrated: 11/ /2016 By: A.T. Myren

Cylinders:

1. # DOT3AA2265 Concentration: 0.00 % CO_2 Cyl. Press.: 1780 psi.
   Certified By: Oxarc Date: 2/25/16
2. # EB-004176 Concentration: 12.45 % CO_2 Cyl. Press.: 960 psi.
   Certified by: Liquid Technology Corp Date: 4/15/15
3. # 250-1175 Concentration: 21.0 % CO_2 Cyl. Press.: 590 psi.
   Certified by: Oxarc Date: 8/22/94
4. # SX-40585 Concentration: 6.04 % CO_2 Cyl. Press.: 1140 psi.
   Certified by: Matheson Tri Gas Date: 4/12/10

Analyzer: Calibrated Range: 0 – 25 % Output: 0 – 1.0 v.

Flow: 1.5 scfh Measured by: Rotameter: X Mass Flowmeter: ______

Calibration Results

Point #	Cyl. #	% CO_2	Expected		Actual		Adj.		% Dif.	Curve Conc.	Potentiometer	
			Meter	DVM	Meter	DVM	Meter	DVM			Unadj.	Adj.
1	1	0.00	00.0	.000	00.0	.000	—	—	See	Next	4.57	—
2	2	12.45	49.8	.498	48.75	.497	48.75	.498	Page		9.26	9.29
3	3	21.0	84.0	.840	83.0	.842	—	—	↓		—	—
4	4	6.04	24.2	.242	22.0	.23	—	—	↓		—	—
5	1	0.00	00.0	.000	00.0	.000	—	—	↓		—	—

Comments:

Linear Regression Results

Y= MX + B

Slope M= .0402276

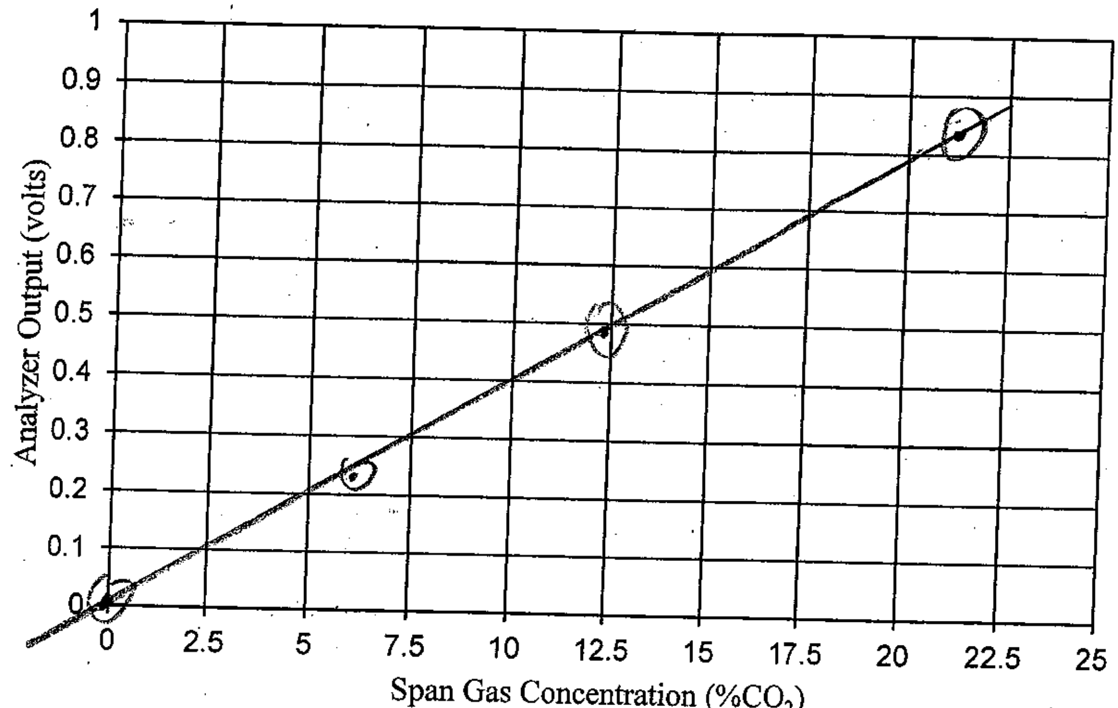
Y Intercept (B)= -0.038968

Correlation Coefficient (r) 0.9999306

Analyzer: Horiba PIR 2000

SN: 607204

Date: 1/3/2017



Comments:

Volts	% CO_2 from cal Curve	± % CO_2 from actual	Δ %	± 2.0% of full scale = ± 0.500
0.000 =	0.0982246	0.0982246	+0.39	ok
0.498 =	12.4760737	+0.0260737	+0.21	ok
0.842 =	21.0262345	+0.0262345	+0.12	ok
0.233 =	5.8894672	-0.1505328	-2.49	ok

0.500 = 12.5257839

Myren Consulting Inc.
512 Williams Lake Rd; Colville, WA 99114; (509)685-9458
QA WS, REV 1/10

CO Analyzer
Multipoint Calibration Report Form

Site: Colville Lab Date: 1/3/2017
Analyzer: Make: CAI Model: 200 SN: 1M12002
Calibration by: A.T. Myren
Cal Gas Flow: 1.5 dscfh Measured by: Rotameter: X Mass Flowmeter: ____
BP: 28.71 "Hg Instrument ID: Princo
Temp: 59 °F Instrument ID: Center Stand Digicator
Analyzer Last Calibrated: 11/ /2016 By: A.T. Myren
Cylinders:

1. #DOT3AA2265 Concentration: 0.00 %CO Cyl. Press.: 1780 psi.
   Certified By: Oxarc Date: 2/05/16
2. #EG 004176 Concentration: 2.61 %CO Cyl. Press.: 960 psi.
   Certified by: Liquid Technology Corp Date: 4/15/15
3. #250-1175 Concentration: 4.03 %CO Cyl. Press.: 590 psi.
   Certified by: Oxarc Date: 8/22/97
4. #SX-40585 Concentration: 1.29 %CO Cyl. Press.: 1140 psi.
   Certified by: Matheson Tri Gas Date: 4/12/10

Analyzer: Calibrated Range: 0-10% % Output: 0-10.0 v.
Flow: 1.5 dscfh Measured by: Rotameter: X Mass Flowmeter: ____

Calibration Results

Point #	Cyl. #	% CO	Expected		Actual		Adj.		Curve Conc.	% Dif.	Potentiometer	
			Meter	DVM	Meter	DVM	Meter	DVM			Unadj.	Adj.
1	1	00.0	00.0	00.0	-.08	-0.08	.00	.00	See	next	547	6.72
2	2	2.61	2.61	2.61	2.71	2.69	2.61	2.60	Page		490	4.32
3	3	4.03	4.03	4.03	4.14	4.11	—	—	↓		—	—
4	4	1.29	1.29	1.29	1.32	1.32	—	—	↓		—	—
5	1	00.0	0.00	0.00	00.0	0.00	—	—	↓		—	—

Comments:

Linear Regression Results

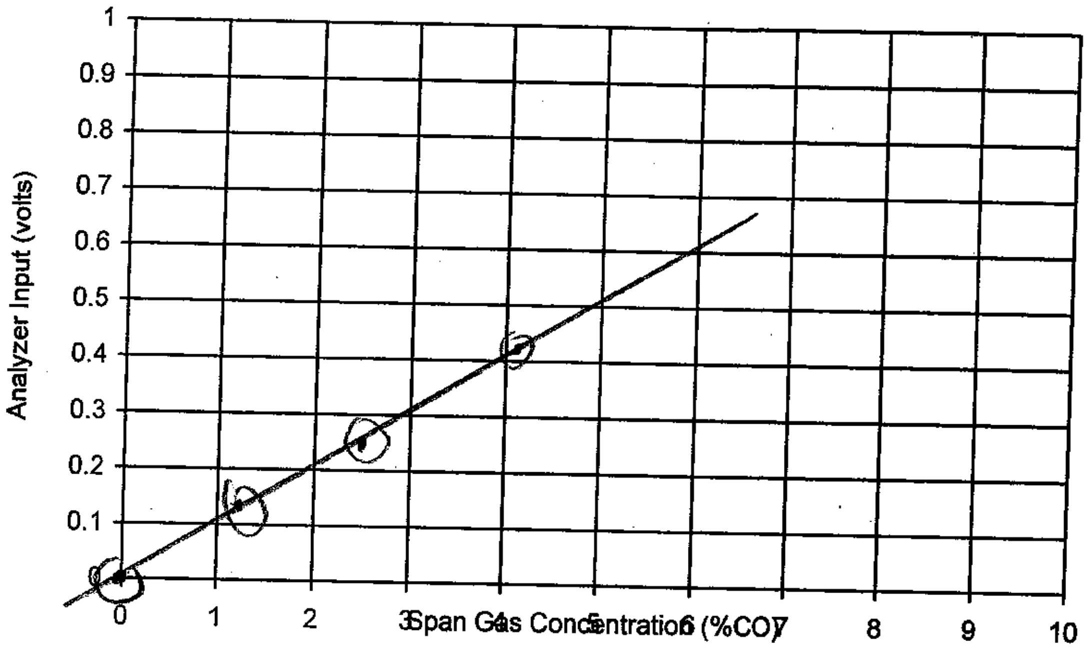
Y= MX + B

Slope M= 1.0313342

Y Intercept (B)= -0.0593850

Correlation Coefficient (r) 0.999388

Analyzer: CAI Model 200
SN:1M12002
Date: 1/3/2017



Comments:

Volts	% CO from = Cal Curve	± %CO Conc. Diff	Δ%	±2.0% of Full Scale
0.00	.0540395	+0.540395	+1.08	ok
2.60	2.5895628	-0.0204372	-0.78	ok
4.11	4.0621167	+0.0321167	+0.80	ok
1.32	1.34113052	+0.0513052	3.98	ok

= 5.0 x .02 = .100%

LIQUID TECHNOLOGY CORPORATIO[N]
"INDUSTRY LEADER IN SPECIALTY GASES"

Certificate of Analysis
- EPA PROTOCOL GAS -

Customer	OXARC, Inc (Spokane, WA)
Date	April 15, 2015
Delivery Receipt	DR-56053
Gas Standard	2.50% CO, 12.50% Carbon Dioxide/Nitrogen - EPA PROTOCOL
Final Analysis Date	April 15, 2015
Expiration Date	April 16, 2023
Component	Carbon Monoxide, Carbon Dioxide
Balance Gas	Nitrogen

Analytical Data:
EPA Protocol, Section No. 2.2, Procedure G-1.

DO NOT USE BELOW 100 [P]

Replicate Concentrations
Carbon Monoxide: 2.61% +/- 0.02%
Carbon Dioxide: 12.45% +/- 0.10%
Nitrogen: Balance

Reference Standards:

			GMIS Traceability
SRM/GMIS:	SRM	GMIS	
Cylinder Number:	CAL-017030	EB-0051547	SRM-2745
Concentration:	4.009% CO (+/- 0.017%)	9.923% CO2 (+/- 0.062%)	CAL-016193
Expiration Date:	07/15/19	02/04/22	15.633% CO2 (+/- 0.037%)
NIST Sample Number:	52-D-54	NA	06/02/17
			9-C-55

Certification Instrumentation

Component:	Carbon Monoxide	Carbon Dioxide
Make/Model:	Nicolet 6700	Nicolet 6700
Serial Number:	APW1100563	APW1100563
Principal of Measurement:	FTIR	FTIR
Last Calibration:	April 15, 2015	April 04, 2015

Cylinder Data

Cylinder Serial Number:	EB-0041761	Cylinder Outlet:	CGA 350
Cylinder Volume:	119 Cubic Feet	Cylinder Pressure:	1700 psig, 70°F

Analytical Uncertainty and NIST Traceability are in compliance with EPA-600/R-12/531.

Certified by: Cole Dylewski

Cole Dylewski

PGVP Vendor ID: E1

"UNMATCHED EXCELLENCE"

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MEDICAL GASES

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SAFETY PRODUCTS
FIRE EQUIPMENT

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FAX (509) 535-0368

BOISE, ID 83709
7615 W. LEMHI ST.
(208) 376-0377
FAX (208) 376-1133

COEUR D'ALENE, ID 83814
3530 RAMSEY RD.
(208) 765-3311
FAX (208) 667-5974

COLVILLE, WA 99114
328 W. 1ST.
(509) 684-3776
FAX (509) 684-6742

ELLENSBURG, WA 98926
704 N. WENAS
(509) 925-1518
FAX (509) 925-1136

HERMISTON, OR 97838
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McNARY HIWAY
(503) 567-7377
FAX (503) 567-2265

KENNEWICK, WA 99336
800 W. COLUMBIA DR.
(509) 582-4202
FAX (509) 586-9859

LEWISTON, ID 83501
2513 3RD. AVE., NORTH
(208) 743-6571
FAX (208) 746-8374

MOSES LAKE, WA 98837
1401 WHEELER ROAD
(509) 765-9247
FAX (509) 766-9958

OKANOGAN, WA 98840
2256 ELMWAY
(509) 826-3205
FAX (509) 826-3905

PASCO, WA 99302
716 SOUTH OREGON
(509) 547-2494
FAX (509) 547-3103

TWIN FALLS, ID 83303
729 COMMERCIAL AVE.
(208) 734-9711
FAX (208) 734-7923

WENATCHEE, WA 98801
OHME GARDENS RD.
(509) 662-8417
FAX (509) 662-1229

YAKIMA, WA 98903
1004 EAST MEAD
(509) 248-0827
FAX (509) 452-8704

Primary Standard Certificate of Analysis
Method of Analysis Micro GC / Gravimetric
Customer: Myren Consulting   Reference # PM7234-2
P.O.#   Cylinder # 250-1175

Results of Investigation

Component	Requested	Concentration
Air	N/A	N/A
Argon	N/A	N/A
Carbon Dioxide	21.0%	21.0%
Carbon Monoxide	4.00%	4.03%
Helium	N/A	N/A
Hydrogen	N/A	N/A
Methane	N/A	N/A
Nitrogen	Balance	Balance
Oxygen	21.0%	21.0%

Hazard Class	UN 1956
DOT Shipping Name	Compressed Gas NOS
Shipping Volume (scf approximate)	160 scf @ ntp
Cylinder Pressure	1500 psig
CGA Valve Connection	350

Oxarc Primary Standard mixtures are prepared with gravimetric techniques using weights traceable to NIST. Mixture blended to +/- 1% relative to minor component and certified to +/- 1% analytical accuracy.

Authorized Signature [signature]   Date 8/25/97
Travis Auger

Comments:

MATHESON TRI•GAS

ask. . .The Gas Professionals™

Certificate of Analysis - EPA Protocol Mixtures

1650 Enterprise Parkway
Twinsburg, Ohio 44087
215-648-4000

Customer: OXARC INC
Cylinder Number: SX-40586
Cylinder pressure: 1600 psig
Last Analysis date: 4/9/2010
Expiration Date: 3/18/2013

Protocol:	Reference #	Lot #
G1	519323	109-96-17643

DO NOT USE THIS CYLINDER WHEN THE PRESSURE FALLS BELOW 150 PSIG

REPLICATE RESPONSES

Component	Certified Conc	Date	Responses	Date	Responses
Oxygen	5.98% ± 1% REL	3/18/2010	5.98% 5.98% 5.99%		
Carbon Dioxide	6.04% ± 1% REL	3/18/2010	6.03% 6.07% 6.01%		
Carbon Monoxide	1.29% ± 1% REL	4/2/2010	1.30% 1.30% 1.30%	4/9/2010	1.29% 1.28% 1.29%

ANCE GAS: Nitrogen

REFERENCE STANDARDS

Component:	Oxygen	Carbon Dioxide	Carbon Monoxide
SRM #:	NTRM-82658	SRM-1674b	SRM-2639a
Sample #:	01110212	7-F-05	54-D-51
Cylinder #:	SX-20658	CAL-014611	CAL-013889
Concentration:	10.09%	6.876 %	0.991 %

CERTIFICATION INSTRUMENTS

Component:	Oxygen	Carbon Dioxide	Carbon Monoxide
Make/Model:	Rosemount 755	Varian 3800 GC	Varian 3800 GC
Serial Number:	2002832	LR-92489	LR-92489
Measurement Principle:	Paramagnetic	TC, FID	TC, FID
Last Calibration:	2/26/2010	3/16/2010	4/2/2010

Notes: T134744

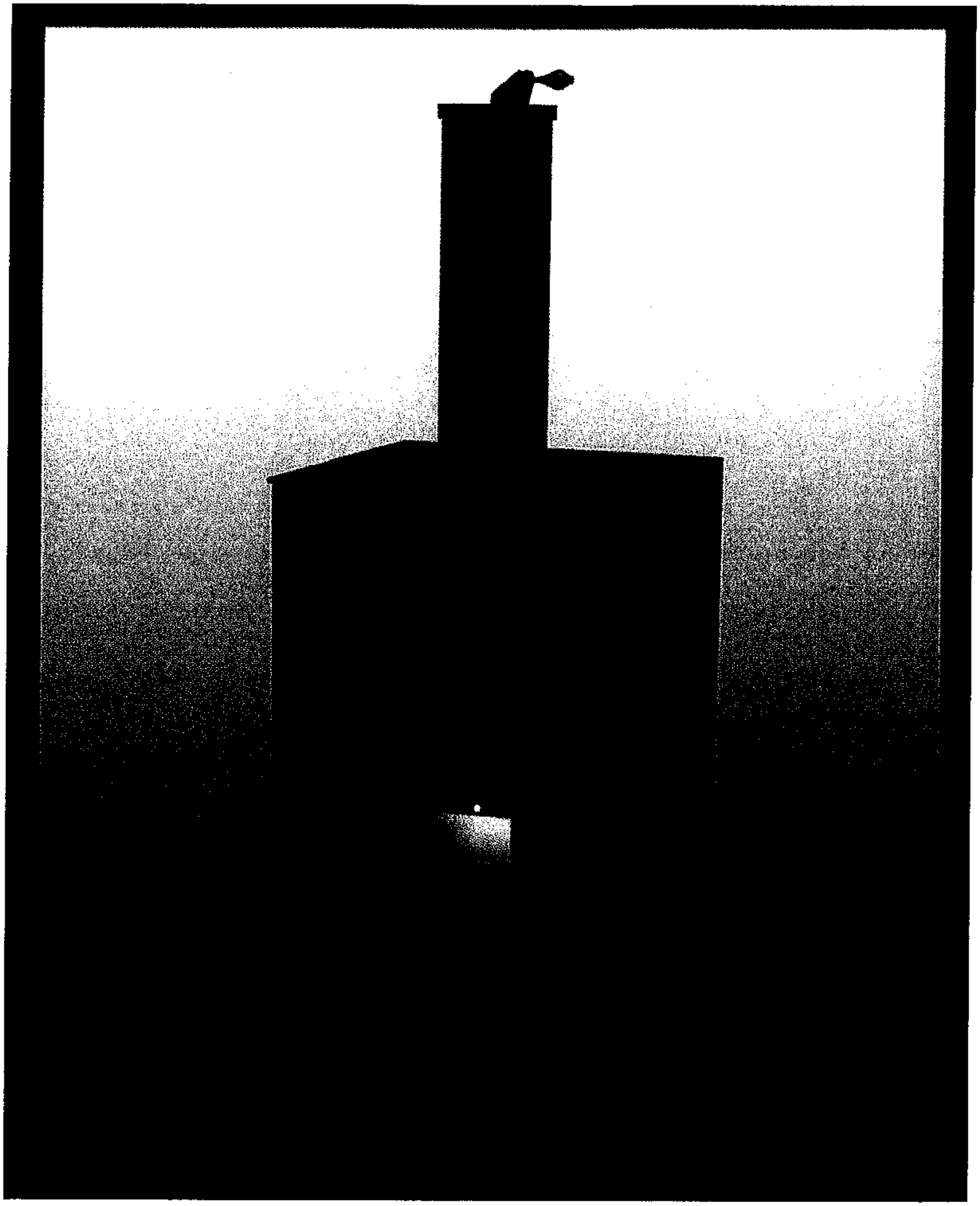
This certification was performed according to EPA Traceability Protocol for Assay & Certification of Gaseous Calibration Standards September 1997, using procedure G1 and/or G2.

Analyst [signature] Date 4/12/2010

509 Stoves
Owner's Operation Manual
Model 509-1

UL 1482 STANDARD FOR SOLID-FUEL TYPE ROOM HEATERS- Edition 7 - Revision Date 2015/08/19
ULC S627 SPACE HEATERS FOR USE WITH SOLID FUELS- Edition 3 - Issue Date 2000/06/01
ASTM E1509 STANDARD SPECIFICATION FOR ROOM HEATERS, PELLET FUEL-BURNING TYPE - Issue Date 2012/10/01

MADE IN U.S.A.



MODEL 509-1

CAUTION!!!

IMPORTANT OPERATING AND MAINTENANCE INSTRUCTIONS INCLUDED.

DO NOT DISCARD.

LEAVE THIS MANUAL WITH THE HOMEOWNER.

Failure to follow the information in this manual may result in a fire; causing property damage, personal injury, or death. Read this booklet completely before installing or operating this appliance.

Do not modify this appliance in any way.

Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.

Comply with all minimum clearances to combustibles as specified. Failure to comply may cause a house fire.

Glass and other surfaces are hot during operation and for some time after the fire has gone out. Supervise children around this appliance. Warn children and adults about high temperatures. High temperatures may ignite clothing or other flammable materials. Keep clothing, furniture, draperies and other combustible materials away.

DO NOT OPERATE WITH THE DOOR OPEN.

CALIFORNIA PROP 65 WARNING:
Use of this product may produce smoke which contains chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm.

IMPORTANT WARNINGS

CAUTION: Read this manual thoroughly before starting installation. For your safety, follow the installation, operation and maintenance instructions exactly without deviation. Failure to follow these instructions may result in a possible fire hazard and will void the warranty. If this appliance is not properly installed, a house fire may result. Contact local building or fire officials about requirements and installation inspection in your area.

1. DO NOT CONNECT THIS UNIT TO A CHIMNEY FLUE CONNECTED TO ANOTHER APPLIANCE.
2. Do not connect this appliance to air ducts or any air distribution system.
3. Do not install a flue damper in the exhaust venting system of this appliance.
4. Do not use class B venting intended for gas appliances as a chimney or connector pipe on this appliance.
5. The minimum clearances must be maintained for all combustible surfaces and materials including; furniture, carpet, drapes, clothing, wood, papers, etc. Do not store firewood next to or touching the appliance.
6. INSTALLATION DISCLAIMER - This stoves exhaust system works with negative combustion chamber pressure and a slightly positive chimney pressure. Therefore, it is imperative that the exhaust system is gas tight and installed correctly. Since 509 Fabrications, Inc. has no control over the installation of your stove, 509 Fabrications, Inc. grants no warranty, implied or stated for the installation or maintenance of your stove, and assumes no responsibility for any consequential damage(s).
7. Burning any kind of fuel consumes oxygen. If outside air is not ducted to the appliance, ensure that there is an adequate source of fresh air available to the room where the appliance is installed. WE HIGHLY RECOMMEND USING OUTSIDE AIR SOURCE IN CASE OF APPLIANCE SHUT DOWN, NO SMOKE WILL FILL THE ROOM.
8. The stove will not operate using natural draft, nor without a power source for the blower and fuel feeding systems.
9. 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 well away from the heater while it is in use.
10. CONTINUOUS OPERATION: When operated correctly, this appliance cannot be overfired. Continuous operation at a maximum burn can, however, shorten the life of the electrical components (blowers, motors, and electronic controls), and is not recommended. Typical approved operation would include running at the low to mid-range setting with occasional running on the maximum setting during the coldest periods of the winter. The blower speed control should be turned to HIGH when operating the stove on the high heat setting.
11. CAUTION: HOT IN OPERATION. An appliance hot enough to warm your home can severely burn anyone touching it. Keep children, clothing and furniture away. Contact may cause skin burns. Do not let children touch the appliance. Train them to stay a safe distance from the unit.
12. APPROVED FUEL: This appliance is designed specifically for densified wood fuels only. This appliance is NOT approved to burn cardboard, nut hulls, cherry pits, corn, etc. regardless if it js in log form. Failure to comply with this restriction will void all warranties and the safety listing of the stove. Consult with your authorized 509 Fabrications, Inc. dealer for more information on approved densified log fuels.
13. FLY ASH BUILD-UP: For all densified fuel heaters, the combustion gases will contain small particles of fly ash. This will vary due to the ash content of the fuel being burned. Over time, the fly ash will collect in the exhaust venting system and restrict the flow of the flue gases. The exhaust venting system should be inspected regularly and cleaned as necessary.
14. SOOT FORMATION Incomplete combustion, such as occurs during startup, shutdown, or incorrect operation of the room heater will lead to some soot formation which will collect in the exhaust venting system. A precautionary inspection on a regular basis is advisable to determine the necessity of cleaning. The exhaust venting system should be inspected regularly and cleaned as necessary.
15. DISPOSING OF ASHES: Any ashes removed from the stove must be deposited in a metal container with a tight-fitting lid. The closed container of ashes should be placed on a noncombustible floor or on the ground, well away from all combustible materials, outside of the dwelling pending final disposal. If the ashes are disposed of by burial in soil or otherwise locally dispersed, they should be retained in the closed container until all cinders have been thoroughly cooled.
16. SAVE THESE INSTRUCTIONS.
17. See the listing label on the appliance or see Safety / Listing Label

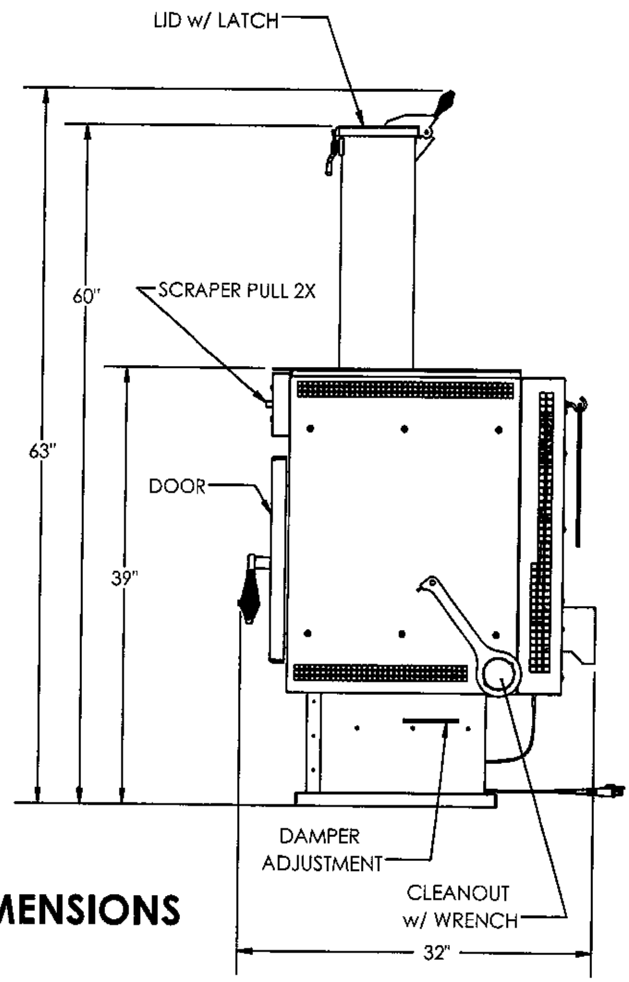
509 Fabrication

Thank you for purchasing our 509 Fabrications, Inc Densified Fuel Log Stove.
This manual is designed to be simple. After reading through it if you have any questions, please feel free to email me anytime at Dusty@509Fab.com <mailto:Dusty@509Fab.com>. I will respond to you as soon as possible.

Very Important: In the unlikely event if your electricity goes out, do not open the door or the lid on the top of the stove. The stove is designed to be air tight. Let the fire go out naturally.
Do not have the lid and the door open at the same time while the fire is burning. You will get smoke in the room. Only open one at a time.
Do not burn wood or any other substance in this stove except natural densified fuel logs with no additives. Burning these types of fuel will void your warranty and heavily damage the inner workings of the stove and exhaust motor.

This manual will cover:

1. Where and How to Install the stove including air intake and exhaust
2. How to Power the stove
3. Types of fuel you "Can and Cannot Burn"
4. How to Light the stove
5. How to Operate the stove and problem solving
6. How to Clean the stove
7. Maintenance
8. Clearance to combustibles
9. Limited Warranty
10. Important Warnings



DIMENSIONS

How to Install the stove

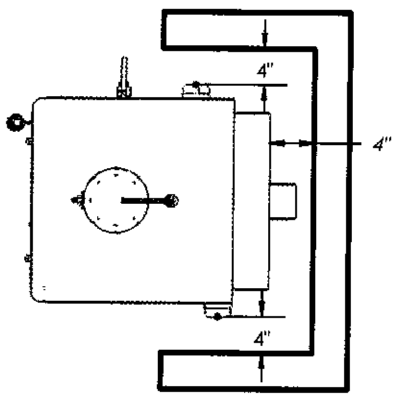
The stove should be installed by a licensed stove company or a licensed HVAC Technician. Some states and counties require permits be obtained before you install your stove.

The outlet on the bottom combustion blower motor is 3" in diameter. Double wall pipe with stainless steel for the inner liner must be used in all installs. It is most commonly called Pellet Pipe. Your installer will know clearances for pipes through the walls and if you choose to run the pipe up instead of out the wall, you will more likely need to use 4" double wall pipe.

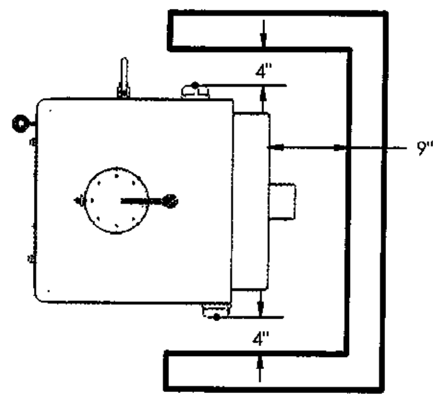
The intake pipe fitting located on the bottom center of the stove is 3". A single wall pipe can be used for the intake air to the outside of the home.

Place the stove on an approved fire pad. Check with your installer in the state you are in to determine clearances on the size of pad. Some can be even with the base of the stove and others need to be one foot or more in size than the outer dimensions of the stove.

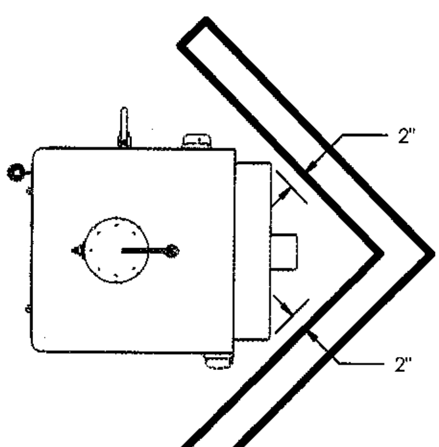
The stove is designed to be pushed back to within inches of the back wall and to be at least one foot from any sidewalls or any other surface. Check with your local permit inspector to verify your clearance from combustibles in your state. We have UL specifications on the stove for clearance to combustibles. (see #8)



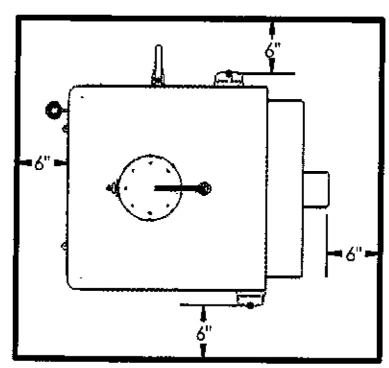
HORIZONTAL INSTALL-EXHAUST
Rear Wall or Alcove



VERTICAL INSTALL-EXHAUST
Rear Wall or Alcove



Corner Wall



Floor Protection

DuraVent - PelletVent Pro - Pipe

Building structure and Air intake and output, The following pages show requirments per UL testing of this stove

509 FAB suggest the DuraVent products and Specifactions (*See Attached Manual*) As an Industerial leader in Pellet Stove Pipe products

How to Power the stove

The stove has one plug-in, 3 prong 6 Ft. cord. Plug it into a 3-prong outlet. **The stove should be plugged into its own outlet for safety and power surges.**

The Fan and Igniter switches are on the left side of the stove on the base. The upper convection fan is plugged into to outlet under the stove.

The round knob is your first switch on the side of the stove and it is on the far left. This switch controls the upper air that will flow into the room. It has a variable speed and can be set to your needs.

The second switch is for your combustion blower. This switch will need to be turned to the up position and be on at all times that the stove is in operation.

The third switch is for your Hot Air Igniter. It is "ON" when the switch is located in the up position. The normal time for ignition is 1 to 3 minutes. **It is very important to not leave this on after you are done lighting the stove. You could damage the igniter.**

What you "Can and Cannot Burn" in your stove.

1. The stove **is not** designed to burn cord wood or wood round logs. **DO NOT BURN WOOD!**
2. The stove **is not** designed to burn any log that has additives in the log to help it burn. These types of logs will void your warranty if burned in your stove. The materials in these logs will also "clog up" the way the stove breathes to be able to operate efficiently and it will also plug up the fan blades on the motor that takes the exhaust out of the stove. Most of these logs that **are not** designed to be burned in your stove will have a wrapper on the log. Some examples of these types of logs are:

A. Duraflame

B. Java Log

C. Pine Mountain

D. Enviro Log

3. You can use the little fire starters that have wax additives in them to light your fire if needed. **One per starting operation.**

Log Fuel for the Stove .

Some logs over time will become "scaley" or rough feeling. This means that they have taken on moisture, just like a pellet will, over time, for a pellet stove. You cannot burn old pellets in a pellet stove but you can still burn your logs in your new stove, they just tend to create moisture inside the tube and water will be on the inside of the lid, so be careful opening the lid to keep the drops from spilling onto the top of the stove.

Be careful when selecting your new logs. They should be smooth and glossy felling to the touch, and have a slight dark color on the outside. Some older logs will start taking shape like a banana, they are not the ones to buy, they are too old to burn well. If you have logs left over from the previous season, it is best to mix them in with the new logs as you burn the stove, and use them to chop into kindling for starting the stove.

If a log sticks in the feed tube then you need to take the scraper tool provided and push it down the tube. Normally a couple of taps with the scraper tool will loosen the log and it will fall down to be burned in the fire.

How to Light the stove

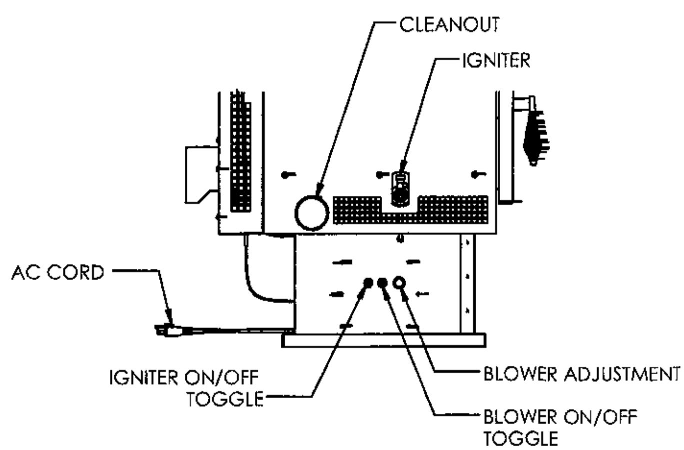
DO NOT USE ANY TYPE OF FIRE STARTING LIQUIDS LIKE CHARCOAL LIGHTER FLUID, GAS, OR ANY OTHER COMBUSTIBLE FOR ANY REASON.

1. Open the door and make sure there is not a log left in the firebox. You can do this by looking at the bottom of the feed tube and down inside the square box. If you cannot clearly see in the fire box, slide the brick in the front over and look in with a flashlight. Slide the brick back into place when finished. If **there is a log in there then follow this procedure**

A. Move the log over to the right.

B. Drop in several little chunks of new log on the left-hand side, as many as can be fit in there without packing them in. Then proceed to # 8.

2. Close the door and latch it.
3. Open up the top lid on the stove
4. Slide the damper handle (located on the right side of the stove on the base) all the way to the front part of the base.
5. Break off some small ends of the logs using a hatchet or our log chipper found on our website. These pieces should be small chunks not full round discs from the logs. Drop about 3 cups of these pieces down the open lid.
6. Chop or break off 3 round discs about ½ inch thick from a log and drop those down the tube.
7. Grab a North Idaho Energy Log, a Presto Log, or a Home Fire Prest-Log or any natural style log and drop it down the tube. **Try and hang onto it as you initially slide it down the tube**
8. Close the top lid and latch it.
9. Open up the ball valve on the left side of the stove. In the closed position the handle will be alongside the stove. In the open position, it will be out 90 degrees from the stove.
10. Turn on the round knob to full speed
11. Turn on the Combustion blower motor, the second middle switch to the up position.
12. Turn the Igniter toggle switch, the 3rd switch to the far left on the base of the stove, to the up position.
13. When you see flames inside the stove, then slide the damper handle towards the back of the stove.
14. Turn off the igniter toggle switch, the 3rd switch to the far left on the base of the stove.
15. Turn the ball valve back to the closed position so it is in-line with the side of the stove.
16. Load the stove with extra logs.
17. Let the stove burn on high for at least 25 minutes before turning the damper down to low or medium burn. There is an indicator on the side of the base to determine your setting. On high you will go through a log every 2 hours or so. On low you will get from 4 to 6 hours out of a log. These figures are based on North Idaho Energy Logs. Other logs that are smaller will burn shorter periods. (Some logs will burn cooler as well in the amount of heat the stove produces, so find the logs that are right for you and your home and use them.) Different brands of logs are available in different parts of the country, just make sure they are a natural log with no additives.



OPERATION - START UP

How to Operate the stove and Problem Solving

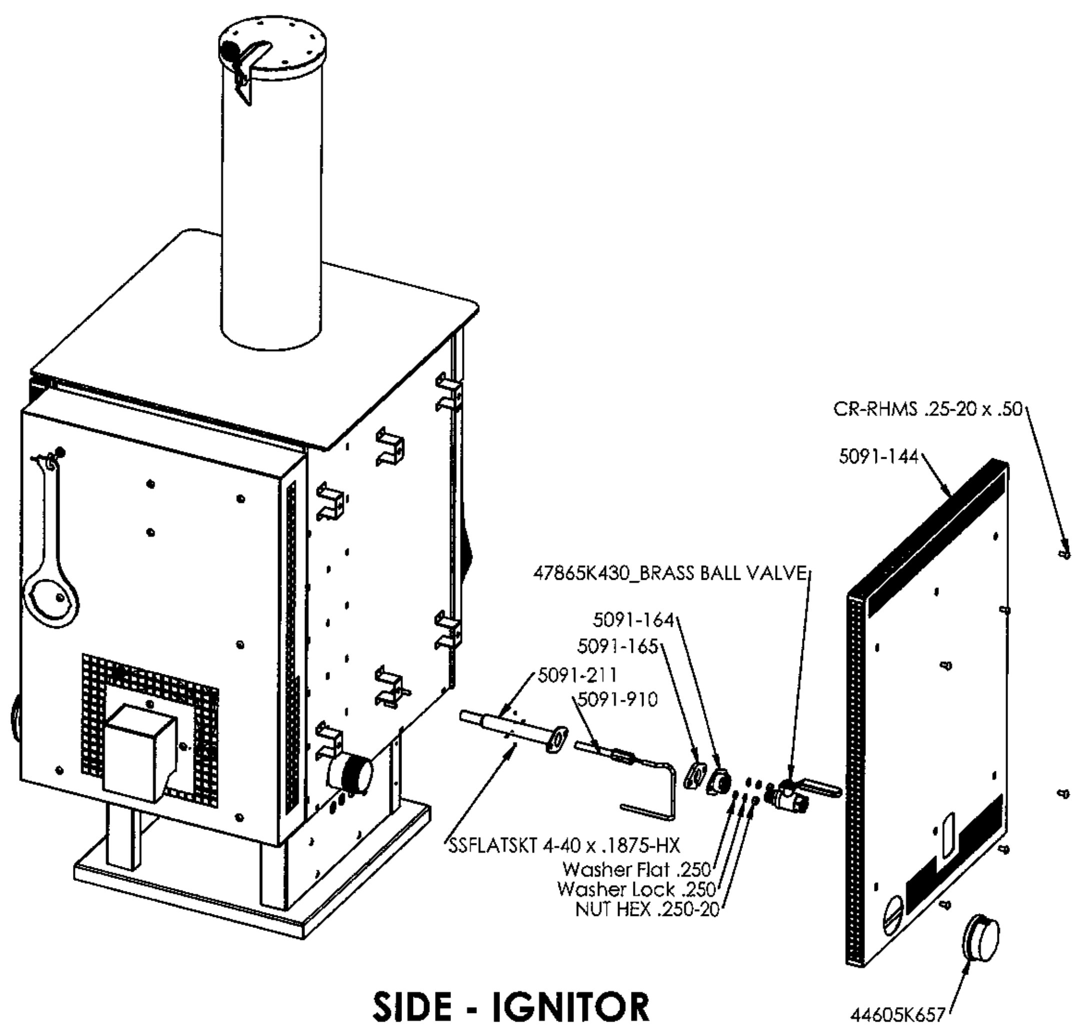
The stove is very easy to operate as it does not have moving parts, and only the 2 fan motors. The biggest mistake to be made on this stove is to not let it burn for at least 25 minutes on high after lighting it. This is crucial to how the stove performs.

1. **I can't get my fire to light with the igniter.** Solutions: The igniter may be covered by a piece of fuel in the fire box. Slide the front brick over and look down in the fire box. Slide the log chunks over to the right of the left edge of the firebox. This will uncover the hole in the brick where the hot air is introduced to light the kindling in the firebox.
2. **My stove is not putting out any heat.** Inspect the fire through the door and make sure that the combustion blower is running and the upper convection blower is blowing air. If you can see a log in the firebox that is not glowing red or flaming, you may need to turn it up. Open up the damper by sliding the lever handle towards the rear of the stove. Let the stove burn for at least half an hour and then turn down to the setting you desire.
3. **My stove is not putting out any heat.** Inspect the fire through the door and make sure the combustion blower is running and the upper convection blower is blowing air. If you do not see glowing or burning in the firebox, then you may have a log stuck in the feed tube. Open up the top lid and look down the feed tube. If you can see a log in the feed tube, then follow this procedure: First, close the lid on top and then open the door. Feel for heat without touching anything on or inside the stove. If it is very hot when you open the door, then close the door and open the feed tube lid. Using a suitable tool, like a round rod, tap the log from the lid side down the feed tube. It will fall into the firebox. Open up the damper by sliding it towards the rear of the stove and let it burn on high for ½ hour and then reset to your desired setting.
4. **My stove is not putting out any heat.** Check the combustion blower and make sure it is on. It is powered "ON" by the middle toggle switch on the base of the stove. Make sure you have power to the plug where the stove is plugged in. You can do this by plugging another appliance into the wall and see if it comes on. If the appliance comes on you will need to call a repair company to replace the blower motor. (I have the blower motors available on my website and I will get you one out right away.)
5. **My stove is not blowing any heat from the convection blower out the front of the stove.** Make sure the blower is plugged in and the switch is turned on. Try unplugging the blower motor from the plug in on the backside of the stove under the base and plugging it into an extension cord. Then plug that cord directly into the wall. If the blower motor does not come on, then the switch or the blower motor is bad. Have a repair company come and fix it and order a blower off of our website.

How to Clean the stove

FOR YOUR SAFETY, IT IS IMPERATIVE TO MAKE SURE THE STOVE IS OFF AND COLD FOR ANY CLEANING PROCEDURE.

1. The glass is NORMALLY easy to clean. The best way to clean the glass is to take a razor blade with a built in safety handle and scrape the glass and then clean it with a product like "Simple Green" or glass cleaner and a paper towel.
2. The inside around the firebox needs to be vacuumed out about every 2 to 3 weeks or longer depending on how often you burn. **Use an "ash vacuum" only to do this. It is what they are made for and then the dust will not blow in the house.** The ash vacuums are available on my website.
3. Inspect the firebox by sliding the front brick to the side or removing the brick. Use a flash light to look in the firebox. If needed, vacuum the firebox out completely.
4. **VERY IMPORTANT!! Every 3 to 4 days take the special wrench provided and using the pin end slide it into the hole on the rod sticking out by the tubes on the top front of the stove. Use wrench to pull the rod from front to back completely 5 or 6 times. This will clean off the radiant tubes so they transfer heat better.**
5. **Every Time you clean the stove...** Use the special wrench provided to loosen the caps on each side of the stove. Unscrew them and use the ash vacuum to vacuum out those tubes. You can slide the end of the hose all the way in until it hits the other side of the stove. Look inside the tube with a light to make sure you have that area clean.
6. The body of the stove itself can be cleaned with glass cleaner, **ONLY WHEN COLD.**

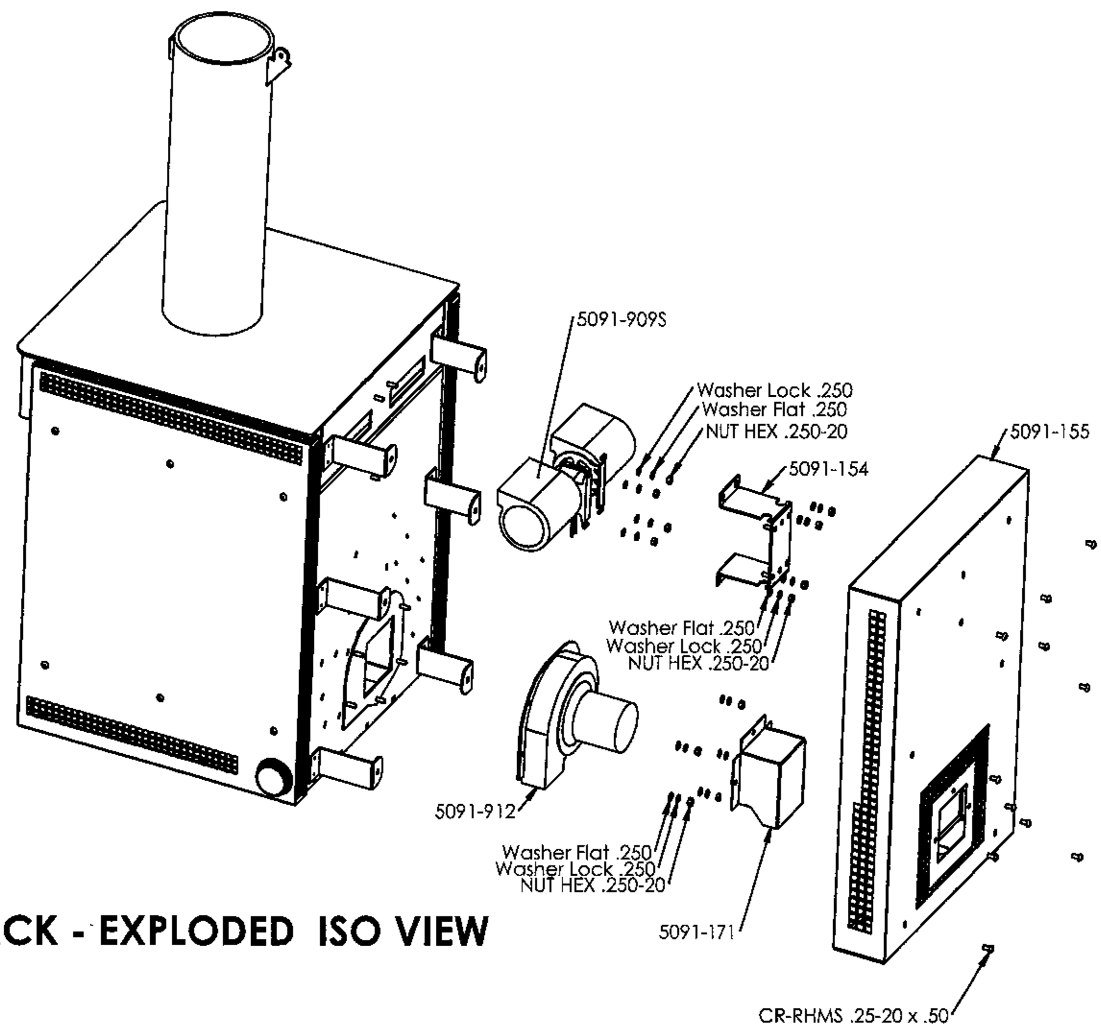


SIDE - IGNITOR

Maintenance

1. Normal cleaning should be all that is necessary. Make sure to clean the radiant heat tubes with the scraper rod and wrench handle every day. This is a 30 second procedure.

One time a year the Lower Combustion motor should be removed and cleaned. The blades will have buildup on them from regular burning. This buildup needs to be removed and cleaned by a professional and the motor re-installed, making sure all nut fasteners and lock washers are used for re-install and tightened down securely. Do not over-tighten the nuts. If the gasket is damaged, it should be replaced to prevent air leaks.
With the combustion motor removed, inspect your chimney pipe inspected for debris, and have it cleaned by a professional at this time if needed. When it is re-installed make sure that all connections are re-sealed and secure.

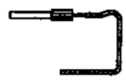


BACK - EXPLODED ISO VIEW

Replacement Parts and Accessories

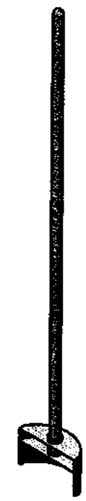
Call 509 Fabrication for Price and Aviability

GLASS, DOOR MAIN



IGNITOR

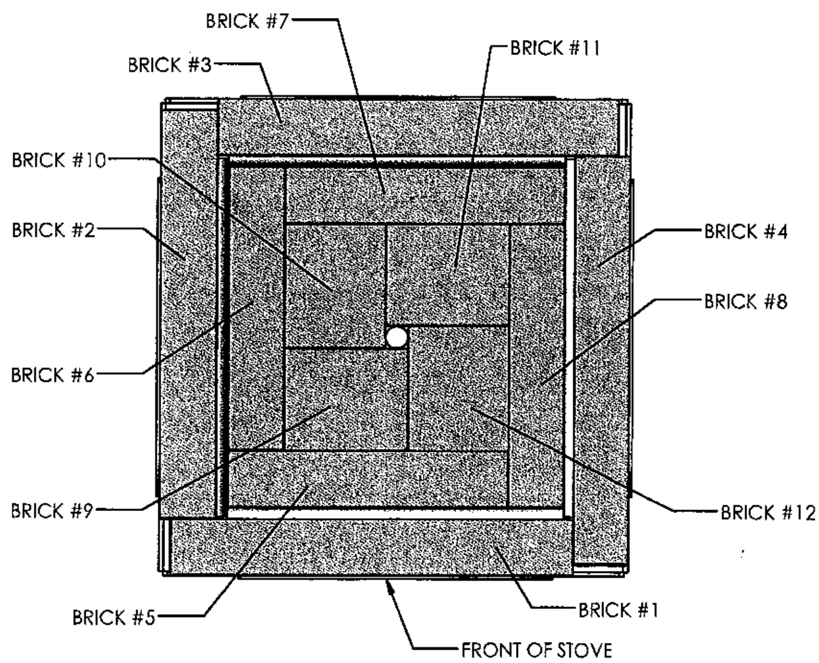
WRENCH-PULLER



SCRAPER, WELDMENT

BLOWER

DRAFT FAN



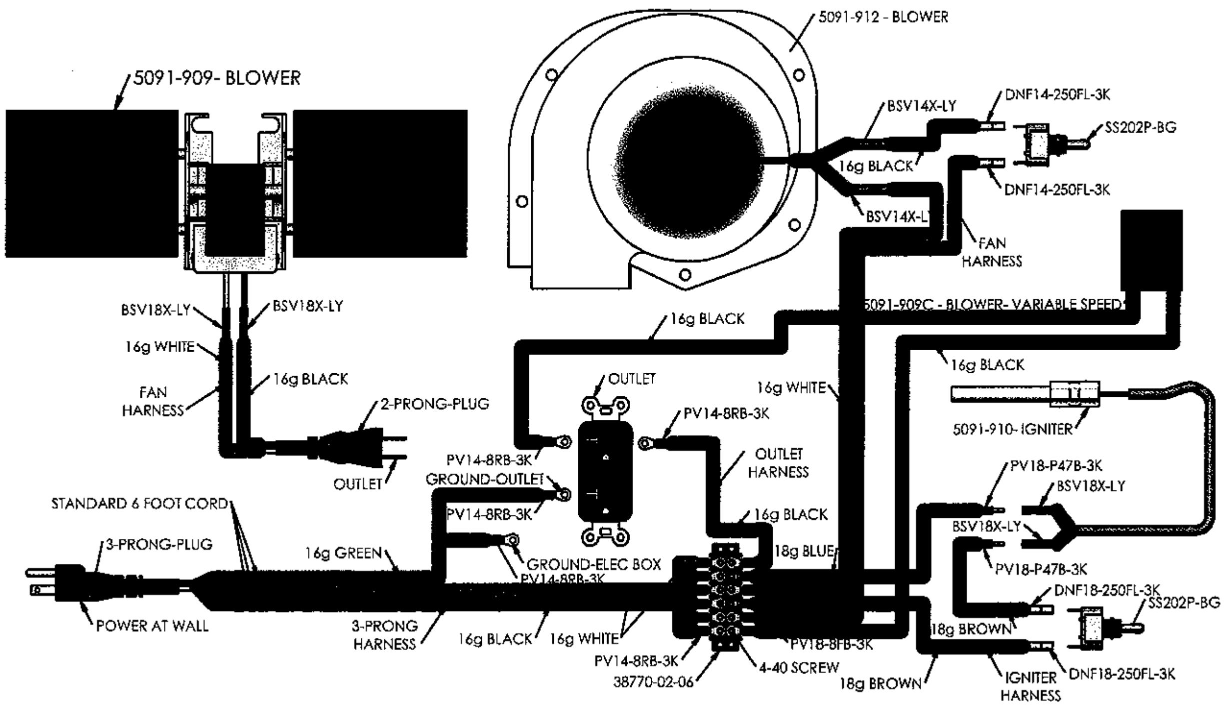
BRICK-FIREBOX

Brick replacement

The upper row of bricks are standard fire bricks except for the front facing brick. It has been cut down for air flow. The bricks can be obtained on the website or a home improvement store.

The inside row of bricks are identified and counted from the front facing brick that stands on its side. Front brick is #1 brick. #2 is to the left, brick #3 is in the back and brick #4 is the one on the right. These bricks are all special to their designated placement, and how they are cut and shaped. The bricks in the bottom of the firebox, if needing replaced, will all have to be replaced at the same time. They are available on the website.

Wiring Diagram



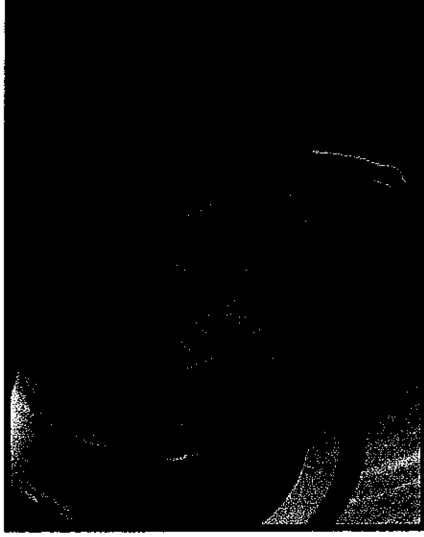
Warranty

These stoves are all built by hand and Made in America by 509 Fabrications, Inc. Post Falls, ID. They have been made with the finest parts and materials available and metal thicknesses that will last a lifetime.

1. The stove body itself, minus the finish paint, is warranted for life by the original purchaser.
2. The convection blower is warranted for 1 year from date of purchase.
3. The Combustion blower motor is warranted for 1 year from date of purchase.
4. The glass is warranted for 1 year from date of purchase.
5. The fire bricks do not have any warranty.

509 Fabrications, Inc.
Post Falls, ID.
www.509Fab.com <http://www.509Fab.com>
Dusty@509Fab.com <mailto:Dusty@509Fab.com>
https://www.facebook.com/509Fab/

Installation Instructions



Venting System for Pellet, Corn, Oil, and Biofuel appliances.

PELLETVENT PRO

DuraVent
Member of M&G Group

A MAJOR CAUSE OF VENT RELATED FIRES IS FAILURE TO MAINTAIN REQUIRED CLEARANCES (AIR SPACES) TO COMBUSTIBLE MATERIALS. IT IS OF THE UTMOST IMPORTANCE THAT DOUBLE WALL PELLETVENT PRO BE INSTALLED ONLY IN ACCORDANCE WITH THESE INSTRUCTIONS.

NOTE:
Read through all of these instructions before beginning your installation. Failure to install as described in this instruction will void the manufacturer's warranty, and may have an effect on your homeowner's insurance and UL listing status. Keep these instructions for future reference. This booklet also contains instructions for installing a venting system within an existing masonry chimney, and for installations passing through a cathedral ceiling.

Dear Customer, Installer, or End User:
We welcome any comments, ideas, input or complaints regarding matters pertaining to DuraVent products.

If you are searching for tech support or product information, please phone us at 800-835-4429. Or email us at:
techsupport@duravent.com

c UL us LISTED ULC LISTED

MH8381, MH14420

VENTING SYSTEM FOR PELLET, CORN, OIL, AND BIOFUEL APPLIANCES.

For the most up-to-date installation instructions, see www.duravent.com

CONTENTS

PELLETVENT PRO

DuraVent
Member of M&G Group

CLEARANCES AND APPLICATIONS

Dura-Vent's PelletVent Pro is listed by Underwriters Laboratories as vent for listed appliances that burn oil, pellet, corn, and other biofuels. PelletVent Pro is also listed as a masonry reliner with the minimum clearance 0" from vent to masonry, and 0" clearance from the masonry to nearby combustibles. Never fill any required clearance space with insulation or any other materials (except insulation explicitly approved by DuraVent as noted below). Combustible materials include (but are not limited to) lumber, plywood, sheetrock, plaster and lath, furniture, curtains, electrical wiring, and building insulation <u>except that noted below</u>.

In the United States and Canada the minimum clearance to combustibles from PelletVent Pro is 1" for oil, pellet, corn or other biofuel applications.

NON-COMBUSTIBLE INSULATION

DuraVent approves the field application of <u>non-combustilble</u> insulation within the clearance to combustible distance (in wall thimbles or support boxes only) if/when desirable. Approved insulation must be listed / compliant with ASTM E136/ULC S114 as Non-Combustible, have a melting temperature above 2000°F/1100°C, be water resistant with low moisture absorbtion and be acceptable to the AHJ. Materials would include those made from stone (aka "rockwool" or "mineral wool" insulations). **<u>NOTE- Fiberglass insulation is NOT approved</u>!**

VENT LISTING

PelletVent Pro is listed by Underwriters Laboratories (files MH8381 & MH14420) to UL 641 Type L Low Temperature Venting Systems, UL1777 Relining, ULC S609 Low Temperature Vents, and ULC/ORD-C441 Standard for Pellet Vents .

INSTALLATION NOTES

Proper planning for your PelletVent Pro installation will result in greater safety, efficiency, and convenience, saving both time and money. Use only authorized Dura-Vent PelletVent, CornVent, PelletVent Pro and MGNA listed parts. Do not install damaged parts.

1. WARNING: When passing through ceilings and walls, make sure all combustible materials and combustible building insulation products are a minimum of 1" from the vent pipe
2. For horizontal terminations, make sure NFPA 211 rules are followed for minimum distance from windows and openings.
3. Do not mix and match with other manufacturer's products or improvised solutions.
4. Practice good workmanship. Sloppy work could jeopardize your PelletVent Pro installation.
5. Never use a vent with an inside diameter that is smaller than the appliance flue outlet.
6. Multistory: Where PelletVent Pro passes through the ceiling, use Dura-Vent Firestop/ Support assembly.
7. PelletVent Pro placement: When deciding the location of your stove and vent, try to minimize the alteration and reframing of structural components of the building.
8. Sections of pipe are connected to each other by pushing them firmly together and twisting. Screws are not required. However, if screws are desired, use 1/4"-long sheet metal screws. Important! Do not penetrate the inner liner with screws.
9. Never install single-wall pipe to freestanding

pellet stoves. Single-wall pipe may be connected to a fireplace insert, provided it is inside the fireplace, and the fireplace has completely sealed surroundings.

10. Do not connect Type B Gas Vent pipe with aluminum liners to pellet appliances.

LUBRICANTS & GASKETS

PelletVent Pro utilizes an internal O-ring gasket on the outside of the inner liner in the female end of the Pipe Section. Depending on production date, these gaskets may be factory lubricated or field lubricated with soapy water / anti-seize. If your O-ring gasket is missing or it becomes damaged during connection, you must replace and lubricate the new O-ring gasket. Contact DuraVent technical service for further information.

SEALANTS

PelletVent Pro does not require additional sealant to be used at pipe joints, but in certain circumstances sealant may be used if desired. Seal the inner liner overlap at the male end of pipe for best results ***(Figure 6)***

Note: 500ºF RTV silicone sealant is required on the following component connections:

- Connecting PelletVent Pro biofuel (with gaskets) to PelletVent Pro (without gasket) or another PelletVent or CornVent.
- Connecting certain Appliance Adapters or other non-gasketed parts to the appliance outlet
- When using the Adjustable Length section.

FUEL SELECTION, BEST PRACTICES

PelletVent Pro is a multi-fuel venting system approved for burning wood pellets, corn, and other approved biofuels, plus, oil and kerosene. Be sure to follow the recommendations of the appliance manufacturer for the burning of corn or other types of biofuel. A major reason for accelerated vent corrosion from burning corn is due to acidic condensate forming in the system. The moisture content of corn contributes significantly to condensate in the vent. The lower the moisture content of the corn, the less condensate you are likely to have in the vent. While corn with a moisture content of 15% may be allowed in the appliance, using a fuel with lower moisture content will help reduce condensate formation.

Vent Runs: Condensate is more likely to form in longer vents because the exhaust temperature cools further away from the appliance. If the exhaust cools to a certain point, moisture in the exhaust condenses in the vent, which can lead to accelerated vent corrosion. Keep the vent for corn-burning appliances short wherever possible to maintain hot flue gas temperatures and keep moisture suspended in the exhaust. If a longer horizontal vent or taller vertical vent is needed, it is recommended that the vent run inside the building envelope or inside a chase enclosure to minimize the vent's exposure to cold temperatures. When terminating a corn burning system horizontally a stainless steel outer Pipe Section and the Round Horizontal Termination Cap are required. Be sure to follow all other applicable building codes and maintain all minimum clearances in enclosures.

Appliance Operation: Regardless of the fuel you choose always operate your appliance in accordance with the appliance manufacturer's recommendations. If you burn corn, operating the appliance at its lowest setting has a greater chance for condensate to form in the vent due to the low exhaust temperature. In order to help reduce condensate from forming inside the vent system, operate the appliance at higher temperatures when colder weather is encountered. Higher operation settings provide for warmer flue temperatures, which help to keep moisture suspended in the flue gases. **Inspection and Maintenance:** When burning corn, be sure to inspect the appliance and vent often to determine if there has been any corrosion or damage to the system. Be sure to keep the venting system clean, including the tee cap (if applicable). The ash that results from burning corn can trap condensate in the tee cap and inside the vent, hastening corrosion to the system if left unchecked. Using pelletized fuel does not eliminate the need for inspection and cleaning. Lesser quality pellets create more soot accumulation and can clog venting sooner than the cleaner burning pellets. While it is not necessary to clean out liquid fuel burning systems with a brush, all other systems should be visually inspected monthly during the heating season, and cleaned at least once a year

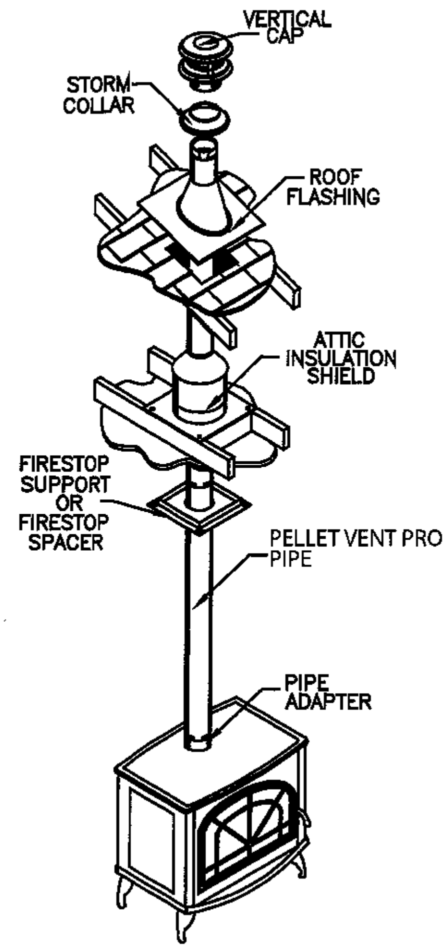


Figure 1

TOOLS AND EQUIPMENT YOU MAY NEED

Eye Protection
Gloves
Screwdriver
Hammer
High-Temperature Waterproof (RTV) Sealant
Tape Measure
Saber or Keyhole Saw
Level and Plumb bob

PERMITS

Contact your local building department or fire officials regarding any needed permits, restrictions, and installation inspection requirements in your area.

GENERAL INSTALLATION INSTRUCTIONS

PelletVent Pro is listed with a minimum 1" clearance to combustibles

1. Follow the stove/appliance manufacturer's instructions.
A. Choose an appliance that is listed by a recognized testing laboratory.
B. Connect only one flue per appliance.
C. Only burn fuels approved for use by your appliance manufacturer.

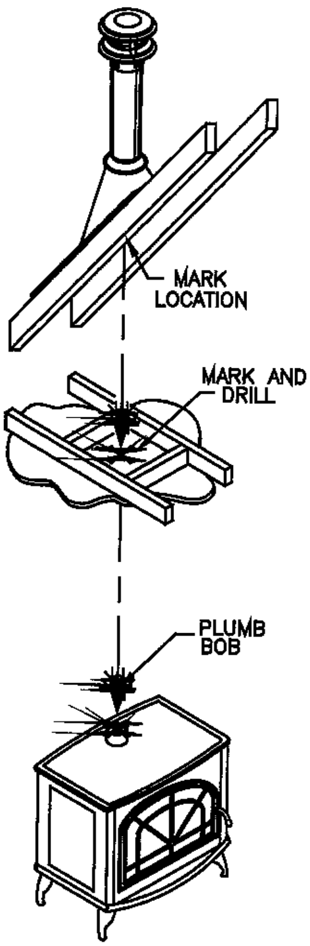


Figure 2

D. Follow the appliance manufacturer's instructions and safety manual for maximum efficiency and safety. Over firing can damage the appliance and vent.

2. If the vent exit is on top of the stove ***(Figure 1)***:

A. Place the appliance according to the manufacturer's instructions.

B. Drop a plumb bob to the center of the appliance flue outlet and mark center point on the ceiling ***(Figure 2)***. At your marked center point, cut and frame a square hole in the ceiling for installation of the Ceiling Support or

PELLETVENT PRO COMPONENT	FRAMING DIMENSIONS
3" & 4" CEILING SUPPORT / FIRESTOP SPACER	7 ¼" X 7 ¼"
3" & 4" CATHEDRAL CEILING SUPPORT BOX	10 ¾" X 10 ¾"
3" & 4" WALL THIMBLE 3" & 4" CAS WALL THIMBLE	7 ¼" X 7 ¼"
3" & 4" WALL THIMBLE AIR INTAKE KIT	11" X 11"

Table 1

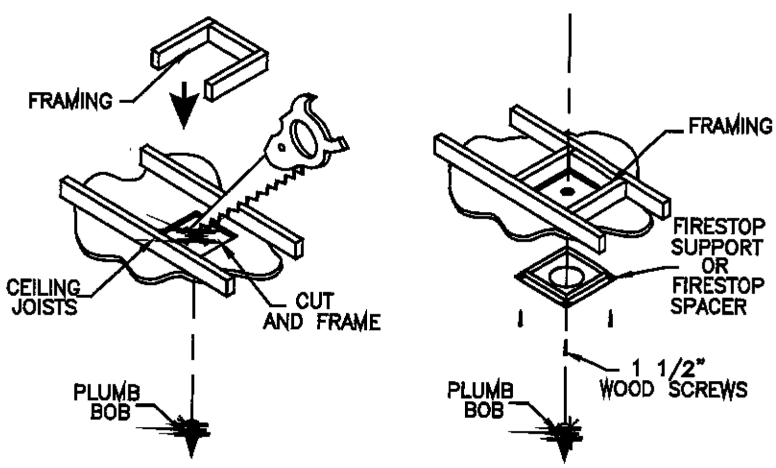


Figure 3

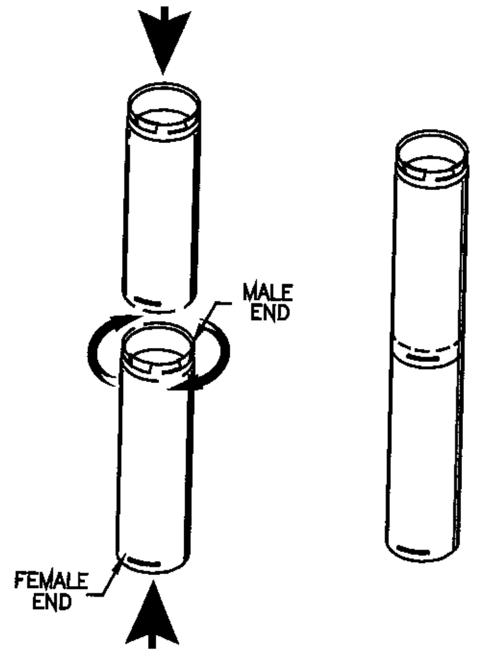


Figure 4

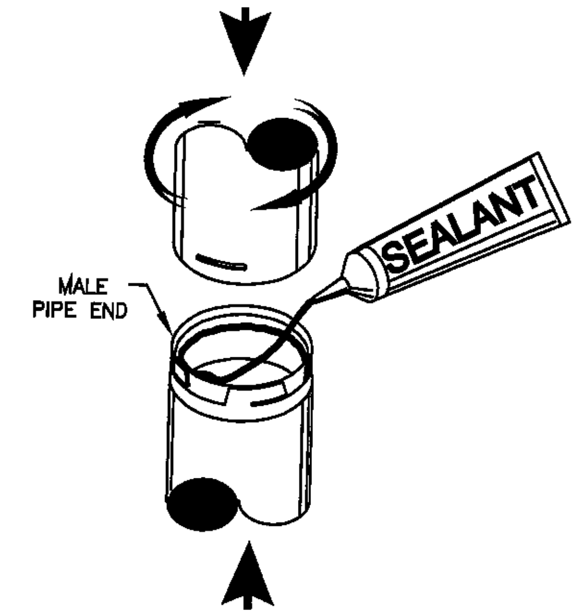


Figure 5

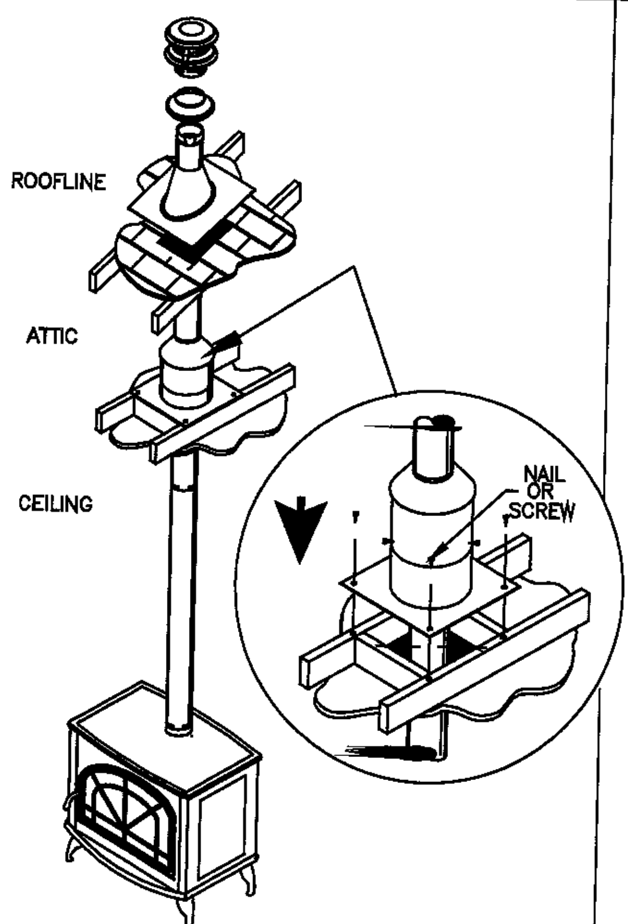


Figure 6

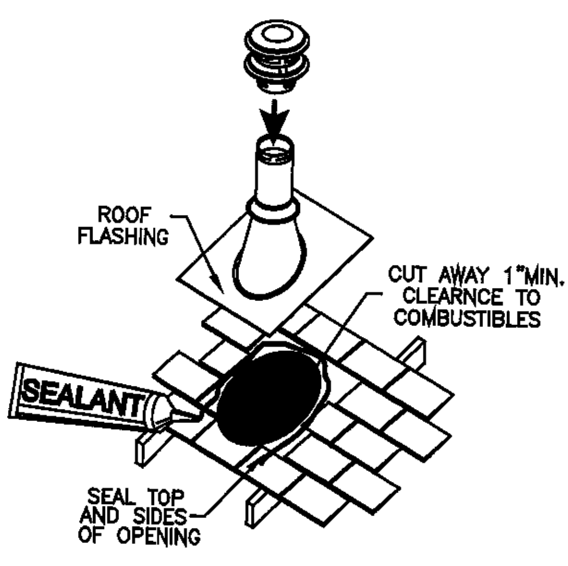


Figure 7

Firestop Spacer ***(Figure 3)***. Refer to ***Table 1*** for the dimensions of the hole.

C. Connect Pipe Adapter or Increaser Adapter to stove: Due to the variety of different stove collars, the Pipe Adapter will need high-temperature non-hardening sealant in order to achieve a leak-free connection. .

D. Connect Pipe Sections. Attach PelletVent Pro Pipe Sections by pushing male and female ends of pipe together and twisting until pipe is in locked position ***(Figure 4)***. PelletVent Pro pipe sections do not require any sealant; however in certain instances high temp silicone sealant may be used. Seal connection where the inner liners overlap for best results ***(Figure 5)***. Screws are not needed, but 1/4" screws can be used if desired, however, be sure you do not penetrate the inner liner.

E. When the pipe passes through the Ceiling Support Firestop Spacer at ceiling, tighten bolt and clamp around pipe. Where the vent passes through additional floors and ceilings, always install a Ceiling Support Firestop Spacer.

F. ALWAYS MAINTAIN AT LEAST 1" CLEARANCE FROM COMBUSTIBLE MATERIALS TO THE VENT PIPE.

G. When the PelletVent Pro enters the attic, install an Attic Insulation Shield around the vent ***(Figure 6)***. This will prevent insulation and debris from collecting near the vent pipe. Use (4) nails or wood screws to secure the base of the Attic Insulation Shield to the framed opening. Adjust the height of the Attic Insulation Shield by sliding the top cylindrical shield over the one from the base. Ensure that the top of the Shield is above the level of building insulation. Secure the Shield in place with at least two (2) sheet metal screws through the side of the cylindrical shield. Attach collar around pipe, then lower to the top of the Attic Insulation shield.

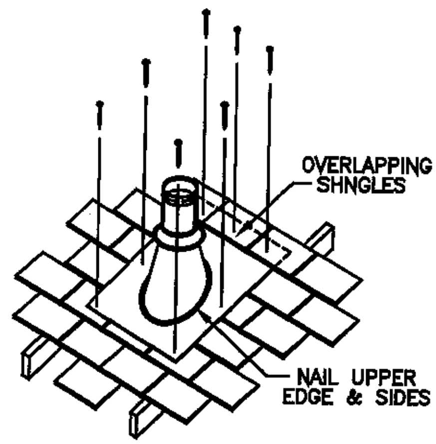


Figure 8

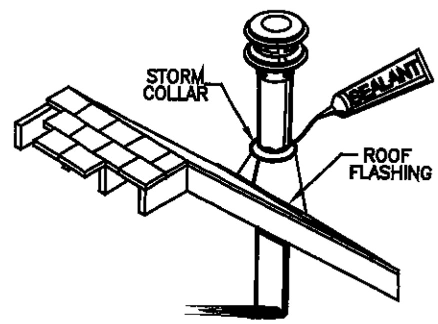


Figure 9

H. After lining up for the hole in roof, using the same method as 2. (B), cut either a round or square hole in the roof ***(Figure 7)***. Always cut the hole with the proper clearance to the vent pipe. Install the upper edge and sides of Flashing under the roofing materials and nail to the roof along the upper edge and sides ***(Figure 8)***. Do not nail across the lower edge. Seal all nail heads with non-hardening waterproof sealant.

I. To finish, apply non-hardening waterproof sealant where the Storm Collar will meet the vent and Flashing; slide Storm Collar down until it rests upon the Roof Flashing ***(Figure 9)***. Holding the base of Cap, firmly twist lock your Vertical Termination Cap onto supported Pipe

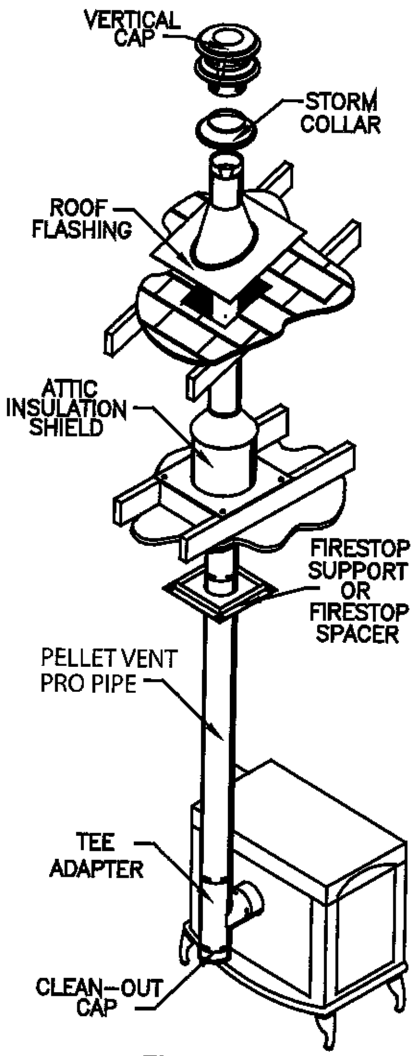


Figure 10

Section protruding through the roof line.

3. If the flue exits on back of stove and an interior installation is desired ***(Figure 10)***:
A. Place the appliance according to the manufacturer's instructions.
B. Connect the Tee Adapter or combine Tee with Cleanout and Pipe Adapter then seal and secure the Pipe Adapter to the back of the stove.
C. Continue to assemble Pipe Sections as described in **Step 2.**

4. If the flue exit is on the back of stove, and

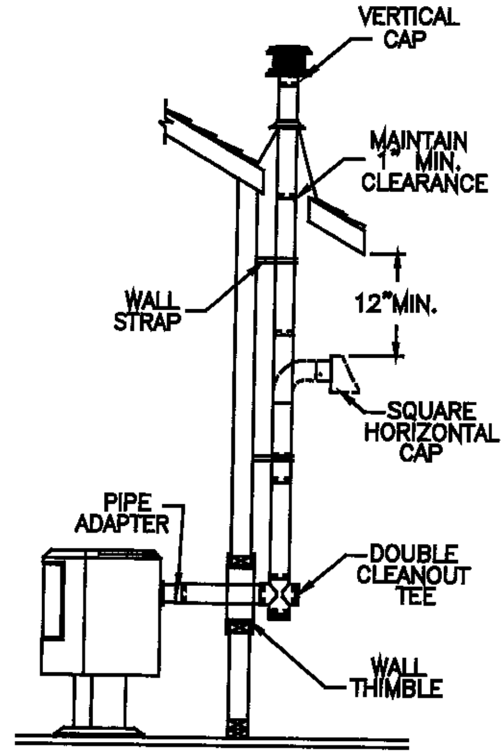


Figure 11

an exterior vertical installation or partial vertical installation is desired ***(Figure 11)***:
A. Place the appliance according to manufacturer's instructions.
B. Cut and frame a square opening in the wall as specified in ***Table 1***. PelletVent Pro can be installed with the standard Wall Thimble, Wall Thimble Air Intake Kit , or CAS Wall Thimble for through the wall installations. If the CAS Wall Thimble is used, refer to the PelletVent Pro CAS Installation Instructions for direction on how to install the Combustion Air System (CAS). The Wall Thimble Air Intake Kit allows combustion air to be drawn through the framed Thimble opening, eliminating the need to cut another opening in wall. The small flex provided with this kit allows connection to the Pellet Stove combustion air inlet. Note that when installing the Wall Thimble Air Intake Kit, the pipe will not be centered within the framed opening. Loosely assemble both

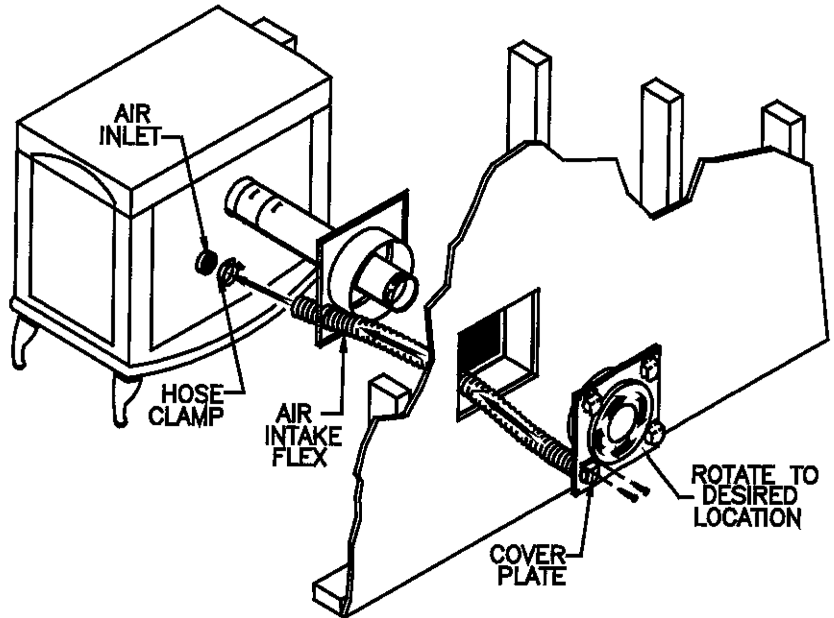


Figure 12

halves of the Wall Thimble onto Pipe Section. Connect the flexible hose with clamp to the exterior half of the Wall Thimble. Guide the flex through the opening in black interior half of Wall Thimble, gently pull the flex towards appliance ***(Figure 12)***, and if necessary trim excess flex to required length with snips. Secure flex to combustion air inlet of the stove with clamp provided. Only connect metal flex to the appliance; do not substitute or install plastic flex. The cover plate comes installed on the lower left corner of the thimble with intake guard pointing downward to deflect rain. If it is desired to rotate thimble and air inlet to another corner, remove the (2) screws on the inlet guard and re-attach over air inlet at new location. Secure black interior half of the Wall Thimble to the interior wall, and the unpainted exterior half are to be secured to the exterior wall on both styles of thimbles ***(Figure 13)***. The Wall Thimbles adjust to fit walls from 4"-8" thick. For installation in thicker walls an extension tube may be field fabricated. **WARNING:** Do ***NOT*** install any combustible insulation or other combustible material not approved by DuraVent within the Wall Thimble

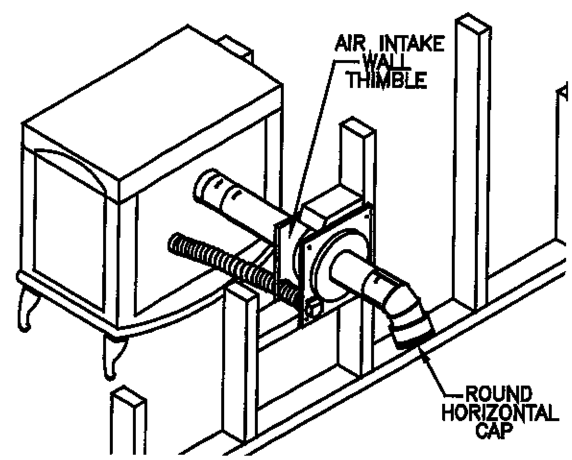


Figure 13

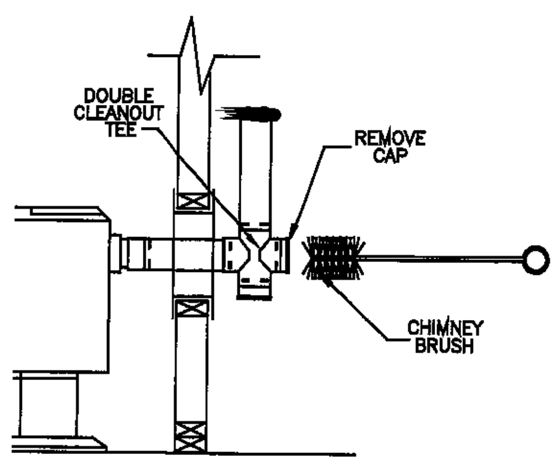


Figure 14

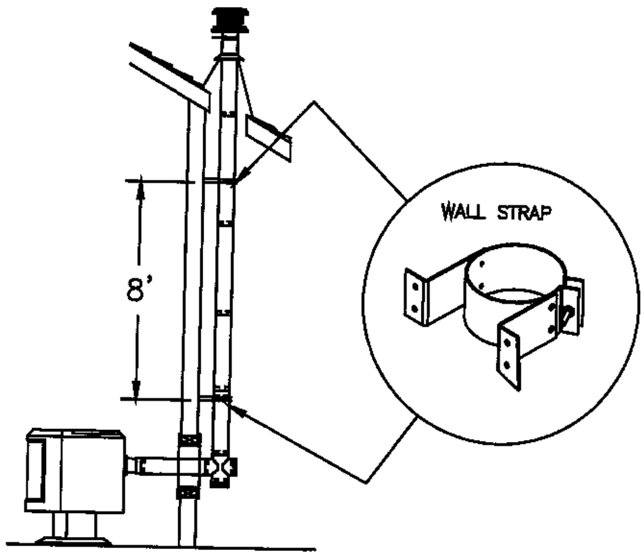


Figure 15

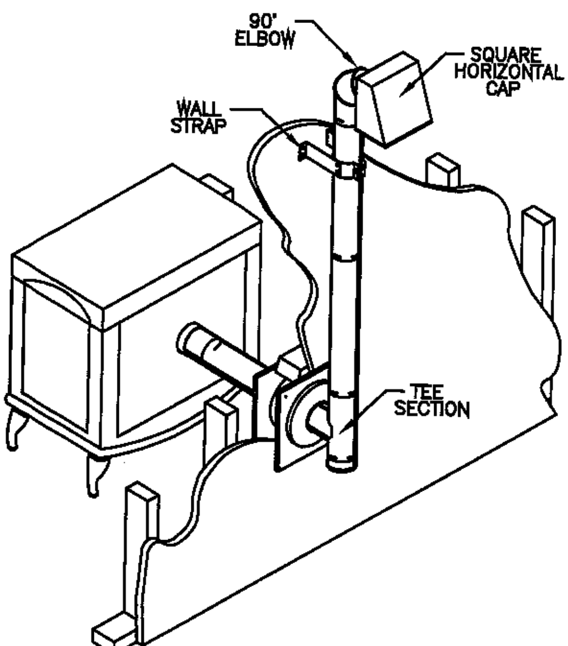


Figure 16

itself. Doing so can create a fire hazard. The Wall Thimble ensures the clearance to combustible material is maintained to make a safe installation. Non-Combustible insulation (as defined earlier in this text) may be installed within the thimble and clearance to combustible distance if desired. **Note: Fiberglass insulation is NOT APPROVED**.

C. Connect a Pipe Adapter and Pipe Section together then seal connection to rear exhaust outlet. Attach a Single Tee with Clean out adapter or a Double Tee with Clean-Out Adapter, and proceed attaching Pipe Sections up the wall. Installing a Double Tee with Cleanout Adapter on the exterior of wall, allows brushing of the Horizontal Vent run through to appliance ***(Figure 14)***.

D. Attach Wall Strap just above the tee. Wall Straps must be placed every 8-feet along an exterior vertical run ***(Figure 15)***. If your exterior vertical run terminates horizontally before penetrating the roofline, install at least one Wall Strap on the Pipe Section before 90 Degree Elbow and Horizontal Cap ***(Figure 16)***. Under no circumstances can a Vertical Cap be installed adjacent to vertical wall. PelletVent Pro offers fixed and Adjustable Wall Straps to maintain a 1"-3" clearance, as desired. If Assemble Pipe Sections in the same manner described in Step 2 of the general instructions.

E. Seal the exterior section of the Wall Thimble to the wall with non-hardening waterproof sealant. As an option, you may also seal the gap between the pipe and Wall Thimble with sealant.

5. If the flue exit is on back of the stove, and a horizontal through-the-wall installation is desired ***(Figure 13)***:

A. Place the appliance according to manufacturer's instructions.

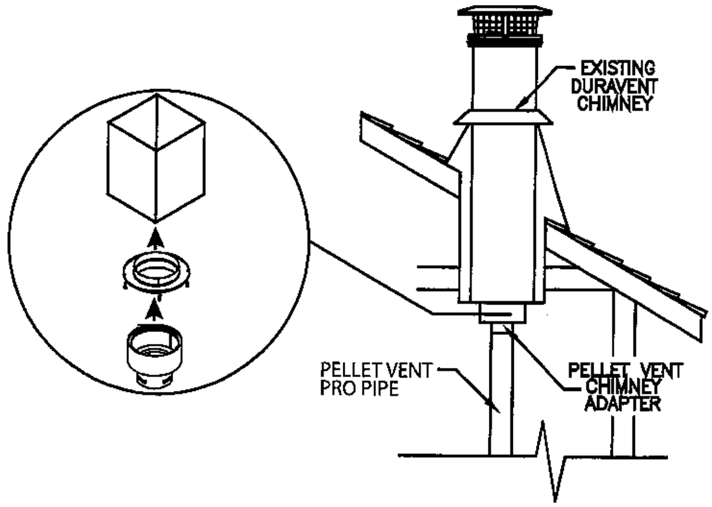


Figure 17

B. Connect the Appliance Adapter and sufficient Pipe Sections, seal and secure to back of stove. Horizontal Pipe sections must penetrate Wall Thimble and extend at least 6" beyond the exterior wall after Horizontal Cap is attached. If you are burning Corn you must use a Round Horizontal Cap. Pipe Sections exposed to exhaust gases between wall and Cap must have a Stainless Steel outer liner. The Round Horizontal Cap can be swiveled to be directed away from nearby objects (fence, plants, etc.), but must still be pointing in a generally downward direction. Important: Horizontal Caps must be pointed in a downward direction to insure rain and snow do not enter the cap, and cause potential damage to the appliance.

C. Follow the below listed NFPA 211 rule for distance of exit terminal from windows and openings:

NFPA 211 (2006 ed.) Section 10.4 Termination: 10.4.5

(1) The exit terminal of a mechanical draft system other than a direct vent appliance (sealed combustion system appliance) shall be located in accordance with the following:

(a) Not less than 3 ft (.91m) above any forced air inlet located within 10 ft. (3m).

(b) Not less than 4 ft. (1.2m) below, 4 ft. (1.2m) horizontally from or 1 ft. (305mm) above any door, window or gravity air inlet into any building

(c) Not less than 2 ft. (0.61m) from an adjacent building and not less than 7 ft. (2.1m) above grade when located adjacent to public walkways.

If using the Wall Thimble Air Intake Kit, the installation may be considered a direct vent system, as defined by NFPA 211. Check with local building officials for clarification. If so, the clearances for the exit terminal are as follows: For an appliance with an input of 10,000 Btu/h (2930 W) or less, the vent terminal shall be located at least 6" from any opening into a building. For an appliance with an input of greater than 10,000 Btu/h but less than 50,000 Btu/h (14650 W), the vent terminal shall be located not less than 9" from any opening into a building. For an appliance with an input over 50,000 Btu/h (14650 W), the vent terminal shall be located not less than 12" away from any building opening. The bottom of the vent terminal and air intake must be located a minimum of 12" above grade.

6. If it is desired to attach to an existing 6"-

8" DuraTech, DuraPlus or DuraPlus HTC chimney, either roof supported or ceiling supported ***(Figure 17)***:

A. Remove any existing connector pipe, adapter or connector going into the ceiling support box.

B. Visually inspect with a flashlight the condition of the interior of the chimney for cleanliness and structural integrity. All evidence of soot and creosote must be removed from the existing chimney system. If you doubt your ability to accomplish this, contact a certified chimney sweep. Do not use chemical cleaners, as these can possibly damage the inside of the chimney. Do any required maintenance on the existing chimney system at this time.

C. Install a DVL/DuraBlack Chimney Adapter in the existing Ceiling Support Box. Note that the DVL/DuraBlack Chimney Adapter only connects to Dura-Vent chimney systems.

D. Connect the appropriate size Chimney Adapter to the DVL/DuraBlack Chimney Adapter.

E. Connect the appliance to the Chimney Adapter using an Appliance Adapter, lengths of pipe as required, and an Adjustable Length pipe. Slide the Adjustable Length down over the top pipe section, position the installation vertically plumb, then slip the Adjustable Length up and twist lock it to the Chimney Adapter. Once all the components are firmly seated and properly aligned, carefully drill three 1/8" diameter holes through the outer sleeve only in the center of the slots located at the bottom of the Adjustable Length pipe. Do not penetrate the inner liner. Use (3) 1/4" length sheet metal screws to secure the

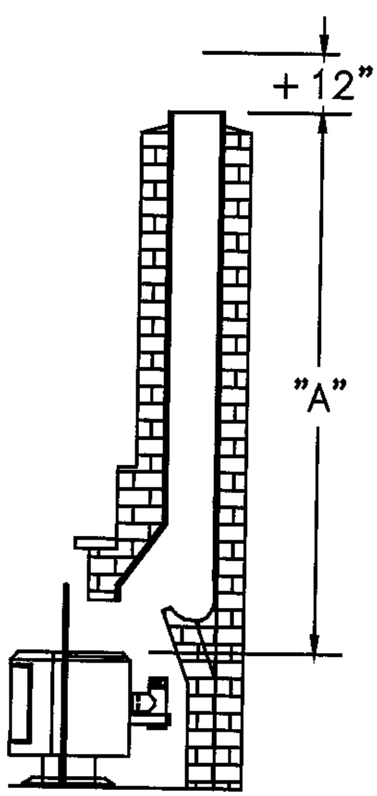


Figure 18

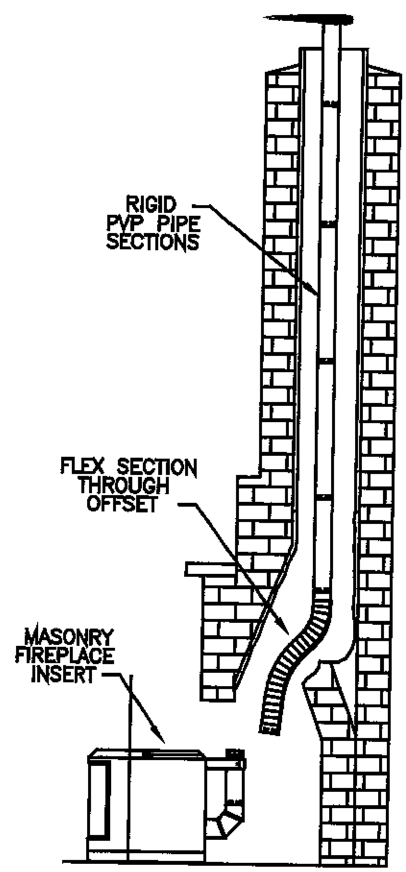


Figure 19

Adjustable Length pipe.

INSTALLATION INTO A MASONRY FIREPLACE

1. Have the masonry chimney inspected by a certified chimney sweep or installer to determine its structural condition.

2. Carefully read the pellet stove or insert installation instructions.

3. Measure and record the dimensions as shown in ***(Figure 18)***.

4. Use dimension "A" to determine total pipe requirements. Add 12 additional inches to ensure the termination is an adequate distance above the roofline.

5. The gross pipe required will be dimension "A" plus 12 inches. Five feet of this will be Flex Pipe. The remainder will be rigid pipe. For each joint, subtract 1-1/2 inches to allow for the overlap. You may need extra pipe, or an adjustable length pipe section to achieve the correct height.

6. Assemble the first rigid Pipe Section to the Flex Pipe, ensuring that the "UP" arrows shown on the pipe labels are, in fact, pointing up. Push the sections together and twist to lock. Screws are not required for a firm lock, however, should it be desired to use them, use stainless steel sheet metal screws 1/4-inch long - do not penetrate the inner liner of the pipe.

7. Repeat this process for the remainder of the pipe sections, and lower the assembly down the chimney as shown in ***(Figure 19)***.

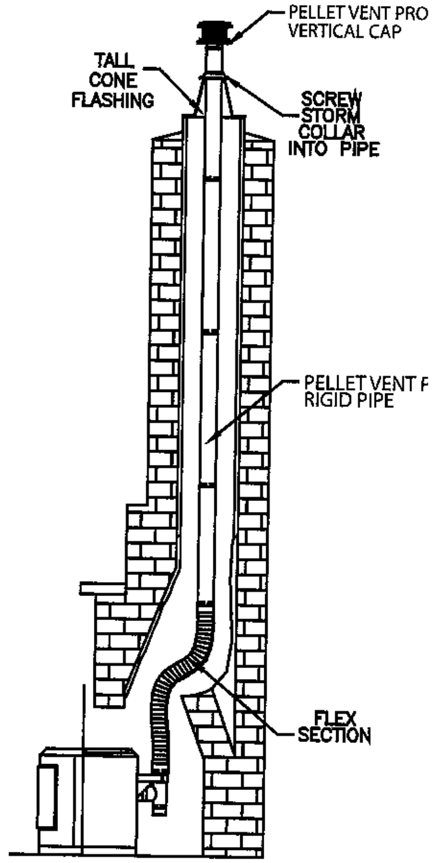


Figure 20

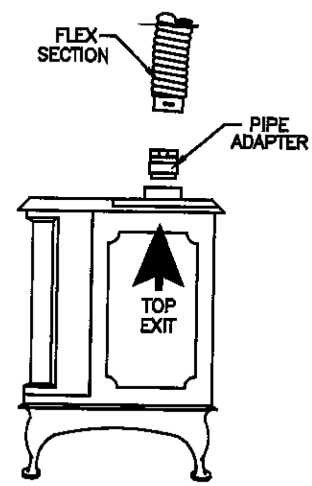


Figure 21

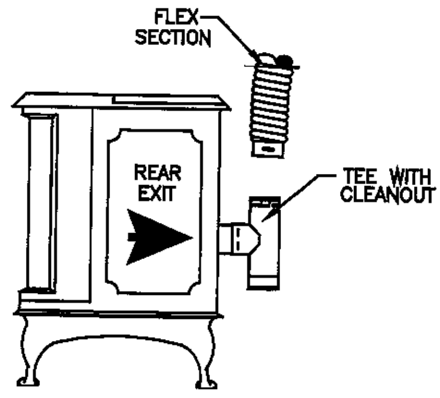


Figure 22

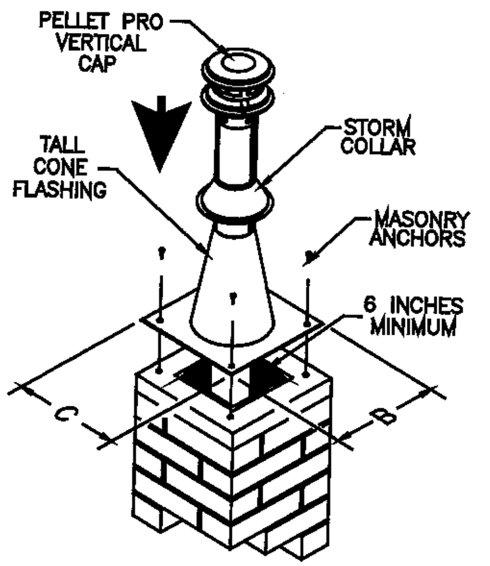


Figure 23

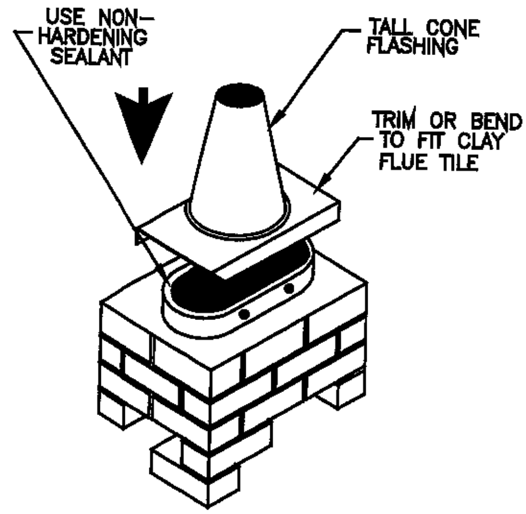


Figure 25

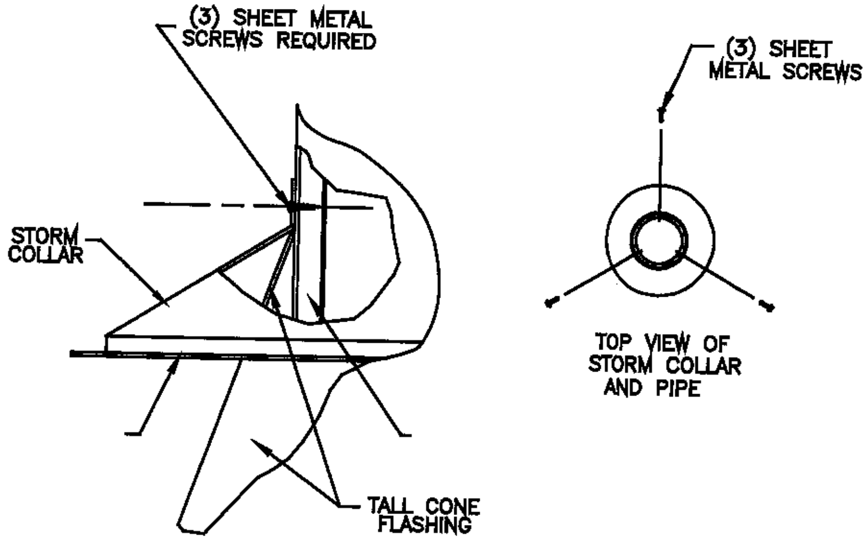


Figure 24

Lower it below its normal position in order to connect the Flex Pipe to the pipe on the appliance. It may be necessary to tie a line to the top section, to pull it back up later.

8. In making the connection at the appliance, configurations other than the one shown in ***(Figure 20)*** may be made. It may be necessary to contact the manufacturer of the unit to determine exactly what may or may not be done to make the correct connection. Some typical arrangements are shown in ***(Figures 21 and 22)***. An Appliance Adapter or Increaser Adapter may be needed, depending on the exit size of the stove or insert collar.

9. If a Tee or Tee Adapter is necessary to make the connection, as shown in ***(Figure 22)***, the Tee has a removable Clean out Adapter on its base to enable cleaning. Ensure Tee is adequately supported.

10. Connect the appliance to the coupling on the bottom of the Flex Pipe, by twisting to the locked position. Push the appliance into the fireplace to its final resting place. Go to the top of the chimney and pull the vent system up to its desired height.

11. For support at the termination of the PelletVent, use a Tall Cone Flashing, and a Storm Collar. This will require 14 inches of pipe above the top of the masonry chimney. Pull the pipe up through the flashing to the desired height. Mark location of the Storm Collar. Slip the Storm Collar down over the pipe and affix it to the pipe with a 1/4"-long stainless steel sheet metal screw ***(Figures 23 & 24)***. The Storm Collar will then support the entire vent system. Install the Cap. Seal the joint at the Storm Collar, and any other joints or seams which may appear suspect. ***(Figure 25)*** shows a Tall Cone Flashing modified to fit a chimney where the tile liner protrudes above the masonry, as another alternate termination technique. This completes the masonry installation.

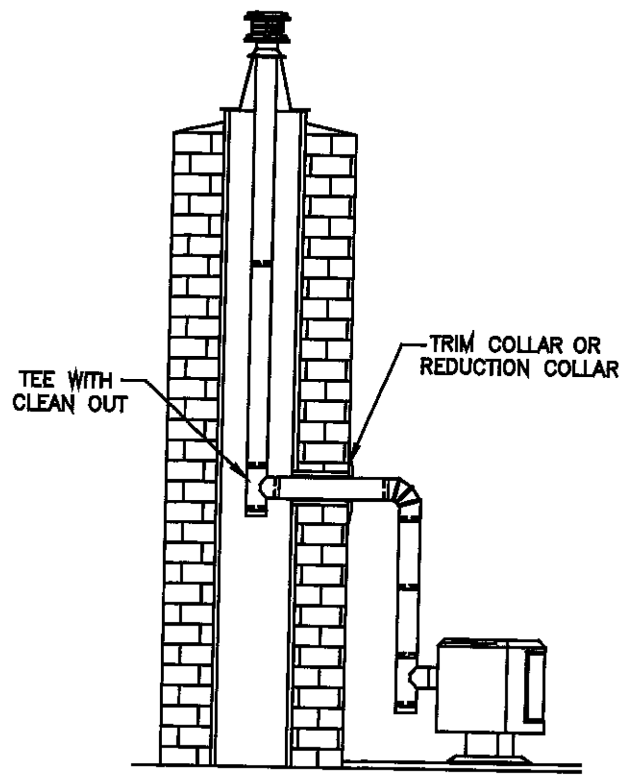


Figure 26

INSTALLATION THROUGH SIDE OF MASONRY CHIMNEY

1. Set the appliance in its final location and mark the center of the hole where the pipe is to penetrate the masonry chimney. Ensure that you comply with the manufacturer's specifications in regards to clearance and distances from combustible surfaces.

2. The PelletVent Pro system is assembled essentially the same as previously described for installation in an existing masonry chimney with the exceptions listed:

A. No Flex Pipe is required, unless the masonry chimney has an offset. If an offset exists, then a Flex Pipe will be needed from the offset down to opening in masonry.

B. A Tee Section is installed at the bottom end of the vertical pipe ***(Figure 26)***.

C. A Reduction Collar or a Trim Collar is required to go around the pipe section that

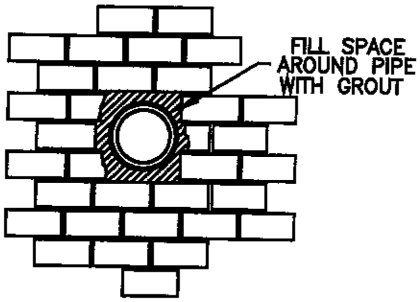


Figure 27

passes through the masonry to give it a finished look.

3. It will be necessary to break out the masonry around the location of the pipe center line mark to a diameter of at least 4 inches for 3 inch pipe, and at least 5 inches in diameter for 4 inch pipe.

4. Install the Tee on the bottom of the vertical pipe system and lower it down the chimney until the center of the branch of the Tee is level with the center of the hole in the masonry. Connect horizontal pipe section to the Tee branch.

5. Holding the pipe at the proper elevation, install the Storm Collar and Cap, as described in ***Step 11*** for the fireplace installation.

6. Connect the horizontal Pipe Section through the masonry to the Tee by pushing it through the hole in the masonry, and lining it up with the branch of the Tee. Then insert Pipe Section into the Tee, while twisting to lock it.

7. Once the horizontal Pipe Section is in place, the space between the pipe and the masonry may be filled with high temperature grout, if desired ***(Figure 27)***.

8. Install the Reduction Collar or Trim Collar over rough opening, then 90° Elbow, and the required vertical Pipe Sections down to the appliance. An Adjustable Pipe length may be needed, as well as an Appliance Adapter or Increaser Adapter.

9. Conduct a final inspection of the entire job, and review the manufacturer's operating and installation instructions once more, before firing the appliance.

INSTALLATION IN A CATHEDRAL CEILING

1. Mark a line on the side of the Cathedral Ceiling Support Box to correspond to the line of the roof pitch, as shown in ***(Figure 28)***. Allow for the Support Box to protrude below the low side of the finished ceiling a minimum of 2 inches.

2. Position the appliance at its proper location on the floor. Pay close attention to the manufacturer's installation instructions regarding the clearance to combustibles, etc. Position appliance so Support Box will not interfere with roof rafters or other structural framing.

3. Run a plumb line from the center of the flue exit on the stove to the ceiling. Mark the point on the ceiling where the plumb line intersects. This represents the center of the support box. Drill a small hole through the ceiling at this point, so it can be located from the top of the roof.

4. From the roof, locate and mark the outline of the Support Box.

5. Remove shingles or other roof covering as necessary to cut the rectangular hole for the Support Box. Cut the hole 1/8-inch larger than the dimensions of the Support Box ***(Figure 29)***. The rectangular hole should be centered on the small hole which you drilled through the ceiling to mark the location. Again, verify that you are not cutting through rafters or framing members.

6. Run the Support Box through the roof as shown in ***(Figure 30)***, and place it so that the bottom of the Support Box protrudes at least 2 inches below the low side of your opening in the finished ceiling

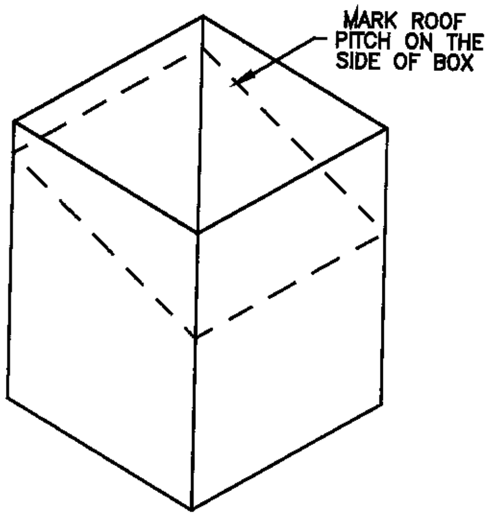


Figure 28

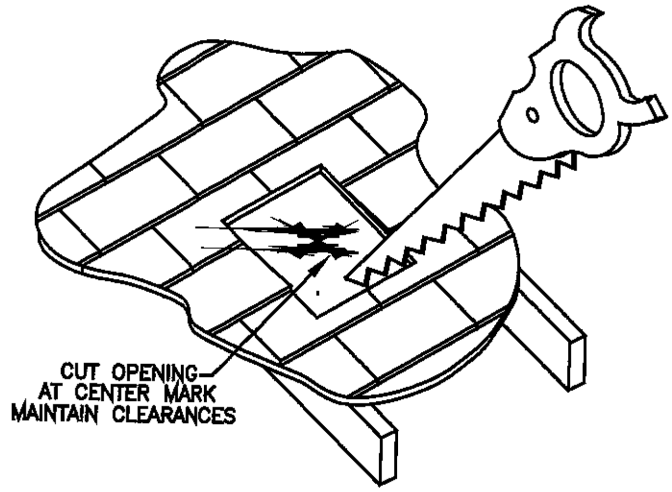


Figure 29

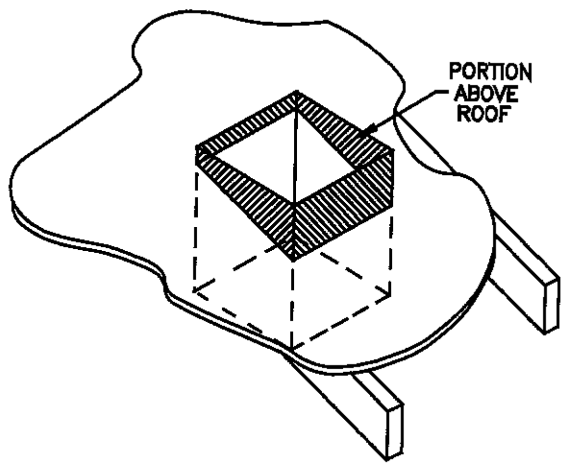


Figure 30

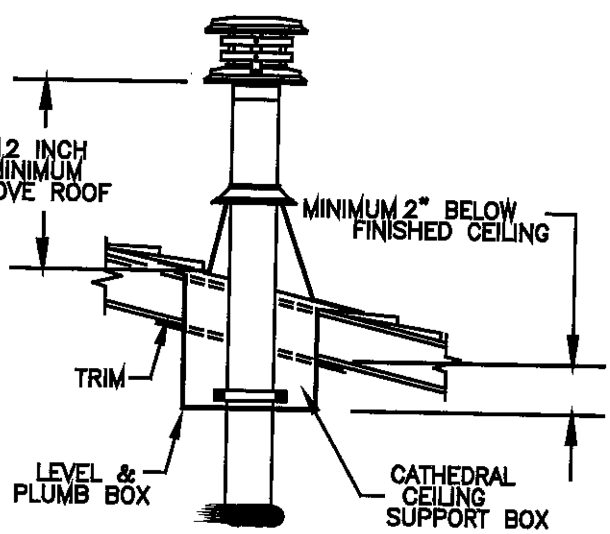


Figure 31

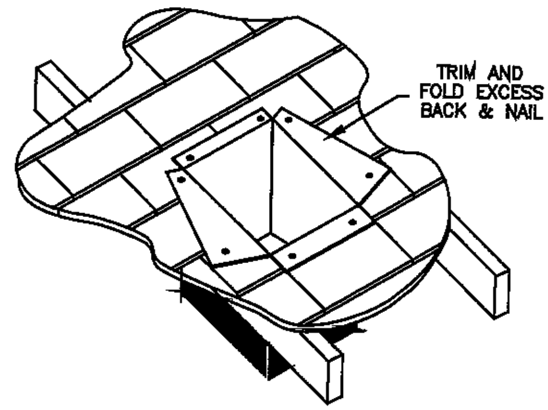


Figure 32

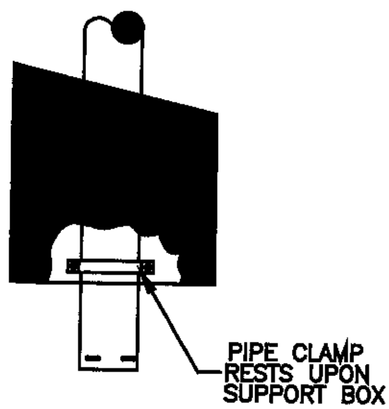


Figure 33

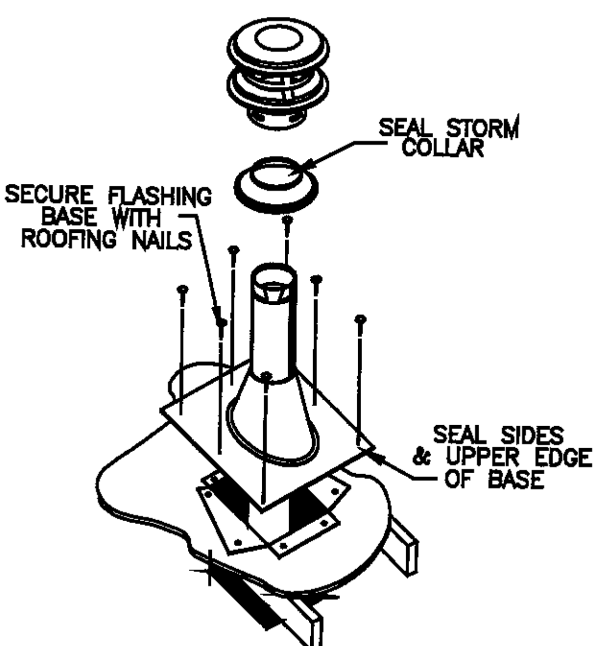


Figure 34

(Figure 31). Align the Support Box vertically and horizontally with a level. Temporarily tack the Support Box in place through the inside walls and into the roof sheathing.

7. If the Support Box protrudes the roofline use tin snips to cut from the top corners down to the roof line, and fold the resulting flap over the roof sheathing ***(Figure 32)***. Before nailing it to the roof, run a bead of non-hardening sealant around the outside top edges of the Support Box so as to make a seal between the box and the roof. Clean out any combustible material or debris from inside the Support Box.

8. Place the Support Clamp, included with Support Box, loosely around Pipe Sections running through hole in Support Box ***(Figure 33)***.

9. Connect the necessary amount of Pipe Sections to reach the stove and extend at least 12-inches above the roof before attaching Termination Cap ***(Figure 32)***.

10. After all PelletVent Pro Pipe Sections and components are assembled and connected down to the appliance seal and secure the Appliance Adapter to stove. Using a level, make slight adjustments in the position of the appliance until the pipe is truly vertical. Tighten the bolts in the Support Clamp ***(Figure 33)***. Note that the overall length of the PelletVent Pro system can be no longer than 42 feet.

11. Slip Roof Flashing over the supported Pipe Section(s) protruding through the roof. Apply sealant to underside of Roof Flashing along upper edge and sides. Secure the base of Roof Flashing to the roof with roofing nails ***(Figure 34)***. Ensure that the roofing material overlaps the top edge of the Roof Flashing.

CLEANING AND MAINTENANCE

1. Have your system cleaned by a certified chimney sweep if you have doubts about your ability to clean it. Use a plastic or flexible steel brush. Do not use a stiff brush that will scratch the stainless steel liner of your system.

2. PelletVent Pro systems must be installed so that access is provided for inspection and cleaning.

3. The system should be inspected at least once every month during the heating season.

4. Do not use chemical cleaners. They can damage the vent pipe.

5. To increase the life PelletVent Pro, coat all exterior metal parts with high temperature, rustproof paint. This is highly recommended, particularly in areas near the ocean.

6. In case of a chimney fire, close all appliance draft openings shut off appliance and call your Fire Department. Do not use the appliance or vent until it has been inspected for possible damage and silicone gaskets replaced.

7. Dura-Vent is not responsible for flue by-products that might discolor roofs or walls.

M&G DURAVENT WARRANTY

M&G DuraVent, Inc. ("DuraVent") provides this limited lifetime warranty for all of its products to the original purchaser, with the exception of Ventinox (lifetime), DuraBlack (five years) and all Termination Caps (five years). Subject to the limitations set forth below, DuraVent warrants that its products will be free from substantial defects in material or manufacturing, if properly installed, maintained and used. This Warranty is non-transferable with the exception of Ventinox which is transferable from the original homeowner to the buyer of the home for a period of ten (10) years. This warranty does not cover normal wear and tear, smoke damage or damage caused by chimney fires, acts of God, or any product that was: (1) purchased other than from an authorized DuraVent dealer, retailer or distributor; (2) modified or altered; (3) improperly serviced, inspected or cleaned; or (4) subject to negligence or any use not in accordance with the printed materials provided with the product as determined by DuraVent. This limited lifetime warranty applies only to parts manufactured by DuraVent.

DuraVent provides the following warranties for its products: One Hundred Percent (100%) of the purchase price or MSRP at time of purchase, whichever is lower, for 15 years from the date of purchase, and Fifty Percent (50%) thereafter, except for the following limitations: Ventinox liner and components in wood, oil, wood pellet, and gas installations are warranted at One Hundred Percent (100%) for the lifetime of the original homeowner; Ventinox 316 liner and components for coal burning installations which are warranted One Hundred Percent (100%) for ten years; all Termination Caps and DuraBlack® are warranted at One Hundred Percent (100%) for five years, and at Ten Percent (10%) thereafter.

All warranty obligations of DuraVent shall be limited to repair or replacement of the defective product pursuant to the terms and conditions applicable to each product line. These remedies shall constitute DuraVent's sole obligation and sole remedy under this limited warranty. This warranty provides no cash surrender value. The terms and conditions of this limited lifetime warranty may not be modified, altered or waived by any action, inaction or representation, whether oral or in writing, except upon the express, written authority of an executive officer of DuraVent.

VENTINOX WARRANTY CONDITIONS
Liner and Component warranties contained herein are subject to the following conditions: (1) The Liner and Components must be installed according to DV's installation instructions; (2) The Liner and Components are used only to line or reline chimneys venting residential appliances for which the liner was intended; and (3) documented annual inspection of the Liner and Components and maintenance as deemed necessary, beginning one year after the date of installation and continuing throughout the warranty period, by a Nationally Certified Chimney Sweep or VENTINOX® installer. The Liner and Components warranty is further subject to compliance with the following requirements throughout the warranty period: The chimney must have a chimney cap and chemical chimney cleaners must not be used when cleaning the Liner or Components. Plastic-bristle flue cleaning brushes are recommended. Corn, biofuels, driftwood or other wood containing salt, preservative-treated lumber, plastic and household trash or garbage, or wood pellets containing such materials must not be burned in the appliance or fireplace. In case of a chimney fire, the chimney must be inspected and approved by a certified Chimney Sweep before reuse. After each annual inspection, maintenance, and cleaning, the certified Chimney Sweep must fill out and date the appropriate section of the warranty card provided with the chimney liner.

LIMITATIONS ON INTERNET SALES:
Notwithstanding any other terms or conditions of this limited lifetime warranty, DuraVent provides no warranty for the following specific products if such products are both: (a) purchased from an Internet seller; and (b) not installed by a qualified professional installer: DuraTech®, DuraPlus HTC®, PelletVent Pro®, FasnSeal®, and DuraVent's relining products including DuraLiner®, DuraFlex® 304, DuraFlex® 316, DuraFlex® Pro, DuraFlex® SW, and Ventinox®. For purposes of this warranty, a trained professional installer is defined as one of the following: licensed contractors with prior chimney installation experience, CSIA Certified Chimney Sweeps, NFI Certified Specialists, or WETT Certified Professionals.

DuraVent reserves the right to inspect defective product to determine if it qualifies for replacement under the terms of this limited lifetime warranty. All warranty claims must be submitted with proof of purchase. Labor and installation costs are not covered under this warranty. To obtain warranty service contact DuraVent promptly at DuraVent Warranty Service, 902 Aldridge Rd., Vacaville CA 95688, or call 800-835-4429.

WHERE LAWFUL, DuraVent DISCLAIMS ALL OTHER WARRANTIES, INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT WILL DuraVent BE LIABLE FOR INCIDENTAL, CONSEQUENTIAL, PUNITIVE OR SPECIAL DAMAGES OR DIRECT OR INDIRECT LOSS OF ANY KIND, INCLUDING BUT NOT LIMITED TO PROPERTY DAMAGE AND PERSONAL INJURY. DuraVent'S ENTIRE LIABILITY IS LIMITED TO THE PURCHASE PRICE OF THIS PRODUCT. SOME STATES DO NOT ALLOW LIMITATIONS ON IMPLIED WARRANTIES, OR THE EXCLUSION OR LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES, SO THE ABOVE LIMITATIONS AND EXCLUSIONS MAY NOT APPLY TO YOU. THIS LIMITED WARRANTY GIVES YOU SPECIFIC LEGAL RIGHTS, AND YOU MAY ALSO HAVE OTHER RIGHTS THAT VARY FROM STATE TO STATE.

For the most up-to-date installation instructions, see www. duravent.com
REV 7.20.2010

M&G DuraVent, Inc. PO Box 1510 Vacaville CA 95696-1510
Manufactured in Vacaville CA and Albany NY

DuraVent
Member of M&G Group

Customer Service Support 800-835-4429 707-446-4740 FAX www.duravent.com

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820003167-L550 5/2016

WOODSTOVE DATA SHEET # 30
STOVE STORAGE

The OPTIMUM DENSIFIED FUEL LOG STOVE tested by Myren Consulting, Inc. is being held in custody by:

509 FABRICATORS, INC.
14823 n. Peone Pines Drive
Mead, WA 99201

Phone 509 993 3767

Contact: Dusty Henderson

The unit was tested at Myren Consulting's lab in Colville, WA. It was sealed on 1/10/17 after the unit had cooled after testing. The following page contains photos taken after the unit was sealed on 1/10/17.

The unit was sealed with several lengths of metal banding/strapping that were placed around the stove in a manner that prevents the door from being opened. A label that clearly identifies the unit as a sealed EPA test stove and/ or a Myren Consulting, Inc. address label is placed over the strapping and taped into place with 2" clear packing tape. The stove was also loaded onto a pallet and strapped to a pallet for transport back to 509 Fab and to its final storage location. A sample stove storage label follows this page.

Once the unit is/ was certified by EPA, the unit will be returned to 509 Fab via the manufacturer's truck.

Carrier: ______________________________

Shipped on: ______________________________

WST5-Form11

WARNING

SEALED EPA TEST STOVE

DO NOT OPEN OR TAMPER WITH THE SEALS AND PACKAGING ON THIS STOVE.

TO DO SO WILL VOID THE CERTIFICATION ON THIS STOVE.

509 Optimum

WST5-Form11

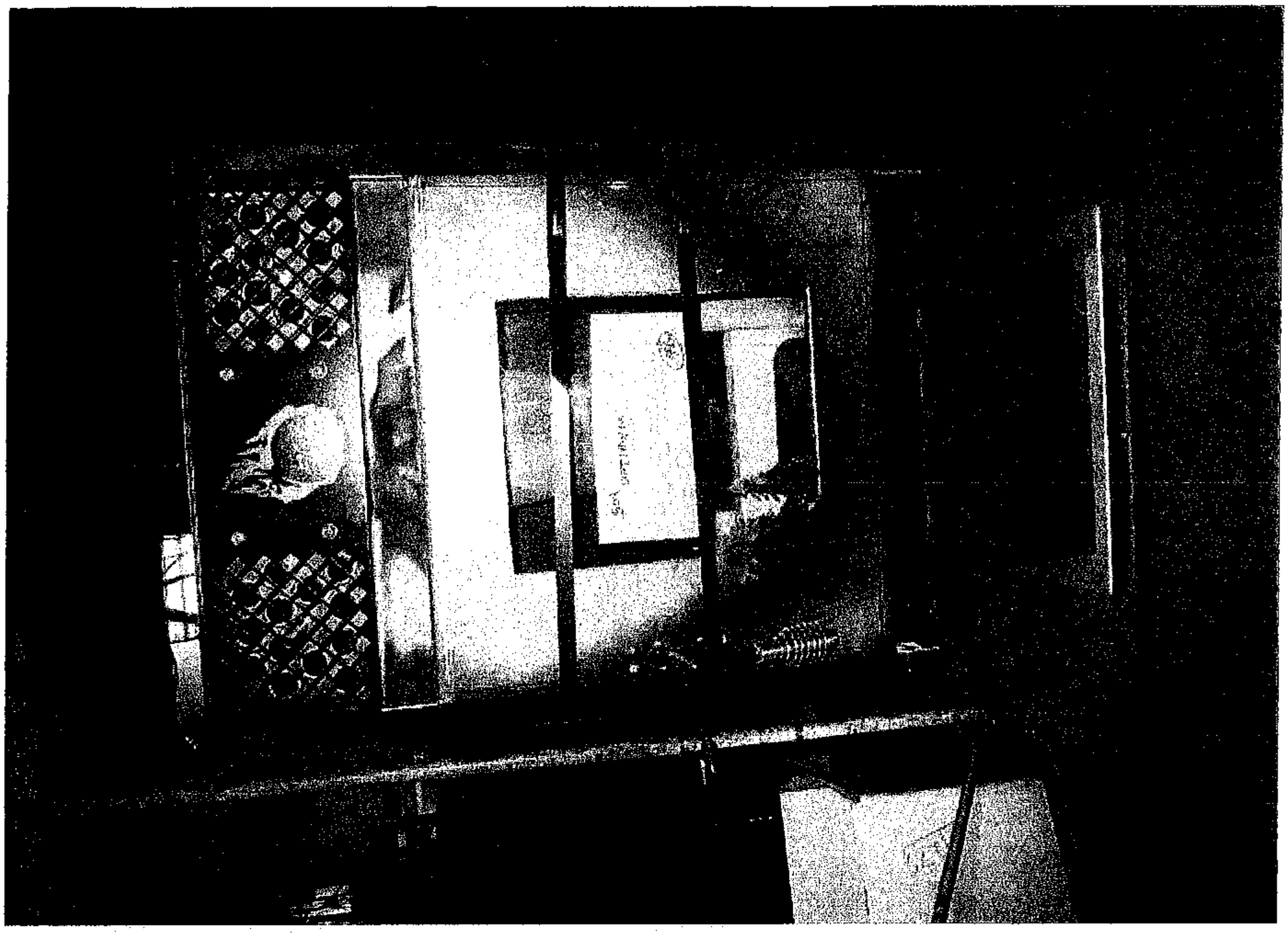
WARNING

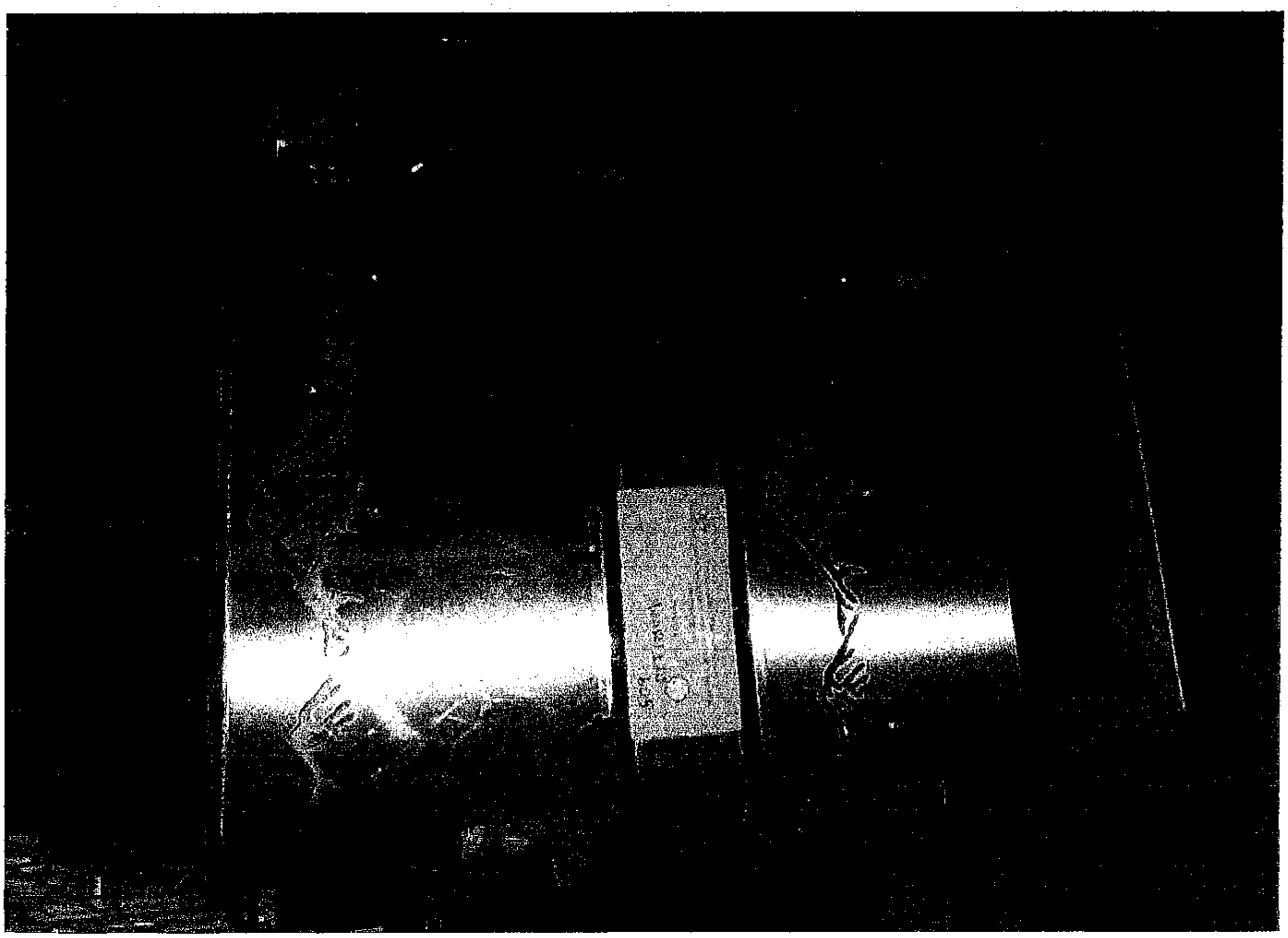
SEALED EPA TEST STOVE

DO NOT OPEN OR TAMPER WITH THE SEALS AND PACKAGING ON THIS STOVE.

TO DO SO WILL VOID THE CERTIFICATION ON THIS STOVE.

509 Optimum





Appendix E

Myren Consulting Test Report Addendum Dated September 21, 2017

US EPA WOOD HEATER CERTIFICATION TEST REPORT ADDENDUM

509 FABRICATORS, INC.
OPTIMUM DENSIFIED FUEL LOG STOVE

SEPTEMBER 21, 2017

MYREN CONSULTING, INC.

OFFICE

512 WILLIAMS LAKE ROAD
COLVILLE, WA 99114
PHONE 509-684-1154

LABORATORY

501 C WILLIAMS LAKE ROAD
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512 Williams Lake Road
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email:myren.ben@gmail.com

509 FAB Optimum 2nd Sanchez Letter

21 September 2017

Dr. Rafael Sanchez, PhD.
U.S.EPA
Office of Enforcement and Compliance Assurance
Office of Compliance
William Jefferson Clinton Building, South
Room 7419D
1200 Pennsylvania Ave., N.W.
Washington, DC 20003

Dear Dr. Sanchez:

Myren Consulting, Inc. has prepared a certification test report for the first certification test run on the Optimum densified fuel log stove and sent it to the manufacturer's certifying third party entity, Omni Test lab. Based upon a review of the information and data in that initial test report, EPA required a second certification test run before it would certify the unit. This Addendum contains the information and data for that second run. As the test results indicate, the unit's emissions are below both the 2015 EPA standard of 4.5 g/h and 2020 EPA standard of 2.0 g/h.

This Addendum does not contain some of the information found in the original test report, i.e., Drawings and Owners Manual, because it would be redundant to do so.

A comment is warranted here. This unit is the first unit that burns densified fuel logs to be certification tested. How it operates is very differently from both wood stoves and pellet stoves. It is truly an "outside the box hybrid" that combines operational features from both wood and pellet stoves, so the way it operates and was tested reflects this. Thus, there was a long period of negotiations between 509 Fabricators, Myren Consulting and EPA personnel to reach a viable test protocol. Because we had to conduct two certification tests that each generated an integrated average, I averaged the integrated averages to come up with a g/h emission rate, %OE HHV, CO g/h, etc.

That information and the averages are all in the Data Summary section.

If you or anyone else has any questions about the information or data in either of the test reports for the 509 OPTIMUM, please contact me immediately. And Thank You for your patience and help in getting this unit tested.

Sincerely,

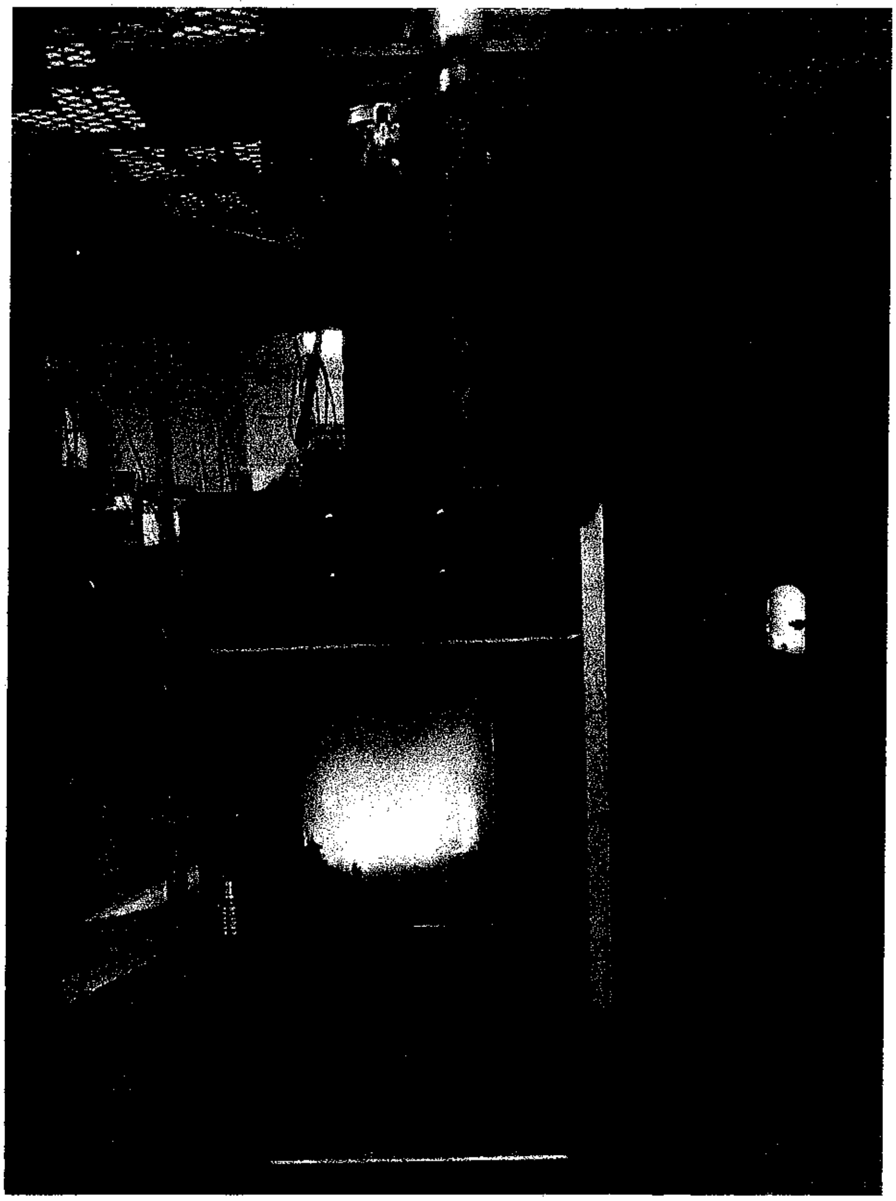
Ben Myren

Alben T. Myren Jr.
President
ATM/im

US EPA WOOD HEATER
CERTIFICATION TEST REPORT ADDENDUM

509 FABRICATORS, INC.
OPTIMUM DENSIFIED FUEL LOG STOVE

SEPTEMBER 21, 2017



MYREN CONSULTING, INC.

OFFICE	LABORATORY
512 WILLIAMS LAKE ROAD	501 C WILLIAMS LAKE ROAD
COLVILLE, WA 99114	COLVILLE, WA 99114
PHONE 509-684-1154	PHONE 509-685-9458

EMAIL myren.ben@gmail.com

****

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.

****

Confidential

****

Report Certification

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

Date: 9/18/17 Signature: Albert D. Myren Jr.
Title: President

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

Date: 9/18/17 Signature: Albert D. Myren Jr.
Title: President

PELLET STOVE
TABLE OF CONTENTS

TESTING LOCATION AND PERSONNELL INFORMATION

Unit Name: OPTIMUM DENSIFIED FUEL LOG STOVE

Manufacturer Name: 509 FABRICATORS, INC.

**Manufacturer Address: 14823N. Peone Pines Drive
Mead, WA 99201**

Manufacturer Phone: 509 993 3767

**Manufacturer Contact Person: Dusty Henderson
email: Dusty@509fab.com**

Observers & Affiliation: Dusty Henderson & Gary Henderson, both from 509 Fabricators

SUPERVISOR: Ben Myren

MYREN CONSULTING'S LAB TEAM: Ilse Myren, Ben Myren, Eric Schaefer

LAB LOCATION: Myren Consulting's lab in Colville, WA 99114

ELEVATION: ~ 1650 FEET

MYREN CONSULTING, INC.

**LABORATORY
501-C WILLIAMS LAKE ROAD
COLVILLE, WA 99114
509 685 9458**

**OFFICE
512 WILLIAMS LAKE ROAD
COLVILLE, WA 99114
509 684 1154
email: <myren.ben@gmail.com>**

Pellet Stove Test Report Page Number Index

	Section	Location	
1. Integrated Test Results	Data Summary	Integrated Test Results	p. 1
2. Summary Table of Other Data	Data Summary	Data Summary Sheets	p. 2-4
3. Wood Heater Description	Stove QC	Wood Heater Description	p.1 (vari)
4. Manufacturer's Testing Instructions	Operators Manual	P. 1 of Section	vari
5. Test Camber Installation Description	Installation Description	Introduction	p. x
6. Pellet Stove Aging Documentation	Aging		p. 1-2
7. Pretest Burn Procedures	Individual Test Runs	Data Sheets	#9,13
8. Pretest Facility Measurements	Individual Test Runs	Data Sheets	#8, 16
9. Test Fuel Measurements			
A. Fuel Moisture	Individual Test Runs	Data Sheets	#11
10. Heater Operation and Air Supply Settings	Individual Test Run	Data Sheets	#9, 13
11. Calibrations			
A Platform Scale			
1. Semi Annual	Cal Data	P. 1	
2. Pre and Post Test	Individual Test Run	Data Sheet #16	
B.Analytical Balance			
3. Semi Annual	Cal Data	P. 3 (Variable)	
4. Pre Weighing Check	Individual Test Run	Data Sheet #4-4	
C. Temperature			
5. Thermometers	Cal Data	P. 5	
6. Thermocouple Readout(s)			
a. Semi Annual	Cal Data	P. 6	
b. Daily Check	Individual Test Run	Data Sheet #16	
D. Dry Gas Meters			
a. Semi Annual Calibration	Cal Data	P. 7 (Variable # of pp.)	
b. Post Test Audits	Cal Data	(Variable # of pp.)	
c. Transfer Meter Calibration	Cal Data	(Variable # of pp.).	
E. Miscellaneous Test Equipment			
a. Anemometer	Cal Data	P. 11	
b. Barometer	Cal Data	P. 11	
c. Draft/ Static Pressure Gauge	Cal Data	P. 11	

ASTM E2515/ EPA M5G-1 Individual Test Run Page Index (Pellet Stove)

The data sheets in the individual test runs are organized in the following sequence.

TEST SERIES INFORMATION AND DISCUSSION

MODEL LINE: OPTIMUM DENSIFIED FUEL LOG STOVE MODEL 1

TEST UNIT: OPTIMUM DENSIFIED FUEL LOG STOVE MODEL 1

Manufacturer: 509 FABRICATORS INC.

Date Received: 12/28/16

Date(s) Aged: 12/27/2016 - 1/1/2017. See AGING Section in first test report

Test Date(s): 1/9/2017, 9/5/2017

PM Sampling Method(s):
Test Run #1: ASTM E2515 using 4″ fiber glass filters (EPA M5G-1)
Test Run #2: ASTM E2515 using 4″ Pall TX-40 TFE coated filters (EPA M5G-1)

Operating and Fueling Protocol: EPA M28R, ASTM E2779 Revised. See letters to EPA (Rafael Sanchez, OEC, D.C., Stef Johnson, OAQPS, RTP and Mike Toney, OAQPS, RTP) and their written and email responses.

Number of Test Runs: 2

The OPTIMUM Densified Fuel Log stove manufactured by 509 FABRICATORS, INC. located in Mead, WA was tested by Myren Consulting, Inc. using the Environmental Protection Agency's (EPA) Test Method 28R, "*Certification and Auditing of Wood Heaters*", ASTM E2515-11, "*Standard Test Method for Determination of Particulate Emissions Collected in a Dilution Tunnel*" and ASTM E2779-10, *Standard Test Method for Determining Particulate Matter Emissions from Pellet Heaters"*. (See the Federal Register/ Vol.80, No.50/ Monday, March 16, 2015. [pp.13672-13753]). On March 28, 2015 Myren Consulting, Inc. requested approval from EPA to use four-inch filters when conducting all PM emission certification tests and received the approval to do so on April 7, 2015. Thus the PM sampling and PM sample processing procedures used during the certification tests found in this test report are what are found in EPA M5G-1 in the previous NSPS. (See the Federal Register/ Vol.53,No.38/ Friday, February 26, 1988/ pp.5860-54926, especially in Method 5G in Appendix A on pp. 5884-5892.) The particulate matter (PM) emission data was calculated as specified in the Wood Heater New Source Performance Standard (NSPS) dated March 16, 2015. The percent overall efficiency (%OE) for the overall test run and for each test segment (High, Medium and Low) was calculated using the %OE algorithm found in CSA's B415.1-10.

All events and information pertinent to the test data are recorded on the data sheets for each test run, particularly on pp. 13 and 14.

Any deviations made or noted from the promulgated methods other than those that were accepted and certified by EPA during the laboratory accreditation process are listed and discussed below. The OPTIMUM densified fuel log stove was tested at Myren Consulting's lab in Colville, WA using Myren Consulting Inc.'s lab accreditation. A copy of the letter from EPA (Johnson) granting Myren Consulting, Inc. accreditation under the 2015 NSPS and a copy of Myren Consulting's new Laboratory Accreditation Certificate (#2) are included in the following pages.

A brief note about how the four-inch (EPA M5G-1) particulate samples were processed is necessary to help the reviewer understand the net catch values. First, filters are weighed in pairs to reduce weighing errors. Second, experience has shown that the small portions of the filters that are left on the frits (filter supports) 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 petri dish. Because trying to recapture these small pieces of filter material during weighing causes them to disintegrate into smaller and smaller pieces, which makes obtaining accurate catch weights difficult, 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 catch weights that are used during the particulate emission rate calculation process. However, the filter material lost off the filters is accounted for in the acetone wash catch.

ASTM E2779-10 Equation 1 calls for a dry moisture content for the test fuel used during testing. There is no way to measure the moisture content of pellets or densified fuel logs on a dry basis. Instead one can determine the wet basis moisture content by drying a sample. This is what done and the data for this is on Data Sheet 11 in the test run. Once the wet basis moisture content is known, it is then possible to calculate the fuel burnt on a dry basis, which again is what was done. The dry burn rate (DBR) determination is the same. The revised procedures and equations used to determine the actual DBR are to be found on the page after Data Sheet 11 in the Section titled TEST RUN.

The following pages contain: (1.) A discussion of test results. (2.) A diagram showing the height of the appliance and chimney used during testing (4" ICC EXCEL Pellet Pipe) and the location of the sampling ports in the chimney. (3.) A diagram of the EPA M5G 6" diameter dilution tunnel used by Myren Consulting during EPA Certification testing, (4.) 3 pages with photos showing the front, back and right and left sides of the test unit. Note that the back photo shows how the venting system was attached to the stove along with the static pressure probe and the stack temperature at 1 foot probe. And there is also a full page photo of the testing installation configuration, i.e., the stove with attached flue pipe venting into the dilution tunnel hood, (5.) photos of a North Idaho Energy log, the densified fuel log that was used during testing, (6.) A copy of the letter from EPA granting Myren Consulting, Inc accreditation under the 2015 NSPS, (7.) a copy of the new EPA Laboratory Accreditation Certificates (#2) for Myren Consulting's Colville lab, (8.) a copy of the 30 day advance certification test notification sent to EPA for the week the unit was tested, (9.) four pages with information that is pertinent to the test run and (10.) copies of the following information:

(1.) A memo dated 26 November 2013 sent to Dr. Sanchez at EPA that initiated the development of a testing protocol for a stove that burns densified fuel logs.

(2.) A memo dated 30 April 2016 sent to Mike Toney and Stef Johnson at EPA (OAQPS, RTP) that provided additional information about the stove, the fuel it burns and what the test protocol might be.

(3.) A letter dated 6 December 2016 sent to Mike Toney (EPA, OAQPS, RTP) about whether (or not) Myren Consulting, Inc. could test the unit.

(4.) Emails from Toney and Sanchez granting Myren consulting, Inc. approval to test the unit with the agreed upon protocol, which is basically a variant of ASTM E 2779 except that fuel had to be added during the test run and the primary air control (PAC) was adjusted manually to change the dry burn rate (DBR).

Note: You can see by the photos that the unit has undergone substantial revision since development began. The manufacturer's personnel listed in the memo addresses also reflect the ownership changes (3X) that have occurred during the product development process.

Myren Consulting, Inc. conducted the first EPA certification test on 1/9/17 and prepared and submitted a report to Omni, the manufacturer's certifying third party entity. A review of the test data in the report revealed that the dry burn rate (DBR) (kg/h) for the medium segment of the test was >50% of the DBR of the High burn segment. Because of this technicality, the third party certifying entity would not issue a Certificate of Conformity. This led the manufacturer and Myren Consulting to approach EPA with a revised testing protocol that reversed the burn rate segments, i.e., instead of running another Hi, Medium, Low sequence the burn rate segments would be Low, Medium and High. The thought was that it might be possible to achieve a Medium burn that was <50% of the high burn using this testing sequence. Unfortunately, due to the way the appliance burns it was not possible to get a Medium burn that had a DBR that was< 50% of the High burn, no matter how the stove was operated. Once it became evident that it was impossible to get a Medium burn that had a DBR that was <505 of the High burn, the manufacturer asked that this requirement be waived because the unit really isn't a pellet stove and the use of an arbitrary pellet stove requirement to prevent the unit from being certified wasn't fair. The correspondence that eventually led to an agreed upon testing protocol is also in the following pages and includes copies of:

1. A letter dated 21 July 2017 from Ben Myren, MCI to Stef Johnson, EPA/OAQPS which recognizes that EPA will require one additional certification test run before it will grant certification for the OPTIMUM.
2. A letter dated 23 July 2017 from Ben Myren, Myren Consulting, Inc. (MCI) to Stef Johnson, EPA/OAQPS that contains a proposed revised testing protocol for the OPTIMUM.
3. A letter date 23 July 2017 from Ben Myren, MCI to Dr. Rafael Sanchez, EPA/OECA that request that MCI be allowed to unseal the OPTIMUM test stove so that an additional test run can be done.
4. A letter dated 11 August 2016 from Edward J Messina, EPA, to Sebastian Button, OMNI that addresses specific issues about additional test runs and unsealing stoves.
5. A letter dated 9 August 2017 from Stef Johnson, EPA/AQAD that approves the revised testing proposal contained in the Myren July 23rd letter.
6. A letter and email dated 11 August 2017 from Ben Myren, MCI to Dr. Rafael Sanchez, EPA/OECA that addresses some of the issues that are in the Messina letter that are specific to %)9's OPTIMUM. This response included the submittal on

August 11, 2017 of a complete copy to EPA (Sanchez) of the test report that had been prepared and submitted to OMNI for the first certification test run. UPS tracking info also included.

7. A letter dated 12 August 2017 from Ben Myren, MCI to Stef Johnson, EPA/AQAD that proposed another revision to the test protocol. This revision was based upon the manufacturer's data that indicated, that due to the way the unit operates, it is impossible to achieve a Medium burn that has a DBR that was <50% of the high burn's DBR. Option 2 in this letter asked that the 50% requirement be waived.

8. A letter dated 16 August 2017 to Stef Johnson, EPA/AQAD that requested that the manufacturer be allowed to make two design changes to the unit prior to doing any subsequent testing. This letter included some drawings that showed the proposed design changes.

9. An email dated 16 August 2017 from Rafael Sanchez, EPA/OECA that granted permission to unseal the OPTIMUM test stove.

10. A letter dated 22 August 2017 from Stef Johnson, EPA/AQAD to Ben Myren, MCI that approved the proposed testing protocol that was in the 12 August 2017 Myren letter.

11. A copy of an email dated 22 August 2017 from Mike Toney, EPA AQAD to Dusty Henderson, 509 and Ben Myren, MCI which discussed the design changes in the Myren 16 August letter.

12. A letter dated 22 August 2017 from Ben Myren, MCI to Stef Johnson, EPA/AQAD in which the manufacturer modified his design change proposal.

13. A letter dated 23 August 2017 from Ben Myren, MCI to Stef Johnson, EPA/AQAD that contained some additional information in support of the manufacturer being allowed to make one small design change, i.e., the addition of a small tube to deliver a very small amount of air to the top of the feed tube to help reduce condensation in the feed tube and help prevent the logs from sticking in the feed tube.

14. Copies of a series of emails clarifying the situation about how the wood heater must be unsealed and granting the manufacturer's request to add the small air feed tube.

15. A letter dated 30 August 2017 to Rafael Sanchez, EPA/OECA that again clarifies the situation and summarizes the proposed revised testing protocol.

16. Copies of a series of emails that discusses the situation and the way forward.

17. A copy of an email dated 1 September 2017 in which Mike Toney, EPA/AQAD grants permission to test the unit as was proposed in the Myren 30 August 2017 letter.

The unit was unsealed and tested on 9/5/17 and resealed on9/6/17.

DISCUSSION:

(1.) The 2 run test series was done at Myren Consulting's lab in Colville, WA.
(2.) The test series required 2 test runs.
(3.) Because the whole testing format for pellet stoves has changed in the new NSPS, there are several revisions to the report format. Specifically the following changes have been made:
   a. The first page in the Data Summary section is titled Summary Results which reports the test data in the format requested by EPA. This has been altered to reflect the fact that 2 integrated test runs were done on this unit.
   b. Because the pellet stove test is now an integrated sample test, there are no weighted average calculations because collecting the integrated sample "automatically" generates an "integrated weighted average". Instead of the pages used to calculate a weighted average, there is now a single page titled *Average Test Results,* which reports the PM emission rate (g/h and lbs./MM Btu output), the overall efficiency (%OE)(HHV and LHV) and CO (g/h and g/lb. of dry fuel) for the unit.
   c. A new page has been added to the Data Summary Section (p. 3) which summarizes the PM Sampling Train Performance information and addresses the *Dual Train Comparison* criteria found in ASTM E2515 Section 11.7. The average emission rate calculated and reported on this new page using the data from the 2 PM sampling trains is then also reported on the page titled *Integrated Test Results*. Also reported on this page are the performance data for the "Room Blank" train and the PM emission rate (g/h) and dry burn rate (DBR) (kg/h) data for the 0-60 minute filter set from Train 1.
   d. Section 60.534(d) requires that filter sets be changed (switched) at 1 h into a test run on one of the PM sampling trains. This was done on Train 1 during the test run. Thus there are additional data sheets in each test run for the 2 filter sets used

in Train 1 to accomplish this requirement. As noted above, the PM emission rate for the first hour is reported on the computer spreadsheet for that PM sample and again in the Data Summary section itself.

e. ASTM E2515 requires 2 PM sampling trains and a third "Room Blank" train. That means there are also additional data sheets for Trains 2 and 3 in the section with the Raw Data sheets for the test run and in the Cal Data Section where the calibration and post test audit data is presented for the equipment used in all 3 of these trains.

Please look at the Table of Contents (p. iv), the Pellet Stove Test Report Page Number Index (pp. vi-vii) and the Individual Test Run Page Index (p. ix) to find any pages of interest. Or call Myren Consulting, Inc. at either 509 685 9458 (Lab)or 509 684 1154 (Office) if further assistance is needed.

Stack Measurements and Sampling Port Locations

~~Class A~~ Chimney

Manufacturer: ICC

Model: Excel Pellet

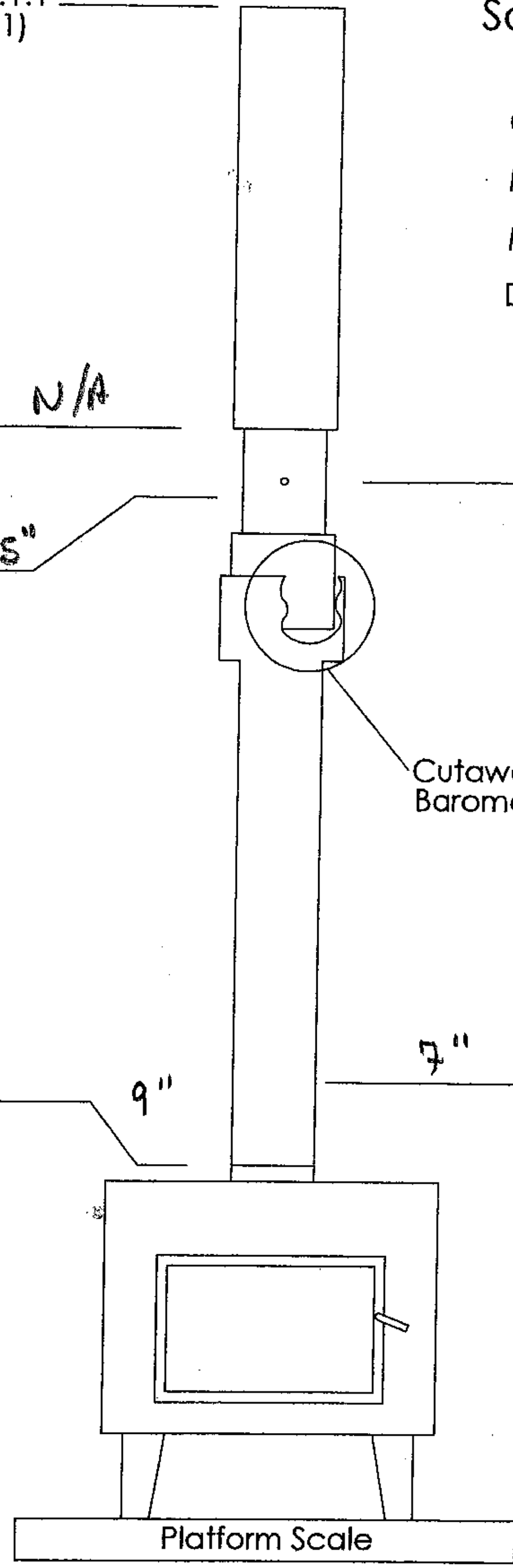
Diameter: 4"

Total Stack Height 15.0' ± 1' (M28R 4.1.1 ASTM E2780 9.2.1) 178"

Steel Flue Pipe Ht. 8.5' ± .5' (M28R 4.1.1 ASTM E2780 9.2.1) N/A

Combustion Gas Sample Port 2" Above Stack Temp Probe Ht. (CSA B415 6.3.2)

Stack Temp. Probe Ht. 8.5' ± .5' (ASTM E2780 9.2.4) 103.375"



Cutaway Detail On Barometric Oil Seal

Static Pressure Probe Ht. <1.0' Above Flue Connector (M28 6.2.3) 7"

Stove Ht. At Flue Collar 9"

Unit: Optimum

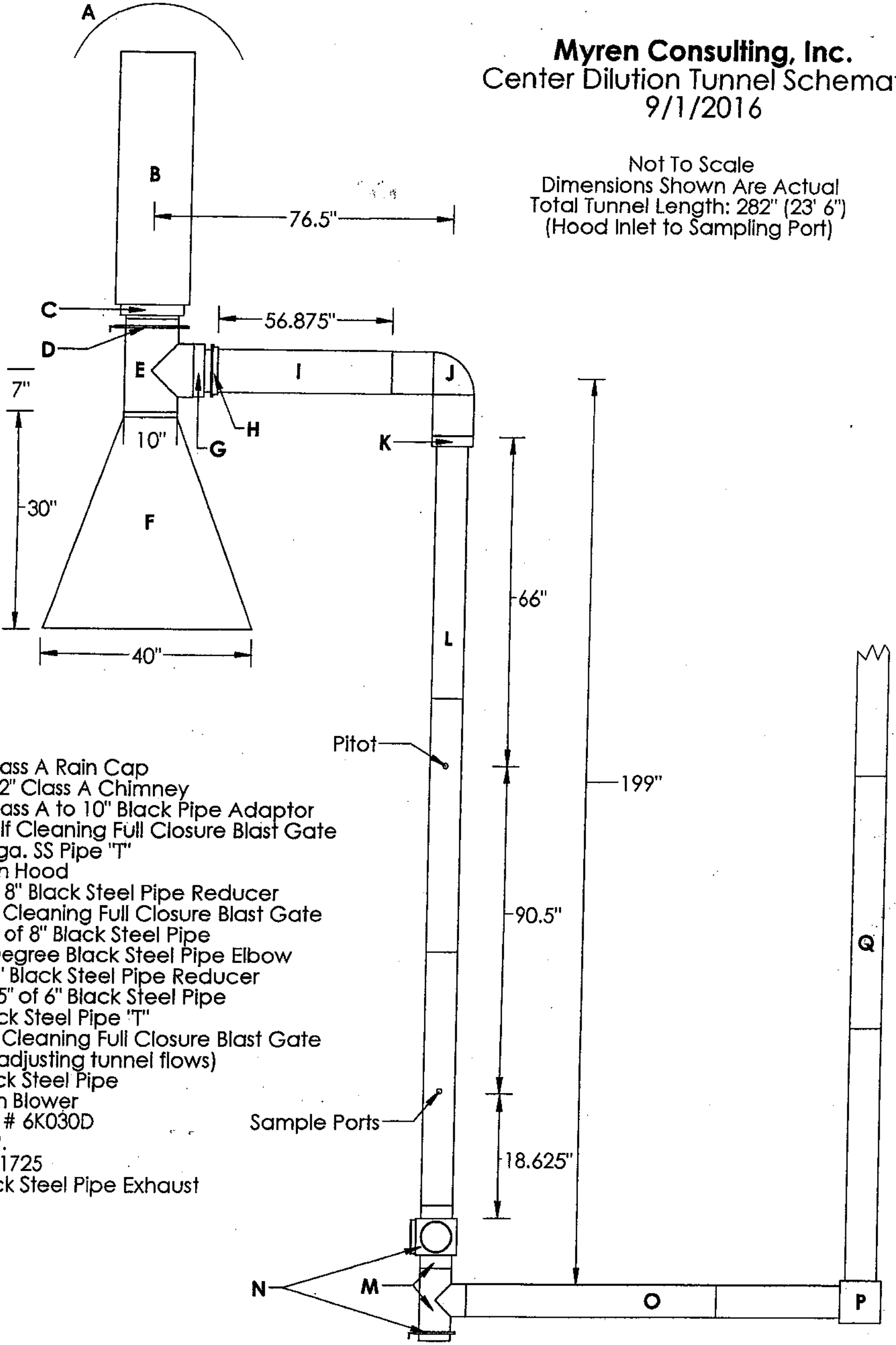
Date: 9/5/17

Technician(s): ATM ESS

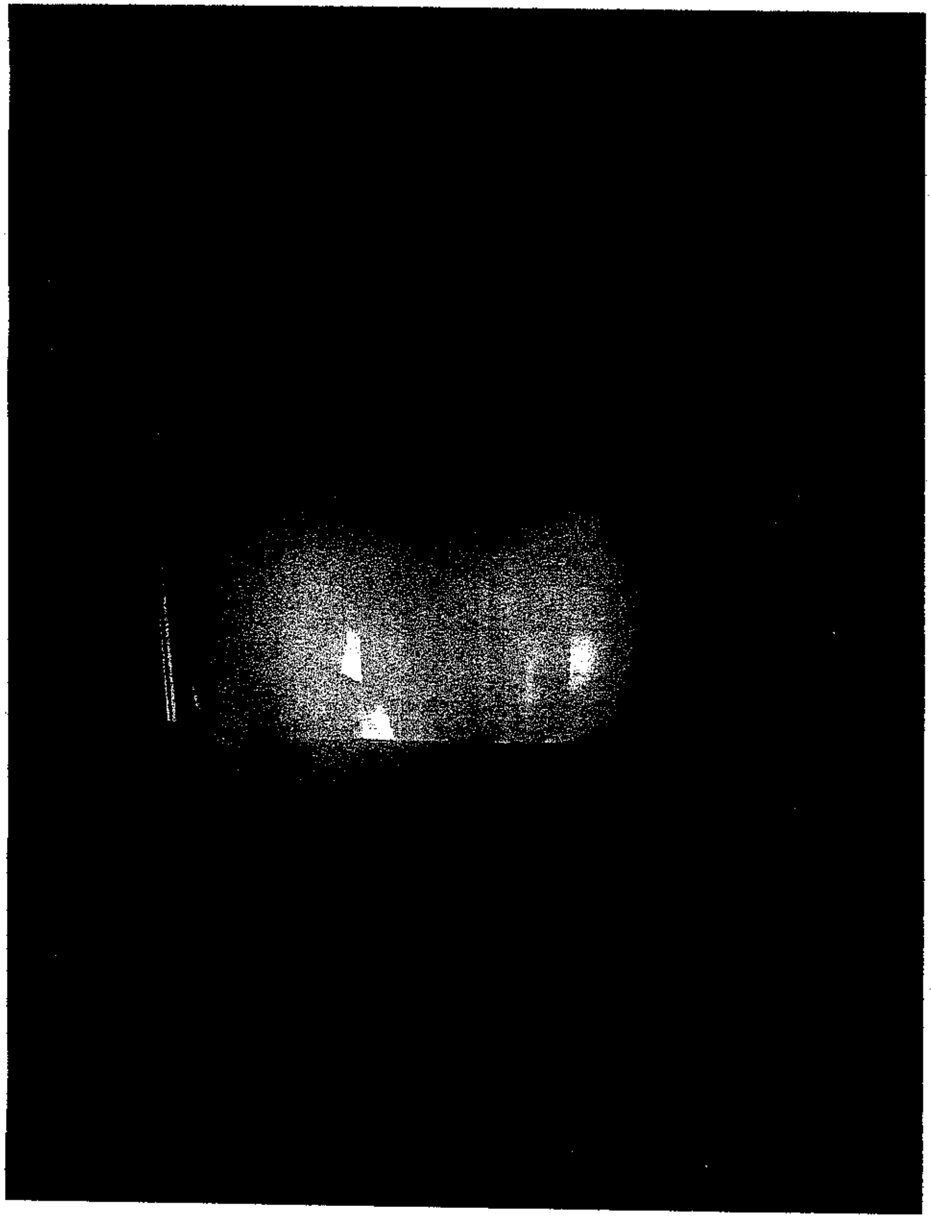
Exact Same set up was used for EPA 2

Myren Consulting, Inc.
Center Dilution Tunnel Schematic
9/1/2016

Not To Scale
Dimensions Shown Are Actual
Total Tunnel Length: 282" (23' 6")
(Hood Inlet to Sampling Port)

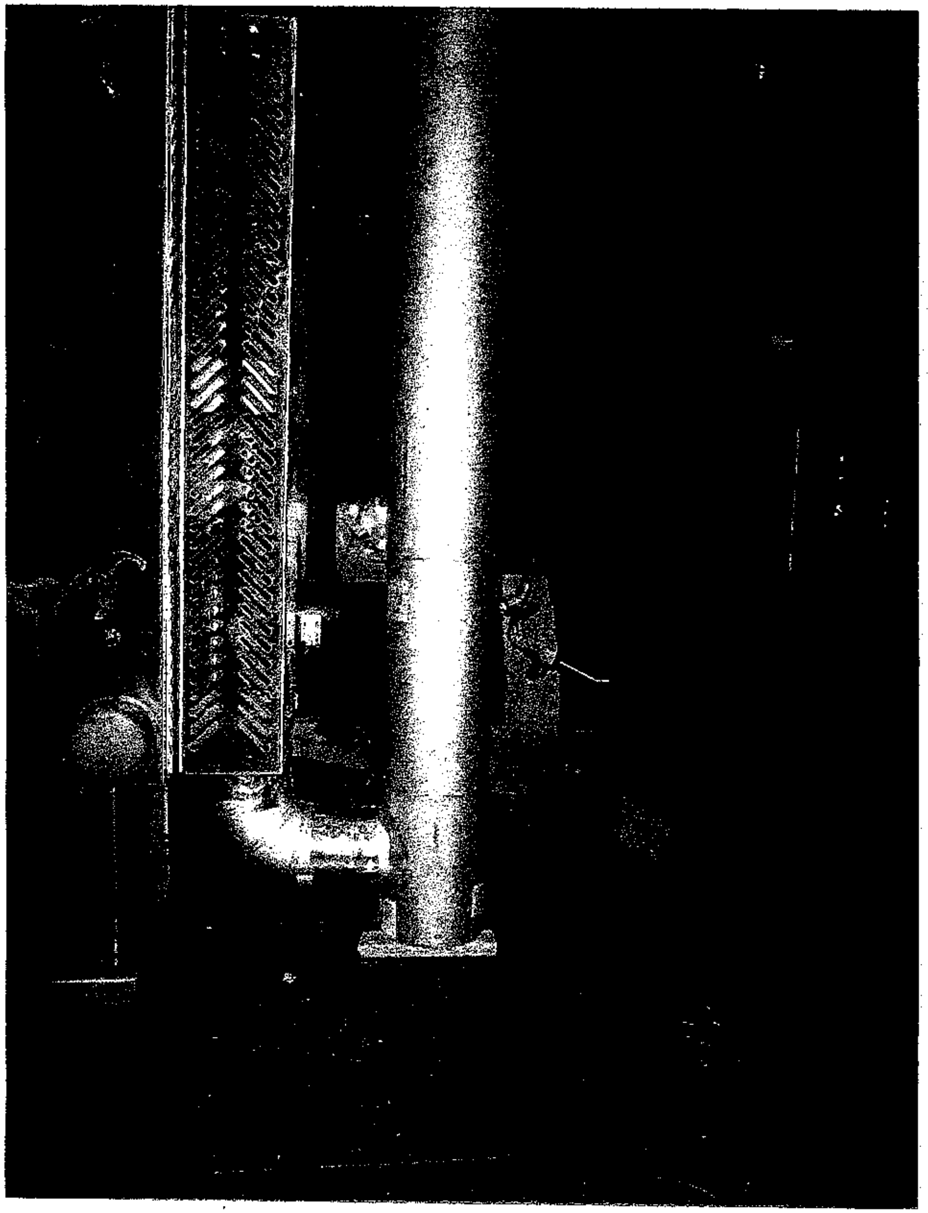


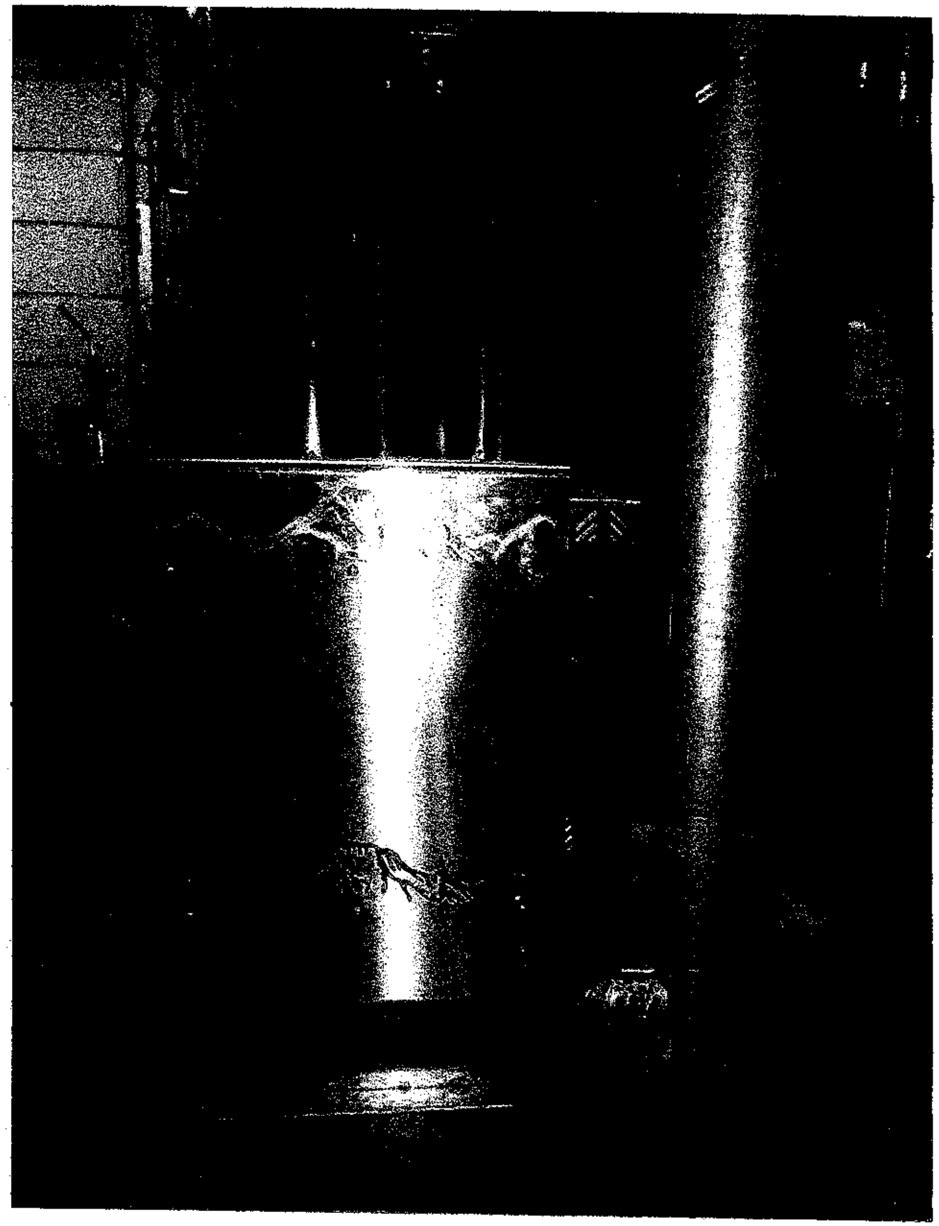
A: 12" Class A Rain Cap
B: 48" - 12" Class A Chimney
C: 12" Class A to 10" Black Pipe Adaptor
D: 10" Self Cleaning Full Closure Blast Gate
E: 10" 22ga. SS Pipe "T"
F: Dilution Hood
G: 10" to 8" Black Steel Pipe Reducer
H: 8" Self Cleaning Full Closure Blast Gate
I: 56.875" of 8" Black Steel Pipe
J: 8" 90 Degree Black Steel Pipe Elbow
K: 8" to 6" Black Steel Pipe Reducer
L: 175.125" of 6" Black Steel Pipe
M: 6" Black Steel Pipe "T"
N: 6" Self Cleaning Full Closure Blast Gate
(for adjusting tunnel flows)
O: 6" Black Steel Pipe
P: Dayton Blower
Model # 6K030D
1/3 H.P.
R.P.M. 1725
Q: 6" Black Steel Pipe Exhaust



FRONT VIEW

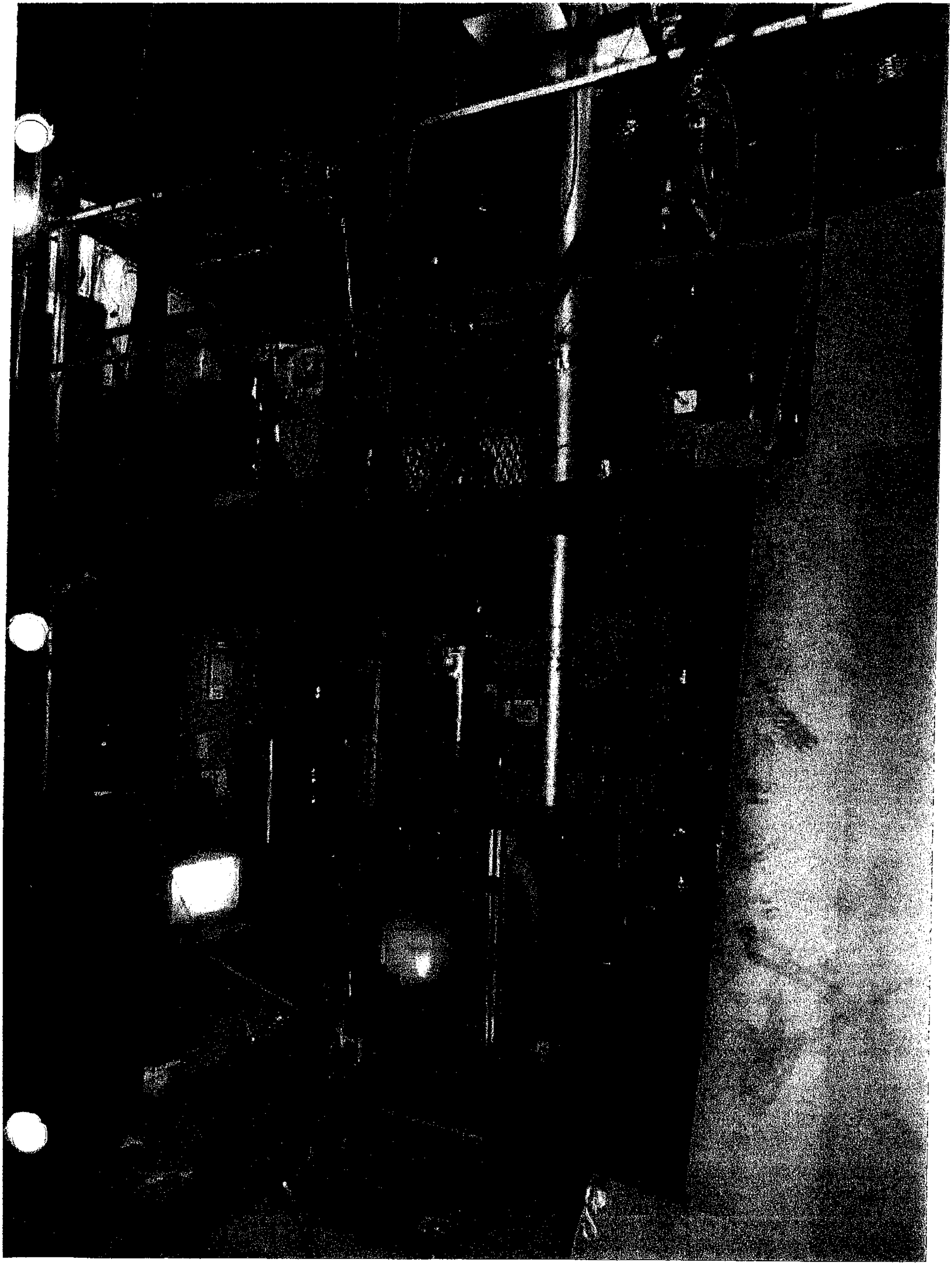
LEFT SIDE

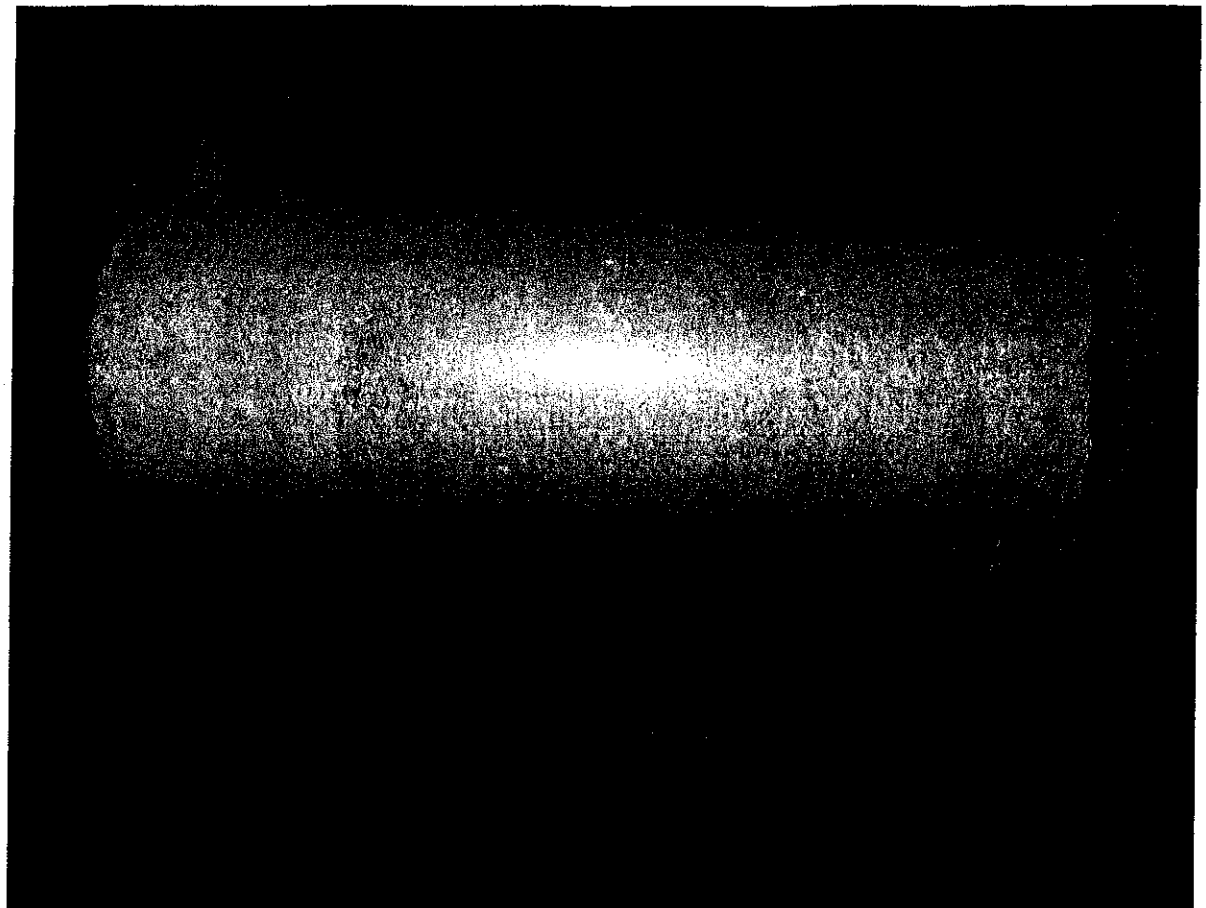




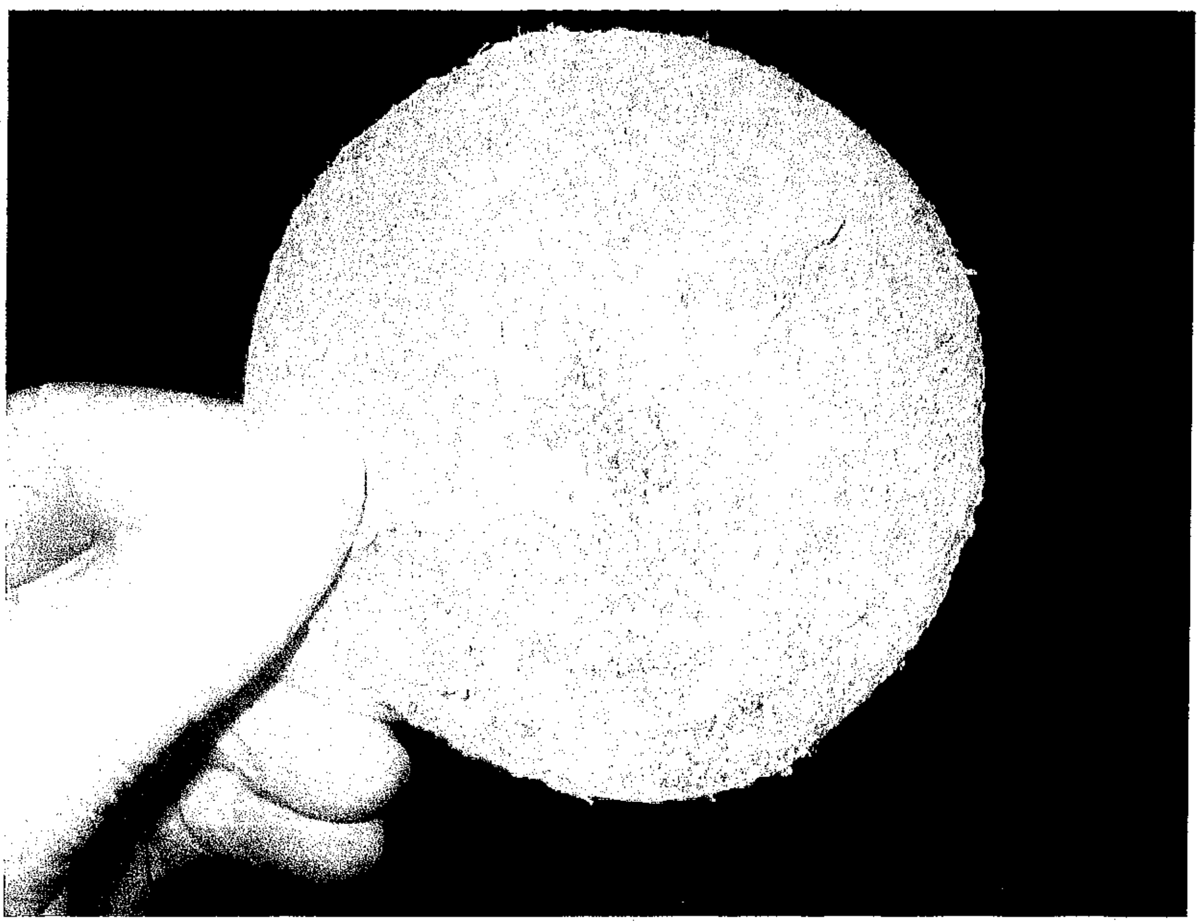
REAR VIEW
SHOWING CHIMNEY INSTALLATION

RIGHT SIDE





NORTH IDAHO ENERGY LOG ~ 8.0 LBS./ LOG



CROSS SECTION OF NORTH IDAHO ENERGY LOG

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

NOV 12 2015

OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

Ben Myren
Myren Consulting, Inc.
512 Williams Lake Road
Coleville, WA 99114

Dear Mr. Myren:

Thank you for your recent inquiry regarding the United States Environmental Protection Agency (EPA) wood heater laboratory accreditation program. The review of your reaccreditation letter that you submitted November 10, 2015 is complete and acceptable. Enclosed is your current certificate of accreditation. Myren Consulting, Inc. is accredited under Subpart AAA 40 CFR Standards of Performance for New Residential Wood Heaters Sections (60.534, 60.535) and Subpart QQQQ 40 CFR Standards of Performance for New Residential Hydronic Heaters and Forced-Air Furnaces Sections (60.5476, 60.5477). Please follow the requirements for EPA Test Method 28R Certification and Auditing of Wood Heaters in Appendix A-8 to Part 60-Test Methods 26 through 30B. This approval expires on March 16, 2018, unless renewed by Myren Consulting, Inc.

As a condition of your lab accreditation, Myren Consulting, Inc. must abide by the following provisions:
(i) Agree to participate biennially in an independently operated proficiency testing program with no direct ties to the laboratories participating;
(ii) Agree to allow the EPA, regulatory agencies and certifying bodies access to observe certification testing;
(iii) Agree to comply with calibration, reporting and recordkeeping requirements that affect testing laboratories; and
(iv) Agree to perform a compliance audit test at the manufacturer's expense at the testing cost normally charged to such manufacturer if the laboratory is selected by the EPA to conduct a compliance audit test of the manufacturer's model line;
(v) Have no conflict of interest and receive no financial benefit from the outcome of certification testing conducted pursuant to §60.5475;
(vi) Agree to not perform initial certification tests on any models manufactured by a manufacturer for which the laboratory has conducted research and development design services within the last 5 years;
(vii) Agree to seal any wood heater on which it performed certification tests, immediately upon completion or suspension of certification testing, by using a laboratory-specific seal.
(viii) Agree to immediately notify the EPA of any suspended tests through email and in writing, giving the date suspended, the reason(s) why, and the projected date for restarting.

Emission test reports should be submitted to EPA's Office of Enforcement and Compliance Assurance, at one of the following addresses:

U.S. Postal Service
U.S. EPA
Office of Enforcement and Compliance
Assurance, Office of Compliance
William Jefferson Clinton Building, South
Mail Code 2227A
1200 Pennsylvania Ave, NW
Washington, DC 20003

Attn: Wood heater Certification Lead

Private Courier
U.S. EPA
Office of Enforcement and Compliance
Assurance, Office of Compliance
William Jefferson Clinton Building, South
Room 7419D
1200 Pennsylvania Ave, NW
Washington, DC 20003

Attn: Woodheater Certification Lead

I would like to thank you for your cooperation in the wood heater certification program.

Sincerely,

Steffan Johnson
Measurement Technology Group

Enclosure (2)

cc.

Julius Banks, OECA (2227A)
Rafael Sanchez, OECA (2227A)
Adam Baumgart-Getz, OID (C304-05)
Amanda Aldridge, OID (C304-05)
David Cole, OID (C304-05)

CERTIFICATE OF ACCREDITATION

This certifies that:

Myren Consulting, Inc

Has satisfied the requirements for laboratory accreditation for the certification of wood heaters pursuant to subpart AAA of 40 CFR Part 60, New Source Performance Standards For Residential Wood Heaters and subpart QQQQ of 40 CFR Part 60, Standards of Performance for New Hydronic Heaters and Forced Air Furnaces.

November 12, 2015 - March 16, 2018
EFFECTIVE DATE

MEASUREMENT TECHNOLOGY GROUP
GROUP LEADER

Methods 28R, 28 WHH, 28 WHH-PTS,
All Methods listed in Sections 60.534 and 60.5476
METHODS

2
CERTIFICATE NUMBER

Myren Consulting, Inc.

512 Williams Lake Road
Colville, WA 99114

Office: (509)684-1154 Lab: (509)685-9458
Fax: (509)684-3987 email:myren.ben@gmail.com

DATE: 14 July 2017

TO: Dr. Rafael Sanchez, PhD., EPA

CC: Dusty Henderson, 509 Fabricators
Sebastion Button, Omni

FROM: Ben Myren

RE: Wood Heater 30 Day Advance Certification Test Notification

Section 60.534(e)(1) of the Wood Heater NSPS requires that EPA be notified at least 30 days in advance of the start or resumption of EPA Certification Testing for each specific model line. To comply with the above requirement, Myren Consulting, Inc. hereby notifies EPA that Myren Consulting, Inc., 512 Williams Lake Road, Colville, WA 99114 plans to start an EPA Certification Test series on the unit identified below.

UNIT: 509 FABRICATORS DENSIFIED FUEL LOG STOVE

Manufactured by:

509 FABRICATORS
14821 N. Peone Pines Dr.
Mead, WA 99201

Contact Person: Dusty Henderson
Phone: 509 993 3767
F:
email: unlimitedpower59@yahoo.com

Monday, September 4, 2017.

The testing will be conducted at:

Myren Consulting, Inc.
512 Williams Lake Road
Colville, WA 99114

Contact Person: Ben Myren
Lab: 509 685 9458 F: 509 684 3987
email: myren.ben@gmail.com

The 3rd Party Certifying Entity will be

Omni
13327 NE Airport Way
Portland, OR 97230

Contact Person; Sebastion Button
P: 503 643 3788 F: 503 643 3799
email: sbutton@omni-test.com

If you have any questions about this notification, contact me immediately.

MYREN CONSULTING, INC. ASTM E2515 DATA SHEET # 5-3 PAGE 1 OF 1

DETERMINATION OF TUNNEL FLOW FOR 100% SMOKE CAPTURE

Rev 2 - 10/2/16

UNIT: Optimum DATE: 9/5/17 TECHNICIAN(S): A.T. Myren

Δp @ 100% Smoke Capture: .009" H_2O Tunnel Temperature: 289 °F = 749 °A BP: 28.52 in. Hg

Tunnel Diameter: (6" tunnel = 0.1963 ft^2, 12" tunnel = 0.7854 ft^2)

Gas Velocity in the Center of the Dilution Tunnel (Vscent) (EPA M2 EQN 2-9, ASTM E 2515-07 EQN 7)

(9) Vstrav = (85.49) (0.99 cp) (.0949 √ΔP "H_2O) $\sqrt{\dfrac{749 \text{ Ts °A } \{0\}}{(28.52 \text{ Ps "Hg}) \{2\} \ (28.78 \text{ lb./ lb. mole})}}$ = 7.67251 fps

{2} {2} {5}

Estimated Pitot Correction Factor (Fp): .95 {3}

Stack Gas Dry Volumetric Flow Rate - Qsd (EPA M2 EQN 2-10, ASTM E 2515-07 EQN 3)

(10) Qsd = 3600(1 - 0.02 Bws) (7.67251 fps) {2} (.1963 ft^2) {4} (.95 [Fp]) {3} [(528 °A) (28.52 Ps "Hg) {2} /

(749 T_s °A) {0} (29.92" Hg) = 3,391.954 {1} dscfhr (or dscfh)

(10A) 3,391.954 {1} dscfhr ÷ 60 = 56.53 {1} dscfmin (or dscfm) X 5 = 282.7 {1} dscfm - Maximum Allowed Qsd

Note: Number in { } under blank lines denotes number of decimals to be used. If a blank calls for an answer already calculated, use the number of decimals previously specified for that answer.

Room Temperature Probe Location

Myren Consulting, Inc.

Unit: Optimum
Date: 9/5/17
Tech: A.T. Myren

The room temperature probe was located on the same plane as the primary air inlet and 42 " from the front of the heater as shown below.
(see EPA M28/M28R section 6.2.3, ASTM E2515 section 9.7.1)

Room Temperature Probe:

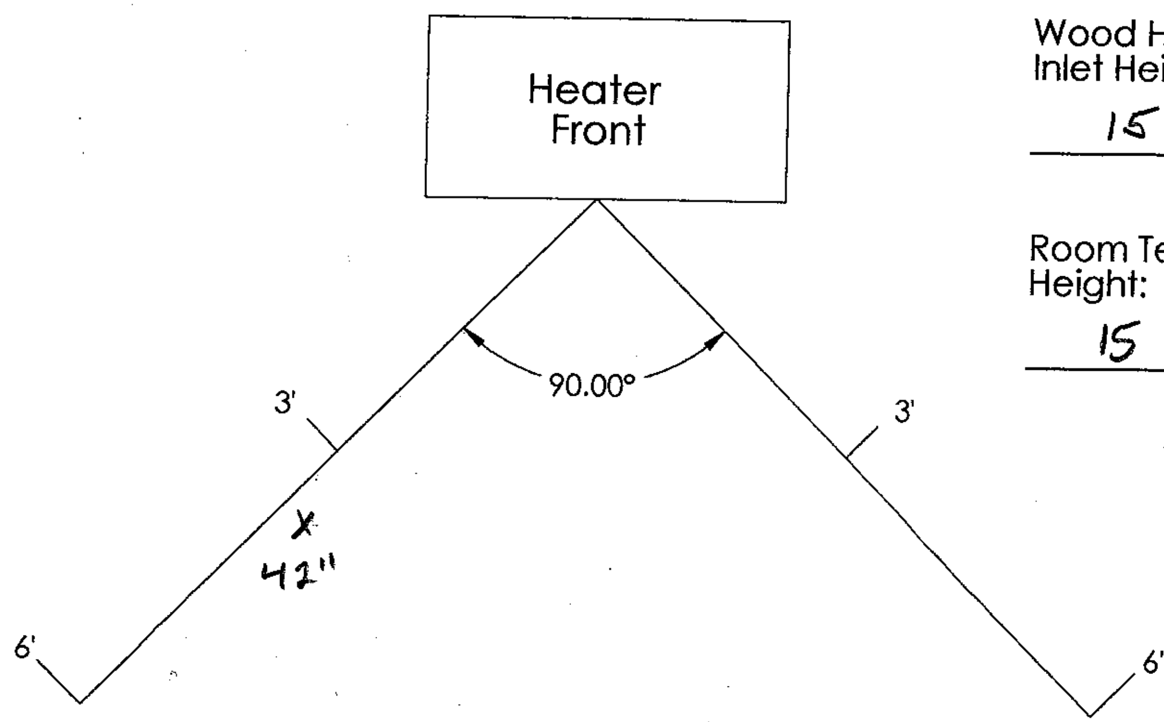
K Type Thermocouple

Wood Heater Primary Air Inlet Height:

15 " above floor.

Room Temperature Probe Height:

15 " above floor.



MYREN CONSULTING, INC.
Unit: Optimum
Date: 9/5/2017
Tech: A.T.Myren
Rev 0 5.21.2016

INDUCED DRAFT CHECK

Depending upon the unit being tested, once the appliance was installed on the platform scale or in the test facility and the tunnel flow was determined for 100% smoke capture (See ASTN E 2515, Section 9.2.4), an induced draft check was performed as per EPA M28/ M28R Section 4.1.2/ ASTM E2515 Section 9.2.3 to verify that the dilution tunnel was not inducing a draft of >0.005″ H_2O on the unit.

The static pressure probe located ≤1.0 foot above the flue collar (EPA M28/ M28R Section 6.2.3/ ASTM E2515 Section 9.2.3) that was connected to a 0.05-0-0.25 inch H_2O manometer was used to make the induced draft determination. The reading resolution on the 0.05-0-0.25 inch H_2O manometer is 0.001 inch H_2O, which is greater than the 0.002 inch H_2O resolution stipulated in EPA M28/ M28R Section 3.9 for the instruments used to measure static pressure.

The results of the induced draft check are as follows:

Flue Damper:		n/a	
Door Open:	Primary Air Control Closed*:	.000	″ H_2O
	Primary Air Control Open:	.000	″ H_2O
Door Closed:	Primary Air Control Closed*:	.000	″ H_2O
	Primary Air Control Open:	.000	″ H_2O

*Note: In units with a "stop" in the primary air control, the primary air "closed" induced draft check was conducted with the primary air control set at the "stop". In units that had no "stop", the induced draft check was conducted with the primary air control either fully closed or set so that the amount the primary air orifice was open was at the minimum amount possible.

unit has a combustion fan, so induced draft check was performed with the fan off

Room Blank Probe Location

Myren Consulting Inc.

Unit: Optimum

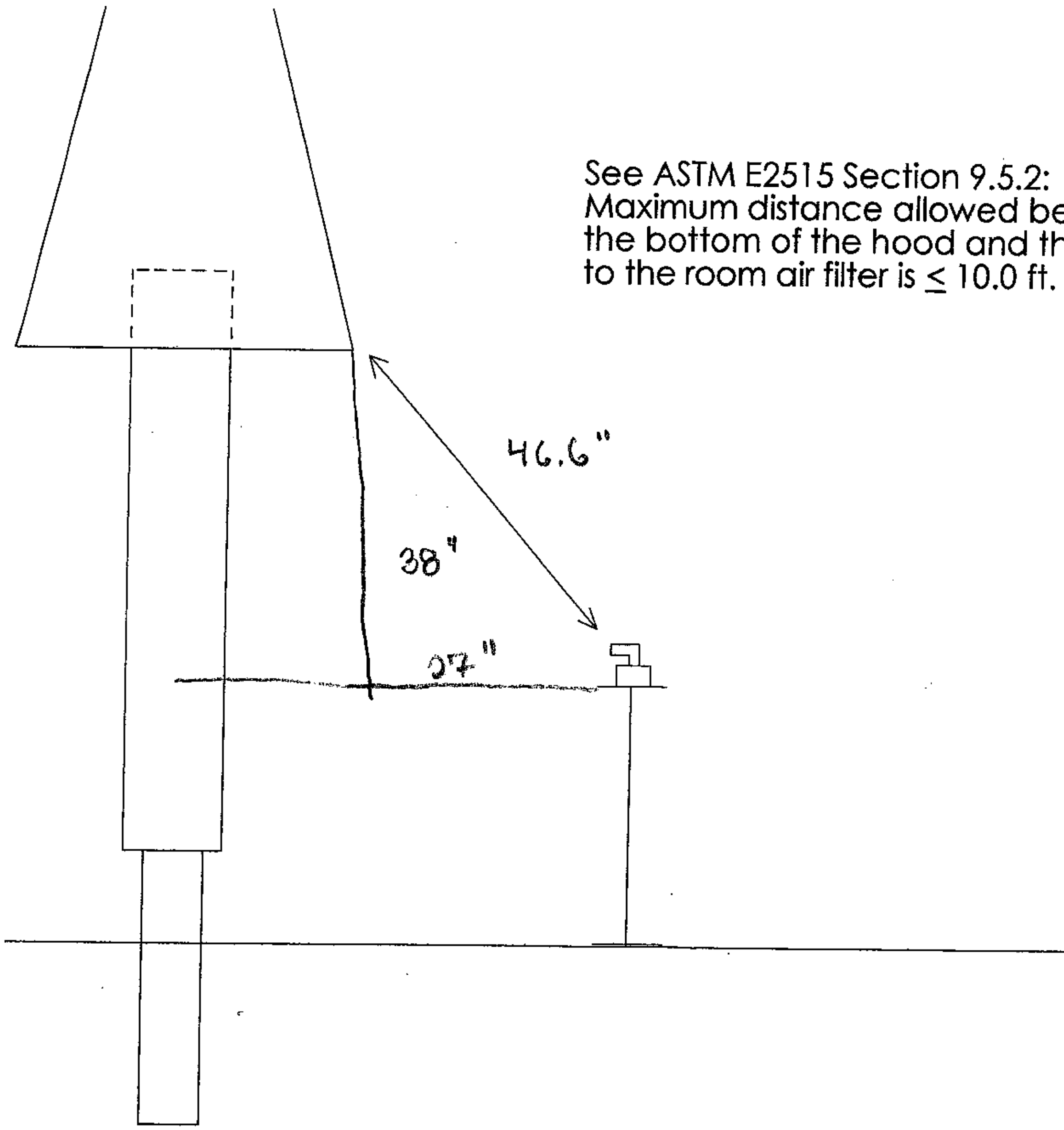
Date: 9/5/17

Tech: A.T. Myren

Run: EPA 2

The room blank probe inlet was located 46.6 "
from the bottom of the dilution tunnel hood.

See ASTM E2515 Section 9.5.2:
Maximum distance allowed between the bottom of the hood and the inlet to the room air filter is ≤ 10.0 ft.



Myren Consulting, Inc.

512 Williams Lake Road
Colville, WA 99114

Office: (509)684-1154 Lab: (509)685-9458
Fax: (509)684-3987 email: myren.ben@gmail.com

DATE: 26 November 2013

TO: Dr. Rafael Sanchez, PhD., EPA

CC: Reyn Smith, Presto Log Stove; Mike Toney, EPA; Gil Wood EPA

FROM: Ben Myren

RE: Certification Testing Protocol for a Densified Fuel Log Stove

What follows is a proposed EPA Certification Testing protocol for an appliance that burns densified fuel logs (Presto Logs).

Densified Fuel Logs:

Densified fuel logs are nothing more than big pellets with a diameter of 5 inches, a (nominal) length of 12 inches and an average weight of 7-8 lbs. These numbers vary from manufacturer to manufacturer. The advertised moisture content is 2.0%, probably taken immediately after production. We have checked the moisture in 1 log and found it to be 6.7%. The increase in moisture content is probably due to the log being exposed to ambient air and moisture after production.

Densified Fuel Log Burner:

Unlike most pellet stoves, there are no electronic controls on the unit other than two on/off toggle switches which turn the combustion and convection air fans on and off. The stove has an angled feed tube that holds at least 3 logs that are gravity fed into the burn area in the firebox. Like a woodstove the burn rate is controlled by the amount of combustion air entering the unit. The combustion air is pulled through the unit by a 178 cfm fan located downstream of the firebox. The amount of combustion air is controlled by a "butterfly damper" in the combustion air inlet and is adjusted by a control rod on the lower right front of the unit. The exhaust gasses leave the firebox through a slot in the top of the burn chamber into a heat exchange chamber that has 20-27" long 1.0"ID tubes with convection air from a 273 cfm fan flowing through them.

2 photos of the unit are attached.

Test Protocol:

We propose the following set up and procedures for testing the unit:

1. Use 14-16' of 4" pellet vent as the stack.
2. Eliminate the use of the 5 surface thermocouples used to calculate "Delta T". The unit operates in basically a "steady state" mode, so the one hour of preburn before each test should insure a fairly uniform temperature profile start to finish.
3. Use the procedures specified in EPA M28, Section 6.7. This includes a 1 one hour preburn and a 2 hour PM emissions test for each possible burn category. Tests will be run with the air control at:
   A. The maximum possible air setting
   B. The minimum possible air setting
   C. With the air control set to produce dry burn rates in any of the required burn categories between what is produced by A. and B.

Note: At present the maximum dry burn rate (DBR) is about 2.35 kg/hr and the minimum DBR is about 1.4 kg/hr. The manufacturer hopes to reduce the minimum DBR to something below 1.25 kg/hr, hopefully to about 1.0 kg/hr. So depending upon what they can accomplish, tests may be needed in all 4 burn categories.

Because the fuel is a densified fuel log, a two hour test should produce viable, accurate test results. However there is one issue that needs to be addressed, that being the amount of sample catch. One of the most recent 2 hour R&D runs using EPA M5G-1 to collect a PM sample had a front filter catch of 2.0 mg. The back half filter catch was 0 and the acetone wash catch was about 0.2mg with an average sampling rate of 0.4913 cfm. Using ASTM E 2515 (EPA M5G-3) as an alternative not an option because the nominal sampling rate of 0.15 cfm is about 1/3 of the sampling rate used in M5G-1 tests, so the catch would be about 1/3 of the M%G-1 catch, or roughly 0.7 mg. The constant weight tolerance criteria of ±0.5 mg and ±0.2 mg for M5G-1 and ASTM E 2515 respectively yields a potential error of ±22.7% for M5G-1 ((1.7 - 2.2)/2.2) and 28.5% for ASTM E2515 ((.5-.7)/.7). To try to reduce this error as much as possible, we propose to increase the sampling rate to at least 1 cfm - as much as possible (1.4 cfm ?) without exceeding the filter face velocity criteria set of 30 ft/min set forth in M5G section 7.2.1. (See attached memo about face velocities and sampling flows.)

We look forward to your reply. Let me know if you have any questions.

Have a Happy Thanksgiving!

Regards,
Ben

Myren Consulting, Inc.

512 Williams Lake Road
Colville, WA 99114

Office: (509)684-1154 Lab: (509)685-9458
Fax: (509)684-3987 email: myren.ben@gmail.com

DATE: 30 April 2016

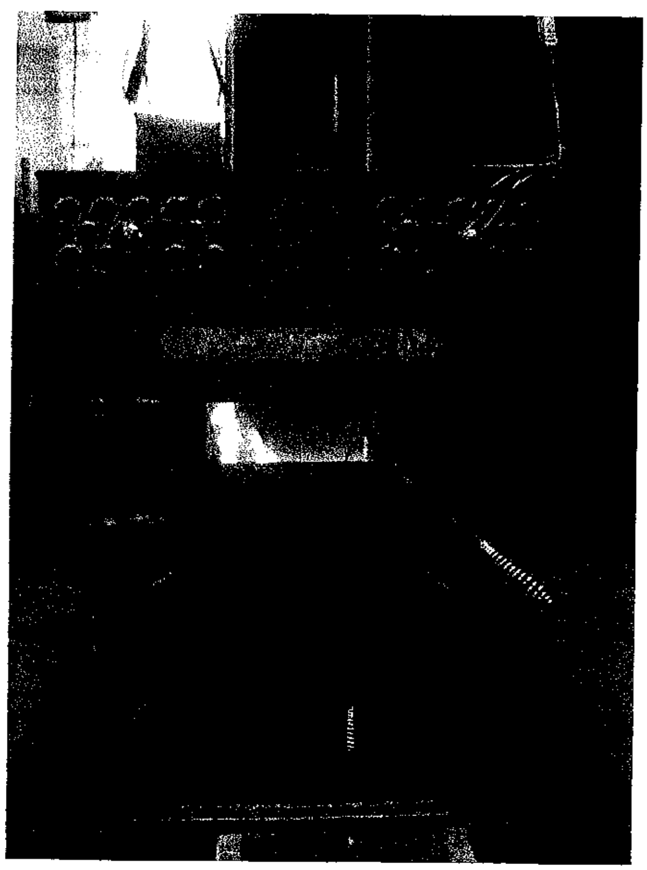
TO: Mike Toney, EPA; Stef Johnson, EPA

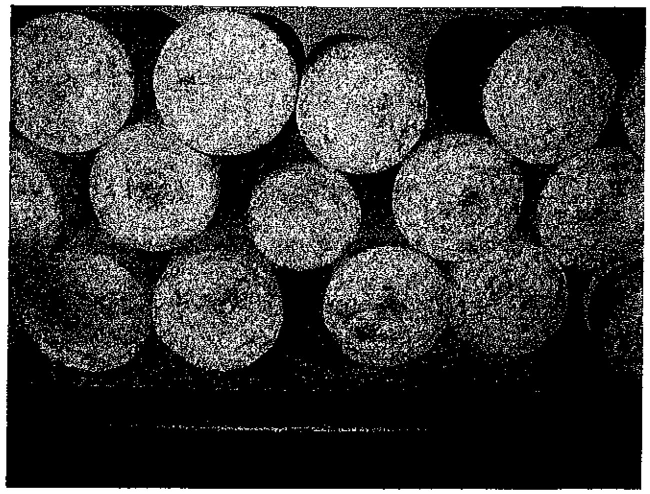
CC: Adam Baumgart-Getz, EPA; Amanda Aldridge, EPA, Rafael Sanchez, EPA; David Cole, EPA, Larry Brockman, EPA; Dusty Henderson, 509 Fabricators

FROM: Ben Myren

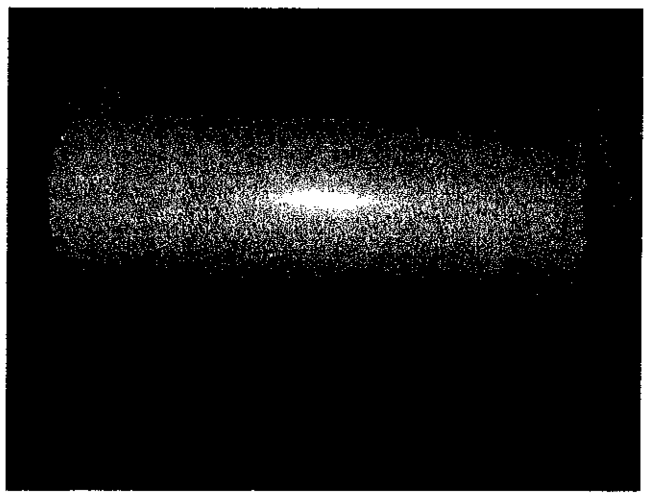
RE: DENSIFIED FUEL LOG WOOD HEATER

I have been working with a client that is developing a wood heater that burns densified fuel logs, a.k.a., Presto logs. The photos below show the most recent prototype burning in my lab on 4/26/16 and some densified fuel logs.

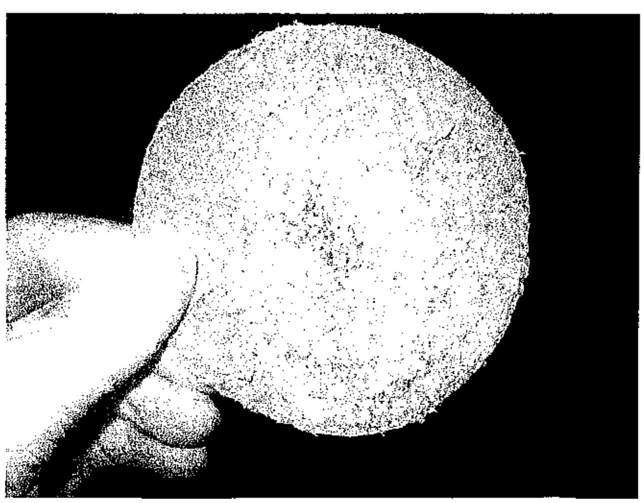




Note the 2 different sizes (diameters). The larger diameter log is a North Idaho Energy Log and the smaller diameter log is an actual Presto log.



This is a close up of a North Idaho Energy Log. It weighs about 8 lbs.



This is a close up of the end of a North Idaho Energy Log. You can see the compacted wood particles.

STOVE OPERATION:

The fuel is gravity fed into the combustion chamber via a 6" ID vertical feed tube that holds 3.5 logs. You can see part of the feed tube in the photo of the stove. The part of the feed tube inside the stove is glowing red hot. The dry burn rate (DBR) is controlled by the combustion air fed into the burn chamber. The unit has 4 combustion air settings: High, Medium, Low and Off. When set on Off, no air enters the firebox. The unit has 2 fans, one for combustion air and the other for convection air.

Since densified fuel logs are nothing more than a "big pellet", I am suggesting that we use ASTM E2779 as the basis for testing the unit. We could easily fill up the tube with logs and run an integrated 6 h test with 1 h on High, 2 h on Medium and 3 h on Low to determine PM emissions and use CSA B415.1-10 to determine the overall efficiency (%OE).

My intent with this letter is to start a dialogue with EPA with the end result of the dialogue being an agreed upon alternative testing protocol that can be used to test the stove so that the unit can be certified. I am certain that EPA will have a number of questions about this unit, but at least this memo should get the process started.

I look forward to your comments, questions and answers.

Regards,

Ben Myren
President

Myren Consulting, Inc.

512 Williams Lake Road
Colville, WA 99114

Office: (509)684-1154 Lab: (509)685-9458
Fax: (509)684-3987 email: myren.ben@gmail.com

Date: 6 December 2016

To: Mike Toney, EPA

CC: Adam Baumgart-Getz, EPA; Amanda Aldridge, EPA; David Cole, EPA; Rafael Sanchez, EPA, Steffan Johnson, EPA; Dusty Henderson, 509 Fabricators

From: Ben Myren

RE: Section 60.535(a)(2)(vi)

Section 60.535(a)(2)(vi) states

> "…Agree to not perform initial certification tests on any models manufactured by a manufacturer for which the laboratory has conducted research and design services within the past 5 years…".

Myren Consulting, Inc. has done some evaluation testing on at least 2 stove prototypes of a stove designed to burn densified fuel logs during the past 3 years for 2 different firms - same stove, but with a change in ownership. This evaluation testing included both PM emissions and overall efficiency (%OE) measurements. During this testing the manufacturer would make design changes and Myren Consulting, Inc. would conduct the PM and %OE measurements and report the results. The manufacturer would then use that data to make a decision about the next design change. The manufacturer then used all of that information to design and build a new prototype that has many different "k-list" design changes. These changes include a different combustion blower (less CFMs), a different feed tube, a completely redesigned firebox (larger) and a different convection air pathway. Myren Consulting, Inc. had no input in the decisions that led to these design changes and the construction of the latest prototype.

To provide and insure total transparency, Myren Consulting, Inc. has performed 2 PM and %OE evaluation tests (Hi and Low) on this new prototype to verify its performance. The data indicated that the unit was ready for certification testing, so at the manufacturer's request Myren Consulting (1.) submitted some 30 day advance certification test notifications to EPA and (2.) resent a memo to EPA about a proposed test protocol for the unit that was based upon ASTM E2779.

My question is, "Since Myren Consulting, Inc. did not have any input in the development of the design of the most recent prototype other than to supply the manufacturer with test data, can Myren Consulting, Inc. conduct the certification test on this unit?"

I want to be totally upfront on this because I do not want to jeopardize the manufacturer's certification or Myren Consulting, Inc.'s laboratory accreditation. When Myren Consulting, Inc. has done R&D work on a unit, I have referred the manufacturer to a different Lab for the actual certification testing. Case in point, the Kiwi 2.1 VcV stove. I look forward to your reply.

Regards,

Ben Myren

Gmail

Alben T. Myren Jr <myren.ben@gmail.com>

Test Protocol for the Densified Fuel Log Stove

5 messages

Alben T. Myren Jr <myren.ben@gmail.com> Tue, Dec 27, 2016 at 6:51 PM
To: Mike Toney <toney.mike@epamail.epa.gov>, Dusty Henderson <unlimitedpower59@yahoo.com>

Mike,

Received the OK from Sanchez to test the stove that burns densified fuel logs. The manufacturer is bringing the stove to Colville tomorrow so we can start aging it. So by 1.3.17 we will be ready to test. I have turned in 30 day certification test advance notices for the unit for the weeks starting on 1.2.17 and 1.9.17. I know the manufacturer wants to test so he can have numbers for the trade show. So where are we on the protocol? Do I need to turn in some more 30 day advance notices for this stove?

Ben

Toney, Mike <Toney.Mike@epa.gov> Wed, Dec 28, 2016 at 6:55 AM
To: "Alben T. Myren Jr" <myren.ben@gmail.com>, Dusty Henderson <unlimitedpower59@yahoo.com>
Cc: "Johnson, Steffan" <johnson.steffan@epa.gov>

Hi Ben,

Please call me regarding the protocol if you need to. I looked in my email but did not see one. I know what we talked about regarding the densified pellet heater using ASTM 2779 for the test method. Since Rafael gave you approval you can test using ASTM 2779 for the pellet heater and ASTM 2515 for particulates. Remember to take the first hour filter pull as required in the rule and to measure the CO during testing and to conduct CSA B415 for efficiency. We also need a preburn before testing just like regular wood heater testing, so more than one pellet maybe required during testing but this will be your call. Have a great test.

From: Alben T. Myren Jr [mailto:myren.ben@gmail.com]
Sent: Tuesday, December 27, 2016 9:51 PM
To: Toney, Mike <Toney.Mike@epa.gov>; Dusty Henderson <unlimitedpower59@yahoo.com>
Subject: Test Protocol for the Densified Fuel Log Stove

Mike,

Received the OK from Sanchez to test the stove that burns densified fuel logs. The manufacturer is bringing the stove to Colville tomorrow so we can start aging it. So by 1.3.17 we will be ready to test. I have turned in 30 day certification test advance notices for the unit for the weeks starting on 1.2.17 and 1.9.17. I know the manufacturer wants to test so he can have numbers for the trade show. So where are we on the protocol? Do I need to turn in some more 30 day advance notices for this stove?

Ben

Alben T. Myren Jr <myren.ben@gmail.com> Wed, Dec 28, 2016 at 8:43 AM
To: "Toney, Mike" <Toney.Mike@epa.gov>, "Sanchez, Rafael" <sanchez.rafael@epa.gov>
Cc: Dusty Henderson <unlimitedpower59@yahoo.com>, "Johnson, Steffan" <johnson.steffan@epa.gov>

Mike, Attached is the memo I sent earlier about testing the densified fuel log stove. And, yes, we are planning to do (1.) a 1 hour preburn on "High" before the start of the high burn test, (2.) a filter set change at 60 minutes in Train 1 at the end of the high burn test segment, (3.) collect all of the necessary data for B415 for CO and %OE, (4.) and reload the stove (add a log or logs) sometime during the test. We will try to sort out when to add the extra logs during aging. My thought is to add the log(s) at the end of the 2 h Med burn segment. It only takes about 15-30 seconds to add a log, so the impact on the data should be minimal So if you would add the logs at 176 minutes, the stove would have a chance to recover by the next reading (180 minutes). (Remember that the added logs will be on top of the logs that are actually burning at the bottom of the feed tube, so it will be a while before the added logs actually start to burn.) At which time you would take the necessary readings and turn the stove to Low. That would make it easy to do the B415 entries.

Rafael, Dusty is bring the stove up to the lab today. We plan to set it up and start aging it as soon as it arrives. As noted above we will try to sort out when to add the logs during aging.. If all goes as planned we will do the integrated test series next week, probably on Wed.

Any thoughts or input from either DC or RTP is welcome.

REGARDS. Ben
[Quoted text hidden]

TONEY DENSIFIED FUEL LOG TESTING PROTOCOL MEMO 4.30.16.doc
439K

Toney, Mike <Toney.Mike@epa.gov> Wed, Dec 28, 2016 at 8:48 AM
To: "Alben T. Myren Jr" <myren.ben@gmail.com>, "Sanchez, Rafael" <Sanchez.Rafael@epa.gov>
Cc: Dusty Henderson <unlimitedpower59@yahoo.com>, "Johnson, Steffan" <johnson.steffan@epa.gov>

Hi Ben,

I remember the email now. You are good to go.

From: Alben T. Myren Jr [mailto:myren.ben@gmail.com]
Sent: Wednesday, December 28, 2016 11:44 AM
To: Toney, Mike <Toney.Mike@epa.gov>; Sanchez, Rafael <Sanchez.Rafael@epa.gov>
Cc: Dusty Henderson <unlimitedpower59@yahoo.com>; Johnson, Steffan <johnson.steffan@epa.gov>
Subject: Re: Test Protocol for the Densified Fuel Log Stove

[Quoted text hidden]

Alben T. Myren Jr <myren.ben@gmail.com> Wed, Dec 28, 2016 at 1:48 PM
To: "Toney, Mike" <Toney.Mike@epa.gov>

Thank You! We will run the test on Wed of next week. Ben
[Quoted text hidden]

Had to delay testing due to technical issues and weather (cold). Tested unit on 1.9.17

Myren Consulting, Inc.

512 Williams Lake Road
Colville, WA 99114

Office: (509)684-1154 Lab: (509)685-9458

email: <myren.ben@gmail.com>

Date: July 21 2017

To: Stef Johnson, OAQPS, RTP, EPA

CC: Mike Toney, EPA; Adam Baumgart-Getz, EPA, Dr. Rafael Sanchez, EPA; Dusty Henderson, 509

From: Ben Myren

RE: REVISEDTESTING PROTOCOL FOR THE 509 OPTIMUM TEST STOVE

509 Fabricators is in receipt of a letter (email) from EPA (Johnson, OAQPS, RTP) in which EPA requests one additional test run on 509's Optimum which burns densified fuel log stove to demonstrate that the stove can achieve a medium dry burn rate that is less than 50% of the high burn rate. On behalf of 509 Fabricators, I am submitting the following revised test protocol to EPA. This revised protocol is based upon our discussions during our brief meeting on 7.21.17 in Albany, NY. If you have any questions about this proposed revision to the test protocol, please contac6 me immediately.

Regards,

Ben Myren

Myren Consulting, Inc.

512 Williams Lake Road
Colville, WA 99114

Office: (509)684-1154 Lab: (509)685-9458
Fax: (509)684-3987 email: myren.ben@gmail.com

DATE: 23 July 2017

TO: Stef Johnson, EPA, OAQPS, RTP

CC: Mike Toney, EPA; Adam Baumgart-Getz, EPA; Dr. Rafael Sanchez, EPA; Dusty Henderson, 509

FROM: Ben Myren

RE: Revised Certification Testing Protocol for a Densified Fuel Log Stove

What follows is a revised proposed EPA Certification Testing protocol for the 509 Optimum wood heater, an appliance that burns densified fuel logs ("Presto" Logs).

Densified Fuel Logs:

Densified fuel logs are nothing more than big pellets with a diameter of ~5 inches, a (nominal) length of 12 inches and an average weight of 7-8 lbs. These numbers vary from manufacturer to manufacturer and form log to log. The advertised moisture content is 2.0%, probably taken immediately after production. We have checked the moisture in 1 log and found it to be 6 - 7%. The increase in moisture content is probably due to the log being exposed to ambient air and moisture after production.

Densified Fuel Log Burner:

Unlike most pellet stoves, there are no electronic controls on this unit other than on/off toggle switches which turn the combustion and convection air fans on and off. The stove has a vertical feed tube that holds about 3.5 logs that are gravity fed into the burn area in the firebox. Like a woodstove the burn rate is controlled by the amount of combustion air entering the unit. The combustion air is pulled through the unit by a combustion air fan located downstream of the firebox. The amount of combustion air is controlled by a slider plate in the combustion air inlet and is adjusted by a control rod on the lower right front of the unit.

Revised Test Protocol:

We propose the following revisions to the test method.

1. The ignition period to start the stove. The primary air setting will be set at wide open. The ignition period will last 15-30 minutes, enough to get the fuel ignited and sustain combustion during the 1 hour preburn conducted at the Low setting followed by 3 hours on Low.
2. At 15-30 minutes the Primary Air Control (PAC) will be set to the "Low Burn" setting and a 1 hour preburn will commence.
3. At the end of the 1 hour of preburn on "Low", the test will start. No change will be made to the PAC, i.e., it will remain on "Low".
4. After 3 hours have elapsed, the PAC will be adjusted to the "Medium" setting.
5. After 2 hours have elapsed, the PAC will be adjusted to the "High" setting.
6. After 1 hour has elapsed, the test is over.
7. Fuel will be added when deemed either necessary or appropriate.

As noted in our discussions, this proposed protocol is the exact reverse of the sequence specified in ASTM E2779, which what was used during the first EPA certification test. The required sequence in E2779, 1 hour preburn on high followed by a 1 hour test segment on High, results in an accumulated firebox temperature that is very high and so, because the unit does not have a control board like pellet stoves do, it takes a very long period of time to get the unit to cool down. Add to that a gravity feed system, which depending upon when the fuel is actually added, can cause the burn rate to vary from test segment to test segment. It is hoped that this revised protocol will enable us to demonstrate that the unit can burn at reduced dry burn rates if the unit does not get to hot. (Woodstoves can have the same problem.)

Our plan is to actually try this proposed sequence and see if it will work and then provide EPA with the DBR data to confirm that what is proposed is acceptable. Should we find that what is proposed does not work as hoped, then we will submit a second revised protocol to EPA and try again.

We look forward to your reply. Let me know if anyone has any questions.

Regards,

Ben

Myren Consulting, Inc.

512 Williams Lake Road

Colville, WA 99114

Office: (509)684-1154 Lab: (509)685-9458

email: <myren.ben@gmail.com>

Date: July 21 2017

To: Dr Rafael Sanchez

CC: Stef Johnson, EPA; Mike Toney, EPA; Adam Baumgart-Getz, EPA, Dusty Henderson, 509

From: Ben Myren

RE: UNSEALING 509 OPTIMUM TEST STOVE

509 Fabricators is in receipt of a letter (email) from EPA (Johnson, OAQPS, RTP) in which EPA requests one additional test run on 509's Optimum stove which burns densified fuel logs. The purpose of this additional test run is to demonstrate that the stove can achieve a medium dry burn rate that is less than 50% of the high burn rate. On behalf of 509 Fabricators I am submitting this request to EPA so that we can unseal the original test stove and use it for the additional test run. If you have any questions about this request, please contact me immediately.

Regards,

Ben Myren

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

AUG 11 2016

OFFICE OF
ENFORCEMENT AND
COMPLIANCE ASSURANCE

Sebastian Button
Testing Supervisor
OMNI-Test Laboratories, Inc.
13327 NE Airport Way
Portland, Oregon 97230

RE: OMNI-Test Laboratories, Inc. (OMNI) November 20, 2015 Request for Clarification concerning the 2015 Standards of Performance for New Residential Wood Heaters, New Residential Hydronic Heaters and Forced-Air Furnaces (Subparts AAA and QQQQ) (2015 Standards)

Dear Mr. Button:

This letter is in response to the three November 20, 2015, OMNI letters requesting clarification of several issues under 40 CFR 60 subparts AAA and QQQQ. In the letters, OMNI requested clarification of several hypothetical scenarios and asked questions that do not directly address the applicability of the 2015 Standards. The U.S. Environmental Protection Agency (EPA) finds these questions outside the scope of an applicability determination. The term "applicability determination" is limited to the Agency's formal decisions, issued in response to a non-hypothetical and site-specific request about the applicability of a specific rule to a specific facility. Therefore, in lieu of issuing an applicability determination, this letter provides the following regulatory interpretations.

<u>Question 1:</u> Do the 2015 Standards allow unsealing of a wood heater, for which a full certification test series has not been completed, for further testing?

<u>Answer 1:</u> The 2015 Standards do not specifically address the unsealing of a wood heater for which a test laboratory has suspended a compliance test. As provided in 40 CFR 60 subparts AAA and QQQQ, sections 60.535(a)(2)(vii) and 60.5477(a)(2)(vii), respectively, an EPA-approved test laboratory is required to "...seal any wood heater on which it performed certification tests, immediately upon completion or suspension of certification testing, by using a laboratory-specific seal." Sections 60.535(a)(2)(viii) and 60.5477(a)(2)(viii) require the EPA-approved test laboratory to immediately provide written notification to the EPA of any suspended tests, and submit the operation and test data that was obtained prior to the tests being suspended. However, sections 60.535(a)(2)(viii) and 60.5477(a)(2)(viii) also require the test laboratory to provide written notification to EPA as to when testing is scheduled to be restarted.

Therefore, EPA interprets such sections as to allow the unsealing of a wood heater for the purpose of further testing in specific circumstances, which we have outlined below.

Question 2: Can the manufacturer provide new parts or make simple modifications to the sealed wood heater in lieu of making and shipping a new prototype?

Answer 2: Yes. However, the wood heater cannot be unsealed for the purpose of providing new parts or making modifications until the following steps are taken:

- The test laboratory must submit the operation and test data obtained from the suspended test to EPA.
- When submitting the operation and test data, the laboratory must also provide a written request to unseal the wood heater. The request is to include a detailed description of the modifications to be performed by the test laboratory on the unsealed wood heater and confirmation that the tested wood heater will be re-sealed in accordance with the 2015 Standards.
- After the EPA has reviewed the operation and test data along with the written request to unseal the wood heater, the EPA will notify the test laboratory and the manufacturer as to whether the wood heater may be unsealed. If EPA allows for the wood heater to be unsealed, only the test laboratory may unseal the heater. (See EPA Letter WDS-132 (February 21, 1990), https://cfpub.epa.gov/adi/pdf/adi-woodstoves-wds-132.pdf)
- Once the wood heater is unsealed, the test laboratory may make modifications to the heater and begin a new test series. Any changes made by the test laboratory to the heater (along with engineering drawings) must be documented and submitted to the EPA.
- All results of the new test series along with a complete test report must be submitted to the EPA.
- Upon completion of the new test series, the wood heater must be re-sealed with a lab-specific seal in accordance with the 2015 Standards. (60.535(a)(2)(vii)).

Question 3: Does a wood heater that has undergone an incomplete test certification have to be sealed and archived in perpetuity?

Answer 3: No. However, when the wood heater is sealed per sections 60.535(a)(2)(vii) and 60.5477(a)(2)(vii), the wood heater must remain sealed until the operation and test data obtained from the suspended test is submitted by the test laboratory and reviewed by the EPA. Once the data is reviewed, the EPA will notify the test laboratory and the manufacturer that the wood heater may be unsealed. There are no specific retention requirements in the 2015 Standards for a sealed wood heater that never completes certification testing.

Question 4: What are the certification requirements under 40 CFR 60 subpart AAA section 60.533(e)?

Answer 4: Under certain circumstances and as provided in 40 CFR 60 subpart AAA section 60.533(e), the EPA could have issued a conditional, temporary certificate of compliance to a manufacturer if it had submitted a full test report by an EPA-approved test laboratory and a complete application. The application must have included all required compliance statements by the manufacturer with the exception of a certificate of conformity by an EPA-approved third-party certifier. The conditional, temporary certificate of compliance would have been valid until May 16, 2016, and would have allowed the manufacture and sale of the affected wood heater model line until such date or until the Administrator completed the review of the application, whichever was earlier. By May 16, 2016, the manufacturer would have had to submit a certificate of conformity by an EPA-approved third-party certifier.

Question 5: Are the certifications of conformity that an EPA-accredited test laboratory submitted to the EPA "de facto temporary certificates of compliance" because they were not required for EPA to issue a temporary certificate of compliance to a manufacturer?

Answer 5: No. As provided in 60.533(e), a conditional, temporary certificate of compliance could have only been granted by the EPA if the manufacturer submitted a complete certification application (i.e., application must have included the full test report by an EPA-approved test laboratory and all required compliance statements by the manufacturer with the exception of a certificate of conformity by an EPA-approved third-party certifier) that met all the requirements of section 60.533(b).

Question 6: Would submission of a certificate of conformity with a complete certification package, (i.e., application and full test report), prior to May 16, 2016, have made a manufacturer requesting certification ineligible to receive a temporary certificate of compliance?

Answer 6: No. The manufacturer could have received a conditional, temporary certificate of compliance under 60.533(e) until the EPA review of the application was complete. However, if the manufacturer submitted a complete package including the certificate of conformity, the temporary certificate would not have been necessary as EPA could have issued the permanent certificate.

Question 7: What are the requirements for quality assurance audits for model lines that are deemed certified under section 60.533(h)(1)?

Answer 7: As provided in section 60.533(m), "the manufacturer of a model line with a compliance certification under paragraph (h)(1) of this section must conduct a quality assurance program that satisfies the requirements of this paragraph (m) by May 16, 2016." The requirements for quality assurance audits for model lines that are deemed certified under §60.533(h)(1) are as follows:

(1) Specific inspection and testing requirements for ensuring that all units within a model line are similar in all material respects that would affect emissions to the wood heater submitted for certification testing and meet the emissions standards in section 60.532;
(2) Must be approved by the third-party certifier as part of the certification of conformity process specified in section 60.533(f);
(3) Include regular (at least annual) unannounced audits by the third-party certifier under ISO–IEC Standard 17065 to ensure that the manufacturer's quality assurance plan is being implemented;
(4) Include a report for each audit under ISO–IEC Standard 17065 that fully documents the results of the audit. The third-party certifier must be authorized and required to submit

all such reports to the Administrator and the manufacturer within 30 days of the audit. The audit report must identify deviations from the manufacturer's quality assurance plan and specify the corrective actions that need to be taken to address each identified deficiency;

(5) Within 30 days after receiving each audit report, the manufacturer must report to the third-party certifier and to the Administrator its corrective actions and responses to any deficiencies identified in the audit report. No such report is required if an audit report did not identify any deficiencies. (section 60.533(m(1)-(5))

Question 8: Are manufacturers required to contract the services of a third-party certifier to conduct quality assurance audits?

Answer 8: Yes. On or after May 16, 2016, manufacturers are required by section 60.533(m) to contract the services of a third-party certifier to conduct quality assurance audits.

Question 9: What are the requirements for deemed certified wood heaters under section 60.533(m)?

Answer 9: As provided in section 60.533(m), manufacturers must have had in place by May 16, 2016, a quality assurance program that satisfied the requirements under section 60.533(m)(1) through (5). However, the third-party certifier was not required to issue a certificate of conformity because the 2015 Standards provided a path for model lines to be deemed certified without having to undergo the rigors of the third party certifier process if they satisfied the requirements under section 60.533(h)(1). As noted above, the periodic third party quality assurance audit process would still need to be conducted.

Question 10: Does a certificate of compliance issued prior to May 15, 2015, at an emission level less than or equal to the 2015 emission standard need to be renewed before May 15, 2020?

Answer 10: No. Manufacturers of model lines that were deemed certified per section 60.533(h)(1) and for which a certificate of compliance had been issued prior to May 15, 2015, demonstrating an emission level less than or equal to the 2015 emission standards, do not need to renew their certificates until May 15, 2020. The preamble and the regulatory text of section 60.533(h)(1) state that heaters with EPA certifications under the 1988 Standards that show compliance with the Step 1 emission levels are automatically deemed certified to meet the Step 1 emission limits under the 2015 Standards until May 15, 2020. No separate certification is required.

The EPA considers this response to be a regulatory interpretation to a request for clarification. This response has been prepared in consultation with the Office of General Counsel and the Office of Air Quality Planning and Standards. If you have any questions, please contact Rafael Sanchez of my staff at 202-564-7028 or email at sanchez.rafael@epa.gov.

Sincerely,

Edward J. Messina, Director
Monitoring, Assistance, and Media Programs Division
Office of Compliance

cc: Amanda Aldridge, OAQPS
Adam Baumgart-Getz, OAQPS
Scott Jordan, OGC
Sara Ayres, OC

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

AUG 0 9 2017

OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

Mr. Alben Myren
Myren Consulting, Inc
512 Williams Lake Road
Coleville, WA 99114

Dear Mr. Myren,

I am writing in response to your July 23, 2017 letter we received on July 25, 2017 regarding testing of the 509-1 Optima wood heater manufactured by 509 Fabrications Inc, 14821 N. Peone Pines Dr, Mead, Washington, 99021. As we understand it, the 509-1 Optima wood heater is subject to the testing requirements of 40 CFR 60, Subpart AAA, Standards of Performance for New Residential Wood Heaters (Subpart AAA) and is considered a pellet fuel wood heater. The 509-1 Optima is a device that burns densified "Presto Log" fuel logs. The 509-1 Optima does not operate like a traditional pellet wood heater where the fuel feed and combustion air are controlled electronically, but instead it utilizes manual controls. The fuel logs are gravity fed into the burn area and the combustion and convection air are controlled by on/off toggle switches.

You state that the 509-1 Optima was originally tested using the test procedures of ASTM E2779 -11 "Standard Test Method for Determining Particulate Matter Emissions from Pellet Heaters" as required by Subpart AAA. The medium burn rate requirement was not obtainable because the heater burn rate was greater than the less than or equal to fifty percent of high burn requirement as defined in the ASTM E2779-11. You believe this higher medium burn rate was due to the heater slowly reducing in temperature and had enough time occurred, the heater would have produced a valid medium burn rate. You are requesting an alternative test method procedure for the 509-1 Optima wood heater such that the burn rate category sequence outlined in ASTM 2779-11- high, medium, and low - be reversed to low, medium and high as you believe this revised order would produce a proper medium burn rate.

With the caveats listed below, we approve your alternative method request for testing the 509-1 Optima wood stove, as required in Subpart AAA, Section 60.534(d) to reverse the order of the burn rate categories tested to low, medium, and high. In conducting this testing, the manufacturer or approved test lab must also measure the first hour of particulate matter emissions for each test run using a separate filter in one of the two parallel sampling trains. These results must be reported separately and also included in the total particulate matter emissions per run. As per Section 60.534(e) of Subpart AAA, the manufacturer must have the approved test laboratory measure the efficiency, heat output and carbon monoxide emissions of the tested wood heater using Canadian Standards Administration (CSA) Method B415.1-10. For particulate matter emission concentrations, ASTM E2515-11 must be used.

The following changes to ASTM E2515-11 "Standard Test Method for Determination of Particulate Matter Emissions Collected by a Dilution Tunnel" may be followed:

1. Sample filters may be Pall TX-40 or equivalent Teflon-coated glass fiber, and 47 mm, 90 mm, or 100 mm in diameter.

2. Four inch filters are acceptable.

This approval must be included in your certification test report. If you have additional questions regarding these decisions, please contact Michael Toney of my staff at (919) 541-5247.

Sincerely,

Steffan M. Johnson, Group Leader
Measurement Technology Group

cc: Michael Toney, EPA/AQAD (E143-02)
Rafael Sanchez, EPA/OECA (2227A)
Adam Baumgart-Getz, EPA/OID (C311M)
David Cole, EPA/OID (C311M)
Amanda Aldridge, EPA/OID (C311M)
Ben Myren, Myren Consulting, Inc.
Dusty Henderson, 509 Fabrictions, Inc.

From: Alben T. Myren Jr [mailto:myren.ben@gmail.com]
Sent: Friday, August 11, 2017 10:00 AM
To: Sanchez, Rafael <Sanchez.Rafael@epa.gov>; WoodHeaterReports <WoodHeaterReports@epa.gov>; Messina, Edward <Messina.Edward@epa.gov>; Aldridge, Amanda <Aldridge.Amanda@epa.gov>; Baumgart-Getz, Adam <Baumgart-Getz.Adam@epa.gov>; Jordan, Scott <Jordan.Scott@epa.gov>; Sara Ayers <ayers.sara@epa.gov>; Johnson, Steffan <johnson.steffan@epa.gov>; Toney, Mike <Toney.Mike@epa.gov>; Dusty Henderson <unlimitedpower59@yahoo.com>; Sebastian Button <sbutton@omni-test.com>
Subject: 509 Fabricator's Optimum wood heater

Rafael, et al.

Please see attached information.

Regards,

Ben Myren

Myren Consulting, Inc.

509 684 1154 (office)

509 685 9458 (lab)

Alben T. Myren Jr <myren.ben@gmail.com> Thu, Aug 17, 2017 at 7:35 AM
To: "Sanchez, Rafael" <Sanchez.Rafael@epa.gov>
Cc: Dusty Henderson <unlimitedpower59@yahoo.com>, Sebastian Button <sbutton@omni-test.com>

Rafael, Thank you. Ben Myren
[Quoted text hidden]

Myren Consulting, Inc.

512 Williams Lake Road
Colville, WA 99114
Office: (509) 684-1154 Lab: (509) 685-9458
email:myren.ben@gmail.com

509 FAB Optimum Sanchez 8.11.17 Letter

11 August 2017

Dr. Rafael Sanchez, PhD.
U.S.EPA
Office of Enforcement and Compliance Assurance
Office of Compliance
William Jefferson Clinton Building, South
Room 7419D
1200 Pennsylvania Ave., N.W.
Washington, DC 20003

Dear Dr. Sanchez:

Myren Consulting, Inc. (MCI) is in receipt of a letter dated August 11, 2017 that is addressed to Sebastian Button, Testing Supervisor at OMNI-Test Laboratories, Inc. (OMNI) from Edward J. Messina, Director of Monitoring, Assistance, and Media Programs Division in EPA's Office of Compliance. The letter is in response to a number of questions Mr. Button raised about a number of issues under 40 CFR Subparts AAA and QQQQ. Some of the questions raised, specifically questions 1, 2 and 3, apply to EPA certification testing Myren Consulting, Inc. did for 509 Fabricators, Inc. (509) on their OPTIMUM wood heater that burns densified fuel logs. Of the other questions, just question 8 would seem to generically apply to 509 because the certification testing was done after May 15, 2017. I know for a fact that 509 has initiated action to acquire the services of a third-party certifier to conduct quality assurance audits, so that is not an issue.

I will now respond to the questions that do apply to 509 on a question by question basis.

<u>Question 1:</u>

1. As required the test stove was sealed by MCI immediately after certification testing was completed. Photographs of the sealed stove are in the Storage section in the original test report prepared for 509.
2. No written notification of suspension of testing was sent to EPA because at the time testing was finished, it

was not anticipated that any additional testing would be required, i.e., it was thought testing on the OPTIMUM was done.

3. MCI is sending EPA (Sanchez) today via one day (UPS Red) a complete copy of the EPA certification test report that was prepared for 509 and eventually sent to OMNI. This copy of the EPA certification test report will provide EPA with all of the operation and test data for the EPA certification test that was conducted on the OPTIMUM on January 9, 2017.
   COMMENT: The OPTIMUM burns densified fuel logs and an alternative test method was developed for the unit because none of the operating and fueling protocols in the other wood heater test methods would work for the unit. Copies of the back and forth exchanges between the staff of EPA's Measurement Technology Group in RTP and MCI that led to the development of the protocol that was used during EPA certification testing are in the Introduction Section of the test report.
4. On July 14, 2017 MCI submitted 6 thirty day advance written notifications to EPA (Sanchez) for 6 consecutive weeks starting with the week beginning on August 14, 2017 and ending on September 18, 2017. (Copies of these 6 notifications accompany this letter.) Additional notifications may be sent to EPA to insure that once an agreed upon way forward is reached, 509 can conduct an additional test or tests immediately.
5. As of August 11, 2017 the test unit is still sealed and is in MCI's lab in Colville, WA.

<u>Question 2:</u>

1. As noted above in response 3 to Question 1, MCI will be sending EPA (Sanchez) a complete copy of the original certification test report via a one day courier today.
2. On July 21, 2017 MCI sent a memo to EPA specifically requesting that MCI be allowed to unseal the OPTIMUM test unit. The request contained the reason for the request, i.e., 509 wishes to conduct an additional test on the unit to demonstrate that the dry burn rate (DBR) for the Medium setting is less than 50% of the DBR for the High burn. (A copy of that request accompanies this letter.)
3. To that end, on behalf of 509 MCI has submitted a request for a modified alternative test protocol to the Measurement Technology Group in RTP on July 23, 2017 and has received formal approval on August 9, 2017 from the Measurement Technology Group to use that protocol to conduct an additional certification test accordingly. (A copy of both the modified alternative test protocol

proposal and EPA's approval accompany this letter.) At this time it is not anticipated that any physical modifications will need to be made to the wood heater. Should physical modifications be deemed necessary, MCI will contact EPA and provide a detailed description of the proposed modifications prior to making them.

4. The wood heater will be resealed in accordance with the language in the 2015 NSPS immediately after the additional testing has been completed.
5. Only MCI will unseal the wood heater.
6. All the necessary specified documentation and data will be provided to EPA in the test report that contains the data for any and all additional test runs that are performed on the unsealed wood heater.

Question 3:

1. This question does not really seem to apply because 509 does intend to certify the OPTIMUM, so the test unit will need to sealed and archived in perpetuity. See the answer to Question 2, #4 above.

If you or anyone else has any questions about the information in this letter or in the test report, please contact me immediately.

Sincerely,

Alben T. Myren Jr.
President

CC: Edward Messina, OC
Amanda Aldridge, OAQPS
Adam Baumgart-Getz, OAQPS
Scott Jordan, OGC
Sara Ayers, QC
Steffan Johnson, OAQPS, EMG
Mike Toney, OAQPS, EMG
Dusty Henderson, 509 Fabricators
Sebastian Button, OMNI

Your parcel has been delivered

iShip_Services@iship.com

Mon 8/14/2017 2:48 PM

To:lifelinewa@hotmail.com <lifelinewa@hotmail.com>;

Your parcel has been delivered

Join our email program to receive exclusive offers and resources

Your parcel has been delivered

The parcel to **U.S. EPA-Office of Compliance** has been delivered.

Your shipment information

Who sent it...
Myren Consulting

(Sender's street address omitted intentionally from this email)
COLVILLE, WA 99114-8614

Who will receive it...
U.S. EPA-Office of Compliance
Dr. Rafael Sanchez, PhD.
(Recipient's street address omitted intentionally from this email)
WASHINGTON, DC 20004-2403 US
Mon 14 Aug 2017 09:15 AM

Who is carrying it...
The UPS Store #4352
509-684-3340

Carrier detail...
UPS Next Day Air Saver

Tracking details...
Tracking No.:
1Z18WA201393898472
Shipment ID:
MM8ESP6TVJYVK
Order / Item #: --
Reference #: --

Ship date
Friday, August 11, 2017

Delivery date...
Mon 14 Aug 2017 09:15 AM

Tracking your item

Myren Consulting, Inc.

512 Williams Lake Road
Colville, WA 99114

Office: (509) 684-1154 Lab: (509) 685-9458
email: myren.ben@gmail.com

Date: 12 August 2017

To: Stef Johnson, EPA/AQAD

CC: Mike Toney, EPA/AQAD; Rafael Sanchez, EPA/OECA; Adam Baumgart-Getz, EPA/OID; David Cole, EPA/OID, Amanda Aldridge, EPA/OID; Dusty Henderson, 509

From: Ben Myren

RE: REVISED ALTERNATIVE TESTING PROTOCL FOR THE OPTIMUM WOOD HEAT MANUFACTURED BY 509 FABRICATORS.

In a memo to EPA (Johnson) dated 23 July 2017 Myren Consulting proposed a second alternative test method for the OPTIMUM wood heater manufactured by 509 Fabricators of Mead, WA. The OPTIMUM burns densified fuel logs. One EPA 6 hour integrated certification test has been performed on the OPTIMUM and the emission rate was 1.89 g/h. Unfortunately the unit failed to meet one of the test criteria in ASTM E2779-10, that being that the dry burn rate (DBR) of the Medium burn segment of the integrated test had to be ≤50% of the DBR of the Maximum segment's DBR. Since that proposal was submitted to EPA, the manufacturer has been burning a unit trying to achieve a Medium test segment with a DBR that is ≤50% of the DBR of the Maximum segment's DBR and has not been able to successfully meet that requirement. The problem is that the firebox (firepot) contains a lot of brick which is slow to either accumulate or release heat and this heat release rate affects the DBR. In short, we are in one of those "Can't get there from here" situations. Thus I think we need to rethink what the certification requirements are and/or need to be for this unit.

Here are some thoughts for consideration.

1. It is a one of a kind unit.
2. It burns densified fuel logs that weigh between 5 and 8 lbs.
3. It is not a pellet stove as is defined in Section 60.531 *Pellet Stove* because it does not burn pellets or chip fuel with pellets being defined in Section 60.531 *Pellet Fuel* "…as refined and densified fuel shaped into small pellets or briquettes…" with the word of interest being *small*. A 5 or

8 lb. fuel log is not *small* in any sense of the word when compared to a typical pellets burned in a pellet stove.

4. The unit does meet the definition of a "…manually controlled heater…" as is defined in Section 3.2.9 in ASTM E2779-10 but it does not have a "…fuel feed system…" as is defined in ASTM E2779-10 Section 3.2.5 as a "…mechanism for delivering fuel from the hopper to the burn pot…". Webster's (1991) defines *Mechanism* as "…an assembly of moving parts performing a complete functional motion…".
5. The unit does have a *firebox* which could be considered to be a "burn pot" as defined in ASTM E2779-10 Section 3.2.2 and a *fuel feed tube* which could be considered to be a "fuel hopper" as per ASTM E2779-10 Section 3.2.7, but there is no fuel feed system as per ASTM E2779-10 Section 3.2.5 to move the fuel from the feed tube to the firebox. That is accomplished by gravity. So the unit is not a Pellet Stove as is currently defined in the NSPS and ASTM E2779-10 because it does not have a fuel feed system.
6. When Myren Consulting sent an alternative test method proposal to EPA (Toney. Johnson) on 30 April 2016, ASTM E2779-10 seemed the most likely candidate as the basis for an alternative test method because of the integrated test cycle found in Section 9.4.1 and the fact that densified fuel logs are nothing more than a very large pellet.
7. The stumbling block in that thought process is the requirement in ASTM E2779-10 Section 9.4.1.2 that the Medium burn segment have a DBR that is ≤50% of the Maximum burn segment's DBR. We just didn't understand how heat transfer in the feed tube and firebox in the unit worked.

<u>Conclusion:</u>

The OPTIMUN, or any other appliance that burns densified fuel logs for that matter, is not a "Pellet stove" as is defined in either the NSPS or in ASTM E2779-10. Nor does it operate like a pellet stove because it has no fuel feed system. Thus it is a new appliance category, so requiring it to perform like a pellet stove, or a stick stove for that matter, is not an applicable way to assess its performance, as the issue with the ≤50% DBR requirement in Section 9.4.1.2 indicates.

<u>OTPIONS:</u>

There seem to be 2 ways forward.

1. Turn the unit into a Single Burn Rate (SBR) appliance by fixing the Primary Air Control (PAC) at some setting.

(Because the unit is gravity fed, the consumer would then control the DBR by the way they add fuel to the unit.

2. Eliminate the ≤50% DBR requirement for appliances that burn densified fuel logs because that requirement really doesn't seem to apply to this appliance category, i.e., it is an arbitrary requirement carried forward from a test method for another appliance category. (With this option the consumer would be able to control the DBR by the way they add the fuel logs and by adjusting the PAC.)

PROPOSAL:

If 2 above is acceptable, and there isn't any real reason it shouldn't be because this is a new appliance category, 509 proposes to conduct one additional 6 hour integrated test using the reversed DBR testing sequence of 1 h of preburn on Low, 3 h of testing on Low, 2 h of testing on Medium and then 1 h of testing on High that was proposed in a Myren Consulting memo to EPA (Johnson) dated 23 July 2017 and approved in a letter from EPA (Johnson) dated 9 August 2017 and then average the results from the 2 tests to determine compliance with EPA's 2020 standard of 2.0 g/h in Section 60.532(b). 509 is more than willing to test to determine compliance as long as there is a way forward to certification and being able to market their product. This is a very unique product and while it probably has a limited market, this kind of innovation needs to be encouraged by finding a way to work together so it can be brought to market.

We thank you in advance for your consideration of this revised proposal and look forward to your reply and to working with you all and finishing this project. Both Dusty and I will make ourselves available for a conference call at any time convenient for EPA if one is deemed necessary.

Highest Regards,

Ben Myren
President
Myren Consulting, Inc.

Myren Consulting, Inc.

512 Williams Lake Road
Colville, WA 99114
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email:myren.ben@gmail.com

509 FAB Optimum Johnson8.16.17 Memo

Date: 16 August 2017

To: Stef Johnson, EPA/AQAD

CC: Mike Toney, EPA/AQAD; Rafael Sanchez, EPA/OECA; Adam Baumgart-Getz< EPA/OID, David Cole, EPA/OID; Amanda Aldridge, EPA/OID; Dusty Henderson, 509

From: Ben Myren

On 12 August 2017 Myren Consulting, Inc. (MCI) sent a memo to EPA (Johnson, EPA/AQAD) requesting another revision to the Alternative Test Method for Optimum wood heater that burns densified fuel logs that is manufactured by 509 Fabricators of Mead, WA. This memo builds upon the 12 August memo to EPA and is also in response to portions of a letter from EPA dated August 11, 2017 that is addressed to Sebastian Button, Testing Supervisor at OMNI-Test Laboratories, Inc. (OMNI) from Edward J. Messina, Director of Monitoring, Assistance, and Media Programs Division in EPA's Office of Compliance. In that letter, Question 2/ Answer 2 Point 3, states that

> "…Once the wood heater is unsealed, the test laboratory may make modifications to the heater and begin a new test series. Any changes made by the test laboratory to the heater (along with engineering drawings) must be documented and submitted to the EPA…"

It is assumed that these changes must happen before any additional testing occurs and that EPA must approve the design changes in advance.

In the 11 August 2017 letter about a revised Alternative Test Method to EPA referenced above, no mention of any design changes was made because none were anticipated. Now, based upon some additional testing, the manufacturer would like to make two design changes which are as follows:

1. The damper plate (primary air control slider) will be modified as is shown in the accompanying drawing. This design change is intended to give better control of the

amount of air entering the stove at the lower dry burn rates.

2. The feed tube will have a small air inlet added to it as per the two DWGs DOO. The purpose of this air is to decrease the amount of condensation that occurs in the upper part of the feed tube. It is thought that this condensation is causing the logs to "stick" in the feed tube and thus is at least partially responsible for the varying dry burn rates that have occurred during testing. It is not thought that this additional air will totally eliminate the "sticking", but test data from manufacturer's in-house tests thus far indicates that it does help eliminate some of the "sticking".

Are these two design changes *K-list* design changes?

1. While the change to the damper/ slider plate would seem to be, remember that this unit is an induced draft unit that has a combustion air fan pulling air thru the unit and thus far reducing the amount the damper plate is open has had minimal impact on the dry burn rate, so it is anticipated that this design change will not have a major/ significant impact on the unit's performance.
2. The tube for the air being delivered to the feed tube to prevent condensation is 3/8" OD/ 1/4" ID, so the amount of air that is being delivered to the feed tube is very small and that air is being pulled down the feed tube into the fire box, so basically the same amount of air will be entering the fire box/ combustion chamber.

It is hoped that even with the above 2 proposed design changes, Option 2 proposed as the revised Alternative Test Method in my memo dated 12 August 2017 will still be acceptable, i.e., 509 will do one more integrated test run this time starting with the Low burn and ending with the High burn and then average the test results from the 2 runs.

If you or anyone else has any questions about the request/ information in this memo, please contact me immediately.

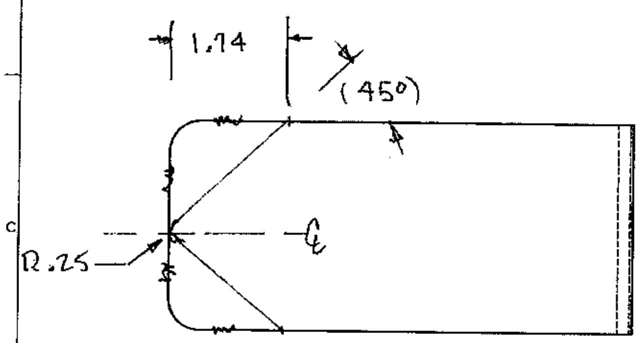
Sincerely,

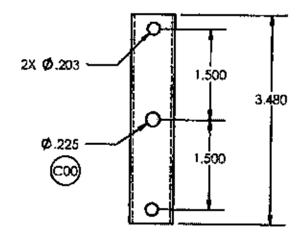
Alben T. Myren Jr.
President

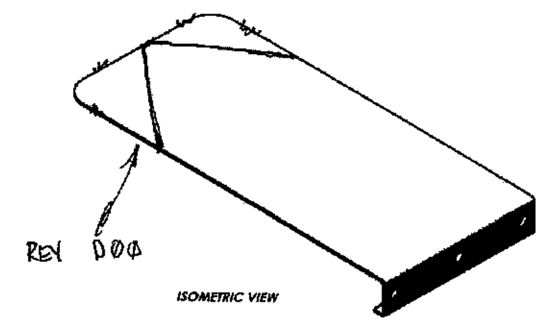
NOTES:
1. REMOVE ALL BURRS AND SHARP EDGES
2. NO POWDER COAT

REVISION

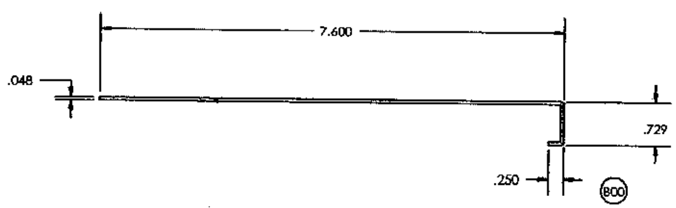
REV.	DESCRIPTION	DATE	APPROVED
A00	PROTOTYPE BUILD	08-02-16	Troy Watt
B00	MODIFIED FLANGES	12/25/2016	Troy Watt
C00	COMPLETE REDESIGN DAMPER HANDEL; HOLE DIA	5/6/2017	Troy Watt
D00	MODIFIED PROFILE OF DAMPER	8-12-17	TW







ISOMETRIC VIEW



REV D00

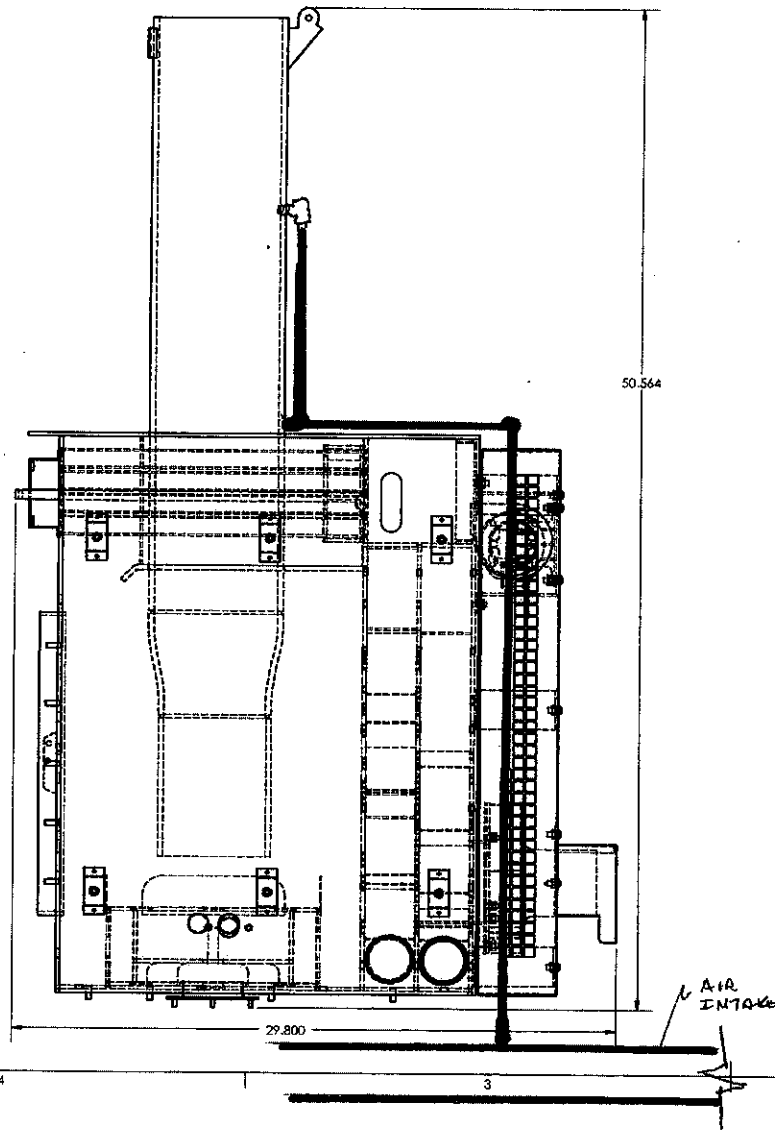
PROPRIETARY AND CONFIDENTIAL
THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF 509 FABRICATION INC. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF 509 FABRICATION INC IS PROHIBITED

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
X.X ±0.04
X.XX ±0.02
X.XXX ±0.01
FRACTIONS: ±1/16
ANGULAR: ±.5°
MACHINED SURFACE FINISH:
THIRD ANGLE PROJECTION
REMOVE ALL BURRS AND SHARP EDGES
DO NOT SCALE DRAWING

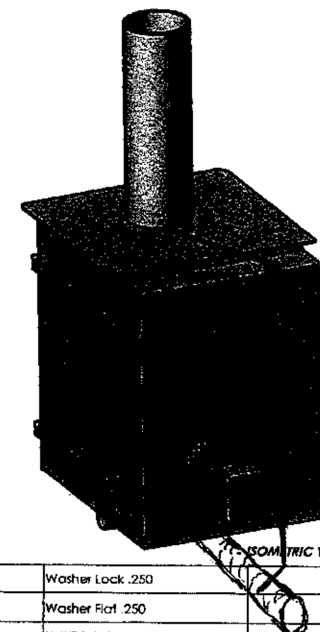
MATERIAL: ASTM A1008 Cold Rolled Steel
THICKNESS: 0.048
DRAWN Troy Watt 08-02-16
DESIGNER 08-02-16
FLAT FILE #
FINISH:

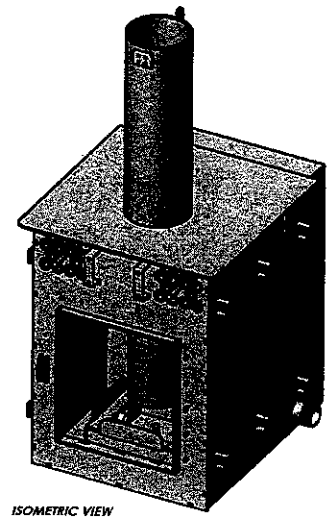
TITLE DAMPER, BOTTOM
SIZE B DWG. NO. 5091-148
REV ~~C00~~
SCALE: NONE
SHEET 1 OF 1

NOTES:
1. REMOVE ALL BURRS AND SHARP EDGES
2. BLOWER AND FAN SHOWN IN ASSEMBLY FOR REFERENCE ONLY
3. BLOWER AND FAN IN (#5091-305) ELECTRICIAL ASSEMBLY B.O.M



REVISION			
REV.	DESCRIPTION	DATE	APPROVED
A00	PROTOTYPE BUILD	08-02-16	Troy Watt
B00	MODIFACTIONS, SHIELDS AND STOVE	2/2/2017	Troy Watt
C00	REMOVED HEAT SHIELDS FROM B.O.M.	5/16/2017	Troy Watt
D00	ADDED NEW TUBE to INTAKE	8-12-17	TW





ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
8	Washer Lock .250	WASHER, LOCK 1/4"	13
7	Washer Flat .250	WASHER, FLAT, 1/4" STEEL, PLAIN	13
6	HNUT 0.2500-20-D-N	NUT, HEX 1/4-20	13
5	CR-RHMS 0.25-20x0.5x0.5-N	ROUND HEAD MACHINE SCREW 1/4-20 x 1/2"	11
4	5091-500	WELDMENT, STOVE, MAIN	1
3	5091-471	COVER, FAN, SHROUD BLOWER, HWD ASSY	1
2	5091-454	BLOWER, MOUNT, HWD ASSY	1
1	5091-155	SHROUD BLOWER	1

Bill of Material

PROPRIETARY AND CONFIDENTIAL THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF 509 FABRICATION INC. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF 509 FABRICATION INC IS PROHIBITED

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
X.X ±0.04
X.XX ±0.02
X.XXX ±0.01
FRACTIONS: ±1/16
ANGULAR: ±.5°
MACHINED SURFACE FINISH:
THIRD ANGLE PROJECTION
REMOVE ALL BURRS AND SHARP EDGES
DO NOT SCALE DRAWING

MATERIAL:
THICKNESS:
DRAWN Troy Watt 08-02-16
DESIGNER Troy Watt 08-02-16
FLAT FILE #
FINISH:

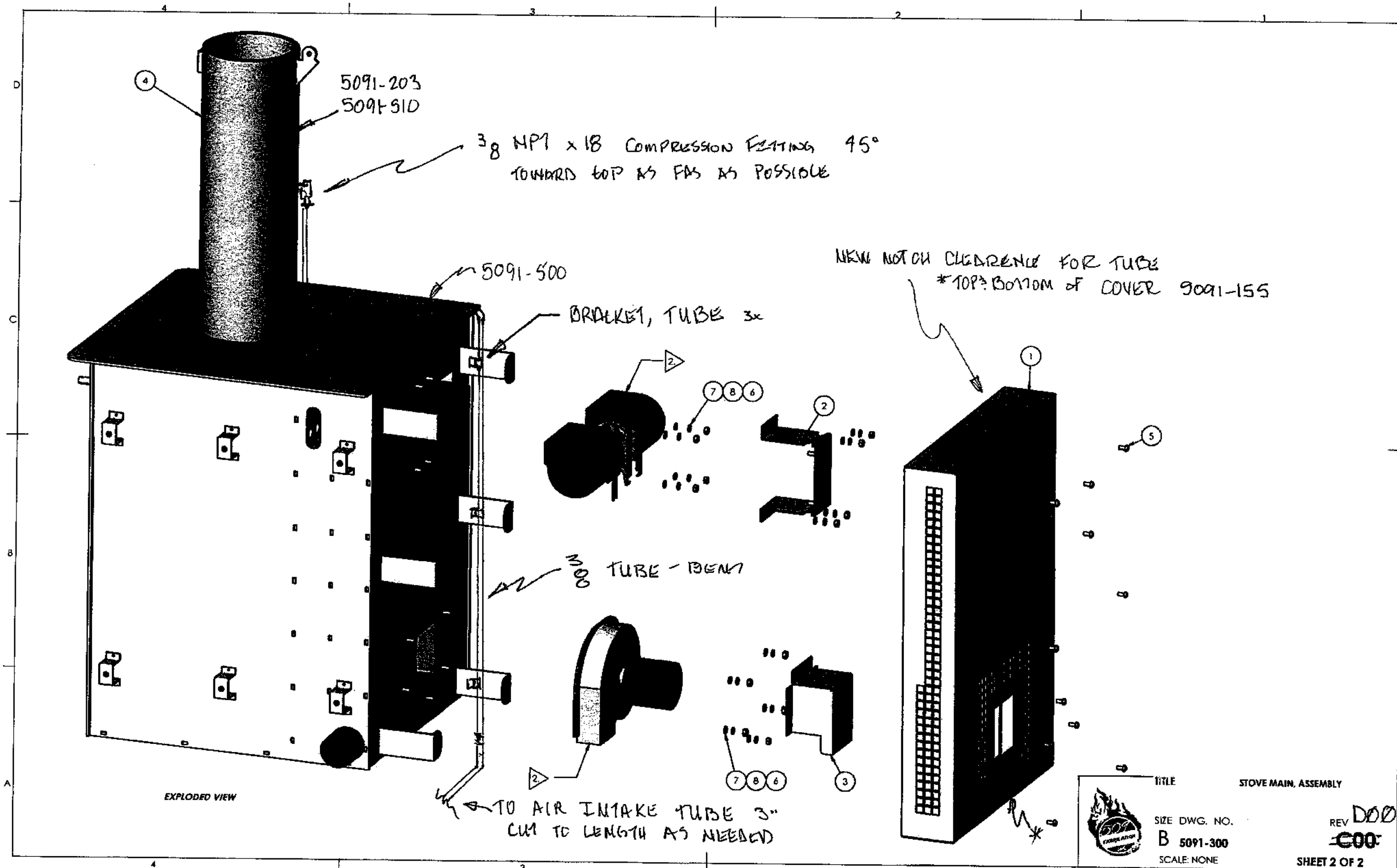
TITLE STOVE MAIN, ASSEMBLY

SIZE B DWG. NO. 5091-300

REV ~~C00~~ D00

SCALE: NONE

SHEET 1 OF 2



5091-203
5091-510
3/8 MPT x 18 COMPRESSION FITTING 45°
TOWARD TOP AS FAR AS POSSIBLE
5091-500
BRACKET, TUBE 3x
3/8 TUBE - BENT
TO AIR INTAKE TUBE 3"
CUT TO LENGTH AS NEEDED
NEW NOTCH CLEARANCE FOR TUBE
* TOP & BOTTOM OF COVER 5091-155
EXPLODED VIEW
TITLE
STOVE MAIN, ASSEMBLY
SIZE DWG. NO.
B 5091-300
SCALE: NONE
REV D00
C00
SHEET 2 OF 2

Gmail

Alben T. Myren Jr <myren.ben@gmail.com>

RE: 509 Fabricator's Optimum wood heater

2 messages

Sanchez, Rafael <Sanchez.Rafael@epa.gov> Wed, Aug 16, 2017 at 2:27 PM
To: "Alben T. Myren Jr" <myren.ben@gmail.com>, Dusty Henderson <unlimitedpower59@yahoo.com>, Sebastian Button <sbutton@omni-test.com>

Ben,

This email is in response to your July 21, 2017 and August 11, 2017 requests to unseal the 509 Fabricator's Optimum wood heater. I have reviewed the submitted documentation as requested in my August 10, 2017 email, including the August 24, 2017 test report. Therefore, Myren Consulting, Inc. may now unseal the above-referenced wood heater in accordance to the August 10, 2017 email. If you have any questions, please let me know.

Rafael Sanchez, Ph.D.

Wood Heater Program Lead

Air Branch

Monitoring, Assistance, and Media Programs Division

Office of Compliance

U.S. Environmental Protection Agency (EPA)

Room 7149-D

1200 Pennsylvania Ave., NW

MS:2227A

Washington, DC 20460

202-564-7028

202-564-0050 fax

Please make a note of the new inbox for wood heater certification requests: WoodHeaterReports@epa.gov

If you have a wood heater question, please visit the USEPA Wood Heater Compliance Monitoring Program website at http://www2.epa.gov/compliance/wood-heater-compliance-monitoring-program. On that web page, you will find information about the EPA wood heater compliance program including the List of EPA Certified Wood Heaters.

This message may contain sensitive and/or privileged information. If you believe you have received this e-mail in error, please notify me and delete the e-mail immediately.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

AUG 2 2 2017

OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

Mr. Alben Myren
Myren Consulting, Inc.
512 Williams Lake Road
Coleville, WA 99114

Dear Mr. Myren,

I am writing in response to your August 12, 2017 letter we received on August 14, 2017 regarding testing of the 509-1 Optimum wood heater manufactured by 509 Fabrications Inc., 14821 N. Peone Pines Drive, Mead, Washington, 99021. As we understand it, the 509-1 Optimum wood heater is subject to the testing requirements of 40 CFR 60, Subpart AAA, Standards of Performance for New Residential Wood Heaters (Subpart AAA). The 509-1 Optimum is a device that burns densified "Presto Log" fuel logs. The 509-1 Optimum does not operate like a traditional pellet wood heater where the fuel feed and combustion air are controlled electronically, but instead it utilizes manual controls. The fuel logs are gravity fed into the burn area and the combustion and convection air are controlled by on/off toggle switches.

On August 9, 2017, EPA approved an alternative test method request to allow Myren Consulting, Inc. to test the 509-1 Optimum using the test procedures of ASTM E2779 -10 "Standard Test Method for Determining Particulate Matter Emissions from Pellet Heaters" as required by Subpart AAA, with the burn rate category sequence in ASTM E2779 -10 - high, medium, and low - reversed to low, medium and high, as you believed this revised order would produce the required medium burn rate of less than or equal to fifty percent of the high burn rate defined in the ASTM E2779 -10.

In your August 12, 2017 letter, you explain that, despite use of the reversed burn sequence, the 509-1 Optimum was not able to achieve the required medium burn rate in the alloted 6- hour run time. You state the problem is that the firebox (firepot) in the 509-1 Optimum contains a lot of brick which is slow to either accumulate or release heat and this heat release rate affects the dry burn rate. In addition, the firebox (firepot) has fuel continuously burning inside it, much like a wood stove, and that burning fuel helps keep the bricks hot. This heat is necessary to maintain the temperature necessary for low particulate matter emission thermal incineration. You note that you now have a better understanding of how the heat transfer in the feed tube and firebox in the unit works and conclude that it will be difficult to impossible to produce the medium burn rate of less than or equal to fifty percent of the high burn rate within the 6 - hour run time.

In your revised request, you ask that the medium burn rate for the 509-1 Optimum not be constrained to less than fifty percent of the high burn because the 509-1 Optimum is not a traditional pellet stove and cannot physically meet the ASTM E2779 -10 defined medium burn rate. You also propose that 509 Fabrications, Inc. will conduct one additional integrated six-hour reverse burn rate category test and that both tests will be averaged to demonstrate compliance with the 2020 emission standard of 2.0 g/hr as outlined in Section 60.532(b) of Subpart AAA.

With the caveats listed below, we are approving your alternative method request for testing the 509-1 Optimum wood stove, as required in Subpart AAA, Section 60.534(d) to (1) continue to reverse the order of the burn rate categories tested to low, medium, and high and (2) to average the emission results of two six- hour integrated test runs. In addition, the medium burn rate will not be constrained to equal or less than fifty percent of the high burn rate category. This alternative test method approval is specific to the 509-1 Optimum appliance. In conducting this testing, the manufacturer or approved test lab must also measure the first hour of particulate matter emissions for each test run using a separate filter in one of the two parallel sampling trains. These results must be reported separately and also included in the total particulate matter emissions per run. As per Section 60.534(e) of Subpart AAA, the manufacturer must have the approved test laboratory measure the efficiency, heat output, and carbon monoxide emissions of the tested wood heater using Canadian Standards Administration (CSA) Method B415.1-10. For particulate matter emission concentrations, ASTM E2515-11 must be used.

The following changes to ASTM E2515-11 "Standard Test Method for Determination of Particulate Matter Emissions Collected by a Dilution Tunnel" may be followed:

1. Sample filters may be Pall TX-40 or equivalent Teflon-coated glass fiber, and 47 mm, 90 mm, or 100 mm in diameter.

2. Four inch filters are acceptable.

This approval letter must be included in your certification test report. If you have additional questions regarding these decisions, please contact Michael Toney of my staff at (919) 541-5247.

Sincerely,

Steffan M. Johnson, Group Leader
Measurement Technology Group

cc: Michael Toney, EPA/AQAD (E143-02)
Rafael Sanchez, EPA/OECA (2227A)
Adam Baumgart-Getz, EPA/OID (C311M)
David Cole, EPA/OID (C311M)
Amanda Aldridge, EPA/OID (C311M)
Dusty Henderson, 509 Fabrictions, Inc.

Gmail

Alben T. Myren Jr <myren.ben@gmail.com>

509-1 Optimum alternative test method request dated August 16, 2017.

1 message

Toney, Mike <Toney.Mike@epa.gov> Tue, Aug 22, 2017 at 9:10 AM
To: "Alben T. Myren Jr" <myren.ben@gmail.com>, Dusty Henderson <unlimitedpower59@yahoo.com>
Cc: "Sanchez, Rafael" <Sanchez.Rafael@epa.gov>, "Baumgart-Getz, Adam" <Baumgart-Getz.Adam@epa.gov>, "Cole, David" <Cole.David@epa.gov>, "Aldridge, Amanda" <Aldridge.Amanda@epa.gov>, "Johnson, Steffan" <johnson.steffan@epa.gov>

Hi Ben,

I just sent your alternative test method approval for the August 12, 2017, request but wanted to add insight to your August 16, 2017 request. In your August 16, 2017 request you indicate two design changes that may be considered K-list changes, the damper/slide plate and the air tube feeding air to the feed tube. We cannot make a decision for this because this is Rafael's call. However, for the alternative test method request dated August 12, 2017 that we responded to on today August 22, 2017 is based on the data that was already collected prior to the recommended changes in the your August 16, 2017 request. In other words, the air setting plate and air tube feeding air to the feed tube must be the same as the original data set for you to conduct the additional six hour integrated test that will be averaged. We allowed the medium to be greater than the 50 percent of maximum in the approval, your option two.

If the manufacturer still wants to make the changes as noted in the August 16, 2017 test method request, this will be considered a new test and the August 22, 2017 approval for the August 12, 2017 request would be void. Let me know if you have any questions.

Myren Consulting, Inc.

512 Williams Lake Road

Colville, WA 99114

Office: (509) 684-1154 Lab: (509) 685-9458

email:myren.ben@gmail.com

Date: 22 August 2017

To: Stef Johnson, EPA/AQAD

CC: Mike Toney, EPA/AQAD; Rafael Sanchez, EPA/OECA; Adam Baumgart-Getz< EPA/OID, David Cole, EPA/OID; Amanda Aldridge, EPA/OID; Dusty Henderson, 509

From: Ben Myren

On 12 and 16 August 2017 Myren Consulting, Inc. (MCI) sent a memo to EPA (Johnson, EPA/AQAD) requesting revisions to the Alternative Test Method for Optimum wood heater that burns densified fuel logs that is manufactured by 509 Fabricators of Mead, WA. This memo builds upon the 12 and 16 August memos to EPA.

In the 12 August 2017 memo about the revised Alternative Test Method sent to EPA referenced above, no mention of any design changes was made because none were anticipated. Then, based upon some in-house testing, the manufacturer proposed in the 16 August memo to make two design changes which were described in detail in the 16 August memo and are/ were:

1. The damper plate (primary air control slider) will be modified.
2. The feed tube will have a small air inlet added to it as per the two DWGs DOO that were attached to the 16 August memo.

We are now in receipt of (1.) a letter from Stef Johnson dated 22 August 2017 which grants approval to do the reversed Low - Medium - High burn rate test sequence and waives the requirement that the Medium test segment have a dry burn rate (DBR) that is ≤50% of the High burn test segment DBR and (2.) an email from Mike Toney that states that if the manufacturer still wishes to make these design changes, the approval contained in the 22 August letter is void.

The manufacturer understands the situation and so wishes to withdraw the request to make the modification to the primary air control slider plate. However, the manufacturer would still like to add the tube to deliver air to the top of the feed tube to prevent condensation. This tube is very small, 3/8" OD/ 1/4" ID, and has 3 right angle bends in it, with each right angle bend decreasing the air flow by 7-10%, so the amount of air that is being delivered to the feed tube is very small and that air is being pulled down the feed tube into the fire box by the combustion air fan, so basically the same amount of air will be entering the fire box/ combustion chamber, it is just apportioned slightly differently.

It is hoped that with just the one minor proposed design change outlined above, Option 2 proposed as the revised Alternative Test Method in my memo dated 12 August 2017 will still be acceptable, i.e., 509 will do one more integrated test run this time starting with the Low burn and ending with the High burn and then average the test results from the 2 runs and that EPA will continue to waive the requirement that the Medium test segment have a dry burn rate (DBR) that is ≤50% of the High burn test segment DBR.

If this proposed option/ revision to the alternative test method is acceptable, let me know via email in the morning. I will check my email and, if need be, call you immediately. Look forward to your reply.

Sincerely,

Alben T. Myren Jr.
President

Myren Consulting, Inc.

512 Williams Lake Road
Colville, WA 99114

Office: (509) 684-1154 Lab: (509) 685-9458

email:myren.ben@gmail.com

509 FAB Optimum Johnson 8.22.17 Memo

Date: 23 August 2017

To: Stef Johnson, EPA/AQAD

CC: Mike Toney, EPA/AQAD; Rafael Sanchez, EPA/OECA; Adam Baumgart-Getz< EPA/OID, David Cole, EPA/OID; Amanda Aldridge, EPA/OID; Dusty Henderson, 509

From: Ben Myren

Re: ADDITIONAL INFORMATION IN SUPPORT OF GRANTING THE ALTERNATIVE TEST METHOD AND TESTING REQUIREMENTS PROPOSED IN THE 8.22.17 MEMO

On 22 August 2017 Myren Consulting, Inc. (MCI) sent a memo to EPA (Johnson, EPA/AQAD) requesting further revisions to the Alternative Test Method for Optimum wood heater that burns densified fuel logs that is manufactured by 509 Fabricators of Mead, WA. This memo is intended to provide additional information in support of EPA granting the alternative test method and testing requirements that were proposed in that 22 August memo.

In that memo 509 requested that it be allowed to add a small tube that would deliver a very small amount of combustion air to the top of the feed tube. To try to quantify what the amount of air might be that would be delivered to the feed tube via this small tube, Myren Consulting calculated the stack flow for the certification test done on 1.9.2017 and found that the average stack flow for the entire test was 13.287 dscfm. Thus the amount of air that would be delivered to the feed tube through a 0.25" ID tube that is roughly 3 feet long and has 3 ninety degree bends in it would be a very small percentage of that 13.287 dscfm, as was stated in the 22 August memo.

I hope this information helps with your deliberations. If you need any more information about this, feel free to call. I look forward to your reply.

Sincerely,
Alben T. Myren Jr.
President

	A	B	C	D	E	F	G	H
1		METHOD 5H FLOW RATE (STACK) CALCULATIONS						
2		(put general info in col B, data info in col G)						
3	Lab name:	MYREN CONSULTING		Yhc) 1=cat, 2=noncat			3	
4	Stv manu:	509				3=pellet:		
5	Model no:	OPTIMUM		Test chrg(lb wet):			31.2	
6	Test date:	1.9.2017		Wood moist (%wet):			5.63	
7	Run no:	EPA 1		'Run time (min):			360	
8				'Burn rate (dry kg/hr):			2.226515	
9	----------	----------	----------	----------	----------	----------	----------	----------
10	run time	O2	CO2	CO	Fo	Stack Gas Flow Rate		
11	(min)	(%)	(%)	(%)	(1-1.12)	(dscfh)	(dscfm)	(dsm3/hr)
12	0	10	10.89	0.11	1.00	797.2226	13.28704	22.59701
13	5	8	12.72	0.43	1.00			
14	10	9.09	11.63	0.43	1.00			
15	15	9.97	10.91	0.11	1.00			
16	20	10.43	10.46	0.09	1.00		Average	
17	25	10.98	9.92	0.08	1.00	Stack Gas Concentrations		
18	30	11.12	9.77	0.1	1.00	(O2)	(CO2)	(CO)
19	35	10.14	10.71	0.17	1.00	11.0774	9.658767	0.403151
20	40	11.64	9.24	0.12	1.00			
21	45	11.84	9	0.2	1.00			
22	50	13.93	6.83	0.36	0.99			
23	55	13.73	6.93	0.55	1.00			
24	60	14.39	6.06	0.98	0.99		PROPRIETARY	
25	65	6.39	14.17	0.87	0.99		DATA	
26	70	8.24	12.67	0.06	1.00			
27	75	9.51	11.41	0.05	1.00			
28	80	10.04	10.74	0.33	1.00			
29	85	11.28	9.62	0.08	1.00			
30	90	11.32	9.57	0.1	1.00			
31	95	10.98	9.92	0.08	1.00			
32	100	9.02	11.85	0.13	1.00			
33	105	9.49	11.36	0.18	1.00			
34	110	9.95	10.94	0.1	1.00			
35	115	11.12	9.77	0.11	1.00			
36	120	10.45	10.41	0.16	1.00			
37	125	9.44	10.98	1.03	1.00			
38	130	9.72	11.11	0.22	1.00			
39	135	6.82	13.69	0.85	1.00			
40	140	7.79	12.72	0.86	1.00			
41	145	9.9	10.91	0.25	1.00			
42	150	8.34	12	1.2	1.00			
43	155	10.08	10.74	0.25	1.00			
44	160	10.19	10.46	0.57	1.00			
45	165	10.69	10.19	0.12	1.00			
46	170	10.77	10.11	0.11	1.00			
47	175	12.85	8.03	0.13	0.99			
48	180	15	5.86	0.15	0.99			
49	185	13.57	7.23	0.28	0.99			
50	190	11.11	9.77	0.12	1.00			
51	195	13.07	7.73	0.28	1.00			

	A	B	C	D	E	F	G	H
52	200	16.14	4.52	0.56	0.99			
53	205	9.38	11.21	0.71	1.00			
54	210	8.76	11.76	0.85	1.00			
55	215	9.06	11.33	1.1	1.00			
56	220	7.59	12.18	2.34	1.00			
57	225	6.61	13.12	2.42	1.00			
58	230	9.5	10.84	1.2	1.00			
59	235	10.23	10.66	0.1	1.00			
60	240	7.77	12.35	1.64	1.00			
61	245	8.54	12.3	0.2	1.00			
62	250	9.93	10.86	0.29	1.00			
63	255	12.02	8.87	0.1	1.00			
64	260	12.36	8.52	0.12	1.00			
65	265	13.01	7.85	0.15	1.00			
66	270	13.4	7.46	0.16	0.99			
67	275	13.89	6.96	0.19	0.99			
68	280	14.38	6.46	0.19	0.99			
69	285	13.16	7.68	0.21	0.99			
70	290	13.77	7.06	0.22	0.99			
71	295	10.41	10.31	0.43	1.00			
72	300	11.33	9.52	0.19	1.00			
73	305	13.22	7.53	0.38	0.99			
74	310	14.9	5.74	0.59	0.99			
75	315	11.34	9.49	0.22	1.00			
76	320	12.68	8.13	0.26	1.00			
77	325	10.74	10.02	0.37	1.00			
78	330	11.38	9.2	0.73	1.00			
79	335	10.52	10.26	0.31	1.00			
80	340	10.9	9.97	0.14	1.00			
81	345	13.13	7.75	0.11	1.00			
82	350	14.33	6.36	0.14	1.02			
83	355	15.33	5.52	0.18	0.99			
84	360	16.55	4.27	0.23	0.99			

Gmail **Alben T. Myren Jr <myren.ben@gmail.com>**

Additional info in support of alternative test method and testing requirements for the 509 OPTIMUM

6 messages

Alben T. Myren Jr <myren.ben@gmail.com> Wed, Aug 23, 2017 at 12:53 PM
To: Steffan Johnson <johnson.steffan@epa.gov>, "Toney, Mike" <toney.mike@epa.gov>, "Baumgart-Getz, Adam" <Baumgart-Getz.Adam@epa.gov>, "Sanchez, Rafael" <sanchez.rafael@epa.gov>, WoodHeaterReports <WoodHeaterReports@epa.gov>, "Aldridge, Amanda" <Aldridge.Amanda@epa.gov>, David Cole <Cole.David@epamail.epa.gov>, Dusty Hendersen <dusty@509fab.com>

See attached. Ben

Johnson EPA 509 letter 8.23.17.doc
34K

Dusty Henderson <dusty@509fab.com> Wed, Aug 23, 2017 at 1:17 PM
To: "Alben T. Myren Jr" <myren.ben@gmail.com>

Got it. Thanks. They must be close? To decision time that is.

On Aug 23, 2017 12:53 PM, "Alben T. Myren Jr" <myren.ben@gmail.com> wrote:
See attached. Ben

Alben T. Myren Jr <myren.ben@gmail.com> Wed, Aug 23, 2017 at 7:37 PM
To: Dusty Henderson <dusty@509fab.com>

Let's hope. Ben
[Quoted text hidden]

Toney, Mike <Toney.Mike@epa.gov> Thu, Aug 24, 2017 at 4:29 AM
To: "Alben T. Myren Jr" <myren.ben@gmail.com>, "Johnson, Steffan" <johnson.steffan@epa.gov>, "Baumgart-Getz, Adam" <Baumgart-Getz.Adam@epa.gov>, "Sanchez, Rafael" <Sanchez.Rafael@epa.gov>, WoodHeaterReports <WoodHeaterReports@epa.gov>, "Aldridge, Amanda" <Aldridge.Amanda@epa.gov>, "Cole, David" <Cole.David@epa.gov>, Dusty Hendersen <dusty@509fab.com>

Hi Rafael,

Myren Consulting sent additional letters dated August 22, 2017 and August 23, 2017. The August 22, letter states that the manufacturer will leave the primary air control as originally designed but wanted to add additional small air holes in the fuel feeding tube area. This holes will help reduce the moisture in the feeding system. The August 23, 2017 letter gives additional information regarding the feed tube air. Please make a ruling so Myren consulting can make a decision moving forward. Thanks Rafael.

From: Alben T. Myren Jr [mailto:myren.ben@gmail.com]
Sent: Wednesday, August 23, 2017 3:53 PM
To: Johnson, Steffan <johnson.steffan@epa.gov>; Toney, Mike <Toney.Mike@epa.gov>; Baumgart-Getz, Adam <Baumgart-Getz.Adam@epa.gov>; Sanchez, Rafael <Sanchez.Rafael@epa.gov>; WoodHeaterReports

<WoodHeaterReports@epa.gov>; Aldridge, Amanda <Aldridge.Amanda@epa.gov>; Cole, David <Cole.David@epa.gov>; Dusty Hendersen <dusty@509fab.com>
Subject: Additional info in support of alternative test method and testing requirements for the 509 OPTIMUM

See attached. Ben

Dusty Henderson <dusty@509fab.com> Thu, Aug 24, 2017 at 6:36 AM
To: "Toney, Mike" <Toney.Mike@epa.gov>
Cc: "Alben T. Myren Jr" <myren.ben@gmail.com>

Mike
It is actually just one hole in the tube not holes so we don't confuse anyone about the very very small amount of air that will enter the feed tube at the top.
Dusty
[Quoted text hidden]

Sanchez, Rafael <Sanchez.Rafael@epa.gov> Wed, Aug 30, 2017 at 1:45 PM
To: "Alben T. Myren Jr" <myren.ben@gmail.com>
Cc: "Dusty Henderson (unlimitedpower59@yahoo.com)" <unlimitedpower59@yahoo.com>, "Toney, Mike" <Toney.Mike@epa.gov>

Ben,

This is in reference to your August 22 and 23, 2017 letters to the EPA regarding certain modifications to the 509 Optimum wood heater. Specifically, you requested that modifications to the heater be allowed to add a small tube that would deliver a very small amount of combustion air to the top of the feed tube. The EPA is granting your request in accordance to the August 10, 2017 email to Ben Myren Consulting granting permission and describing the steps required to unseal the 509 Optimum wood heater. In the August 10, 2017 email, the EPA requested, among other requirements, that the following steps be followed:

- Once the wood heater is unsealed, the test laboratory may make modifications to the heater and/or begin a new test series. Any changes made by the test laboratory to the heater (along with engineering drawings) must be documented and submitted to the EPA.
- All results of the new test series along with a complete test report must be submitted to the EPA.
- Upon completion of the new test series, the wood heater must be re-sealed with a lab-specific seal in accordance with the 2015 Standards. (60.535(a)(2)(vii)).

If you have any questions, please let me know.

Rafael Sanchez, Ph.D.

Wood Heater Program Lead

Air Branch

Monitoring, Assistance, and Media Programs Division

Office of Compliance

U.S. Environmental Protection Agency (EPA)

Room 7149-D

1200 Pennsylvania Ave., NW

MS:2227A

Washington, DC 20460

202-564-7028

202-564-0050 fax

Please make a note of the new inbox for wood heater certification requests: WoodHeaterReports@epa.gov

If you have a wood heater question, please visit the USEPA Wood Heater Compliance Monitoring Program website at http://www2.epa.gov/compliance/wood-heater-compliance-monitoring-program. On that web page, you will find information about the EPA wood heater compliance program including the List of EPA Certified Wood Heaters.

This message may contain sensitive and/or privileged information. If you believe you have received this e-mail in error, please notify me and delete the e-mail immediately.

From: Alben T. Myren Jr [mailto:myren.ben@gmail.com]
Sent: Wednesday, August 23, 2017 3:53 PM
To: Johnson, Steffan <johnson.steffan@epa.gov>; Toney, Mike <Toney.Mike@epa.gov>; Baumgart-Getz, Adam <Baumgart-Getz.Adam@epa.gov>; Sanchez, Rafael <Sanchez.Rafael@epa.gov>; WoodHeaterReports <WoodHeaterReports@epa.gov>; Aldridge, Amanda <Aldridge.Amanda@epa.gov>; Cole, David <Cole.David@epa.gov>; Dusty Hendersen <dusty@509fab.com>
Subject: Additional info in support of alternative test method and testing requirements for the 509 OPTIMUM

See attached. Ben

Myren Consulting, Inc.
512 Williams Lake Road
Colville, WA 99114

Office: (509) 684-1154 Lab: (509) 685-9458

email:myren.ben@gmail.com

Date: 30 August 2017

To: Rafael Sanchez, EPA/OECA

CC: Mike Toney, EPA/AQAD; Stef Johnson, EPA/ AQAD; Adam Baumgart-Getz, EPA/OID, David Cole, EPA/OID; Amanda Aldridge, EPA/OID; Dusty Henderson, 509

From: Ben Myren

RE: CLARIFICATION OF YOUR EMAIL DATED 30 AUGUST 2017 ABOUT THE 509 OPTIMUM WOOD HEATER

Myren Consulting, Inc. (MCI) has sent a series of memos to EPA (Johnson, EPA/AQAD) and you requesting revisions to the Alternative Test Method for Optimum wood heater that burns densified fuel logs that is manufactured by 509 Fabricators of Mead, WA. This memo seeks to clarify the approval that was granted in your email dated 30 August 2017.

Specifically, in my memo dated 22 August 2017 sent to EPA about a revision to the Alternative Test Method, 509 asked that it be allowed to make just one minor design change to the unit, that being the addition of one small bleed ¼" hole in the feed tube that would delivery a very small amount of air to the feed tube to keep the fuel logs from sticking in the feed tube due to condensation. You granted that request in your email dated 30 August 2017. However, left unanswered is the question in my 12 August memo that was referred to in the second paragraph on page 2 of my memo dated 22 August 2017 which asked if just one additional integrated test run would be required if EPA were to grant approval for the minor design change discussed above. Specifically, the manufacturer is proposing to:

1. Unseal the stove
2. Make the design change and add the feed tube and hole for delivering bleed air to the feed tube.
3. Conduct one additional "reversed" integrated 6 hour test starting with a one hour preburn on Low, followed by a 3 hour test segment on Low, then a 2 hour test segment on Medium and then a one hour test segment on High. A

filter set will be changed in one of the trains at 60 minutes. PM sampling will begin at the start of the 3 hour Low burn test segment and continue until the end of the 60 minute High burn test segment.

4. Pall TX-40 TFE coated 4" filters will be used.
5. The PM data from this "reversed" integrated test will be averaged with the PM test data from the first "normal" integrated test (1.89 g/h) to calculate an average emission rate for the OPTIMUM and that average emission rate will be used to determine compliance with EPA's 2020 standard of 2.0 g/h. All other data that is required to be reported to EPA will be handled in the same way. e.g., the reported CO g/h will be the average of the test results from the 2 runs.
6. All of the test data from both test runs will be included in a complete test report sent to EPA. The test report will document the design change with photos and engineering drawings.
7. The test stove will be resealed immediately after the additional test run.

So is the above proposed course of action is acceptable to EPA? Y/N? Let us know via email.

I have turned in a 30 day notification for the OPTIMUM for next week on 7/14/2017, so if the above course of action is approved, the unit will be tested next week on Tuesday or Wednesday. We will both check our emails and, if need be, we can call you immediately. Look forward to your reply. And Thank You! in advance for your reply - and have a great Labor Day weekend!

Sincerely,

Alben T. Myren Jr.
President

Gmail

Alben T. Myren Jr <myren.ben@gmail.com>

The Optimum Wood Heater

5 messages

Alben T. Myren Jr <myren.ben@gmail.com> Thu, Aug 31, 2017 at 4:08 PM
To: "Sanchez, Rafael" <sanchez.rafael@epa.gov>, WoodHeaterReports <WoodHeaterReports@epa.gov>, Steffan Johnson <johnson.steffan@epa.gov>, "Toney, Mike" <toney.mike@epa.gov>, "Baumgart-Getz, Adam" <Baumgart-Getz.Adam@epa.gov>, "Aldridge, Amanda" <Aldridge.Amanda@epa.gov>, David Cole <Cole.David@epamail.epa.gov>, Dusty Hendersen <dusty@509fab.com>

Rafael,

We are in receipt of your email dated 30 August 2017 and just to insure that we have all of our "i's" dotted and "T's" crossed, I am sending this last memo to insure we all agree about what is going to take place as 509 moves forward and we do the one additional test run on the OPTIMUM.. As the memo states, if you agree, then we will do the test on Tuesday or Wednesday of next week..

Regards,

Ben Myren

SANCHEZ 509 letter 8.30.17.doc
38K

Dusty Henderson <dusty@509fab.com> Thu, Aug 31, 2017 at 4:14 PM
To: "Alben T. Myren Jr" <myren.ben@gmail.com>

Ben
I got an email from Rafael stating that it is Mikes call on the testing. Is that the email you are referring to?
D
[Quoted text hidden]
--
Thanks,

Dusty Henderson, President.
509 Fabrications, Inc.

Alben T. Myren Jr <myren.ben@gmail.com> Thu, Aug 31, 2017 at 8:39 PM
To: Dusty Henderson <dusty@509fab.com>

Dusty, At this point I am not certain what email applies any more. The lines seems to blur continuously. OK so if it Mike's call I will send him an email stating such and see if we can get an answer form somebody. Ben
[Quoted text hidden]

Toney, Mike <Toney.Mike@epa.gov> Fri, Sep 1, 2017 at 6:29 AM
To: "Alben T. Myren Jr" <myren.ben@gmail.com>, "Sanchez, Rafael" <Sanchez.Rafael@epa.gov>, WoodHeaterReports <WoodHeaterReports@epa.gov>, "Johnson, Steffan" <johnson.steffan@epa.gov>, "Baumgart-Getz, Adam" <Baumgart-Getz.Adam@epa.gov>, "Aldridge, Amanda" <Aldridge.Amanda@epa.gov>, "Cole, David" <Cole.David@epa.gov>, Dusty Hendersen <dusty@509fab.com>

Hi Ben,

We are all on one page. I needed Rafael to give you permission to unseal the stove. At one time 509 Fabricators was planning on changing the primary air control in addition to the small hole in the fuel feeding tube to prevent moisture

Gmail **Alben T. Myren Jr <myren.ben@gmail.com>**

THE OPTIMUM

1 message

Alben T. Myren Jr <myren.ben@gmail.com> Thu, Aug 31, 2017 at 8:47 PM
To: "Toney, Mike" <toney.mike@epa.gov>, Steffan Johnson <johnson.steffan@epa.gov>, "Baumgart-Getz, Adam" <Baumgart-Getz.Adam@epa.gov>, "Sanchez, Rafael" <sanchez.rafael@epa.gov>, WoodHeaterReports <WoodHeaterReports@epa.gov>, "Aldridge, Amanda" <Aldridge.Amanda@epa.gov>, David Cole <Cole.David@epamail.epa.gov>, Dusty Hendersen <dusty@509fab.com>

Mike, Rafael says it is your call on the testing that was proposed in my memo dated and reiterated in the memo I sent yesterday (8/30/2017). Starting on the bottom of page 1 of my 8/30/17 memo I outline a proposed course of action that includes all of the requirements that have been set forth in both Rafael's and Stef's letters and emails. All we need is an OK to proceed. Thanks in Advance and have a great weekend with your family.

Regards,

Ben Myren

build up. Since 509 changed their mind and will not be changing the air control and that it will be the same we are on one page. The small air hole in the fuel feeding tube should not be a problem. You should be good to go for your testing on Tuesday or Wednesday next week. Have a good week end.

From: Alben T. Myren Jr [mailto:myren.ben@gmail.com]
Sent: Thursday, August 31, 2017 7:09 PM
To: Sanchez, Rafael <Sanchez.Rafael@epa.gov>; WoodHeaterReports <WoodHeaterReports@epa.gov>; Johnson, Steffan <johnson.steffan@epa.gov>; Toney, Mike <Toney.Mike@epa.gov>; Baumgart-Getz, Adam <Baumgart-Getz.Adam@epa.gov>; Aldridge, Amanda <Aldridge.Amanda@epa.gov>; Cole, David <Cole.David@epa.gov>; Dusty Hendersen <dusty@509fab.com>
Subject: The Optimum Wood Heater

[Quoted text hidden]

Alben T. Myren Jr <myren.ben@gmail.com> Fri, Sep 1, 2017 at 7:53 AM
To: "Toney, Mike" <Toney.Mike@epa.gov>, Dusty Hendersen <dusty@509fab.com>

Mike, Thank you!!!! From both Dusty and I. And have a great weekend with the wife and kids. They aren't kids anymore if I am doing my math right, but rather young ladies who are off to college and perhaps even beyond that. How time flies.
Ben

[Quoted text hidden]

Test Method 28R for Certification and Auditing of Wood Heaters

SUMMARY RESULTS-DENSIFIED FUEL LOG HEATERS

Run #	Date	Setting	Dry Burn Rate (kg/h)[1]	Run Time (minutes)	Heat Output Btu/h	PM Emissions (g/h) 1st h	PM Emissions (g/h) Int. Avg.	CO Emissions (g/h) Segment	CO Emissions (g/h) Int. Avg.	%OE (%) (B415) (HHV) Segment	%OE (%) (B415) (HHV) Int. Avg.
1	1.9.17	High	2.319	60	33,114	1.503		70.51		78.3	
2	9.5.17	High	1.976	60	27.834			117.98		77.2	
1	1.9.17	Medium	2.899	120	42,099			96.32		79.6	
2	9.5.17	Medium	1.546	120	22,368			102.21		79.3	
1	1.9.17	Low	1.761	180	25,198			104.79		79.5	
2	9.5.17	Low	1.045	180	14,856	1.542		85.39		77.9	
Integrated Averages:											
1	1.9.17		2.226	360	32,183		1.890	94.68		79.0	
2	9.5.17		1.367	360	19,573		1.104	95.10		78.5	

Note: (1.) There is no test run in Dry Burn Rate (BDR) Categories 1 (<0.80 kg/h) because the unit's dry burn rate is controlled by its primary air control and combustion air fan, the density and size of the fuel logs themselves, the amount of fuel remaining in the feed tube at any given time and how the fuel logs "settle" in the feed tube. The logs are gravity fed and logs can "warp" and hang up in the feed tube which slows the DBR. The weight of the logs left in the feed tube affects the feed rate because the weight pressing down from above is what causes the burning end of a log to disintegrate into smaller pieces, i.e., the more weight, the faster the disintegration, which allows more unburnt fuel to drop into the combustion chamber. The DBR data for EPA test 1 reflects this operating scenario. When the "High" burn test segment was started, the unit had been burning for a little over 75 minutes (~15 minutes for ignition and 60 minutes for Preburn). A fuel log was added at approximately 5 minutes into preburn, so at the end of the "High" burn segment there was enough room in the feed tube to add 2 logs (15.2 lbs.). The DBR for the 60 minute "High" burn segment was 2.319 kg/h with a partially full feed tube. The DBR for the 120 minute "Medium" burn segment was which was started with a full feed tube was 2.899 kg/h. Even though the Primary Air Control (PAC) setting had been reduced to the "Medium" setting, the DBR increased. That clearly shows how the amount of fuel in the feed tube can impact the DBR and that the amount of primary air being pulled through the unit really does not impact the DBR very much. The unit burned 13.5 lbs. in the 120 minute "Medium" burn test segment. At the end of the Medium burn segment, the PAC was adjusted to the Low burn setting and 1 fuel log (8 lbs.) was added at 20 minutes into the "Low" burn test segment. The DBR immediately increased due to the extra weight in the feed tube and then slowed as the amount of fuel in the feed tube decreased. (See Data Sheet #14, pages 4 of 7 and 5 of 7.in the first test run.) Additional fuel (3.4 lbs, approximately ½ a log, was added at 312 minutes because the DBR had dropped down to 0.1 lb./ 5 minutes and we were worried that the fire might go out. Again, as soon as fuel was added the DBR increased, but the increase in the burn rate was not as great as when 2 logs were added, again showing how the amount of fuel in the feed tube impacts the burn rate. (See Data Sheet #14, page 6 of 7 in the first test run.) The wild swings in combustion gas (CO_2, O_2 and CO) concentrations also confirms that the amount of fuel in the feed tube is what primarily controls how this stove performs. See Data Sheet #14, p4 of 7, at 205 and 210 minutes in the first test run and look at the DBR and CO_2 and CO concentrations. At 205 minutes the DBR was 0.1 lb and the CO_2 and CO concentrations were 11.21 and 0.71% respectively. At 210 minutes the DBR was 0.6 lbs. and the CO_2 and CO concentrations were 11.76 and 0.85% respectively. When fuel is added the CO_2 concentration doesn't change much.

The data for Test Run #1 is from a test where the burn rate sequence followed what is in ASTM E2779-10 - 60 minute preburn on high, 60 minute High burn test segment, 120 minute Medium burn test segment and a 180 minute Low burn test segment. The data for test run # 2 is from a test with a "reversed" burn rate sequence - 60 minute preburn on Low, 180 minute Low burn test segment, 120 minute Medium burn test segment and a 60 minute High burn test segment. The difference in burn rates for each test segment is primarily due to two things: (1.) the temperature profile of the unit was substantially different and (2.) the fueling scenario was different.

The data shows that no mater how a consumer might operate the stove, its emissions performance should be below 2.0 g/h and the overall efficiency should be about 78.5% (HHV), i.e., it is very consistent. Also note that the integrated average %OE's (HHV) were within 0.5% of each other.

SUMMARY OF ASTM E2515 PARTICULATE EMISSIONS SAMPLING TRAIN PERFORMANCE

		T1					T2						
RUN #	DBR (kg/hr)	CATCH (mg)	SAMPLE RATE (cfm)	SAMPLE VOl (dscf)	AVG.% PROP	EMISSIONS (g/h)	CATCH (mg)	SAMPLE RATE (cfm)	SAMPLE VOL (dscf)	AVG. % PROP	EMISSIONS g/h)	Avg. g/h.	% DIFF
EPA 1	2.226	43.2	.539	173.086	99.973	1.975	39.6	.526	172.942	99.966	1.805	1.890	4.50
EPA 2	1.367	28.3	.511	170.780	99.977	1.165	25.4	.508	168.486	100.026	1.042	1.104	5.57

SUMMARY OF ASTM E2515 AMBIENT AIR (ROOM BLANK) SAMPLING TRAIN PERFORMANCE

RUN #	CATCH (mg)	SAMPLE RATE (cfm)	SAMPLE VOL. (dscf)	AMBIENT PM CONCENTRATION (mg/dscf)
EPA 1	1.8	0.5245	174.665	0.010305
EPA 2	3.9	0.4983	160.927	0.024235

TRAIN 1 0-60 MINUTE DBR and PM EMISSIONS

Run #	DBR (kg/h)	CATCH mg	EMISSIONS g/h
EPA 1	2.312	5.7	1.503
EPA 2	1.284	6.1	1.542

NOTES:

(1.) EPA 1 was run using the standard dry burn rate sequence specified in ASTM e2779-10 (high to low). EPA 2 was run using a "reversed" dry burn rate sequence (low to high). This impacted the overall dry burn rate because the unit's temperature profile during the course of the test was quite different (cooler0.

(2.) The high ambient PM concentration reported for Run 2 is because of the wood smoke from forest fires that blanketed the area. See photos in the introduction Section.

509 OPTIMUM DENSIFIED FUEL LOG STOVE AVERAGE TEST RESULTS

The average test results listed below are the average of the test results from the two certification test runs done on the OPTIMUM. These averages are different from weighted averages which are based upon the probability factors listed in EPA M28/ M28R, Table 1 and the calculation procedures shown in M28/ M28R Figure 28-5. These averages are based on the test data generated by the test method itself (ASTM E2779) which requires that a pellet/ densified fuel log heater be operated at three different settings, each for a specific period of time, i.e., 1 h on High, 2 h on Medium and 3 h on Low. Because of the way the OPTIMUM operates, a second test run was done, this time with the burn rate sequence reversed, i.e., 3 h on Low, 2 h on Medium and 1 h on High, to demonstrate that while the unit was incapable of achieving a medium burn rate (kg/h) that was <50% of the high burn rate (kg/h) because of the slow way in which the unit responds to a change in the air control setting, the unit still performed well. The averages reported below for each parameter are the average of the integrated average from each test run for that parameter.

Example: The integrated average PM emission rate 1.805 g/h for test run 1 and 1.104 g/h for test run 2. The average of these two integrated averages is 1.497 g/h.

The average particulate matter (PM) emission rate (g/h) is

1.497 g/h.

The average particulate matter (PM) emissions (lbs./ MM Btu output) is

0.125 lb./MM Btu output

The average overall HHV efficiency (%OE HHV) is

78.5%.

The average overall LHV efficiency (%OE LHV) for the is

85.3%.

The average CO emissions (g/h) is

94.89 g/h

The average CO emissions (g/ kg dry fuel) is

56.14 g/ dry kg of fuel

Woodstove Data Summary

Run #	1	2							Units
Particulate Emissions:									
Emission Rate:	1.89	1.104							g/hr
Emission Factor:	0.85	.807							g/kg
(Dry fuel weight basis)									
Efficiency Values: (CSA B415.10-1)									
Combustion Efficiency:	97.0	95.3							%
Heat Transfer Efficiency: HHV:	81.6	82.0							%
Heat Transfer Efficiency: LHV:	88.2	89.2							%
Overall Efficiency: HHV:	79.0	78.5							%
Overall Efficiency: LHV:	85.6	85.0							%
Heat Output:									
Avg. EPA Btu/hr. for test cycle	33,231	20,408							Btu/hr.
Avg. B415 Btu/hr. for test cycle	32,183	19,573							Btu/hr.
Fuel Burn Rates:									
Avg. Dry Burn Rate (Wet Basis)	2.359	1.444							kg/hr.
Avg. Dry Burn Rate (Dry Basis)	2.226	1.367							kg/hr.
PM Sampling Parameters:									
Avg. Tunnel Flow(Qsd):	137.562	137.275							dscfm
Avg. Tunnel Velocity(Vs):	809.431	788.235							ft./min.
Pitot Correction Factor:	.95663	.94309							
Total Sample Volume:	See page titled "Summary of ASTM E2515 Particulate Emissions Sampling Train Performance"								dscf
Avg. Sampling Flow Rate:									cfm
Avg. % Proportionality:									%
Total Particulate Catch:									mg

Woodstove Data Summary

	Run # 1	2							
Fuel Moisture Content:									
Kindling (Wet basis):	—								%
Pre Test Fuel (Wet basis):	—								%
Test Fuel (Wet basis):	5.629	5.613							%
Air/Fuel Ratio:									
lbs. air/lbs. fuel:	12.14	17.98							
Average Stack Gas Composition:									
Avg. % CO_2:	9.66	6.38							%
Avg. % O_2: (stochiometrically)	11.08	14.35							%
Avg. % CO:	0.40	0.42							%
Average Stack Gas Flow Rate:									
Stack Flow Rate- EPA CMB									dscfm
Draft (static):	-.0910	-.0313							in. H_2O
Average Stack Gas Emission Factors:									
CO:	42.52	69.76							g/Kg
	94.68	95.10							g/hr.

Woodstove Data Summary

Run #	1	2							Units
Average Temperatures:									
Stack Gas:	304.0	211							°F
Stove Top:	N/A	↓							°F
Stove Left Sidewall:	↓	↓							°F
Stove Back:	↓	↓							°F
Stove Right Sidewall:	↓	↓							°F
Stove Bottom:	↓	↓							°F
Primary Combustion Chamber Gas:	↓	↓							°F
Secondary Combustion Chamber Gas:	↓	↓							°F
Catalytic Combustor Exit Gas:	↓	↓							°F
Stove Temperature Change:	↓	↓							°F
Test Chamber Environment:									
Avg. Barometric Pressure:	28.179	28.496							in. Hg
Avg. Temperature:	72.5	70							°F
Avg. % Ambient Moisture:	0.90	1.625							% H_2O
Avg. % Relative Humidity:	40.25	65.75							% RH
Avg. Air Velocity:	>0.450	>5.410							ft/sec
Avg. Dilution Tunnel Draft: (If Applicable)	.000	.000							in/H_2O
Test Fuel Weight and Burn Time:									
Density (Dry basis):	N/A	N/A							g/cm^3
Coal Bed Weight:	N/A	N/A							lbs.
Pre Test Fuel Weight (Inc. Kindling):	6.1	4.2							lbs.
Test Fuel Load Weight:	31.2	19.1							lbs.
Total Test Cycle Burn Time:	360	360							min.

AGING DATA

The Optimum Densified Fuel Log stove was aged by Myren Consulting, Inc. The Aging installation configuration was the same as the installation used during certification testing. During Aging the stove was run on the Medium setting used during certification testing and the temperature and the (wet) burn rate data were collected using a Data Acquisition System (DAS). The Aging data was then transferred from the DAS spreadsheet to the Aging data pages in this section. The dry burn rate (DBR) varies during the aging process because the densified fuel logs sometimes warp (bend) and then stick in the feed tube, slowing the DBR. When the log(s) finally drop, the DBR will speed up for a while.

There is no Aging data in this addendum to the original test report because the Aging data was included in the original test report.

1641 Sigman Road
PO Box 919
Conyers, GA 30012
1-770-922-8000 ext 303
.tpinspection.com

TIMBER PRODUCTS INSPECTION

Analytical Report

E96-9191
MYREN CONSULTING INC
512 Williams Lake Road
Colville, WA 99114

Company Contact: Ben Myren

TP ID Number:	DBL150422-2	**Sample Weight (lbs):**	0.54
Product Recognized As:	Ground Biomass	**Sample Received:**	11/5/2015
Sample Designation:	Energy Log Composite	**Report Date:**	11/10/2015
Sample Date:	10/30/2015	**Purchase Order:**	

Parameter	As-Received	Dry Basis	Analytical Method	ISO 17025
Total Moisture (%)	8.03		ASTM E871	Q
Ash (%)	0.38	0.41	ASTM D1102	Q
GCV (BTU/lb)	8046	8749	ASTM E711	Q
Carbon (%)	46.73	50.81	CEN/EN 15104	Q
Hydrogen (%)	6.34	6.90	CEN/EN 15104	Q
Nitrogen (%)	0.15	0.16	CEN/EN 15104	Q
Sulfur (%)	0.01	0.01	CEN/EN 15104	Q
Oxygen (%)	38.36	41.71	CEN/EN 15104	Q

V2 - Added Calorific Value

INTERNATIONAL ACCREDITATION SERVICE
Leading Accreditors Since 1975

Prepared By:

Christopher Cox - Assistant Laboratory Manager

Findings are based on the sample submitted. TP Inspection is accredited by ALSC for the PFI/ALSC Densified fuel Standards Program. TP Inspection is accredited by the International Accreditation Service to ISO 17025. Specific test procedures included in TP Inspection's scope of accreditation are identified with a "Q". Test parameters performed by our sister laboratory, Technical Laboratory Rotterdam (TLR) are designated with an "S". TLR is an ISO 17025 accredited laboratory by the Dutch Accreditation Council RvA. Other outsourced parameters are designated with an "O".

MYREN CONSULTING, INC

Manufacturer: 509 FAB
Model: OPTIMUM
Date: 9.5.17
Run: EPA 2
Control #:
Test Duration: 360
Output Category: VARIABLE

Technicians: ATMYREN

Test Results in Accordance with CSA B415.1-09

	HHV Basis	LHV Basis
Overall Efficiency	78.5%	85.0%
Combustion Efficiency	95.3%	95.3%
Heat Transfer Efficiency	82%	89.2%

Output Rate (kJ/h)	20,634	19,573	(Btu/h)
Burn Rate (kg/h)	1.36	3.00	(lb/h)
Input (kJ/h)	26,295	24,944	(Btu/h)

Test Load Weight (dry kg)	8.18	18.03	dry lb
MC wet (%)	5.613		
MC dry (%)	5.95		
Particulate (g)	6.6221		
CO (g)	571		
Test Duration (h)	6.00		

Emissions	Particulate	CO
g/MJ Output	0.05	4.61
g/kg Dry Fuel	0.81	69.76
g/h	1.10	95.10
lb/MM Btu Output	0.12	10.71

Air/Fuel Ratio (A/F)	17.98

VERSION: 2.2 12/14/2009

VERSION: 2.2 12/14/2009

Manuf ~509 FAB
~PTIMUM
~5.17

Run: EPA 2

Control #:

Test Duration: 360

Output Category: VARIABLE

Appliance Type: NON CAT (Cat, Non-Cat, Pellet)

Temp. Units: F (F or C)
Weight Units: lb (kg or lb)

Wood Moisture (% wet): 5.61
Load Weight (lb wet): 19.10
Burn Rate (dry kg/h): 1.36
Total Particulate Emissions: 6.6221 g

Fuel Data

	D. Fir	
HHV	19,288	kJ/kg
%C	50.81	
%H	6.9	
%O	41.88	
%Ash	0.41	

Default Fuel Values

	D. Fir	Oak
HHV (kJ/kg)	19,810	19,887
%C	48.73	50
%H	6.87	6.6
%O	43.9	42.9
%Ash	0.5	0.5

Note 1: For other fuels, use the heating value and fuel composition determined by analysis of fuel sample in accordance with Clause 9.2.

Note 2: In cases where the "Fuel Weight Remaining" is the same for three or more readings in a row, a "divide by zero error" will occur in the calculation sheet. In such cases, adjust the weight values by interpolation between the first occurence and the next reading showing a decrease in weight.

Elapsed Time (min)	Fuel Weight Remaining (lb)	Flue Gas Composition (%) CO	CO_2	O_2	Temp. (°F) Flue Gas	Room Temp
Averages		0.42	6.38	14.35	210.75	70.14
0	19.10	0.20	6.61	14.23	183.0	66.0
5	18.90	0.19	5.96	14.89	183.0	66.0
10	18.70	0.27	6.93	13.88	185.0	66.0
15	18.40	0.23	7.08	13.75	186.0	65.0
20	18.00	0.31	6.93	13.86	189.0	66.0
25	17.80	0.38	6.83	13.92	190.0	66.0
30	17.50	0.20	7.03	13.81	191.0	66.0
35	17.30	0.19	6.03	14.82	193.0	66.0
40	16.90	0.43	5.86	14.87	194.0	67.0
45	16.80	0.41	6.18	14.56	196.0	67.0
50	16.60	0.24	6.16	14.66	197.0	67.0
55	16.20	0.26	5.96	14.85	197.0	67.0
60	16.10	0.30	6.26	14.53	198.0	67.0
65	15.80	0.39	7.06	13.69	199.0	68.0
70	15.50	0.72	7.39	13.19	200.0	68.0
75	15.20	0.23	6.61	14.22	201.0	68.0
80	15.00	0.22	6.33	14.50	202.0	68.0
85	14.50	0.27	5.68	15.13	202.0	68.0
90	14.20	0.33	6.01	14.77	203.0	68.0
95	14.10	0.31	5.58	15.21	203.0	68.0
100	13.80	0.34	4.80	15.97	202.0	69.0
105	13.75	0.31	4.40	16.39	201.0	69.0
110	13.60	0.33	4.18	16.60	200.0	70.0
115	13.30	0.49	5.48	15.22	200.0	69.0
120	13.20	0.42	4.35	16.38	197.0	69.0
125	13.10	0.60	3.03	17.61	193.0	70.0
130	13.00	0.72	2.72	17.86	191.0	70.0
135	12.95	0.97	3.38	17.08	188.0	70.0
140	12.90	0.97	3.03	17.43	185.0	69.0
145	12.80	0.89	2.57	17.93	181.0	69.0
150	12.70	0.90	3.10	17.39	178.0	71.0
155	12.60	0.81	2.55	17.99	175.0	71.0
160	12.50	0.70	2.52	18.07	175.0	70.0
165	12.10	0.39	6.01	14.74	171.0	70.0
170	12.00	0.41	6.28	14.46	170.0	70.0
175	11.80	0.36	6.06	14.70	170.0	70.0
180	11.80	0.40	6.16	14.58	171.0	70.0
185	11.60	0.50	6.53	14.16	177.0	71.0
190	11.20	0.44	6.53	14.19	181.0	70.0
195	10.90	0.43	7.03	13.70	186.0	71.0
200	10.60	0.30	6.63	14.16	189.0	70.0
205	10.40	0.33	6.88	13.90	193.0	70.0
210	10.10	0.36	6.43	14.33	197.0	71.0
215	9.90	0.50	5.63	15.06	200.0	71.0
220	9.60	0.42	5.73	15.00	203.0	71.0
225	9.40	0.47	5.23	15.48	204.0	72.0
230	9.00	0.42	5.58	15.15	204.0	71.0
235	8.90	0.31	7.59	13.20	206.0	71.0
240	8.50	0.31	7.76	13.03	208.0	71.0
245	8.10	0.34	7.34	13.43	210	72
250	7.70	0.45	8.99	11.725	213	72
255	7.40	0.65	9.21	11.405	217	72
260	7.00	0.28	9.09	11.71	220	72
265	6.60	0.56	8.26	12.4	224	72
270	6.30	0.28	7.76	13.04	227	72
275	6.00	0.26	6.71	14.1	228	72
280	5.70	0.28	5.88	14.92	229	72
285	5.50	0.71	5.51	15.075	230	72
290	5.30	0.37	6.68	14.075	229	72
295	4.90	0.33	6.21	14.565	229	73
300	4.60	0.36	7.81	12.95	229	72
305	4.40	0.43	7.71	13.015	246	74
310	4.00	0.49	8.51	12.165	254	73
315	3.70	0.3	8.64	12.15	262	72
320	3.30	0.5	7.36	13.33	268	73
325	2.80	0.24	8.11	12.71	272	74
330	2.40	0.25	9.19	11.625	277	73
335	2.00	0.55	9.94	10.725	282	73
340	1.50	0.94	8.24	12.23	285	73
345	1.20	0.47	7.61	13.095	288	73
350	0.90	0.35	6.11	14.655	289	74
355	0.40	0.29	9.44	11.355	294	74
360	0.00	0.25	8.49	12.325	295	75

MYREN CONSULTING, INC

Manufacturer:	509 FAB	**Technicians:**	ATMYREN
Model:	OPTIMUM		
Date:	9.5.17		
Run:	EPA 2		
Control #:			
Test Duration:	60		
Output Category:	HIGH		

Test Results in Accordance with CSA B415.1-09

	HHV Basis	LHV Basis
Overall Efficiency	77.2%	83.7%
Combustion Efficiency	95.9%	95.9%
Heat Transfer Efficiency	81%	87.3%

Output Rate (kJ/h)	29,342	27,834	(Btu/h)
Burn Rate (kg/h)	1.97	4.34	(lb/h)
Input (kJ/h)	37,997	36,044	(Btu/h)

Test Load Weight (dry kg)	1.97	4.34	dry lb
MC wet (%)	5.613		
MC dry (%)	5.95		
Particulate (g)	0		
CO (g)	118		
Test Duration (h)	1.00		

Emissions	Particulate	CO
g/MJ Output	0.00	4.02
g/kg Dry Fuel	0.00	59.89
g/h	0.00	117.98
lb/MM Btu Output	0.00	9.34

Air/Fuel Ratio (A/F)	14.11

VERSION: 2.2 12/14/2009

VERSION: 2.2 12/14/2009

acturer: 509 FAB
Model: OPTIMUM
Date: 9.5.17
Run: EPA 2
Control #:
Test Duration: 60
Output Category: HIGH

Appliance Type: NO. (Cat, Non-Cat, Pellet)

Temp. Units: F (F or C)
Weight Units: lb (kg or lb)

Wood Moisture (% wet): 5.61
Load Weight (lb wet): 4.60
Burn Rate (dry kg/h): 1.97
Total Particulate Emissions: g

Fuel Data

	D. Fir	
HHV	19,288	kJ/kg
%C	50.81	
%H	6.9	
%O	41.88	
%Ash	0.41	

Default Fuel Values

	D. Fir	Oak
HHV (kJ/kg)	19,810	19,887
%C	48.73	50
%H	6.87	6.6
%O	43.9	42.9
%Ash	0.5	0.5

Note 1: For other fuels, use the heating value and fuel composition determined by analysis of fuel sample in accordance with Clause 9.2.

Note 2: In cases where the "Fuel Weight Remaining" is the same for three or more readings in a row, a "divide by zero error" will occur in the calculation sheet. In such cases, adjust the weight values by interpolation between the first occurence and the next reading showing a decrease in weight.

Elapsed Time (min)	Fuel Weight Remaining (lb)	Flue Gas Composition (%) CO	CO_2	O_2	Temp. (°F) Flue Gas	Room Temp
	Averages	0.42	8.24	12.49	272.38	73.31
0	4.60	0.36	7.81	12.95	229.0	72.0
5	4.40	0.43	7.71	13.02	246.0	74.0
10	4.00	0.49	8.51	12.19	254.0	73.0
15	3.70	0.30	8.64	12.15	262.0	72.0
20	3.30	0.50	7.36	13.33	268.0	73.0
25	2.80	0.24	8.11	12.71	272.0	74.0
30	2.40	0.25	9.19	11.63	277.0	73.0
35	2.00	0.55	9.94	10.73	282.0	73.0
40	1.50	0.94	8.24	12.23	285.0	73.0
45	1.20	0.47	7.61	13.10	288.0	73.0
50	0.90	0.35	6.11	14.66	289.0	74.0
55	0.40	0.29	9.44	11.36	294.0	74.0
60	0.00	0.25	8.49	12.33	295.0	75.0

MYREN CONSULTING, INC

Manufacturer: 509 FAB
Model: OPTIMUM
Date: 9.5.17
Run: EPA 2
Control #:
Test Duration: 120
Output Category: MEDIUM

Technicians: ATMYREN

Test Results in Accordance with CSA B415.1-09

	HHV Basis	LHV Basis
Overall Efficiency	79.3%	85.9%
Combustion Efficiency	95.5%	95.5%
Heat Transfer Efficiency	83%	90.0%

Output Rate (kJ/h)	23,578	22,366	(Btu/h)
Burn Rate (kg/h)	1.54	3.40	(lb/h)
Input (kJ/h)	29,737	28,208	(Btu/h)

Test Load Weight (dry kg)	3.08	6.80	dry lb
MC wet (%)	5.613		
MC dry (%)	5.95		
Particulate (g)	0		
CO (g)	204		
Test Duration (h)	2.00		

Emissions	Particulate	CO
g/MJ Output	0.00	4.33
g/kg Dry Fuel	0.00	66.29
g/h	0.00	102.21
lb/MM Btu Output	0.00	10.07

Air/Fuel Ratio (A/F)	16.68

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VERSION: 2.2 12/14/2009

N ıcturer: 509 FAB

Model: OPTIMUM

Date: 9.5.17

Run: EPA 2

Control #:

Test Duration: 120

Output Category: MEDIUM

Appliance Type: NOı (Cat, Non-Cat, Pellet)

Temp. Units F (F or C)

Weight Units lb (kg or lb)

Wood Moisture (% wet):	5.61
Load Weight (lb wet):	7.20
Burn Rate (dry kg/h):	1.54
Total Particulate Emissions:	g

Fuel Data

	D. Fir	
HHV	19,288	kJ/kg
%C	50.81	
%H	6.9	
%O	41.88	
%Ash	0.41	

Default Fuel Values

	D. Fir	Oak
HHV (kJ/kg)	19,810	19,887
%C	48.73	50
%H	6.87	6.6
%O	43.9	42.9
%Ash	0.5	0.5

Note 1: For other fuels, use the heating value and fuel composition determined by analysis of fuel sample in accordance with Clause 9.2.

Note 2: In cases where the "Fuel Weight Remaining" is the same for three or more readings in a row, a "divide by zero error" will occur in the calculation sheet. In such cases, adjust the weight values by interpolation between the first occurence and the next reading showing a decrease in weight.

Elapsed Time (min)	Fuel Weight Remaining (lb)	Flue Gas Composition (%) CO	CO_2	O_2	Temp. (°F) Flue Gas	Room Temp
Averages		0.40	6.93	13.81	208.16	71.40
0	7.20	0.40	6.16	14.58	171.0	70.0
5	7.00	0.50	6.53	14.16	177.0	71.0
10	6.60	0.44	6.53	14.19	181.0	70.0
15	6.30	0.43	7.03	13.70	186.0	71.0
20	6.00	0.30	6.63	14.16	189.0	70.0
25	5.80	0.33	6.88	13.90	193.0	70.0
30	5.50	0.36	6.43	14.33	197.0	71.0
35	5.30	0.50	5.63	15.06	200.0	71.0
40	5.00	0.42	5.73	15.00	203.0	71.0
45	4.80	0.47	5.23	15.48	204.0	72.0
50	4.40	0.42	5.58	15.15	204.0	71.0
55	4.30	0.31	7.59	13.20	206.0	71.0
60	3.90	0.31	7.76	13.03	208.0	71.0
65	3.50	0.34	7.34	13.43	210.0	72.0
70	3.10	0.45	8.99	11.73	213.0	72.0
75	2.80	0.65	9.21	11.41	217.0	72.0
80	2.40	0.28	9.09	11.71	220.0	72.0
85	2.00	0.56	8.26	12.40	224.0	72.0
90	1.70	0.28	7.76	13.04	227.0	72.0
95	1.40	0.26	6.71	14.10	228.0	72.0
100	1.10	0.28	5.88	14.92	229.0	72.0
105	0.90	0.71	5.51	15.08	230.0	72.0
110	0.70	0.37	6.68	14.08	229.0	72.0
115	0.30	0.33	6.21	14.57	229.0	73.0
120	0.00	0.36	7.81	12.95	229.0	72.0

MYREN CONSULTING, INC

Manufacturer:	509 FAB
Model:	OPTIMUM
Date:	9.5.17
Run:	EPA 2
Control #:	
Test Duration:	180
Output Category:	LOW

Technicians: ATMYREN

Test Results in Accordance with CSA B415.1-09

	HHV Basis	LHV Basis
Overall Efficiency	77.9%	84.4%
Combustion Efficiency	94.5%	94.5%
Heat Transfer Efficiency	82%	89.3%

Output Rate (kJ/h)	15,661	14,856	(Btu/h)
Burn Rate (kg/h)	1.04	2.30	(lb/h)
Input (kJ/h)	20,100	19,067	(Btu/h)

Test Load Weight (dry kg)	3.13	6.89	dry lb
MC wet (%)	5.613		
MC dry (%)	5.95		
Particulate (g)	0		
CO (g)	256		
Test Duration (h)	3.00		

Emissions	Particulate	CO
g/MJ Output	0.00	5.45
g/kg Dry Fuel	0.00	81.94
g/h	0.00	85.39
lb/MM Btu Output	0.00	12.67

Air/Fuel Ratio (A/F)	21.02

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VERSION: 2.2 12/14/2009

M 'urer: 509 FAB
.Model: OPTIMUM
Date: 9.5.17
Run: EPA 2
Control #:
Test Duration: 180
Output Category: LOW

Appliance Type: NON CAT (Cat, Non llet)

Temp. Units F (F or C)
Weight Units lb (kg or lb)

Wood Moisture (% wet):	5.61
Load Weight (lb wet):	7.30
Burn Rate (dry kg/h):	1.04
Total Particulate Emissions:	g

Fuel Data

	D. Fir	
HHV	19,288	kJ/kg
%C	50.81	
%H	6.9	
%O	41.88	
%Ash	0.41	

Default Fuel Values

	D. Fir	Oak
HHV (kJ/kg)	19,810	19,887
%C	48.73	50
%H	6.87	6.6
%O	43.9	42.9
%Ash	0.5	0.5

Note 1: For other fuels, use the heating value and fuel composition determined by analysis of fuel sample in accordance with Clause 9.2.

Note 2: In cases where the "Fuel Weight Remaining" is the same for three or more readings in a row, a "divide by zero error" will occur in the calculation sheet. In such cases, adjust the weight values by interpolation between the first occurence and the next reading showing a decrease in weight.

Elapsed Time (min)	Fuel Weight Remaining (lb)	Flue Gas Composition (%) CO	CO_2	O_2	Temp. (°F) Flue Gas	Room Temp
Averages		0.43	5.38	15.34	190.27	68.22
0	7.30	0.20	6.61	14.23	183.0	66.0
5	7.10	0.19	5.96	14.89	183.0	66.0
10	6.90	0.27	6.93	13.88	185.0	66.0
15	6.60	0.23	7.08	13.75	186.0	65.0
20	6.20	0.31	6.93	13.86	189.0	66.0
25	6.00	0.38	6.83	13.92	190.0	66.0
30	5.70	0.20	7.03	13.81	191.0	66.0
35	5.50	0.19	6.03	14.82	193.0	66.0
40	5.10	0.43	5.86	14.87	194.0	67.0
45	5.00	0.41	6.18	14.56	196.0	67.0
50	4.80	0.24	6.16	14.66	197.0	67.0
55	4.40	0.26	5.96	14.85	197.0	67.0
60	4.30	0.30	6.26	14.53	198.0	67.0
65	4.00	0.39	7.06	13.69	199.0	68.0
70	3.70	0.72	7.39	13.19	200.0	68.0
75	3.40	0.23	6.61	14.22	201.0	68.0
80	3.20	0.22	6.33	14.50	202.0	68.0
85	2.70	0.27	5.68	15.13	202.0	68.0
90	2.40	0.33	6.01	14.77	203.0	68.0
95	2.30	0.31	5.58	15.21	203.0	68.0
100	2.00	0.34	4.80	15.97	202.0	69.0
105	1.95	0.31	4.40	16.39	201.0	69.0
110	1.80	0.33	4.18	16.60	200.0	70.0
115	1.50	0.49	5.48	15.22	200.0	69.0
120	1.40	0.42	4.35	16.38	197.0	69.0
125	1.30	0.60	3.03	17.61	193.0	70.0
130	1.20	0.72	2.72	17.86	191.0	70.0
135	1.10	0.97	3.38	17.08	188.0	70.0
140	1.05	0.97	3.03	17.43	185.0	69.0
145	1.00	0.89	2.57	17.93	181.0	69.0
150	0.90	0.90	3.10	17.39	178.0	71.0
155	0.80	0.81	2.55	17.99	175.0	71.0
160	0.70	0.70	2.52	18.07	175.0	70.0
165	0.30	0.39	6.01	14.74	171.0	70.0
170	0.20	0.41	6.28	14.46	170.0	70.0
175	0.05	0.36	6.06	14.70	170.0	70.0
180	0.00	0.40	6.16	14.58	171.0	70.0

MYREN CONSULTING, INC.
Dilution Tunnel Traverse Data with 8
Traverse Points Rev 3, 10.2.16

Unit: Optimum
Run #: EPA 2
Date: 9/5/17
Technicians: ADM ESS
TIME: 1129

Point	Location	Δp	$\sqrt{\Delta p_{trav}}$	Δp	$\sqrt{\Delta p_{cent}}$	T_{trav}	T_{cent}
W-1	0.5″	.030	.173			82	
2	1.5	.039	.197			82	
Center	Center			.040	.200		82
3	4.5	.040	.200			83	
4	5.5	.035	.187			82	
S-1	0.5	.034	.184			83	
2	1.5	.038	.195			83	
Center	Center			.040	.200		83
3	4.5	.040	.200			83	
4	5.5	.030	.173			83	
	Totals		1.509		.400	661	165
	Average		.1886		.2000	82.6	82.5
	°R = (°F + 460)					542.6	542.5

BP = 28.54 "Hg Ps = BP = 28.54 " Hg

LEAK CHECKS: Manometer Pre Test Check - Level: OK Zeroed: OK Tech: ESS

Manometer Post Test Check - Level: OK Zeroed: OK Tech: ESS

Pg Leg: Pre Test: Pressure: 7.270 ″ H_2O Movement: .000 ″ H_2O Tech: ESS

Post Test: Pressure: 7.600 ″ H_2O Movement: .000 ″ H_2O Tech: ESS

Velocity Head Leg: Pre Test: Pressure: 7.480 ″ H_2O Movement: .000 ″ H_2O Tech: ESS

Post Test: Pressure: 6.580 ″ H_2O Movement: .000 ″ H_2O Tech: ESS

MYREN CONSULTING, INC. **ASTM E2515 DATA SHEET # 5-2**

DILUTION TUNNEL GAS VELOCITY & VOLUMETRIC FLOW RATE CALCULATIONS Rev 6/6/11

UNIT: Optimum DATE: 9/5/17 RUN #: EPA 2 TECHNICIAN(S): ATM ESS

Average Gas Velocity in the Dilution Tunnel Vstrav (EPA M2 EQN 2-9, ASTM E 2515 EQN 7)

(9) Vstrav = (85.49) (0.99 cp) (.1886 {4} $\overline{X}$ $\overline{\sqrt{\Delta P}}$ "H_2O) $\sqrt{\dfrac{542.6 \text{ {1} Ts °A}}{(28.54 \text{ {3} Ps "Hg}) (28.78 \text{ lb./ lb. mole})}}$ = 12.97358 {5} fps

(9A) Vs = (12.97358 {5} fps) (60) = 778.415 {3} fpm

Gas Velocity in the Center of the Dilution Tunnel - Vscent (EPA M2 EQN 2-9, ASTM E 2515 EQN 7)

(9) Vscent = (85.49) (0.99 cp) (.2000 {4} $\overline{X}$ $\sqrt{\Delta P}$ "H_2O) $\sqrt{\dfrac{542.5 \text{ {1} Ts °A}}{(28.54 \text{ {3} Ps "Hg}) (28.78 \text{ lb./ lb. mole})}}$ = 13.75650 {5} fps

(9A) Vs = (13.75650 {5} fps) (60) = 825.390 {3} fpm

EPA M5G1 Section 4.2.2, ASTM E 2515 EQN 1 Adjustment Factor for Center of Tunnel Pitot Tube Location

Fp = Vstrav/ Vscent = 12.97358 {5} ÷ 13.75650 {5} = .94309 {5}

Average Stack Gas Dry Volumetric Flow Rate - Qsd (EPA M2 EQN 2-10, ASTM E 2515 EQN 3)

(10) Qsd = 3600(1 - 0.02 Bws) (12.97358 {5} fps) (.1963 {4} ft^2) [(528 °A) (28.54 {3} Ps "Hg) / (542.6 {1} T_s °A) (29.92" Hg) = 8339.792 {3} dscfhr (or dscfh)

(10A) 8339.792 {3} dscfhr ÷ 60 = 138.997 {2} dscfmin (or dscfm)

Note: Number in { } under blank lines denotes number of decimals to be used. If a blank calls for an answer already calculated, use the number of decimals previously specified for that answer.

EPA 2 T 1 0-60

MYREN CONSULTING CERTIFICATION TEST DATA

DILUTION TUNNEL CALCULATIONS

4/15/10, Ms=28.78, Bws=2.0% 6"Tunnel

File Name:	EPA 1 T 1 0-60
Manufacturer:	509 FAB
Model Number:	OPTIMUM
Lab Name:	MYREN
Test Date:	9.5.17
Run Number:	EPA 1 T 1 0-60
Meter Box Y Factor:	1.0195
Barometric Pressure (in Hg):	28.515
Dry Gas Meter Temp(avg.)(F):	**80**
Delta H(Avg.)(in H2)):	**0.900**
Gas meter initial reading:	605.7010
Gas meter final reading:	636.1960
Total Particulate Catch(mg):	6.1
Sampling Flow Rate(cfm):	0.508
Tunnel Flow (Qsd) (dscfm)	**138.371**
Emission Rate(g/hr):	**1.542**
Emission Factor(g/kg)	**1.201**
Avg. of Delta P Sq. Roots:	**0.2000**
Vs (Avg.)(ft/min):	**782.084**
Tunnel Avg. Temperature (F):	**87.143**
Test time(min):	60
Fuel Load: (lbs. Dry):	2.8316
Wood moisture(%wet):	5.6128
Burn rate(dry kg/hr):	**1.284**
Sample Volume (dscf)	**29.050**
Avg. Tunnel Static (-inch H2O):	**0.0000**
Room Blank Catch (mg/dscf):	0.024235
Total PM Emissions(Er))(g):	**1.5421**
Pitot Correction Factor:	0.94309
Front Filter Number:	P120
Back Filter Number:	P120
Beaker number:	31
PRELIMINARY RESULTS	
FINAL RESULTS:	AUDITED

DATA SUMMARY

MODEL:	OPTIMUM
RUN:	EPA 1 T 1 0-60
DATE:	9.5.17
DBR:	1.284
EMISSION RATE (g/hr)(unadj):	1.5421
EMISSION FACTOR (g/kg):	1.2007
AVG. % PROPORTIONALITY :	99.954

RUN TIME (min)	PITOT DELTAP (in H2O)	TNL TEMP (°F)	GAS METER RDG (ft3)	GAS METER TEMP (°F)	GAS METER DELTA H (in.H2O)	TUNNEL VELOCITY (ft/min)	PROP RATE (%)	dDGM vol std (ft3)	Tunnel Static (- Inch H2O)	SQUARE ROOT DELTA P	DRY GAS METER READING (M3)
0	0.040	85	605.701	67	0.900	780.55			0.000	0.20000	
10	0.040	85	610.743	73	0.900	780.55	102.6	4.890	0.000	0.20000	
20	0.040	86	615.761	76	0.900	780.91	100.5	4.826	0.000	0.20000	
30	0.040	87	620.854	81	0.900	781.62	100.6	4.861	0.000	0.20000	
40	0.040	88	625.974	84	0.900	782.34	99.7	4.851	0.000	0.20000	
50	0.040	89	631.085	87	0.900	783.05	98.6	4.816	0.000	0.20000	
60	0.040	90	636.196	89	0.900	783.77	97.7	4.794	0.000	0.20000	
70											
80											
90											
100											
110											
120											
130											
140											
150											
160											
170											
180											
190											
200											
210											
220											
230											
240											
250											
260											
270											
280											
290											
300											
310											
320											
330											
340											
350											
360											
370											
380											

EPA 2 T 1 9.5.17

DILUTION TUNNEL CALCULATIONS

4/15/10, Ms=28.78, Bws=2.0%

MYREN CONSULTING CERTIFICATION TEST DATA

	6"Tunnel
File Name:	EPA 1 T 1
Manufacturer:	509 FAB
Model Number:	OPTIMUM
Lab Name:	MYREN
Test Date:	9.5.17
Run Number:	EPA 1 T 1
Meter Box Y Factor:	1.0195
Barometric Pressure (in Hg):	28.496
Dry Gas Meter Temp(avg.)(F):	**93**
Delta H(Avg.)(in H2)):	**0.900**
Gas meter initial reading:	605.7010
Gas meter final reading:	789.4970
Total Particulate Catch(mg):	28.3
Sampling Flow Rate(cfm):	0.511
Tunnel Flow (Qsd) (dscfm)	**137.275**
Emission Rate(g/hr):	**1.165**
Emission Factor(g/kg)	**0.852**
Avg. of Delta P Sq. Roots:	**0.2000**
Vs (Avg.)(ft/min):	**788.325**
Tunnel Avg. Temperature (F):	**95.541**
Test time(min):	360
Fuel Load: (lbs. Dry):	18.0849
Wood moisture(%wet):	5.6128
Burn rate(dry kg/hr):	**1.367**
Sample Volume (dscf)	**170.780**
Avg. Tunnel Static (-inch H2O):	**0.0000**
Room Blank Catch (mg/dscf):	0.024235
Total PM Emissions(Er))(g):	**6.9916**
Pitot Correction Factor:	0.94309
Front Filter Number:	P120, P122
Back Filter Number:	P120, P122
Beaker number:	31, 39
PRELIMINARY RESULTS	
FINAL RESULTS:	AUDITED

DATA SUMMARY

MODEL:	OPTIMUM
RUN:	EPA 1 T 1
DATE:	9.5.17
DBR:	1.367
EMISSION RATE (g/hr)(unadj):	1.1653
EMISSION FACTOR (g/kg):	0.8523
AVG. % PROPORTIONALITY :	99.977

RUN TIME (min)	PITOT DELTAP (in H2O)	TNL TEMP (°F)	GAS METER RDG (ft3)	GAS METER TEMP (°F)	GAS METER DELTA H (in.H2O)	TUNNEL VELOCITY (ft/min)	PROP RATE (%)	dDGM vol std (ft3)	Tunnel Static (- Inch H2O)	SQUARE ROOT DELTA P	DRY GAS METER READING (M3)
0	0.040	85	605.7010	67	0.900	780.81			0.000	0.20000	
10	0.040	85	610.7430	73	0.900	780.81	106.4	4.887	0.000	0.20000	
20	0.040	86	615.7610	76	0.900	781.17	104.2	4.822	0.000	0.20000	
30	0.040	87	620.8540	81	0.900	781.88	104.3	4.858	0.000	0.20000	
40	0.040	88	625.9740	84	0.900	782.60	103.4	4.848	0.000	0.20000	
50	0.040	89	631.0850	87	0.900	783.31	102.2	4.813	0.000	0.20000	
60	0.040	90	636.1960	89	0.900	784.03	101.4	4.791	0.000	0.20000	
70	0.040	91	641.3350	90	0.900	784.74	101.5	4.804	0.000	0.20000	
80	0.040	92	646.4630	91	0.900	785.45	101.0	4.785	0.000	0.20000	
90	0.040	92	651.5800	92	0.900	785.81	100.4	4.766	0.000	0.20000	
100	0.040	92	656.6890	93	0.900	785.81	99.9	4.750	0.000	0.20000	
110	0.040	93	661.8110	93	0.900	786.16	100.0	4.758	0.000	0.20000	
120	0.040	93	666.9230	94	0.900	786.52	99.7	4.744	0.000	0.20000	
130	0.040	93	672.0450	95	0.900	786.52	99.5	4.745	0.000	0.20000	
140	0.040	92	677.1700	95	0.900	786.16	99.3	4.743	0.000	0.20000	
150	0.040	92	682.3010	95	0.900	785.81	99.4	4.749	0.000	0.20000	
160	0.040	92	687.4340	95	0.900	785.81	99.4	4.751	0.000	0.20000	
170	0.040	92	692.5630	95	0.900	785.81	99.4	4.747	0.000	0.20000	
180	0.040	92	697.6850	96	0.900	785.81	99.0	4.736	0.000	0.20000	
190	0.040	94	702.7990	97	0.900	786.52	98.7	4.720	0.000	0.20000	
200	0.040	95	707.8990	96	0.900	787.59	98.5	4.707	0.000	0.20000	
210	0.040	96	713.0000	97	0.900	788.30	98.6	4.708	0.000	0.20000	
220	0.040	97	718.1110	97	0.900	789.01	98.7	4.713	0.000	0.20000	
230	0.040	97	723.2280	97	0.900	789.36	98.9	4.719	0.000	0.20000	
240	0.040	98	728.3130	98	0.900	789.71	98.1	4.685	0.000	0.20000	
250	0.040	98	733.4260	98	0.900	790.07	98.5	4.707	0.000	0.20000	
260	0.040	99	738.5230	98	0.900	790.42	98.3	4.692	0.000	0.20000	
270	0.040	100	743.6250	98	0.900	791.13	98.5	4.697	0.000	0.20000	
280	0.040	100	748.6830	98	0.900	791.48	97.6	4.656	0.000	0.20000	
290	0.040	100	753.7930	98	0.900	791.48	98.6	4.704	0.000	0.20000	
300	0.040	100	758.8930	98	0.900	791.48	98.4	4.695	0.000	0.20000	
310	0.039	104	764.0000	98	0.900	787.91	99.1	4.701	0.000	0.19748	
320	0.040	106	769.1040	98	0.900	790.01	99.7	4.698	0.000	0.20000	
330	0.040	108	774.2250	97	0.900	796.41	100.0	4.718	0.000	0.20000	
340	0.040	109	779.3100	97	0.900	797.47	99.3	4.689	0.000	0.20000	
350	0.040	109	784.3760	97	0.900	797.82	98.9	4.672	0.000	0.20000	
360	0.040	109	789.4970	96	0.900	797.82	100.2	4.727	0.000	0.20000	

T1 0-60

Method 5G Particulate Sampling Data

Unit: Optimum
Run: EPA 2
Date: 9/5/17
Page: 1 of 1 Rev 12/15

Meter Box 456-P Meter Y 1.0195 Filter #'s: (F) P120 (R) P120

.409/.410 Filter/O-Ring ID #: —

Pre Test Leak Check: .001 CFM@ -15.0 in Hg Filter Size: TFE 110 mm

.566/.566 Probe ID #: N/A

Post Test Leak Check: .000 CFM@ -12.0 in Hg Probe Length: 24 in glass

Time		Meter Reading (ft³)	Pitot		Tunnel Temp (°F)	Meter Temp (°F)	Gas Meter Δh	Vac (in Hg)
Clock	Elapsed		ΔP	Pg				
1145	00	605.701	.040		85	67	.90	0
55	10	610.743	.040		85	73	.90	0
1205	20	615.761	.040		86	76	.90	0
15	30	620.854	.040		87	81	.90	0
25	40	625.974	.040		88	84	.90	0
35	50	631.085	.040		89	87	.90	0
45	60	636.196	.040		90	89	.90	0
	70							
	80							
	90							
	00							
	10							
	20							
	30							
	40							
	50							
	60							
	70							
	80							
	90							

BP
00 28.52
60 28.51
Avg. = 28.515 in Hg"

Pre Test Filter Tare Weight Check
F
R .9357

End of Test Weight
F .9383 R
.9356
.0027

metallic Brown T1-60t

Method 5G Particulate Sampling Data

Unit: Optimum
Run: EPA 2
Date: 9/5/17
Page: 1 of 2 Rev 12/15

Meter Box 45G-P Meter Y 1.0195 Filter #'s: (F) P122 (R) P122

.328/.329 Filter/O-Ring ID #: —

Pre Test Leak Check: .001 CFM@ -15.0 in Hg Filter Size: TFE 110 mm

Probe ID #: N/A

Post Test Leak Check: ____ CFM@ ____ in Hg Probe Length: 36 in SS

Time: Clock	Time: Elapsed	Meter Reading (ft³)	Pitot: ΔP	Pitot: Pg	Tunnel Temp (°F)	Meter Temp (°F)	Gas Meter Δh	Vac (in Hg)
	00							
	10							
	20							
	30							
	40							
	50							
1245	(60)	636.196	.040		90	89	.90	0
55	70	641.335	.040		91	90	.90	0
1305	80	646.463	.040		92	91	.90	0
15	90	651.580	.040		92	92	.90	0
25	100	656.689	.040		92	93	.90	0
35	110	661.811	.040		93	93	.90	0
45	(120)	666.923	.040		93	94	.90	0
55	130	672.045	.040		93	95	.90	0
1405	140	677.170	.040		92	95	.90	0
15	150	682.301	.040		92	95	.90	0
25	160	687.434	.040		92	95	.90	0
35	170	692.563	.040		92	95	.90	0
45	(180)	697.685	.040		92	96	.90	0
55	190	702.799	.040		94	97	.90	0

BP

00	28.52	300	28.48
60	28.51	360	28.47
120	28.51		
180	28.49		
240	28.49		

Avg. = 28.496 in Hg"

Pre Test Filter Tare Weight Check
F ____
R .9285

End of Test Weight
F .9467 R ____

.9287

18.0

metallic Brown T1-60 F

Method 5G Particulate Sampling Data

Unit: Optimum
Run: EPA 2
Date: 9/5/17
Page: 2 of 2 Rev 12/15

Meter Box 45G-P Meter Y 1.0195 Filter #'s: (F) P122 (R) P122

Filter/O-Ring ID #: ——

Pre Test Leak Check: ______ CFM@ ______ in Hg Filter Size: TFE 110 mm

.520/.520 Probe ID #: ——

Post Test Leak Check: .000 CFM@ -12.0 in Hg Probe Length: 36 in SS

Time		Meter Reading $(m^3)(ft^3)$	Pitot		Tunnel Temp (°F)	Meter Temp (°F)	Gas Meter Δh	Vac (in Hg)
Clock	Elapsed		ΔP	Pg				
1505	200	707.899	.040		95	96	.90	0
15	210	713.000	.040		96	97	.90	0
25	220	718.111	.040		97	97	.90	0
35	230	723.228	.040		97	97	.90	0
45	240	728.313	.040		98	98	.90	0
55	250	733.426	.040		98	98	.90	0
1605	260	738.523	.040		99	98	.90	0
15	270	743.625	.040		100	98	.90	0
25	280	748.683	.040		100	98	.90	0
35	290	753.793	.040		100	98	.90	0
45	300	758.893	.040		100	98	.90	0
55	310	764.000	.039		104	98	.90	0
1705	320	769.104	.040		106	98	.90	0
15	330	774.225	.040		108	97	.90	0
25	340	779.310	.040		109	97	.90	0
35	350	784.376	.040		109	97	.90	0
45	360	789.497	.040		109	96	.90	0
	70							
	80							
	90							

BP

00	28.52	300	28.48
60	28.51	360	28.47
120	28.51		
180	28.49		
240	28.49	Avg. = 28.496 in Hg"	

Pre Test Filter Tare Weight Check
F ______
R .9285

End of Test Weight
F .9467 R ______
.9287
180

Woodstove Data Sheet #4-1: Initial Filter Pair Tare Weights

Into Desiccator: Date: 4/10/17 Time: 1015 By: ESS Front Half X Back Half ______

Manufacturer: PALL Size: 110 mm TFE Lot. No.: T15924FW Grade: EMFAB TX40H120

Balance Used: Sartorius Model: CP224S SN: 24850860

Filter #'s	First Wt.	2017 Date	Time	By	Second Wt.	2017 Date	Time	By	Third Wt.	Date	Time	
P101	.9003	4/13	1056	ESS	.9004	8/3	1445	ATM				
P102	.9318		1054	ESS	.9316		1447	ATM				
P103	.9303		1053	ESS	.9301		1448	ATM				
P104	.9299		1052	ESS	.9301		1450	ATM				
P105	.9316		1051	ESS	.9318		1451	ATM				
P106	.9327		1050	ESS	.9325		1452	ATM				
P107	.9270		1049	ESS	.9272		1453	ATM				
P108	.9307		1047	ESS	.9305		1454	ATM				
P109	.9281		1046	ESS	.9281		1455	ATM				
P110	.9327		1045	ESS	.9328		1456	ATM				
P111	.9347		1044	ESS	.9347		1456	ATM				
P112	.9362		1043	ESS	.9362		1457	ATM				
P113	.9375		1042	ESS	.9376		1458	ATM				
P114	.9316		1041	ESS	.9316		1459	ATM				
P115	.9343		1040	ESS	.9338		1500	ATM	.9339	9/11	1523	E
P116	.9336		1039	ESS	.9336		1502	ATM				
P117	.9283		1037	ESS	.9278		1504	ATM	.9278	9/11	1522	E
P118	.9324		1036	ESS	.9322		1506	ATM				
P119	.9348		1035	ESS	.9348		1508	ATM				
P120	.9355		1034	ESS	.9356		1508	ATM	509 EPA 2 T1 0-6			
P121	.9351		1033	ESS	.9351		1510	ATM	509 EPA 2 T2			
P122	.9286		1031	ESS	.9287		1510	ATM	509 EPA 2 T1 60+			
P123	.9336		1030	ESS	.9336		1512	ATM				
P124	.9323		1029	ESS	.9324		1512	ATM				
P125	.9320	↓	1028	ESS	.9320	↓	1514	ATM				

P122: P[illegible]
P123: HHTwP [illegible]
P124: HHTwP insert PSD 11
P125: HHTwP insert PSD 10

Checked by______________ Date:__________ Time:______________

QA Reweigh

Filter #	WT	Date	Time	By
P116	.9337	9/16	1605	[illegible]
P114	.9316	9/16	1608	[illegible]
P110	.9326	9/16	1609	[illegible]
P106	.9326	9/16	1612	[illegible]

Balance Room Environmental Conditions

WB	DB	%RH	Date	Time	By
54	65	48	4/13/17	1024	ESS
58	70	48	8/3/17	1323	ESS
54	65	47	9/11/17	1512	ESS
53	64	46	9/16/17	1434	AM

		1st	2nd	3rd	4th	5th
Date		4/13/17	8/3/17	9/11/17	9/16/17	______
Post Weighing	0.0000g	0.0000	0.0000	0.0000	0.000	______
Scale Check	100.0000g	99.9991	99.9992	99.9992	99.9991	______

Woodstove Data Sheet #4-2: Initial Beaker Weights (Tare Weights)

Into Dessicator: Date ~~3/20/17~~ 3/31/17 Time ~~1444~~ 1800 By ATM

Balance Used: Sartorius Model: CP224S SN:24850860

Bkr #	First Wt	Date (2017)	Time	By	Second Wt	Date (2017)	Time	By	Third Wt	Date	Time	By
30	70.7846	3/29	2043	Jm	70.7847	9/5	1514	ATM	509 EPA	2 T	2 /	
30												
31	69.6652	3/29	2112	Jm	69.6653	9/5	1352	ATM	509 EPA	2 T	10-60	
31												
32	53.5988	9/5	1407	ATM								
32												
33	53.1490	9/5	1403	ATM								
33												
34	53.2611	9/5	1508	ATM								
34											/	
35	53.2807	3/29	2102	Jm	53.2808	3/31	1755	ATM	509 EPA 2	T3		
35												
36	53.5725	3/29	2047	Jm	53.5735	9/5	1359	ATM				
36												
37	53.7259	9/15	1510	ATM								
37												
38	53.2512	3/29	2109	Jm	53.2512	3/31	1750	ATM			/	
38												
39	53.1491	3/29	2111	Jm	53.1492	3/30	1621	ATM	509 EPA 2	T1	60 +	
39												

Checked by______________________ Date:__________ Time:______________

QA Reweigh

Beaker #	WT	Date	Time	By

Balance Room Environmental Conditions

WB	DB	%RH	Date (2017)	Time	By
54	65	48	3/29	2027	ATM
54	65	48	3/30	1612	ATM
57	69	47	3/31	1744	ATM
54	66	44	9/5	1257	ATM

	1st	2nd	3rd	4th	5th
Date	3/29	3/30	3/31	9/5/16	
Post Weighing 0.0000g	0.0000	0.0000	.0000	.0000	
Scale Check 100.0000g	99.9993	99.9992	99.9991	99.9993	

Woodstove Data Sheet #4-1: Initial Filter Weights (Tare Weights)

Into Dessicator: Date 3/22/16 Time 1012 By ATM Front Half X Back Half ______

Manufacturer: Pall Size: 110 mm Lot.No.: T15924FW Grade: EMFAB TX40HI wt
Balance Used: Sartorius Model: CP224S SN: 24850860

Filter #	First Wt	2016 Date	Time	By	Second Wt	Date	Time	By	Third Wt	Date	Time	By
RB1	.4663	3/26	1410	ATM	.4664	3/28	1955	Jm				
RB2	.4648	|	1411	ATM	.4648	|	1956	Jm				
RB3	.4667		1412	ATM	.4668		1957	Jm				
RB4												
RB5	.4655		1413	ATM	.4656		1958	Jm				
RB6	.4651		1414	ATM	.4651		1959	Jm				
RB7	.4659		1415	ATM	.4659		2000	Jm				
RB8	.4643		1416	ATM	.4644		2001	Jm	RFO 54			
RB9	.4665		1416	ATM	.4664		2002	Jm	RW			
RB10	.4652		1417	ATM	.4652		2002	Jm	RFO	55		
RB11	.4626		1418	ATM	.4626		2003	Jm	RFO	56		
RB12	.4676		1419	ATM	.4676		2003	Jm	RFO	57		
RB13	.4657		1420	ATM	.4657		2004	Jm	RFD	58		
RB14	.4640		1421	ATM	.4639		2005	Jm				
RB15	.4652		1421	ATM	.4652		2006	Jm				
RB16	.4651		1422	ATM	.4651		2007	Jm	RW			
RB17	.4695		1423	ATM	.4695		2008	Jm	509 EPA 2		←	
RB18	.4679		1424	ATM	.4678		2009	Jm				
RB19	.4680		1424	ATM	.4679		2010	Jm				
RB20	.4685		1425	ATM	.4685		2010	Jm				
RB21	.4662		1426	ATM	.4660		2011	Jm				
RB22	.4648		1427	ATM	.4648		2012	Jm				
RB23	.4671		1428	ATM	.4672		2013	Jm				
RB24	.4660	↓	1428	ATM	.4660	↓	2014	Jm				

Checked by A.T. Myun Date: 3/29/16 Time: 2016

QA Reweigh

Filter #	WT	Date	Time	By
RB3	.4667	3/29	913	ESS
RB10	.4654	3/29	915	ESS
RB17	.4695	3/29	917	ESS
RB21	.4658	3/29	918	ESS

Balance Room Environmental Conditions

WB	DB	%RH	Date	Time	By
54	65	48	3/25/16	1351	ATM
54	65	48	3/28/16	1935	ATM
50	60	48	3/29/16	909	ESS

Post Weighing Scale Check	Date	1st 3/26	2nd	3rd 3/29	4th	5th
	0.0000g	0.0000	0.0000	0.0000	____	____
	100.0000g	99.9995	99.9996	99.9995	____	____

Woodstove Data Sheet #4-2: Initial Beaker Weights (Tare Weights)

Into Dessicator: Date 10/21/16 Time 1700 By ATM

Balance Used: Sartorius Model: CP224S SN:24850860

Bkr #	First Wt	2016 Date	Time	By	Second Wt	2016 Date	Time	By	Third Wt	Date	Time	By
60	70.5364	11/3	11:23	ATM	70.5370	11/22	0922	JM	(70.5368)	11/23	1820	ATM
60												
61	70.8354	11/3	1121	ATM	70.8363	11/22	0920	JM	70.8356	11/23	1805	ATM
61	70.8353	11/25	0824	JM	(70.8353)	11/26	949	ATM	← Blank			
62	68.7331	11/3	1116	AM	(68.7330)	11/22	0924	JM	Thelin T-4000	EPA 6	T-	
62												
No # 63	70.6252	11/3	1119	ATM	(70.6253)	11/22	0921	JM	Thelin T-4000	EPA 6	T1	
63												

Acetone Blank Beaker

Checked by_______________ Date:_________ Time:_________

QA Reweigh

Beaker #	WT	Date	Time	By

Balance Room Environmental Conditions

WB	DB	%RH	Date 2016	Time	By
58	70	48	11/3	1028	ATM
			11/22		
			11/23		
			11/25		
			11/26		

	1st	2nd	3rd	4th	5th
Date	11/3/16	11/22/16	11/23/16	11/25/16	11/26/16
Post Weighing 0.0000g	0.0000	0.0000	0.0000	0.0000	0.0000
Scale Check 100.0000g	99.9992	99.9992	99.9992	99.9992	99.9993

Fisher optima lot No. 158570

50 ml Acetone Blank 12/19/16

Woodstove Data Sheet #4-3: Constant Final Weights

Unit: Optimum
Run #: EPA 2
Date: 9/5/17
WST5-Form 9, Pg 1, Rev 10/10

Final Beaker Weights

Beaker	Into	Date	Time	By	First	Date	Time	By	Second	Date	Time	By	Third	Date	Time	By
61	70.8444	12/23	1412	AM	70.8354	12/29	1135	ATM	70.8352	12/30	1430	Jon				

Final Filter Weights

	Filter #	Into Dessic	Date	Time	By	First	Date	Time	By	Second	Date	Time	By	Third	Date	Time	By
F																	
R																	

QA Reweigh: Final Weight

Date	Beaker #	Final Wt	By

Date	Filter #	Final Wt	By

Scale Room Environmental Conditions

Weighing Session	2016 Date	Time	By	WB	DB	%RH
1	12/29	1125	ATM	54	68	39
2	12/30	1207	ATM	49	61	40
3						
4						
5						
6						
7						

Scale Room Environmental Conditions

Weighing Session						
8						
9						
10						
11						
12						

Comment
Beaker ✓ wt. 70.8353 (12/19/16)
" Tare wt. 70.8353 (11/26/16)

Unit Optimum
Run # EPA 2
Date: 9/15/17
WST5-Form 9, Pg 1, Rev 10/10

T1 0-60

Woodstove Data Sheet #4-3: Constant Final Weight

60 ml

Final Beaker Weights

Beaker	Into	Date	Time	By	First	Date	Time	By	Second	Date	Time	By	Third	Date	Time	By
31	69.6667	9/6	2115	Jm	69.6671	9/7	1610	ESS	69.6687	9/12	1443	ATM	69.6688	9/16	1455	Jm

Final Filter Weights

	Filter #	Into Dessic	Date	Time	By	First	Date	Time	By	Second	Date	Time	By	Third	Date	Time	By
F	P120	.9383	9/6	1400	AM	.9383	9/6	2111	Jm	.9381	9/7	1612	ESS	.9382	9/12	1436	ATM
R																	

QA Reweigh: Final Weight

2017 Date	Beaker #	Final Wt	By
9/17	31	96.6689	AM

Date	Filter #	Final Wt	By

Scale Room Environmental Conditions

Weighing Session	2017 Date	Time	By	WB	DB	%RH
1	9/6	1130	ATM	58	70	47
2	9/6	2052	Jm	58	70	47
3	9/7	1358	ESS	56	67	48
4	9/12	1430	AM	54	65	47
5	9/16	1434	ATM	53	64	46
6	9/17	920	AM	52	65	41
7						

Scale Room Environmental Conditions

Weighing Session						
8						
9						
10						
11						
12						

Comment

Unit Optimum
Run # EPA 2
Date: 9/5/17
WST5-Form 9, Pg 1, Rev 10/10

Woodstove Data Sheet #4-3: Constant Final Weights

T1 60+

60 ml

Final Beaker Weights

Beaker	Into	Date	Time	By	First	Date	Time	By	Second	Date	Time	By	Third	Date	Time	By
39	53.1523	9/6	2114	ATM	53.1529	9/7	1601	ESS	53.1539	9/12	1452	AM	15.1540	9/16	1453	Sm

Final Filter Weights

	Filter #	Into Dessic	Date	Time	By	First	Date	Time	By	Second	Date	Time	By	Third	Date	Time	By
F	P122	.9467	9/6	1244	ATM	.9468	9/10	2107	Sm	.9461	9/7	1602	ESS	.9461	9/12	1434	ATM
R																	

QA Reweigh: Final Weight

Date 2017	Beaker #	Final Wt	By
9/17	39	53.1540	ATM
Date	**Filter #**	**Final Wt**	**By**

Scale Room Environmental Conditions

Weighing Session	2017 Date	Time	By	WB	DB	%RH
1	9/6	2107	Sm	56	70	40
2	9/7	1358	ESS	56	67	48
3	9/12	1420	ATM	54	65	47
4	9/16	1434	ATM	53	64	46
5	9/17	928	ATM	52	65	41
6						
7						

Scale Room Environmental Conditions

8						
9						
10						
11						
12						

Comment

Train 1 Woodstove Particulate Catch Processing Sheet
Woodstove Data Sheet #5
ASTM E 2515/ EPA M5G-1

T1

Unit: Optimum
Run: EPA 2 **Train** 1
Date: 9/5/17
Technicians: ATM ESS
Revised 11/15 - Data Sheet #5

0-60

60+ Metallic brown

0-60 Minutes:
Filters:

Filter # (Front): P120 **Beaker #:** 31 **Final Wt.:** 69.6688 g
Tare Wt.: .9356 g **ml** 60 **Tare Wt.:** 69.6653 g
Filter # (Rear): ____ **Desiccant: Acetone** **Net Wt.:** .0035 g
Tare Wt.: ____ g **Beaker Tare Wt,. Check:** 69.6652 g

0-60 Minute Combined Filter Final Weight: .9382 g
0-60 Minute Combined Filter Tare Weight: .9356 g
0-60 Minute Combined Net Catch Weight: .0026 g

60 Minutes Plus:

Filter # (Front): P122 **Beaker #:** 39 **Final Wt.:** 53.1540 g
Tare Wt.: .9287 g **ml** 60 **Tare Wt.:** 53.1492 g
Filter # (Rear): — **Desiccant: Acetone** **Net Wt.:** .0048 g
Tare Wt.: — g **Beaker Tare Wt. Check:** 53.1491 g

60 Minute Plus Combined Filter Final Weight: .9461 g
60 Minute Plus Combined Filter Tare Weight: .9287 g
60 Minute Plus Combined Net Catch Weight: .0174 g

Acetone Blank Calculation: **Blank Date:** 12/19/16 **Blank Beaker #:** 61 **Desiccant: 50 ml Acetone**
Final Wt.: 70.8352 **g - Tare Wt.:** 70.8353 **g = Net Catch Wt.:** -0.0001 = 0.0000 **g**
Net Catch Weight: 0.0000 **g / 50 ml Acetone =** .0000 **g/ml Acetone Blank Residual Value**

0-60 Minute Acetone Residue Value Calculation:
(.0000 **g/ml Acetone)(** 60 **ml Acetone) =** .0000 **g Residue Value**

60 Minute Plus Acetone Residue Value Calculation:
(.0000 **g/ml Acetone)(** 60 **ml Acetone) =** .0000 **g Residue Value**

Total Particulate Catch Calculations:		**0-60 Minute**		**60 Minute Plus**
Combined Filter Net Catch Weight:		.0026 g		.0174 g
Acetone Wash Catch Weight:	.0035 g		.0048 g	
Less Acetone Residual Value:	- .0000 g		- .0000 g	
Equals Net Acetone Wash Catch:		.0035 g		.0048 g
Total Net Catch (Combined Filter + Acetone Catch):		.0061 g		.0222 g
		6.1 mg		22.2 mg

Total Train 1 Net Catch (0-60 Minute + 60 Minute Plus Catches): 28.3 mg

EPA 2 T 2 9.5.17

DILUTION TUNNEL CALCULATIONS

MYREN CONSULTING CERTIFICATION TEST DATA

4/15/10, Ms=28.78, Bws=2.0% 6"Tunnel

		RUN TIME (min)	PITOT DELTAP (in H2O)	TNL TEMP (°F)	GAS METER RDG (ft3)	GAS METER TEMP (°F)	GAS METER DELTA H (in.H2O)	TUNNEL VELOCITY (ft/min)	PROP RATE (%)	dDGM vol std (ft3)	Tunnel Static (- Inch H2O)	SQUARE ROOT DELTA P	DRY GAS METER READING (M3)
File Name:	EPA 2 T 2												
Manufacturer:	509 FAB												
Model Number:	OPTIMUM												
Lab Name:	MYREN												
Test Date:	9.5.17	0	0.040	85	464.300	68.0	0.850	780.81			0.000	0.20000	
Run Number:	EPA 2 T 2	10	0.040	85	469.339	69.0	0.850	780.81	102.0	4.730	0.000	0.20000	
Meter Box Y Factor:	0.9847	20	0.040	86	474.327	71.5	0.850	781.17	100.4	4.666	0.000	0.20000	
Barometric Pressure (in Hg):	28.496	30	0.040	87	479.319	71.5	0.850	781.88	100.1	4.659	0.000	0.20000	
Dry Gas Meter Temp(avg.)(F):	**79**	40	0.040	88	484.321	72.5	0.850	782.60	100.2	4.664	0.000	0.20000	
Delta H(Avg.)(in H2)):	**0.850**	50	0.040	89	489.380	73.5	0.850	783.31	101.1	4.708	0.000	0.20000	
Gas meter initial reading:	464.300	60	0.040	90	494.420	74.0	0.850	784.03	100.5	4.684	0.000	0.20000	
Gas meter final reading:	647.296	70	0.040	91	499.421	74.5	0.850	784.74	99.6	4.644	0.000	0.20000	
Total Particulate Catch(mg):	25.4	80	0.040	92	504.468	76.0	0.850	785.45	100.3	4.678	0.000	0.20000	
Sampling Flow Rate(cfm):	0.508	90	0.040	92	509.530	76.0	0.850	785.81	100.3	4.685	0.000	0.20000	
		100	0.040	92	514.590	76.5	0.850	785.81	100.2	4.681	0.000	0.20000	
Tunnel Flow (Qsd) (dscfm)	**137.275**	110	0.040	93	519.661	77.0	0.850	786.16	100.3	4.687	0.000	0.20000	
Emission Rate(g/hr):	**1.042**	120	0.040	93	524.730	78.0	0.850	786.52	100.0	4.678	0.000	0.20000	
Emission Factor(g/kg)	**0.762**	130	0.040	93	529.799	78.0	0.850	786.52	99.8	4.674	0.000	0.20000	
Avg. of Delta P Sq. Roots:	**0.2000**	140	0.040	92	534.879	78.5	0.850	786.16	99.8	4.682	0.000	0.20000	
Vs (Avg.)(ft/min):	**788.325**	150	0.040	92	539.984	79.0	0.850	785.81	100.1	4.701	0.000	0.20000	
Tunnel Avg. Temperature (F):	**95.541**	160	0.040	92	545.087	80.0	0.850	785.81	99.8	4.692	0.000	0.20000	
Test time(min):	360	170	0.040	92	550.184	80.0	0.850	785.81	99.5	4.682	0.000	0.20000	
Fuel Load: (lbs. Dry):	18.0849	180	0.040	92	555.287	80.0	0.850	785.81	99.6	4.688	0.000	0.20000	
Wood moisture(%wet):	5.6128	190	0.040	94	560.391	80.5	0.850	786.52	99.7	4.687	0.000	0.20000	
Burn rate(dry kg/hr):	**1.367**	200	0.040	95	565.482	81.0	0.850	787.59	99.4	4.670	0.000	0.20000	
Sample Volume (dscf)	**168.486**	210	0.040	96	570.593	81.0	0.850	788.30	99.8	4.686	0.000	0.20000	
Avg. Tunnel Static (-inch H2O):	**0.0000**	220	0.040	97	575.686	82.0	0.850	789.01	99.3	4.666	0.000	0.20000	
Room Blank Catch (mg/dscf):	0.024235	230	0.040	97	580.774	82.0	0.850	789.36	99.1	4.657	0.000	0.20000	
Total PM Emissions(Er))(g):	**6.2525**	240	0.040	98	585.868	82.0	0.850	789.71	99.2	4.662	0.000	0.20000	
Pitot Correction Factor:	0.94309	250	0.040	98	590.953	82.0	0.850	790.07	99.1	4.654	0.000	0.20000	
Front Filter Number:	P121	260	0.040	99	596.047	82.0	0.850	790.42	99.3	4.662	0.000	0.20000	
Back Filter Number:	P121	270	0.040	100	601.176	82.5	0.850	791.13	100.0	4.692	0.000	0.20000	
Beaker number:	30	280	0.040	100	606.299	82.5	0.850	791.48	99.8	4.684	0.000	0.20000	
PRELIMINARY RESULTS		290	0.040	100	611.422	83.0	0.850	791.48	99.7	4.682	0.000	0.20000	
FINAL RESULTS:	AUDITED	300	0.040	100	616.545	83.0	0.850	791.48	99.6	4.680	0.000	0.20000	
DATA SUMMARY		310	0.039	104	621.656	83.0	0.850	787.91	100.0	4.669	0.000	0.19748	
MODEL:	OPTIMUM	320	0.040	106	626.804	83.0	0.850	790.01	101.3	4.703	0.000	0.20000	
RUN:	EPA 2 T 2	330	0.040	108	631.935	83.5	0.850	796.41	100.7	4.685	0.000	0.20000	
DATE:	9.5.17	340	0.040	109	637.046	83.5	0.850	797.47	100.0	4.665	0.000	0.20000	
DBR:	1.367	350	0.040	109	642.156	82.5	0.850	797.82	100.2	4.668	0.000	0.20000	
EMISSION RATE (g/hr)(unadj):	1.0421	360	0.040	109	647.296	82.5	0.850	797.82	100.9	4.700	0.000	0.20000	
EMISSION FACTOR (g/kg):	0.7622												
AVG. % PROPORTIONALITY :	100.026	380											

T 2

Method 5G Particulate Sampling Data

Unit: Optimum
Run: EOR 2
Date: 9/5/17
Page: 1 of 2 Rev 12/15

Meter Box 511-M Meter Y .9847
Filter #'s: (F) P121 (R) P121
Filter/O-Ring ID #: ——

.701/.7025
Pre Test Leak Check: .0015 CFM@ -16.75 in Hg
Filter Size: TFE 110 mm

.3435
Probe ID #: ——
Post Test Leak Check: .0025 CFM@ -13.5 in Hg
Probe Length: 36 in SS

Time		Meter Reading [redacted](ft³)	Pitot		Tunnel Temp (°F)	Meter Temp (°F)	Gas Meter Δh	Vac (in Hg)
Clock	Elapsed		ΔP	Pg				
1145	00	464.300	.040		85	68	.85	-2.0
55	10	469.339	.040		85	69	.85	-2.0
1205	20	474.327	.040		86	71.5	.85	-2.0
15	30	479.319	.040		87	71.5	.85	-2.0
25	40	484.321	.040		88	72.5	.85	-2.0
35	50	489.380	.040		89	73.5	.85	-2.0
45	60	494.420	.040		90	74	.85	-2.0
55	70	499.421	.040		91	74.5	.85	-2.0
1305	80	504.468	.040		92	76	.85	-2.0
15	90	509.530	.040		92	76	.85	-2.0
25	100	514.590	.040		92	76.5	.85	-2.0
35	110	519.661	.040		93	77	.85	-2.0
45	120	524.730	.040		93	78	.85	-2.0
55	130	529.799	.040		93	78	.85	-2.0
1405	140	534.879	.040		92	78.5	.85	-2.0
15	150	539.984	.040		92	79	.85	-2.0
25	160	545.087	.040		92	80	.85	-2.0
35	170	550.184	.040		92	80	.85	-2.0
45	180	555.287	.040		92	80	.85	-2.0
55	190	560.391	.040		94	80.5	.85	-2.0

BP

00	28.52	300	28.48
60	28.51	360	28.47
120	28.51		
180	28.49		
240	28.49		

Avg. = 28.496 in Hg"

Pre Test Filter Tare Weight Check
F
R .9352

End of Test Weight
F .9556 R
.9351
0205

T2

Method 5G Particulate Sampling Data

Unit: Optimum
Run: EPA 2
Date: 9/15/17
Page: 2 of 2 Rev 12/15

Meter Box: 511-M Meter Y: 0.9847 Filter #'s: (F) P121 (R) P121

.701/.7025

Filter/O-Ring ID #: —

Pre Test Leak Check: .0015 CFM@ -16.75 in Hg Filter Size: TFE 110 mm

Probe ID #: —

3435/.346

Post Test Leak Check: .0025 CFM@ -13.5 in Hg Probe Length: 36 in SS

Time		Meter Reading (ft³)	Pitot		Tunnel Temp (°F)	Meter Temp (°F)	Gas Meter Δh	Vac (in Hg)
Clock	Elapsed		ΔP	Pg				
1505	200	565.482	.040		95	81	.85	-2.0
15	210	570.593	.040		96	81	.85	-2.0
25	220	575.686	.040		97	82	.85	-2.0
35	230	580.774	.040		97	82	.85	-2.0
45	(240)	585.868	.040		98	82	.85	-2.0
55	250	590.953	.040		98	82	.85	-2.0
1605	260	596.047	.040		99	82	.85	-2.0
15	270	601.176	.040		100	82.5	.85	-2.0
25	280	606.299	.040		100	82.5	.85	-2.0
35	290	611.422	.040		100	83	.85	-2.0
45	(300)	616.545	.040		100	83	.85	-2.0
55	310	621.656	.039		104	83	.85	-2.0
1705	320	626.804	.040		106	83	.85	-2.0
15	330	631.935	.040		109	83.5	.85	-2.0
25	340	637.046	.040		109	83.5	.85	-2.0
35	350	642.156	.040		109	82.5	.85	-2.0
45	(360)	647.296	.040		109	82.5	.85	-2.0
	70							
	80							
	90							

BP

00	28.52	300	28.48
60	28.51	360	28.47
120	28.51		
180	28.49		
240	28.49		

Avg. = 28.496 in Hg"

Pre Test Filter Tare Weight Check
F
R .9352

End of Test Weight
F ____ R ____
.9351

Unit Optimum
Run # EPA 2
Date: 9/5/17

Woodstove Data Sheet #4-3: Constant Final Weights

T2

WST5-Form 9, Pg 1, Rev 10/10

60 ml

Final Beaker Weights

Beaker	Into	Date	Time	By	First	Date	Time	By	Second	Date	Time	By	Third	Date	Time	By
30	70.7896	9/6	1141	ATM	70.7892	9/6	2100	Jm	70.7892	9/7	1605	ESS	70.7899	9/12	1443	ATM
					70.7900	9/16	1504	Jm								

Final Filter Weights

	Filter #	Into Dessic	Date	Time	By	First	Date	Time	By	Second	Date	Time	By	Third	Date	Time	By
F	D121	.9556	9/5	1930	ATM	.9553	9/6	1139	ATM	.9555	9/6	2108	Jm	.9554	9/7	1607	ESS
						.9552	9/12	1433	ATM								
R																	

QA Reweigh: Final Weight

Date 2017	Beaker #	Final Wt	By
9/17	30	70.7899	ATM

Date	Filter #	Final Wt	By

Scale Room Environmental Conditions

Weighing Session	2017 Date	Time	By	WB	DB	%RH
1	9/6	1130	ATM	58	70	47
2	9/6	2052	Jm	58	70	47
3	9/7	1358	ESS	56	67	48
4	9/12	1420	ATM	54	65	47
5	9/16	1454	ATM	53	64	46
6	9/17	918	ATM	52	65	41
7						

Scale Room Environmental Conditions

Weighing Session						
8						
9						
10						
11						
12						

Comment

Train 2/ Room Blank Woodstove
Particulate Catch Processing Sheet
Woodstove Data Sheet #5
ASTM E 2515/ EPA M5G-1

T2

Unit: Optimum
Run: EPA 2 **Train** 1
Date: 9/5/17
Technicians: AM ESS
Revised 11/15 - Data Sheet #5A

Filters:

Filter # (Front): P121 **Beaker #:** 30 **Final Wt.:** 70.7900 g
Tare Wt.: .9351 g **ml** 60 **Tare Wt.:** 70.7847 g
Filter # (Rear): ______ **Desiccant: Acetone** **Net Wt.:** .0053 g
Tare Wt.: ______ g **Beaker Tare Wt,. Check:** 70.7845 g

Combined Filter Final Weight: .9552 g
Combined Filter Tare Weight: .9351 g
Combined Net Catch Weight: .0201 g

Acetone Blank Calculation: **Blank Date:** 12/19/16 **Blank Beaker #:** 61 **Desiccant: 50 ml Acetone**
Final Wt.: 70.8352 g - **Tare Wt.:** 70.8353 g = **Net Catch Wt.:** -0.0001 = 0.0000 g
Net Catch Weight: .0000 g / **50 ml Acetone =** .0000 **g/ml Acetone Blank Residual Value**

Acetone Residue Value Calculation:

(.0000 g/ml Acetone)(60 ml Acetone) = .0000 g **Residue Value**

Total Particulate Catch Calculations:

Combined Filter Net Catch Weight: .0201 g
Acetone Wash Catch Weight: .0053 g
Less Acetone Residual Value: - .0000 g
Equals Net Acetone Wash Catch: .0053 g
Total Net Catch (Combined Filter + Acetone Catch): .0254 g
25.4 mg

EPA 2 T 3

ROOM BLANK SAMPLE FLOW PROPORTIONALITY

MYREN CONSULTING CERTIFICATION TEST DATA

5/1/2008

File Name:	EPA 2 T 3
Manufacturer:	509 FAB
Model Number:	OPTIMUM
Lab Name:	MYREN
Test Date:	9.5.17
Run Number:	EPA 2 T 3
itial Meter Reading (cf):	46.6154
Final Meter Reading (cf):	225.9891
Test Time (Min):	360.0
verage Sample Rate (cfm):	0.4983
Preliminary Results:	X
Final results:	
BP:	28.496
Average Δ_h:	0.120
Dry Gas Meter Temp (F):	79.5
Sample Volume (dscf):	160.927
Dry Gas Meter Y:	0.9626
al Room Blank Catch (mg):	3.900
Room Blank mg/dscf	0.024235
Avg. Sampling Rate $\Delta_{a(e)}$:	-2.896

RUN TIME (min)	GAS METER READING (Cu, Ft,)	INTERVAL SAMPLE VOLUME (Cu. Ft.)	SAMPLING RATE % DIFFERENCE	INTERVAL SAMPLING RATE (cfm)	DRY GAS METER READING (M3)	DRY GAS METER Δ_h	DRY GAS TEMP F
0	46.6154				1.3200	0.12	68.5
10	51.7466	5.1312	0.0000	0.51312	1.4653	0.12	69.0
20	56.8001	5.0535	-1.5141	0.50535	1.6084	0.12	70.5
30	61.8254	5.0253	-2.0647	0.50253	1.7507	0.12	73.0
40	66.8401	5.0147	-2.2712	0.50147	1.8927	0.12	74.0
50	71.8759	5.0359	-1.8582	0.50359	2.0353	0.12	75.0
60	76.9012	5.0253	-2.0647	0.50253	2.1776	0.12	75.0
70	81.9018	5.0006	-2.5465	0.50006	2.3192	0.12	76.0
80	86.9165	5.0147	-2.2712	0.50147	2.4612	0.12	77.0
90	91.8923	4.9758	-3.0282	0.49758	2.6021	0.12	77.0
100	96.8717	4.9794	-2.9594	0.49794	2.7431	0.12	78.0
110	101.8510	4.9794	-2.9594	0.49794	2.8841	0.12	78.0
120	106.8339	4.9829	-2.8906	0.49829	3.0252	0.12	79.0
130	111.8204	4.9864	-2.8217	0.49864	3.1664	0.12	79.5
140	116.8139	4.9935	-2.6841	0.49935	3.3078	0.12	80.0
150	121.7968	4.9829	-2.8906	0.49829	3.4489	0.12	80.0
160	126.7161	4.9193	-4.1294	0.49193	3.5882	0.12	80.5
170	131.6849	4.9688	-3.1659	0.49688	3.7289	0.12	80.5
180	136.6395	4.9546	-3.4412	0.49546	3.8692	0.12	81.0
190	141.6048	4.9652	-3.2347	0.49652	4.0098	0.12	81.0
200	146.5700	4.9652	-3.2347	0.49652	4.1504	0.12	81.5
210	151.5282	4.9582	-3.3723	0.49582	4.2908	0.12	82.0
220	156.4899	4.9617	-3.3035	0.49617	4.4313	0.12	82.0
230	161.4551	4.9652	-3.2347	0.49652	4.5719	0.12	82.5
240	166.3851	4.9299	-3.9229	0.49299	4.7115	0.12	82.5
250	171.3856	5.0006	-2.5465	0.50006	4.8531	0.12	83.5
260	176.3438	4.9582	-3.3723	0.49582	4.9935	0.12	83.5
270	181.3055	4.9617	-3.3035	0.49617	5.1340	0.12	83.5
280	186.2743	4.9688	-3.1659	0.49688	5.2747	0.12	83.0
290	191.2430	4.9688	-3.1659	0.49688	5.4154	0.12	83.5
300	196.2154	4.9723	-3.0970	0.49723	5.5562	0.12	83.5
310	201.1806	4.9652	-3.2347	0.49652	5.6968	0.12	83.5
320	206.1458	4.9652	-3.2347	0.49652	5.8374	0.12	83.5
330	211.1040	4.9582	-3.3723	0.49582	5.9778	0.12	83.5
340	216.0657	4.9617	-3.3035	0.49617	6.1183	0.12	83.0
350	221.0274	4.9617	-3.3035	0.49617	6.2588	0.12	82.5
360	225.9891	4.9617	-3.3035	0.49617	6.3993	0.12	82.0

T3

Method 5G Particulate Sampling Data

Unit: Optimum
Run: EPA 2
Date: 9/5/17
Page: 1 of 2 Rev 12/15

Meter Box Train 3 Meter Y 0.9626 Filter #'s: (F) RB 17 (R) ——

.3008/.30085 = .00005 cmm

Filter/O-Ring ID #: ——

Pre Test Leak Check: .0018 CFM@ -21.0 in Hg Filter Size: TFE 110 mm

.4006/.4007 = .0001 cmm

Probe ID #: ——

Post Test Leak Check: .018 CFM@ -13.0 in Hg Probe Length: —— in N/A

Time: Clock	Time: Elapsed	Meter Reading (m³)	Pitot ΔP	Pitot Pg	Tunnel Temp (°F)	Meter Temp (°F)	Gas Meter Δh	Vac (in Hg)
1145	00	1.3200				68.5	.12	-1.5
55	10	1.4653				69	.12	-1.5
1205	20	1.6084				70.5	.12	-1.5
15	30	1.7507				73	.12	-1.5
25	40	1.8927				74	.12	-1.5
35	50	2.0353				75	.12	-1.5
45	(60)	2.1776				75	.12	-1.5
55	70	2.3192				76	.12	-1.5
1305	80	2.4612				77	.12	-1.5
15	90	2.6021				77	.12	-1.5
25	100	2.7431				78	.12	-1.5
35	110	2.8841				78	.12	-1.5
45	(120)	3.0252				79	.12	-1.5
55	130	3.1664				79.5	.12	-1.5
1405	140	3.3078				80	.12	-1.5
15	150	3.4489				80	.12	-1.5
25	160	3.5882				80.5	.12	-1.5
35	170	3.7289				80.5	.12	-1.5
45	(180)	3.8692				81	.12	-1.5
55	190	4.0098				81	.12	-1.5

BP

00	28.52	300	28.48
60	28.51	360	28.47
120	28.51		
180	28.49		
240	28.49		

Avg. = 28.496 in Hg"

Pre Test Filter Tare Weight Check
F
R .4697

End of Test Weight
F .4712 R

.4695
.0017

(T3)

Method 5G Particulate Sampling Data

Unit: Optimum
Run: EPA 2
Date: 9/5/17
Page: 2 of 2 Rev 12/15

Meter Box: Train 3 Meter Y: 0.9626 Filter #'s: (F) RB17 (R) ——

.3008/.30085 -.00005 Filter/O-Ring ID #: ——

Pre Test Leak Check: .0018 CFM@ -21.0 in Hg Filter Size: TFE 110 mm

.4006/.4007 .0001 cmm Probe ID #: ——

Post Test Leak Check: ____ CFM@ -13.0 in Hg Probe Length: —— in N/A

Time: Clock	Time: Elapsed	Meter Reading (m^3)	Pitot: ΔP	Pitot: Pg	Tunnel Temp (°F)	Meter Temp (°F)	Gas Meter Δh	Vac (in Hg)
1505	200	4.1504				91.5	.12	-1.5
15	210	4.2908				82	.12	-1.5
25	220	4.4313				82	.12	-1.5
35	230	4.5719				82.5	.12	-1.5
45	(240)	4.7115				82.5	.12	-1.5
55	250	4.8531				83.5	.12	-1.5
1605	260	4.9935				83.5	.12	-1.5
15	270	5.1340				83.5	.12	-1.5
25	280	5.2747				83	.12	-1.5
35	290	5.4154				83.5	.12	-1.5
45	(300)	5.5562				83.5	.12	-1.5
55	310	5.6968				83.5	.12	-1.5
1705	320	5.8374				83.5	.12	-1.5
15	330	5.9778				83.5	.12	-1.5
25	340	6.1183				83	.12	-1.5
35	350	6.2588				82.5	.12	-1.5
45	(360)	6.3993				82	.12	-1.5
	70							
	80							
	90							

BP

00	28.52	300	28.48
60	28.51	360	28.47
120	28.51		
180	28.49		
240	28.49		

Avg. = 28.496 in Hg"

28.47

Pre Test Filter Tare Weight Check

F ____

R .4697

End of Test Weight

F .4712 R ____

.4695

.0017

Unit Optimum
Run # EPA 2
Date: 9/5/17
WST5-Form 9, Pg 1, Rev 10/10

T3

Woodstove Data Sheet #4-3: Constant Final Weights

30 ml

Final Beaker Weights

Beaker	Into	Date	Time	By	First	Date	Time	By	Second	Date	Time	By	Third	Date	Time	By
35	53.2814	9/6	2115	[illegible]	53.2818	9/7	1615	ESS	53.2830	9/12	1438	AM	53.2830	9/16	1457	[illegible]

Final Filter Weights

	Filter #	Into Dessic	Date	Time	By	First	Date	Time	By	Second	Date	Time	By	Third	Date	Time	By
F	RB17	.4712	9/6	1202	AM	.4713	9/6	2052	[illegible]	.4711	9/7	1616	ESS	.4712	9/12	1435	AM
R																	

QA Reweigh: Final Weight

Date 2017	Beaker #	Final Wt	By
9/17	35	53.2831	AM
Date	**Filter #**	**Final Wt**	**By**

Scale Room Environmental Conditions

Weighing Session	2017 Date	Time	By	WB	DB	%RH
1	9/6	2052	[illegible]	58	70	47
2	9/7	1358	ESS	56	67	48
3	9/12	1430	AM	54	65	47
4	9/16	1434	AM	53	64	46
5	9/17	928	AM	52	65	41
6						
7						

Scale Room Environmental Conditions

Weighing Session						
8						
9						
10						
11						
12						

Comment

Train 2/ Room Blank Woodstove
Particulate Catch Processing Sheet
Woodstove Data Sheet #5
ASTM E 2515/ EPA M5G-1

(T3)

Unit: Optimum
Run: EPA 2 Train 3
Date: 9/5/17
Technicians: ATM ESS
Revised 11/15 - Data Sheet #5A

Filters:

Filter # (Front): RB1 Beaker #: 35 Final Wt.: 53.2830 g
Tare Wt.: .4695 g ml 30 Tare Wt.: 53.2808 g
Filter # (Rear): ______ Desiccant: Acetone Net Wt.: .0022 g
Tare Wt.: ______ g Beaker Tare Wt,. Check: 53.2810 g

Combined Filter Final Weight: .4712 g
Combined Filter Tare Weight: .4695 g
Combined Net Catch Weight: .0017 g

Acetone Blank Calculation: Blank Date: 12/19/16 Blank Beaker #: 61 Desiccant: 50 ml Acetone

Final Wt.: 70.8352 g - Tare Wt.: 70.8353 g = Net Catch Wt.: -0.0001 = 0.0000 g

Net Catch Weight: .0000 g / 50 ml Acetone = ______ g/ml Acetone Blank Residual Value

Acetone Residue Value Calculation:

(.0000 g/ml Acetone)(30 ml Acetone) = .0000 g Residue Value

Total Particulate Catch Calculations:

Combined Filter Net Catch Weight: .0017 g

Acetone Wash Catch Weight: .0022 g

Less Acetone Residual Value: - .0000 g

Equals Net Acetone Wash Catch: .0022 g

Total Net Catch (Combined Filter + Acetone Catch): .0039 g

3.9 mg

From: 6/25/17

Through: ______

Woodstove Data Sheet 4-4 Scale QC Record Sheet
Scale 2

Scale: Sartorius
Model: CPA 2245
SN: 24850860
Rev: 7.15

Level	Recali-brated	100g Weight	10g Weight	1g Weight	100mg Weight	10mg Weight	2017 DATE	TIME	TECH	BP	LINE VOLTS	WET BULB	DRY BULB	% RH
Yes	No	99.9991	10.0000	1.0000	.1000	.0100	6/25/17	1935	ATM	28.56	120	54	66	44
Yes	No	99.9991	10.0000	0.9999	.0999	.0100	6/26/17	812	ATM	28.34	119	56	67	48
Yes	No	99.9992	10.0000	0.9999	.0999	.0099	6/27/17	1719	AM	28.75	119	59	71	48
Yes	No	99.9992	9.9999	0.9999	.1000	.0100	6/28/17	1718	ATM	28.36	118	58	70	48
Yes	NO	99.9991	9.9998	1.0000	0.0999	0.0100	7/13/17	1512	ESS	28.38	119	55	66	48
Yes	NO	99.9992	9.9998	0.9999	0.1000	0.0100	8/3/17	1323	ESS	28.44	118	58	70	48
Yes	No	99.9993	10.0000	0.9999	.1000	.0100	9/5/17	1257	ATM	28.51	118	54	66	44
Yes	No	99.9991	9.9999	1.0000	.1000	.0100	9/6/17	1130	ATM	28.50	118	58	70	47
Yes	No	99.9992	9.9999	1.0000	.1000	.0100	9/6/17	2052	ATM	28.35	120	58	70	47
Yes	No	99.9991	9.9999	1.0000	0.1000	0.0100	9/7/17	1558	ESS	28.29	120	56	67	48
Yes	NO	99.9992	9.9999	1.0000	0.1000	0.0100	9/11/17	1512	ESS	28.48	118	54	65	47
Yes	No	99.9992	9.9999	1.0000	.1000	0.0100	9/12/17	1420	ATM	28.29	119	54	65	47
Yes	No	99.9991	9.9999	1.0000	.1000	.0100	9/16/17	1434	ATM	28.48	120	53	64	46
Yes	No	99.9991	9.9999	1.0000	.1000	.0100	9/17/17	928	ATM	28.48	119	52	65	41

Woodstove Data Sheet 4-4 Scale QC Record Sheet
Scale 2

From: 4/1/17
Through: 6/20/17

Scale: Sartorius
Model: CPA 2245
SN: 24850860
Rev: 5/10

Level	Recali-brated	100g Weight	10g Weight	1g Weight	100mg Weight	10mg Weight	DATE	TIME	TECH	BP	LINE VOLTS	WET BULB	DRY BULB	% RH
Yes	No	99.9992	10.0000	1.0000	0.1000	0.0100	4/1/17	1942	ATM	28.42	119	54	65	48
Yes	No	99.9992	9.9999	1.0000	0.1000	0.0100	4/2/17	1416	ATM	28.47	121	53	64	47
Yes	No	99.9991	9.9999	.9999	0.1000	0.0100	4/4/17	2200	ATM	28.50	119	52	64	43
Yes	No	99.9992	10.0000	1.0000	.1000	.0099	4/7/17	850	ATM	28.05	120	53	64	47
Yes	No	99.9991	9.9999	1.0000	.0999	.0100	4/8/17	1137	ATM	28.32	120	54	66	45
Yes	Yes	99.9991	9.9999	1.0000	.0999	.0100	4/13/17	1024	ESS	28.23	119	54	65	48
		QC Services Here		1000	4/19/17	Post	visit	wt. ✓						
Yes	Yes	99.9991	9.9999	0.9999	0.0999	0.0100	4/19/17	1040	ESS	28.60	118	53	64	47
Yes	NO	99.9991	10.0000	1.0000	0.1000	0.0100	4/25/17	1217	ESS	28.35	117	56	67	49
Yes	No	99.9992	10.0000	0.0999	0.1000	0.0100	5/24/17	1610	ATM	28.28	119	62	76	48
Yes	NO	99.9992	9.9999	1.0000	0.1000	0.0100	5/26/17	1609	ESS	28.34	119	59	71	48
Yes	No	99.9991	9.9999	.9999	0.1000	0.0100	5/27/17	1235	ATM	28.52	120	59	71	48
Yes	No	99.9992	10.0000	.9999	0.0999	0.0100	5/28/17	910	ATM	28.59	120	61	73	49
Yes	No	99.9992	9.9998	.9999	0.0999	0.0100	6/4/17	920	ATM	28.36	119	61	73	49
		AC on	@ 1017	on 6/5/17										
Yes	No	99.9992	9.9999	1.0000	0.1000	0.0100	6/5/17	1630	ATM	28.52	120	55	66	48
Yes	No	99.9991	9.9999	0.9999	0.1000	0.0100	6/6/17	646	ATM	28.56	118	58	70	48
Yes	No	99.9991	9.9999	1.0001	0.1000	0.0100	6/7/17	1441	ATM	28.22	117	57	69	47
Yes	No	99.9992	10.0000	1.0000	0.1000	0.0100	6/9/17	1756	ATM	28.19	120	54	65	47
Yes	No	99.9992	10.0000	1.0000	0.1000	0.0100	6/13/17	1848	ATM	28.27	117	55	66	48
Yes	No	99.9992	9.9999	1.0000	0.1000	0.0100	6/14/17	1705	ATM	28.40	119	54	65	47
Yes	No	99.9991	9.9999	1.0000	0.1000	0.0100	6/15/17	2148	ATM	28.34	118	58	69	48
Yes	No	99.9992	9.9999	1.0000	0.1000	0.0100	6/16/17	0700	ATM	28.36	119	57	69	47
Yes	No	99.9991	9.9999	0.9999	0.1000	0.0100	6/16/17	2022	ATM	28.31	118	57	69	47
Yes	No	99.9993	10.0000	0.9999	0.1000	0.0099	6/17/17	654	ATM	28.53	119	56	68	46
Yes	NO	99.9992	9.9999	0.9999	0.1000	0.0100	6/20/17	1502	ESS	28.40	119	59	71	48

From: 11/5/16
Through: 3/31/17

Woodstove Data Sheet 4-4 Scale QC Record Sheet
Scale 2

Scale: Sartorius
Model: CPA 2245
SN: 24850860
Rev: 5/10

Level	Recali-brated	100g Weight	10g Weight	1g Weight	100mg Weight	10mg Weight	DATE	TIME	TECH	BP	LINE VOLTS	WET BULB	DRY BULB	% RH
Yes	No	99.9992	9.9999	1.0000	0.1000	0.0100	11/22/16	848	ATM	28.53	121	54	66	45
Yes	No	99.9992	9.9999	1.0000	0.1000	0.0100	11/23/16	1740	ATM	28.44	120	53	64	47
Yes	No	99.9993	10.0000	1.0000	0.1000	0.0100	11/24/16	1005	ATM	28.52	120	53	64	47
Yes	No	99.9993	9.9999	0.9999	0.1000	0.0099	11/25/16	740	ATM	28.32	118	52	63	46
Yes	No	99.9992	9.9999	1.0000	0.1000	0.0100	11/26/16	833	ATM	28.22	121	54	65	48
Yes	No	99.9992	9.9999	1.0000	0.1000	0.0100	11/27/16	1413	ATM	28.11	119	51	63	42
Yes	No	99.9992	9.9999	1.0000	0.1000	0.0100	12/29/16	1125	ATM	28.63	119	54	68	39
Yes	No	99.9992	9.9999	1.0000	0.1000	0.0100	12/30/16	1207	ATM	28.56	121	49	61	40
Yes	Yes	99.9992	9.9999	0.9999	0.0999	0.0100	1/1/17	1441	ATM	28.28	120	53	65	44
Yes	No	99.9992	9.9999	1.0000	0.0999	0.0100	1/3/17	1200	ESS	28.71	121	50	65	31
Yes	No	99.9993	9.9999	1.0000	0.0999	0.0100	1/4/17	1246	ATM	28.71	118	48	61	32
Yes	No	99.9993	9.9999	1.0000	0.1000	0.0100	1/5/17	1654	ATM	28.63	120	51	66	32
Yes	No	99.9992	9.9999	1.0000	0.1000	0.0100	1/6/17	1930	ATM	28.62	121	50	64	34
Yes	No	99.9993	9.9999	1.0000	0.0999	0.0100	1/7/17	1007	ATM	28.65	120	49	63	33
Yes	No	99.9992	9.9999	1.0000	0.1000	0.0100	1/8/17	1903	ATM	28.18	120	50	64	34
Yes	No	99.9991	9.9999	1.0000	0.1000	0.0099	1/9/17	936	ESS	28.19	119	50	64	34
Yes	No	99.9992	9.9999	0.9999	0.0999	0.0100	1/10/17	1053	ATM	28.24	120	53	65	44
Yes	No	99.9993	9.9999	1.0000	0.1000	0.0100	1/10/17	1950	ATM	28.25	120	52	66	35
Yes	Yes	99.9992	9.9999	1.0001	0.1000	0.0099	1/11/17	1539	ESS	28.38	119	46	60	30
Yes	Yes	99.9992	9.9999	1.0000	0.1000	0.0100	1/12/17	1234	ATM	28.66	121	50	64	34
Yes	No	99.9993	9.9999	1.0000	0.1000	0.0100	1/16/17	1531	ESS	28.69	119	50	65	32
Yes	No	99.9992	9.9999	.9999	0.1000	0.0100	1/20/17	1110	ATM	27.74	118	53	65	44
Yes	No	99.9993	9.9999	1.0000	0.1000	0.0100	1/22/17	924	ATM	28.72	120	[illegible]	64	43
Yes	No	99.9992	9.9999	1.0000	0.0999	0.0100	3/29/17	2027	ATM	28.29	120	54	65	48
Yes	No	99.9993	9.9999	.9999	0.0999	0.0100	3/30/17	1612	ATM	28.41	120	54	65	48
Yes	Yes	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3/31/17	[illegible]	ATM	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

From: 9/16/16
Through: 11/4/16

Woodstove Data Sheet 4-4 Scale QC Record Sheet
Scale 2

Scale: Sartorius
Model: CPA 2245
SN: 24850860
Rev: 5/10

Level	Recali-brated	100g Weight	10g Weight	1g Weight	100mg Weight	10mg Weight	2016 DATE	TIME	TECH	BP	LINE VOLTS	WET BULB	DRY BULB	% RH
Yes	No	99.9992	10.0000	1.0000	.1000	.0100	9/16	2145	ATM	28.	119	60	72	48
Yes	No	99.9992	10.0000	1.0000	.1000	.0100	9/17	1417	ATM	28.30	116	58	70	48
Yes	No	99.9991	9.9999	1.0000	.1000	.0101	9/18	1200	ATM	28.43	118	54	67	41
Yes	No	99.9992	9.9999	.9999	.1000	.0100	9/19	1048	ATM	28.50	120	56	67	49
Yes	No	99.9992	9.9999	1.0000	.1000	.0100	9/19	2220	ATM	28.53	120	53	65	44
Yes	NO	99.9991	9.9999	1.0000	0.1000	.0100	9/28	1413	ESS	28.44	120	54	65	47
Yes	NO	99.9990	9.9999	1.0000	0.1000	0.0099	9/30	1457	ESS	28.33	118	60	72	48
Yes	No	99.9993	10.0000	1.0000	0.1000	0.0100	10/2	910	ATM	28.49	120	53	64	47
Yes	No	99.9992	9.9999	1.0000	0.1000	0.0100	10/3	929	ATM	28.35	120	52	63	46
Yes	No	99.9992	9.9999	1.0000	0.1000	0.0100	10/8	1915	ATM	28.32	120	56	67	49
Yes	No	99.9993	10.0000	1.0000	0.1000	0.0100	10/9	1057	ATM	28.49	120	56	68	46
Yes	No	99.9992	10.0000	0.9999	0.1000	0.0099	10/15	1002	ATM	28.19	120	56	67	49
Yes	No	99.9992	9.9999	1.0000	0.1000	0.0101	10/17	1523	ATM	28.22	120	55	66	48
Yes	No	99.9992	10.0000	0.9999	0.1000	0.0100	10/18	1938	ATM	28.55	120	56	68	46
Yes	No	99.9992	9.9999	1.0000	0.1000	0.0100	10/19	1548	ATM	28.72	119	57	69	46
Yes	Yes	QC Services Here - Post Visit Weight ✓					10/20	1640	ATM	28.43	120	—	—	—
Yes	Yes	99.9992	9.9999	1.0000	0.1000	0.0100	10/20	1705	ATM	28.45	120			—
Yes	Yes	99.9993	9.9999	1.0000	0.1000	0.0100	10/22	1846	ATM	28.46	119	56	67	49
Yes	No	99.9993	10.0000	1.0000	0.1000	0.0100	10/23	1400	ATM	28.48	120	56	67	49
Yes	No	99.9993	9.9999	1.0000	0.1000	0.0100	10/24	1742	ATM	28.28	119	58	70	48
Yes	No	99.9992	9.9999	1.0000	0.1000	0.0100	10/25	1712	ATM	28.49	119	58	70	48
Yes	No	99.9992	10.0000	1.0000	0.1000	0.0100	10/26	1444	ATM	28.42	119	55	66	48
Yes	NO	99.9992	10.0000	1.0000	0.1000	0.0100	11/1	1132	ESS	28.35	120	57	69	46
Yes	No	99.9991	9.9999	1.0000	0.1000	0.0100	11/2	1809	ATM	28.43	119	57	69	46
Yes	No	99.9992	9.9999	0.9999	0.0999	0.0100	11/3	1028	ATM	28.58	120	58	70	48
Yes	Yes	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

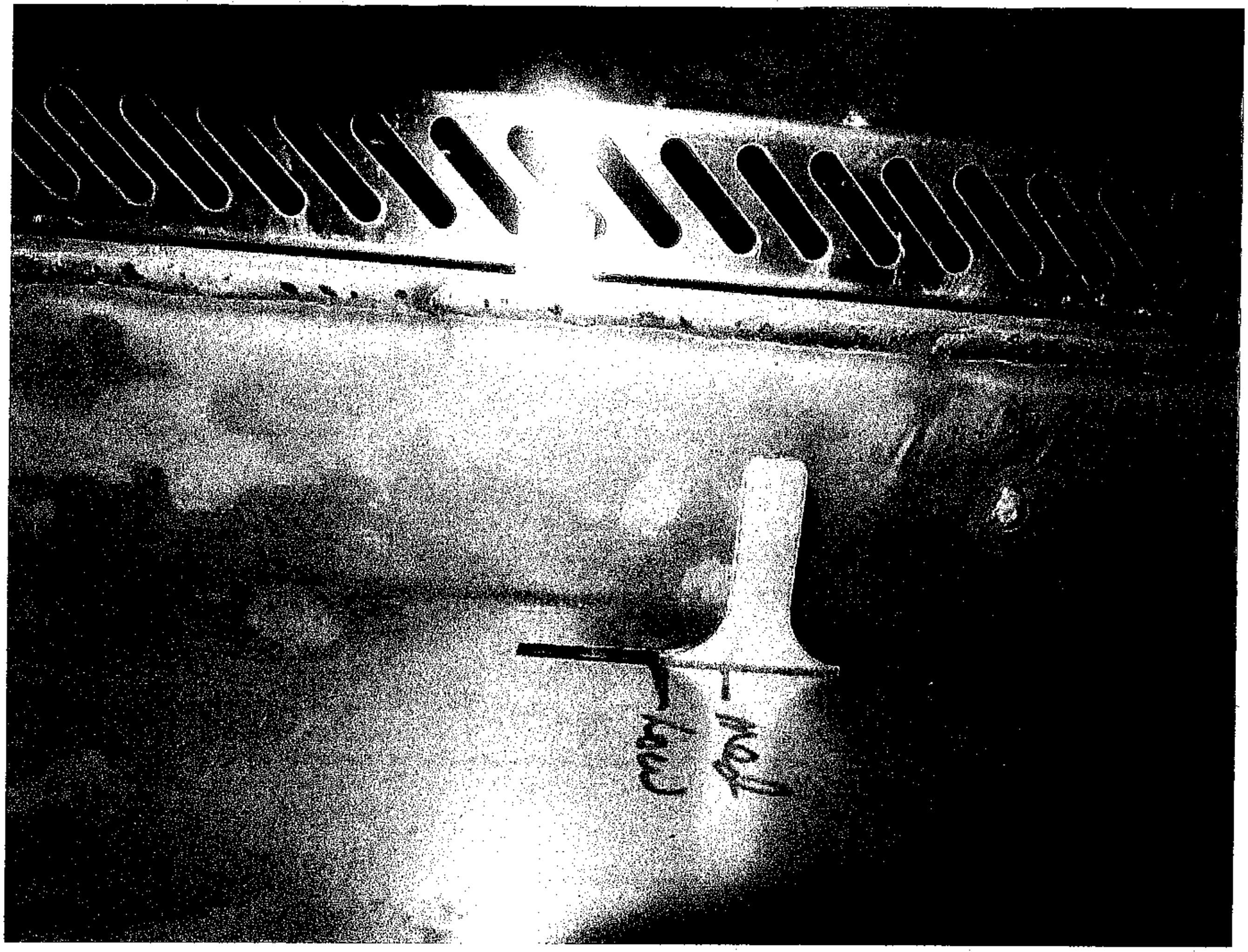
From: 2/24/16

Through: 4/1/16

Woodstove Data Sheet 4-4 Scale QC Record Sheet
Scale 2

Scale: Sartorius
Model: CPA 2245
SN: 24850860
Rev: 7.15

Level	Recali-brated	100g Weight	10g Weight	1g Weight	100mg Weight	10mg Weight	DATE	TIME	TECH	BP	LINE VOLTS	WET BULB	DRY BULB	% RH
Yes	NO	99.9994	10.0000	1.0000	0.1000	0.0101	2/24/16	1054	ESS	28.72	118	53	65	43
Yes	No	99.9996	10.0000	1.0000	0.1000	0.0100	2/24/16	1850	ATM	28.68	118	54	66	45
Yes	No	99.9995	9.9999	1.0000	0.1000	0.0100	3/4/16	1020	ATM	28.50	120	55	67	45
Yes	No	99.9994	10.0000	1.0001	0.1001	0.0100	3/4/16	2121	ATM	28.31	120	58	70	46
Yes	No	99.9996	9.9999	0.9999	0.1000	0.0101	3/5/16	2053	ATM	28.17	119	58	70	46
Yes	No	99.9995	9.9999	1.0000	0.1000	0.0100	3/6/16	759	ATM	27.97	119	54	65	48
Yes	No	99.9995	10.0000	1.0000	0.1000	0.0100	3/6/16	1251	ATM	28.10	119	57	69	47
Yes	NO	99.9994	10.0000	1.0001	0.0999	0.0101	3/6/16	2023	ATM	28.14	119	57	70	44
Yes	NO	99.9994	9.9999	0.9999	0.0999	0.0100	3/7/16	1026	ESS	28.30	119	53	64	47
Yes	No	99.9994	9.9999	0.9999	0.1000	0.0100	3/7/16	2032	ATM	28.38	119	55	66	48
Yes	NO	99.9995	9.9999	0.9999	0.1000	0.0101	3/8/16	1537	ESS	28.38	121	54	65	48
Yes	No	99.9995	9.9999	1.0000	0.1000	0.0100	3/9/16	1804	ATM	28.30	118	53	64	46
Yes	No	99.9996	10.0000	1.0000	0.1000	0.0100	3/10/16	1516	ATM	28.27	120	54	65	48
Yes	No	99.9996	10.0000	1.0000	0.1000	0.0100	3/11/16	1902	ATM	28.18	119	54	65	48
Yes	Yes	99.9995	9.9999	1.0000	0.0999	0.0100	3/12/16	1632	ATM	28.18	119	54	65	48
Yes	No	99.9996	9.9999	0.9999	0.0999	0.0100	3/13/16	0825	ATM	28.25	119	54	67	41
Yes	No	99.9995	10.0000	0.9999	0.1000	0.0100	3/23/16	1015	ATM	28.27	120	54	67	41
Yes	No	99.9995	9.9999	1.0000	0.1000	0.0100	3/24/16	1351	ATM	28.40	117	54	65	48
Yes	No	99.9994	9.9999	1.0000	0.1000	0.0099	3/25/16	935	ESS	28.51	119	53	64	46
Yes	No	99.9995	10.0000	1.0000	0.1000	0.0100	3/26/16	12:50	ATM	28.53	118	50	61	45
Yes	No	99.9995	9.9999	1.0000	0.1000	0.0100	3/27/16	12:20	ATM	28.37	120	49	60	44
Yes	NO	99.9996	9.9999	1.0000	0.1000	0.0100	3/28/16	1935	ATM	28.48	119	54	65	48
Yes	NO	99.9995	9.9999	1.0000	0.0999	0.0101	3/29/16	909	ESS	28.53	119	50	60	48
Yes	NO	99.9996	9.9999	1.0000	0.1000	0.0100	3/31/16	859	ATM	28.54	119	48	64	37
Yes	No	99.9995	9.9999	1.0000	0.1000	0.0100	4/1/16	1542	ATM	28.51	120	58	70	48



THE PRIMARY AIR CONTROL SETTINGS TO BE USED DURING TESTING ARE SHOWN ABOVE. SET THE AIR CONTROL SO THAT THE FORWARD EDGE OF THE CONTROL IS ALIGNED WITH THE LINES FOR EACH SETTING AS IS SHOWN ABOVE FOR THE LOW BURN SETTING.

OPERATION OF THE OPTIMUM DENSIFIED FUEL LOG STOVE.

The Optimum was operated according to the manufacturer's written instructions. (See the second page in the Manual Section.) As agreed upon, these instructions were changed for this test run. The primary air control (PAC) was adjusted for each test segment as per the revised written instructions.

COMMENT:

As noted in the cover letter to Dr Sanchez in the front of this report, this unit is the first unit that burns densified fuel logs to be EPA certification tested and that it combines features found in both wood and pellet stoves, making the unit an "outside of the box" hybrid". That in and of itself creates some issues for those who are conducting the tests because the unit is a batch, gravity fed appliance with a combustion air fan that has only 1 speed.

What follows is basically a repeat of the information provided under Note 1 on the first page in the Data Summary Section that is titled

WOOD BURNING HEATERS UNIT: 509 OPTIMUM Densified Fuel Log Stove

Test Method 28R for Certification and Auditing of Wood Heaters. Pall 110 mm TX-40 EMFAB TFE coated filters were required and used for this test run. (See letter from Stef Johnson, EPA/ OAQPS dated 22 August 2017. A copy of this letter is in the Introduction Section.)

There is no test run in Dry Burn Rate (BDR) Category 1 (<0.80 kg/h) because the unit's dry burn rate is controlled by its primary air control and combustion air fan, the density and size (diameter) of the fuel logs themselves, the amount of fuel remaining in the feed tube at any given time and how the fuel logs "settle" in the feed tube. The logs are gravity fed and logs can "warp" due to heat and moisture content and hang up in the feed tube which slows the DBR. The weight of the logs left in the feed tube also affects the feed rate because the weight pressing down from above is what causes the burning end of a log to disintegrate into smaller pieces, i.e., the more weight, the faster the disintegration, which allows more unburnt fuel to drop into the combustion chamber. The DBR data for this Reversed Test Segment scenario reflects this. When the "Low" burn test segment was started, the unit had been burning for a little over 75 minutes (~15 minutes for ignition on High and 60 minutes for Preburn on Low). Fuel logs were added to the unit before ignition, so preburn and the first part of the 180 minute Low burn test segment were run without any additional fuel being added. At 109:00 minutes into the test a 7.4 lb log was added because the dry burn rate had decreased substantially. Unfortunately by the time the log was added the stove had lost a considerable amount of "momentum", so the DBR did not pick up until a second 7.4 lb log was added at 159:00 minutes, just before the end of the Low burn segment. At 180 minutes the Primary air control was adjusted to the Medium setting and the Medium test segment began. The logs "dropped" twice during the Medium test segment. At the end of the Medium segment, the Primary air control was adjusted to the "High" burn setting. No additional fuel was added during either the Medium or High burn test segments.

So what controls the DBR in this unit is the combination of (1.) the amount of fuel left in the feed tube, (2.) the primary air control setting and (3.) the amount of time the unit has been burning at a given setting. It quickly becomes evident that the amount of time the unit has been burning at any given setting will initially see a heat build up and an increase in the DBR followed by a decrease in heat and a decrease in the DBR.

Wood Density Determination
Woodstove Test Data Sheet #11

Unit: Optimum
Run#: EPA 2
Date: 9/5/17
Technician: AM

Rev 5/10

Wood Piece: Nominal Dimensions: ______ X ______ X ______
Depth (D): ______ cm
Width (W): ______ cm
Length(L): ______ cm
______ cm Length $\overline{X}$ = ______ cm
______ cm
______ cm Volume: ______ cm^3
(D x W x L)

Room Temperature: ______ °F Correction Factor: ______
Meter Readings Corrected for temperature: Yes ______ No ______
Note: Record Moisture Meter readings to the nearest 0.5% or 0.1%

	Uncor	Cor	Avg % Moisture (Dry) ______ %
Top:		%	
Bottom:		%	Avg % Moisture (Wet) ______ %
Side:		%	Scale: Leveled In ✓ Out ✓
$\overline{X}$:		%	Zeroed: In ✓ Out ✓

Wet Weight: ______ g Dry Weight: ______ g
% Moisture Dried Basis: ______ %
([1 – (Dry Wt/Wet Wt)] X 100)

I use analytical balance

Density = ______ g/ ______ cm^3 = ______ g/cm^3
(dry wt) (volume)

	Date	Time	Temp
Into Dryer	9/8/16	1956	140 °F
Out of Dryer	9/19/16	1522	215 °F

turned up

(Minimum Time in Dryer: 24 hrs.)

Pellet Fuel Moisture Content Determintation
Tare Beaker Wt. # 60 - 70.5368 g

Log ~~Pellet~~ Name: N. Idaho Energy Log
Log Pellet Manufacturer: N. Idaho Energy Log
Pellet Grade: N/A

Wet Wt: 142.4224 g - 70.5368 g = 71.8856 g
Gross Wet Wt. Tare Beaker Wt. Net Wet Wt.

Dry Wt: 138.3876 g - 70.5368 g = 67.8508 g
Gross Dry Wt. Tare Beaker Wt. Net Dry Wt.

% Moisture Wet Basis: 5.6128 %
[1 – (Net Dry Wt./Net Wet Wt.)] X 100

MYREN CONSULTING, INC.
ASTM E2779 Densified Fuel Heater Eqns.
Forms/ Densified Fuel Stoves/ Eqns.
Rev 6. 4.20.17 P. 1 of 2

Unit: Optimum
Run #: SPQ 2
Date: 9/5/17
Tech: AJM

ASTM E2779 EQN 1: Kilograms/ Pounds of dry fuel burnt, db (Revised)

Note: EQN 1 assumes that no fuel will be added to the unit while it is being tested. That was not possible with the Optimum because of the unit's dry burn rate, i.e., the stove will run out of fuel and go out if one does not add fuel to the unit sometime during the 6 hour integrated test. So the M_{Bdb} (the dry mass of the fuel burnt) equals the total of the pounds of fuel burnt (M_{Bwb} during each 5 minute sampling interval, in this case 18.9 lbs. , minus the moisture content, in this case 5.6128%

M_{Bdb} = (M_{Bdb})(100)/(100 + FM)

FM = average fuel moisture content of test fuel, % wet basis, 5.6128%.

M_{Bdb} = weight of the fuel burned during the test run, dry basis, kg(lb), 18.9.

M_{Bdb} = (19.1 **lbs)(100)/(100+** 5.6128 **) =** 18.0849 **lbs / 2.2046 lbs/ kg =** 8.203 **kg**

ASTM EQN2: Kilograms/ Pounds of Dry Fuel Burnt During a Test Segment (S_1), db

Note: Again, do to the way this stove burns and the need to add fuel at some point (or points) during a test run, so the M_{Bbdi} (the dry mass of the fuel burnt during each sampling interval) equals the total of the pounds of fuel burnt during each 5 minute sampling interval for each test segment minus the moisture content, in this case 5.6128%

M_{BSidb} = (M_{SSIwb} – M_{SESIwb})(100)/(100+FM) (Revised)

***i* = test run segment in accordance with the "Reversed Test Segment" sequence found in 9.4 Table 1 that was agreed upon for this test run.**

Test Segment 1 (Low): 0-180 minutes: x
M_{BS1db} =(7.3 **lbs.)(100)/(100+** 5.6128 **) =** 6.9120 **lbs/ 2.2046 lbs/kg =** 3.1353 **kg** x
Test Segment 2 (Medium): 180-300 minutes: x
M_{BS2db} =(7.2 **lbs.)(100)/(100+** 5.6128 **) =** 6.8174 **lbs/ 2.2046 lbs/kg =** 3.0923 **kg** x
Test Segment 3 (High): 300-360 minutes: x
M_{BS3db} = (4.6 **lbs.)(100)/(100+** 5.6128 **) =** 4.3555 **lbs/ 2.2046 lbs/kg =** 1.9757 **kg** x

MYREN CONSULTING, INC.
ASTM E2779 Densified Fuel Heater Eqns
Forms/ Densified Fuel Stoves/ Eqns.
Rev 6 4.20.17 P. 2 of 2

Unit: Optimum
Run #: EPA 2
Date: 9/8/17
Tech: ATM

ASTM EQN 3: Average Dry Burn Rate BR (DBR)

BR (DBR) = (60(M_{Bdb}))/θ

BR (DBR) = Average dry burn rate over the full integrated test run, kg/h (lb/h), where
Θ = total length of full integrated test run, min.
M_{Bdb} = the total mass of fuel burnt, dry basis, kg (lb.)

BR (DBR) = (60(8.203 **kg)/** 360 **=** 1.3672 **kg/h** X

ASTM EQN 4: Average Dry Burn Rate (DBR) over a Test Segment *i*, kg/h(lb/h)

BR $(DBR)_{Si}$ = (60(M_{Bidb}))/θ

BR $(DBR)_{Si}$ = Average dry burn rate over test run segment *i*, kg/h (lb/h) where
$Θ_{Si}$ = total length of test segment *i*, min.
M_{Bidb} = the total mass of fuel burnt dry basis, kg (lb.) during each test segment, i.

Test Segment 1 (Low): 0-180 minutes
BR $(DBR)_{S1}$ = (60(3.1353 **kg)/** 180 **=** 1.045 **kg/h** X
Test Segment 2 (Medium): 180-300 minutes
BR $(DBR)_{S2}$ = (60(3.0923 **kg)/** 120 **=** 1.546 **kg/h** X
Test Segment 3 (High) : 300-360 minutes
BR $(DBR)_{S3}$ = (60(1.9757 **kg)/** 60 **=** 1.9757 **kg/h** ✓

Pre Burn Data
Record Sheet #13

Preburn Start Wt.________ Lbs. Up________ lbs.
Test Start Wt Range________________ lbs.
Baro. Pressure 28.57 "Hg

Unit: Optimum Date: 9/15/17
Run: EPA 2 Technician(s): ATM ESS
Page: 1 of 1 WST2-Form 16, Rev 6/11

Minute/⏱		Scale Weight	Burn Rate (T/C#-)	Stack (1)	Stove Top (2)	Left Side (3)	Back (4)	Right Side (5)	Bottom (6)	Firebox (7)	2nd Burn Catalytic (8)	Room Temp (9)	Static	Stack @ 1' (20)	Comments (Hot Box On ✓)
0	1045	533.8	0.0	145								63	-.023	168	Primary Air Set At Low
5	50	533.5	.3	148								63	-.023	174	Secondary Air Set At N/A
10	55	533.1	.4	153								64	-.025	183	Fan: ON
15	1100	532.6	.5	158								64	-.025	189	Tunnel on at: 1106
20	05	532.2	.4	164								64	-.027	194	Buckets Iced ✓
25	10	531.9	.3	170								64	-.028	198	Analyzers Spanned ✓
30	15	531.5	.4	175								65	-.029	202	Pumps Turned on at: 1126
35	20	531.3	.2	177								65	-.029	203	ΔT ΔΔT
40	25	530.9	.4	178								65	-.029	204	
45	30	530.7	.2	179								65	-.030	206	
50	35	530.3	.4	181								65	-.029	207	
55	40	530.0	.3	182								65	-.029	209	Tunnel ΔP
X	X	–		–		–			–		–		–	X	Probe In Tunnel ✓ —
60	1145	529.6	.4	183								66	-.030	210	
65															
70															
75															
80															
85															
90															
95															
100															
105															
110															
115															

Myren Consulting Inc Data Sheet #14 P 1 of 7 Unit Optimam Date 9 / 5 / 17 Run EPA 2

Test End Wt. 525.3 ΔT ______ Barometric Pressure 28.52 "Hg Gas Flow @ 1.5" Technician(s) ATM ESS

Time E/T Min	Time ⏲	Scale WT.	Lbs. Left	Burn Rate	CO_2 V.	CO_2 %	O_2 %	CO V.	CO %	Gas Bal	Stack Temp #1	Stack Static Pressure	Opacity	Notes: T3 Radf Cond 18	Notes: Stack @ 1'	Notes: C Gas Tunnel Vac
0	1145	529.6	19.1	0.0	.257	6.61	14.23	.20	.20	(33.0)	183	-.030		53	210	-7.5
05	50	529.4	18.9	.2	.231	5.96	14.89	.19	.19	31.4	183	-.029	C	42	211	-7.5
10	55	529.2	18.7	.2	.270	6.93	13.87	.27	.27	25.7	185	-.029	"	41	213	-7.5
15	1200	528.9	18.4	.3	.276	7.08	13.74	.23	.23	30.8	186	-.029	"	41	215	-7.5
20	05	528.5	18.0	.4	.270	6.93	13.85	.31	.31	22.4	189	-.029	"	41	219	-7.8
25	10	528.3	17.8	.2	.266	6.83	13.92	.38	.38	18.0	190	-.029	"	41	221	-7.8
30	15	528.0	17.5	.3	.274	7.03	13.81	.20	.20	35.2	191	-.029	"	42	224	-7.8
35	20	527.8	17.3	.2	.234	6.03	14.81	.19	.19	31.7	193	-.030	"	42	226	-7.8
40	25	527.4	16.9	.4	.227	5.86	14.87	.43	.43	13.6	194	-.030	"	42	227	-7.8
45	30	527.3	16.8	.1	.240	6.18	14.55	.41	.41	15.1	196	-.030	"	42	228	-7.9
50	35	527.1	16.6	.2	.239	6.16	14.66	.24	.24	25.7	197	-.031	"	42	230	-7.9
55	40	526.7	16.2	.4	.231	5.96	14.85	.26	.26	22.9	197	-.031	"	42	230	-7.9
Total				2.9							(2284)	(-.356)				

3.0 lbs burnt in 1st hour 2.8316 d lbs.

Time E/T Min	Time ⏲	Top #2	Left #3	Back #4	Right #5	Bottom #6	Firebox #7	Fr. 2nd #8	Amb #9	Tnl. #10	C Gas Box #11	C Gas Impin #12	T1 Part. Filt. #13	T1 Part. Cond. #14	T2 Part Filt #15	T2 Part Cond #16	T3 Part Filter #17
0	1145								66	85	212	32	67	57	66	59	72
05	50								66	85	213	32	68	38	67	44	72
10	55								66	85	225	33	70	40	69	44	73
15	1200								65	86	226	33	71	39	70	44	74
20	05								66	86	224	33	72	39	71	45	75
25	10								66	87	225	33	73	39	72	45	76
30	15								66	87	227	33	74	39	73	45	76
35	20								66	88	228	33	75	40	74	45	77
40	25								67	88	228	33	75	40	75	45	77
45	30								67	89	227	33	76	40	75	45	77
50	35								67	89	226	33	77	40	76	45	78
55	40								67	89	226	33	77	40	76	46	78
Total									(795)								

Myren Consulting Inc Data Sheet #14 P 2 of 7 Unit Optimum Date 9 / 5 / 17 Run EPA 2

Test End Wt. 525.3 ΔT ____ Barometric Pressure 28.51 "Hg Gas Flow @ 1.5" Technician(s) ATM ESS

Time E/T Min	Time ⏱	Scale WT.	Lbs. Left	Burn Rate	CO_2 V.	CO_2 %	O_2 %	CO V.	CO %	Gas Bal	Stack Temp #1	Stack Static Pressure	Opacity	Notes	T3 Part Cond #18	Stack @ 1'	C Gas Train Vac
60	1245	526.6	16.1	.1	.243	6.26	14.53	.30	.30	20.9	198	-.031	C	Swapped T1 Filter	43	231	-7.9
65	50	526.3	15.8	.3	.275	7.06	13.69	.39	.39	18.1	199	-.031	"		43	232	-8.0
70	55	526.0	15.5	.3	.288	7.39	13.19	.72	.72	10.3	200	-.031	"	Log Dropped	43	233	-8.0
75	1300	525.7	15.2	.3	.257	6.61	14.22	.23	.23	28.7	201	-.031	"		43	235	-8.0
80	05	525.5	15.0	.2	.246	6.33	14.50	.22	.22	28.8	202	-.031	"		43	236	-8.0
85	10	525.0	14.5	.5	.220	5.68	15.12	.27	.27	21.0	202	-.030	"		44	237	-8.0
90	15	524.7	14.2	.3	.233	6.01	14.77	.33	.33	18.2	203	-.030	"		44	237	-8.0
95	20	524.6	14.1	.1	.216	5.58	15.20	.31	.31	18.0	203	-.031	"		44	237	-8.0
100	25	524.3	13.8	.3	.185	4.80	15.97	.34	.34	14.1	202	-.030	"		44	235	-8.0
105	30	524.3	13.8	0.	.169	4.40	16.38	.31	.31	14.2	201	-.030	"	524.1 - 531.5	44	234	-8.0
110	35	531.5	13.6	*.2	.160	4.18	16.60	.33	.33	12.7	200	-.030	"	*Added Log @ 109:00	44	232	-8.0
115	40	531.2	13.3	.3	.212	5.48	15.21	.49	.49	11.2	200	-.030	"	7.4 lbs.	44	231	-8.0
Total				2.9							2411	-.366					

Time E/T Min	Time ⏱	Top #2	Left #3	Back #4	Right #5	Bottom #6	Firebox #7	Fr. 2nd #8	Amb #9	Tnl. #10	C Gas Box #11	C Gas Impin #12	Part. Filt. #13 (T1)	Part. Cond. #14 (T1)	Part Filter #15 (T2)	Part Cond #16 (T2)	Part. Filter #17 (T3)
60	1245			524.3					67	90	226	33	77	41	77	46	79
65	50			+ 7.4		105 -	13.75	.05	68	90	226	33	71	41	77	46	79
70	55			531.7		110	13.60	.15	68	91	226	34	72	41	77	46	79
75	1300							.2	68	91	226	33	73	40	78	46	80
80	05								68	92	226	33	75	41	78	47	80
85	10								68	92	226	33	76	41	78	47	81
90	15								68	92	226	34	77	41	79	47	82
95	20								68	92	226	34	78	41	79	47	82
100	25								69	92	227	34	78	41	79	47	83
105	30								69	93	226	34	78	42	79	47	84
110	35								70	93	225	34	79	42	79	47	84
115	40								69	93	223	34	79	42	80	47	84
Total									820								

Myren Consulting Inc Data Sheet #14 P 3 of 7 Unit Optimum Date 9/5/17 Run EPA 2

Test End Wt. 525.3 ΔT ______ Barometric Pressure 28.51 "Hg Gas Flow @ 1.5" Technician(s) ATM ES T3

Time E/T Min	Time ⏲	Scale WT.	Lbs. Left	Burn Rate	CO_2 V.	CO_2 %	O_2 %	CO V.	CO %	Gas Bal	Stack Temp #1	Stack Static Pressure	Opacity	Notes	Part Cond 10	Stack @ 1'	C Gas Train VAC
120	1345	531.1	13.2	.1	.167	4.35	16.38	.42	.42	10.4	197	-.030	C		44	229	-8.0
125	50	531.0	13.1	.1	.114	3.03	17.61	.60	.60	(5.0)	193	-.028	"		44	224	-8.0
130	55	530.9	13.0	.1	.102	2.72	17.86	.72	.72	3.8	191	-.028	"		45	221	-8.0
135	1400	530.8	12.9	.1	.128	3.38	17.08	.97	.97	3.5	188	-.027	"		45	216	-8.0
140	05	530.8	12.9	0	.114	3.03	17.43	.97	.97	3.1	185	-.026	"		45	211	-8.0
145	10	530.7	12.8	.1	.096	2.57	17.92	.89	.89	2.9	181	-.026	"		45	205	-8.0
150	15	530.6	12.7	.1	.117	3.10	17.39	.90	.90	3.4	178	-.025	"		45	201	-8.0
155	20	530.5	12.6	.1	.095	2.55	17.99	.81	.81	3.1	175	-.025	"		45	197	-8.0
160	25	537.8	12.5*	.1	.094	2.52	18.07	.70	.70	3.6	175	-.025	"	530.5-537.9	45	195	-8.0
165	30	537.4	12.1	.4	.233	6.01	14.74	.39	.39	(15.4)	171	-.023	"	* Added Log 159:00	45	191	-8.5
170	35	537.3	12.0	.1	.244	6.28	14.45	.41	.41	15.3	170	-.022	"	7.4 lbs.	45	191	-8.5
175	40	537.1	11.8	.2	.235	6.06	14.70	.36	.36	16.8	170	-.022	"		45	192	-8.5
Total				1.5							(2174)	(-.307)					

7.3 lbs wet burned in 1st 180 mins

Time E/T Min	Time ⏲	Top #2	Left #3	Back #4	Right #5	Bottom #6	Firebox #7	Fr. 2nd #8	Amb #9	Tnl. #10	C Gas Box #11	C Gas Impin #12	Part. Filt. #13 (T1)	Part. Cond. #14 (T1)	Part. Filter #15 (T2)	Part. Cond. #16 (T2)	Part. Filter #17 (T3)
120	1345								69	93	222	34	79	42	80	47	84
125	50								70	93	223	34	80	42	81	47	84
130	55								70	93	223	34	80	42	81	47	84
135	1400								70	93	224	34	80	42	81	47	85
140	05								69	92	225	34	81	42	81	47	85
145	10								69	92	225	34	81	42	81	47	85
150	15								71	92	225	34	81	42	81	48	84
155	20								71	92	225	34	81	42	81	48	84
160	25								70	92	225	34	81	42	81	48	84
165	30								70	92	225	35	81	42	81	48	84
170	35								70	92	225	35	81	42	82	48	84
175	40								70	92	225	34	81	43	82	48	85
Total									(839)								

Myren Consulting Inc Data Sheet #14 P 4 of 7 Unit Optimum Date 9/15/17 Run EPA 2

Test End Wt. 525.3 ΔT ____ Barometric Pressure 28.49 "Hg Gas Flow @ 1.5" Technician(s) ATM [illegible]

Time E/T Min	Time ⊙	Scale WT.	Lbs. Left	Burn Rate	CO_2 V.	CO_2 %	O_2 %	CO V.	CO %	Gas Bal	Stack Temp #1	Stack Static Pressure	Opacity	Notes	T3 Part Cond 18	Stack @	C Gas Tunnel Vac
180	1445	537.1	11.8	0	.239	6.16	14.58	.40	.40	15.4	171	-.023	C	set PAL TO MED.	45	194	-8.5
185	50	536.9	11.6	.2	.254	6.53	14.16	.50	.50	13.1	177	-.024	"		45	200	-8.8
190	55	536.5	11.2	.4	.254	6.53	14.19	.44	.44	14.8	181	-.025	"		45	206	-8.8
195	1500	536.2	10.9	.3	.274	7.03	13.69	.43	.43	16.4	186	-.026	"		45	212	-8.8
200	05	535.9	10.6	.3	.258	6.63	14.16	.30	.30	22.1	189	-.026	"		45	216	-8.8
205	10	535.7	10.4	.2	.268	6.88	13.89	.33	.33	20.9	193	-.027	"		45	222	-8.8
210	15	535.4	10.1	.3	.250	6.43	14.33	.36	.36	17.9	197	-.028	"		46	226	-8.9
215	20	535.2	9.9	.2	.218	5.63	15.06	.50	.50	11.3	200	-.030	"		46	230	-8.9
220	25	534.9	9.6	.3	.222	5.73	15.00	.42	.42	13.6	203	-.030	"		46	232	-8.9
225	30	534.7	9.4	.2	.202	5.23	15.47	.47	.47	11.1	204	-.030	"		46	233	-8.9
230	35	534.3	9.0	.4	.216	5.58	15.15	.42	.42	13.3	204	-.030	"		46	233	-8.9
235	40	534.2	8.9	.1	.296	7.59	13.20	.31	.31	24.5	206	-.020	"		46	235	-9.0
Total				2.9 X							(2311)	(-.329)					

Time E/T Min	Time ⊙	Top #2	Left #3	Back #4	Right #5	Bottom #6	Firebox #7	Fr. 2nd #8	Amb #9	Tnl. #10	C Gas Box #11	C Gas Impin #12	T1 Part. Filt. #13	T1 Part. Cond. #14	T2 Part Filter #15	T2 Part Cond #16	T3 Part Filter #17
180	1445								70	92	225	34	82	43	82	49	85
185	50								71	93	225	35	82	43	82	48	85
190	55								70	94	226	35	82	43	82	48	85
195	1500								71	95	227	35	82	43	83	49	86
200	05								70	95	227	35	82	43	83	49	86
205	10								70	95	228	35	83	43	83	49	86
210	15								71	96	229	35	83	43	83	49	87
215	20								71	96	230	35	83	44	84	49	87
220	25								71	97	230	35	83	44	84	50	87
225	30								72	97	230	35	83	44	84	50	87
230	35								71	97	229	36	83	44	84	50	87
235	40								71	97	229	36	83	44	84	50	88
Total									(849)								

Myren Consulting Inc Data Sheet #14 P 5 of 7 Unit Optimum Date 9 / 5 / 17 Run EPA 2

Test End Wt. 525.3 ΔT ____ Barometric Pressure 28.49 "Hg Gas Flow @ 1.5" Technician(s) ATM ESS

Time E/T Min	Time ⏲	Scale WT.	Lbs. Left	Burn Rate	CO_2 V.	CO_2 %	O_2 %	CO V.	CO %	Gas Bal	Stack Temp #1	Stack Static Pressure	Opacity	Notes	T3 Part Cond ID	Stack @ 1"	C Gas from VAC
240	1545	533.8	8.5	.4	.303	7.76	13.02	.31	.31	25.0	208	-.030	C		46	238	-9.0
245	50	533.4	8.1	.4	.286	7.34	13.43	.34	.34	21.6	210	-.031	"		46	241	-9.0
250	55	533.0	7.7	.4	.352	8.99	11.73	.45	.45	20.0	213	-.031	"		46	246	-9.0
255	1600	532.7	7.4	.3	.361	9.21	11.40	.65	.65	14.2	217	-.032	OW	Log Dropped	46	251	-9.0
260	05	532.3	7.0	.4	.356	9.09	11.71	.28	.28	32.5	220	-.033	C		46	256	-9.1
265	10	531.9	6.6	.4	.323	8.26	12.40	.56	.56	14.8	224	-.034	"		46	260	-9.1
270	15	531.6	6.3	.3	.303	7.76	13.04	.28	.28	27.7	227	-.034	"		47	265	-9.1
275	20	531.3	6.0	.3	.261	6.71	14.10	.26	.26	25.8	228	-.034	"		47	267	-9.1
280	25	531.0	5.7	.3	.228	5.88	14.92	.28	.28	21.0	229	-.035	"		47	268	-9.1
285	30	530.8	5.5	.2	.213	5.51	15.08	.71	.71	7.8	230	-.035	"	Log Dropped	47	267	-9.1
290	35	530.6	5.3	.2	.260	6.68	14.07	.37	.37	13.1	229	-.035	"		47	267	-9.1
295	40	530.2	4.9	.4	.241	6.21	14.57	.33	.33	18.8	229	-.035	"		47	266	-9.1
Total				4.0							2664	-.399					

7.2 lbs burnt in 120 min Medium Segment

Time E/T Min	Time ⏲	Top #2	Left #3	Back #4	Right #5	Bottom #6	Firebox #7	Fr. 2nd #8	Amb #9	Tnl. #10	C Gas Box #11	C Gas Impin #12	T1 Part. Filt. #13	T1 Part. Cond. #14	T2 Part Filter #15	T2 Part Cond #16	T3 Part Filter #17
240	1545								71	98	228	36	83	44	84	50	88
245	50								72	98	228	36	83	44	84	50	88
250	55								72	98	227	36	83	44	84	50	88
255	1600								72	99	227	36	83	44	84	50	88
260	05								72	99	227	36	83	45	84	50	88
265	10								72	99	227	36	83	45	84	51	88
270	15								72	100	228	36	84	45	84	51	88
275	20								72	100	228	36	84	45	84	51	88
280	25								72	100	228	36	84	45	85	51	88
285	30								72	100	228	36	84	45	85	51	88
290	35								72	100	229	36	84	45	85	51	88
295	40								73	100	229	36	84	45	85	51	88
Total									864								

Myren Consulting Inc Data Sheet #14 P 6 of 7 Unit Optimam Date 9/5/17 Run EPA 2

Test End Wt. 525.3 ΔT ____ Barometric Pressure 28.48 "Hg Gas Flow @ 1.5" Technician(s) ATM ESS

Time E/T Min	Time ⏱	Scale WT.	Lbs. Left	Burn Rate	CO_2 V.	CO_2 %	O_2 %	CO V.	CO %	Gas Bal	Stack Temp #1	Stack Static Pressure	Opacity	Notes (T3 Part Cond #18)	Stack @ 1'	C Gas Train VAC
300	1645	529.9	4.6	.3	.305	7.81	12.95	.36	.36	21.7	229	-.034	C	set PAC to Hi ✓ 47	267	-9.2
305	50	529.7	4.4	.2	.301	7.71	13.01	.43	.43	17.9	246	-.036	"	47	283	-9.2
310	55	529.3	4.0	.4	.333	8.51	12.18	.49	.49	17.4	254	-.036	"	47	292	-9.5
315	1700	529.0	3.7	.3	.338	8.64	12.15	.30	.30	28.8	262	-.038	"	47	302	-9.5
320	05	528.6	3.3	.4	.287	7.36	13.33	.50	.50	14.7	268	-.040	"	47	309	-9.5
325	10	528.1	2.8	.5	.317	8.11	12.71	.24	.24	33.8	272	-.041	"	47	314	-9.8
330	15	527.7	2.4	.4	.360	9.19	11.63	.25	.25	36.8	277	-.041	"	47	320	-9.8
335	20	527.3	2.0	.4	.390	9.94	10.72	.55	.55	18.1	282	-.041	"	47	326	-9.9
340	25	526.8	1.5	.5	.322	8.24	12.23	.94	.94	(8.8)	285	-.044	"	47	331	-9.9
345	30	526.5	1.2	.3	.297	7.61	13.09	.47	.47	(16.2)	288	-.044	"	47	334	-9.9
350	35	526.2	.9	.3	.237	6.11	14.66	.35	.35	17.4	289	-.044	"	47	337	-9.9
355	40	525.7	.4	.5	.370	9.44	11.35	.29	.29	32.6	294	-.045	"	47	342	-9.9
Total				4.5							(3246)	(-.484)				

Time E/T Min	Time ⏱	Top #2	Left #3	Back #4	Right #5	Bottom #6	Firebox #7	Fr. 2nd #8	Amb #9	Tnl. #10	C Gas Box #11	C Gas Impin #12	Part. Filt. #13 (T1)	Part. Cond. #14 (T1)	Part Filter #15 (T2)	Part Cond #16 (T2)	Part Filter #17 (T3)
300	1645								72	100	229	37	84	46	85	51	88
305	50								74	103	229	36	84	46	85	51	89
310	55								73	104	229	37	85	46	85	51	89
315	1700								72	105	230	37	85	46	86	51	89
320	05								73	106	231	36	85	46	86	51	89
325	10								74	107	232	37	85	46	86	51	89
330	15								73	108	232	37	85	46	86	51	90
335	20								73	108	232	37	85	46	86	51	90
340	25								73	109	231	37	85	46	86	51	90
345	30								73	108	231	37	85	46	86	52	90
350	35								74	109	231	37	85	46	86	51	90
355	40								74	110	230	37	85	46	86	51	90
Total									(878)								

Myren Consulting Inc Data Sheet #14 P 7 of 7 Unit Optimum Date 9 / 5 / 17 Run EPA 2

Test End Wt. 525.3 ΔT ____ Barometric Pressure 28.47 "Hg Gas Flow @ 1.5" Technician(s) ATM ESS

Time E/T Min	Time ⏱	Scale WT.	Lbs. Left	Burn Rate	CO_2 V.	CO_2 %	O_2 %	CO V.	CO %	Gas Bal	Stack Temp #1	Stack Static Pressure	Opacity	Notes: T3 Part Cond #18	Stack @ 1'	C Gas Train VAC
360	1745	525.3	0	.4	.332	8.49	12.33	.25	.25	34.0	295	-.045		48	344	-9.9
365											(15385)	(-2.2860)	Total			
370											(210.8)	(-.0313)	÷ 73			
375			✓	4.6 lbs burnt during the Hi Segment												
380																
385				19.1 lbs burnt during the entire test												
390																
395																
400																
405																
410																
415																
Total				.4												

Time E/T Min	Time ⏱	Top #2	Left #3	Back #4	Right #5	Bottom #6	Firebox #7	Fr. 2nd #8	Amb #9	Tnl. #10	C Gas Box #11	C Gas Impin #12	T1 Part. Filt. #13	T1 Part. Cond. #14	T2 Part Filter #15	T2 Part Cond #16	T3 Part Filter #17
360	1745	|	|	|	|	|	|	|	75	109	230	37	86	46	86	52	89
365									(5120)	Total							
370									(70.1)	÷ 73							
375																	
380																	
385																	
390																	
395																	
400																	
405																	
410																	
415																	
Total																	

WST6-Form 8 Rev 12/09

Pre and Post Test Zero/Span Check
Woodstove Data Sheet # 15-1

Site: Myren Consulting, Colville, WA Date: 9/5/17 Analyte: CO_2

Source: Optimum Run #: EPA 2

Zero Cyl #: DOT 3AA 22065 Conc. 00.0 % CO_2 Cyl Press: 1670 psi

Certified By: Oxarc Date: 2/25/16

Span Cyl #: EB-0041761 Conc. 12.45 % CO_2 Cyl Press: 200 psi

Certified By: Liquid Technology Corp Date: 4/15/15

Analyzer: Make: Horiba Model: PIR-2000 SN: 607024

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

Flow: 1.5 SCFH Measured By: Rotameter: X Flowmeter: ______

EPA Span Values= 25.0% CO_2

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

Pre Run Audit: By: A.T. Myren Time: 1102 Temp: 61 °F

Audit Results

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
Zero	00.0	00.0	00.0	00.0	.000	.16869	+0.16869	+0.67
Span	48.5	.485	12.45	48.0	.485	12.3219	-0.12806	-1.03

Comments:

Post Run Audit: By: [illegible] Time: 1836 Temp: 78 °F

Audit Results

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
Zero	00.0	00.0	00.0	00.0	.001	.19375	+0.19375	+0.78
Span	48.5	.485	12.45	48.9	.496	12.59796	+0.14758	+1.185

Comments:

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

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

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

Pre and Post Test Zero/Span Check
Woodstove Data Sheet # 15-3

Site: Myren Consulting, Inc. Lab, Colville, WA **Date:** 9/5/17 **Analyte:** CO

Source: Optimum **Run #:** EPA 2

Zero Cyl #: DOT 3AA 22065 **Conc.** 00.0 % CO **Cyl Press:** 1670 psi

Certified By: Praxair **Date:** 2/25/16

Span Cyl #: EB-0041761 **Conc.** ____ % CO **Cyl Press:** 200 psi

Certified By: Liquid Technology Corp **Date:** 4/15/15

Analyzer: Make: California Analytical Instruments **Model:** 200 **SN:** 1M12002

Range: 0 – 10.0 % CO **Analyzer Output:** 0 – 10.0 v.

Flow: 1.5 scfh **Measured By: Rotameter:** X **Flowmeter:** ____

EPA Span Values = 0 - 5.0 % CO or 0 - 10.0 % CO

EPA Control Limits = ± 2.5% of 5.0 % CO = ± 0.125 % CO, ± 2.5% of 10.0 % CO = ± 0.250 % CO

Pre Run Audit: By: A.T. Myren **Time:** 1102 **Temp:** 61 °F

Pre Test Audit Results

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
Zero	00.0	.000	00.0	0.00	00.0	-0.01972	-0.01972	-0.39
Span	2.61	2.61	2.61	2.61	2.61	2.54509	-0.06491	-2.49

Comments:

Post Run Audit: By: SJB **Time:** 1836 **Temp:** 78 °F

Post Test Audit Results

Point #	Expected Response			Actual Response			± Conc. Difference	Δ %
	Meter	DVM	%	Meter	DVM	%		
Zero	00.0	.000	00.0	0.11	0.12	+0.09820	+0.09820	-1.96
Span	2.61	2.61	2.61	2.77	2.76	2.69249	+0.08249	3.16

Comments:

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

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

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

Quality Checks
Woodstove Data Sheet #16

Unit: 509 Optimum
Run: EPA 2
Date: 9 / 5 / 2017
Technicians: ATM ESS
WST6-Form3, Rev 6/11

Thermocouple Check (at ambient): T/C # 1: 64 °F; T/C # 2: — °F
T/C # 3: — °F; T/C # 4: — °F; T/C # 5: — °F;
T/C # 6: — °F; T/C # 7: — °F; T/C # 8: — °F;
T/C # 9: 63 °F; T/C # 10: 68 °F; T/C # 11: 248 °F;
T/C # 12: 28 °F; T/C # 13: 64 °F; T/C # 14: 55 °F;
T/C # 15: 63 °F; T/C # 16: 57 °F; T/C # 17: 64 °F;
T/C # 18: 52 °F; T/C # 19: — °F; T/C # 20: 65 °F;
T/C # 21: — °F; T/C # 22: — °F; T/C # 23: — °F;
T/C # 24: — °F; T/C # 25: — °F; T/C # 26: — °F;

Comments T/C#11, Hot box turned on, T/C#12, bucket iced, T/C#14, Bucket Iced T/C #16, Bucket Iced, T/C #18, Bucket Iced

Thermocouple Readout: Pretest Zero/Span Check and Calibration:

Zero	Adj	Post Test Check	%Difference
(0°F): 0 °F	to: — °F	Zero (0°F): 1 °F	
Span	Adj	Span	
(2000°F): 1999 °F	to: 2000 °F	(2000°F): 2003 °F	

(Allowable % Difference = 1.5%. Use Formulas on Woodstove Data Sheet #15 to calculate % Difference, % Difference calculated in degrees absolute.)

Thermocouple Readout Pretest Linearity Check

0°F = 0 °F; 200°F = 201 °F; 400°F = 398 °F
600°F = 601 °F; 800°F = 801 °F; 1000°F = 1000 °F
1200°F = 1198 °F; 1400°F = 1399 °F; 1600°F = 1600 °F
1800°F = 1800 °F; 2000°F = 2000 °F

Combustion Gas (CO_2, O_2, CO) Train Leak Check: Pre OK✓ ESS Post OK✓ ESS
Draft (Static) Gauge Zero Check: Pre OK✓ ESS Post OK✓ ESS
Scale Check Pre (Wt, #'s): 525.5 – 520.5 = 5.0lbs. OK✓ ESS
Post (Wt, #'s): 529.6 – 524.6 = 5.0lbs. OK ✓ ESS

Stack Cleaned Prior to the Run: Yes ✓ No ____
Tunnel Cleaned Prior to the Run: Yes ✓ No ____

FIREPLACE DATA SHEET #10 16-1
Quality Checks (Revised 2/10)

Unit: Optimum
Run #: EPA 2
Date: 9/5/17

H1

Ambient Blank Probe Inlet Location 38 " from the bottom of the hood (Spec = ≤ 6.6') and 29 " from the chimney centerline (Spec = ≤ 3.3').

Dilution Tunnel Draft: Start: .000 Stop: .000 Avg.: .000 "H_2O

Test Chamber Air Velocity: Start: >5.<10 Stop: >5.<10 Avg.: >5.<10 ft/min

Test Chamber Ambient Moisture (AM)/ Relative Humidity (%RH)

Start: Wet Bulb 58 Dry Bulb 64 =%RH 1.50, %AM (%By Vol) 70
Stop: Wet Bulb 65 Dry Bulb 74 =%RH 1.75, %AM (% by Vol) 61.5
Avg. %RH 1.625, %AM (% by Vol) 65.75

Minimum Tunnel Flow For 100% Smoke Capture: Pitot Reading (Δp): .09
~ Tunnel Flow: 58 dscfm

Fireplace Back Wall Temperature Immediately Prior to Test Start: N/A °F

Scale Check: Pre (Wt., #): 525.5 - 520.5 = 5.0 lbs / 5.0 lbs = OK ESS
Post (Wt.,#): 529.6 - 524.6 = 5.0 lbs / 5.0 lbs = OK ESS

Scale Zero Drift: Pre: — lbs. Post: — lbs. Drift: — lbs.

Combustion Gas (CO_2, O_2 &CO) Train Leak Checks: Pre: OK ✓ ESS Post: OK ✓ ESS
Draft (Static [P_g]) Gauge Level and Zero Check: Pre: OK ✓ ESS Post: OK ✓ ESS

THERMOCOUPLE CHECK (@ Ambient):

				T/C #1:	63	T/C #2:	—
T/C #3:	—	T/C #4:	—	T/C #5:	—	T/C #6:	—
T/C #7:	—	T/C #8:	—	T/C #9:	64	T/C #10:	64
T/C #11:	105 (on)	T/C #12:	25 I	T/C #13:	64	T/C #14:	54
T/C #15:	62	T/C #16:	59	T/C #17:	62	T/C #18:	55
T/C #19:	—	T/C #20:	62	T/C #21:	—	T/C #22:	—

Thermocouple Readout:

Pretest Zero & Span Check and Calibration — **Post Test Zero & Span Check**

Zero (0° F): 0 ° F Adj to: — ° F — 0° F 1 Δ%: -0.22
Span (2000° F): 1999 ° F Adj to: 2000 ° F — Span (2000° F): 2003 Δ%: -0.12

Pretest Thermocouple Readout Linearity Check:

0 °F = 0 200 °F = 201 400 °F = 398 600 °F = 601

800 °F = 801 1000 °F = 1000 1200 °F = 1198 1400 °F = 1399

1600 °F = 1600 1800 °F = 1800 2000 °F = 2002

Stack Cleaned Prior to Test: Yes ✓ No ______

Tunnel Cleaned Prior to Test: Yes ✓ No ______

Becherini Scale Center, Inc.
317 E. Sprague
Spokane, WA 99202

SCALE CALIBRATION RECORD

Customer: Myren	Date: 9/1/17
Work Order Number: 49320	PO Number:

Equipment Mfg.	Serial Number	Specifications	Weight used	Initial Readings	Final Readings
1. Panther	4466459	1000 x .1	Ø		
	Pass...Fail		50		
Notes: DOA will be new Scale deck			100		
			300		
			500		
			Ø		

Equipment Mfg.	Serial Number	Specifications	Weight used	Initial Readings	Final Readings
2. Panther	0015555 56CH	5K x 1	Ø		
	Pass...Fail		50		
Notes: DNF Spare Readout			100		
			300		
			500		
			Ø		

Equipment Mfg.	Serial Number	Specifications	Weight used	Initial Readings	Final Readings
3. Panther	00025736AJ	1000 x .1	Ø	0	Ø
	(Pass)...Fail		50	50	50
Notes: Scale calibrated w/cert. weights. South Scale			100	99.9	100
			300	299.6	300
			500	498.8	500
			Ø	Ø	Ø

Equipment Mfg.	Serial Number	Specifications	Weight used	Initial Readings	Final Readings
4. Panther	00926516KL	1000 x .1	Ø	Ø	
	(Pass)...Fail		50	50	
Notes: Scale checks good. Center Scale			100	100	
			300	300	
			500	500	
			Ø	Ø	

Additional Comments:

Last Checked: 11/16	Next Check Due: —
Weights Certified: 10/16	Technician: BB

Calibration checked IAW NIST handbook 44

Becherini Scale Center, Inc.
317 E. Sprague
Spokane, WA 99202

SCALE CALIBRATION RECORD

Customer: MYREN | Date: 9/1/17

Work Order Number: 49320 | PO Number:

Equipment Mfg.	Serial Number	Specifications	Weight used	Initial Readings	Final Readings
1. SARTORIUS	25359106	15K x .5	Ø	0	0
CISL1-4	(Pass) ...Fail		50	50	50
			500	499	500
			1000	998	1000
			~~2000~~ 3926	~~3926~~	3926
			Ø	Ø	Ø

Notes: STRAIN TEST w/ ~~40~~26 lbs CALIBRATED w/ 3926 lbs SCALE CHECKS GOOD

Equipment Mfg.	Serial Number	Specifications	Weight used	Initial Readings	Final Readings
2. OHAUS	2350003	24 x .002	Ø	0	Ø
RANGER	(Pass) ...Fail		.5	.5	.5
			4	4	4
			20	20.002	20
			24	24.002	24
			Ø	Ø	Ø

Notes: LEVELED SCALE, SCALE CHECKS GOOD.

Equipment Mfg.	Serial Number	Specifications	Weight used	Initial Readings	Final Readings
3.					
	Pass...Fail				

Notes:

Equipment Mfg.	Serial Number	Specifications	Weight used	Initial Readings	Final Readings
4.					
	Pass...Fail				

Notes:

Additional Comments:

Last Checked: 11/16 | Next Check Due: —

Weights Certified: 10/16 | Technician: BB [signature]

Calibration checked IAW NIST handbook 44

8669-1

QUALITY CONTROL SERVICES

Established 1974

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2340 SE 11TH Ave. Portland, Oregon 97214 • Box 14831 Portland, Oregon 97293
(503) 236-2712 • FAX (503) 235-2535 • www.qc-services.com

ACCREDITED
Calibration Services
Certificate Number: 1550.01
Laboratory code: 115953

Myren Consulting
512 Williams Lake Road
Colville, WA 99114

Report Number: MYRC0224850860170419

A2LA ACCREDITED
CERTIFICATE OF CALIBRATION WITH DATA

INSTRUMENT INFORMATION

Item	Make	Model	Serial Number	Customer ID	Location
Balance	Sartorius	CPA224S	24850860	N/A	Lab
Units	**Readability**	**SOP**	**Cal Date**	**Last Cal Date**	**Cal Due Date**
g	0.0001	QC012	4/19/17	10/20/16	10/2017

FUNCTIONAL CHECKS

ECCENTRICITY
Test Wt: 100 Tol: 0.0003
As-Found: Pass: ☑ Fail: ☐
As-Left: Pass: ☑ Fail: ☐

LINEARITY
Test Wt: 50 x 4 Tol: 0.0002
As-Found: Pass: ☑ Fail: ☐
As-Left: Pass: ☑ Fail: ☐

STANDARD DEVIATION
Test Wt: 200 Tol: 0.0001

1. 200.0001	5. 200.0003	9. 200.0003
2. 200.0002	6. 200.0003	10. 200.0003
3. 200.0001	7. 200.0003	**Result**
4. 200.0002	8. 200.0003	0.00008

ENVIRONMENTAL CONDITIONS
☐ Good ☑ Fair ☐ Poor
Temperature: 19.0°C

A2LA ACCREDITED SECTION OF REPORT

Standard	As-Found	As-Left	Expanded Uncertain
200	200.0007	200.0001	0.00020
100	100.0003	100.0001	0.00020
50	50.0001	50.0000	0.00020
10	10.0000	10.0001	0.00020
1	1.0000	1.0000	0.00020
0.1	0.1000	0.1000	0.00020

CALIBRATION STANDARDS

Item	Make	Model	Serial Number	Cal Date	Cal Due Date	NIST ID
Weight Set	Rice Lake	30 kg-1mg	S751	1/26/17	1/2018	20170116

Permanent Information Concerning this Equipment:

Comments/Info Concerning this Calibration:
4/17 Performed span adjustment.

Report prepared/reviewed by: [signature] **Date:** 4.19.2017 **Technician:** R. Hintz
Signature: [signature]

THIS CERTIFICATE SHALL NOT BE REPRODUCED WITHOUT THE APPROVAL OF QUALITY CONTROL SERVICES, INC.

The uncertainty is calculated according to the ISO Guide to the Expression of Uncertainty in Measurement and includes the uncertainty of standards used combined with the observed standard deviation and readability of the unit under test. The uncertainty is expanded with a k factor of 2 for an approximate 95% level of confidence. Instruments listed above were calibrated using standards traceable to the National Institute of Standards and Technology (NIST). Calibration data reflect results at the time and location of calibration. Calibration data should be reviewed to insure that the instrument is performing to its required accuracy. Calibrations comply with ISO/IEC 17025 and ANSI/Z540-1-1994 quality standards.

Member: National Conference of Standards Laboratories and Weights & Measures

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ACCREDITED
Calibration Services
Certificate Number: 1550.01
Laboratory code: 115953

Myren Consulting
512 Williams Lake Road
Colville, WA 99114

Report Number: MYRC0224850860161020

A2LA ACCREDITED
CERTIFICATE OF CALIBRATION WITH DATA

INSTRUMENT INFORMATION

Item	Make	Model	Serial Number	Customer ID	Location
Balance	Sartorius	CPA224S	24850860	N/A	Lab
Units	**Readability**	**SOP**	**Cal Date**	**Last Cal Date**	**Cal Due Date**
g	0.0001	QC012	10/20/16	4/13/16	4/2017

FUNCTIONAL CHECKS

ECCENTRICITY
Test Wt: 100 Tol: 0.0003
As-Found: Pass: ☑ Fail: ☐
As-Left: Pass: ☑ Fail: ☐

LINEARITY
Test Wt: 50 x 4 Tol: 0.0002
As-Found: Pass: ☑ Fail: ☐
As-Left: Pass: ☑ Fail: ☐

STANDARD DEVIATION
Test Wt: 100 Tol: 0.0001

1. 100.0000	5. 100.0000	9. 100.0000
2. 100.0000	6. 100.0000	10. 100.0000
3. 99.9999	7. 99.9999	**Result**
4. 100.0000	8. 100.0000	0.00004

ENVIRONMENTAL CONDITIONS
☐ Good ☑ Fair ☐ Poor
Temperature: 19.8°C

A2LA ACCREDITED SECTION OF REPORT

Standard	As-Found	As-Left	Expanded Uncertaint
200	199.9997	200.0000	0.00014
100	99.9998	100.0000	0.00014
50	49.9999	49.9999	0.00014
10	10.0000	9.9999	0.00014
1	1.0000	1.0000	0.00014
0.1	0.1000	0.1000	0.00014

CALIBRATION STANDARDS

Item	Make	Model	Serial Number	Cal Date	Cal Due Date	NIST ID
Weight Set	Rice Lake	30 kg-1mg	S751	1/4/16	1/2017	20160003

Permanent Information Concerning this Equipment:

Comments/Info Concerning this Calibration:

Report prepared/reviewed by: [signature] **Date:** 10·2016

Technician: R. Hintz
Signature: [signature]

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The uncertainty is calculated according to the ISO Guide to the Expression of Uncertainty in Measurement and includes the uncertainty of standards used combined with the observed standard deviation and readability of the unit under test. The uncertainty is expanded with a k factor of 2 for an approximate 95% level of confidence. Instruments listed above were calibrated using standards traceable to the National Institute of Standards and Technology (NIST). Calibration data reflect results at the time and location of calibration. Calibration data should be reviewed to insure that the instrument is performing to its required accuracy. Calibrations comply with ISO/IEC 17025 and ANSI/Z540-1-1994 quality standards.

Established 1974

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Laboratory code: 115953

Myren Consulting
512 Williams Lake Road
Colville, WA 99114

Report Number: MYRC0224850860160413

A2LA ACCREDITED
CERTIFICATE OF CALIBRATION WITH DATA

INSTRUMENT INFORMATION

Item	Make	Model	Serial Number	Customer ID	Location
Balance	Sartorius	CPA224S	24850860	N/A	Lab
Units	**Readability**	**SOP**	**Cal Date**	**Last Cal Date**	**Cal Due Date**
g	0.0001	QC012	4/13/16	11/4/15	10/2016

FUNCTIONAL CHECKS

ECCENTRICITY
Test Wt: 100 Tol: 0.0003
As-Found: Pass: ☑ Fail: ☐
As-Left: Pass: ☑ Fail: ☐

LINEARITY
Test Wt: 50 x 4 Tol: 0.0002
As-Found: Pass: ☑ Fail: ☐
As-Left: Pass: ☑ Fail: ☐

STANDARD DEVIATION
Test Wt: 100 Tol: 0.0001

1. 100.0000	5. 100.0000	9. 100.0001
2. 100.0001	6. 100.0000	10. 100.0001
3. 100.0000	7. 100.0001	**Result**
4. 100.0001	8. 100.0001	0.00005

ENVIRONMENTAL CONDITIONS
☐ Good ☑ Fair ☐ Poor
Temperature: 19.8°C

A2LA ACCREDITED SECTION OF REPORT

Standard	As-Found	As-Left	Expanded Uncertainty
200	200.0004	200.0000	0.00015
100	100.0001	100.0000	0.00015
50	50.0000	49.9999	0.00015
10	10.0000	9.9999	0.00015
1	0.9999	1.0000	0.00015
0.1	0.0999	0.1000	0.00015

CALIBRATION STANDARDS

Item	Make	Model	Serial Number	Cal Date	Cal Due Date	NIST ID
Weight Set	Rice Lake	30 kg-1mg	S751	1/4/16	1/2017	20160003

Permanent Information Concerning this Equipment:

Comments/Info Concerning this Calibration:
4/16 Performed internal span overwrite adjustment.

Report prepared/reviewed by: [signature] **Date:** 4.13.2016 **Technician:** R. Hintz
Signature: [signature]

THIS CERTIFICATE SHALL NOT BE REPRODUCED WITHOUT THE APPROVAL OF QUALITY CONTROL SERVICES, INC.

The uncertainty is calculated according to the ISO Guide to the Expression of Uncertainty in Measurement and includes the uncertainty of standards used combined with the observed standard deviation and readability of the unit under test. The uncertainty is expanded with a k factor of 2 for an approximate 95% level of confidence. Instruments listed above were calibrated using standards traceable to the National Institute of Standards and Technology (NIST). Calibration data reflect results at the time and location of calibration. Calibration data should be reviewed to insure that the instrument is performing to its required accuracy. Calibrations comply with ISO/IEC 17025 and ANSI/Z540-1-1994 quality standards.

Member: National Conference of Standards Laboratories and Weights & Measures

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Laboratory code: 115953

Myren Consulting
512 Williams Lake Road
Colville, WA 99114

Report Number: MYRC0224850860151104

A2LA ACCREDITED
CERTIFICATE OF CALIBRATION WITH DATA

INSTRUMENT INFORMATION

Item	Make	Model	Serial Number	Customer ID	Location
Balance	Sartorius	CPA224S	24850860	N/A	Lab
Units	**Readability**	**SOP**	**Cal Date**	**Last Cal Date**	**Cal Due Date**
g	0.0001	QC012	11/4/15	4/15/15	4/2016

FUNCTIONAL CHECKS

ECCENTRICITY
Test Wt: 100 Tol: 0.0003
As-Found: Pass: ☑ Fail: ☐
As-Left: Pass: ☑ Fail: ☐

LINEARITY
Test Wt: 50 x 4 Tol: 0.0002
As-Found: Pass: ☑ Fail: ☐
As-Left: Pass: ☑ Fail: ☐

STANDARD DEVIATION
Test Wt: 100 Tol: 0.0001

1. 100.0000	5. 99.9999	9. 99.9999
2. 99.9999	6. 99.9999	10. 99.9999
3. 100.0000	7. 99.9999	**Result**
4. 100.0000	8. 99.9998	0.00006

ENVIRONMENTAL CONDITIONS
☐ Good ☑ Fair ☐ Poor
Temperature: 12.6°C

A2LA ACCREDITED SECTION OF REPORT

Standard	As-Found	As-Left	Expanded Uncertainty
200	199.9998	200.0001	0.00017
100	99.9999	100.0000	0.00017
50	50.0000	50.0000	0.00017
10	10.0000	10.0001	0.00017
1	1.0000	1.0000	0.00017
0.1	0.1000	0.1000	0.00017

CALIBRATION STANDARDS

Item	Make	Model	Serial Number	Cal Date	Cal Due Date	NIST ID
Weight Set	Rice Lake	30 kg-1mg	S751	12/2/14	12/2015	OR-13-314-C

Permanent Information Concerning this Equipment:

Comments/Info Concerning this Calibration:

Report prepared/reviewed by: [signature] **Date:** 11-4-2015

Technician: R. Hintz
Signature: [signature]

THIS CERTIFICATE SHALL NOT BE REPRODUCED WITHOUT THE APPROVAL OF QUALITY CONTROL SERVICES, INC.

The uncertainty is calculated according to the ISO Guide to the Expression of Uncertainty in Measurement and includes the uncertainty of standards used combined with the observed standard deviation and readability of the unit under test. The uncertainty is expanded with a k factor of 2 for an approximate 95% level of confidence. Instruments listed above were calibrated using standards traceable to the National Institute of Standards and Technology (NIST). Calibration data reflect results at the time and location of calibration. Calibration data should be reviewed to insure that the instrument is performing to its required accuracy. Calibrations comply with ISO/IEC 17025 and ANSI/Z540-1-1994 quality standards.

DENSITY STANDARD USED FOR TROEMNER PRECISION WEIGHTS

Troemner Inc. adjusts all new weights and all weights received for recalibration on the basis of apparent mass versus material of density 8.0g/cm³ at 20°C. This action is in accordance with the recommendations of the American Society for Testing and Materials specification ANSI/ASTM E 617 and the International Organization of Legal Metrology (OIML) International Recommendation No. 20.

Previously, all weights had usually been adjusted on the basis of apparent mass versus "brass," a hypothetic material of defined density 8.4g/cm³ at 0°C and 8.3909g/cm³ at 20°C. This practice originated in the early 1800's and was adopted in all of the English speaking countries as well as a number of other countries. Now most mass standards and test weights are made from stainless steel (density ranges from 7.77g/cm³ to 8.0g/cm³). A number of countries have adopted the recommendations of OIML and the foremost balance manufacturers are adjusting the built-in weights in their balances on the basis of apparent mass versus 8.0g/cm³. In order to smooth the transition in this country, the Reports of Calibration of the National Bureau of Standards are reporting the corrections to calibrated mass standards on both bases.

In terms of normal weighing procedures the change is very small. For a given weight, the mass value assigned on the basis of apparent mass versus density 8.0g/cm³ material will be 7 parts per million higher than the value assigned on the basis of apparent mass versus "density 8.4g/cm³" material. In many cases the allowed weight adjustment tolerances are so large that this change is immaterial although closely adjusted weights often have a smaller tolerance than the correction change. For example at the 1 kilogram level the change is 7 mg. For comparison the ANSI/ASTM E 617 Class 6 tolerance for 1 kilogram is 100 mg while the Class 1 tolerance is 2.5 mg. A detailed discussion of mass and mass values is given in Reference 3.

Precision Weights manufactured by Troemner Inc. to ASTM Class 1, 1.1, 2, 3, 4, 5, and 6 tolerances and the equivalent OIML and NBS tolerances are of the following materials:

Designation	*Base Material*	*Density*	*Weight Range*
Stainless Steel	18-8	7.84g/cm³ at 20°C	1 g & larger
Stainless Steel	18-8	8.0g/cm³ at 20°C	50 mg to 500 mg
Aluminum	1100	2.7g/cm³ at 20°C	30 mg & smaller

References:

1. ANSI/ASTM E 617
   Available from: Troemner Inc. 6825 Greenway Ave., Phila. Pa. 19142 215-724-0800 or American Society for Testing and Materials, 1916 Race Street, Phila., Pa. 19103
2. OIML INTERNATIONAL RECOMMENDATION No. 20
   Available from: Organisation Internationale De Metrologie Legale 11 Rue Turgot - 75009 Paris, France
3. NBS MONOGRAPH 133, MASS AND MASS VALUES
   Available from: Superintendent of Documents, U.S. Government Printing Office Washington, D.C. 20402 Order by SD Catalog No. C13.44:1331 Stock Number 0303-01178

TROEMNER INC.
Manufacturers of Precision Weights...
Mass Standards • Balances • Laboratory Apparatus
6825 Greenway Avenue - Philadelphia, Pa. 19142
215/724-0800

Wts. used for Scale QC Checks, P. 4-4.

ALTEK

CERTIFICATE OF CALIBRATION

This is to Certify that your Altek Unit has been calibrated using standards whose accuracies are traceable to the National Institute of Standards and Technology (formerly NBS) within the limits of the NIST Calibration Services. Actual records pertaining to these standards are on file and are available for examination.

Certified by: Altek Industries Corp.
Recommend Recalibration: Annually

In service date 4/11/96

Serial # 177533

Model K2100F Serial No.

T. Kuech
Calibration Technician

31 AUG 95
Factory Calibration Date

ALTEK INDUSTRIES CORP
210 Commerce Drive, Rochester, NY 14623 U.S.A.
(716) 334-3720 FAX (716) 334-6673
800-32-ALTEK
800-322-5835
Anywhere in USA

MYREN CONSULTING, INC.
512 Williams Lake Road
Colville, WA 99114
Office: 509 684 1154
Lab: 509 685 9458

Calibration Data Sheet # 65
Revision 1 3/3/04

THERMOCOUPLE READOUT CALIBRATION

DATE: 7/19/17
TECHNICIAN: ESS

Thermocouple Readout Manufacturer: Omega

Model #: 400B-TC Serial #: 11020109 Type: K Range: 0-2100°F

Location: Center Dial Station - Dial Station #2

Calibrated with: Altec SN 177553 0-2100°F

As found: 0° F = 0 Adjusted to: —
2100° F = 2103 Adjusted to: 2100

		% Dif			% Dif			% Dif
0 =	0	0 ✓	800 =	802	- .016 ✓	1600 =	1601	- .005 ✓
100 =	97	+ .054 ✓	900 =	899	+ .007 ✓	1700 =	1700	0 ✓
200 =	202	- .030 ✓	1000 =	1001	- .007 ✓	1800 =	1801	- .004 ✓
300 =	298	+ .026 ✓	1100 =	1099	+ .006 ✓	1900 =	1900	0 ✓
400 =	400	0 ✓	1200 =	1199	+ .006 ✓	2000 =	2001	- .004 ✓
500 =	498	+ .021 ✓	1300 =	1299	+ .006 ✓	2100 =	2100	0 ✓
600 =	602	- .019 ✓	1400 =	1400	0 ✓			
700 =	698	+ .017 ✓	1500 =	1500	0 ✓			

$$\% \text{ Dif} = \frac{(\text{Reference Temperature } ^\circ F + 460) - (\text{Readout Temperature } ^\circ F + 460)}{\text{Reference Temperature } ^\circ F + 460}$$

Or

$$\% \text{ Dif} = \frac{(\text{Reference Temperature } ^\circ C + 273) - (\text{Readout Temperature } ^\circ C + 273)}{\text{Reference Temperature } ^\circ C + 273}$$

MYREN CONSULTING, INC.
512 Williams Lake Road
Colville, WA 99114
Office: 509 684 1154
Lab: 509 685 9458

Calibration Data Sheet # 65
Revision 1 3/3/04

THERMOCOUPLE READOUT CALIBRATION

DATE: 7/19/17
TECHNICIAN: ESS

Thermocouple Readout Manufacturer: Omega

Model #: 115KF Serial #: 004487KF Type: K Range: 0-1900°F

Location: Apex 45G - P meter Box

Calibrated with: Altec SN 177-533 0-2100°F

As found: 0° F = 0 Adjusted to: —
1900° F = 1900 Adjusted to: —

Ref	Reading	% Dif	Ref	Reading	% Dif	Ref	Reading	% Dif
0 =	0	0 ✓	800 =	799	+ .008 ✓	1600 =	1599	+ .005 ✓
100 =	95	+ .089 ✓	900 =	896	+ .029 ✓	1700 =	1699	+ .005 ✓
200 =	202	- .030 ✓	1000 =	1000	0 ✓	1800 =	1800	0 ✓
300 =	299	+ .013 ✓	1100 =	1099	+ .006 ✓	1900 =	1900	0 ✓
400 =	399	+ .012 ✓	1200 =	1198	+ .012 ✓	2000 =		
500 =	498	+ .021 ✓	1300 =	1297	+ .017 ✓	=		
600 =	599	+ .009 ✓	1400 =	1399	+ .005 ✓			
700 =	696	+ .034 ✓	1500 =	1498	+ .010 ✓			

$$\% \text{ Dif} = \frac{(\text{Reference Temperature } ^\circ F + 460) - (\text{Readout Temperature } ^\circ F + 460)}{\text{Reference Temperature } ^\circ F + 460}$$

Or

$$\% \text{ Dif} = \frac{(\text{Reference Temperature } ^\circ C + 273) - (\text{Readout Temperature } ^\circ C + 273)}{\text{Reference Temperature } ^\circ C + 273}$$

MYREN CONSULTING, INC.
512 Williams Lake Road
Colville, WA 99114
Office: 509 684 1154
Lab: 509 685 9458

Calibration Data Sheet # 65
Revision 1 3/3/04

THERMOCOUPLE READOUT CALIBRATION

DATE: 7/19/17
TECHNICIAN: ESS

Thermocouple Readout Manufacturer: JENCO

Model #: 768-KF02 Serial #: 900167 Type: K Range: 0 - 1999°/F

Location: Apex 511-M Meter Box

Calibrated with: Altec SN 177533 0-2100°/F

As found: 0° F = -1 Adjusted to: 0
1999° F = 1991 Adjusted to: 1999

		% Dif			% Dif			% Dif
0 =	0	0 ✓	800 =	801	-.0028 ✓	1600 =	1618	-.0087 ✓
100 =	95	+.0089 ✓	900 =	902	-.0015 ✓	1700 =	1714	-.0065 ✓
200 =	200	0 ✓	1000 =	1008	-.0055 ✓	1800 =	1811	-.0049 ✓
300 =	296	+.0053 ✓	1100 =	1110	-.0064 ✓	1900 =	1904	-.0017 ✓
400 =	394	+.0070 ✓	1200 =	1213	-.0078 ✓	~~2000~~ 1999 =	1999	0 ✓
500 =	492	+.0083 ✓	1300 =	1317	-.0097 ✓	=		
600 =	596	+.0038 ✓	1400 =	1418	-.0087 ✓			
700 =	696	+.0034 ✓	1500 =	1518	-.0092 ✓			

$$\% \text{ Dif} = \frac{(\text{Reference Temperature } ^\circ F + 460) - (\text{Readout Temperature } ^\circ F + 460)}{\text{Reference Temperature } ^\circ F + 460}$$

Or

$$\% \text{ Dif} = \frac{(\text{Reference Temperature } ^\circ C + 273) - (\text{Readout Temperature } ^\circ C + 273)}{\text{Reference Temperature } ^\circ C + 273}$$

Woodstove Data Sheet # 55
Revision 0 12/18/01

THERMOMETER CALIBRATION DATE: 7/18/17 TECHNICIAN: A.T. Mynun

MANUFACTURER:	Ertco	Ertco	Fisher	Taylor	Taylor	Premium	
CAT #.	10053F6	E17	ASTM59F	1330 N/A	1330 N/A	—	
SERIAL NO.	1697	K35473	AD4544	—	—	—	
RANGE:	-1 to 100°C	0-260°C	0-180°F	20-120°F	20-120°F	0-220°F	
GRADUATIONS:	0.1 C	1°C	1°F	1°F	1°F	2°F	
TYPE:	Tube	Tube	Tube	Tube	Tube	dial	
TEMP. POINT							
1	.6	1.0	33	34	34	34	
2	5.8	6.0	42	42	43	44	
3	14.1	15	61	62	62	64	
4	24.6	25	76.4	77	78	80	

COMMENTS:

$°F = (°C \times 9/5) + 32$
$°C = (5/9)(°F - 32)$

EVER READY THERMOMETER CO., INC.
228 LACKAWANNA AVENUE
WEST PATTERSON, NJ 07424
(201) 812-7474

R E P O R T O F C A L I B R A T I O N

LIQUID-IN-GLASS-THERMOMETER

CALIBRATED BY EVER READY THERMOMETER CO.

MARKED: ERTCO CAT 1005-3FC S/N-1697
RANGE: -1 TO +101 DEGREES C IN 0.1 DEGREE GRADUATIONS.

THERMOMETER READING	CORRECTION (ITS-90)**
0.00 C	0.00 C
10.00	0.00
20.00	0.00
30.00	0.00
37.00	0.00
40.00	0.00
50.00	0.00
56.00	0.00
60.00	0.02
70.00	0.00
80.00	0.00
90.00	0.00
100.00	0.00

** ALL TEMPERATURES IN THIS REPORT ARE BASED ON THE INTERNATIONAL TEMPERATURE SCALE OF 1990 (ITS-90) PUBLISHED IN THE METROLGIA 27, NO. 1, 3/10/90.

THIS THERMOMETER WAS CALIBRATED AGAINST A STANDARD CALIBRATED AT THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST) FORMERLY THE NATIONAL BUREAU OF STANDARDS (NBS) IN ACCORDANCE WITH ASTM METHOD E 77, AND NBS MONOGRAPH 174.

FOR A DISCUSSION OF ACCURACIES ATTAINABLE WITH SUCH THERMOMETERS SEE NBS MONOGRAPH 250-23.

IF NO SIGN IS GIVEN ON THE CORRECTION, THE TRUE TEMPERATURE IS HIGHER THAN THE INDICATED TEMPERATURE; IF THE SIGN GIVEN IS NEGATIVE, THE TRUE TEMPERATURE IS LOWER THAN THE INDICATED TEMPERATURE. TO USE THE CORRECTIONS PROPERLY, REFERENCE SHOULD BE MADE TO THE NOTES GIVEN BELOW.

CONTINUED

TEST NUMBER: 152439
DATE: 07/16/96
STANDARD SERIAL NO. 128239
NIST IDENTIFICATION NO. 88024

REPORT OF CALIBRATION

LIQUID-IN-GLASS-THERMOMETER

THE THERMOMETER WAS TESTED IN A LARGE, CLOSED-TOP, ELECTRICALLY HEATED, LIQUID BATH, BEING "IMMERSED" 76MM. THE TEMPERATURE OF THE ROOM WAS ABOUT 25 DEGREES C (77 DEGREES F). IF THE THERMOMETER IS USED UNDER CONDITIONS WHICH WOULD CAUSE THE AVERAGE TEMPERATURE OF THE EMERGENT LIQUID COLUMN TO DIFFER MARKEDLY FROM THAT PREVAILING IN THE TEST, APPRECIABLE DIFFERENCES IN THE INDICATIONS OF THE THERMOMETER WOULD RESULT.

THE TABULATED CORRECTIONS APPLY PROVIDED THE ICE-POINT READING, TAKEN AFTER EXPOSURE FOR NOT LESS THAN 3 DAYS TO A TEMPERATURE OF ABOUT 20 DEGREES C (70 DEGREES F) IS 0.00 DEGREES C. IF THE ICE-POINT READING IS FOUND TO BE HIGHER (OR LOWER) THAN STATED, ALL OTHER READINGS WILL BE HIGHER (OR LOWER) TO THE SAME EXTENT. IF THE THERMOMETER IS USED AT A GIVEN TEMPERATURE SHORTLY AFTER BEING HEATED TO A HIGHER TEMPERATURE. AN ERROR OF 0.01 DEGREES OR LESS, FOR EACH 10 DEGREE DIFFERENCE BETWEEN THE TWO TEMPERATURES, MAY BE INTRODUCED. THE TABULATED CORRECTIONS APPLY IF THE THERMOMETER IS USED IN THE UPRIGHT POSITION; IF USED IN A HORIZONTA POSITION, THE INDICATIONS MAY BE A FEW HUNDREDTHS OF A DEGREE HIGHER.

TEST NUMBER: 152439
DATE: 07/16/96
STANDARD SERIAL NO. 128239
NIST IDENTIFICATION NO. 88024

C. [signature]

Charles Tang-Nian
QUALITY CONTROL MANAGER

Dry Gas Meter Calibration Data

Date: 7/18/17 Technician: ATM ESS

Calibration Meter Mfr: Rockwell SN: 1052202 Y: 0.9947

Meter Box ID 45G-P Meter Mfr: Rockwell SN: 3039270

Electrical Check Ok Pitot Leak Check N/A

Leak Check Front Half OVER Back Half OVER

BP = 28.40 in. Hg

Orifice (Δh) in. H_2O	Gas Volume	Cal. Meter (Vc), (cu.ft.)	Dry Gas Meter (Vm), (m^3)(ft^3)	Temperature	Cal. Meter (Tc), °F	Dry Gas Meter Inlet (Tmi), (°F) (°C)	Dry Gas Meter Outlet (Tmo), (°F)(°C)	Time (Θ), Min.	
.80	initial	394.747	681.600	initial	68	72	72		0
.80	final	400.005	686.765	mid	68.5	74	74	11:00	0
.80				final	68.5	76	76		0
	total	5.258	5.165	avg.	68.3	74	74	74	
			.470 ft³/min.		528.3	534	534	534	
.90	initial	400.445	687.200	initial	68.5	74	74		0
.90	final	405.604	692.312	mid	69	79	79	10:00	0
.90				final	69	81	81		0
	total	5.159	5.112	avg.	68.8	78	78	78	
			.511 ft³/min		528.8	538	538	538	
1.00	initial	406.092	692.800	initial	69	79	79		0
1.00	final	411.274	697.980	mid	69.5	84	84	9:30	0
1.00				final	69.5	86	86		0
	total	5.182	5.180	avg.	69.3	83	83	83	
			.545 ft³/min.		529.3	543	543	543	
	initial			initial					
	final			mid					
				final					
	total			avg.					
	initial			initial					
	final			mid					
				final					
	total			avg.					

$$Y = \frac{(Y)(Vc)(Pb)(Tm + 460)}{(Vm)(Pb + \Delta h/13.6)(Tc + 460)} \qquad \Delta h@ = \frac{(0.0317)(\Delta h)}{Pb(Tmo + 460)} [(Tc + 460)(\Theta)] / [(Vc)(Yc)]^2$$

Back Half Leak Check

	Manometer Reading	Leg 1	Manometer Reading	Leg 2
Start	9.88 " H_2O		8.87	Ok
Stop	9.88 " H_2O		8.87	
movement	0.00 " H_2O in 60 Seconds. = Ok		0.00	

Front Half Leak Check.

	Vac in Hg	Meter Reading Start	Meter Reading Stop	Leak Rate cmm	Leak Rate cfm
DGM	-16.8	.916	.917	—	.001
TM	-16.8	.990	.990	—	.000

Meter Box Calibration Page 2

$$Y = \frac{(Y_c)(V_c)(BP)(T_m + 460)}{(V_m)(BP + \Delta H/13.6)(T_c + 460)} =$$

Y = (.9947)(5.258)(28.40)(74 +460) / (5.165)(28.40 + .80 /13.6)(68.3 + 460) = 79,318.099 / 77,654.724 = 1.0214
(534; 528.3)

Y = (.9947)(5.159)(28.40)(78 +460) / (5.112)(28.40 + .90 /13.6)(68.8 + 460) = 78,407.618 / 76,950.497 = 1.0189
(538; 528.8)

Y = (.9947)(5.182)(28.40)(83 +460) / (5.180)(28.40 + 1.00 /13.6)(69.3 + 460) = 79,489.121 / 78,067.983 = 1.0182
(543; 529.3)

Y = ( )( )( )(+460) / ( )(+ /13.6)(+ 460) = ____ = ____

Y = ( )( )( )(+460) / ( )(+ /13.6)(+ 460) = ____ = ____

Y Factor	Variation
1.0214	+.0019
1.0189	-.0006
1.0182	-.0013
3.0585	

(± 0.02 Allowed From Average Y)

Avg Y 1.0195

METER BOX 45G-P
DATE 7/18/17

$$\Delta H@ = \frac{(0.0317)(\Delta H)}{(Pb)(T_{mo} + 460)} \cdot \left[\frac{(T_w + 460)(\Theta)}{(Y_c)(V_c)}\right]^2 =$$

$$\Delta H@ = \frac{(0.0317)(.80)}{(28.40)(74 + 460)} \cdot \left[\frac{(68.3 + 460)(11.0)}{(.9947)(5.258)}\right]^2 = 2.0645$$

(534; 528.3)

$$\Delta H@ = \frac{(0.0317)(.90)}{(28.40)(78 + 460)} \cdot \left[\frac{(68.8 + 460)(10.0)}{(.9947)(5.159)}\right]^2 = 1.9828$$

(538; 528.8)

$$\Delta H@ = \frac{(0.0317)(1.00)}{(28.40)(83 + 460)} \cdot \left[\frac{(69.3 + 460)(9.5)}{(.9947)(5.182)}\right]^2 = 1.9562$$

(543; 529.3)

$$\Delta H@ = \frac{(0.0317)(\quad)}{(\quad)(\quad + 460)} \cdot \left[\frac{(\quad + 460)(\quad)}{(\quad)(\quad)}\right]^2 = \_\_\_\_$$

$$\Delta H@ = \frac{(0.0317)(\quad)}{(\quad)(\quad + 460)} \cdot \left[\frac{(\quad + 460)(\quad)}{(\quad)(\quad)}\right]^2 = \_\_\_\_$$

ΔH@	VARIATION (± 0.20 ALLOWED)
2.0645	+.0633
1.9828	-.0184
1.9562	-.0450
6.0035	

AVG ΔH@ 2.0012

Post Test
Meter Box Audit
Woodstove Data Sheet #32

Unit: Optimum
Date: 9/16/17
Technician: ESS
WST9-Form2, Rev 6/11

45 G-P

Meter Box Calibration Audit
Test Data

Run #	1	2	3	4	5	6	7	8	9	10
Avg.Δh	.90									
Max Vac	0									

Avg. Test Series Δh: .90 in H_2O. Test Series Max Vac: 0 in Hg

Audit Dry Gas Meter Mfr: Rockwell SN: 1052202 Correction Factor (Y): .9947
Test Dry Gas Meter Mfr: Rockwell SN: 3039270 Correction Factor (Y): 1.0195

Audit Data

		Audit #1	Audit #2	Audit #3
BP ("Hg):		28.49	28.48	28.48
Vac("Hg):		0	0	0
Audit Meter:	Final Vol	460.112	465.578	471.175
	Initial Vol	455.031	460.483	466.110
	Vol (V_c, Ft^3)	5.081 ✓	5.095 ✓	5.065 ✓
Audit Meter Temp (°F) (Tc)	Initial	59.5	63	64
	Mid	61	63.5	64.5
	Final	62	64	65
	Avg (°F/°A)	60.8 ✓ (520.8) ✓	63.5 ✓ (523.5) ✓	64.5 ✓ (524.5) ✓
Δh("H_2O)	Initial	.90	.90	.90
	Mid	.90	.90	.90
	Final	.90	.90	.90
	Avg	.90 ✓	.90 ✓	.90 ✓
Dry Gas Meter:	Final Vol	795.927	801.375	806.986
	Initial Vol	790.900	796.300	801.900
	Vol(V_d)(ft^3)	5.027 ✓	5.075 ✓	5.086 ✓
Dry Gas Meter Temp (°F) : Inlet (T_m)	Initial	65	67	71
	Mid	70	73	77
	Final	71	75	79
	Avg(°F/°A)	68.7 ✓ (528.7) ✓	71.7 ✓ (531.7) ✓	75.7 ✓ (535.7) ✓
Dry Gas Meter Temp (°F) : Outlet (T_m)	Initial	65	67	71
	Mid	70	73	77
	Final	71	75	79
	Avg(°F/°A)	68.7 ✓ (528.7) ✓	71.7 ✓ (531.7) ✓	75.7 ✓ (535.7) ✓
Avg Dry Gas Meter Temp (T_m - °F/°A)		68.7 ✓ (528.7) ✓	71.7 ✓ (531.7) ✓	75.7 ✓ (535.7) ✓
Time (minutes)		10:00	10:00	10:00

Note: If volume is in m^3, multiply by 35.314667 to obtain ft^3.
Note: Add 460° to all temperatures for degrees Absolute.

Back Half Leak Check

	Start	Stop	Δ
Leg 1	8.470	8.470	.000
Leg 2	8.690	8.690	.000

45 G-P

$$Y = \frac{(V_c)(MCF)(BP)(T_m)}{(V_d)(BP + \Delta h/13.6)(T_c)}$$

Y Factor % Difference = $\frac{Act - Exp}{Exp}$ X 100

Note: MCF = Meter Correction Factor (Y) for Dry Gas Meter used as a Transfer Standard

Run 1

Y = (5.081)(.9947)(28.49)(68.7 (528.7)) / (5.027)(28.49 + .90/13.6)(60.8 (520.8)) = 76,127.764 / 74,761.829 = 1.0183

Δ% = (1.0183 - 1.0195) / 1.0195 X 100 = -.118 %

Run 2

Y = (5.095)(.9947)(28.48)(71.7 (531.7)) / (5.075)(28.48 + .90/13.6)(63.5 (523.5)) = 76,743.738 / 75,840.411 = 1.0119

Δ% = (1.0119 - 1.0195) / 1.0195 X 100 = -.744 %

Run 3

Y = (5.065)(.9947)(28.48)(75.7 (535.7)) / (5.086)(28.48 + .90/13.6)(64.5 (524.5)) = 76,865.808 / 76,149.980 = 1.0094

Δ% = (1.0094 - 1.0195) / 1.0195 X 100 = -.991 %

Note: The Y Factor % Difference must be < ±5.0% to be acceptable. Avg. Δ%= -.618

Determination of Interpolated Y Factor for Average Certification Test Series Δ H from Dry Gas Meter Calibration Data:

_______ (A) inch H_2O Δh= _______ (C) Calculated Calibration Y Factor (from Calibration)

_______ (B) inch H_2O Δ h = _______ (D) Calculated Calibration Y Factor (from Calibration)

_______ (B) - _______ (A) = _______ X100 = _______ (E) _______ (D) - _______ (C) = _______ / _______ (E) = _______ (F)

_______ Avg Δ h - _______ (A) = _______ X 100 = _______ (G)

(_______ F X _______ G) + _______ C = _______ Interpolated Y Factor For Avg. Test Series Δ h

Dry Gas Meter Back Half Leak Check: .000 **inch H_2O in One Minute**

Front Half Leak Check — **Meter Reading** — **Leak Rate**

Meter	Vac In. Hg	Start	Stop	cmm	cfm
DGM	-17.4	.9805	.982	—	.0015
TM	-17.4	.007	.008	—	.001

Dry Gas Meter Calibration Data

Date: 7/18/17 Technician: ATM ESS

Calibration Meter Mfr: Rockwell SN: 1052202 Y: 0.9947

Meter Box ID 511-M Meter Mfr: Rockwell SN: 322914

Electrical Check Ok Pitot Leak Check N/A

Leak Check Front Half OVER Back Half OVER

BP = 28.44 in. Hg

Orifice (Δh) in. H_2O	Gas Volume			Temperature				Time (Θ), Min.
		Cal. Meter (Vc), (cu.ft.)	Dry Gas Meter (Vm), (m^3)(ft^3)		Cal. Meter (Tc), °F	Dry Gas Meter Inlet (Tmi), (°F) (°C)	Dry Gas Meter Outlet (Tmo), (°F)(°C)	
.70	initial	365.620	430.600	initial	60.5	62	61	
.70	final	370.750	435.831	mid	61	64	63	11:30
.70				final	62	65	63	
	total	5.130	5.231	avg.	61.2	63.7	62.3	63
			.455 ft³/min.		521.2	523.7	522.3	523
.75	initial	371.419	436.500	initial	62	65	64	
.75	final	376.564	441.722	mid	63	67	65	11:00
.75				final	63.5	68	65	
	total	5.145	5.222	avg.	62.8	66.7	64.7	65.7
			.475 ft³/min		522.8	526.7	524.7	525.7
.80	initial	377.239	442.400	initial	63.5	67	66	
.80	final	382.300	447.514	mid	64.5	69	67	10:30
.80				final	64.5	69	67	
	total	5.061	5.114	avg.	64.2	68.3	66.7	67.5
			.487 ft³/min.		524.2	528.3	526.7	527.5
.85	initial	382.983	448.200	initial	64.5	69	67	
.85	final	388.101	453.378	mid	64.5	70	68	10:15
.85				final	65.5	70	68	
	total	5.118	5.178	avg.	64.8	69.7	67.7	68.7
			.505 ft³/min.		524.8	529.7	527.7	528.7
.90	initial	388.718	454.000	initial	66	70	69	
.90	final	393.860	459.214	mid	65.5	71	69	10:00
.90				final	66.5	72	69	
	total	5.142	5.214	avg.	66	71	69	70
			.521 ft³/min		526	531	529	530

$$Y = \frac{(Y)(Vc)(Pb)(Tm + 460)}{(Vm)(Pb + \Delta h/13.6)(Tc + 460)} \qquad \Delta h@ = \frac{(0.0317)(\Delta h)}{Pb(Tmo + 460)} \left[(Tc + 460)(\Theta)\right] / \left[(Vc)(Yc)\right]^2$$

Back Half Leak Check

	Manometer Reading in H_2O		Manometer in H_2O	
Start	9.75"	Leg 1	8.60"	Leg 2
Stop	9.75"		8.60	
Δ	0.00	ok	0.00	ok

Front Half Leak Check

	Vac in. Hg	Meter Reading Start	Meter Reading Stop	Leak Rate cmm	Leak Rate cfm
DGM	-17.0	.656	.658	—	.002
TM	-17.0	.674	.674	—	.000

Meter Box Calibration Page 2

$$Y = \frac{(Y_c)(V_c)(BP)(T_m + 460)}{(V_m)(BP + \Delta H/13.6)(T_c + 460)} =$$

$$Y = \frac{(.9947)(5.130)(28.44)(63 + 460)}{(5.231)(28.44 + .70/13.6)(61.2 + 460)} = \frac{75{,}899.823}{77{,}679.066} = 0.9771$$

(523; 521.2)

$$Y = \frac{(.9947)(5.145)(28.44)(65.7 + 460)}{(5.222)(28.44 + .75/13.6)(62.8 + 460)} = \frac{76{,}514.733}{77{,}793.507} = 0.9836$$

(525.7; 522.8)

$$Y = \frac{(.9947)(5.061)(28.44)(67.5 + 460)}{(5.114)(28.44 + .80/13.6)(64.2 + 460)} = \frac{75{,}523.222}{76{,}398.472} = 0.9885$$

(527.5; 524.2)

$$Y = \frac{(.9947)(5.118)(28.44)(68.7 + 460)}{(5.178)(28.44 + .85/13.6)(64.8 + 460)} = \frac{76{,}547.551}{77{,}453.104} = 0.9883$$

(528.7; 524.8)

$$Y = \frac{(.9947)(5.142)(28.44)(70 + 460)}{(5.214)(28.44 + .90/13.6)(66 + 460)} = \frac{77{,}095.611}{78{,}180.013} = 0.9861$$

(530; 526)

Y Factor	Variation (± 0.02 Allowed From Average Y)
0.9771	-.0076
0.9836	-.0011
0.9885	+.0038
0.9883	+.0036
0.9861	+.0014

Avg Y 0.9847

4.9233
.9847

$$\Delta H@ = \frac{(0.0317)(\Delta H)}{(Pb)(T_{mo} + 460)} \cdot \left[\frac{(T_w + 460)(\Theta)}{(Y_c)(V_c)}\right]^2 =$$

$$\Delta H@ = \frac{(0.0317)(.70)}{(28.44)(62.3 + 460)} \cdot \left[\frac{(61.2 + 460)(11.5)}{(.9947)(5.130)}\right]^2 = 2.0611$$

$$\Delta H@ = \frac{(0.0317)(.75)}{(28.44)(64.7 + 460)} \cdot \left[\frac{(62.8 + 460)(11)}{(.9947)(5.145)}\right]^2 = 2.0118$$

$$\Delta H@ = \frac{(0.0317)(.80)}{(28.44)(66.7 + 460)} \cdot \left[\frac{(64.2 + 460)(10.5)}{(.9947)(5.061)}\right]^2 = 2.0238$$

$$\Delta H@ = \frac{(0.0317)(.85)}{(28.44)(67.7 + 460)} \cdot \left[\frac{(64.8 + 460)(10.25)}{(.9947)(5.118)}\right]^2 = 2.0045$$

$$\Delta H@ = \frac{(0.0317)(.90)}{(28.44)(69 + 460)} \cdot \left[\frac{(66 + 460)(10)}{(.9947)(5.142)}\right]^2 = 2.0056$$

522.3 524.7 526.7 527.7 529 521.2 522.8 524.2 524.8 526

ΔH@	VARIATION (± 0.20 ALLOWED)
2.0611	+.0397
2.0118	-.0096
2.0238	+.0024
2.0045	-.0169
2.0056	-.0158

AVG ΔH@ 2.0214

Post Test
Meter Box Audit
Woodstove Data Sheet #32

Unit: Optimum
Date: 9/6/17
Technician: ESS
WST9-Form2, Rev 6/11

511-M

Meter Box Calibration Audit
Test Data

Run #	1	2	3	4	5	6	7	8	9	10
Avg.Δh	.85									
Max Vac	-2.0									

Avg. Test Series Δh: .85 in H_2O. Test Series Max Vac: -2.0 in Hg

Audit Dry Gas Meter Mfr: Rockwell SN: 1052202 Correction Factor (Y): .9947
Test Dry Gas Meter Mfr: Rockwell SN: 322914 Correction Factor (Y): .9847

Audit Data

		Audit #1	Audit #2	Audit #3
BP ("Hg):		28.48	28.50	28.50
Vac("Hg):		-2.0	-2.0	-2.0
Audit Meter:	Final Vol	478.250	483.760	489.531
	Initial Vol	473.029	478.659	484.299
	Vol (V_c, Ft^3)	5.221	5.101	5.232
Audit Meter Temp (°F) (Tc)	Initial	64	65	66
	Mid	64	65	66
	Final	64	65	65.5
	Avg (°F/°A)	64 (524)	65 (525)	65.8 (525.8)
Δh("H_2O)	Initial	.85	.85	.85
	Mid	.85	.85	.85
	Final	.85	.85	.85
	Avg	.85	.85	.85
Dry Gas Meter:	Final Vol	654.586	660.247	666.144
	Initial Vol	649.200	655.000	660.800
	Vol(V_d)(ft^3)	5.386	5.247	5.344
Dry Gas Meter Temp (°F) : Inlet (T_m)	Initial	66	67	69
	Mid	67	69	70
	Final	68	69	71
	Avg(°F/°A)	67 (527)	68.3 (528.3)	70 (530)
Dry Gas Meter Temp (°F) : Outlet (T_m)	Initial	65	67	68
	Mid	66	67	68
	Final	66	68	69
	Avg(°F/°A)	65.7 (525.7)	67.3 (527.3)	68.3 (528.3)
Avg Dry Gas Meter Temp (T_m - °F/°A)		66.3 (526.3)	67.8 (527.8)	69.2 (529.2)
Time (minutes)		10:15	10:00	10:15

Note: If volume is in m^3, multiply by 35.314667 to obtain ft^3.
Note: Add 460° to all temperatures for degrees Absolute.

$$Y = \frac{(V_c)(MCF)(BP)(T_m)}{(V_d)(BP + \Delta h/13.6)(T_c)}$$ 511-M

Y Factor % Difference = $\frac{Act - Exp}{Exp}$ X 100

Note: MCF = Meter Correction Factor (Y) for Dry Gas Meter used as a Transfer Standard

Run 1

Y = (5.221)(.9947)(28.48)(66.3 (526.3)) / (5.386)(28.48 + .85 /13.6)(64 (524)) = 77,842,929 / 80,554,470 = .9663

Δ% = (.9663 - .9847) / .9847 X 100 = -1.869 %

Run 2

Y = (5.101)(.9947)(28.50)(67.8 (527.8)) / (5.247)(28.50 + .85 /13.6)(65 (525)) = 76,324,099 / 78,680,405 = .9701

Δ% = (.9701 - .9847) / .9847 X 100 = -1.483 %

Run 3

Y = (5.232)(.9947)(28.50)(69.2 (529.2)) / (5.344)(28.50 + .85 /13.6)(65.8 (525.8)) = 78,491.847 / 80,257.060 = .9780

Δ% = (.9780 - .9847) / .9847 X 100 = -.680 %

Note: The Y Factor % Difference must be < ±5.0% to be acceptable. Avg. Δ%= -1.344

Determination of Interpolated Y Factor for Average Certification Test Series Δ H from Dry Gas Meter Calibration Data:

_______ (A) inch H_2O Δh= _______ (C) Calculated Calibration Y Factor (from Calibration)

_______ (B) inch H_2O Δ h = _______ (D) Calculated Calibration Y Factor (from Calibration)

_______ (B) - _______ (A) = _______ X100 = _______ (E)   _______ (D) - _______ (C) = _______ / _______ (E) = _______ (F)

_______ Avg Δ h - _______ (A) = _______ X 100 = _______ (G)

(_______ F X _______ G) + _______ C = _______ Interpolated Y Factor For Avg. Test Series Δ h

Dry Gas Meter Back Half Leak Check: .000 **inch H_2O in One Minute**

Front Half Leak Check — **Meter Reading** — **Leak Rate**

Meter	Vac In. Hg	Start	Stop	cmm	cfm
DGM	-17.0	.628	.630	—	.002
TM	-17.0	.427	.4285	—	.0015

Back Half Leak Check

	Start	Stop	Δ
Leg 1	8.920	8.920	.000
Leg 2	9.070	9.070	.000

Dry Gas Meter Calibration Data

Date: 7/19/17 Technician: ESS

Calibration Meter Mfr: Rockwell SN: 1052202 Y: .9947

Meter Box ID Train 3 Meter Mfr: Kimmon SN: 8004745

Electrical Check ok ✓ Pitot Leak Check N/A

Leak Check Front Half Over Back Half Over

BP = 28.45 in. Hg

Orifice (Δh) in. H_2O	Gas Volume			Temperature				Time (Θ), Min.	V1
		Cal. Meter (Vc), (cu.ft.)	Dry Gas Meter (Vm), (m^3)(ft^3)		Cal. Meter (Tc), °F	Dry Gas Meter Inlet (Tmi), (°F) (°C)	Dry Gas Meter Outlet (Tmo), (°F)(°C)		
.100	initial	431.009	0.5900	initial	65	69	68		0
.100	final	436.064	0.7390	mid	65.5	71	69	12:00	0
			.1490 m^3	final	66	71	69		0
.100	total	5.055	5.262 ft.^{3}	avg.	65.5	70.3	68.7	69.5	
			.438 ft.^{3}/min.		525.5	530.3	528.7	529.5	
.110	initial	436.950	0.7650	initial	66	70	69		0
.110	final	441.996	0.9138	mid	66	72	69	11:00	0
			.1488 m^3	final	66	72	70		
.110	total	5.046	5.255 ft.^{3}	avg.	66	71.3	69.3	70.3	0
			.478 ft.^{3}/min.		526	531.3	529.3	530.3	
.120	initial	442.889	0.9400	initial	66	70	69		0
.120	final	447.996	1.0904	mid	67	72	70	10:30	0
			.1504 m^3	final	67	73	69		
.120	total	5.107	5.311 ft.^{3}	avg.	66.7	71.7	69.3	70.5	0
			.506 ft.^{3}/min.		526.7	531.7	529.3	530.5	
.135	initial	448.668	1.1100	initial	67	70	70		0
.135	final	453.883	1.2638	mid	67	73	70	10:00	0
			.1538 m^3	final	67	73	70		0
.135	total	5.215	5.431 ft.^{3}	avg.	67	72	70	71	
		8	.543 ft.^{3}/min.		527	532	530	531	
	initial			initial					
	final			mid					
				final					
	total			avg.					

$$Y = \frac{(Y)(Vc)(Pb)(Tm + 460)}{(Vm)(Pb + \Delta h/13.6)(Tc + 460)} \qquad \Delta h@ = \frac{(0.0317)(\Delta h)}{Pb(Tmo + 460)} \left[(Tc + 460)(\Theta)\right] / \left[(Vc)(Yc)\right]^2$$

Back Half Leak Check

	Manometer Reading
START	7.61" H_2O
STOP	7.61" H_2O

movement 0.00" H_2O in 60 sec. = OK ✓

Front Half Leak Check

	VAC	Meter Reading Start	Stop	Leak Rate CMM	Leak Rate CFM
DGM	-17.2	.0175	.0175	.0000	.000
TM	-17.2	.387	.387	—	.000

Meter Box Calibration Page 2

$$Y = \frac{(Y_c)(V_c)(BP)(T_m + 460)}{(V_m)(BP + \Delta H/13.6)(T_c + 460)} =$$

$$Y = \frac{(.9947)(5.055)(28.45)(69.5 + 460)}{(5.262)(28.45 + .100/13.6)(65.5 + 460)} = \frac{75{,}746.316}{78{,}689.732} = 0.9626$$

(529.5; 525.5)

$$Y = \frac{(.9947)(5.046)(28.45)(70.3 + 460)}{(5.255)(28.45 + .110/13.6)(66 + 460)} = \frac{75{,}725.694}{78{,}661.855} = 0.9627$$

(530.3; 526)

$$Y = \frac{(.9947)(5.107)(28.45)(70.5 + 460)}{(5.311)(28.45 + .120/13.6)(66.7 + 460)} = \frac{76{,}670.030}{79{,}607.972} = 0.9631$$

(530.5; 526.7)

$$Y = \frac{(.9947)(5.215)(28.45)(71 + 460)}{(5.431)(28.45 + .135/13.6)(67 + 460)} = \frac{78{,}365.196}{81{,}456.209} = 0.9621$$

(531; 527)

$$Y = \frac{(\quad)(\quad)(\quad)(\quad + 460)}{(\quad)(\quad + \quad /13.6)(\quad + 460)} = \_\_\_\_ = \_\_\_\_$$

Y Factor	Variation	(± 0.02 Allowed From Average Y)
0.9626	0.0000	
0.9627	+0.0001	
0.9631	+0.0005	
0.9621	-0.0005	

Avg Y 0.96226

Post Test
Meter Box Audit
Woodstove Data Sheet #32

Unit: Optimum
Date: 9/6/17
Technician: ESS
WST9-Form2, Rev 6/11

Train 3

Meter Box Calibration Audit
Test Data

Run #	1	2	3	4	5	6	7	8	9	10
Avg.Δh	.12									
Max Vac	-1.5									

Avg. Test Series Δh: .12 in H_2O. Test Series Max Vac: -1.5 in Hg

Audit Dry Gas Meter Mfr: Rockwell SN: 1052202 Correction Factor (Y): .9947
Test Dry Gas Meter Mfr: Kimmon SN: B004745 Correction Factor (Y): .9626

Audit Data

		Audit #1	Audit #2	Audit #3
BP ("Hg):		28.48	28.44	28.42
Vac("Hg):		-1.5	-1.5	-1.5
Audit Meter:	Final Vol	496.461	502.364	508.177
	Initial Vol	491.225	497.221	503.073
	Vol (V_c, Ft^3)	5.236	5.143	5.104
Audit Meter Temp (°F) (Tc)	Initial	67	68	69
	Mid	67.5	68.5	69.5
	Final	68	68.5	69.5
	Avg (°F/°A)	67.5 (527.5)	68.3 (528.3)	69.3 (529.3)
Δh("H_2O)	Initial	.12	.12	.12
	Mid	.12	.12	.12
	Final	.12	.12	.12
	Avg	.12	.12	.12
Dry Gas Meter:	Final Vol	6.6146	6.7890	6.9604
	Initial Vol	6.4600	6.6370	6.8100
	Vol(V_d)[redacted](m^3)	.1546 m3 (5.460 ft3)	.1520 m3 (5.368 ft3)	.1504 m3 (5.311 ft.3)
Dry Gas Meter Temp (°F) : Inlet (T_m)	Initial	70	71	73
	Mid	71	73	74
	Final	72	74	75
	Avg(°F/°A)	71 (531)	72.7 (532.7)	74 (534)
Dry Gas Meter Temp (°F) : Outlet (T_m)	Initial	69	71	71
	Mid	69	71	71
	Final	70	71	72
	Avg(°F/°A)	69.3 (529.3)	71 (531)	71.3 (531.3)
Avg Dry Gas Meter Temp (T_m - °F/°A)		70.2 (530.2)	71.8 (531.8)	72.7 (532.7)
Time (minutes)		10:45	10:30	10:30

Note: If volume is in m^3, multiply by 35.314667 to obtain ft^3.
Note: Add 460° to all temperatures for degrees Absolute.

.1416

$$Y = \frac{(V_c)(MCF)(BP)(T_m)}{(V_d)(BP + \Delta h/13.6)(T_c)}$$ Train 3

Y Factor % Difference = $\frac{Act - Exp}{Exp}$ X 100

Note: MCF = Meter Correction Factor (Y) for Dry Gas Meter used as a Transfer Standard

Run 1

Y = (5.236)(.9947)(28.48)(70.2 (530.2)) / (5.460)(28.48 + .12 /13.6)(67.5 (527.5)) = 78,645.063 / 82,052.085 = .9585

Δ% = (.9585 - .9626) / .9626 X 100 = -.426 %

Run 2

Y = (5.143)(.9947)(28.44)(71.8 (531.8)) / (5.368)(28.44 + .12 /13.6)(68.3 (528.3)) = 77,372,489 / 80,678.428 = .9590

Δ% = (.9590 - .9626) / .96026 X 100 = -0.374 %

Run 3

Y = (5.104)(.9947)(28.42)(72.7 (532.7)) / (5.311)(28.42 + .12 /13.6)(69.3 (529.3)) = 76,861.624 / 79,916.615 = .9618

Δ% = (.9618 - .9626) / .9626 X 100 = -.083 %

Note: The Y Factor % Difference must be < ±5.0% to be acceptable. Avg. Δ%= -.294

Determination of Interpolated Y Factor for Average Certification Test Series Δ H from Dry Gas Meter Calibration Data:

_____ (A) inch H_2O Δh= _____ (C) Calculated Calibration Y Factor (from Calibration)

_____ (B) inch H_2O Δ h = _____ (D) Calculated Calibration Y Factor (from Calibration)

_____ (B) - _____ (A) = _____ X100 = _____ (E)   _____ (D) - _____ (C) = _____ / _____ (E) = _____ (F)

_____ Avg Δ h - _____ (A) = _____ X 100 = _____ (G)

(_____ F X _____ G) + _____ C = _____ Interpolated Y Factor For Avg. Test Series Δ h

Dry Gas Meter Back Half Leak Check: .000 inch H_2O in One Minute

Front Half Leak Check — Meter Reading — Leak Rate

Meter	Vac In. Hg	Start	Stop	cmm	cfm
DGM	-18.0	.4170	.4170	.0000	.000
TM	-18.0	.708	.708	—	.000

Back Half Leak Check

Start	Stop	Δ
7.490	7.490	.000

APEX INSTRUMENTS REFERENCE METER CALIBRATION
USING WET-TEST METER #11AE6   15-POINT ENGLISH UNITS
Myren Consulting

Calibration Meter Information	
WTM Model #	AL-20
WTM Serial #	11AE6
WTM Gamma	0.9999

Calibration Conditions			
Date	Time	23-May-17	9:45
Barometric Pressure		29.45	in Hg
Calibration Technician		EW	
DGM Serial Number		S-110	1052202

Factors/Conversions		
Std Temp	528	°R
Std Press	29.92	in Hg
K_1	17.647	°R/in Hg

Calibration Data

Run Time	Dry Gas Meter						Calibration Meter						Results: Dry Gas Meter			
Elapsed	Meter Pressure	Volume Initial	Volume Final	Sample Volume	Outlet Temp Initial	Outlet Temp Final	Volume Initial	Volume Final	Sample Volume	Outlet Temp Initial	Outlet Temp Final	Meter Pressure	Calibration Factor Value	Calibration Factor Variation	Flowrate Std & Corr	
(Θ)	$P_{(m)}$	(V_{mi})	(V_{mf})	(V_m)	(t_{mi})	(t_{mf})	(Vw_i)	(Vw_f)	(V_w)	(t_{wi})	(t_{wf})	$P_{(wtm)}$	(Y)	(ΔY)	$(Q_{m(std)(corr)})$	
min	in H_2O	cubic feet	cubic feet	cubic feet	°F	°F	cubic feet	cubic feet	cubic feet	°F	°F	in H_2O			cfm	
5	-5.0	194.550	200.678	6.128	75.2	75.2	181.490	187.530	6.040	74	74	2.5	0.9940	0.0004	1.168	Variation
5	-5.0	200.678	206.811	6.133	75.2	75.2	187.530	193.570	6.040	74	74	2.5	0.9932	-0.0004	1.168	from overall
5	-5.0	206.811	212.942	6.131	75.2	77.0	193.570	199.600	6.030	74	74	2.5	0.9935	0.0000	1.166	average Y
										Passed Calibration Factor Variation			0.9936	Averages	1.168	-0.0011
6	-3.9	236.755	242.762	6.007	77.0	77.0	223.190	229.100	5.910	74	74	2.3	0.9933	-0.0003	0.953	Variation
6	-3.9	242.762	248.785	6.023	77.0	77.0	229.100	235.030	5.930	74	74	2.3	0.9940	0.0004	0.956	from overall
6	-3.9	248.785	254.816	6.031	77.0	77.0	235.030	240.965	5.935	74	74	2.3	0.9935	-0.0001	0.957	average Y
										Passed Calibration Factor Variation			0.9936	Averages	0.955	-0.0011
7	-2.9	254.816	260.260	5.444	77.0	77.0	240.965	246.320	5.355	74	74	2.1	0.9911	-0.0009	0.741	Variation
7	-2.9	260.260	265.694	5.434	77.0	77.0	246.320	251.670	5.350	74	74	2.1	0.9920	0.0000	0.740	from overall
7	-2.9	265.694	271.134	5.440	77.0	77.0	251.670	257.030	5.360	74	74	2.1	0.9927	0.0008	0.741	average Y
										Passed Calibraion Factor Variation			0.9919	Averages	0.741	-0.0028
10	-2.3	271.134	276.689	5.555	77.0	77.0	257.030	262.530	5.500	74	74	1.9	0.9966	0.0004	0.533	Variation
10	-2.3	276.689	282.223	5.534	77.0	77.0	262.530	268.000	5.470	74	74	1.9	0.9949	-0.0013	0.530	from overall
10	-2.3	282.223	287.735	5.512	77.0	77.0	268.000	273.460	5.460	74	74	1.9	0.9970	0.0009	0.529	average Y
										Passed Calibration Factor Variation			0.9962	Averages	0.530	0.0015
15	-2.0	218.936	224.887	5.951	77.0	77.0	205.510	211.410	5.900	74	74	1.8	0.9974	-0.0008	0.381	Variation
15	-2.0	224.887	230.820	5.933	77.0	77.0	211.410	217.300	5.890	74	74	1.8	0.9987	0.0006	0.380	from overall
15	-2.0	230.820	236.755	5.935	77.0	77.0	217.300	223.190	5.890	74	74	1.8	0.9984	0.0002	0.380	average Y
										Passed Calibration Factor Variation			0.9982	Averages	0.381	0.0035
										Overall Average Y			0.9947			Passed

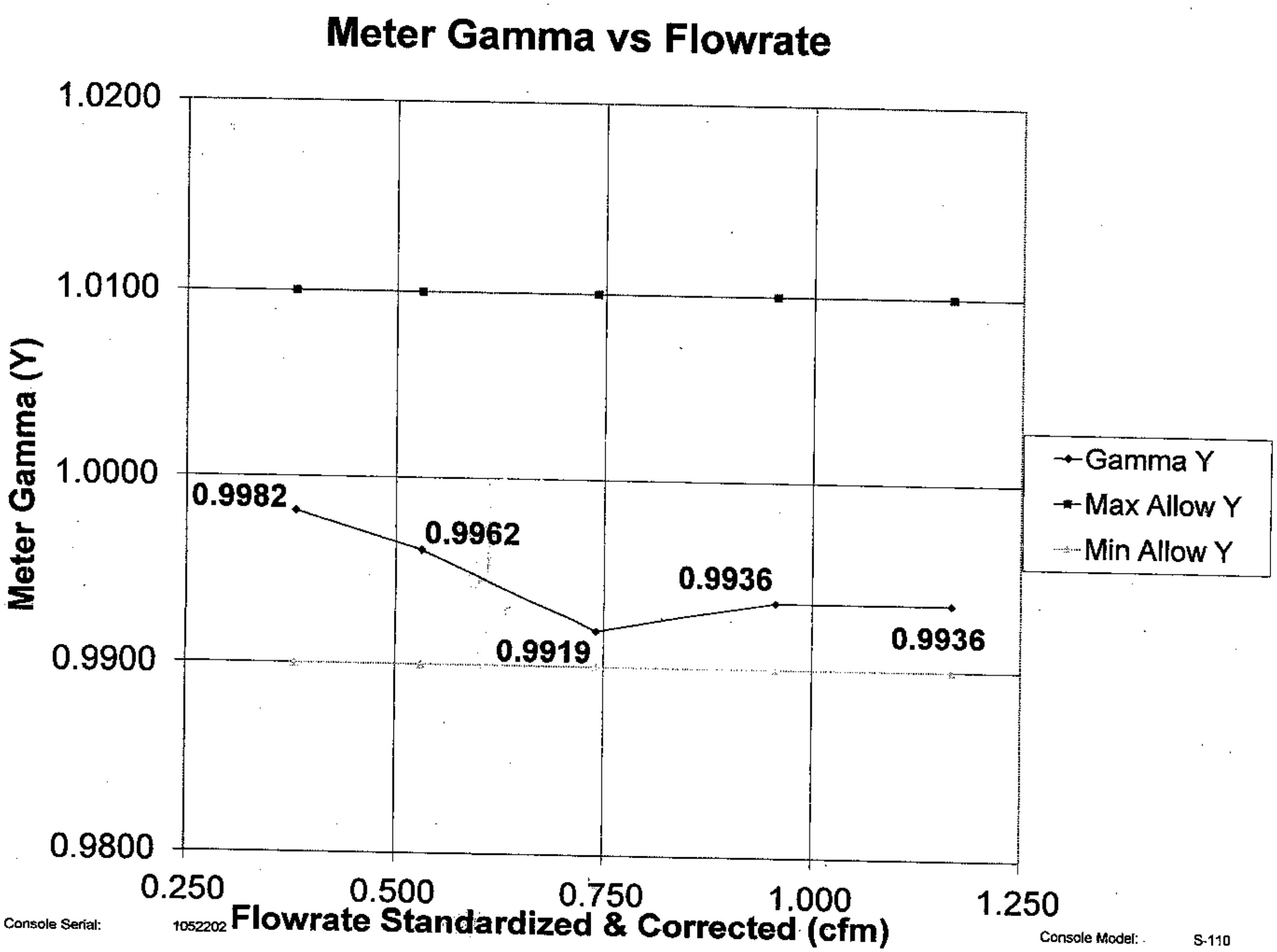
Note: For Calibration Factor Y, the ratio of the reading of the calibration meter to the dry gas meter, acceptable tolerance of individual values from the average is +-0.02.

I certify that the above Dry Gas Meter was calibrated in accordance with USEPA Methods, CFR 40 Part 60, using the Precision Wet Test Meter # 11AE6, which in turn was calibrated using the American Bell Prover # 3785, certificate # F107, which is traceable to the National Bureau of Standards (N.I.S.T.).

Signature [signature]   Date 5/23/17

Calibration Date: 5-23-2017

Calibration Technician: EW

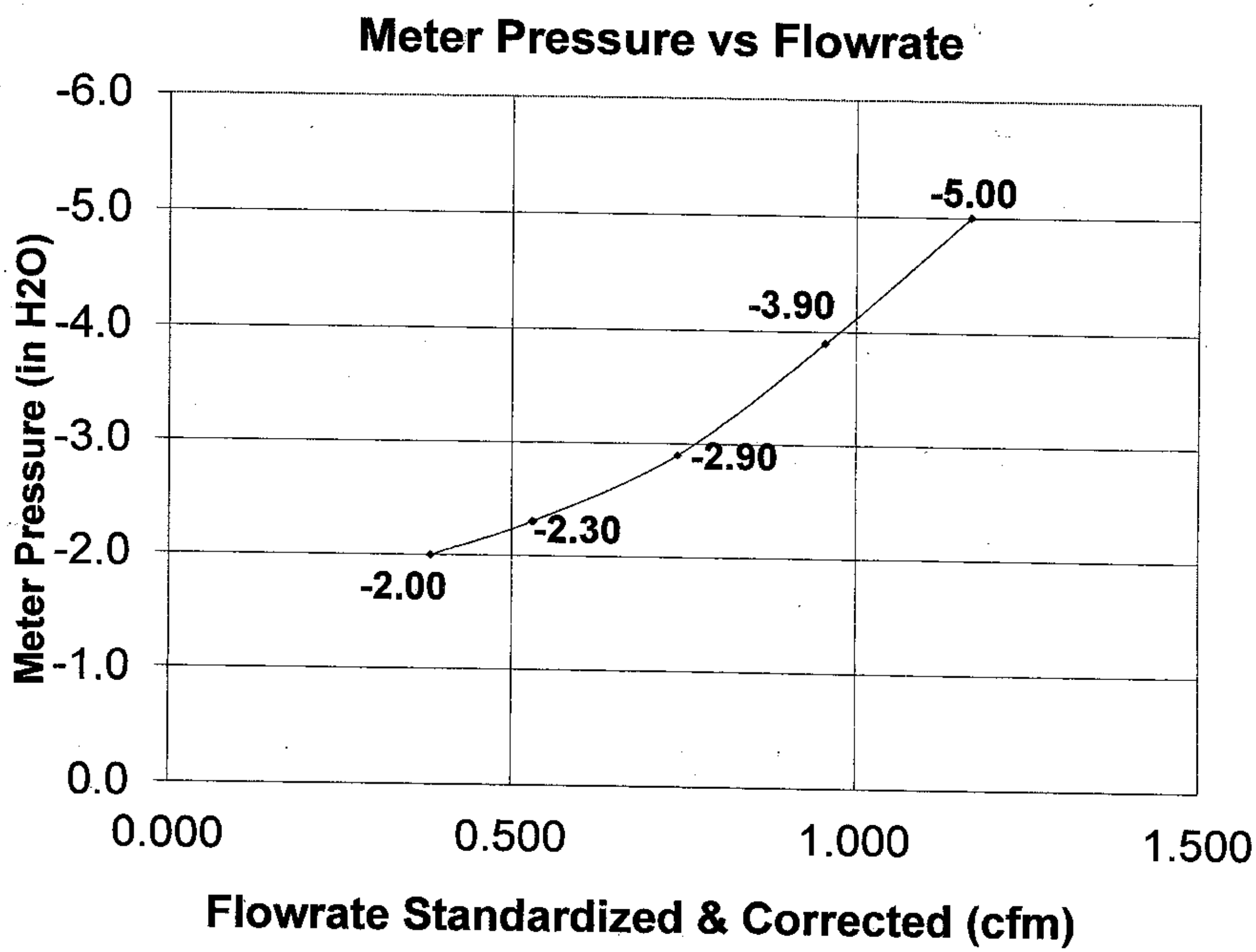


Console Serial: 1052202

Console Model: S-110

Calibration Date: 5-23-2017

Calibration Technician: EW



Console Serial: 1052202

Console Model: S-110

VANEOMETER CALIBRATION

Myren Consulting used a Dwyer Model 3480 Vaneometer to measure test chamber air velocity. The manufacturer's specifications for accuracy are ± 5.0% from 0 to 100 fpm and ± 10% from 100 to the top of the scale. Myren Consulting insures that the instrument is level and clean prior taking each reading. According to EPA personnel (Westlin, RTP) no further calibration is necessary.

DRAFT GUAGE CALIBRATION

Myren Consulting used a Dwyer Model 115 AV, a -0.05 - 0.0 - 0.25" inclined red oil manometer (readability resolution ± 0.001" H_2O) 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 needs no further calibration.

The manometer is leveled and zeroed at the start of each test, checked as necessary during a run to verify that the settings have not changed and again at the end of each test run. The results of these checks are recorded on Woodstove Data Sheet #16 in each individual test.

BAROMETER CALIBRATION

Myren Consulting used a Princo Model 453 SN W14275 Mercury barometer and a Weems and Plath aneroid barometer to measure the barometric pressure (BP). The Weems and Plath barometer was calibrated daily by comparing it to the Princo and adjusting it as necessary. The Princo when calibrated following the manufacturer's instructions is a primary standard and needs no further calibration.

MOISTURE METER CALIBRATION

Myren Consulting uses a Delmhorst J-2000 which was calibrated daily using the "Check" feature. Then the operation of the moisture meter was checked with a Delmhorst Moisture Content Standard Model MCS-1 at 12.6 and 23.8%. The results of these checks are recorded on Data Sheet #10.

The readings obtained with the moisture meter are then corrected as per the manufacturer's written instructions for temperature. If Delmhorst #496 insulated pins are used, the meter is set at 222 using the Set Pin Calibration instructions. The meter is set at 1 for the Species correction. 1 is the setting for D. Fir

Delmhorst Instrument Co.
J-2000 Quick Reference Guide

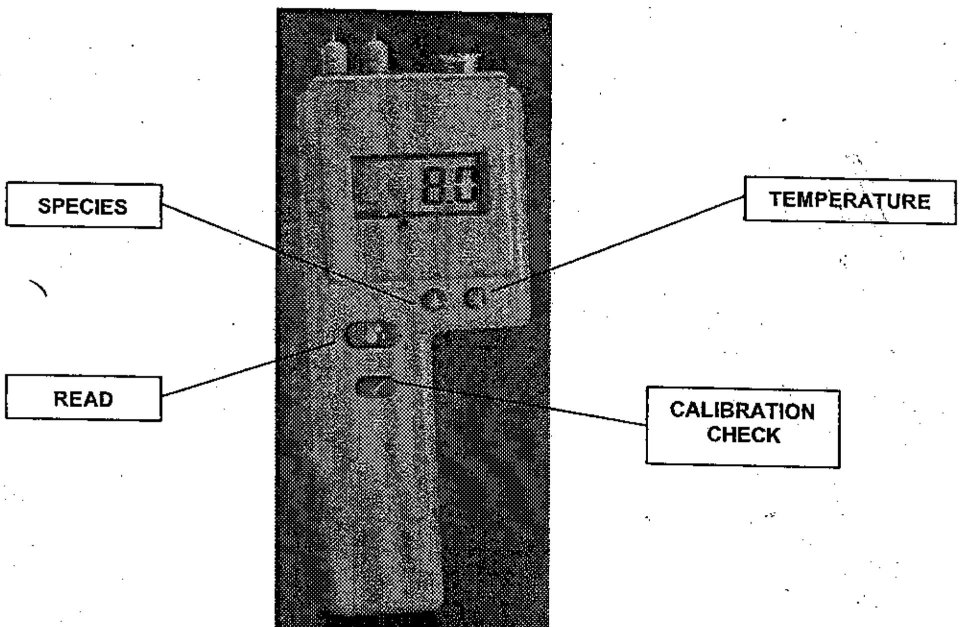


Fig. 1 Button Definition

GETTING STARTED

1. Set the wood species by holding down the **SPECIES** button until the desired scale number is displayed. The default species setting is #1 Douglas Fir (see **Species Code Chart** for a full listing).
2. Align the contact pins parallel to the grain and push them to their full penetration into the wood and press the **READ** button. The meter displays the %MC for two seconds.

SET TEMPERATURE

1. Temperature correction is necessary if the wood temperature is outside the range of 50°F (10°C) to 90°F (32°C).The default temperature setting is 70°F.
2. To increase the temperature value, hold the **TEMPERATURE** button until the desired temperature value is displayed.
3. To decrease the temperature value, press and release the **TEMPERATURE** button then hold the **SPECIES** button within one second. Hold the **SPECIES** button until the desired temperature value is displayed.
4. To change between Fahrenheit and Celsius press and release the **TEMPERATURE** button and within one second press the **CALIBRATION CHECK** button and release when you are in the mode needed.

SET PIN CALIBRATION

1. To change between insulated and un-insulated pin setting, press and release the **SPECIES** button, then press the **CALIBRATION CHECK** button within one second to cycle between 222 for insulated and 444 for un-insulated pins (the default setting is un-insulated).

CHECK CALIBRATION

1. Press the **READ** button and the **CALIBRATION CHECK** button simultaneously.
2. Meter is in calibration if it displays 12% (+ or - .2).
3. Make sure the pins are not in contact with anything when checking the calibration.

REVIEW ACCUMULATED READINGS

1. The meter will accumulate up to 100 readings.
2. To view the readings press and release the **CALIBRATION CHECK** button. The meter displays the number of accumulated readings, then the average of those readings, then the highest stored reading.
3. To erase readings hold the **CALIBRATION CHECK** button down for 5 seconds. All accumulated readings will be erased and the meter will display "0".

RESET METER

1. Press and release the **CALIBRATION CHECK** button.
2. Within one second press the **SPECIES** button.
3. Default settings will be restored (Species #1 Douglas Fir and 70°F temperature). The meter will display 170.
4. Any previously stored readings will be erased.

Delmhorst Instrument Co.
51 Indian Lane East
Towaco, NJ 07082
Ph: 877-DELMHORST (877) 335-6467
Fax: 973-334-2657
Web Site: www.delmhorst.com

Woodstove Data Sheet #26-A
CEM Gas Train Response Time
Semi Annual Check

Date	7/19/18	→				→					
Technicians	ATM	→				→					
Elapsed Time	CO_2 Conc.(V)	CO_2 Conc.(V)	CO_2 Conc.(V)	CO Conc.(V)	CO Conc.(V)	CO Conc.(V)	O_2 Conc.(V)	O_2 Conc.(V)	O_2 Conc.(V)	Conc.(V)	Conc.(V)
0 Seconds	.284	.281	.279	1.65	1.68	1.69					
15	.283	.280	.279	1.66	1.68	1.68					
30	.169	.167	.165	1.63	1.64	1.64					
45	.087	.086	.086	.90	.92	.91					
60	.029	.027	.027	.62	.63	.64					
75	.004	.004	.004	.40	.42	.43					
90	.003	.004	.003	.15	.16	.16					
105	.003	.003	.003	.08	.09	.09					
120	.002	.002	.002	.06	.06	.06					
135	.002	.002	.002	.05	.05	.05					
150	.001	.001	.002	.04	.04	.04					
165	.001	.001	.001	.03	.04	.04					
180	.001	.001	.001	.02	.03	.03					
Initial Response Time (seconds)	>15, <30	>15, <30	>15, <30	>30, <45	>30, <45	>30, <45					
95% Response Time (seconds)	>60, <75	>60 <75	>60 <75	>105 <120	>105 <120	>105 <120					
Analyser Flow Rate	1.5scfh	→				→					

Comments: 95% = .014 .014 .014 .08 .08 .08

Pre Optimum
EPA 2

Myren Consulting Inc.
512 Williams Lake Rd; Colville, WA 99114; (509)685-9458
QA WS, REV 1/10

CO_2 Analyzer

Multipoint Calibration Report Form

Site: Myren Lab, Colville, WA Date: 9/5/2017

Analyzer: Make: Horiba Model: PIR 2000 SN: 607204

Calibration by: A.T. Myren

Cal Gas Flow: 1.5 scfh Measured by: Rotameter: X Mass Flowmeter: ______

BP: 28.58 "Hg Instrument ID: Princo

Temp: 61 °F Instrument ID: Omega Digicator Center

Analyzer Last Calibrated: 1 / 3 / 17 By: A.T. Myren

Cylinders:

1. #DOT 3AA 22065 Concentration: 0.00 %CO_2 Cyl. Press.: 1680 psi.
   Certified By: OxARC Date: 2/25/16
2. #EB-0041761 Concentration: 12.45 %CO_2 Cyl. Press.: 200 psi.
   Certified by: Liquid Technology Corp Date: 4/15/15
3. #250-1175 Concentration: 21.0 %CO_2 Cyl. Press.: 660 psi.
   Certified by: Oxarc Date: 3/22/97
4. #SX-40585 Concentration: 6.04 %CO_2 Cyl. Press.: 1160 psi.
   Certified by: Matheson Tri Gas Date: 4/12/10

Analyzer: Calibrated Range: 0 – 25 % Output: 0 – 1.0 v.

Flow: 1.5 scfh Measured by: Rotameter: X Mass Flowmeter: ______

Calibration Results

Point #	Cyl. #	% CO_2	Expected		Actual		Adj.		% Dif.	Curve Conc.	Potentiometer	
			Meter	DVM	Meter	DVM	Meter	DVM			Unadj.	Adj.
1	1	0.00	00.0	.000	00.0	-.001	00.0	.000	See	next	4.88	4.90
2	2	12.45	49.8	.498	48.0	.485			Page			
3	3	21.0	84.0	.840	83.0	.836	–	–			–	–
4	4	6.04	24.2	.242	22.5	.228	–	–			–	–
5	1	0.00	00.0	.000	00.0	.000	–	–			–	–

Comments:
.485
.820

Linear Regression Results

Y= MX + B

Slope M= .0398933

Y Intercept (B)= -0.0065963

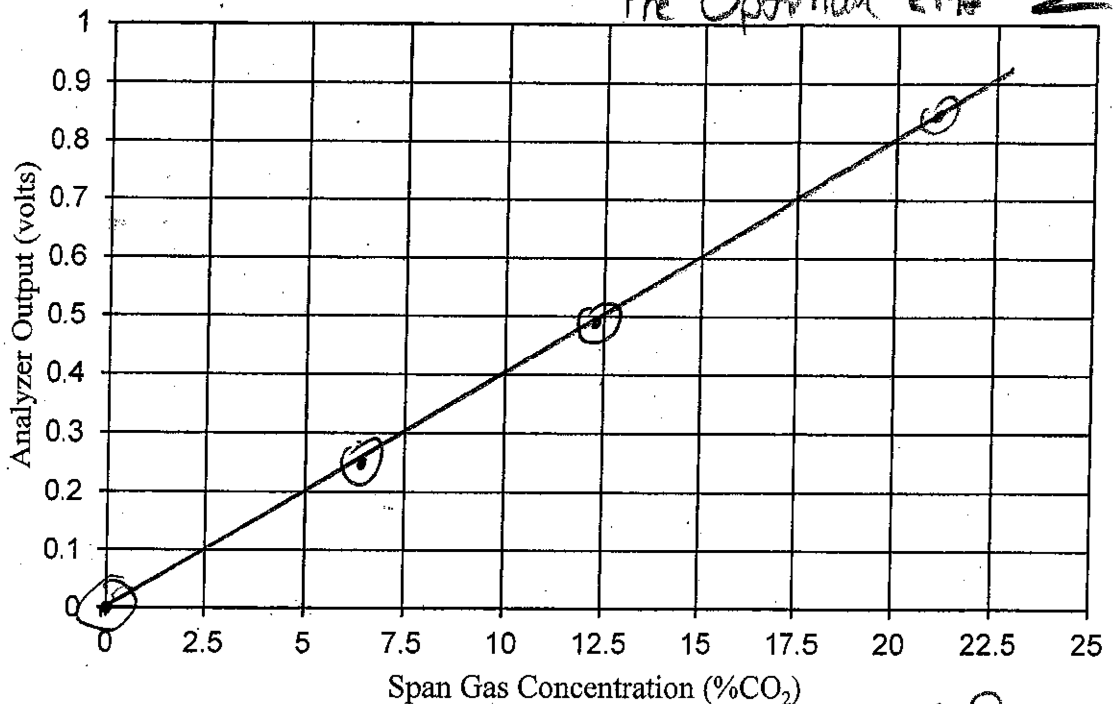
Correlation Coefficient (r) 0.9998277

Analyzer: Horiba PIR 2000

SN: 607204

Date: 9/8/2017

Pre Optimum EPA Z



Comments:

V. =	Cal Curve Conc	± Conc difference from Expected	Δ%	Δ from 2% of full scale (25%) .500
0.00	.10297	+ .10297	+0.41	+ 0.41
.485	12.3063	− .1437	−1.15	−1.15
.836	21.1380	+ .1380.	+0.65	+0.65
.228	5.840	− .2000	−3.31	−8.31

Myren Consulting Inc.
512 Williams Lake Rd; Colville, WA 99114; (509)685-9458

Pre Optimum
EPA 2

QA WS, REV 1/10

CO Analyzer

Multipoint Calibration Report Form

Site: Myren Lab, Colville, WA Date: 9/5/17

Analyzer: Make: CAI Model: 200 SN: 1M12002

Calibration by: A.T. Myren

Cal Gas Flow: 1.5 dscfh Measured by: Rotameter: X Mass Flowmeter:

BP: 28.58 "Hg Instrument ID: Pranco

Temp: 61 °F Instrument ID: Omega Digicator

Analyzer Last Calibrated: 1/3/17 By: A.T. Myren

Cylinders:

1. #DOT 3AA22665 Concentration: 0.00 %CO Cyl. Press.: 1680 psi.
   Certified By: Oxarc Date: 2/25/16
2. #EB-0041761 Concentration: 2.61 %CO Cyl. Press.: 200 psi.
   Certified by: Liquid Technology Corp Date: 4/15/15
3. #250-1175 Concentration: 4.03 %CO Cyl. Press.: 660 psi.
   Certified by: Oxarc Date: 8/22/97
4. #SX-40585 Concentration: 1.29 %CO Cyl. Press.: 1160 psi.
   Certified by: Matheson Tri Gas Date: 4/12/10

0-5%

Analyzer: Calibrated Range: 0-10% % Output: 0-10.0 v.

Flow: 1.5 dscfh Measured by: Rotameter: X Mass Flowmeter:

Calibration Results

Point #	Cyl. #	% CO	Expected		Actual		Adj.		Curve Conc.	% Dif.	Potentiometer	
			Meter	DVM	Meter	DVM	Meter	DVM			Unadj.	Adj.
1	1	0.00	00.0	.000	-.12	-.12	.00	0.00	See next		6.26	6.40
2	2	2.61	2.61	2.61	2.97	2.97	2.62	2.61	Page		4.68	3.76
3	3	4.03	4.03	4.03	4.16	4.14	—	—			—	—
4	4	1.29	1.29	1.29	1.40	1.40	—	—			—	—
5	1	0.00	0.00	.000	0.00	.000	—	—				

Comments:

Linear Regression Results

Y= MX + B

Slope M= 0.9838593

Y Intercept (B)= -0.0270326

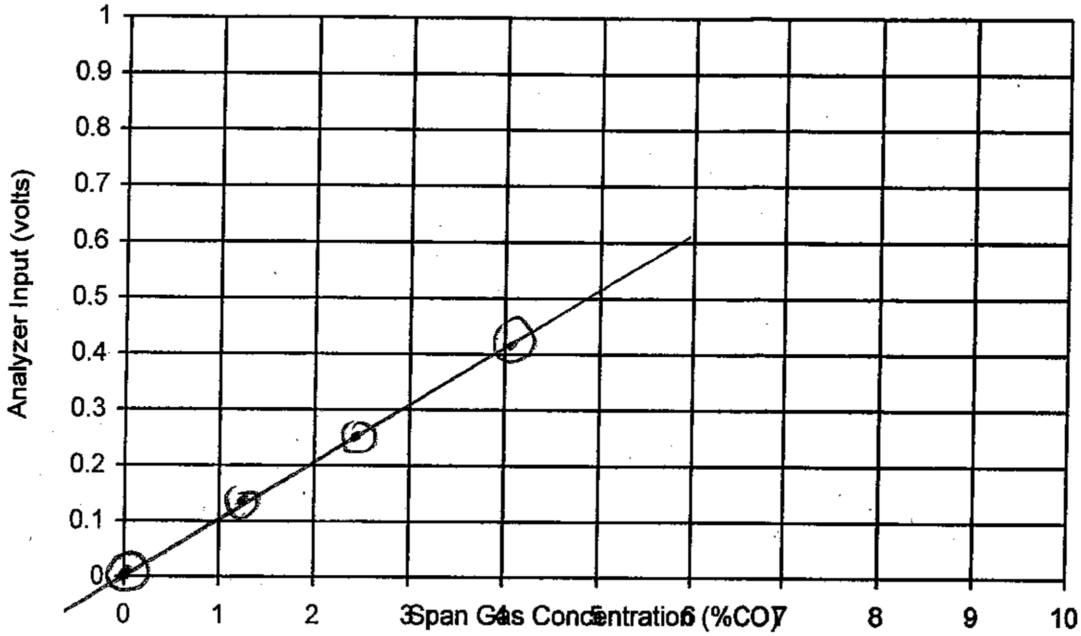
Correlation Coefficient (r) 0.9996115

Analyzer: CAI Model 200

SN:1M12002

Date: 9/5/17

Pre Optimum EPA 2



Comments:

V. =	Cal curve conc.	± Conc difference from expected	Δ%	Δ from 2%
0.00	-0.0123	- 0.0123	+ 1.89	
2.61	2.5493	-0.0607	-2.33	
4.14	4.0509	+0.0209	+0.52	
1.38	1.3421	+0.05210	4.039	

LIQUID TECHNOLOGY CORPORATION

"INDUSTRY LEADER IN SPECIALTY GASES"

Certificate of Analysis

- EPA PROTOCOL GAS -

Customer	OXARC, Inc (Spokane, WA)
Date	April 15, 2015
Delivery Receipt	DR-56053
Gas Standard	2.50% CO, 12.50% Carbon Dioxide/Nitrogen - EPA PROTOCOL
Final Analysis Date	April 15, 2015
Expiration Date	April 16, 2023

Component	Carbon Monoxide, Carbon Dioxide
Balance Gas	Nitrogen

Analytical Data:
EPA Protocol, Section No. 2.2, Procedure G-1.

DO NOT USE BELOW 100 psig

Replicate Concentrations

Carbon Monoxide: 2.61% +/- 0.02%

Carbon Dioxide: 12.45% +/- 0.10%

Nitrogen: Balance

Reference Standards:

			GMIS Traceability
SRM/GMIS:	SRM	GMIS	SRM-2745
Cylinder Number:	CAL-017030	EB-0051547	CAL-016193
Concentration:	4.009% CO (+/- 0.017%)	9.923% CO2 (+/- 0.062%)	15.633% CO2 (+/- 0.037%)
Expiration Date:	07/15/19	02/04/22	06/02/17
NIST Sample Number:	52-D-54	NA	9-C-55

Certification Instrumentation

Component:	Carbon Monoxide	Carbon Dioxide
Make/Model:	Nicolet 6700	Nicolet 6700
Serial Number:	APW1100563	APW1100563
Principal of Measurement:	FTIR	FTIR
Last Calibration:	April 15, 2015	April 04, 2015

Cylinder Data

Cylinder Serial Number:	EB-0041761	Cylinder Outlet:	CGA 350
Cylinder Volume:	119 Cubic Feet	Cylinder Pressure:	1700 psig, 70°F

Analytical Uncertainty and NIST Traceability are in compliance with EPA-600/R-12/531.

Certified by: Cole Dylewski

Cole Dylewski

PGVP Vendor ID: E12015

"UNMATCHED EXCELLENCE"

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FAX (208) 376-1133

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1401 WHEELER ROAD
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FAX (509) 766-9958

OKANOGAN, WA 98840
2256 ELMWAY
(509) 826-3205
FAX (509) 826-3905

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716 SOUTH OREGON
(509) 547-2494
FAX (509) 547-3103

TWIN FALLS, ID 83303
729 COMMERCIAL AVE.
(208) 734-9711
FAX (208) 734-7923

WENATCHEE, WA 98801
OHME GARDENS RD.
(509) 662-8417
FAX (509) 662-1229

YAKIMA, WA 98903
1004 EAST MEAD
(509) 248-0827
FAX (509) 452-8704

Primary Standard Certificate of Analysis
Method of Analysis Micro GC / Gravimetric
Customer: Myren Consulting **Reference #** PM7234-2
P.O.# **Cylinder #** 250-1175

Results of Investigation

Component	Requested	Concentration
Air	N/A	N/A
Argon	N/A	N/A
Carbon Dioxide	21.0%	21.0%
Carbon Monoxide	4.00%	4.03%
Helium	N/A	N/A
Hydrogen	N/A	N/A
Methane	N/A	N/A
Nitrogen	Balance	Balance
Oxygen	21.0%	21.0%

Hazard Class	UN 1956
DOT Shipping Name	Compressed Gas NOS
Shipping Volume (scf approximate)	160 scf @ ntp
Cylinder Pressure	1500 psig
CGA Valve Connection	350

Oxarc Primary Standard mixtures are prepared with gravimetric techniques using weights traceable to NIST. Mixture blended to +/- 1% relative to minor component and certified to +/- 1% analytical accuracy.

Authorized Signature Travis Auger Date 8/25/97
Travis Auger

Comments:

MATHESON TRI•GAS
ask. . .The Gas Professionals™
1650 Enterprise Parkway
Twinsburg, Ohio 44087
215-648-4000

Certificate of Analysis - EPA Protocol Mixtures

Customer: OXARC INC
Cylinder Number: SX-40586
Cylinder pressure: 1600 psig
Last Analysis date: 4/9/2010
Expiration Date: 3/18/2013

Protocol:	Reference #	Lot #
G1	519323	109-96-17643

DO NOT USE THIS CYLINDER WHEN THE PRESSURE FALLS BELOW 150 PSIG

REPLICATE RESPONSES

		Date:	Date:
Component:	Oxygen	3/18/2010	
Certified Conc:	5.98% ± 1% REL	5.98%	
		5.98%	
		5.99%	
Component:	Carbon Dioxide	3/18/2010	
Certified Conc:	6.04% ± 1% REL	6.03%	
		6.07%	
		6.01%	
Component:	Carbon Monoxide	4/2/2010	4/9/2010
Certified Conc:	1.29% ± 1% REL	1.30%	1.29%
		1.30%	1.28%
		1.30%	1.29%

ANCE GAS: Nitrogen

REFERENCE STANDARDS

Component:	Oxygen	Carbon Dioxide	Carbon Monoxide
SRM #:	NTRM-82658	SRM-1674b	SRM-2639a
Sample #:	01110212	7-F-05	54-D-51
Cylinder #:	SX-20658	CAL-014611	CAL-013889
Concentration:	10.09%	6.876 %	0.991 %

CERTIFICATION INSTRUMENTS

Component:	Oxygen	Carbon Dioxide	Carbon Monoxide
Make/Model:	Rosemount 755	Varian 3800 GC	Varian 3800 GC
Serial Number:	2002832	LR-92489	LR-92489
Measurement Principle:	Paramagnetic	TC, FID	TC, FID
Last Calibration:	2/26/2010	3/16/2010	4/2/2010

Notes: T134744

This certification was performed according to EPA Traceability Protocol for Assay & Certification of Gaseous Calibration Standards September 1997, using procedure G1 and/or G2.

Analyst Phitji D. Mntz Date 4/12/2010

WOODSTOVE DATA SHEET # 30
STOVE STORAGE

The OPTIMUM DENSIFIED FUEL LOG STOVE tested by Myren Consulting, Inc. is being held in custody by:

509 FABRICATORS, INC.
14823 n. Peone Pines Drive
Mead, WA 99201

Phone 509 993 3767

Contact: Dusty Henderson

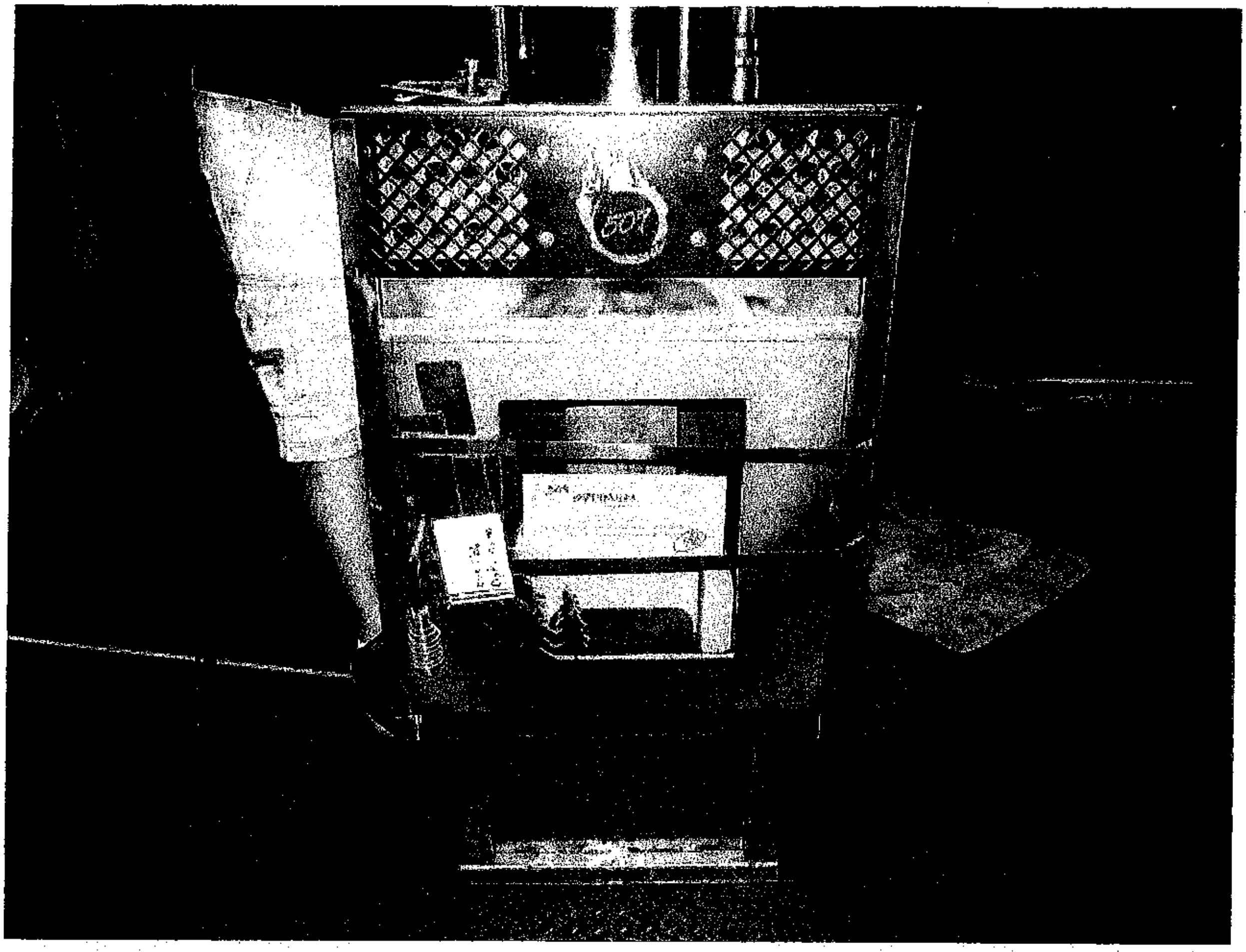
The unit was tested at Myren Consulting's lab in Colville, WA. It was sealed on 1/10/2017 after the unit had cooled after testing. The seals were broken on 9/5/2017 just before the second EPA test run. The unit was resealed on 9/6/2017. The following pages contains photos taken before the seals were broken and the after the unit was resealed on 9/6/2017.

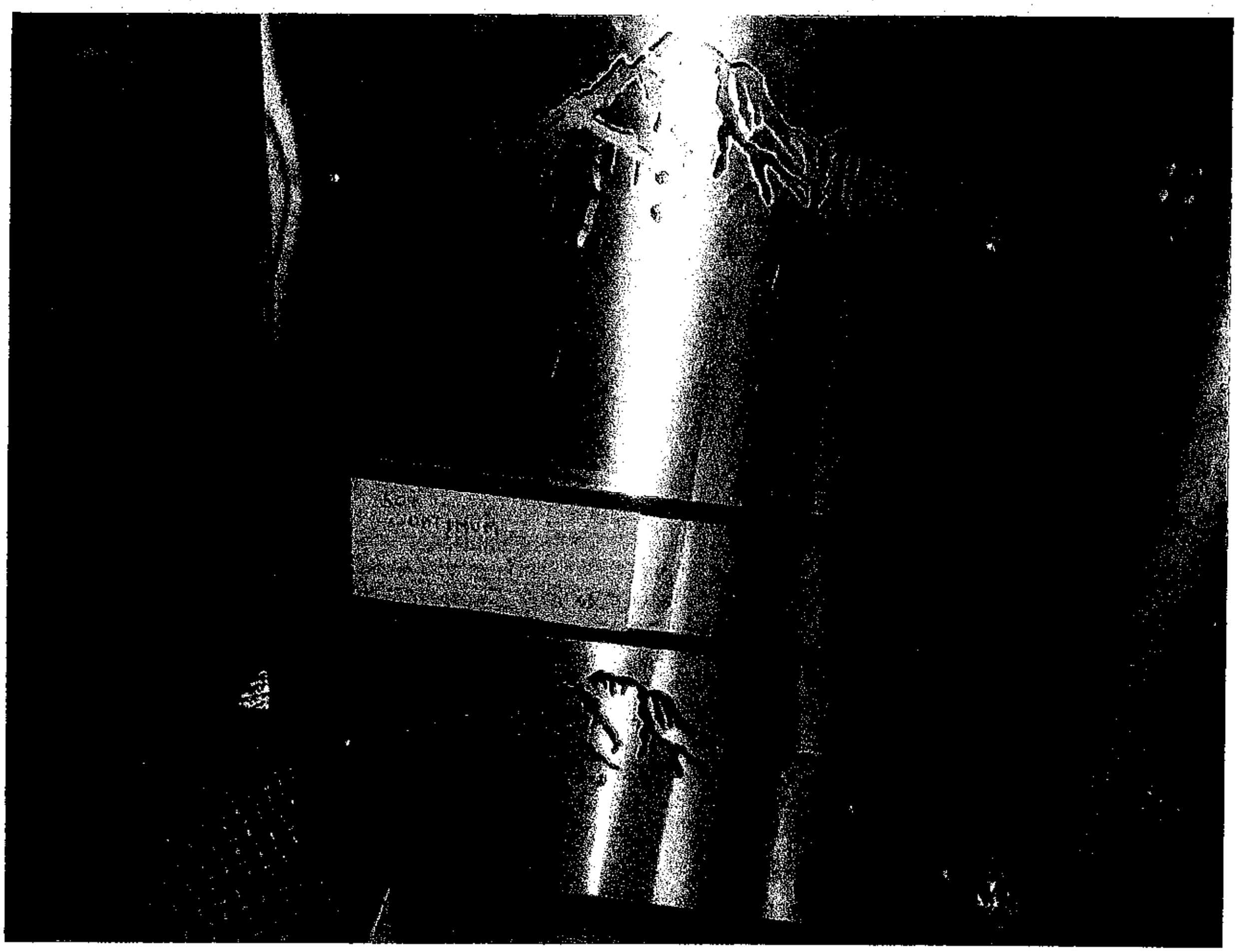
The unit was sealed with several lengths of metal banding/strapping that were placed around the stove in a manner that prevents the door from being opened. A label that clearly identifies the unit as a sealed EPA test stove and/ or a Myren Consulting, Inc. address label is placed over the strapping and taped into place with 2" clear packing tape. The stove was also loaded onto a pallet and strapped to a pallet for transport back to 509 Fab and to its final storage location. A sample stove storage label follows this page.

Once the unit is/ was certified by EPA, the unit will be returned to 509 Fab via the manufacturer's truck.

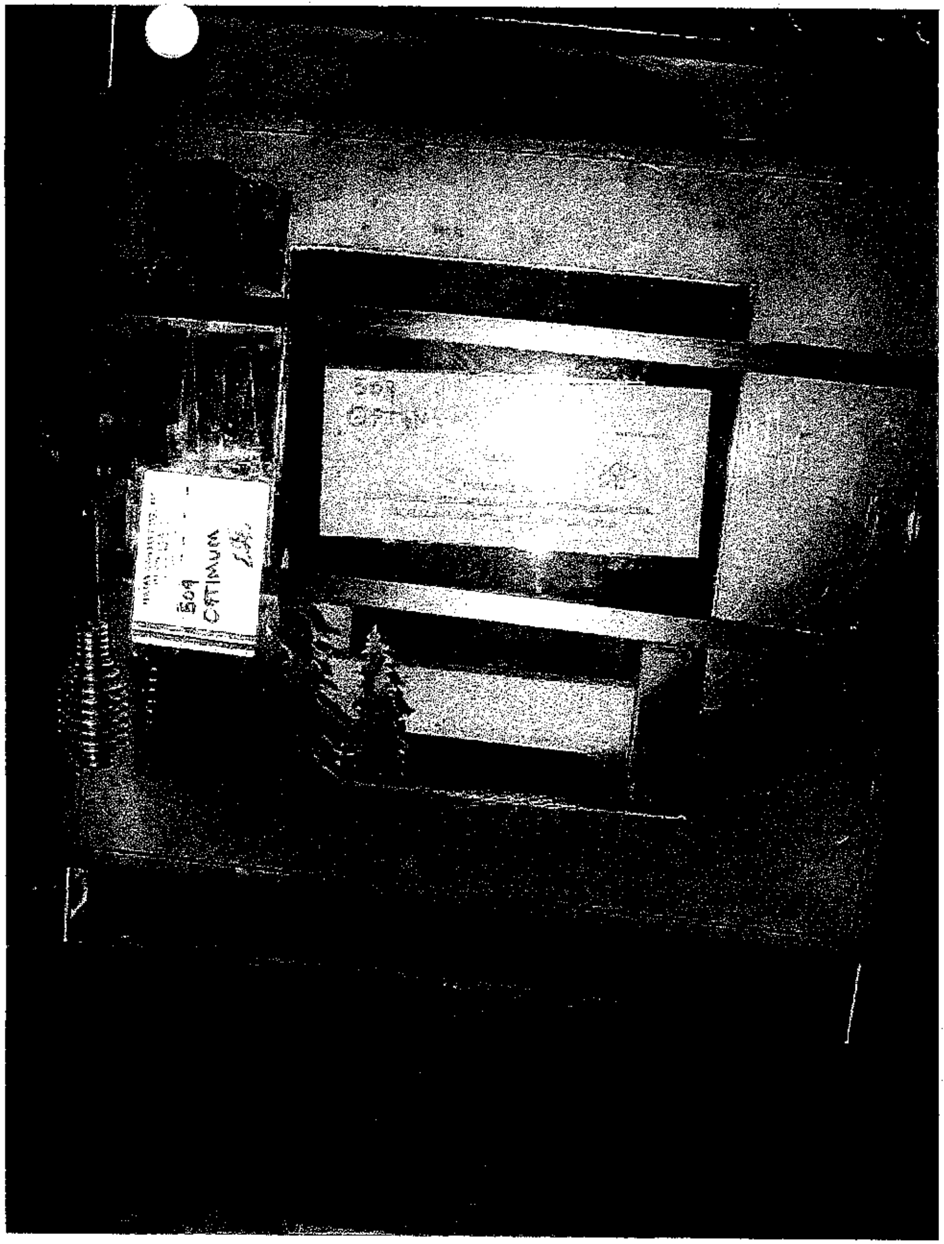
Carrier: ______________________________

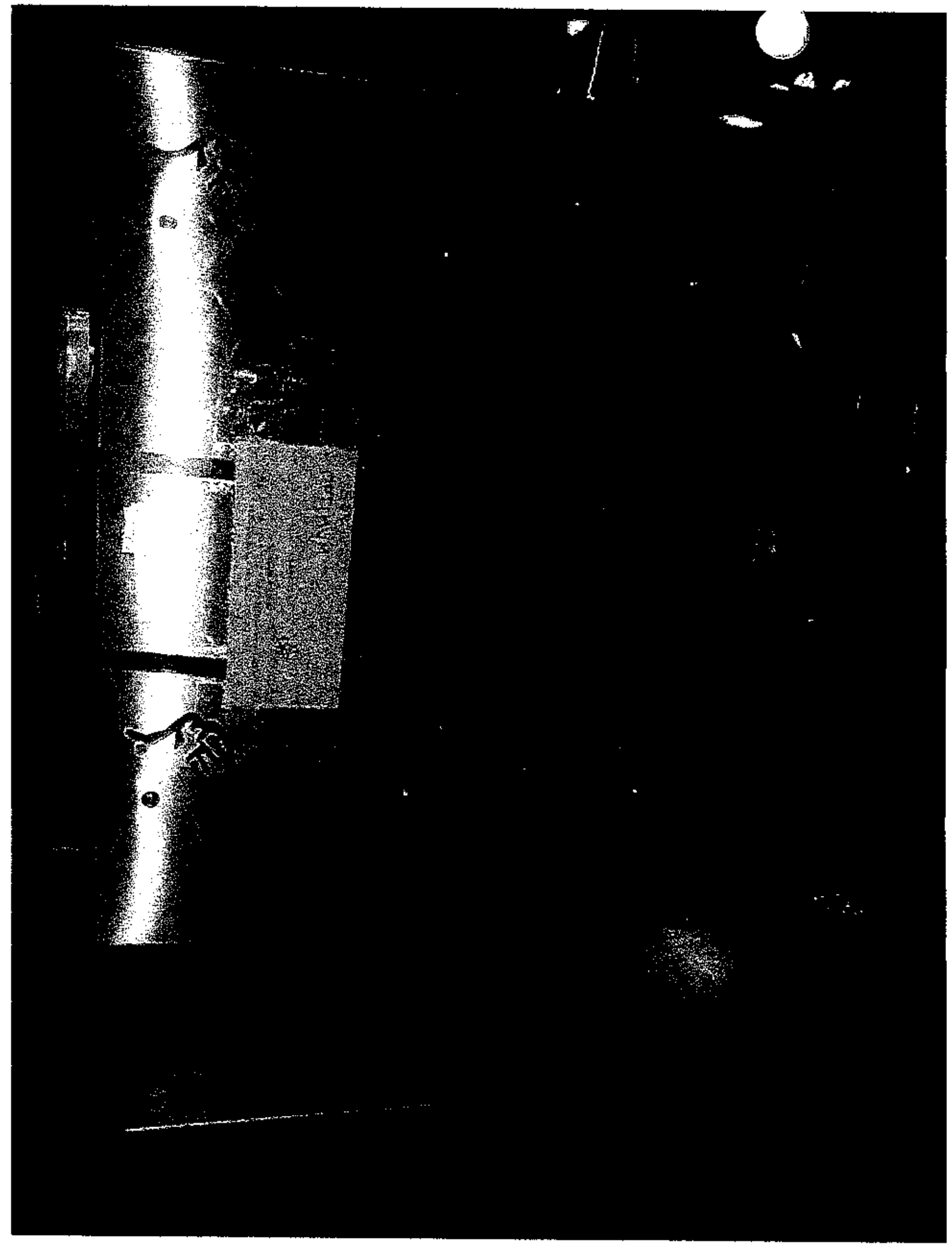
Shipped on: ______________________________





Preunsealing on 9/5/2017





Resealed stove on 9/6/2017